FINAL - Volume I of II

Site Inspection Report
Culebra Island Site
Puerto Rico

U.S. Army Corps of Engineers
Southeast and Pacific IMA Region

FUDS Project No. I02PR006802 through 14
Contract No. W912DY-04-D-0005
Task Order 0008

Prepared for:

U.S. Army Corps of Engineers, Jacksonville District
701 San Marco Boulevard
Jacksonville, Florida 32207
and
U.S. Army Engineering & Support Center, Huntsville
4820 University Square
Huntsville, Alabama 35816-1822

Prepared by
PARSONS
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September 2007

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September 11, 2007

U.S. Army Engineering & Support Center
ATTN: CEHNC-OE-DC (Ms. Chris Cochrane)
4820 University Square
Huntsville, Alabama 35816-1822
256-895-1696

Subject: Contract W912DY-04-D-0005, Delivery Order 0008
MMRP SI for SE and Pacific IMA Region – Final SI Report, Volumes I & II
Culebra Island, Puerto Rico

Dear Ms. Cochrane:

Parsons has prepared this Final Site Inspection (SI) Report in accordance with the Performance Work Statement (PWS) to include the completed Munitions Response Site Prioritization Protocol (MRSPP). The MRSPP notification announcement was prepared with coordination with USACE, Jacksonville District (CESAJ) Public Affairs Office (PAO) and Project Manager (PM) and appeared in the agreed newspaper prior to the second (closeout) TPP Meeting held at Marina Puerto Del Rey, Ceiba, Puerto Rico on June 12, 2007. The comments received from U.S. Fish and Wildlife Service, Puerto Rico Environmental Quality Board, and the National Oceanic and Atmospheric Administration following the second TPP Meeting have been incorporated into the Final as discussed at the meeting.

Two copies have been provided for your internal files. We have simultaneously forwarded six copies to Jose Mendez for distribution to the regulators and other key project stakeholders. In addition, single copies have been forwarded to Jeff Waugh, CESAJ, HTRW CX, and MM CX; electronic copies have also been provided.

If you have any questions or comments, please contact me at (678) 969-2384 or (404) 606-0346 (cell) or the Deputy Program Manager (Ms. Laura Kelley) at (678) 969-2437.

Sincerely,

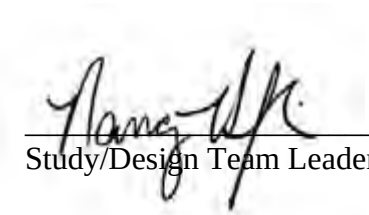
PARSONS

Don Silkebakken, P.E.
MMRP SI Project/Program Manager

cc: HQ Jeff Waugh – 1CD
SAJ Jose Mendez – 6 copies/ 12 CDs
Betina Johnson/Deborah Walker (MM CX) – 1 copy/1 CD
Heidi Novotny (HTRW CX) – 1 CD
SAJ Daphne Ross – 1 copy/ 2 CDs
Laura Kelley/Project File (744647.17000)

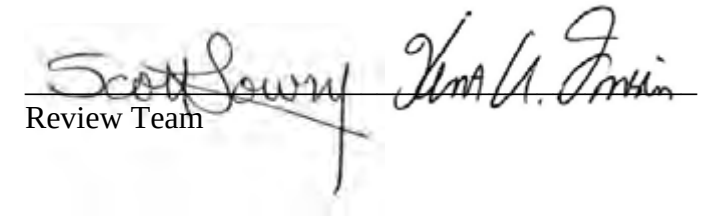
CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Parsons has completed the Final Site Inspection report for Culebra Island, Puerto Rico. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures, using justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.



Study/Design Team Leader — September 11, 2007 Date

Study/Design Team Members — September 11, 2007 Date



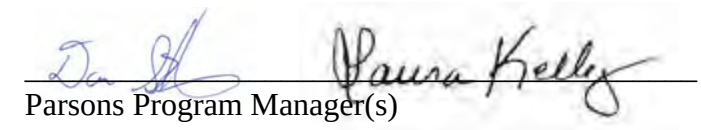
Review Team — September 11, 2007 Date

Independent Technical Review Team Leader — September 11, 2007 Date

Significant concerns and the explanation of the resolution are as follows:

None

As noted above, all concerns resulting from independent technical review of the project have been considered.



Parsons Program Manager(s) — September 11, 2007 Date

U.S. Army Corps of Engineers
Southeast and Pacific IMA Region

FINAL
Site Inspection Report
Culebra Island, Puerto Rico

FUDS Project No. I02PR006802
September 2007

In Support of
FUDS MMRP Site Inspections Project

Prepared by:
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Contract: W912DY-04-D-0005
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ACRONYMS AND ABBREVIATIONS

§	section
AAF	Army Air Field
amsl	above mean sea level
AP	armor piercing
ASR	archive search report
ATG	air to ground
bgs	below ground surface
bls	below land surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CESAJ	U.S. Army Corps of Engineers Jacksonville District
CFR	Code of Federal Regulations
CoRIS	Coral Reef Information System
CRREL	Cold Regions Research and Engineering Laboratory
CSEM	conceptual site exposure model
CSM	conceptual site model
CZMP	Coastal Zone Management Program
DEP	Defense Environmental Programs
DERP	Defense Environmental Restoration Program
DNER	(Puerto Rico) Department of Natural and Environmental Resources
DoD	Department of Defense
DQO	data quality objective
EE/CA	engineering evaluation and cost analysis
Ellis	Ellis Environmental Group, LC
EOD	explosive ordnance disposal
EPA	Unites States Environmental Protection Agency
ER	Engineer Regulation
ERA	ecological risk assessment
ESE	Environmental Science and Engineering, Inc.
ESV	ecological screening value
FDE	Findings and Determination of Eligibility
FLEX	Fleet Landing Exercise
FUDS	Formerly Used Defense Site
GIS	geographic information system
GPS	Global Positioning System
GSA	General Service Administration
HE	high explosive
HEI	high-explosive incendiary
HQ	hazard quotient
HRS	Hazard Ranking System
HTW	hazardous and toxic waste
INPR	inventory project report
Marines	U.S. Marine Corps
MC	munitions constituent
MD	munitions debris
MEC	munitions and explosives of concern
mg/kg	milligram per kilogram
mm	millimeter
MMRP	Military Munitions Response Program
MRS	munition response site

MRSPP	Munitions Response Site Prioritization Protocol
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Navy	U.S. Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDAI	no Department of Defense action indicated
NHA	National Heritage Area
NHL	National Historic Landmark
No.	number
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRIS	National Register Information System
NWI	National Wetlands Inventory
NWRS	National Wildlife Refuge System
OSE	Office of the State Engineer
Parsons	Parsons Corporation
PRASA	Puerto Rico Aqueduct and Sewer Authority
PREQB	Puerto Rico Environmental Quality Board
PRG	preliminary remediation goal
PSAP	programmatic sampling and analysis plan
PWP	programmatic work plan
QA	quality assurance
QC	quality control
QR	qualitative reconnaissance
RAC	risk assessment code
RDA	recommended daily allowance
RfD	reference dose
RI/FS	remedial investigation and feasibility study
RMIS	Risk Management Information System
ROE	right of entry
SHPO	State Historic Preservation Office
SI	site inspection
SLERA	screening level ecological risk assessment
SLRA	screening level risk assessment
SSL	soil screening level
SS-WP	site-specific work plan
STL	Severn Trent Laboratories
TCRA	time-critical removal action
TESS	Threatened and Endangered Species System
TPP	technical project planning
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville
USC	U.S. Code
USCB	U.S. Census Bureau
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	unexploded ordnance

GLOSSARY OF TERMS

anomaly	Any item that deviates from the expected subsurface ferrous and non-ferrous material at a site (i.e., pipes, power lines, etc.).
magnetometer	An instrument for measuring the strength of a magnetic field; used to detect buried iron and other metal objects.
military munitions	All ammunition products and components produced for or used by the armed forces for national defense and security, including ammunition products or components under the control of the Department of Defense, the Coast Guard, the Department of Energy, and the National Guard. The term includes confined gaseous, liquid, and solid propellants; explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries, including bulk explosives and chemical warfare agents; chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges; and devices and components thereof.
munitions and explosives of concern (MEC)	Military munitions that may pose unique explosives safety risks, including UXO, discarded military munitions, or munitions constituents present in high enough concentrations to pose an explosive or other health hazard.
munitions constituents (MC)	Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.
munitions debris	Remnants of munitions (e.g., penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal.
munitions response	Response actions, including investigation, removal actions, and remedial actions, to address the explosive safety, human health, or environmental risks presented by unexploded ordnance, discarded military munitions, or munitions constituents, or to support a determination that no removal or remedial action is required.

munitions response area (MRA)	Any area on a defense site that is known or suspected to contain UXO, discarded military munitions, or MC. Examples include former ranges and munitions burial areas. A munitions response area is comprised of one or more munitions response sites.
munitions response site (MRS)	A discrete location within an MRA that is known to require a munitions response.
projectile	Object projected by an applied force and continuing in motion by its own inertia. This includes bullets, bombs, shells, grenades, guided missiles, and rockets.
unexploded ordnance (UXO)	Military munitions that have been primed, fuzed, armed, or otherwise prepared for action; that have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material; and that remain unexploded whether by malfunction, design, or any other cause.

EXECUTIVE SUMMARY

ES.1 PROJECT OBJECTIVES

ES.1.1 The objective of this site inspection (SI) is to determine whether the Culebra Island formerly used defense site (FUDS) warrants further investigation under the Military Munitions Response Program (MMRP). The Culebra Island FUDS consists of 13 munitions response sites (MRSs) to be recommended for further action or no Department of Defense action indicated (NDAI) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 process. Further action in the CERCLA process can include time-critical removal action (TCRA) if an imminent threat to the public or environment is identified, or a remedial investigation and feasibility study (RI/FS) can be initiated to evaluate feasible response actions.

ES.1.2 The recommendation for each MRS is determined through evaluation of munitions and explosives of concern (MEC), munitions debris (MD) indicative of MEC, and munitions constituents (MC) associated with known or suspected MEC. Data were collected through review of previous investigation results and historical military records, collection of soil and sediment samples, and qualitative reconnaissance on site.

ES.1.3 The technical project planning (TPP) process determined that the collection of 27 soil samples and five sediment samples was sufficient to meet the SI project objectives. The samples were taken within known range areas or near sites where MEC or MD had been identified. To provide ambient data, three of the soil samples were taken in areas where contamination was not anticipated.

ES.2 SUMMARY OF RESULTS

ES.2.1 Assessment of the Culebra Island FUDS site included evaluating site-specific conditions that could impact the potential for complete exposure pathways to human and ecological receptors at the site. The SI evaluation included performing approximately 50 miles of walked QR and collecting 32 samples. The samples were analyzed for MC, including explosives and metals, and analytical results were compared to the following three criteria to determine the need to perform a screening level risk assessment (SLRA) for each particular analyte:

- Was the analyte a potential constituent of munitions known or suspected of being used on site;
- Was the analyte considered a hazardous substance listed in 40 CFR Part 302, Table 302.4 of CERCLA;
- Was the analyte detected above the maximum ambient concentration.

ES.2.2 No explosive compounds were detected in any of the soil or sediment samples; metals were detected in all of the MRSs. SLRAs were performed for each analyte that met all three criteria. The SLRAs compared MC detections in soil and sediment to EPA Region 9 residential soil preliminary remediation goals (PRGs) for human health risk and EPA Region 4 ecological screening values (ESVs) for ecological risk. All detected

metals retained for SLRA were found to be below human health screening levels. Metals were detected above ecological screening values at MRSs 02, 04 through 10, 13, and 14.

ES.3 CONCLUSIONS REGARDING POTENTIAL MUNITIONS AND EXPLOSIVES OF CONCERN

Culebra Island and the surrounding cays and cayos were used for aerial bombing, maneuvers, artillery firing, and amphibious training by the U.S. Navy and the U.S. Marine Corps between 1902 and 1975. Reported munitions included various projectiles, rockets, mortars, high explosive (HE) bombs, and practice bombs. During the SI, the field team did not observe any MEC; however, they identified MD in six of the MRSs. Overall there is potential for MEC at 12 of the 13 MRSs (all except MRS 14).

ES.4 CONCLUSIONS REGARDING POTENTIAL EXPOSURE PATHWAYS

ES.4.1 MC exposure pathways are not considered complete unless all four of the following elements are present (EPA, 1989):

- A source and mechanism for chemical release;
- An environmental transport/exposure medium;
- A receptor exposure point; and
- A receptor and a likely route of exposure at the exposure point.

ES.4.2 The SI evaluated the potential for complete MC exposure pathways to human and ecological receptors through soil, groundwater, surface water, and air. There are no groundwater receptor exposure points, and the climate on the island is too wet and vegetated to generate significant quantities of fugitive dust; therefore, the groundwater and air pathways are considered incomplete for human or ecological receptors at all MRSs. Soil and surface water pathways may be complete for human and/or ecological receptors on several MRSs.

ES.5 RECOMMENDATIONS

ES.5.1 Due to the presence of MEC and MD observed during previous investigations and during the SI field visit, 12 of the 13 MRSs at the Culebra Island FUDS are recommended to proceed to RI/FS. During the RI/FS, further evaluation of MC is recommended for MRS 06 to evaluate potential human health risk due to possible direct fire in the lagoon at Mosquito Bay. Additionally, further evaluation of MC is recommended MRSs 02, 04-10, and 13 to evaluate potential ecological risk.

CHAPTER 1

INTRODUCTION

1.1 PROJECT OBJECTIVES

1.1.1 Parsons Corporation (Parsons) has performed a site inspection (SI) of Culebra Island, Puerto Rico (Formerly Used Defense Site [FUDS] Project Number I02PR0068) under Contract Number W912DY-04-D-0005, Task Order Number 0008, from the U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville (USAESCH).

1.1.2 The Department of Defense (DoD) has established the Military Munitions Response Program (MMRP) to address DoD sites suspected of containing munitions and explosives of concern (MEC) or munitions constituents (MC). Under the MMRP, the United States (U.S.) Army Corps of Engineers (USACE) is conducting environmental response activities at FUDS for the Army, DoD's executive agent for the FUDS program.

1.1.3 Pursuant to USACE's Engineer Regulation (ER) 200-3-1 (USACE, 2004c) and the Management Guidance for the Defense Environmental Response Program (DERP) (Office of the Deputy Under Secretary of Defense, Installations and Environment, September 2001), USACE is conducting FUDS response activities in accordance with the DERP statute (10 U.S. Code [USC] Section [§] 2701 et seq.), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 USC §9601 et seq.), Executive Orders 12580 and 13016, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300). Therefore, USACE is conducting remedial SIs, as set forth in the NCP, to evaluate hazardous substance releases or threatened releases from eligible FUDS.

1.1.4 While not all MEC/MC constitute CERCLA hazardous substances, pollutants or contaminants, the DERP statute provides DoD the authority to respond to releases of MEC/MC, and DoD policy states that such responses shall be conducted in accordance with CERCLA and the NCP.

1.1.5 As specified in the delivery order, this report summarizes the work performed during the SI conducted on Culebra Island, Puerto Rico located 17 miles east of the Island of Puerto Rico at approximately latitude 18°33′ N, longitude 65°33′ W. The site location is shown on Figures 1.1A and 1.1B.

1.2 PROJECT SCOPE

1.2.1 The primary objective of the MMRP SI is to determine whether or not a FUDS project warrants further response action under CERCLA. The SI collects a sufficient and appropriate amount of information necessary to make this determination, as well as it 1) determines the potential need for a removal action; 2) collects or develops additional data, as appropriate, for Hazard Ranking System (HRS) scoring by the U.S.

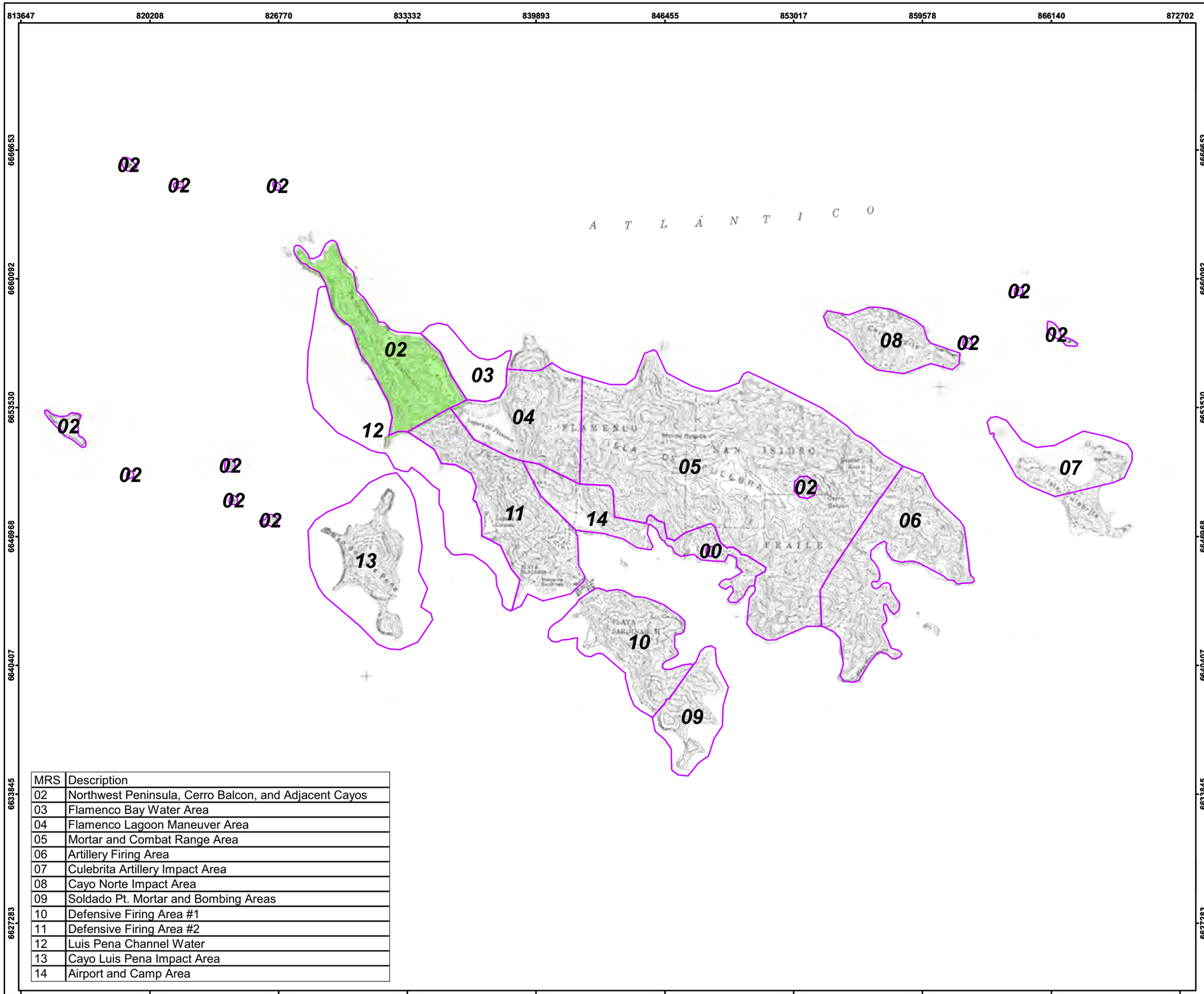
Environmental Protection Agency (EPA); and 3) collects data, as appropriate, to characterize the release for effective and rapid initiation of the remedial investigation and feasibility study (RI/FS). An additional objective of the MMRP SI is to collect the additional data necessary to complete the munitions response site prioritization protocol (MRSPP).

1.2.2 The Culebra Island site falls under the purview of the USACE Jacksonville District (CESAJ). The primary guidance documents used to perform the SI include the Site-Specific Work Plan (SS-WP) for Culebra Island, Puerto Rico (Parsons, 2006b), the Programmatic Work Plan (PWP) (Parsons, 2005), the Programmatic Sampling and Analysis Plan (PSAP) (USACE, 2005a), and the PSAP Addendum (Parsons, 2006a). The performance work statement for this project is found in Appendix A, provided on the attached CD.

Figure 1.1A

Culebra Island

Puerto Rico



MRS	Description
02	Northwest Peninsula, Cerro Balcon, and Adjacent Cayos
03	Flamenco Bay Water Area
04	Flamenco Lagoon Maneuver Area
05	Mortar and Combat Range Area
06	Artillery Firing Area
07	Culebrita Artillery Impact Area
08	Cayo Norte Impact Area
09	Soldado Pt. Mortar and Bombing Areas
10	Defensive Firing Area #1
11	Defensive Firing Area #2
12	Luis Pena Channel Water
13	Cayo Luis Pena Impact Area
14	Airport and Camp Area

Legend

- MRS Boundary
- Area Excluded From SI PER PL93-166

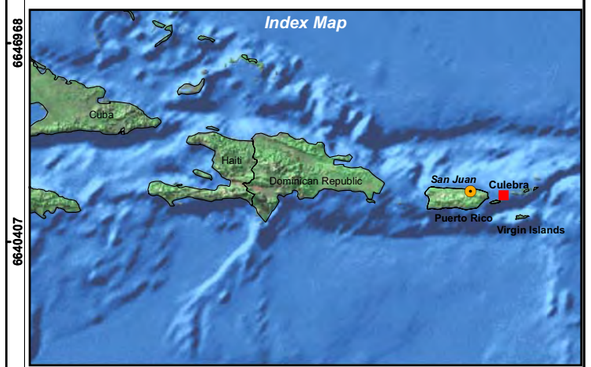


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

5,000 2,500 0 5,000 Feet

N

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U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT
DRAWN BY: BT
CHECKED BY: NH
SUBMITTED BY: DS

Culebra Island

SCALE: As Shown
PROJECT NUMBER: 744647.17000
DATE: September 2007
PAGE NUMBER: 1-3
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Figure 1.1B

Culebra Island

Puerto Rico

MRS	Description
02	Northwest Peninsula, Cerro Balcon, and Adjacent Cayos
03	Flamenco Bay Water Area
04	Flamenco Lagoon Maneuver Area
05	Mortar and Combat Range Area
06	Artillery Firing Area
07	Culebrita Artillery Impact Area
08	Cayo Norte Impact Area
09	Soldado Pt. Mortar and Bombing Areas
10	Defensive Firing Area #1
11	Defensive Firing Area #2
12	Luis Pena Channel Water
13	Cayo Luis Pena Impact Area
14	Airport and Camp Area

Legend

- MRS Boundary
- Area Excluded From SI PER PL93-166

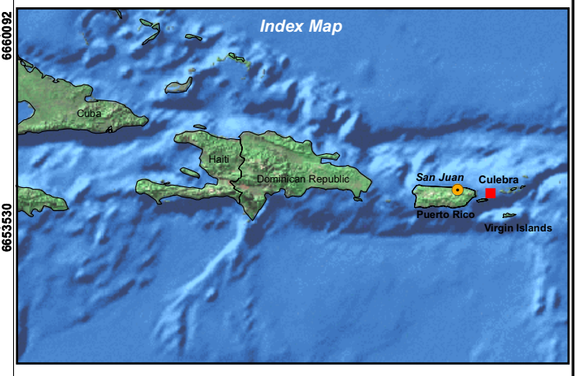

Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

5,000 2,500 0 5,000 Feet

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U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY:	BT
DRAWN BY:	BT
CHECKED BY:	NH
SUBMITTED BY:	DS

Culebra Island

SCALE: As Shown

PROJECT NUMBER: 744647.17000

DATE: September 2007

PAGE NUMBER: 1-4

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CHAPTER 2

PROPERTY DESCRIPTION AND HISTORY

2.1 SITE DESCRIPTION

Culebra Island and the surrounding cays, consisting of approximately 8,430 acres, were used for aerial bombing, maneuvers, artillery firing, and amphibious training by the U.S. Navy (Navy) and U.S. Marine Corps (Marines) between 1902 and 1975 (USACE, 2005b). During military use of the land, the island was inhabited by many residents centralized around the town of Dewey on the west central portion of the island. Currently, the site includes municipal, residential, and recreational areas. Most of the main island of Culebra, as well as Cayo Norte, are privately owned, while the surrounding cays are managed by the U.S. Fish and Wildlife Service (USFWS). The Puerto Rico Department of Natural and Environmental Resources (DNER) also manages land on Culebra. Access is unrestricted on most of the island, although natural barriers such as dense vegetation and rocky cliffs make access to many areas difficult. Portions of the island are also used for cattle grazing.

2.2 SITE LOCATION AND SETTING

2.2.1 Topography and Vegetation

Culebra Island and the surrounding cays have irregular, rugged coastlines with sandy beaches, lagoons, coastal wetlands, and mountainous terrain. The highest point on Culebra is Mount Resaca at approximately 630 feet. Figure 1.1A shows the topography of Culebra Island and the surrounding cays. Vegetation is moderately to extremely dense on undeveloped portions of Culebra, Luis Pena Cay, Northeast Cay, and Culebrita; however, vegetation is sparse or absent on many of the smaller cays as most are rocky with very little soil. Hazardous vegetation include the Mesquite acacia or thorny brush, which may be present on Culebra and all of the surrounding cays, and the poisonous Manchineel tree (also called Manzanillo Tree on Culebra), which is known to be present on Northwest peninsula and near Flamenco Lagoon.

2.2.2 Geology and Soils

Culebra Island and the surrounding cays are part of the Culebra Archipelago. The rocks are predominantly intrusive or extrusive volcanic rocks consisting of andesite lava and tuff. The rocks in the north-central portion of Culebra and on the east side of Cayo Luis Pena contain diorite porphyry inclusions and have little to no porosity due to compaction and quartz and calcite growth in the pore space. Soils are generally shallow and rocky and consist mostly of silts and clays. Loamy organic-rich soils are found in areas of dense vegetation and grasses, while sandy soils are found on tidal flats or areas near the beach. Many of the beaches on Culebra and the surrounding cays have clean

white to tan sand, while other beaches are rocky with a mix of cobbles and pieces of dead coral reef. Figures 2.1 and 2.2 show the geology and soils of Culebra Island, respectively.

2.2.3 Climate

The weather at Culebra Island is generally warm year round due to its tropical marine climate. Average rainfall is approximately 36 inches, with the heaviest rain in May, October, September, and November. The months of August through November are considered the wet season, and the driest months are January through April. Daily temperatures average 80°F year round with an average maximum of 86°F and an average low of 74°F. Winds are generally from the east-northeast during November through January and from the east during February through October. Winds speeds average 8 knots. Hurricane season is from June through November, and severe hurricanes hit Culebra every 10 to 20 years.

2.2.4 Significant Structures

The Culebra Island site is home to the Municipality of Culebra, with just under 2,000 residents and many visitors throughout the year. The island has schools, residential areas, a clinic, an airport, restaurants, hotels, shops, and a few industrial companies. Water is provided by a desalination plant, built by the Navy, located on DNER land near the USFWS and DNER offices. The surrounding cays have no structures except Cayo Norte, which has a few full-time residents, and Culebrita, where the oldest operating lighthouse in the Caribbean is still maintained. Only Culebra and Cayo Norte have full-time residents.

2.2.5 Sensitive Environments

2.2.5.1 The main island of Puerto Rico and its associated islands support 75 federally listed threatened and endangered species consisting of 26 animals and 49 plants. Among this diverse group of fauna and flora are multiple species that are known to exist, potentially exist, or temporarily use areas within the Culebra Island, such as migratory birds. Of the 75 federally listed species, nine are known or are suspected to occupy Culebra Island and/or the associated cays. In addition to the federally listed species, 13 state-listed species are known to occupy Culebra Island and/or the associated cays. The federally and state-listed species includes both terrestrial and marine life. The federally listed species of most concern for the wildlife refuge are the Culebra Island giant anole, Virgin Islands tree boa, roseate tern, brown pelican, green sea turtle, hawksbill sea turtle, leatherback sea turtle, loggerhead sea turtle, Leptocereus grantianus (cactus), and Wheeler's peperomia. Due to declining populations, the elkhorn and staghorn corals in the surrounding waters are proposed to be federally listed threatened and endangered species.

2.2.5.2 According to the National Wildlife Refuge System (NWRS), portions of Culebra Island and 22 of the associated cays are considered National Wildlife Refuge area. The three largest cayos are Culebrita, Cayo Norte, and Luis Pena. These resemble Culebra in that they all have sandy beaches, rugged coastline, and gentle to steep hills. Vegetation ranges from moderate to extremely dense. The smaller cays are primarily

solid rock with sparse or no vegetation. A few of the smaller cays have small beaches; however, most are rugged rock all around.

2.2.5.3 According to the DNER, the conservation priority areas for Culebra and associated cays are as follows:

- All of the lagoons on Culebra
- Monte Resaca
- All beaches around Culebra
- The designated critical habitat area for the Virgin Islands Boa
- Flemenco Peninsula
- Puerto del Manglar
- Los Canos
- Punta Soldado
- Bahia (also called "Ensenada") Cementerio
- All cayos and cays around Culebra
- The Culebra National Wildlife Refuge
- The Canal Luis Pena Natural Reserve

2.2.6 Cultural and Archeological Resources

According to the National Register Information System (NRIS), National Historic Landmarks (NHL) list, National Heritage Areas (NHA) list, and National Park Service (NPS), there is only one registered cultural resource within the boundaries of the Culebra Island site. On the Isla Culebrita is an historic lighthouse called Faro Isla de Culebritas. The lighthouse is not open to the public due to building deterioration. According to the Puerto Rico State Historic Preservation Office (SHPO), there are no known architectural resources within the boundaries of the Culebra Island site; however, an architectural survey has not yet been conducted for Culebra. An archeological survey performed at Lower Camp in 1992 found evidence of prehistoric and historic inhabitants distributed over a half-acre area within the Lower Camp site.

2.2.7 Demographics

The U.S. Census Bureau's (USCB) Census 2000 provided the general demographics of the Municipality of Culebra summarized in Table 2.1 (USCB, 2006). The 2005 American Community Survey data and business and geography information are not available for this area. Table 2.2 shows the total population with respect to distance for each of the 13 munition response sites (MRSs).

TABLE 2.1
DEMOGRAPHIC SUMMARY
MUNICIPALITY OF CULEBRA, PUERTO RICO

General Characteristics	Number	Percent
Total Population	1,868	
Male	970	51.9
Female	898	48.1
Population Density (persons per square mile)	71.8	
Median Age (years)	36.0	
Under 5 Years	138	7.4
18 Years and Over	1,351	72.3
65 Years and Over	237	12.4
Total Housing Units	1,024	
Occupied Housing Units	699	68.3
Owner-Occupied Housing Units	531	76.0
Renter-Occupied Housing Units	168	24.0
Vacant Housing Units	325	31.7

TABLE 2.2
POPULATION WITHIN 4-MILE BUFFER
CULEBRA ISLAND, PUERTO RICO

MRS	On site to ¼ Mile	¼ to ½ Mile	½ to 1 Mile	1 to 2 Miles	2 to 3 Miles	3 to 4 Miles	Total
2	0	11	29	1504	324	0	1868
3	0	0	9	1496	307	29	1841
4	389	378	777	268	23	33	1868
5	553	475	783	57	0	0	1868
6	44	5	0	260	1559	0	1868
7	0	0	18	11	44	211	284
8	2	0	0	47	533	1286	1868
9	59	0	72	1294	441	2	1868
10	390	85	909	460	22	2	1868
11	1518	74	144	75	33	24	1868
12	42	225	1260	265	43	13	1848
13	0	0	0	1616	195	24	1835
14	1116	392	265	93	2	0	1868

Source: U.S. Census 2000 data. Population numbers reflect the use of a center point calculation by determining the geographical center of each census block and applying the total population in each block to the distance range in which the center point falls.

2.2.8 Current and Future Land Use

There are two main commercial areas on Culebra: the town of Dewey, located on the west side of Great Harbor, and the area surrounding the airport. Most of the residential development is on the northwest end of Great Harbor; however, residents are scattered throughout the island. Two houses are present on Cerro Balcon and the field team noted that land had been cleared for development on the southeast side of Cerro Balcon; therefore, future residential development is expected in this area. Lower Town, Flamenco Point, Mount Resaca, Northwest Peninsula, and all of the beaches are managed by the USFWS or DNER for wildlife conservation and recreational use. It is anticipated that the land use will remain the same and that development for similar purposes will likely continue on site.

2.3 SITE OWNERSHIP AND HISTORY

2.3.1 General Site History

2.3.1 In 1898, the Spanish American War concluded and the Kingdom of Spain ceded all public lands in Culebra and its adjacent cays to the U.S. Shortly after, in 1900, President Theodore Roosevelt placed Culebra under the jurisdiction of the Department of the Navy. In 1903, the Navy acquired approximately 4,200 acres of land by transfer and purchase; further donations, transfers, and leases between 1939 and 1965 brought the total land acquired to approximately 4,800 acres. Although portions of the site were never formally acquired, military use included the entire Island of Culebra and all surrounding cays. The Navy retained 87.5 acres near Flamenco Point that are not eligible for FUDS. The 2005 revised Findings and Determination of Eligibility report states that the site, except for 87.5 acres recently transferred from the control of the Navy, has been determined to be formerly used by the DoD (USACE, 2005b).

2.3.2 Although reconnaissance trips, development of a base, and placement of guns began as early as 1902, the first maneuvers at Culebra did not begin until January 1914, with the Marines first Advance Base Expedition establishing several encampments and 3-inch and 5-inch gun batteries at the mouth of Great Harbor. The Marines' use of the island continued over several more decades. In 1922, an exercise was conducted firing 7-inch, 8-inch, 3-inch, 155-millimeter (mm), 75mm, and 37mm guns. In 1924, maneuvers included establishment of ammunitions dumps throughout the island, firing of 75mm and 155mm guns, and mine placement in several water areas around Culebra.

2.3.3 In 1934, the Navy and Marines organized to carry out the first Fleet Landing Exercise (FLEX), Fleet Problem XV. Weapons used during this exercise included .30-caliber machine guns, 3-inch anti-aircraft guns, 6-inch gun batteries, 75mm batteries, and 6-inch naval guns. Six more FLEXs were conducted on Culebra Island between 1935 and 1941. Photographic accounts document additional Marine landing exercises in 1946 and 1947. Marine training at Culebra is believed to have continued until the late 1950s. Culebra Island and surrounding cays were used for bombing and gunnery training by the Navy from 1935 through 1975. Naval exercises included aerial bombardment, submarine torpedo fire, and naval gunfire directed at Northwest Peninsula and many cays. All military use of the island was terminated in 1975. In summary, the Island of Culebra, nearby cays, and surrounding water were used between 1902 and 1975 for training and live fire of bombs, mortars, rockets, torpedoes, projectiles, and small arms.

2.3.4 Beginning in 1978, all of the land acquired by the military on Culebra and the surrounding cays were excessed to the Department of the Interior or transferred to the government of Puerto Rico by quitclaim deed. These lands are currently managed by USFWS, DNER, or the Municipality of Culebra. No official lease or transfer documents have been identified for the remainder of the privately owned land; however, any portion of the island may have been used by the military during its long history of training on Culebra. Figure 2.3 shows the land ownership after disposition of Navy lands.

2.3.2 Munitions Response Site-Specific Site Ownership and History

Much of the Island of Culebra and its surrounding cays were used for training by the military between 1902 and 1975. Many different training operations were conducted at this site, and complete records are not available to designate specific ranges or range complexes. The Island of Culebra and surrounding cays were divided into 14 MRSs based on the islands geography and historic military use. The MRS locations are shown on Figures 1.1A and 1.1B. Because of Culebra Island's long military history, there are very few records of real estate acquisitions and transfers for the majority of the property used by the military. Where known, the ownership and history have been described along with the site operations and waste characteristics in Chapter 2.4 below.

2.4 SITE OPERATIONS AND WASTE CHARACTERISTICS

2.4.1 Munitions Response Site -Specific Descriptions/Operations

The Culebra Island FUDS consists of 13 MRSs, totaling 9,460 acres (8,430 land acres and 1,030 acres of water) (USACE 2005b). Below is a description of each MRS including historical military use, property acquisitions and excesses, known munitions use, and present ownership. The conceptual site model (CSM) found in Appendix J contains a detailed list of the munitions that were likely used at each individual MRS.

2.4.1.1 MRS 02 – Northwest Peninsula, Cerro Balcon, and Adjacent Cayos

2.4.1.1.1 This MRS includes Northwest Peninsula, Cerro Balcon, Cayo Lobo, Cayo Lobito, El Mono, Cayo Del Agua, Cayo Yerba, Cayo Raton, Alcarraza, Los Gemelos, Piedra Stevens, Cayo Tiburon, Cayos Geniqui, and Cayo Sombrerito, encompassing approximately 660 acres. The Navy conducted fleet maneuvers and FLEXs on MRS 02 between 1923 and 1941. During these exercises, Northwest Peninsula and the surrounding cays were heavily bombarded with high-explosive (HE) bombs, projectiles, and rockets, as well as illumination and practice rounds. Training continued through the 1950s and 1960s, and in the early 1960s aerial bombardment was expanded from Northwest Peninsula, Los Gemelos, and Alcarazza to most of the cays on the east and west side of Culebra. Training continued until 1975. Cerro Balcon, in the center of Culebra, was used as a mortar range target. Records show that the property near Cerro Balcon was leased beginning in 1924 to some time around 1939.

2.4.1.1.2 In 1975, the Navy issued a report of excess for the land associated with the Navy's original 1900 holdings. In 1980, the General Services Administration (GSA) transferred 776 acres to the USFWS to establish the Culebra National Wildlife Refuge. The remaining 936 acres were accepted in a quitclaim deed from the Secretary of the Interior by the Governor of Puerto Rico in 1982.

2.4.1.1.3 As part of this quitclaim deed, the governor agreed to the provisions of Section 204 of Public Law 93-166 stating that Northwest Peninsula was accepted in its present condition, having been used as a bombardment area by the Navy. It also stated that the grantor will hold no responsibility for decontamination nor any claims of damage or loss of property or persons associated with use or presence on the property. In accordance with Public Law 93-166, SI data were not collected on Northwest Peninsula.

2.4.1.1.4 Currently, the DNER manages the southern half of Northwest Peninsula and the USFWS manages the northern half of Northwest Peninsula and the cays associated with MRS 02. A non-time critical removal action is currently underway at Cerro Balcon, and surface clearance is being conducted on Cayo Lobo.

2.4.1.2 MRS 03 – Flamenco Bay Water Area

MRS 03 consists of approximately 195 acres of shallow water in Flamenco Bay extending from midway up the east side of Northwest Peninsula to midway up the west side of Flamenco Point. This area was used by the military for amphibious training, and ordnance was fired in the bay. Records show that FLEX Number (No.) 5, conducted in this area in 1939, involved firing 75mm shrapnel projectiles at the mouth of the bay. MEC has been observed in the water in this area. Flamenco Bay is a shallow bay with heavy use for recreational swimming, snorkeling, and diving. This MRS is surrounded by land originally designated for military use by Theodore Roosevelt in 1900. There are no records for lease or excess of this property.

2.4.1.3 MRS 04 – Flamenco Lagoon Maneuver Area

The 550-acre MRS 04 includes Flamenco Lagoon and the hillside east of the lagoon. Records show that Combat Range No. 2, located on the south side of Flamenco Beach, was used for direct and indirect fire of small arms and 81mm mortars from firing positions on the hillside within MRS 04 during FLEX No. 4 in 1938. Firing positions for 75mm projectiles used during FLEX No. 5 in 1939 were also located in MRS 04. There are no records for lease or excess of this property; it is currently under private ownership.

2.4.1.4 MRS 05 – Mortar and Combat Range Area

MRS 05, the largest MRS on Culebra Island, includes most of the landmass between Resaca Beach and Carenero Point, totaling approximately 2,842 acres. Historical training records indicate that many of the hills in this area may have been used for direct fire. Cerro Balcon Mortar Range, which is part of MRS 02, is surrounded by MRS 05. Unexploded ordnance (UXO) has been identified near Cerro Balcon on portions of the MRS 05 property. A non-time critical removal action is currently underway at this location. MRS 05 includes two 1936 combat training areas leased for combat, target, and sweep-of-fire range training. Small arms and 81mm mortars may have been used at Combat Range No. 1 in 1937 during FLEX No. 4. A 1924 standing barrage training area is also included in the MRS. Historical records indicate that 1,500 acres of land within MRS 05 and part of MRS 06 were leased in 1924 from Mr. A. Lugo for gun emplacements and other possible camp sites. The property was returned to Mr. A Lugo in November 1939. Most of MRS 05 is privately owned; however, USFWS manages a large portion of the property surrounding Mount Resaca and DNER manages the property along the beaches on the northeastern side of the site.

2.4.1.5 MRS 06 – Artillery Firing Area

MRS 06 is on the eastern end of Culebra extending from a point at the most northern tip of Mosquito Bay, northeast to a point just west of Duck Point, and east to the end of the island. This area consists of 826 acres and was used by the Marines for artillery firing points for exercises conducted between 1922 and the 1940s. Exercises involving small arms, Stokes mortars, 75mm pack howitzers, 3-inch mortars, and 37mm HE rounds were conducted in Mosquito Bay in 1936. Beginning in 1936, the Marines fired 75mm projectiles from a firing point inland of Mangrove Bay at Weather Channel near Culebrita. Additionally, 1937 U.S. FLEX No. 4 involved use of the lagoon area at the back of Mosquito Bay (Figure 2.5). In 1939, the Marines fired from 1,000 yards northeast of Mosquito Bay toward the cays to the east. From Mosquito Bay, 37mm rounds were fired west to water targets between Point Vaca and Snapper Shoal. The property of MRS 06 was leased from the Vieques Sugar Company and Mr. A Lugo in 1924. Mr. Lugo's lease was terminated in 1939; however, there is no record of the termination on the property owned by the Vieuques Sugar Company. Currently, this MRS is almost entirely privately owned except for the water line, which is owned by the DNER and USFWS.

2.4.1.6 MRS 07 – Culebrita Artillery Impact Area

MRS 07 includes the northern portion of Culebrita as well as Cayo Botella. The Marines used this 375-acre area as an artillery impact area between 1936 and the late 1940s. The United States and the United Kingdom used Cayo Botella for an aircraft bombing/rocket target in 1969. Munitions included 20mm projectiles, Mk 44 and Mk 45 flares, live and practice bombs up to 500 pounds, and 2.75-inch rockets as well as British bombs and rockets. Culebrita beaches are used recreationally, and many boats visit the island each year. Culebrita was part of the land designated for use by the Department of the Navy in 1900; it was reported excess in 1972. This MRS is managed by the USFWS.

2.4.1.7 MRS 08 – Cayo Norte Impact Area

MRS 08 includes only Cayo Norte and covers approximately 306 acres of land. Cayo Norte was leased by the Marines for training; however, it cannot be determined from records whether the site was ever used for training. The property was leased from Mrs. Alma Hasselroth in 1924 for erecting artillery targets for practice. This lease was ended as part of the agreement between the Navy and Mayor of Culebra in 1971. Notes on FLEX No. 5 indicate that impact of Cayo Norte was planned but that difficulties clearing people and cows from the island kept it from being used for an impact area. No UXO has been identified on Cayo Norte. Cayo Norte is privately owned with plans for residential development.

2.4.1.8 MRS 09 – Soldado Point Mortar and Bombing Area

This area consists of 328 acres on the very southern tip of the southwestern peninsula of Culebra. In 1914, a 5-inch battery was established on Soldado Point. Several training exercises including mortar firing, aerial bombing, and strafing were conducted on Soldado Point and the bay northwest of Soldado point during the 1930s and 40s. The Supplemental ASR mentions that 30- and 1,000-pound bombs were dropped in this area (USACE 2005c). Munitions used in the bay included 30-pound fragmentation bombs,

100-pound demolition bombs, 81mm mortars, and small arms. This piece of property was accepted in a quitclaim deed from the Secretary of the Interior by the Governor of Puerto Rico in 1982. This property is managed by the DNER; however, several shacks have been built along the water at Sueno cove.

2.4.1.9 MRS 10 – Defensive Firing Area No. 1

This area consists of 547 acres on the southwest peninsula of Culebra, south of the town of Dewey and north of MRS 09. Marines conducted amphibious landing and ground maneuver training on the beaches and hills in this area from the 1920s through the 1940s. Specifically, the hill on the north end of the MRS has been listed as a 1935 area of direct fire from infantry and tanks, and Snug Bay was shown as a 1935 water area for direct fire. Additionally a 1924 outpost and ammunition storage area is located on the north end of the MRS near Snug Bay (Figure 2.5). MRS 10 has many residents and businesses. Most of the development is near the town of Dewey on the north end of the site; however, houses are scattered throughout the southeastern side of this MRS. This MRS is almost entirely privately owned except for municipality lands such as the police and fire stations.

2.4.1.10 MRS 11 – Defensive Firing Area No. 2

MRS 11 is on the west side of Culebra between Northwest Peninsula and the town of Dewey. The property was part of the land leased from Mr. Jesus Nieves on 7 November 1923. The area is approximately 719 acres, and most of the southern portion of this MRS has been extensively developed for residential use. The areas along the beach and the west side of this site are less developed. The land is privately owned with some municipality properties such as the school, hospital, and government buildings. Several training exercises were conducted in this area, including 75mm and 155mm firing from Firewood Bay at Mono Cay and portions of Cayo de Luis Pena in 1924; FLEX No. 4 with firing of small arms and 81mm mortars in 1936; and FLEX No. 7 in 1941 with boat-to-beach firing of 5-inch and 6-inch projectiles.

2.4.1.11 MRS 12 – Luis Pena Channel Water Areas

MRS 12 consists of 835 acres of water along the west coast of Culebra from Northwest Peninsula to Scorpion Point. These waters make up the Luis Pena Water Refuge, managed by the DNER and used for recreational swimming, boating, fishing, snorkeling, and diving. Many training exercises with live fire were conducted along the beaches on the west side of Culebra, including amphibious landing exercises, boat-to-beach artillery, and direct artillery fire from Firewood Bay to the northern portion of Cayo de Luis Pena.

2.4.1.12 MRS 13 – Cayo Luis Pena Impact Area

Cayo de Luis Pena, with 342 acres of land and 864 total MRS acres, is about one-quarter mile off the western coast of Culebra. The northern tip of this island was used as a firing target during Marine exercises conducted between 1924 and 1941. Records show that 75mm projectiles were fired at the Cay in 1924 and that 155mm, 37mm, 8-inch, and 6-inch rounds may have also been used. In the 1960s, an observation point was erected on the hill top on Luis Pena, including a run-in line, helipad, and living quarters. Cayo de Luis Pena is managed by the USFWS as part of the Culebra National Wildlife Refuge.

2.4.1.13 MRS 14 – Airport and Camp Area

MRS 14 consists of approximately 416 acres of land at the north end of Great Harbor. This area includes the airport and the former Camp Idelfonso or Lower Town. The waterline is managed by DNER and USFWS, while the hillside east of the airport is private residential property with ongoing development. The area of Lower Town on DNER property has remains of old military buildings and magazines as well as some restored buildings currently used for DNER office space. The municipality of Culebra still uses the former military desalination plant located at Lower Town. The former airfield is currently operating as a regional airport for commercial and private use. Historical records indicate that a small arms range may have been present near the airfield.

2.4.2 Regulatory Compliance

The USACE is conducting this SI at the Culebra Island FUDS as part of the FUDS response activities pursuant to and in accordance with the guidance, regulations, and legislation listed in Chapter 1.1.

2.5 PREVIOUS INVESTIGATIONS

2.5.1 1991 Inventory Project Report

An Inventory Project Report (INPR) was signed on 24 December 1991, establishing the Culebra Island site as a FUDS, defining a site boundary, and assigning FUDS Project No. I02PR006800 (USACE, 1991). The Findings and Determination of Eligibility (FDE) concluded that "the site, except for 87.5 acres still under control of the Navy, has been determined to be formerly used by the Department of Defense. It is therefore eligible for the Defense Environmental Restoration Program (DERP)."

2.5.2 1995 Archives Search Report

The Archives Search Report (ASR) was completed by the USACE Rock Island District in February 1995 (USACE, 1995) after reviewing available records, photographs, and reports that documented the history of the site. As part of the ASR, a site visit was conducted in October 1994, during which the team identified munitions debris (MD) on Cayo Botella, Cayos Geniqui, and Cayo del Agua. In addition, MD was identified on Flamenco Beach, Flamenco Peninsula, and the hillside near Cerro Balcon. The ASR listed several ordnance items verified on site by either explosive ordnance disposal (EOD) personnel or the ASR field team. The confirmed munitions listed in the ASR are shown on the CSM in Appendix J.

2.5.3 1995 Interim Remedial Action

In 1995 MTA, Inc. completed an interim remedial action on 3.66 acres of the Flamenco Bay Campground (MRS 02) near Flamenco Beach to dispose of UXO within 2 feet of the ground surface at the campground (MTA, 1995). Work was conducted on the site between 12 May and 26 May 1995. MTA found 11 items of UXO and munitions-related scrap.

2.5.4 1997 Final Engineering Evaluation/Cost Analysis

In March 1997, Environmental Science and Engineering, Inc. (ESE) submitted the final engineering evaluation and cost analysis (EE/CA) for the Former Culebra Island Naval Facility, Culebra Island, Puerto Rico (ESE, 1997). The EE/CA investigation included surface and subsurface sample grids on Flamenco Peninsula, Isla Culebrita, Cayo Botella, Cayo del Agua, Cayo Lobo, and Cerro Balcon. UXO items were found in all areas except Cayo Lobo and Cerro Balcon, where only ordnance-related scrap was identified. Items found included 20mm high-explosive incendiary (HEI) devices, Mk76 practice bombs, Mk50s, 37mm projectiles, 5-inch rockets, 76mm projectiles, 3- to 6-inch naval projectiles, 81mm mortars, and a grenade.

2.5.5 2004 UXO Construction Support

2.5.5.1 In June 2004, Ellis Environmental Group, LC (Ellis) submitted the *Site-Specific Final Report, UXO Construction Support, Culebra Island Wildlife Refuge, Culebra Island, Puerto Rico* (Ellis, 2004a). The report documented clearance efforts conducted by Ellis on Northwest Peninsula. Ellis performed four phases of clearance from January 2001 to February 2004. Phase I consisted of construction support by clearing roadways, a wind generator foundation, a desalination plant foundation, and re-grading the site. Phase II of the construction support was not exercised due to a stop in funding for the construction project. Phase III included surface clearance of 70 acres of bird nesting area and 4-foot-depth subsurface clearance of roadways, firebreaks, and an observation post. Phase IV consisted of demilitarization of scrap, construction of a fence and information kiosk, and development of public awareness information. The public awareness information included a video, UXO safety poster, and UXO safety brochure.

2.5.5.2 During the UXO Construction Support project, Ellis excavated 6,121 holes and recovered 15,479 pounds of scrap metal and 249 UXO items. Appendix L, included on the enclosed CD, contains a copy of the Construction Support document which contains the list of UXO items found during this construction support effort and maps showing the locations of each item found.

2.5.6 2004 Archives Search Report Supplement

The ASR Supplement was completed by the USACE Rock Island District as an addition to the 1995 ASR (USACE, 2004a). This report provides detail of aerial training conducted by the Navy between 1935 and 1975 and identifies the following range areas:

- Mortar Range: This area is also called Cerro Balcon and is part of MRS 02. The following munitions may have been used in this area: Mk1 3-inch HE mortar and M329A1 4.2-inch HE mortar.
- Airfield Rifle Range: This small arms range in MRS 14 is seen on historic maps in the vicinity of the airport. Suspect munitions include general small arms.
- Aerial Mining Range: Practice mines were dropped in the water-covered portion of this area and then cleared by divers or minesweepers.
- Water Mine Field: The water area is suspected to have been used for mine training.

- Water West: Part of this area is included in MRS 12. A local diver reported underwater ordnance in this area. Suspect munitions include Mk II 6-inch HE projectiles.
- Water Center: This area is included in MRS 12. A local diver reported underwater ordnance in this area. Suspect munitions include Mk II 6-inch HE projectiles.
- Water South: This water area includes the small bay north of Soldado Point (part of MRS 09). A local diver reported underwater ordnance in this area. Suspect ordnance includes Mk II 6-inch HE; however, other ordnance types are suspected due to use as 1936 aerial target and 1938 mortar boat firing exercises.
- Shark Rock: Part of MRS 02, also known as Cayo Tiburon, this area was used as a target for aerial gunnery with bombs and rockets. Suspected ordnance includes Mk82 general purpose 500-pound HE bombs and 5-inch Zuni rockets.
- Palada Cay: Part of MRS 02, also known as Cayos Geniqui, this area was used as a target for aerial gunnery with bombs and rockets. Suspected ordnance includes Mk82 general purpose 500-pound HE bombs and 5-inch Zuni rockets.
- Ladrone Cay: Part of MRS 02, also known as Cayo Botella, this area was used as a target for aerial gunnery with bombs and rockets. Suspected ordnance includes Mk82 general purpose 500-pound HE bombs and 5-inch Zuni rockets.
- Culebrita Strafing Range: This strafing range target was on the north side of Culebrita and is part of MRS 07. Suspected munitions include general small arms, .50-caliber small arms, and MKI 20mm HEI.
- Culebrita Torpedo Range: Firing at this range from the water north of Culebrita targeted the sheer cliffs of Cayos Geniqui, part of MRS 02. Suspected munitions include the Navy's general torpedo.
- Naval Gunfire Target Area: This range was a naval gunfire and air-to-ground range with its target located on Northwest Peninsula, MRS 02. Munitions included general small arms, .50-caliber small arms, Mk80s series general purpose bombs, M1 105mm HE, Mk21 8-inch armor piercing (AP), Mk5 16-inch AP, 2.75-inch rockets, and the 11.75-inch Tiny Tim rocket.
- Twin Rocks: This area, also known as Los Gemelos, is part of MRS 02. These cays were used as targets for aerial bombs and rockets. Munitions included Mk80s series general purpose bombs, 5-inch Zuni rockets, and Mk8 5-inch practice rockets.
- Fungy Bowl: This area, also known as Alcarazza, is part of MRS 02. This large rock was used as a target for aerial bombs and rockets. Suspected munitions include Mk80s series general purpose bombs and 5-inch Zuni rockets.
- Cross Cay: This area, also known as Cayo Lobo, is part of MRS 02 and was used as a strafing and bombing target. Munitions included general small arms, .50-caliber small arms, Mk80s series general purpose bombs, and Mk I 20mm HEI.

- Agua Cay: This area, also known as Water Key, is part of MRS 02 and was used as a target for bombing and rocket fire. Munitions include Mk80s series general purpose bombs and 2.75-inch rockets.
- Air-to-Ground North: This target, at the northern tip of Northwest Peninsula, is part of MRS 02. Munitions used include general small arms, .50-caliber small arms, Mk82 500-pound general purpose bombs, 2.75-inch rockets, and 11.75-inch Tiny Tim rockets.
- Air-to-Ground South: This target was located at the northern tip of Northwest Peninsula and is part of MRS 02. Munitions used include general small arms, .50-caliber small arms, Mk82 500-pound general purpose bombs, 2.75-inch rockets, and 11.75-inch Tiny Tim rockets.
- Rifle Range South: This small arms range is believed to be located on undeveloped land near the southern tip of the island in MRS 09. This range has not been confirmed; however, munitions used at this range would have included only general small arms.

This information from the ASR Supplement is also included in the CSM (Appendix J), and range boundaries are provided on Figure 2.4. No site visit was conducted in support of the ASR Supplement.

2.5.7 2005 Revised Inventory Project Report

A Revised INPR was completed in June 2005 (USACE, 2005b). The Revised INPR further clarified the military use of the Island of Culebra and divided the original site, Property No I02PR0068, into 14 separate MRSs. One hazardous and toxic waste (HTW) project was identified and assigned the number 00, and 13 MMRP project areas were identified and assigned Risk Assessment Code (RAC) scores. MRS 01 was not defined. The following MMRP projects and RAC scores were listed:

MRS 02 – Culebra and Cays, RAC 1

MRS 03 – Flamenco Bay Water Area, RAC 1

MRS 04 – Flamenco Lagoon Maneuver Area, RAC 1

MRS 05 – Mortar and Combat Range Area, RAC 1

MRS 06 – Artillery Firing Area, RAC 3

MRS 07 – Culebrita Artillery Impact Area, RAC 1

MRS 08 – Cayo Norte Impact Area, RAC 3

MRS 09 – Soldado Point Mortar and Bombing Area, RAC 2

MRS 10 – Defensive Firing Area No. 1, RAC 2

MRS 11 – Defensive Firing Area No. 2, RAC 1

MRS 12 – Luis Pena Channel Water Areas, RAC 1

MRS 13 – Cayo Luis Pena Impact Area, RAC 1

MRS 14 – Airfield and Camp Area, RAC 3

Details on each MRS are provided above in Chapter 2.4 and in the CSM (Appendix J), and MRS boundaries are shown on Figures 1.1A and 1.1B.

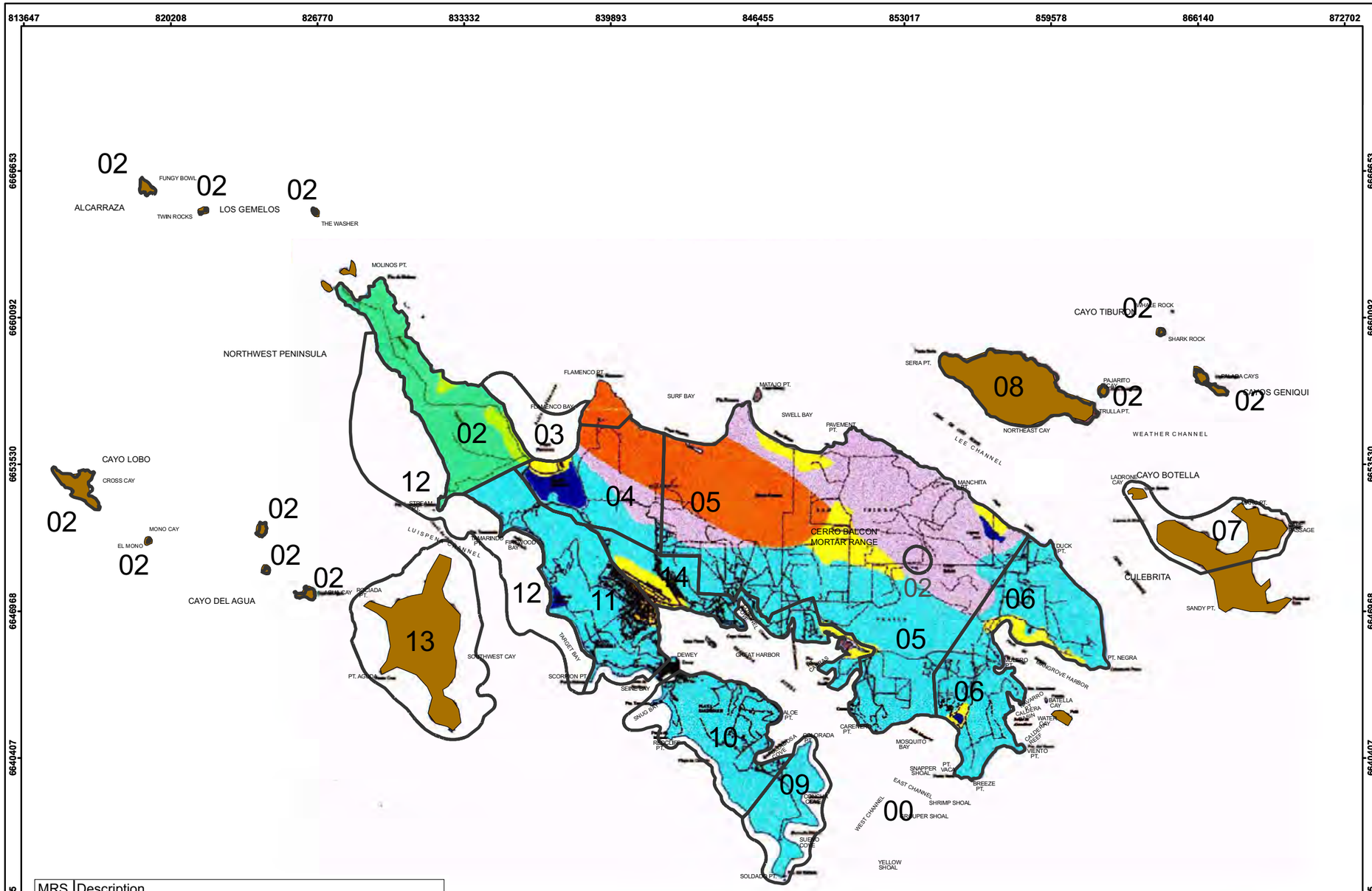
2.5.8 2005 Supplemental Archives Search Report

The Supplemental ASR was completed by the USACE St. Louis District in 2005 as an addition to the 1995 ASR (USACE, 2005c). The Supplemental ASR is the source of most of the historical information pertaining to site operations and identifies the key areas of focus for the SI. This document provided a detailed summary of military activities conducted on Culebra Island and the surrounding cays. The document summarizes planned and/or executed maneuvers and training conducted at the site, including specific time periods, locations, and munitions used. Figure 2.5 shows range and maneuver areas as determined by USACE using historical maps and documents reviewed as part of the Supplemental ASR.

Figure 2.1

Geology of Culebra Island

Puerto Rico



MRS	Description
02	Northwest Peninsula, Cerro Balcon, and Adjacent Cayos
03	Flamenco Bay Water Area
04	Flamenco Lagoon Maneuver Area
05	Mortar and Combat Range Area
06	Artillery Firing Area
07	Culebrita Artillery Impact Area
08	Cayo Norte Impact Area
09	Soldado Pt. Mortar and Bombing Areas
10	Defensive Firing Area #1
11	Defensive Firing Area #2
12	Luis Pena Channel Water
13	Cayo Luis Pena Impact Area
14	Airport and Camp Area

Legend

- MRS Boundary
- Area Excluded From SI PER PL93-166
- Andesite lava and lava breccia
- Andesite tuff
- Diorite and diorite porphyry
- Sand and Clay
- Water Body
- Area Not Mapped

Geology Map Source: Ellis Environmental Group, LC, 2004. Field Sampling and Analysis Report Culebra Island National Wildlife Refuge, PR, June, 2004.

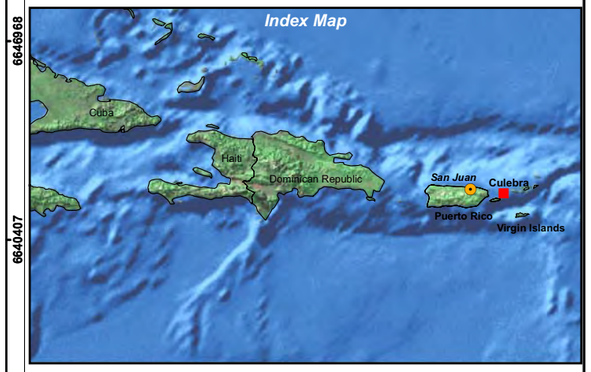


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

N

5,000 2,500 0 5,000 Feet

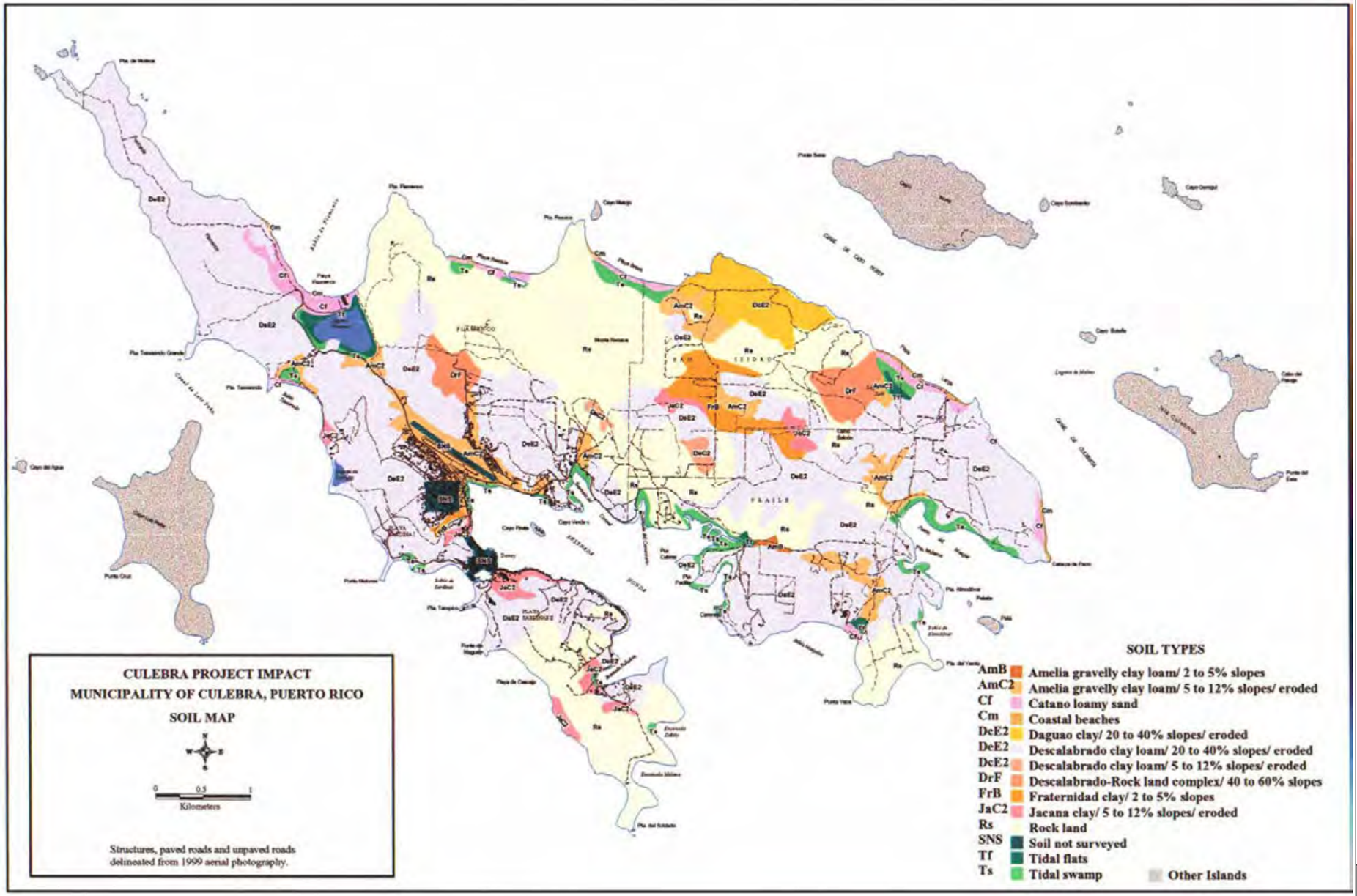
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

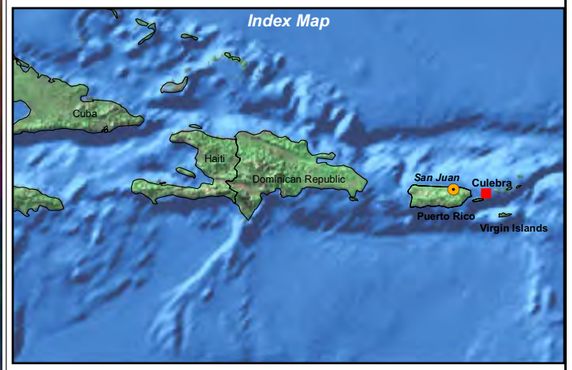
DESIGNED BY: BT	**Geology of Culebra Island**	
DRAWN BY: BT		
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 2-15
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig2_1.mxd	

Figure 2.2

Soils of Culebra Island

Puerto Rico





N

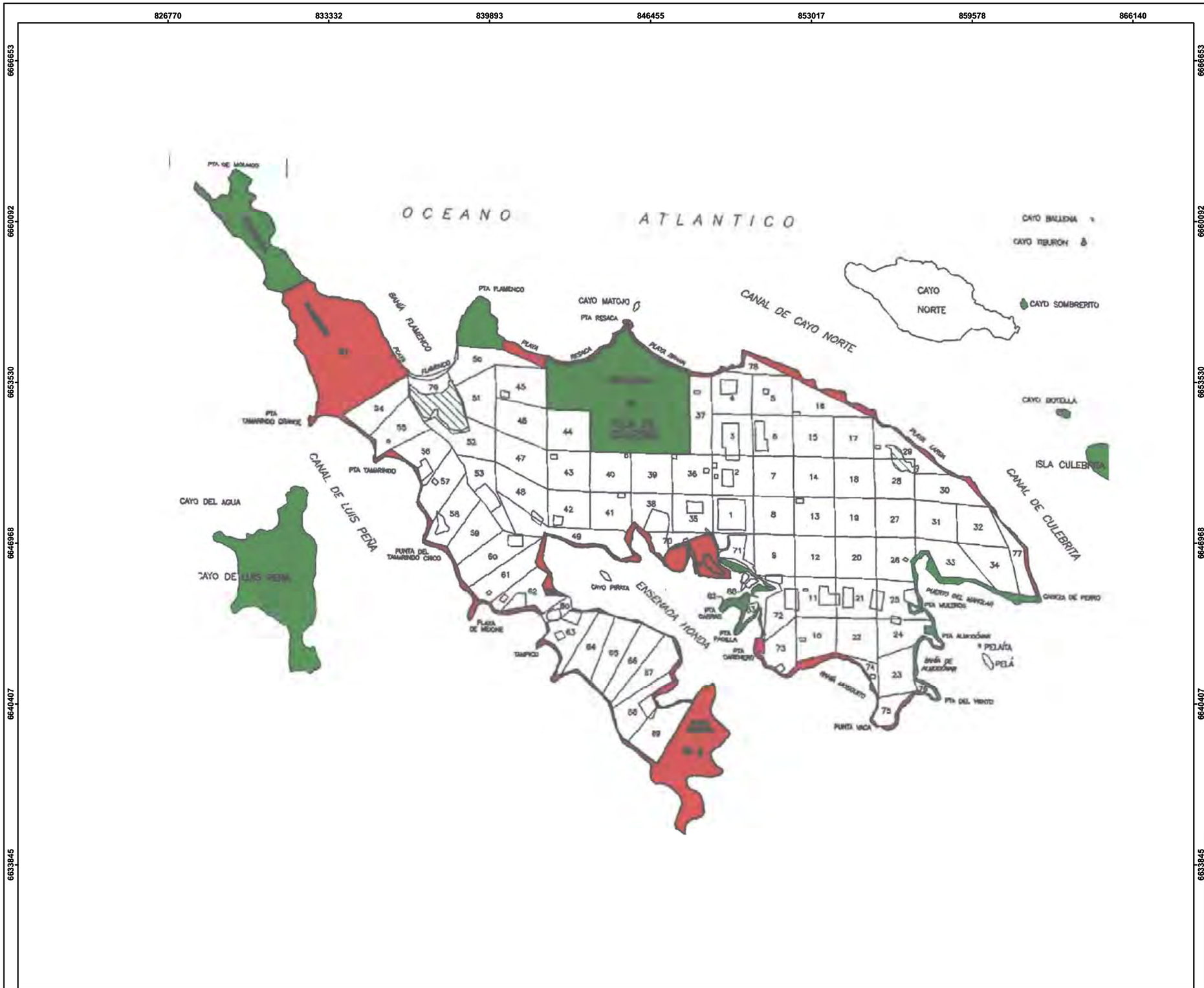
Soils Map Source: Ellis Environmental Group, LC, 2004. Field Sampling and Analysis Report Culebra Island National Wildlife Refuge, PR, June, 2004.

PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER
DESIGNED BY: BT	**Soils of Culebra Island**
DRAWN BY: AB	
CHECKED BY: NH	SCALE: NTS — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 2-16
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig2_2.mxd

Figure 2.3

Disposition of Navy Lands
Culebra Island

Puerto Rico



Legend

- NAVY LANDS
- COMMONWEALTH OF PUERTO RICO (QUITCLAIM DEED FROM SECRETARY WATT)
- CULEBRA NWR
- PRIVATE AND MUNICIPAL LAND

Map Source: US Fish and Wildlife Service and the US Department of the Interior

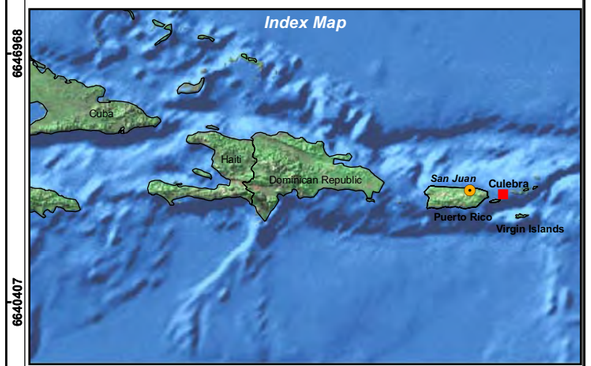


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

N

4,000 2,000 0 4,000 Feet

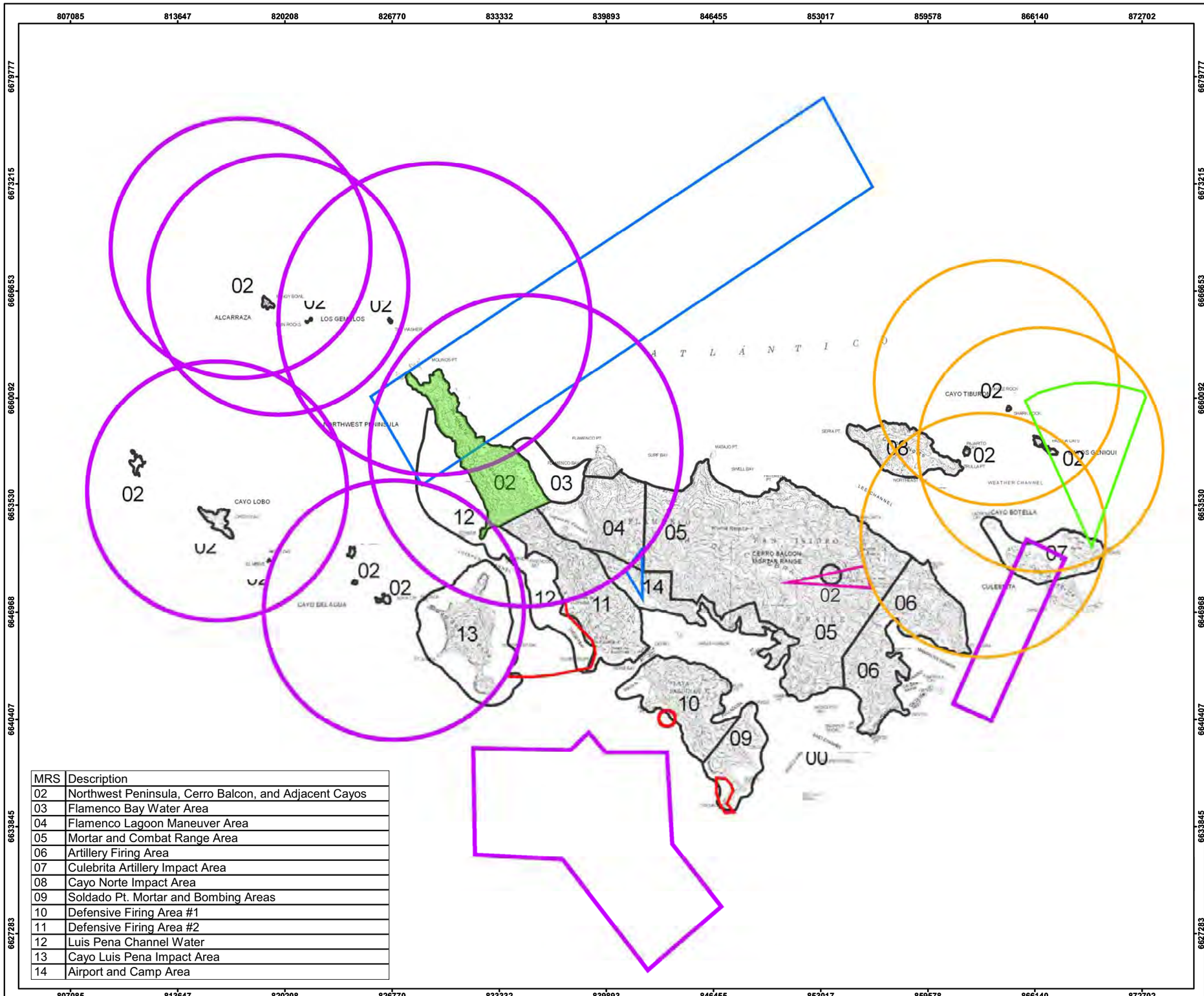
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Disposition of Navy Lands**	
DRAWN BY: BT	SCALE: As Shown	PROJECT NUMBER: 744647.17000
CHECKED BY: NH	DATE: September 2007	PAGE NUMBER: 2-17
SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig2_3.mxd	

Figure 2.4

ASR Supplement Ranges
Culebra Island

Puerto Rico



MRS	Description
02	Northwest Peninsula, Cerro Balcon, and Adjacent Cayos
03	Flamenco Bay Water Area
04	Flamenco Lagoon Maneuver Area
05	Mortar and Combat Range Area
06	Artillery Firing Area
07	Culebrita Artillery Impact Area
08	Cayo Norte Impact Area
09	Soldado Pt. Mortar and Bombing Areas
10	Defensive Firing Area #1
11	Defensive Firing Area #2
12	Luis Pena Channel Water
13	Cayo Luis Pena Impact Area
14	Airport and Camp Area

Legend

- Air-to-Ground
- Bombing Range
- Mortar Range
- Multiple/Combined
- R & D
- Small Arms
- MRS Boundary
- Area Excluded From SI PER PL93-166

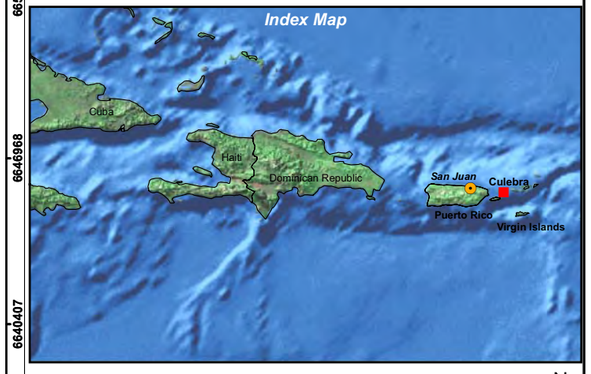


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

6,000 3,000 0 6,000 Feet

N

PARSONS

U.S. ARMY CORPS
OF ENGINEERS
HUNTSVILLE CENTER

DESIGNED BY: BT
DRAWN BY: BT
CHECKED BY: NH
SUBMITTED BY: DS

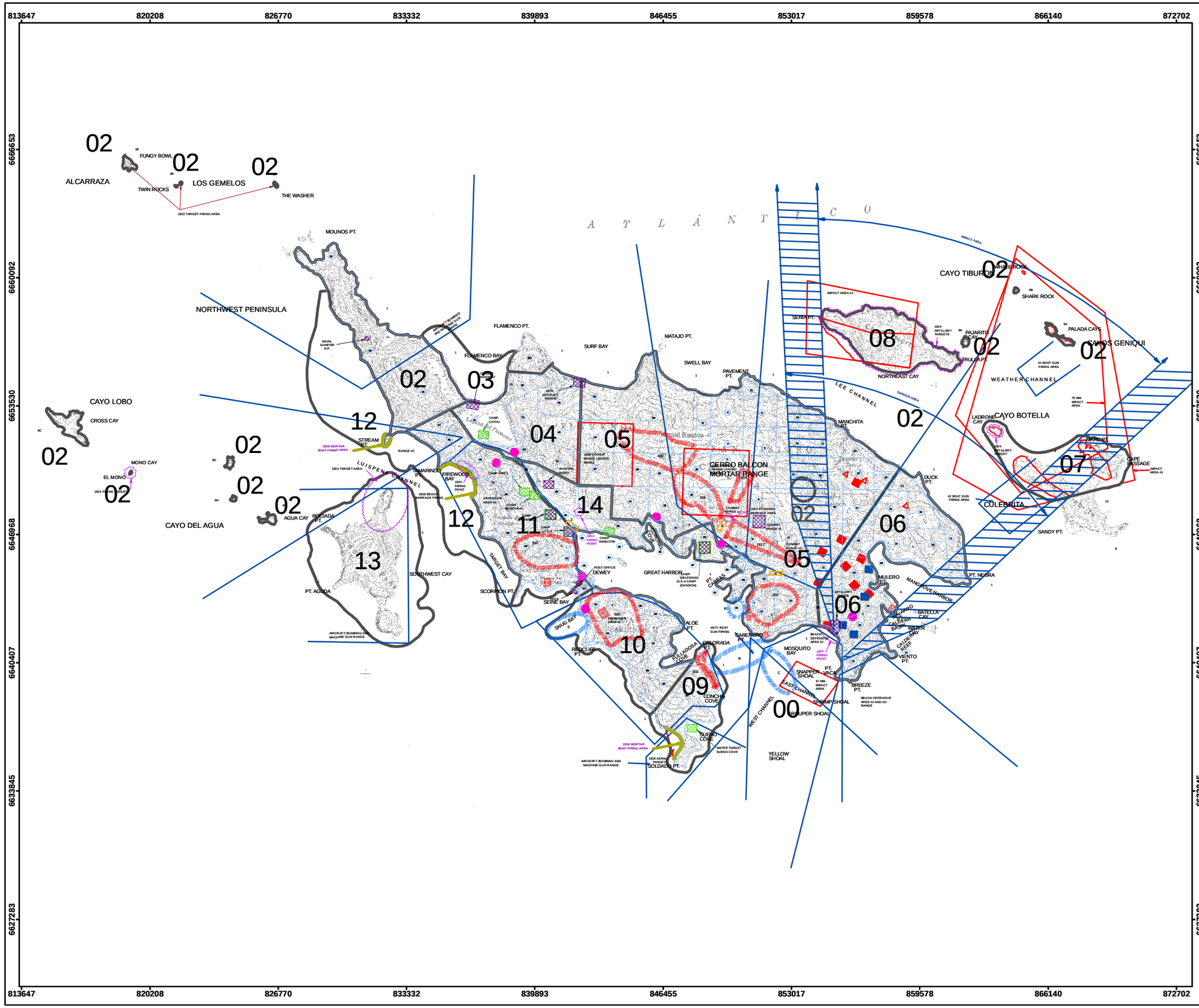
ASR Supplement Ranges

SCALE: As Shown
PROJECT NUMBER: 744647.17000
DATE: September 2007
PAGE NUMBER: 2-18
FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig2_4.mxd

Figure 2.5

Supplemental ASR Ranges and Areas of Use
Culebra Island

Puerto Rico



Legend

- 1924 OUTPOST AND AMMUNITION STORAGE LOCATIONS
- 1887 PROPERTY LOT
- 1902-1903 GUN POSITION
- 1924 MILITARY AREA
- AREA FOR DIRECT FIRE INFANTRY AND TANKS - 1935 (POSSIBLY 1924)
- WATER AREA FOR DIRECT FIRE AT BOATS - 1935 (POSSIBLY 1924)
- STANDING BARRAGE PREVIOUSLY REGISTERED 1935 (POSSIBLY 1924)
- 1936 ARTILERY AREA AND AERIAL TARGET
- FEATURE TAKEN FROM 1937 MAP TITLED "U.S. FLEET LANDING EXCERCISE #4"
- 1938 MILITARY AREA
- 1939 MILITARY EXCERCISE
- FEATURE TAKEN FROM 1936-1949 OBLIQUE PHOTO
- MRS BOUNDARY

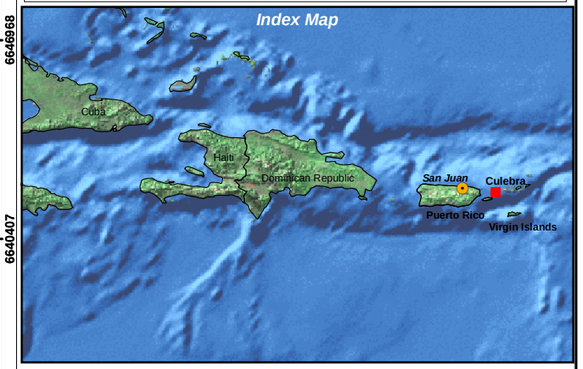


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

N

5,000 2,500 0 5,000 Feet

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY:	BT
DRAWN BY:	BT
CHECKED BY:	NH
SUBMITTED BY:	DS

Supplemental ASR Ranges and Areas of Use

SCALE: As Shown

PROJECT NUMBER: 744647.17000

DATE: September 2007

PAGE NUMBER: 2-19

FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig2_5.mxd

CHAPTER 3

SITE INSPECTION TASK

3.1 HISTORICAL RECORD REVIEW

The existing body of information pertinent to the Culebra Island site was thoroughly reviewed in advance of the technical project planning (TPP) meeting in February 2006 and summarized to the TPP Team as part of the development and concurrence of the selected technical approach for the site. Sampling locations and qualitative reconnaissance (QR) planning were the direct result of this review process. Records reviewed included the 1991 INPR, 1995 ASR, 1995 Interim Remedial Action Report, 1997 EE/CA, 2004 ASR Supplement, 2005 Revised INPR, and 2005 Supplemental ASR. This information has been augmented with institutional knowledge provided by CESAJ, data collected by Parsons during the field effort, and information obtained from ongoing removal and clearance actions on site.

3.2 TECHNICAL PROJECT PLANNING

CESAJ facilitated a TPP meeting on February 28, 2006, followed by a windshield tour of the site on March 1, 2006 and included representatives of the CESAJ, Parsons, the Puerto Rico Environmental Quality Board (PREQB), Puerto Rico DNER, and the USFWS. The TPP Team concurred with the technical approach presented in the Final TPP Memorandum issued on August 23, 2006 (Parsons, 2006c). The TPP Memorandum, TPP worksheets, and data quality objectives (DQOs) have been provided in Appendix B of this SI Report, found on the enclosed CD. Key TPP findings and decision made during the TPP meeting and during review of the SS-WP are summarized below:

- The TPP Team concurred with the technical approach (anticipated RI/FS) as revised at the TPP meeting on February 28, 2006, inclusive of number, type, and location of samples as well as sampling methodology and laboratory analyses. Twenty-eight surface soil samples and five sediment samples were to be collected. Three of the twenty-eight surface soil samples (Nos. 16, 22, and 27, as depicted on the CSM) would be used as ambient samples for comparison of metals. The TPP Team concurred that the site does not support accessible groundwater; thus collection of samples from these media was not deemed warranted at the SI phase.
- The TPP Team agreed that the exact soil sampling locations would be left to the professional judgment of the field team after navigating to the location depicted on the SS-WP Addendum maps. The sampling locations would serve as a starting point to assist the field team in finding conditions indicative of MEC and MC contamination and would represent the fallback sample location in the absence of biased field locations.

- The TPP Team concurred with the use of EPA Region 9 residential soil preliminary remediation goals (PRGs) (EPA, 2004) for explosives and metals comparison for human health risk assessment and EPA Region 4 ecological screening values (ESV) (EPA, 2001) for ecological risk assessment.
- The Commonwealth of Puerto Rico background metals information would not be used for comparison due to differences in the geology of Culebra and that of Puerto Rico; therefore, in addition to EPA Region 9 residential soil PRGs and Region 4 ESVs, metals concentrations would be compared to site ambient metals concentrations obtained from the three ambient samples (Nos. 16, 22 and 27). For comparison, the maximum concentration of each analyte detected from any of the three ambient samples would be used.
- PREQB recognized the likelihood of elevated metals concentrations in soil samples due to the presence of volcanic rock and soil. Therefore, elevated metals concentrations do not necessarily signify the need for additional sampling or RI/FS but would be evaluated in conjunction with other SI findings.
- The TPP Team agreed that no ocean water areas would be investigated as part of the SI. The SI would only evaluate land portions of the site; however the SI would recommend that a detailed study of the hazards associated with MEC presence in the ocean be evaluated as part of the RI/FS.
- The TPP Team agreed that analysis of groundwater for MC and the presence of perchlorate should not be conducted as part of this SI. Human exposure pathways to groundwater are not complete. There are no wells onsite or in the vicinity of the site. Due to the small size and annual desiccation of most surface water bodies on the island, the TPP Team believed that it is more likely that potential MC contamination would be present in lagoon sediment and not in the water itself. Five sediment samples from lagoons in MRSs 04, 05, 07 and 08 would be collected in lieu of collecting water samples from standing water, natural springs, or wells.
- The Project Team did not identify any site-specific issues requiring an expedited project schedule or document reviews for this site.

3.3 NON-MEASUREMENT DATA COLLECTION

Non-measurement data were collected through records searches with the U.S. Geological Survey (USGS) and other library catalogs. The following printed and electronic information sources were consulted for non-measurement data as part of the Culebra Island FUDS SI:

- USGS – Topographic Maps
- U.S. Department of Agriculture Soil Conservation Service – Soil Survey of Humacao Area of Eastern Puerto Rico
- USGS – Provisional Geologic Map of Puerto Rico and Adjacent Islands
- USGS – Water Wells on Isla de Culebra, Puerto Rico USGS open-file report 95-369, G.S. Cherry and J. Ramos

- USGS – Atlas of Ground-Water Resources in Puerto Rico and the U.S. Virgin Islands, USGS Water-Resource Investigations Report 94-198, T.D. Veve and B.E. Taggart
- U.S. Census Bureau – American FactFinder 2006
- USFWS, National Wetlands Inventory (NWI) – Wetlands Online Mapper
- USFWS, Endangered Species Program – Threatened and Endangered Species System (TESS)
- USFWS – NWRS
- National Oceanic and Atmospheric Administration (NOAA):
  - Coastal Zone Management Program (CZMP)
  - National Marine Sanctuaries
  - National Estuarine Research Reserve System
  - Coral Reef Information System (CoRIS)
  - Benthic Habitat Mapping of Puerto Rico and the U.S. Virgin Islands, 2002 CD-ROM
  - The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005. NOAA Technical Memorandum
  - National Marine Fisheries Service
  - Caribbean Fishery Management Council
  - Marine Managed Areas Inventory (Atlas and Table)
  - Center for Coastal Monitoring and Assessment
- NPS – nps.gov home page
- NPS, NRIS – National Register of Historic Places (Culebra, Puerto Rico)
- NPS, National Historic Landmarks Program (Puerto Rico) – List of NHLs
- NPS – Historic Places in Puerto Rico and the Virgin Islands
- NPS, National Heritage Areas Program – List of NHAs
- Puerto Rico DNER
- Puerto Rico SHPO
- USACE Rock Island District – Archive Search Report Findings for Culebra Island National Wildlife Refuge, Culebra, Puerto Rico, 1995
- Garrow & Associates, Inc. – Results of the Archeological Testing and Data Recovery Investigations at the Lower Camp Site, Culebra Island National Wildlife Refuge, Puerto Rico, 1992
- ESE – Final Engineering Evaluation/Cost Analysis: Former Culebra Island Naval Facility, Culebra Island, Puerto Rico, 1997

3.4 DEPARTURES FROM PLANNING DOCUMENT

3.4.1 The SS-WP specified that 28 soil samples and five sediment samples would be collected during the Culebra Island FUDS SI. During the field activities, the field team learned that Ellis was currently conducting surface clearance on Cayo Lobo and that several recent MEC detonations had been conducted. After consultation with the TPP Team, it was decided to forgo sampling at Cayo Lobo and to obtain laboratory analytical results from Ellis for samples that had been collected near MEC items identified on Cayo Lobo and Cerro Balcon. Ellis collected the samples prior to MEC detonation; therefore, they would provide adequate data for MC at MRS 02. The planned sample, CUL-02-SS-06-28, was not collected at Cayo Lobo.

3.4.2 As stated in Chapter 3.1.2.1 of the Final SS-WP (Parsons, 2006b), QR was planned throughout the Island of Culebra, Culebrita, Cayo Norte, Luis Pena Cayo, and Cayo Lobo. The presence of MEC on the surface at Cayo Lobo was enough evidence to recommend RI/FS for MRS 02; therefore, it was decided to forgo the planned QR on Cayo Lobo. Because of lack of right of entry (ROE) in many areas and very dense vegetation throughout the island, the field team was unable to follow the proposed QR paths as shown on Figures 3.2A, 3.2B, and 3.2C of the SS-WP. In cases where ROE was granted, the field team's path was dictated by the location of dense vegetation and, when possible, the field team traversed areas containing low shrubs or grass where the ground surface could be seen. In many cases where ROE was not granted along a particular QR path, the field team conducted QR along public trails and beside gravel roads to make observations and look for evidence of munitions in each MRS.

3.4.3 Several samples were moved slightly from the planned sample locations. None of the proposed sediment sample locations could be reached due to increased water depth in all of the lagoons from flooding the week prior to field mobilization. Sediment samples were collected from near-shore locations, at water depths less than 3 feet, where sediment could be reached with an extended-handle scoop. In cases where ROE could not be obtained, such as SS-04 where the sample was collected from the side of a public gravel road and SS-05 where the sample was collected along the beach on DNER property, the sample was collected near the planned sample location. SS-15 could not be collected as planned because ROE could not be obtained for this piece of property. During the site visit, ROE was granted on an adjacent property and the sample was relocated. SS-10 was moved slightly northwest due to extremely dense vegetation restricting access to the planned sample point. At the request of USFWS, SS-12 was approached from the south to avoid endangered species habitat on the boulder fields west of SS-12. Verbal permission was granted by the landowner to use a private driveway to access this site from the south. A fence line had recently been cut in this area, which allowed the field team to travel approximately 1,000 feet toward the planned sample location. After the end of the fence line, the vegetation quickly became extremely dense and steep terrain restricted the field team from safely approaching the sample location. SS-12 was collected along the south facing slope of Cerro Balcon approximately 750 feet southeast of the planned sample location. SS-23 was collected approximately 175 feet from the planned sample location, which could not be reached as the vegetation and terrain were very restrictive.

CHAPTER 4

MEC FINDINGS

4.1 GENERAL INFORMATION

As stated previously, Culebra Island and the surrounding cays were used by the military from 1903 to 1975. Extensive munitions training has left debris in many areas of the site, and it is likely that MEC still remains in some areas. Of the 13 MRSs, three have confirmed MEC and eight have confirmed MD.

4.1.1 Qualitative Reconnaissance

4.1.1.1 To assess the presence of MEC, the field team conducted slightly more than 50 miles of qualitative reconnaissance from October 26 to November 6, 2006. The QR consisted of visual reconnaissance of the site surface for visual indicators of suspect areas, including earthen berms, distressed vegetation, stained soil, ground scars or craters, target remnants, and visible metallic debris.

4.1.1.2 Figures 4.1A, 4.1B, and 4.1C show the QR paths and observation locations. As discussed in the SS-WP, the QR route was determined by the field team based on the baseline QC procedures described in Chapter 3 of the PWP, visual observations, and areas of predetermined focus (Parsons 2005). Table 4.1 presents the potential MEC anticipated at the site based on previous investigations and the MC that could be attributed to these munitions. The MEC CSM is included in Appendix J.

4.1.1.3 As shown in Appendix E (Photo Documentation Log), the SI team noted 450 discrete field observations throughout the course of the SI, such as topography, drainage, and the presence of any barriers. Pertinent field observations are summarized in Table 4.2. Appendix D includes related field forms.

4.1.2 Data Quality Objectives

4.1.2.1 DQOs are qualitative and quantitative statements that clarify study objectives and specify the type and quality of the data necessary to support decisions. The development of DQOs for a specific site takes into account factors that determine whether the quality and quantity of data are adequate for project needs, such as data collection, uses, types, and needs. While developing these DQOs in accordance with the process presented in Chapter 3, paragraph 3.1.2 of the PWP, Parsons followed the *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001 (EPA, 2006).

TABLE 4.1
CHEMICAL COMPOSITION OF MUNITIONS AND EXPLOSIVES OF CONCERN AND POTENTIAL MUNITIONS CONSTITUENTS
CULEBRA ISLAND, PUERTO RICO

General Munition Type	Type/Model	Case Composition	Filler	Potential Constituent
Small arms ammunition, .30-caliber, with gliding metal jacket	M2 Ball M1 Tracer M2 AP Primer, percussion	Brass	Lead antimony; tracer composition; tungsten chrome steel; single- or double-base powder; primer composition	Lead, antimony, copper, zinc, tungsten, chromium, molybdenum, iron, aluminum, calcium, strontium, magnesium, nitroglycerin
Small arms ammunition, .30-caliber, carbine, with gliding metal jacket	M1 Ball M16 Tracer Propellant Primer, percussion	Brass	Lead antimony; tracer composition; single- or double-base powder; primer composition	Lead, antimony, iron, copper, zinc, molybdenum, aluminum, calcium, strontium, magnesium, nitroglycerin
Small arms ammunition, .50-caliber, with gliding metal jacket	M2 Ball M1 Tracer M10 Tracer M17 Tracer M21 Tracer M2 AP Propellant Primer, percussion	Brass	Soft steel; tracer composition; tungsten chrome steel; single- or double-base powder; primer composition	Calcium, iron, strontium, lead, tungsten, magnesium, molybdenum, nitroglycerin, antimony, pentaerythritol tetranitrate, potassium, TNT, perchlorate
Torpedo, HE, Mk 27 "Cutie"	Battery	Brass, Steel, and/or Copper	HBX-1 (Torpex)	RDX, TNT, aluminum, lead, iron, copper.
Bomb, practice, Mk 76		Steel	Inert Spotting charge: black powder, smokeless powder, zinc oxide, titanium tetrachloride	Iron, potassium, zinc, titanium
Bomb, practice, Mk 106		Steel	Inert Spotting charge: black powder, smokeless powder, zinc oxide, titanium tetrachloride	Iron, potassium, zinc, titanium
Bomb, practice, miniature[3]	AN-MK 23	Cast Steel	Black powder, red phosphorus	Potassium,

TABLE 4.1 (Continued)
CHEMICAL COMPOSITION OF MUNITIONS AND EXPLOSIVES OF CONCERN AND POTENTIAL MUNITIONS CONSTITUENTS
CULEBRA ISLAND, PUERTO RICO

General Munition Type	Type/Model	Case Composition	Filler	Potential Constituent
Bomb, practice, 25 pound.[3]	BDU-33/B W/MK-4 signal ctg	Steel	Black powder, red phosphorus	Potassium, titanium, Red phosphorus
	W/ MK-5 spot chg	Steel	Fluorescein dye	
	BDU-33 A/B W/MK-4 signal ctg	Steel	Black powder, red phosphorus	
	BDU-33 B/B W/MK-4 signal ctg	Steel	Black powder, red phosphorus	
	W/CXU-2/B spot chg		Black powder, titanium tetrachloride	
	BDU-33 D/B W/MK-4 signal ctg		Black powder, red phosphorus	
	W/CXU-3B or A/B signal ctg		titanium tetrachloride	
Projectile, 5 inch		Steel	TNT; Composition B (TNT, RDX)	RDX, TNT, iron
Projectile, 6 inch	Mk II HE	Steel	TNT	TNT, iron
Projectile, 12-inch AP[3]	Mk15 Mod 6	Steel	Explosive D	Ammonium picrate
Projectile, 14-inch[3]	Mk8, Mk16, Mk20 AP	Steel	Explosive D	Ammonium picrate
	Mk9 Bombardment	Steel	Explosive D	
	Mk20 Target	Steel		
	Mk21 Target	Steel	Spotting dye	
Projectile, 16-inch[3]	Mk3, Mk5, Mk8 AP	Steel	Explosive D	Ammonium picrate
	Mk9 Target	Steel		
	Mk10	Steel	Spotting dye	
Projectile, 155 mm[3]		Steel	TNT, Lead Azide, black powder, tetryl booster, FNH propellent	TNT, lead, potassium, tetryl, dinitrotoluene
Projectile, 75 mm, shrapnel[3]	MkI	Steel	Black Powder	Potassium
Rocket, 2.75-inch[3]	M 151, M 229 HE	Steel	Comp B4	RDX, TNT, Calcium
	M 247 He Dual Purp	Steel	Comp B4	
	M 156 WP	Steel	White phosphorus	White phosphorus
	M 257 Illumination	Steel	Illum. comp	magnesium, sodium nitrate
	M 261 Multi-purpose, submunition (M73)	Steel	Comp B	RDX, TNT
	Mk40 Rocket Motor	Aluminum	N-5 propellant	nitroglycerine, lead

TABLE 4.1 (Continued)
CHEMICAL COMPOSITION OF MUNITIONS AND EXPLOSIVES OF CONCERN AND POTENTIAL MUNITIONS CONSTITUENTS
CULEBRA ISLAND, PUERTO RICO

General Munition Type	Type/Model	Case Composition	Filler	Potential Constituent
Rocket, 11.75-inch, aerial, Tiny Tim		Steel	TNT	TNT, iron
5-inch [3]	54 MK 41		(from Ellis log, Explosive D filler M500 series mose fuze PD	Ammonium picrate
Rocket, 5-inch, Zuni[3]		Steel, copper	Composition B (TNT, RDX); double-base propellant	TNT, RDX, nitroglycerin, copper, iron
Naval gun fire, 5-inch[3]	Mk32, Mk38, Mk42, Mk46, Mk47, HE, Common	Steel	Explosive D (ammonium picrate)	Magnesium, RDX, ammonium picrate, potassium,
	Mk15, HE, Common	Steel		
	Mk31, Mk34, Mk35, Mk36, HE, Common	Steel	Black powder and TNT Explosive D, Comp A	
	Mk25, Mk30, Mk 43 Illumination	Steel	(RDX) Black powder, illum composition	
Naval gun fire, 6-inch[3]	Mk35 AP	Steel	Explosive D	Magnesium, ammonium picrate, potassium,
	Mk20, Mk24, Mk27, Mk28, HE, Common	Steel	Explosive D	
	Mk22, Mk23, Mk32, Mk38, Mk41, Illum.	Steel	Black powder, illum. comp.	
	Mk36 Target	Steel	N/A	
	Mk37 Target	Steel	Spotting dye	
Naval gun fire, 3-inch[3]	Mk29 AP	Steel	Explosive D	TNT, RDX, magnesium, ammonium picrate, potassium,
	Mk3 Mod 7, HE, Common	Steel	Black powder, TNT	
	Mk23, Mk26, HE	Steel	Cast TNT	
	Mk31, HE	Steel	Cast TNT, Comp A	
	Mk21, Mk22, Mk24, Mk25, Mk28, Illum.	Steel	Black powder, illum comp.	
Mortar, 81mm	Illumination – M301, Fuse – PD M84, Primer – M34, Ignition cartridge - M6, Propelling charge – M2A1, White phosphorus	Steel	Illuminant mix; double-based powder; white phosphorus	Barium, aluminum, magnesium, zinc, iron, potassium, nitroglycerin, white phosphorus (used on Northwest Peninsula only)
Mortar, 81mm[3]	M43	Steel	TNT, mercury fulminate Priming mixture, lead azide, and tetryl booster	TNT, tetryl, lead, mercury

TABLE 4.1 (Continued)
CHEMICAL COMPOSITION OF MUNITIONS AND EXPLOSIVES OF CONCERN AND POTENTIAL MUNITIONS CONSTITUENTS
CULEBRA ISLAND, PUERTO RICO

General Munition Type	Type/Model	Case Composition	Filler	Potential Constituent
Bomb, 30-pound fragmentation[3]	M 5, 30 lb, Fragmentation	Steel	TNT	TNT
Bomb, 100-pound, demolition[3]	Mk III, 100 lb, Demolition	Steel	TNT	TNT
Bomb, Mk 80 series	Mk 81 Mk 82 Mk 83 Mk 84	Steel	Tritonal or H6	TNT, aluminum, iron
Shell, high-explosive incendiary 20mm,	MK 1 Fuze – MK.III Primer- M36A1 Cartridge M21A11		IMR powder; Tetryl, incendiary mixture; Composition A – ammonium nitrate, tetryl	Ammonium, aluminum, magnesium, tetryl
Projectile, 37mm, unspecified		Steel	FNH	Iron, dinitrotoluene
Projectile, 76mm, unspecified		Steel	TNT; Composition B (TNT, RDX)	RDX, TNT, iron
Shell, 5-inch, illumination	Mk 18	Fuze – brass steel	Black powder; magnesium	Potassium, magnesium
Grenade, hand, practice, smoke, unspecified (live)	Mk II M10 AN-M8 Smoke, HC M16 Smoke M30 Practice	Cast iron; sheet metal	TNT, flaked or granular; EC blank single based powder; hexachlorethane-zinc; colored smoke mixture; black powder; Comp B (TNT, RDX)	TNT, zinc, calcium, iron, strontium, lead, magnesium, molybdenum, RDX
Bomb, practice, AN-Mk 23, 3-pound	AN-Mk23	Zinc or cast iron aluminum spotting charge case	Inert Spotting charge: black powder, smokeless powder, zinc oxide, titanium tetrachloride	Iron, lead, zinc, copper, aluminum, potassium, titanium, dinitrotoluene
Mortar, trench, 3-inch (Stokes)	HE MK I and MK II	Steel	Propellant: nitrocellulose, nitroglycerine Charge: TNT or nitrostarch, barium nitrate, sodium nitrate, ammonium nitrate Fuze: black powder or fulminate of mercury	Potassium, antimony, lead, TNT, nitroglycerine, barium, mercury

TABLE 4.1 (Continued)
CHEMICAL COMPOSITION OF MUNITIONS AND EXPLOSIVES OF CONCERN AND POTENTIAL MUNITIONS CONSTITUENTS
CULEBRA ISLAND, PUERTO RICO

General Munition Type	Type/Model	Case Composition	Filler	Potential Constituent
Projectile, 40mm, unspecified	Projectile, configurations HE HEI Mk 2 (dummy) Fuze: Mk 27, PD Primer Percussion	Steel	Inert cast TNT; cast TNT and incendiary; black powder; unknown primer mixture	Iron, TNT, barium, magnesium, aluminum, sodium, potassium
Torpedo, general, Mk 14/15 Navy	Battery	Brass, steel, and/or copper	HBX (Torpex)	RDX, TNT, aluminum, lead.
FUZE			Black powder filler	potassium

1 – For dedicated small arms only sites, lead, antimony, and copper will be the primary constituents used to identify contamination.
2 – Explosives constituents in small arms are confined to the cartridge only and are expended to project the bullets.
3 – Munitions noted were not identified prior to collection of SI soil and sediment samples; therefore, some potential constituents present may not have been analyzed for during MC sampling. MC shown will be considered in Chapter 5.
AP – Armor Piercing
FNH – Flashless nonhygroscopic
HE – High Explosive
HEI – High Explosive Incendiary
PD – Point Detonating
RDX – Hexahydro-1,3,5-trinitro-1,3,5-triazine
TNT – 2,4,6-Trinitrotoluene

4.1.2.2 The goal of the TPP process is to achieve stakeholder, USACE, and applicable state and federal regulatory concurrence with the DQOs for a given site. The TPP Team approved the former Culebra Island DQOs at the TPP meeting in February 2006. Appendix B of this SI Report presents the TPP documentation, including the DQO worksheets. Appendix B is on the CD enclosed with this SI report. The TPP Team agreed that underwater investigations were beyond the scope of an SI and that sufficient data were already available to move forward to RI/FS in these areas; therefore, two of the 13 MRSs (MRS 03 and MRS 12, both underwater sites) were not investigated during the SI field activities.

4.1.2.3 As stated in Chapter 1.2 of this SI Report, data must be sufficient to do the following: 1) determine whether a removal action is necessary; 2) enable HRS scoring by the EPA; 3) characterize the release for effective and rapid initiation of an RI/FS; and 4) complete the MRSPP.

4.1.2.4 DQOs cover four project objectives that SI data must satisfy: 1) evaluate potential presence of MEC; 2) evaluate potential presence of MC; 3) collect data needed to complete MRSPP scoring sheets; and 4) collect information for HRS scoring.

4.1.2.1 Munitions and Explosives of Concern Data Quality Objective

4.1.2.1.1 The MEC DQO was achieved by evaluating the potential presence of MEC at 11 MRSs on the Culebra Island FUDS. The site visit team searched for visual evidence of MEC and MD at MRS 02 – Culebra and Cays, MRS 04 – Flamenco Lagoon Maneuver Area, MRS 05 – Mortar and Combat Range Area, MRS 06 – Artillery Firing Area, MRS 07 – Culebrita Artillery Impact Area, MRS 08 – Cayo Norte Impact Area, MRS 09 – Soldado Point Mortar and Bombing Area, MRS 10 – Defensive Firing Area No. 1, MRS 11 – Defensive Firing Area No. 2, MRS 13 – Cayo Luis Pena Impact Area, and MRS 14 – Airfield and Camp Area. No MEC were visually identified at any of the MRSs during the SI site visit; however, MD was observed at six of the MRSs.

4.1.2.1.2 Records review revealed that MEC has previously been confirmed in MRSs 02, 03, 05, and 12. Table 4.3 list the MEC that have been recovered on Culebra Island FUDS to date.

4.1.2.2 Munitions Constituents Data Quality Objective

The MC DQO was achieved by evaluating the potential presence of MC at each of the 11 land MRSs on the Culebra Island FUDS. A summary of the MC known to occur in the munitions documented or suspected of being used at the Culebra Island site is provided in Table 4.1. Chapters 5 and 6 provide a full discussion of the sampling results.

4.1.2.3 Munitions Response Site Prioritization Protocol Data Quality Objective

The MRSPP DQO was achieved by obtaining sufficient information to complete the MRSPP scoring sheets. Specific input data were collected, and the three modules for the MRSPP were populated as part of the SI.

4.1.2.4 Hazard Ranking System Data Quality Objective

The HRS DQO was achieved by including information in this SI report necessary for the EPA to populate the HRS score sheets. Source documents for the HRS information include the INPR, ASR, and ASR Supplement documents, as well as the MC sampling results reported in Chapter 5 and information from local and state agencies regarding population, groundwater well users, and drinking water well use.

4.2 MRS 02 – NORTHWEST PENINSULA, CERRO BALCON, AND ADJACENT CAYS

4.2.1 Historical MEC Information

4.2.1.1 The ASR documents the presence of both MD and MEC in MRS 02. During the ASR site visit to Cayos Geniqui, the ASR team observed ordnance components, including the tail fins of an MK 80 series bomb. At Cayo del Agua, the team observed MK 76 practice bombs and fragments with suspension lugs from HE bombs. The ASR team also noted that MD and likely MEC are present on Northwest Peninsula. The ASR team also found fragments of mortars and identified a mortar range at Cerro Balcon (USACE, 1995). There is currently a non-time critial removal action underway at Cerro Balcon.

4.2.1.2 A time-critical removal action (TCRA) was conducted by MTA at the Flamenco Beach Camp Ground in MRS 02 in 1995 (MTA, 1995). Several UXO items,

including projectiles, fuzes, and illumination candles, were found and detonated during the EE/CA conducted by ESE in 1997. MEC items were identified on Cayo del Agua, and MD was identified on Cayo Lobo and Cerro Balcon (ESE, 1997). Ellis Environmental conducted clearance on Northwest Peninsula in 2001 and 2002 and recovered 249 MEC items (Ellis, 2004a). Recent removal action on Cerro Balcon and surface clearance on Cayo Lobo have identified MEC in both areas. The MEC items identified during previous investigations are presented in Table 4.3. Due to the number of items recovered during the clearance, these items were referenced in Table 4.3 and included in Appendix L, Document L-1 in excerpts from *UXO Construction Support, Culebra Island National Wildlife Refuge, Culebra Island, Puerto Rico* (Ellis, 2004a).

4.2.2 Site Inspection Activities

4.2.2.1 During the SI site visit, the field team traveled by boat to the cays surrounding Culebra. All of the cays associated with MRS 02 were small and mostly consisted of rock, many with nesting seabirds although a few had soil and vegetation. Using a small dingy from the main boat, the field team accessed Cayo del Agua and Cayos Geniqui (The Twins). Cayos Geniqui had very steep terrain that was not easily accessible from the beach. The field team made observations from the beach and rocky area on the south side of the northern twin but was unable to reach the southern twin due to wave action between the two cays. No MD or munitions-related debris were observed on the beach or lower portions of the cliffs on Cayos Geniqui. The team was not able to reach the grassy area on the top of the Cayos Geniqui due to the steep terrain.

4.2.2.2 The team was able to circle both sides of Cayo Del Agua and observed many MK 76 practice bombs throughout the entire cay. Two aircraft flare trays and debris from an MK 80 series bomb was also observed. The field team observed a large "T" painted in white on the rock on the southeast side of the cay (Appendix E, Observation Entry 309).

4.2.2.3 Visual observations of the remainder of the cays confirmed that access is extremely difficult due to rocky approaches and sea cliffs. The field team was unable to access any of the other MRS 02 cays.

4.2.2.4 Due to public law 93-166, the field team did not conduct QR on Northwest Peninsula. Cerro Balcon was visited during the site visit; however, due to removal actions underway at Cerro Balcon, the field team restricted the SI to the areas surrounding Cerro Balcon, within MRS 05, and did not make observations on the active removal grids within MRS 02.

4.2.2.5 One soil sample (CUL-02-SS-06-28) was planned in MRS 02 at Cayo Lobo. This sample was not collected due to active clearance activities and recent detonations on Cayo Lobo. However, recent soil sampling has been conducted at Cerro Balcon and Cayo Lobo by Ellis. These samples were collected at locations where MEC had been identified and/or collected prior to detonation of the items. Sampling results were acquired from Ellis and are included in the MC analysis in Chapter 5.

4.2.3 Data Quality Objectives

All four DQOs for MRS 02 were met through QR and evaluation of site conditions. The DQOs for this area did not include SI evaluation of Northwest Peninsula. The field

team did not conduct QR on Cayo Lobo, as active surface clearance efforts being conducted by Ellis had already revealed that MEC items are present on the surface and likely also in the subsurface. Records review and QR determined that MD is present on this site. Additionally, previous investigations have found confirmed MEC at several locations within MRS 02.

4.3 MRS 03 – FLAMENCO BAY WATER AREA

4.3.1 Historical MEC Information

The ASR states that munitions were confirmed at Flamenco Beach by a local diver. These munitions were in MRS 03, which includes the bay at Flamenco Beach. This is the only report of MEC and MD in the water of Flamenco Bay.

4.3.2 Inspection Activities

Due to the limited scope of the SI and the underwater location of this MRS, no field activities or observations were made underwater in this area. It was noted that this bay is regularly used for recreation, including swimming, snorkeling, and diving. No sediment samples were collected in this MRS.

4.3.3 Data Quality Objectives

The TPP team agreed that no QR or MC sampling would be conducted in this area; therefore, there were no specific MEC or MC DQOs for MRS 03. The MRSPP and HRS DQOs were met through document review and non-measurement data collection.

4.4 MRS 04 – FLAMENCO LAGOON MANEUVER AREA

4.4.1 Historical MEC Information

There is no record of MEC being found in the vicinity of MRS 04.

4.4.2 Inspection Activities

During the SI, the field team conducted QR around Flamenco Lagoon, Flamenco Beach, and in the woods between the beach and lagoon. The field team did not observe any MEC or MD in this area but did identify a possible ammunitions dump or military bunker on the east side of Flamenco Lagoon (Appendix E, Observation Entry 158). Soil sample CUL-04-SS-06-11 and sediment samples CUL-04-SE-06-04 and CUL-04-SE-06-03 were collected in the lagoon and surrounding areas as specified in the SS-WP. Samples were analyzed for explosives and total metals. Analytical results are presented in Chapter 5.

4.4.3 Data Quality Objectives

All four DQOs for MRS 04 were met through QR and evaluation of site conditions, including collection of environmental samples for MC analysis.

4.5 MRS 05 – MORTAR AND COMBAT RANGE AREA

4.5.1 Historical MEC Information

The mortar and combat range area was identified during the ASR when the ASR team found MD from a 3-inch Stokes mortar.

4.5.2 Inspection Activities

4.5.2.1 QR was conducted on many parts of MRS 05. The QR area included the land north and south of Cerro Balcon, areas around proposed samples SS-14 and SS-17, at the water treatment plant near the proposed sample SS-15, the south face of Mount Resaca, Playa Larga, Resaca Beach, Brava Beach, and the trails to Resaca and Brava Beaches. During the QR south of Cerro Balcon the field team identified four small arms .30-caliber cartridges and one munitions base to a 4.2-inch mortar. A .30-caliber bullet was found during QR north of Cerro Balcon. These were the only MD seen in MRS 05. Concrete pillars and small concrete pads were observed in the woods near Brava Beach (Appendix E, Observation Entries 463 and 470-472).

4.5.2.2 Soil samples CUL-05-SS-06-12, CUL-05-SS-06-14, CUL-05-SS-06-15, CUL-05-SS-06-17, CUL-05-SS-06-18, and CUL-05-SS-06-19 and sediment sample CUL-05-SE-06-01 were collected in MRS 05 from the locations specified in the SS-WP. Samples were analyzed for explosives and total metals. The results of the laboratory analyses are presented in Chapter 5.

4.5.3 Data Quality Objectives

All four DQOs for MRS 05 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples, as well as records review. MD is present on this site, and MEC have been found in the vicinity of the site. Although much of this site has been residentially developed, vegetation provides a natural barrier to access of many areas except for roadways and trails.

4.6 MRS 06 – ARTILLERY FIRING AREA

4.6.1 Historical MEC Information

MRS 06, on the southeast portion of Culebra, has been investigated through a historical records search, but no previous field observations have been made at the site. There is no record of MEC being found in this MRS; however, military use of this portion of the island did occur. Operations were focused around Mosquito Bay in 1936 with records indicating the use of small arms, Stokes mortars, 75mm pack howitzers, 3-inch mortars, and 37mm HE rounds. Additionally the firing point for the 1939 heavy artillery training was in this MRS. One MD item was also found at this MRS in 1969 when a 20mm training round with no charge was discovered on the beach. This was reported by the Navy as an overshoot or skip off the water from the nearby strafing range. As seen in Figure 2.5, an artillery range from the 1937 Fleet Landing Exercise No. 4 is present at the lagoon at Mosquito Bay.

4.6.2 Inspection Activities

The field team conducted QR along right-of-ways on jeep trails in this area and near sample SS-21 at Point Vaca, but did not identify any MEC or MD. Soil samples CUL-06-SS-06-20 and CUL-06-SS-06-21 were collected from the locations specified in the SS-WP and were analyzed for explosives and total metals. The results of the laboratory analyses are presented in Chapter 5.

4.6.3 Data Quality Objectives

All four DQOs for MRS 06 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples.

4.7 MRS 07 – CULEBRITA ARTILLERY IMPACT AREA

4.7.1 Historical MEC Information

The ASR and Supplemental ASR document historical use of Culebrita as an artillery impact area, torpedo range, and strafing target and Cayo Botella as an aerial target. On Cayo Botella, the ASR team observed several MK 76 practice bombs and HE bomb fragments with suspension lugs as well as practice bombs and MK 80 series bombs in the shallow water off the beach. During the 1997 EE/CA, five test grids were investigated on the northwest peninsula of Culebrita and two grids on Cayo Botella. The Culebrita test grids found 39 UXO items and MD on four of the grids, with the highest concentration on the western side of the ridge. Twenty UXO items were identified on Cayo Botella, and both test grids had MD. MEC items found during previous investigations at MRS 07 are listed in Table 4.3.

4.7.2 Inspection Activities

As part of the SI, the field team spent two days on Culebrita. The team conducted QR on the north and east beaches, along the center of the southern and northeastern lobes, and along the crest of the northwestern lobe of Culebrita. The field team observed MD from a mechanical time fuze on the west-facing slope of the northeastern lobe of Culebrita. Building debris from the observation post and the concrete helipad still remain on the south side of the lighthouse on Culebrita (Appendix E, Observation Entry 276). The field team collected soil samples CUL-07-SS-06-25 and CUL-07-SS-06-26 and sediment sample CUL-07-SE-06-02 from the locations specified in the SS-WP. The samples were analyzed for explosives and total metals. Soil sample CUL-07-SS-06-22 was collected as an ambient sample for comparison purposes. The results of the laboratory analyses are presented in Chapter 5.

4.7.3 Data Quality Objectives

All four DQOs for MRS 07 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples, as well as records review. MEC has been identified on this MRS during previous investigations, and MD was identified by the SI field team. The field team determined that natural barriers to access exist on much of this site. Trails are present on the island; however, vegetation is thick and discourages movement off the trails.

4.8 MRS 08 – CAYO NORTE IMPACT AREA

4.8.1 Historical MEC Information

The records review for the 1995 ARS found no evidence that Cayo Norte was ever fired on; however, it was within the impact area of heavy artillery guns and within the safety fan of several aerial targets on the surrounding cays. Records show that Cayo Norte was leased with the intention of erecting an aerial target in 1924. The 1939 Flex No. 5 Artillery Firing Report, as referenced in the Supplemental ASR, notes that fire was never placed on the cay due to difficulties in clearing people and cattle off Northeast Cay.

The Supplemental ASR states that no ordnance has been identified on Cayo Norte except for items spotted in the water near the eastern half of this cay.

4.8.2 Inspection Activities

The field team spent one day on Cayo Norte to conduct QR and collect soil and sediment samples. QR was conducted along the top of the south-facing slope and along the beach on the south side of the island. The vegetation was extremely dense on the top of the cay and made movement extremely slow. The field team did not observe any MEC or MD on Cayo Norte. Sediment sample CUL-08-SE-06-05 and soil samples CUL-08-SS-06-23 and CUL-08-SS-06-24 were collected at Cayo Norte from the locations specified in the SS-WP. Samples were analyzed for MC and total metals and the results of the analysis are presented in Chapter 5. The site visit team identified concrete steps on the beach along with an unknown era helicopter pad just off the beach on the south side of Cayo Norte (Appendix E, Observation Entry 62).

4.8.3 Data Quality Objectives

All four DQOs for MRS 08 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples, as well as records review.

4.9 MRS 09 – SOLDADO POINT MORTAR AND BOMBING AREAS

4.9.1 Historical MEC Information

This MRS is managed by the DNER. No previous investigations have been conducted on the Soldado Point Mortar and Bombing Area; however, historical documents strongly suggest military use of this portion of the island. There is no record of any MEC or MD being discovered on this MRS.

4.9.2 Inspection Activities

The field team conducted QR along the side of the four-wheel-drive trail to the bay north of Soldado Point, along the bay, and along Sueno Cove. A mortar fin was identified on the beach north of Soldado Point. The field team did not observe any MEC in this MRS. In addition to QR, soil samples CUL-09-SS-06-09 and CUL-09-SS-06-10 were collected in MRS 09 for analysis of explosives and total metals. The results of the laboratory analyses are presented in Chapter 5.

4.9.3 Data Quality Objectives

All four DQOs for MRS 09 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples, as well as records review. Natural barriers to access exist on much of this site; while the beaches and coves are more easily accessible, steep topography and extremely dense vegetation restrict access to the remainder of this MRS.

4.10 MRS 10 – DEFENSIVE FIRING AREA NO. 1

4.10.1 Historical MEC Information

MRS 10, on the southwest portion of Culebra, has been investigated through historical records search, but no previous field observations have been made at the site. There is no record of MEC being found in this MRS; however, military use of this portion of the

island did occur. Records indicate that this area was used for ground maneuver and amphibious landing training by the Marines as well as direct fire by artillery (Figure 2.5).

4.10.2 Inspection Activities

The field team conducted QR near soil sample locations and along the beach at Snug Bay. ROE was not obtained for any land tracts in MRS 10; therefore, QR was conducted along public roadways and on DNER land along the beach. During QR, the field team identified a very old 8-foot-diameter, hand-dug, stone-lined well. The well did not appear to be used for any purpose (Appendix E, Observation Entry 289). The field team did not observe any occurrences of MEC or MD; however, due to lack of ROE, only a small portion of MRS 10 was visually inspected during the site visit. Two soil samples, CUL-10-SS-06-08 and CUL-10-SS-06-07, were collected in MRS 10 for analysis of explosives and total metals. The results of the laboratory analyses are presented in Chapter 5.

4.10.3 Data Quality Objectives

All four DQOs for MRS 10 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples, as well as records review.

4.11 MRS 11 – DEFENSIVE FIRING AREA NO. 2

4.11.1 Historical MEC Information

Historical records indicate that this area was used by the Navy and Marines for ground training maneuvers, amphibious landings, direct fire, and boat-to-beach firing. No previous investigations have been conducted on MRS 11 and no MEC or MD has been reported.

4.11.2 Inspection Activities

The field team conducted QR along the beach and a portion of the road at Firewood Bay, along the beach north of Firewood Bay, and on the hillside near soil sample SS-3. The QR identified a 20mm shell casing on the top of the hill near SS-3, and concrete structures were also observed on the beach near the location of the 1924 firing point in Firewood Bay and at the end of Scorpion Point (Appendix E, Observation Entries 2, 4, and 387). In addition to QR, soil samples CUL-11-SS-06-03, CUL-11-SS-06-04, CUL-11-SS-06-05, and CUL-11-SS-06-06 were collected in MRS 11 for analysis of explosives and total metals. One soil sample, CUL-11-SS-06-27, was biased as an ambient sample for comparison purposes. The results of the laboratory analyses are presented in Chapter 5.

4.11.3 Data Quality Objectives

All four DQOs for MRS 11 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples, as well as records review. MD was identified on the site; however, there are no reports of MEC.

4.12 MRS 12 – LUIS PENA CHANNEL WATER AREAS

4.12.1 Historical MEC Information

During interviews conducted for the ASR, a local scuba dive instructor stated that he had spotted many underwater ordnance items around Culebra, with the highest concentration in the water west of Flamenco Peninsula. It is not known whether these items are MEC or MD, but given the extensive use of Northwest Peninsula as a target, it is likely that UXO remains in this area.

4.12.2 Inspection Activities

Due to the limited scope of the SI and the underwater location of this MRS, no field activities were performed in this area, and no samples were collected.

4.12.3 Data Quality Objectives

The TPP team agreed that no QR or MC sampling would be conducted in this area; therefore, there were no specific MEC and MC DQOs for MRS 12. The MRSPP and HRS DQOs were met through document review and non-measurement data collection.

4.13 MRS 13 – CAYO LUIS PENA IMPACT AREA

4.13.1 Historical MEC Information

Historical documents indicate that Cayo Luis Pena was used as a target during early military operations on Culebra, and later used for an observation post and run-in line during the late 1960s. Records indicate that the north end of the cay may have been used as a target area; however, no MEC or MD have been previously reported on this MRS.

4.13.2 Inspection Activities

The field team spent one day on Cayo de Luis Pena conducting QR on the northwest and south sides of the island. Several pieces of MD were identified, including seven 5-inch expended projectiles, two 3-inch expended projectiles, a flare cartridge, and a .30-caliber blank cartridge. Debris from the former observation post and helipad are still present on the top of the center hill (Appendix E, Observation Entries 214 and 217-219). Additionally, a ceramic wire insulator was observed on the ridgeline down the southern slope of the cay (Appendix E, Observation Entry 236). Two soil samples, CUL-13-SS-06-01 and CUL-13-SS-06-02, were collected on Cayo Luis Pena and analyzed for explosives and total metals. The results of the laboratory analyses are presented in Chapter 5.

4.13.3 Data Quality Objectives

All four DQOs for MRS 11 were met through QR and evaluation of site conditions, including collection and analysis of environmental samples, as well as records review. Several pieces of MD were identified on the site; however, there have been no reports of MEC on Cayo Luis Pena.

4.14 MRS 14 – AIRPORT AND CAMP AREA

4.14.1 Historical MEC Information

MRS 14 is almost entirely developed. Historical documents indicate that a small arms range may have been present near the airport. There have been no reports of MEC except

in cases where MEC were moved from other contaminated areas. The ASR reports that EOD disposed of items in Lower Town that had been brought to the area by a DNER employee after visitors found them on the beach. There are no other reports of MEC or MD in this MRS.

4.14.2 Inspection Activities

QR was conducted near the airport in an attempt to identify the small arms range mentioned in historical documents. During QR the field team identified an area with an unusual magnetometer response. The magnetometer made a sound like popcorn popping as it moved over the mounded dirt indicating many very small metallic spots (Appendix E, Observation Entry 353). The soil was examined on the surface for evidence of small arms but no metallic items could be found. Soil sample CUL-14-SS-06-13 was collected from this area of unusual magnetometer response. The site visit team also conducted QR around Lower Town. Several half-buried concrete structures were seen that may have been remnants of old buildings or magazines (Appendix E, Observation Entry 444). No MEC or MD were identified in this area. Soil sample CUL-14-SS-06-16 was collected near Lower Town and was biased as an ambient sample for comparison purposes. Both soil samples were analyzed for explosives and total metals.

4.14.3 Data Quality Objectives

All four DQOs for MRS 14 were met through QR and evaluation of site conditions (including collection and analysis of environmental samples) as well as records review.

TABLE 4.2
SUMMARY OF QUALITATIVE RECONNAISSANCE OBSERVATIONS
CULEBRA ISLAND, PUERTO RICO

MRS	MEC	Munitions Debris
MRS 02	None	MK 80 series bomb body (1) MK 76 practice bomb body (25+) Aircraft flare tray (2)
MRS 04	None	None
MRS 05	None	4.2-inch mortar round/base (1) .30-caliber cartridge (4) .30-caliber bullet (1)
MRS 06	None	None
MRS 07	None	Mechanical time fuze (1)
MRS 08	None	None
MRS 09	None	Fin set (likely mortar) (1)
MRS 10	None	None
MRS 11	None	20mm shell casing
MRS 13	None	5-inch or 6-inch projectile body (expended) (2) 3-inch projectile body (expended) (2) 5-inch projectile – base ejection with mechanical time fuze (empty) (5) Flare or signal cartridge (1) .30-caliber blank cartridge (1)
MRS 14	None	None

TABLE 4.3
MEC ITEMS PREVIOUSLY IDENTIFIED
CULEBRA ISLAND, PUERTO RICO

Item	Quantity	Notes	MRS	Reference	Location	Date
Bomb, 500 pound	1		02	ASR F-10 & pg 20	West of Cayo Ballena	1983
Bomb, 500 pound	2	60 feet water depth	02	ASR F-10 & pg 20	West of Cayo Geniqui	1983
Torpedo, MK 27	1	60 feet water depth	02	ASR F-10 & pg 20	East of Cayo Geniqui	1983
Candle, illumination, from 5-inch 38 naval projectile	1	Filled with 50% of illumination composition	02	MTA TCRA	Northwet Peninsula Grid No. 1	1995
Bomb, practice, 25 pound, MK 76/BDU-33	1	Appeared spotting had functioned but too corroded to certify	02	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 40mm, M81A1 TP-T	1	Tracer present	02	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 40mm, M81A1 TP-T	1	Tracer partly burnt	02	MTA TCRA	Northwest Peninsula Grid No. 2	1995
BLP, 3 inch, with tracer	1	Condition not determined due to corrosion	02	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 3 inch, 50 HE	1	Armed, PD, fuze	02	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Projectile, 40mm, M81A1 TP-T	1	Tracer Present	02	MTA TCRA	Northwest Peninsula Grid No. 2	1995
Fuze, BD, from 5-inch 38 projectile	1	Tracer Residue Present	02	MTA TCRA	Northwest Peninsula Grid No. 3	1995
Fuze, BD, from 5-inch 38 projectile	1	Condition not determined due to corrosion	02	MTA TCRA	Northwest Peninsula Grid No. 4	1995
Projectile, 40mm, Bofors	1		02	MTA TCRA	Northwest Peninsula Grid No. 4	1995
Candle, illumination, from 5-inch 38 naval projectile	1	Filled with 75% of illumination composition	02	MTA TCRA	Northwest Peninsula Grid No. 4	1995
Naval gun fire, 3-inch	1	Surface, fired, unfuzed	02	EE/CA	Northwest Peninsula NP-1	1997
Rocket, 5-inch, HVAR	1	Sheared on surface	02	EE/CA	Northwest Peninsula NP-11	1997
Naval gun fire, 3-inch	2	4 and 5-inch depth	02	EE/CA	Northwest Peninsula NP-12	1997

TABLE 4.3 (Continued)
MEC ITEMS PREVIOUSLY IDENTIFIED
CULEBRA ISLAND, PUERTO RICO

Item	Quantity	Notes	MRS	Reference	Location	Date
Bomb, practice, MK 23	1	Unknown depth	02	EE/CA	Northwest Peninsula NP-12	1997
Projectile, 20mm HEI	1	3-inch depth	02	EE/CA	Northwest Peninsula NP-12	1997
Fuze, sheared base		Unknown depth, number, or type	02	EE/CA	Northwest Peninsula NP-12	1997
Candle, illumination, 5 inch	3	6-inch depth	02	EE/CA	Northwest Peninsula NP-15	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	2	Unknown depth, sheared fuzes	02	EE/CA	Northwest Peninsula NP-15	1997
Naval gun fire, 6 inch	2	5-inch depth, sheared fuzes	02	EE/CA	Northwest Peninsula NP-16	1997
Mortar, 81mm	1	7-inch depth	02	EE/CA	Northwest Peninsula NP-16	1997
Naval gun fire, 5 inch	1	7-inch depth, sheared fuze	02	EE/CA	Northwest Peninsula NP-16	1997
Naval gun fire, 3 inch	1	6-inch depth, sheared fuze	02	EE/CA	Northwest Peninsula NP-16	1997
Naval gun fire, 3 inch	1	4-inch depth, sheared fuzes	02	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	1	5-inch depth, sheared fuze	02	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	2	6-inch depth, sheared fuzes	02	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 6 inch	1	6-inch depth, sheared fuze	02	EE/CA	Northwest Peninsula NP-17	1997
Grenade, w/o fuze	1	No fuze	02	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	1	Partial	02	EE/CA	Northwest Peninsula NP-17	1997
Naval gun fire, 5 inch	2	5-inch depth, no fuzes	02	EE/CA	Northwest Peninsula NP-18	1997
Candle, illumination, 5 inch	1	Surface	02	EE/CA	Northwest Peninsula NP-19	1997
Naval gun fire, 5 inch	1	Surface	02	EE/CA	Northwest Peninsula NP-20	1997
Naval gun fire, 6 inch	2	Surface, sheared fuzes	02	EE/CA	Northwest Peninsula NP-21	1997
Mortar, 81mm	1	Surface, no fuze	02	EE/CA	Northwest Peninsula NP-21	1997
Fuze, projectile base	1	Surface	02	EE/CA	Northwest Peninsula NP-21	1997
Candle, illumination, 5 inch	2	Surface, no fuze	02	EE/CA	Northwest Peninsula NP-22	1997
Naval gun fire, 3 inch	2	6-inch depth, fired fuzes	02	EE/CA	Northwest Peninsula NP-3	1997
Candle, illumination, 5 inch	2	Surface	02	EE/CA	Northwest Peninsula NP-4	1997
Candle, illumination, 5 inch	1	Unknown depth	02	EE/CA	Northwest Peninsula NP-4	1997
Naval gun fire, 5 inch	1	Fired mod 2 fuze, 8-inch depth	02	EE/CA	Flamenco Beach FB-6	1997
Projectile, 37mm HE	1	No fuze, 5 inch depth	02	EE/CA	Flamenco Beach FB-6	1997

TABLE 4.3 (Continued)
MEC ITEMS PREVIOUSLY IDENTIFIED
CULEBRA ISLAND, PUERTO RICO

Item	Quantity	Notes	MRS	Reference	Location	Date
Warhead, rocket, 5-inch	1	Sand filled with fired fuze, 4-inch depth	02	EE/CA	Flamenco Beach FB-6	1997
Candle, illumination, 5-inch	2	Flares, no fuze, 4-inch depth	02	EE/CA	Flamenco Beach FB-6	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	11	Surface	02	EE/CA	Cayo del Agua AQ-1	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	5	~ 3-inch depth	02	EE/CA	Cayo del Agua AQ-1	1997
Projectile, 76mm	1	Surface	02	EE/CA	Cayo del Agua AQ-1	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	2	Surface	07	EE/CA	Cayo Botella BO-1	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	4	~ 3-inch depth	07	EE/CA	Cayo Botella BO-1	1997
Naval gun fire, 6-inch	1	2-inch depth	07	EE/CA	Cayo Botella BO-1	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	6	Surface	07	EE/CA	Cayo Botella BO-2	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	3	3-inch depth	07	EE/CA	Cayo Botella BO-2	1997
Bomb, practice, MK 76 w/MK 4 spotting charge	3	2-inch depth	07	EE/CA	Cayo Botella BO-2	1997
Spotting charge, MK 4	1	Surface	07	EE/CA	Cayo Botella BO-2	1997
Projectile, 20mm HEI	5	~ 4-inch depth	07	EE/CA	Culebrita IC-4	1997
Projectile, 20mm HEI	2	3-inch depth	07	EE/CA	Culebrita IC-5	1997
Projectile, 20mm HEI	3	2-inch depth	07	EE/CA	Culebrita IC-5	1997
Projectile, 20mm HEI	23	Surface	07	EE/CA	Culebrita IC-6	1997
Projectile, 20mm HEI	2	3-inch depth	07	EE/CA	Culebrita IC-6	1997
Projectile, 20mm HEI	4	2-inch depth	07	EE/CA	Culebrita IC-6	1997
Various UXO (Appendix L)	249	Various UXO identified on Northwest Peninsula	02	UXO Construction Support, Ellis	Northwest Peninsula	2001-2002

TABLE 4.3 (Continued)
MEC ITEMS PREVIOUSLY IDENTIFIED
CULEBRA ISLAND, PUERTO RICO

Item	Quantity	Notes	MRS	Reference	Location	Date
Candle, illumination, 5-inch	1	10-inch depth, unfuzed, magnesium filled	02	Ellis Grid Log	2029724.479N 2529724.682E	2002
Bomb, 100 pound	1	Surface, fuzed, HE	02	Ellis Grid Log	2029921.471N 25279.397E	2002
Bomb, 1,000 pound	1	12-inch depth, fuzed, HE	02	Ellis Grid Log	2029922.685N 252796.915E	2002
Candle, illumination, 5-inch	1	10-inch depth, fuzed, magnesium filled	02	Ellis Grid Log	2029922.685N 252796.915E	2002
Mortar, 81mm	1	18-inch depth, fuzed, w/p filled	02	Ellis Grid Log	2029924.127N 252920.989E	2002
Fuze, M151	1	Unknown filler	02	Ellis Demo Log	Cayo Lobo	2006
Bomb, practice, 25 pound, BDU33	28	Spotting charge, striker fuze	02	Ellis Demo Log	Cayo Lobo	2006
Bomb, practice, 5 pound, MK106	4	Spotting charge, striker fuze	02	Ellis Demo Log	Cayo Lobo	2006
5-inch/ 54 MK 41	1	Explosive D filler M500 series nose fuze PD	02	Ellis Demo Log	Cayo Lobo	2006
3-inch common MK3, MOD 7	1	Empty with no fuze	02	Ellis Demo Log	Cerro Balcon	2006
Fuze, model 1898, 15 second PTTF	2	Black powder filler	02	Ellis Demo Log	Cerro Balcon	2006
3-inch, common MK3, MOD 7	2	TNT filler with MK2 BD fuze	02	Ellis Demo Log	Cerro Balcon	2006
Mortar, 81mm, M43	2	Comb B filler, no fuze	02	Ellis Demo Log	Cerro Balcon	2006

Figure 4.1A

Qualitative Reconnaissance Tracks and Observations Northeastern Section Culebra Island

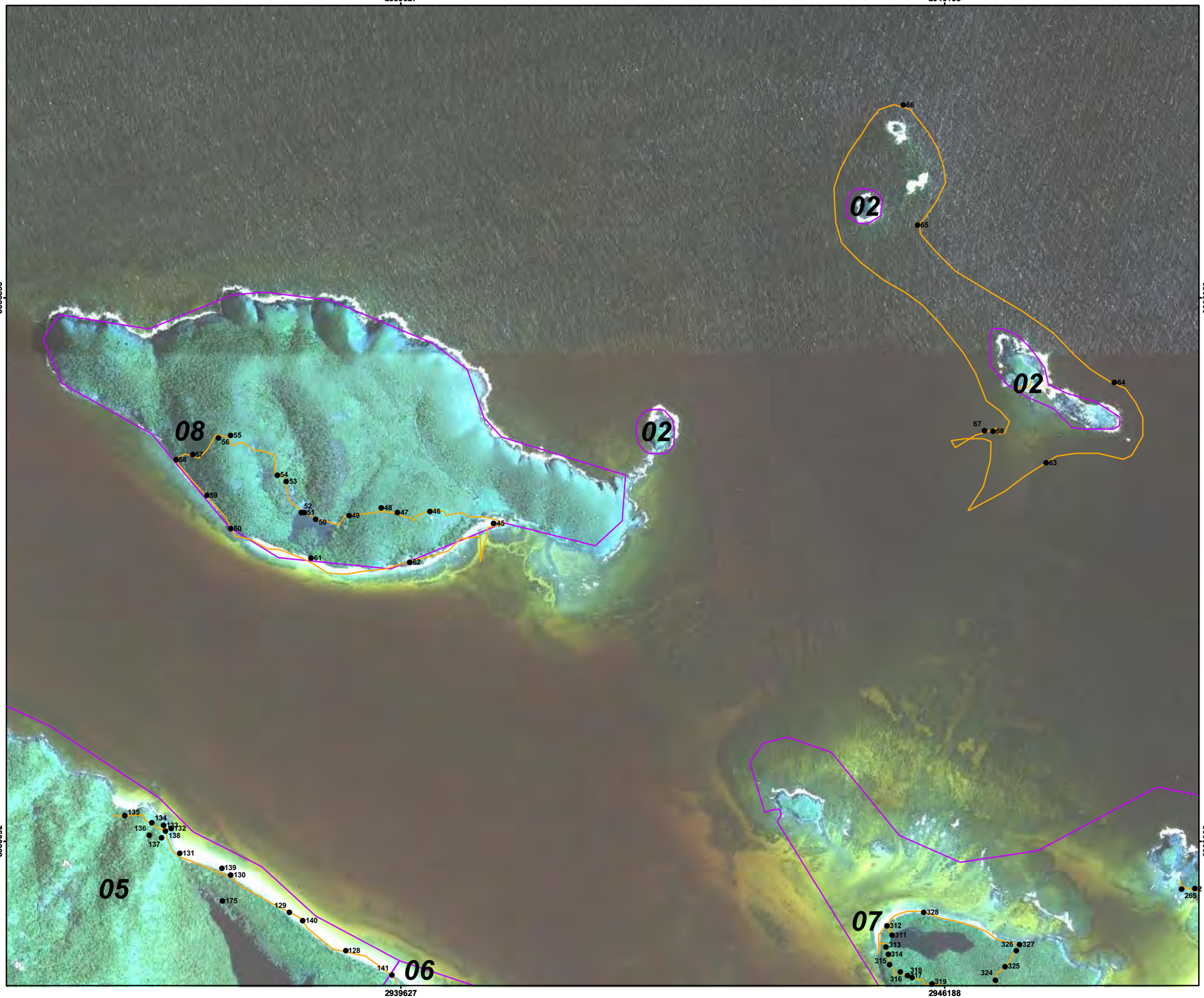
Puerto Rico

2939627

2946188

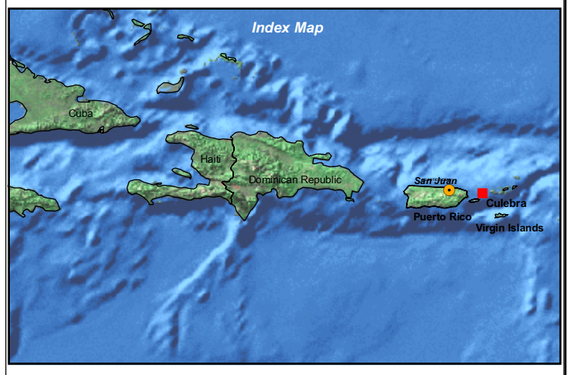
6666653

6660092



Legend

- 112 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (EXCLUDING SMALL ARMS)
- 107 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (SMALL ARMS)
- 108 OTHER FIELD OBSERVATION LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK



N

Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

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PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Qualitative Reconnaissance Tracks and Observations Northeastern Section**		
DRAWN BY: BT			
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000	
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 4-21	
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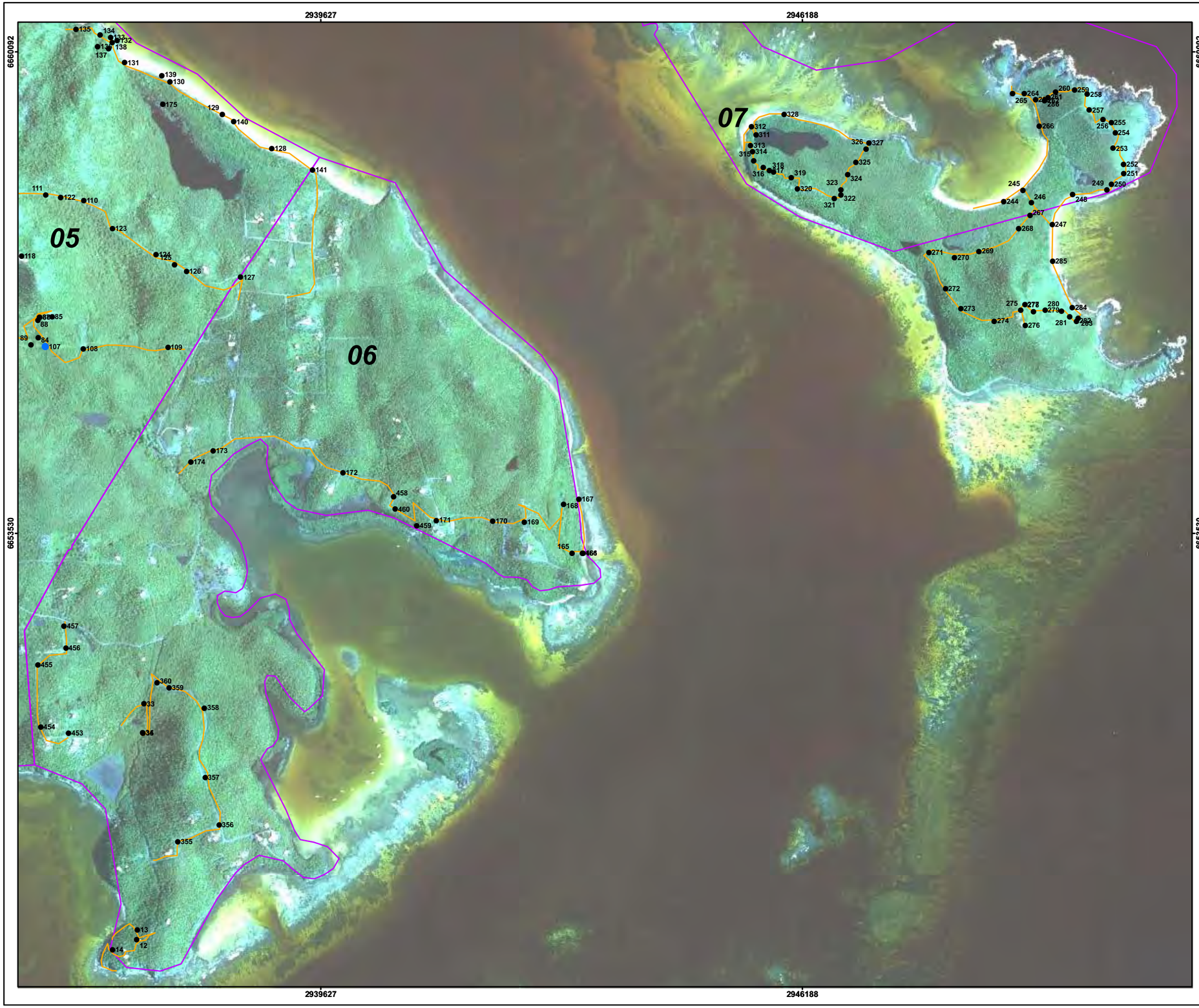
Figure 4.1B

Qualitative Reconnaissance Tracks and Observations Southeastern Section Culebra Island

Puerto Rico



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- 107 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (SMALL ARMS)
- 108 OTHER FIELD OBSERVATION LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK

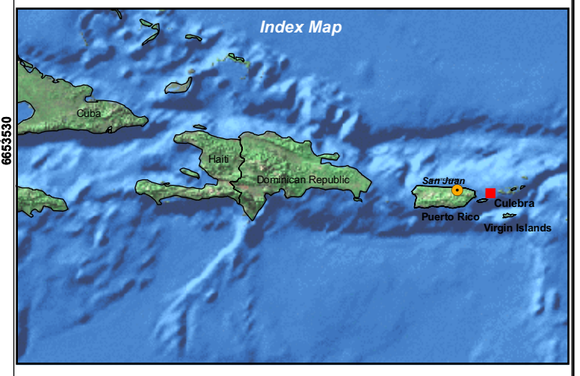

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Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

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SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig4_1b.mxd	

Figure 4.1C

Qualitative Reconnaissance Tracks and Observations Southcentral Section Culebra Island

Puerto Rico

Legend

- 112 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (EXCLUDING SMALL ARMS)
- 107 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (SMALL ARMS)
- 108 OTHER FIELD OBSERVATION LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK

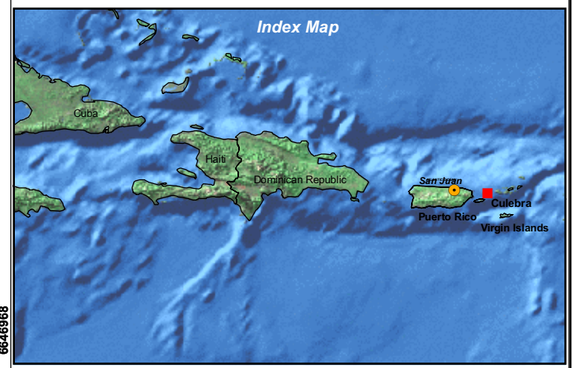

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Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

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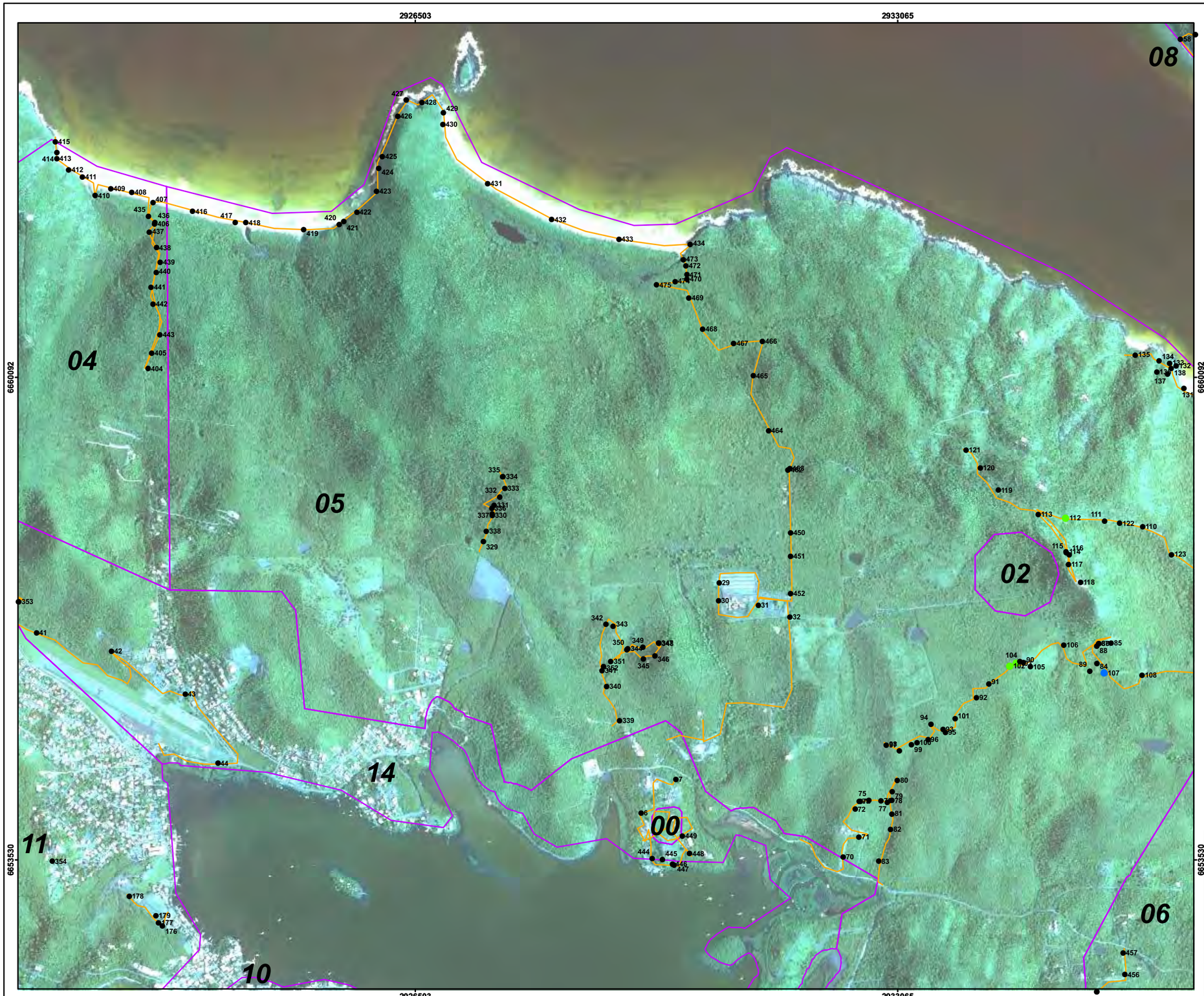
Figure 4.1D

Qualitative Reconnaissance Tracks and Observations Northcentral Section Culebra Island

Puerto Rico



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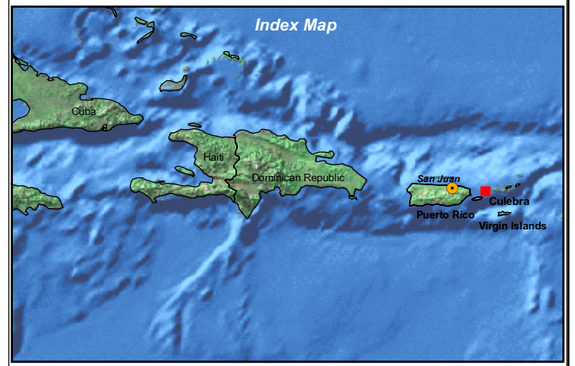
- MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (SMALL ARMS)
- OTHER FIELD OBSERVATION LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK



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Projection: UTM Zone 19N NAD27, Map Units in Feet

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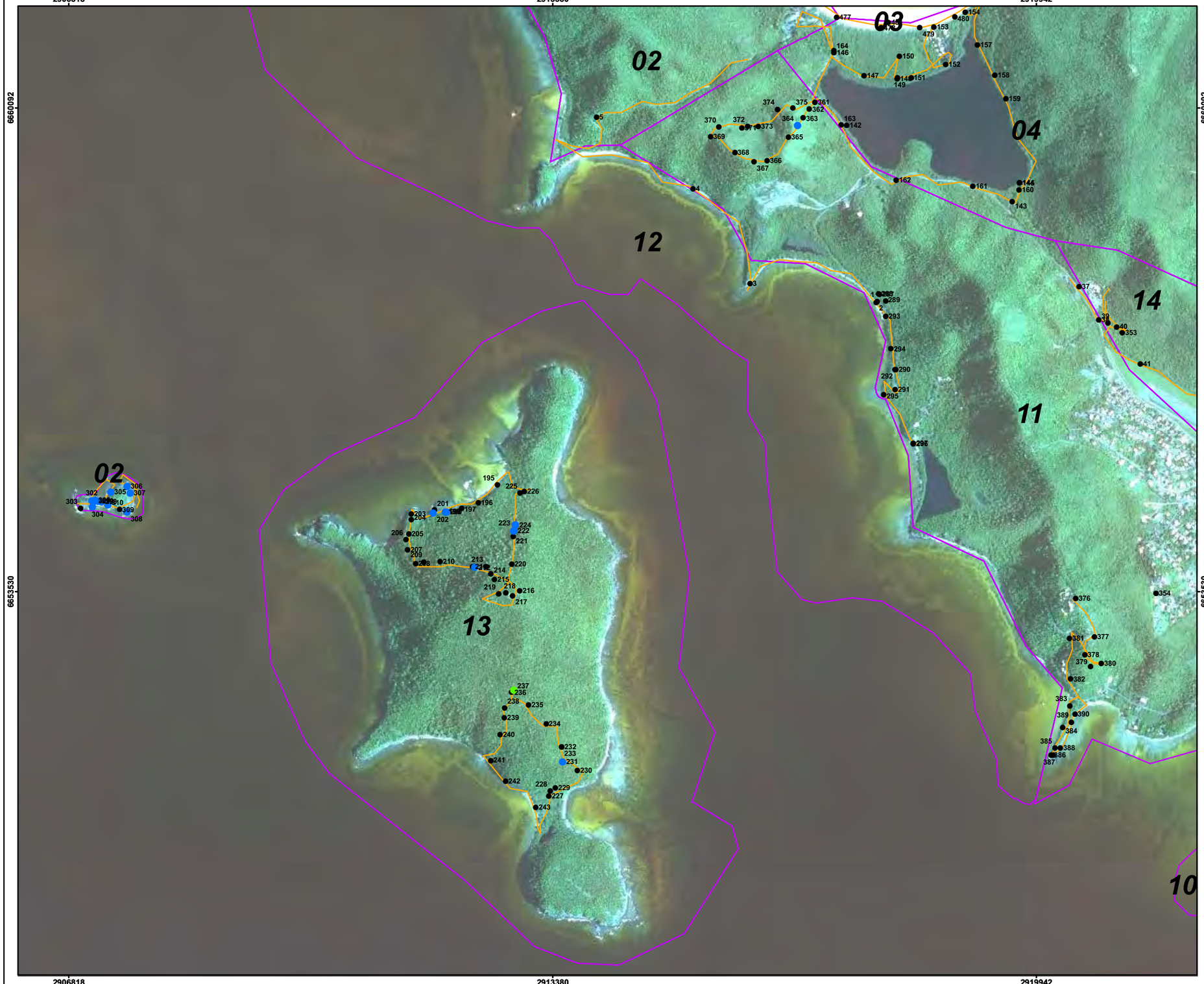
SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig4_1d.mxd	

Figure 4.1E

Qualitative Reconnaissance Tracks and Observations Southwestern Section Culebra Island

Puerto Rico



Legend

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- 107 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (SMALL ARMS)
- 108 OTHER FIELD OBSERVATION LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK

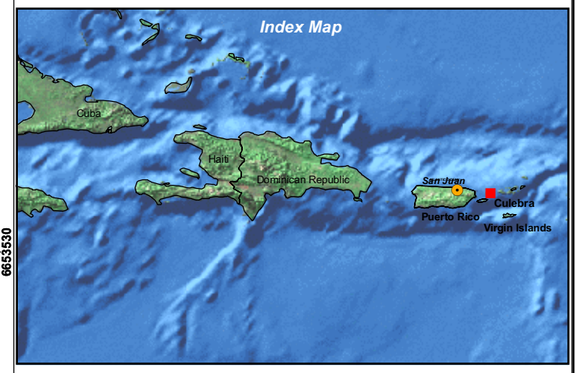

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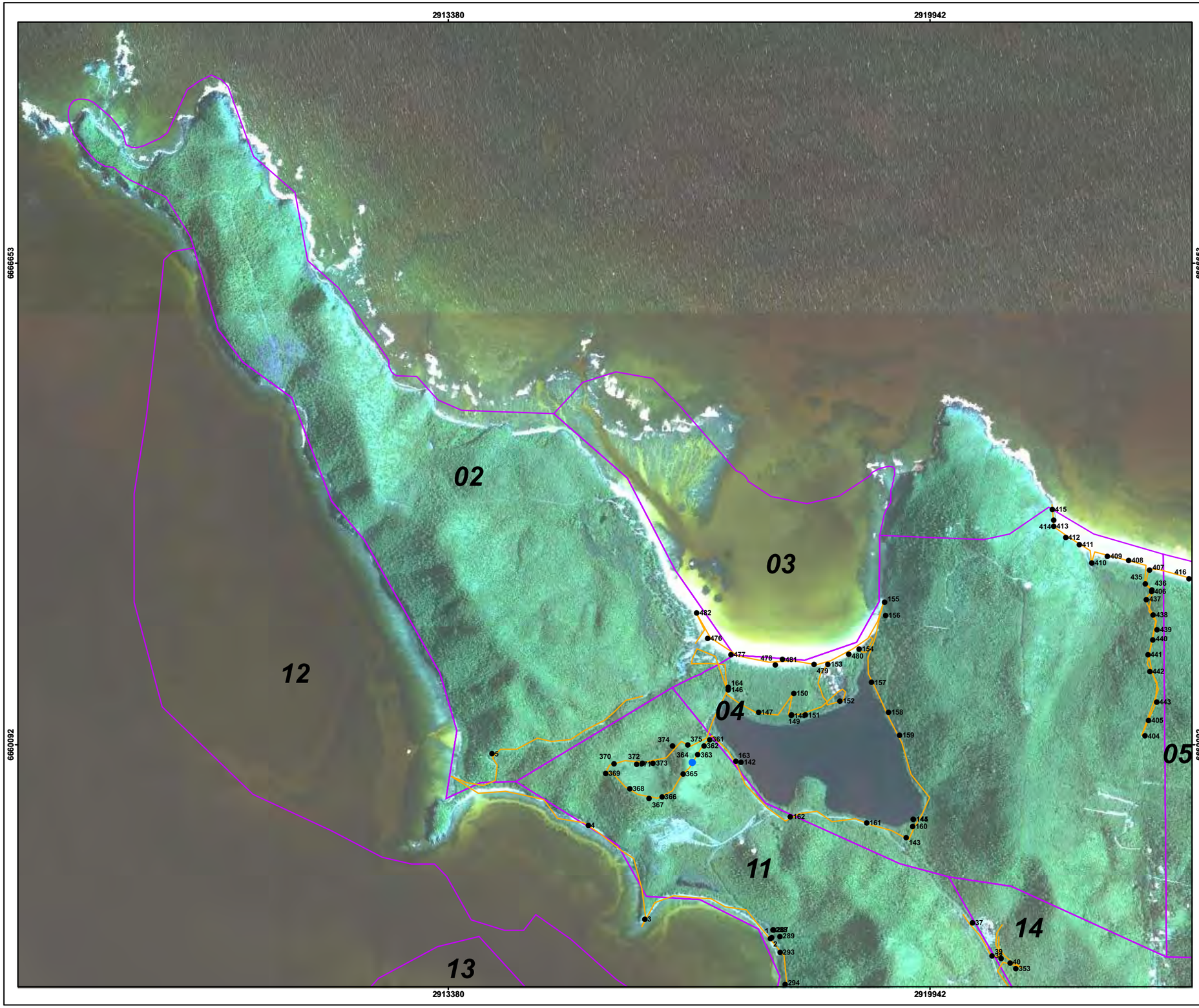
Figure 4.1F

Qualitative Reconnaissance Tracks and Observations Northwestern Section Culebra Island

Puerto Rico



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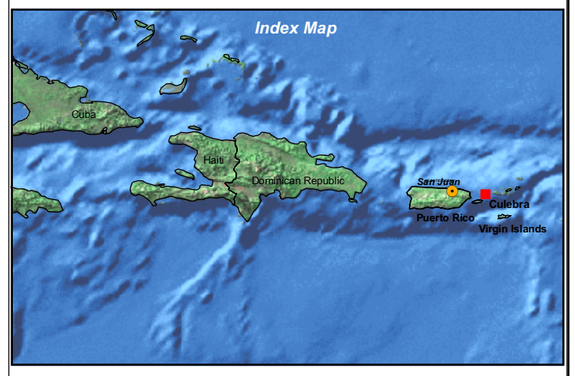
- 112 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (EXCLUDING SMALL ARMS)
- 107 MUNITIONS DEBRIS FIELD OBSERVATION LOCATION (SMALL ARMS)
- 108 OTHER FIELD OBSERVATION LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK



N

Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

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PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

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CHAPTER 5

MIGRATION AND EXPOSURE PATHWAYS AND TARGETS

5.1 Chapter 5 evaluates the potential for adverse impact on human health and the environment based on site-specific conditions, providing the information used in Chapter 6 to evaluate risks posed to potential receptors under current and future land use scenarios. This chapter evaluates exposure pathways for groundwater, surface water, soil, and air. The conceptual site exposure models (CSEM) for the Culebra Island FUDS (Appendix J) summarizes which potential receptor exposure pathways are (or may be) complete and which are (and are likely to remain) incomplete. For an exposure pathway to be complete, all of the following must be true. An example regarding a hypothetical groundwater pathway accompanies the pathway components.

- *There is a source of contamination*. For example, a site has known MEC from which MC have leached and contaminated pertinent media.
- *The contaminant is present in a medium in which it can be transported*. In the example, the MC in soil is mobile and can contaminate groundwater.
- *There is a point of exposure where a contaminant can interact with a receptor*. A drinking water well drawing from the contaminated aquifer is located at the site.
- *A route exists for the medium and receptor to interact at the point of exposure*. A resident uses groundwater for drinking water.
- *A receptor is present*. The resident lives onsite.

5.2 In the hypothetical resident example, all five factors are true; therefore, the groundwater exposure pathway is complete. If any single factor were absent (for example, the MC was immobile in soil, or the resident gets drinking water from another source), the pathway would not be complete. An assessment of the potential significance of completed pathways (that is, whether there is an unacceptable risk) is reserved for Chapter 6.

5.1 GENERAL INFORMATION

General information regarding the geology, hydrogeology, and hydrology of Culebra Island is presented below, followed by a discussion of MRS-specific characteristics and sampling results for the MRSs investigated as part of the SI.

5.1.1 Regional Geological and Hydrogeological Setting

The Island of Culebra and the surrounding cays are made up of volcanic and intrusive rocks consisting of predominantly andesite lava, lava breccia, and tuffs (Figure 2.1). Groundwater on Culebra is scarce and only known to occur in alluvial deposits and in

fractures in volcanic and plutonic rocks. Average annual rainfall is 30 to 50 inches, and all aquifer recharge comes from direct rainfall. The public water supply on Culebra comes from a desalination plant located near Lower Town. In some households, municipal water is supplemented with rooftop cisterns or groundwater for non-drinking water uses.

5.1.2 Regional Groundwater Use

5.1.2.1 The TPP Team agreed that because there are no known cases where groundwater is used for consumption on Culebra Island, Parsons would forgo groundwater sampling during the SI phase, and groundwater would be further evaluated during a subsequent RI/FS if a complete pathway was identified during the SI. The SI found no identifiable receptors that could result in a complete exposure pathway for MC via groundwater use. During research for the SI, three documents on groundwater usage were identified. A 1995 study, *Water Wells on Isla de Culebra, Puerto Rico,* listed 77 wells on the island of Culebra, of which only 16 were being used for any purpose (Cherry, 1995). The report states that well water from 10 wells was being used to flush toilets, water and clean horses, water livestock, and water plants. The remaining six wells were listed as being owned by the Puerto Rico Aqueduct and Sewer Authority (PRASA); however, only two were listed as being pumped, and no information was provided about the use of this water.

5.1.2.2 The second report, *Puerto Rico Water Use Program: Public-Supply Water Use and Wastewater Disposal During 1990*, shows the rate of withdrawal in millions of gallons per day as zero for Culebra (as cited in Veve and Taggart, 1996). The assertion that groundwater is not used as a source of drinking water on Culebra Island is further supported by the third report, *Estimated Water Use in Puerto Rico, 2000* (Molina-Rivera, 2000). This USGS open file report was prepared in cooperation with PRASA and concluded that in 2000 no water was being withdrawn for public-supply water systems or for domestic self-supplied use on Isla de Vieques and Culebra.

5.1.3 Regional Hydrologic Setting

There are no permanently flowing surface water streams on Culebra. Three large ephemeral streams drain the hills north of Great Harbor to the south, and one large ephemeral stream has developed along an old, washed-out jeep road on the north side of the island toward Brava Beach. These ephemeral streams generally only carry water after heavy precipitation. There are many small ephemeral gullies and ditches throughout the island, and several lagoons are present on Culebra as well as Culebrita, Cayo Norte, and Cayo Luis Pena.

5.1.4 Historical Munitions Constituents Information

As part of the current removal action at Cayo Lobo and Cerro Balcon, soil sampling has been conducted in MRS 02; analytical results were obtained by Parsons from Ellis Environmental and are included in Section 5.2. No other historical MC-related groundwater, surface water, soil, or air investigations have been conducted at the Culebra Island FUDS.

5.1.5 Groundwater Sample Locations and Methods

Groundwater was not sampled at the Culebra Island FUDS.

5.1.6 Surface Water / Sediment Sample Locations and Methods

5.1.6.1 For the Culebra Island FUDS, the TPP team agreed that if MC was present in surface water, it would have accumulated in sediment at the lagoons for many years and therefore sediment should be collected to screen for the potential presence of MC in surface water. Sediment samples were collected from five locations within the Culebra Island FUDS (Figures 5.1A, B, and C and Figures 5.2A, B, and C). Each of these sample locations were selected to represent areas with the highest likelihood for the presence of MEC or MC contamination, per the SS-WP (Parsons, 2006b). No ambient sediment samples were collected; therefore, no ambient data is available for background comparison.

5.1.6.2 Sample locations were guided by the preliminary sample locations identified before the SI field team arrived on site and were approved by the UXO technician prior to final location selection and sample collection. For safety reasons, the UXO technician used a Minelab or Schonstedt GA-92XT*i* magnetometer prior to final location selection and collection of the sediment samples. Per the PWP, the magnetometer underwent QC and battery checks each day of use to confirm that it was working properly. The GPS coordinates for each sample location were recorded and updated in the GIS database. STL in Arvada, Colorado analyzed sediment samples for explosives (Method SW8321A) and select metals (EPA SW-846 Methods 6010B or 6020, and Methods 7470A and 7471A for mercury). Table 5.1 presents the analytical results for sediment samples collected at the Culebra Island FUDS.

5.1.6.3 Sections 5.2 through 5.14 provide further evaluation of analytical data for samples collected at each MRS. For a particular analyte to require a SLRA for sediment, the following three criteria must be met:

- The analyte must be a potential constituent of munitions known or suspected of being used on site (Table 4.1);
- The analyte must be considered a hazardous substance listed in 40 CFR Part 302, Table 302.4 of CERCLA; and
- The analyte must be detected on site above the background screening level.

5.1.6.4 Because there is no available background data for sediment at the Culebra Island FUDS, each analyte was retained for consideration in a SLRA if the first two criteria were met. Sections 5.2 through 5.14 further assess the need to perform a SLRA.

5.1.7 Soil Sample Locations and Methods

5.1.7.1 Soil samples were collected from 27 locations within the Culebra Island FUDS (Figures 5.1A, B, and C and Figures 5.2A, B, and C). Twenty-four of these samples were collected at locations selected to represent areas with the highest likelihood for the presence of MEC or MC contamination, per the SS-WP (Parsons, 2006b). Three soil samples were collected outside the MRS boundaries at locations selected to be least

Table 5.1
SUMMARY OF VALIDATED ANALYTICAL RESULTS FOR CULEBRA ISLAND SEDIMENT SAMPLES COLLECTED IN OCTOBER 2006

SAMPLE ID:		CUL-04-SE-06-03		CUL-04-SE-06-04		CUL-05-SE-06-01		CUL-07-SE-06-02		CUL-08-SE-06-05	
DATE SAMPLED:		10/29/06		10/29/06		10/30/06		11/02/06		10/26/06	
LAB SAMPLE ID:		D6J310259005		D6J310259004		D6K020196001		D6K040234005		D6J280175003	
Explosives - SW8321A	**Units**	MRS 04				MRS 05		MRS 07		MRS 08	
1,3,5-Trinitrobenzene	ug/kg	120	U	120	U	120	U	120	U	120	U
1,3-Dinitrobenzene	ug/kg	120	U	120	U	120	U	120	U	120	U
2,4,6-Trinitrotoluene (TNT)	ug/kg	120	U	120	U	120	U	120	U	120	U
2,4-Dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U
2,6-Dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U
2-Amino-4, 6-dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U
2-Nitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U
3-Nitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U
4-Amino-2,6-Dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U
4-Nitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	ug/kg	180	U	180	U	180	U	180	U	180	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	ug/kg	300	U	300	U	300	U	300	U	300	U
Nitrobenzene	ug/kg	120	U	120	U	120	U	120	U	120	U
Nitroglycerin	ug/kg	500	U	500	U	500	U	500	U	500	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	ug/kg	120	U	120	U	120	U	120	U	120	U
Pentaerythritol Tetranitrate (PETN)	ug/kg	500	U	500	U	500	U	500	U	500	U
Total Metals - SW6010B/6020/7471A											
Aluminum	mg/kg	**20000**		**21000**		**14000**	J	**1700**	J	**17000**	
Antimony	mg/kg	0.37	U	0.45	U	0.34	U	0.41	U	0.36	U
Arsenic	mg/kg	**1.6**		**2.5**		**2.6**		**0.63**	J	**1.3**	
Barium	mg/kg	**81**		**60**		**29**		**16**		**140**	
Beryllium	mg/kg	**0.58**		**0.50**		**0.28**	J	**0.054**	J	**0.69**	
Cadmium	mg/kg	**0.12**	J	**0.13**	J	**0.071**	J	**0.016**	J	**0.11**	J
Calcium	mg/kg	**11000**		**33000**		**170000**		**370000**		**4300**	
Chromium	mg/kg	**9.9**		**5.8**		**7.7**		**3.0**		**2.1**	
Cobalt	mg/kg	**16**		**13**		**8.0**		**1.9**		**11**	
Copper	mg/kg	**93**	J	**75**	J	**22**		**6.7**		**19**	
Iron	mg/kg	**40000**		**31000**		**19000**	J	**1900**	J	**39000**	
Lead	mg/kg	**12**		**5.8**		**2.5**		**1.9**		**5.9**	
Magnesium	mg/kg	**5900**		**8800**		**9400**		**7700**		**3700**	
Manganese	mg/kg	**350**		**550**		**310**		**36**		**350**	
Mercury	mg/kg	**0.013**	J	**0.040**	J	**0.013**	J	0.054	U	**0.011**	J
Molybdenum	mg/kg	**0.27**	J	**0.19**	J	**0.23**	J	**0.086**	J	**0.085**	J
Nickel	mg/kg	**6.5**		**5.3**		**3.6**	J	**14**		**0.93**	
Potassium	mg/kg	**4400**		**4000**		**2200**		**510**	J	**2800**	
Selenium	mg/kg	**0.98**		**1.2**		**0.74**		**0.68**	J	**1.2**	
Silver	mg/kg	**0.24**		**0.32**		**0.13**	J	0.16	U	**0.13**	J
Sodium	mg/kg	**4700**		**6300**		**3200**		**6300**		**2200**	
Strontium	mg/kg	**45**		**210**		**2400**	J	**7000**	J	**30**	
Thallium	mg/kg	**0.034**	J	**0.032**	J	**0.03**	J	**0.0049**	J	**0.089**	J
Titanium	mg/kg	**2300**		**1400**		**1300**	J	**150**	J	**610**	
Vanadium	mg/kg	**210**	J	**160**	J	**100**		**8.7**		**81**	
Zinc	mg/kg	**74**	J	**53**	J	**32**	J	**5.0**	J	**61**	J
NOTES AND DATA QUALIFIERS:											

(NO CODE) - Confirmed identification.
U - Analyte was analyzed for but not detected above the adjusted practical quantitation limit (PQL).
UJ - Analyte not detected, reported PRL may be inaccurate or imprecise.
J - Analyte detected, estimated concentration.
* - Field duplicate of sample on left.
Detections are bolded.

likely to contain MC contamination to provide ambient data for background metals comparison. The ambient sample locations were as follows:

- SS-27 was collected behind the school baseball field in the Town of Dewey.
- SS-16 was collected in the woods near the former Lower Town.
- SS-22 was collected on the east-facing slope of Culebrita near the lighthouse.

5.1.7.2 These areas were selected because each was occupied by people during the entire military history on Culebra and historic records did not show small arms or ammunition training in these areas. Therefore, these areas would not have been contaminated by munitions training conducted by the DoD and analysis can provide information on metals that may occur naturally due to the geology of the site.

5.1.7.3 Sample locations were guided by the preliminary sample locations identified before the SI field team arrived on site and were approved by the UXO technician prior to final location selection and sample collection. For safety reasons, the UXO technician used a Minelab or Schonstedt GA-92XT*i* magnetometer prior to final location selection and collection of the soil samples. Per the PWP, the magnetometer underwent QC and battery checks each day of use to confirm that it was working properly. In accordance with the PSAP Addendum, the Cold Regions Research and Engineering Laboratory (CRREL) seven-point wheel composite sampling technique was employed. Samples were collected from 2 to 6 inches bgs, and GPS coordinates for the center point of each sample location were recorded and updated in the GIS database.

5.1.7.4 STL in Arvada, Colorado analyzed soil samples for explosives (Method SW8321A) and select metals (EPA SW-846 Methods 6010B or 6020, and Methods 7470A and 7471A for mercury). Table 5.2 shows the analytical results of the soil samples collected at the Culebra Island FUDS. The detected concentrations of metals were compared to the maximum ambient concentration detected at the site. Table 5.3 shows the determination of the background comparison value using the maximum detected concentration of each analyte in any of the three ambient samples.

5.1.7.5 Sections 5.2 through 5.14 provide analytical data for samples collected at each MRS. For a particular analyte to require a SLRA for soil, the following three criteria must be met:

- The analyte must be a potential constituent of munitions known or suspected of being used on site (Table 4.1);
- The analyte must be considered a hazardous substance listed in 40 CFR Part 302, Table 302.4 of CERCLA; and
- The analyte must be detected on site above the background screening level.

5.1.7.6 Sections 5.2 through 5.14 further assess the need to perform a SLRA for each particular analyte.

5.1.8 Air Sample Locations and Methods

Air samples were not collected at the Culebra Island FUDS.

Table 5.2
SUMMARY OF VALIDATED ANALYTICAL RESULTS FOR CULEBRA ISLAND SOIL SAMPLES COLLECTED IN OCTOBER 2006

SAMPLE ID:		CUL-04-SS-06-11		CUL-04-SS-06-30*		CUL-05-SS-06-12		CUL-05-SS-06-14		CUL-05-SS-06-15		CUL-05-SS-06-17		CUL-06-SS-06-29*		CUL-05-SS-06-18		CUL-05-SS-06-19	
DATE SAMPLED:		10/29/06		10/29/06		11/03/06		11/03/06		10/25/06		10/27/06		10/27/06		10/27/06		10/24/06	
LAB SAMPLE ID:		D6J310259006		D6J310259007		D6K080307001		D6K080307002		D6J280175002		D6J310259001		D6J310259002		D6J310259003		D6J260350002	
Explosives - SW8321A	**Units**	MRS 04										MRS 05							
1,3,5-Trinitrobenzene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
1,3-Dinitrobenzene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2,4,6-Trinitrotoluene (TNT)	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2,4-Dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2,6-Dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2-Amino-4, 6-dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2-Nitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
3-Nitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
4-Amino-2,6-Dinitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
4-Nitrotoluene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	ug/kg	180	U	180	U	180	U	180	U	180	U	180	U	180	U	180	U	180	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	ug/kg	300	U	300	U	300	U	300	U	300	U	300	U	300	U	300	U	300	U
Nitrobenzene	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
Nitroglycerin	ug/kg	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	ug/kg	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
Pentaerythritol Tetranitrate (PETN)	ug/kg	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U
Total Metals - SW6010B/6020/7471A																			
Aluminum	mg/kg	**770**		**750**		**25000**	J	**26000**	J	**29000**		**39000**	J	**34000**		**35000**		**26000**	J
Antimony	mg/kg	0.29	U	0.29	U	0.29	UJ	0.31	U	0.32	U	0.30	UJ	0.30	U	0.30	U	0.32	U
Arsenic	mg/kg	**2.0**		**1.9**		**0.80**	J	**1.8**		**1.4**		**2.3**	J	**2.0**		**1.6**		**1.7**	
Barium	mg/kg	**12**		**11**		**200**	J	**310**		**1300**		**180**	J	**170**		**59**		**290**	
Beryllium	mg/kg	**0.030**	J	**0.037**	J	**0.55**	J	**0.77**		**0.80**		**1.4**		**1.5**		**0.35**	J	**1.4**	
Cadmium	mg/kg	**0.035**	J	**0.035**	J	**0.19**		**0.17**		**0.095**	J	**0.17**		**0.16**		**0.36**		**0.056**	J
Calcium	mg/kg	**300000**		**300000**		**11000**	J	**3100**		**1900**		**2200**		**2000**		**11000**		**3000**	
Chromium	mg/kg	**10**		**9.5**		**2.8**		**16**		**11**		**18**	J	**17**		**150**		**5.1**	
Cobalt	mg/kg	**1.3**		**1.3**		**15**		**47**		**33**		**37**	J	**36**		**30**		**30**	
Copper	mg/kg	**3.6**	J	**3.4**	J	**18**	J	**120**		**160**		**160**	J	**150**	J	**93**	J	**170**	J
Iron	mg/kg	**1000**		**1000**		**31000**	J	**54000**	J	**69000**		**78000**	J	**67000**		**53000**		**55000**	J
Lead	mg/kg	**1.2**		**1.2**		**6.1**		**7.9**		**8.1**		**9.4**		**11**		**2.7**		**4.2**	
Magnesium	mg/kg	**16000**		**15000**		**3100**	J	**2700**	J	**3600**		**3000**		**3000**		**18000**		**4500**	
Manganese	mg/kg	**60**		**59**		**1700**	J	**3000**		**2400**		**1900**	J	**1900**		**1500**		**770**	
Mercury	mg/kg	**0.029**	J	**0.029**	J	**0.059**		**0.042**		**0.0097**	J	**0.049**		**0.049**		**0.047**		**0.023**	J
Molybdenum	mg/kg	**0.15**	J	**0.15**	J	**0.27**	J	**0.34**		**0.15**	J	**0.45**	J	**0.43**		**0.20**	J	**0.13**	J
Nickel	mg/kg	**4.6**		**6.1**		**2.1**		**8.0**		**11**		**11**		**9.7**		**60**		**9.3**	
Potassium	mg/kg	**250**	J	**230**	J	**1200**		**1600**		**2300**		**2000**		**1900**		**4800**		**2600**	
Selenium	mg/kg	**0.49**	J	**0.45**	J	**1.0**	J	**1.6**		**1.2**		**2.2**	J	**2.1**		**0.89**		**0.81**	
Silver	mg/kg	0.11	U	0.11	U	**0.060**	J	**0.20**		**0.19**		**0.31**		**0.33**		**0.27**		**0.16**	
Sodium	mg/kg	**2100**		**2000**		**290**	J	**350**	J	**420**	J	**270**	J	**250**	J	**300**	J	**320**	J
Strontium	mg/kg	**3300**		**3400**		**50**		**37**		**34**		**29**		**27**		**42**		**36**	
Thallium	mg/kg	**0.017**	J	**0.017**	J	**0.040**	J	**0.060**	J	**0.051**	J	**0.085**	J	**0.084**	J	**0.14**		**0.056**	J
Titanium	mg/kg	**48**		**49**		**480**	J	**890**		**1200**		**2000**	J	**1500**		**2700**		**1300**	J
Vanadium	mg/kg	**3.6**	J	**3.3**	J	**92**	J	**260**		**240**		**360**	J	**320**	J	**200**	J	**130**	
Zinc	mg/kg	**5.3**	J	**5.1**	J	**62**	J	**67**		**110**	J	**66**	J	**63**	J	**73**	J	**120**	
NOTES AND DATA QUALIFIERS:																			
(NO CODE) - Confirmed identification. U - Analyte was analyzed for but not detected above the adjusted practical quantitation limit (PQL). UJ - Analyte not detected, reported PRL may be inaccurate or imprecise. J - Analyte detected, estimated concentration. * - Field duplicate of sample on left. Detections are bolded.																			

Table 5.2
SUMMARY OF VALIDATED ANALYTICAL RESULTS FOR CULEBRA ISLAND SOIL SAMPLES COLLECTED IN OCTOBER 2006

SAMPLE ID:	CUL-06-SS-06-20		CUL-06-SS-06-21		CUL-07-SS-06-25		CUL-07-SS-06-32*		CUL-07-SS-06-26		CUL-08-SS-06-23		CUL-08-SS-06-24		CUL-09-SS-06-09		CUL-09-SS-06-10	
DATE SAMPLED:	**10/25/06**		**10/24/06**		**11/02/06**		**11/02/06**		**11/01/06**		**10/26/06**		**10/26/06**		**10/26/06**		**10/24/06**	
LAB SAMPLE ID:	**D6J280175004**		**D6J260350003**		**D6K040234006**		**D6K040234007**		**D6K040234001**		**D6J280175001**		**D6J280175005**		**D6J280175006**		**D6J260350004**	
Explosives - SW8321A	MRS 06				MRS 07						MRS 08				MRS 09			
1,3,5-Trinitrobenzene	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
1,3-Dinitrobenzene	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
2,4,6-Trinitrotoluene (TNT)	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
2,4-Dinitrotoluene	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
2,6-Dinitrotoluene	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
2-Amino-4, 6-dinitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2-Nitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
3-Nitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
4-Amino-2,6-Dinitrotoluene	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
4-Nitrotoluene	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	180	U	180	U	180	UJ	180	U	180	U	180	U	180	U	180	U	180	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	300	U	300	U	300	UJ	300	U	300	U	300	U	300	U	300	U	300	U
Nitrobenzene	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
Nitroglycerin	500	U	500	U	500	UJ	500	U	500	U	500	U	500	U	500	U	500	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	120	U	120	U	120	UJ	120	U	120	U	120	U	120	U	120	U	120	U
Pentaerythritol Tetranitrate (PETN)	500	U	500	U	500	UJ	500	U	500	U	500	U	500	U	500	U	500	U
Total Metals - SW6010B/6020/7471A																		
Aluminum	**19000**		**31000**	J	**26000**	J	**25000**	J	**16000**	J	**27000**		**30000**		**13000**		**34000**	J
Antimony	0.30	U	0.33	U	0.30	UJ	0.29	U	**0.25**	J	0.31	U	0.31	U	0.28	U	0.34	U
Arsenic	**1.6**		**2.2**		**1.7**	J	**1.7**		**1.3**		**2.2**		**1.2**		**2.4**		**1.5**	
Barium	**180**		**150**		**480**	J	**420**		**180**		**200**		**180**		**48**		**120**	
Beryllium	**0.64**		**0.82**		**0.93**	J	**0.89**		**0.58**	J	**0.76**		**0.70**		**0.53**		**0.53**	J
Cadmium	**0.088**	J	**0.10**	J	**0.083**	J	**0.082**	J	**0.16**		**0.15**		**0.25**		**0.088**	J	**0.26**	
Calcium	**4400**		**4500**		**4300**	J	**4000**		**7600**		**11000**		**21000**		**7700**		**8200**	
Chromium	**10**		**19**		**8.0**	J	**8.7**		**9.9**		**2.5**		**2.1**		**2.9**		**19**	
Cobalt	**22**		**20**		**37**	J	**28**		**26**		**17**		**14**		**10**		**23**	
Copper	**130**		**100**	J	**200**	J	**600**	J	**110**		**24**		**28**		**93**		**98**	J
Iron	**50000**		**61000**	J	**53000**	J	**53000**	J	**39000**	J	**61000**		**52000**		**38000**		**51000**	J
Lead	**5.7**		**15**		**69**	J	**72**		**37**		**7.6**		**7.7**		**5.0**		**8.8**	
Magnesium	**3800**		**4800**		**5600**	J	**5200**		**4900**		**6200**		**5300**		**4500**		**7700**	
Manganese	**1300**		**930**		**1400**	J	**1500**		**1800**		**1900**		**1900**		**530**		**1700**	
Mercury	**0.031**	J	**0.046**		**0.032**	J	**0.027**	J	**0.048**		**0.043**		**0.046**		**0.019**	J	**0.035**	J
Molybdenum	**0.99**		**0.29**		**0.24**	J	**0.27**		**0.31**		**0.33**		**0.29**		**0.25**		**0.16**	J
Nickel	**6.8**		**12**		**8.9**		**8.9**		**7.3**		**1.4**		**1.5**		**5.9**		**16**	
Potassium	**4700**		**3800**		**3900**		**3900**		**3300**		**4000**		**4600**		**2900**		**4100**	
Selenium	**1.1**		**0.66**		**1.4**	J	**1.3**		**0.73**		**0.84**		**0.77**		**0.47**	J	**0.92**	
Silver	**0.19**		**0.18**		**0.29**		**0.29**		**0.23**		**0.19**		**0.15**		**0.18**		**0.14**	
Sodium	**180**	J	**270**	J	**260**	J	**260**	J	**530**	J	**220**	J	3500	U	**380**	J	**850**	
Strontium	**39**		**39**		**36**	J	**38**	J	**88**	J	**51**		**48**		**55**		**81**	
Thallium	**0.035**	J	**0.061**	J	**0.021**	J	**0.023**	J	**0.029**	J	**0.19**		**0.14**		**0.0093**	J	**0.046**	J
Titanium	**1000**		**1200**	J	**1300**	J	**1300**	J	**1100**	J	**1600**		**890**		**2000**		**780**	J
Vanadium	**190**		**170**		**210**	J	**220**		**180**		**92**		**71**		**130**		**160**	
Zinc	**72**	J	**65**		**190**	J	**240**	J	**67**	J	**73**	J	**90**	J	**44**	J	**60**	
NOTES AND DATA QUALIFIERS:																		
(NO CODE) - Confirmed identification. U - Analyte was analyzed for but not detected above the adjusted practical quantitation limit (PQL). UJ - Analyte not detected, reported PRL may be inaccurate or imprecise. J - Analyte detected, estimated concentration. * - Field duplicate of sample on left. Detections are bolded.																		

Table 5.2
SUMMARY OF VALIDATED ANALYTICAL RESULTS FOR CULEBRA ISLAND SOIL SAMPLES COLLECTED IN OCTOBER 2006

SAMPLE ID:	CUL-10-SS-06-07		CUL-10-SS-06-08		CUL-11-SS-06-03		CUL-11-SS-06-04		CUL-11-SS-06-05		CUL-11-SS-06-06		CUL-13-SS-06-01		CUL-13-SS-06-02		CUL-14-SS-06-13	
DATE SAMPLED:	10/30/06		10/30/06		11/04/06		11/01/06		11/01/06		11/03/06		10/31/06		10/31/06		11/03/06	
LAB SAMPLE ID:	D6K020196003		D6K020196004		D6K080307005		D6K040234003		D6K040234004		D6K080307004		D6K020196005		D6K020196006		D6K080307003	
Explosives - SW8321A	MRS 10				MRS 11								MRS 13				MRS 14	
1,3,5-Trinitrobenzene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
1,3-Dinitrobenzene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2,4,6-Trinitrotoluene (TNT)	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2,4-Dinitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2,6-Dinitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2-Amino-4, 6-dinitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
2-Nitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
3-Nitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
4-Amino-2,6-Dinitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
4-Nitrotoluene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	180	U	180	U	180	U	180	U	180	U	180	U	180	U	180	U	180	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	300	U	300	U	300	U	300	U	300	U	300	U	300	U	300	U	300	U
Nitrobenzene	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
Nitroglycerin	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U	120	U
Pentaerythritol Tetranitrate (PETN)	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U	500	U
Total Metals - SW6010B/6020/7471A																		
Aluminum	**44000**	J	**24000**	J	**31000**	J	**21000**	J	**16000**	J	**29000**	J	**42000**	J	**49000**	J	**27000**	J
Antimony	0.31	U	0.32	U	0.31	U	0.28	U	0.28	U	0.29	U	0.31	U	0.32	U	0.32	U
Arsenic	**1.4**		**3.3**		**1.9**		**2.4**		**4.1**		**1.8**		**1.3**		**1.0**		**1.1**	
Barium	**92**		**1100**		**61**		**87**		**37**		**120**		**78**		**110**		**600**	
Beryllium	**0.48**	J	**2.4**		**0.48**		**0.46**		**0.17**		**0.44**		**0.43**	J	**0.34**	J	**0.67**	
Cadmium	**0.15**		**0.12**	J	**0.16**		**0.14**		**0.052**	J	**0.14**		**0.25**		**0.14**		**0.23**	
Calcium	**19000**		**2100**		**15000**		**67000**		**140000**		**14000**		**11000**		**14000**		**6900**	
Chromium	**9.6**		**22**		**10**		**7.9**		**2.6**		**1.3**		**13**		**17**		**6.1**	
Cobalt	**22**		**67**		**18**		**14**		**11**		**19**		**26**		**22**		**21**	
Copper	**61**		**230**		**72**		**65**		**63**		**69**		**67**		**94**		**120**	
Iron	**45000**	J	**84000**	J	**45000**	J	**32000**	J	**29000**	J	**36000**	J	**55000**	J	**53000**	J	**51000**	J
Lead	**3.5**		**9.5**		**4.7**		**4.9**		**1.8**		**4.4**		**6.2**		**2.9**		**10**	
Magnesium	**9000**		**4000**		**6900**	J	**5900**		**6300**		**5000**	J	**10000**		**15000**		**5100**	J
Manganese	**1400**		**3400**		**1300**		**1100**		**550**		**1500**		**1900**		**1200**		**920**	
Mercury	**0.023**	J	**0.023**	J	**0.035**	J	**0.030**	J	**0.011**	J	**0.026**	J	**0.048**		**0.031**	J	**0.039**	J
Molybdenum	**0.17**	J	**0.58**		**0.22**	J	**0.30**		**0.18**	J	**0.23**		**0.21**	J	**0.095**	J	**0.17**	J
Nickel	**11**		**11**		**7.9**		**8.1**		**7.5**		**4.2**		**12**		**11**		**7.1**	
Potassium	**1800**		**3200**		**5100**		**3200**		**2600**		**1500**		**6100**		**2900**		**3000**	
Selenium	**0.78**		**2.8**		**1.0**		**1.0**		**0.66**		**0.97**		**0.91**		**0.62**	J	**1.1**	
Silver	**0.20**		**0.26**		**0.25**		**0.18**		**0.10**	J	**0.26**		**0.19**		**0.16**		**0.19**	
Sodium	**520**	J	**510**	J	**250**	J	**750**		**2000**		**510**	J	**430**	J	**410**	J	**380**	J
Strontium	**100**	J	**40**	J	**94**		**1000**	J	**2900**	J	**44**		**41**	J	**58**	J	**76**	
Thallium	**0.032**	J	**0.1**	J	**0.033**	J	**0.10**	J	**0.014**	J	**0.040**	J	**0.047**	J	**0.052**	J	**0.058**	J
Titanium	**1400**	J	**1100**	J	**2200**		**1200**	J	**1500**	J	**980**		**1100**	J	**1400**	J	**790**	
Vanadium	**150**		**680**		**150**		**130**		**110**		**120**		**200**		**250**		**160**	
Zinc	**55**	J	**130**	J	**68**		**52**	J	**27**	J	**61**		**61**	J	**74**	J	**70**	
NOTES AND DATA QUALIFIERS:																		
(NO CODE) - Confirmed identification. U - Analyte was analyzed for but not detected above the adjusted practical quantitation limit (PQL). UJ - Analyte not detected, reported PRL may be inaccurate or imprecise. J - Analyte detected, estimated concentration. * - Field duplicate of sample on left. Detections are bolded.																		

TABLE 5.3
SOIL BACKGROUND CONCENTRATIONS
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	CUL-14-SS-06-16*	CUL-07-SS-06-22*	CUL-11-SS-06-27*	Maximum Site-Specific Ambient Concentration to be used for Background Comparison
Metals					
Aluminum	mg/kg	23000	22000	30000	30000
Antimony	mg/kg	<0.32	<0.32	<0.29	<0.32
Arsenic	mg/kg	2.2	3.4	2.0	3.4
Barium	mg/kg	270	160	140	270
Beryllium	mg/kg	1.5	0.79	0.80	1.5
Cadmium	mg/kg	0.16	0.093	0.32	0.32
Calcium	mg/kg	3300	2600	10000	10000
Chromium	mg/kg	15	14	3.2	15
Cobalt	mg/kg	38	24	28	38
Copper	mg/kg	110	110	58	110
Iron	mg/kg	61000	78000	46000	78000
Lead	mg/kg	76	11	8.2	76
Magnesium	mg/kg	4300	4600	4900	4900
Manganese	mg/kg	2400	1600	2000	2400
Mercury	mg/kg	0.094	0.032	0.057	0.094
Molybdenum	mg/kg	0.43	0.63	0.37	0.63
Nickel	mg/kg	9.4	8.5	4.1	9.4
Potassium	mg/kg	4000	3800	3500	4000
Selenium	mg/kg	1.2	1.3	1.4	1.4
Silver	mg/kg	0.19	0.28	0.19	0.28
Sodium	mg/kg	260	640	350	640
Strontium	mg/kg	33	35	30	35
Thallium	mg/kg	0.079	0.077	0.12	0.12
Titanium	mg/kg	1300	1600	770	1600
Vanadium	mg/kg	300	430	200	430
Zinc	mg/kg	81	52	74	81

5.2 MRS 02 – NORTHWEST PENINSULA, CERRO BALCON, AND ADJACENT CAYOS

5.2.1 Historical Munitions Constituents Information

Previous investigations have not studied MC on the Culebra Island FUDS site; however, soil sampling has been conducted in conjunction with recent MEC removal actions on both Cerro Balcon and Cayo Lobo. As an alternative to sampling during

active removal at the site, Parsons obtained the results of soil sampling previously conducted by Ellis in conjunction with their field effort at these two locations. Soil samples were collected from locations near identified MEC items before detonation of the items. The results of the samples taken prior to MEC detonation on Cayo Lobo and Cerro Balcon are presented in Section 5.2.4. No other MC sampling is known to have been conducted at any of the other MRSs.

5.2.2 Groundwater Migration Pathway

Groundwater can potentially serve as a contaminant transport mechanism that may impact surface water bodies, drinking water supplies, vegetation, and sensitive environments such as wetlands. The likelihood of exposure is influenced by such factors as the volume and concentration of contaminated soil at the ground surface that can be transported to the groundwater, site-specific geology, climate, and the expected future land use.

5.2.2.1 Geologic and Hydrogeologic Setting

Northwest Peninsula is predominately andesite lava and lava breccia. The geology of the surrounding cays has not been mapped. Soil on Northwest Peninsula is described as Descalabrado clay loam that is well-drained and moderately permeable. Cerro Balcon has been mapped as rock outcrops of andesite tuff with little to no soil. The geology and soil types are shown on Figures 2.1 and 2.2.

5.2.2.2 Releases and Potential Releases to Groundwater

There are no known releases of MC to groundwater at any of the Culebra Island FUDS MRSs, including at MRS 02.

5.2.2.3 Groundwater Migration Pathway Receptors

As described in Section 5.1.2 groundwater wells are not used for drinking water on Culebra Island, including at MRS 02. This determination is based on the following:

- There is one well present at this MRS; however, the well is dry. (Cherry, 1995).
- There are no human groundwater receptors within or downgradient of the site due to the lack of residents, and no groundwater receptor exposure points for ecological receptors.

5.2.2.4 Groundwater Sample Locations and Methods

Groundwater sampling was not performed during the SI at MRS 02 or elsewhere on the Culebra Island FUDS.

5.2.2.5 Groundwater Migration Pathway Analytical Results

Groundwater sampling was not performed during the SI at MRS 02 or elsewhere on the Culebra Island FUDS.

5.2.2.6 Groundwater Migration Pathway Conclusions

The groundwater at MRS 02 is not consumed by human or ecological receptors. Therefore, based on the absence of groundwater receptors at the MRS, the groundwater migration pathway is incomplete. Because the groundwater migration pathway is

incomplete, a SLRA for groundwater is not required, and no human health or ecological risk from MC is expected through ingestion of groundwater at MRS 02.

5.2.3 Surface Water Migration Pathway

Surface water can potentially serve as a contaminant transport mechanism that may impact surface water bodies, sediment, drinking water supplies, vegetation, and sensitive environments such as wetlands.

5.2.3.1 Hydrologic Setting

There are no lagoons or surface water bodies on MRS 02. Only small ephemeral gullies are present on Northwest Peninsula.

5.2.3.2 Releases and Potential Releases to Surface Water

There are no known releases of MC to surface water at the Culebra Island FUDS, including MRS 02.

5.2.3.3 Surface Water Migration Pathway Analytical Receptors

Neither surface water nor sediment sampling was performed during the SI at MRS 02.

5.2.3.4 Sample Locations and Methods

Neither surface water nor sediment sampling was performed during the SI at MRS 02.

5.2.3.5 Surface Water Migration Pathway Analytical Results

Neither surface water nor sediment sampling was performed during the SI at MRS 02.

5.2.3.6 Surface Water Migration Pathway Conclusions

5.2.3.6.1 As discussed in Section 5.1.3, ponds or surface water bodies are not present at MRS 02. Therefore, based on the assumption that surface water bodies must be present for a complete surface water migration pathway on site, the surface water migration pathway is incomplete for human health. No human health risk from MC is expected through surface water / sediment at MRS 02.

5.2.3.6.2 Points of exposure for surface water / sediment and associated ecological receptor interaction could occur in the ephemeral gullies during or just after heavy precipitation. No sediment or surface water samples were collected within MRS 02; therefore, a SLRA for surface water / sediment was not performed. Section 6.3.6.1 further discusses potential ecological risk due to MC in surface water / sediment at MRS 02.

5.2.4 Soil Exposure Pathway

Potential soil exposure pathways include incidental ingestion, dermal contact, and inhalation of re-suspended particulates by human and ecological receptors, as well as leaching to groundwater and runoff to surface water and sediment. The likelihood of exposure is influenced by such factors as the volume and concentration of contaminated soil exposed at the ground surface, site-specific geology, climate, and the expected future land use.

5.2.4.1 Physical Source Access Conditions

Portions of MRS 02 are accessed regularly by the general public near Flamenco Beach as well as on trails through Northwest Peninsula. A fence restricts access to Northwest Peninsula; however, this fence is incomplete and is open at gates to allow access to the trails. The vegetation is very restrictive and discourages travel off established trails and roads. Access to the cays is restricted by natural barriers such as rocky approaches and steep sea cliffs in most cases. Some of the cays are physically accessible; however, they are not open to the public. There are no full-time residents within MRS 02; however, USFWS workers and researchers do visit the cays and Northwest Peninsula to conduct bird surveys. Cerro Balcon is privately owned property, and there are no barriers to access.

5.2.4.2 Actual or Potential Contamination Areas

There are no known MC contamination areas within MRS 02.

5.2.4.3 Soil Exposure Receptors

Most of MRS 02 is undeveloped forests and, according to site observations and the 2000 census, no full-time residents reside in MRS 02. The town of Dewey, the main population center of the Island of Culebra, is within 2 miles of MRS 02. Figure 5.3 shows the population present within and surrounding MRS 02. The cays of MRS 02 are inaccessible to the public; however, onsite workers are present on occasion. Northwest Peninsula is accessed regularly via trails for swimming, diving, and snorkeling.

5.2.4.4 Sample Locations and Methods

As described in Section 5.2.1, soil samples were not collected at MRS 02; however, analytical results were obtained from samples collected by Ellis Environmental during field efforts conducted at Cayo Lobo and Cerro Balcon.

5.2.4.5 Soil Migration Pathway Analytical Results

Ten soil samples were collected in MRS 02 and analyzed for explosives and metals. Table 5.4 shows the soil sample analytical results obtained from Ellis Environmental for MRS 02. Explosive compounds were not detected in these samples, but metals were detected in each of the samples. Table 5.5 shows the maximum detected concentrations for each analyte from these 10 soil samples and compares each analyte to the three criteria described in paragraph 5.1.7.5 to determine which analytes should be retained for consideration in a SLRA.

5.2.4.6 Soil Exposure Conclusions

As seen in Table 5.5, two soil analytes met the three criteria described in paragraph 5.1.7.5 and were retained for consideration in a SLRA (chromium and zinc). The SLRA conducted for the soil migration pathway at MRS 02 is presented in Sections 6.2.4.1 and 6.3.5.1.

Table 5.4
SUMMARY OF ANALYTICAL RESULTS FOR CULEBRA ISLAND SOIL SAMPLES COLLECTED BY ELLIS ENVIRONMENTAL

SAMPLE ID:		C08005		B08001		B07002		C08001		B08002		D04001		D04002		C05001		C04001		B05001	
Explosives - SW8321A	**Units**	**MRS 02 - Cayo Lobo Pre-Detonation Soil Samples**										**MRS 02 - Cerro Balcon Pre-Detonation Soil Samples**									
1,3,5-Trinitrobenzene	ug/kg	99	U	100	U	99	U	99	U	100	U	100	U	100	U	99	U	100	U	100	U
1,3-Dinitrobenzene	ug/kg	99	U	100	U	99	U	99	U	100	U	100	U	100	U	99	U	100	U	100	U
2,4,6-Trinitrotoluene (TNT)	ug/kg	99	U	100	U	99	U	99	U	100	U	100	U	100	U	99	U	100	U	100	U
2,4-Dinitrotoluene	ug/kg	99	U	100	U	99	U	99	U	100	U	100	U	100	U	99	U	100	U	100	U
2,6-Dinitrotoluene	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U
2-Amino-4, 6-dinitrotoluene	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U
2-Nitrotoluene	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U
3-Nitrotoluene	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U
4-Amino-2,6-Dinitrotoluene	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	260	U
4-Nitrotoluene	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	ug/kg	250	U	250	U	250	U	250	U	250	U	250	U	250	U	250	U	250	U	360	U
Nitrobenzene	ug/kg	99	U	100	U	99	U	99	U	100	U	100	U	100	U	99	U	100	U	100	U
Nitroglycerin	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	ug/kg	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	200	U	46	U
Pentaerythritol Tetranitrate (PETN)	ug/kg	400	U	400	U	390	U	400	U	400	U	400	U	400	U	400	U	400	U	400	U
Total Metals - SW6010B/6020/7471A																					
Aluminum	mg/kg	**30000**		**27000**		**32000**		**28000**		**25000**		**28000**		**24000**		**24000**		**28000**		**25000**	
Antimony	mg/kg	**0.94**	B	**1**	B	3.1	U	**1.7**	B	**0.79**	B	**1.9**	B	**2**	B	**1.6**	B	**1**	B	**1.5**	
Arsenic	mg/kg	0.98	U	1.3	U	1.5	U	1.1	U	**0.44**	B	**2.6**		**3.6**		**1.9**		**0.92**	B	**2**	
Barium	mg/kg	**39**		**28**		**37**		**52**		**28**		**48**		**45**		**59**		**51**		**60**	
Beryllium	mg/kg	**0.41**		**0.35**	B	**0.44**	B	**0.29**	B	**0.43**		**0.7**		**0.72**		**1**		**0.64**		**1**	
Cadmium	mg/kg	0.2	U	0.25	U	0.31	U	1.1	U	0.21	U	0.22	U	0.22	U	**0.3**		**0.75**		**0.3**	
Calcium	mg/kg	**5900**		**9500**		**8700**		**2800**		**6600**		**8900**		**8300**		**9500**		**7100**		**8900**	
Chromium	mg/kg	**28**		**19**		**30**		**28**		**24**		**42**		**53**		**40**		**110**		**49**	
Cobalt	mg/kg	**23**		**17**		**33**		**16**		**27**		**25**		**24**		**24**		**33**		**25**	
Copper	mg/kg	**77**		**58**		**83**		**73**		**66**		**100**		**110**		**96**		**91**		**110**	
Iron	mg/kg	**48000**		**34000**		**50000**		**83000**		**44000**		**50000**		**57000**		**45000**		**47000**		**48000**	
Lead	mg/kg	**3.3**		**4.2**		**3.6**		**2.1**		**3.9**		**5.8**		**5.7**		**9**		**5**		**2.9**	
Magnesium	mg/kg	**12000**		**12000**		**18000**		**11000**		**12000**		**12000**		**11000**		**8800**		**11000**		**9600**	
Manganese	mg/kg	**830**		**650**		**1200**		**310**		**950**		**1300**		**1300**		**1700**		**1500**		**1500**	
Mercury	mg/kg	0.019	U	**0.021**	B	**0.02**	B	**0.0087**	B	**0.017**	B	**0.047**		**0.028**		**0.031**		**0.042**		**0.033**	
Nickel	mg/kg	**20**		**15**		**24**		**15**		**19**		**21**		**26**		**21**		**44**		**25**	
Potassium	mg/kg	**4400**		**2400**		**3800**		**3800**		**3400**		**7300**		**6100**		**5100**		**5800**		**4800**	
Selenium	mg/kg	0.98	U	**0.61**	B	**0.73**	B	1.1	U	**0.52**	B	1.1	U	1.1	U	**2.7**		**0.63**	B	**3.2**	
Silver	mg/kg	**0.34**	B	**0.17**	B	0.77	U	**0.25**	B	**0.2**	B	**0.46**	B	**0.47**	B	**0.35**	B	**0.32**	B	**0.32**	B
Sodium	mg/kg	**5800**		**1100**		**1300**		**4800**		**1600**		**220**		110	U	**300**		**310**		**420**	
Strontium	mg/kg	**23**		**38**		**34**		**15**		**22**		**36**		**29**		**50**		**37**		**48**	
Thallium	mg/kg	0.98	U	**2.8**		**4.9**		1.1	U	1.1	U	**4.4**		**4.7**		**0.8**	B	**3.8**		1.1	U
Vanadium	mg/kg	**200**		**140**		**200**		**230**		**190**		**180**		**160**		**180**		**160**		**190**	
Zinc	mg/kg	**43**		**83**		**56**		**43**		**150**		**60**		**55**	J	**130**	J	**68**		**52**	J
NOTES AND DATA QUALIFIERS:																					
(NO CODE) - Confirmed identification. U - Analyte was analyzed for but not detected above the practical quantitation limit (PQL). UJ - Analyte not detected, reported																					

Table 5.5
MRS 02
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	32000	30000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 3.1	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	3.6	3.4	**Yes**	No	**Yes**	No	Not a potential MC
Barium	mg/kg	60	270	No	**Yes**	**Yes**	No	Not detected above background
Beryllium	mg/kg	1	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.75	0.32	**Yes**	No	**Yes**	No	Not a potential MC
Calcium	mg/kg	9500	10000	No	**Yes**	No	No	Not detected above background
Chromium	mg/kg	110	15	**Yes**	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	33	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	110	110	No	**Yes**	**Yes**	No	Not detected above background
Iron	mg/kg	83000	78000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Lead	mg/kg	9	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	18000	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	1700	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.047	0.094	No	**Yes**	**Yes**	No	Not detected above background
Nickel	mg/kg	44	9.4	**Yes**	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	7300	4000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	3.2	1.4	**Yes**	No	**Yes**	No	Not a potential MC
Silver	mg/kg	0.77	0.28	**Yes**	No	**Yes**	No	Not a potential MC
Sodium	mg/kg	5800	640	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	50	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	4.9	0.12	**Yes**	No	**Yes**	No	Not a potential MC
Vanadium	mg/kg	230	430	No	No	No	No	Not detected above background
Zinc	mg/kg	150	81	**Yes**	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 100	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 100	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 100	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 100	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 260	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 360	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 100	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 200	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 400	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

5.2.5 Air Migration Pathway

The air migration pathway accounts for hazardous substance migration in gaseous or particulate form through the air. Airborne deposition of contaminants can be a potential threat to people and sensitive environments.

5.2.5.1 Climate

Section 2.2.3 discusses climate.

5.2.5.2 Releases and Potential Releases to Air

There are no known releases to air at MRS 02 or elsewhere at the Culebra Island FUDS.

5.2.5.3 Air Migration Pathway Receptors

Target populations potentially impacted by the air pathway consist of people who reside, work, or go to school within the target distance limit of 4 miles around the site. The entire Island of Culebra is within 4 miles of MRS 02. According to the 2000 census, approximately 1,868 persons live within the municipality of Culebra.

5.2.5.4 Sample and Monitoring Locations and Methods

There is no historical record of air sampling at the Culebra Island FUDS. Air sampling was not conducted as part of the SI at MRS 02 or elsewhere at the Culebra Island FUDS.

5.2.5.5 Air Migration Pathway Analytical Results

There is no historical record of air sampling at the Culebra Island FUDS. Air sampling was not conducted as part of the SI at MRS 02 or elsewhere at the Culebra Island FUDS.

5.2.5.6 Air Migration Pathway Conclusions

5.2.5.6.1 The air migration exposure pathways at MRS 02 and all other Culebra Island FUDS MRS are incomplete, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for generation of fugitive dust.

5.2.5.6.2 Because the air exposure pathways are incomplete, a SLRA for air is not required and no human health or ecological risk from MC is expected through air at MRS 02. While the air pathway is believed to be incomplete, based on the previous arguments, the Region 9 residential soil PRGs include an evaluation of inhalation of fugitive dust. Therefore, an evaluation of the air pathway is included in the SLRA for soil.

5.3 MRS 03 – FLAMENCO BAY WATER AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 03. The CSEM for MRS 03 is in Appendix J.

5.3.1 Groundwater Migration Pathway

MRS 03 includes the underwater area of Flamenco Bay. The geology of this area has not been mapped; however, the surrounding geology indicates that the bedrock is likely a mix of andesite lava, lava breccia, tuff, and diorite and diorite porphyry. The bay floor is covered by sand and coral. The mouth of the bay is wide, and there are no tidal restrictions. MRS 03 is completely underwater in Flamenco Bay. Groundwater is not present; therefore, a groundwater migration pathway at MRS 03 is not relevant or complete. No human health or ecological risk from MC is expected through groundwater at MRS 03.

5.3.2 Surface Water Migration Pathway

MRS 03 is an underwater MRS connected to the Atlantic Ocean. The mouth of the Bay is wide, and there are no tidal restrictions. The ocean would dilute MC; therefore, MC hazard cannot exist in this area. The surface water / sediment migration pathway is incomplete for MRS 03; therefore, no human health or ecological risk from MC is expected through surface water / sediment at MRS 03.

5.3.3 Soil Exposure Pathway

5.3.3.1 Soil in MRS 03 consists of sand on the seafloor in Flamenco Bay. This area is accessible to the general public and is used frequently for recreational swimming, snorkeling, and diving. Contact with the sand would most likely occur at shallow water depths. There are no fences or other restrictions to access. At the time of the 2000 census, there were no full-time residents in MRS 03 or along the beach surrounding MRS 03 (Figure 5.4). There is one hotel within MRS 04 near MRS 03, and Flamenco Bay is a popular recreational area. The town of Dewey is within 1.5 miles of MRS 03.

5.3.3.2 The TPP Team agreed that no soil or sediment sampling would be conducted as part of the SI at MRS 03. The constant movement and exposure of the sand to ocean water greatly reduces the likelihood that MC remains in the soil/sediment at this MRS. Because the soil migration pathway is therefore incomplete, no human health or ecological risk from MC is expected through soil at MRS 03.

5.3.4 Air Migration Pathway

Air at MRS 03 is not considered to be a medium of concern. Air has not been directly contaminated from military use of the site, and there is no potential for an exposure to MC through inhalation of fugitive dust because MRS 03 is entirely underwater; therefore, no human health or ecological risk from MC is expected through air at MRS 03.

5.4 MRS 04 – FLAMENCO LAGOON MANEUVER AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island

FUDS. This section provides additional details specific to MRS 04. The CSEM for MRS 04 is in Appendix J.

5.4.1 Groundwater Migration Pathway

5.4.1.1 Three types of rock exist in MRS 04. Flamenco Lagoon and the area just east of the lagoon are underlain primarily by andesite lava and lava breccia. North of this is a zone of andesite tuff, while the remainder of this area is underlain by diorite and diorite porphyry. Soil surrounding the lagoon is described as tidal flats and tidal swamp, while Catano loamy sand is present in the area between the beach and lagoon. The east side of the MRS is exposed bedrock, while Descalabrado clay loam is present on the southeastern portion. Figures 2.1 and 2.2 show the geology and soil of Culebra Island.

5.4.1.2 Groundwater is likely present within fractures and joints in the volcanic rock and in the alluvium surrounding Flamenco Lagoon. Several abandoned livestock watering wells are present surrounding Flamenco Lagoon, and one abandoned well is located near Resaca Beach. None of the wells are in use (Cherry, 1995). Because there are no drinking water receptors for groundwater at MRS 04, the groundwater migration pathway is incomplete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 04.

5.4.2 Surface Water Migration Pathway

5.4.2.1 The largest surface water body on Culebra Island is Flamenco Lagoon in MRS 04. Flamenco Lagoon is fed by groundwater, surface water, and runoff from MRS 04 and MRS 11. Small ephemeral gullies in MRS 04 drain storm water to Flamenco Lagoon and to the ocean at Resaca Beach.

5.4.2.2 Historical records indicate that direct fire may have occurred in the vicinity of Flamenco Lagoon; therefore, surface water / sediment on MRS 04 is considered a primary exposure medium due to the potential for munitions debris and MEC in the lagoon. Surface water / sediment is also a secondary exposure medium due to the potential for transport of contaminated surface soil to surface water / sediment through runoff or erosion.

5.4.2.3 The points of exposure for surface water / sediment and associated receptor interaction could occur at Flamenco Lagoon or in the ephemeral gullies during or just after heavy precipitation. There are residents within MRS 04 and many annual visitors.

5.4.2.4 The sediment samples collected in MRS 04 (CUL-04-SE-06-04 and CUL-04-SE-06-03) were collected on the west and south sides of Flamenco Lagoon, respectively, in water depths of approximately 3 feet (Figures 5.1B and 5.2B). As shown in Table 5.1, laboratory analysis of the samples detected no explosive compounds but detected several metals. The maximum detected concentration of each metal was compared to the MC list in Table 4.1 and the CERCLA hazardous substance list. Table 5.6 compares maximum detected concentrations of each analyte to these SLRA requirements, as stated in Section 5.1.6 paragraph 5.1.6.3. As seen in Table 5.6, six metals (barium, chromium, copper,

Table 5.6
MRS 04
Sediment Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Potential MC? [a]	CERCLA Hazardous? [b]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A						
Aluminum	mg/kg	21000	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.45	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	2.5	No	**Yes**	No	Not a potential MC
Barium	mg/kg	81	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	0.58	No	**Yes**	No	Not a potential MC
Cadmium	mg/kg	0.13	No	**Yes**	No	Not a potential MC
Calcium	mg/kg	33000	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	9.9	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	16	No	**Yes**	No	Not a potential MC
Copper	mg/kg	93	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	40000	**Yes**	No	No	Not CERCLA hazardous
Lead	mg/kg	12	**Yes**	**Yes**	**Yes**	--
Magnesium	mg/kg	8800	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	550	No	No	No	Not a potential MC
Mercury	mg/kg	0.04	**Yes**	**Yes**	**Yes**	--
Molybdenum	mg/kg	0.27	**Yes**	No	No	Not CERCLA hazardous
Nickel	mg/kg	6.5	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	4400	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	1.2	No	**Yes**	No	Not a potential MC
Silver	mg/kg	0.32	No	**Yes**	No	Not a potential MC
Sodium	mg/kg	6300	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	210	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.034	No	**Yes**	No	Not a potential MC
Titanium	mg/kg	2300	**Yes**	No	No	Not CERCLA hazardous
Vanadium	mg/kg	210	No	No	No	Not a potential MC
Zinc	mg/kg	74	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A						
1,3,5-Trinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	ug/kg	< 180	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	ug/kg	< 300	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS

a - Potential MCs as listed in Table 4.1

b - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

lead, mercury, and zinc) were retained for consideration in the SLRA that was conducted to further evaluate the surface water / sediment migration pathway at MRS 04, as presented in Sections 6.2.5.1 and 6.3.6.2.

5.4.3 Soil Exposure Pathway

5.4.3.1 Portions of MRS 04 are regularly accessed by the general public near Flamenco Beach as well as Resaca Beach via a rough, unmaintained trail (approximately 2,500 feet of foot trail) through MRS 04 from a trailhead at the end of the road 1 mile north of the airport. A few full-time residents and a resort on Flamenco Beach are within MRS 04. There are no fences or physical barriers to this site. The vegetation is very restrictive and discourages travel off established trails and roads.

5.4.3.2 The field team observed no MEC or MD during the QR on MRS 04. Field personnel collected soil sample CUL-04-SS-06-11 from the location shown on Figures 5.1B and 5.2B. This location was selected based on military use of Flamenco Bay and the potential for direct fire in the vicinity of Combat Range No. 2 near SS-11. The CSEM for MRS 04 is in Appendix J. Soil at this MRS is considered a primary exposure medium that may have been contaminated by direct fire.

5.4.3.3 As shown in Table 5.1, laboratory analysis of the sample detected several metals. No explosive compounds were detected at MRS 04 or in any of the samples collected at the Culebra Island FUDS. The maximum detected concentration of each metal was compared to selected background concentrations, the MC list in Table 4.1, and the CERCLA hazardous substance list. Table 5.7 compares maximum detected concentrations of each analyte to these three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.7, none of the soil analytes were retained for consideration in a SLRA. Therefore, a SLRA is not required for the soil migration pathway at MRS 04, and no human health or ecological risk from MC is expected through soil at MRS 04.

5.4.4 Air Migration Pathway

5.4.4.1 At the time of the 2000 census, there were nine full-time residents in MRS 04, and the entire population of Culebra (1,868 persons) resides within 4 miles of MRS 04. There is one hotel within MRS 04, and Flamenco Beach is a popular tourist destination. Most of MRS 04 is undeveloped forests and is accessible to the public. Figure 5.5 shows the 2000 census tract for MRS 04.

5.4.4.2 The air migration exposure pathways at MRS 04 are incomplete because there is no source of MC contamination in soil. Because the air exposure pathways are incomplete, a SLRA for air is not required and no human health or ecological risk from MC is expected through air at MRS 04.

5.5 MRS 05 – MORTAR AND COMBAT RANGE AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 05. The CSEM for MRS 05 is in Appendix J.

Table 5.7
MRS 04
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	770	30000	No	**Yes**	No	No	Not detected above background
Antimony	mg/kg	< 0.29	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	2	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	12	270	No	**Yes**	**Yes**	No	Not detected above background
Beryllium	mg/kg	0.037	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.035	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	300000	10000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	10	15	No	**Yes**	**Yes**	No	Not detected above background
Cobalt	mg/kg	1.3	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	3.6	110	No	**Yes**	**Yes**	No	Not detected above background
Iron	mg/kg	1000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	1.2	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	16000	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	60	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.029	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.15	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	6.1	9.4	No	No	**Yes**	No	Not detected above background
Potassium	mg/kg	250	4000	No	**Yes**	No	No	Not detected above background
Selenium	mg/kg	0.49	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	< 0.11	0.28	No	No	**Yes**	No	Not detected at MRS
Sodium	mg/kg	2100	640	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	3400	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.017	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	49	1600	No	**Yes**	No	No	Not detected above background
Vanadium	mg/kg	3.6	430	No	No	No	No	Not detected above background
Zinc	mg/kg	5.3	81	No	**Yes**	**Yes**	No	Not detected above background
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

5.5.1 Groundwater Migration Pathway

5.5.1.1 Bedrock at MRS 05 is composed of four rock types (Figure 2.1). The west side of the site around Mount Resaca is underlain by diorite and diorite porphyry. The north portion of MRS 05 from the south slope of Cerro Balcon north is underlain by andesite tuff, while the southern portion contains andesite lava and lava breccia. In the central valley between Mount Resaca and Cerro Balcon are sand and clay deposits. The land elevation in the valley varies from 115 to 170 feet above mean sea level (amsl), and groundwater is present at depths of 2 to 50 feet below land surface (bls). This area provides the only substantial source of groundwater on the island. Soil types in this MRS vary greatly. Figure 2.2 is a map showing the soil types in this area.

5.5.1.2 Groundwater is likely present within fractures and joints in the volcanic rock and possibly also within buried weathered zones and/or interflow stream deposits, and is known to be present in alluvial deposits of the central valley. Several abandoned livestock watering wells are in the central valley, as well as one near Brava Beach and four near Playa Larga. The 1995 USGS open file report *Water Wells on Isla de Culebra, Puerto Rico* (Cherry, 1995) shows that in 1995, PRASA operated three wells in the central valley. The specific use of this water is not known; however, the 2000 USGS open file report *Estimated Water Use in Puerto Rico* shows zero groundwater withdrawals on Isla de Vieques and Culebra for public-supply water systems or domestic self-supplied use (Molina, 2000). Because there are no drinking water receptors for groundwater at MRS 05, the groundwater migration pathway is not complete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 05.

5.5.2 Surface Water Migration Pathway

5.5.2.1 There are several lagoons and ponds on MRS 05. Ephemeral streams on MRS 05 drain the central portion of the island toward Great Harbor. The TPP Team agreed that sediment samples from the lagoon would be more likely to contain MC than the water itself because the water is seasonal; therefore, no surface water samples were collected and the TPP Team selected sediment sample CUL-05-SE-06-01 to screen for MC in the sediment at Zoni Lagoon, which may have been contaminated by transport of MC via surface water.

5.5.2.2 The sediment sample collected in MRS 05 (CUL-05-SE-06-01) was collected on the north side of Zoni Lagoon beneath approximately 2.5 feet of water (Figures 5.1A and 5.2A). As shown in Table 5.1, laboratory analysis of the samples detected no explosive compound but detected several metals. The maximum detected concentration of each metal was compared to the MC list in Table 4.1 and the CERCLA hazardous substance list. Table 5.8 compares maximum detected concentrations of each analyte to these SLRA requirements, as stated in Section 5.1.6 paragraph 5.1.6.3. As seen in Table 5.8, six metals (barium, chromium, copper, lead, mercury, and zinc) were retained for consideration in the SLRA that was conducted to further evaluate the surface water / sediment migration pathway at MRS 05, as presented in Sections 6.2.5.2 and 6.3.6.3.

Table 5.8
MRS 05
Sediment Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Potential MC? [a]	CERCLA Hazardous? [b]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A						
Aluminum	mg/kg	14000	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.34	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	2.6	No	**Yes**	No	Not a potential MC
Barium	mg/kg	29	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	0.28	No	**Yes**	No	Not a potential MC
Cadmium	mg/kg	0.071	No	**Yes**	No	Not a potential MC
Calcium	mg/kg	170000	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	7.7	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	8	No	**Yes**	No	Not a potential MC
Copper	mg/kg	22	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	19000	**Yes**	No	No	Not CERCLA hazardous
Lead	mg/kg	2.5	**Yes**	**Yes**	**Yes**	--
Magnesium	mg/kg	9400	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	310	No	No	No	Not a potential MC
Mercury	mg/kg	0.013	**Yes**	**Yes**	**Yes**	--
Molybdenum	mg/kg	0.23	**Yes**	No	No	Not CERCLA hazardous
Nickel	mg/kg	3.6	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	2200	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	0.74	No	**Yes**	No	Not a potential MC
Silver	mg/kg	0.13	No	**Yes**	No	Not a potential MC
Sodium	mg/kg	3200	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	2400	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.03	No	**Yes**	No	Not a potential MC
Titanium	mg/kg	1300	**Yes**	No	No	Not CERCLA hazardous
Vanadium	mg/kg	100	No	No	No	Not a potential MC
Zinc	mg/kg	32	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A						
1,3,5-Trinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	ug/kg	< 180	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	ug/kg	< 300	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS

a - Potential MCs as listed in Table 4.1

b - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

5.5.3 Soil Exposure Pathway

5.5.3.1 MRS 05 is privately owned by many landowners and contains scattered private homes. FWS manages the land surrounding Mount Rasaca and the beaches surrounding MRS 05. At the time of the 2000 census, there were approximately 100 residents within MRS 05 (Figure 5.6). A foot trail at the end of the road to the water treatment plant can be followed less than a mile to Brava Beach. The trail is unimproved but follows an old military jeep road for part of the way. Storm runoff has washed out huge holes in the road, so the trail is not passable by vehicle. There are no fences or barriers to this site; however, vegetation is extremely dense and restricts access to much of the north portion. The vegetation also restricts movement off the trail to Brava Beach.

5.5.3.2 The field team did not observe any MEC during the QR on MRS 05; however, they identified a base plate off a 4.2-inch mortar near MRS 02 at Cerro Balcon and a few pieces of small arms debris in this MRS. Field personnel collected soil samples CUL-05-SS-06-12, CUL-05-SS-06-14, CUL-05-SS-06-15, CUL-05-SS-06-17, CUL-05-SS-06-18, and CUL-05-SS-06-19 at the locations shown on Figures 5.1A and B and 5.2A and B. Samples SS-12, SS-14, SS-15, SS-17, and SS-19 were collected in areas that received direct fire in 1935 according to military reports. SS-18 was collected on the south-facing slope of Cerro Balcon. MEC and MD are known to be present, and removal actions are underway on the west-facing slope of Cerro Balcon. Soil at this MRS is considered a primary exposure medium that may have been contaminated by direct fire.

5.5.3.3 As shown in Table 5.1, laboratory analysis of the six soil samples detected several metals. No explosive compounds were detected at MRS 05 or in any of the samples collected at the Culebra Island FUDS. Table 5.9 compares maximum detected concentrations of each analyte to the three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.9, four of the soil analytes (barium, chromium, copper, and zinc) were retained for consideration in a SLRA that was conducted to further evaluate the soil migration pathway at MRS 05, as presented in Sections 6.2.4.2 and 6.3.5.2.

5.5.4 Air Migration Pathway

5.5.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. The entire Island of Culebra is within 4 miles of MRS 05. The 2000 census reports a population of 1,868 persons within the municipality of Culebra. Figure 5.6 shows the 2000 census tract for MRS 05.

5.5.4.2 The air migration exposure pathway at MRS 05 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

Table 5.9
MRS 05
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	39000	30000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.32	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	2.3	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	1300	270	**Yes**	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	1.5	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.36	0.32	**Yes**	No	**Yes**	No	Not a potential MC
Calcium	mg/kg	11000	10000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	150	15	**Yes**	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	47	38	**Yes**	No	**Yes**	No	Not a potential MC
Copper	mg/kg	170	110	**Yes**	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	78000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	11	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	18000	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	3000	2400	**Yes**	No	No	No	Not a potential MC
Mercury	mg/kg	0.059	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.45	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	60	9.4	**Yes**	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	4800	4000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	2.2	1.4	**Yes**	No	**Yes**	No	Not a potential MC
Silver	mg/kg	0.33	0.28	**Yes**	No	**Yes**	No	Not a potential MC
Sodium	mg/kg	420	640	No	**Yes**	No	No	Not detected above background
Strontium	mg/kg	50	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.14	0.12	**Yes**	No	**Yes**	No	Not a potential MC
Titanium	mg/kg	2700	1600	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Vanadium	mg/kg	360	430	No	No	No	No	Not detected above background
Zinc	mg/kg	120	81	**Yes**	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

5.5.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required and no human health or ecological risk from MC is expected through air at MRS 05. While the air pathway is believed to be incomplete, based on the previous arguments, the Region 9 residential soil PRGs include an evaluation of inhalation of fugitive dust. Therefore, an evaluation of the air pathway is included in the SLRA for soil.

5.6 MRS 06 – ARTILLERY FIRING AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 06. The CSEM for MRS 06 is in Appendix J.

5.6.1 Groundwater Migration Pathway

5.6.1.1 The bedrock at MRS 06 consists predominantly of andesite lava and lava breccia. Some clay and sand deposits are present on the north side of Mangrove Harbor and surrounding the lagoon off Mosquito Beach. Soil in this MRS is generally Descalabrado clay loam. Amelia gravelly clay loam is present in the valleys. Several wells are present in MRS 06 at the base of the valleys leading to Mangrove Harbor and Mosquito Bay. These wells were used for livestock in the past.

5.6.1.2 Groundwater is likely present within valley alluvial deposits, fractures and joints in the volcanic rock, and possibly also buried weathered zones and/or interflow stream deposits. Several abandoned livestock watering wells are present at the bottom of these valleys. None of the wells in this area are in use. Groundwater on MRS 06 is considered a secondary exposure medium because it could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking water receptors for groundwater at MRS 06, the groundwater migration pathway is incomplete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 06.

5.6.2 Surface Water Migration Pathway

5.6.2.1 Several small lagoons and ponds are on MRS 06, and a few ephemeral streams on MRS 06 drain to Mosquito Bay and Mangrove Harbor.

5.6.2.2 Suspected range configurations indicate that the lagoon near Mosquito Bay may have been contaminated by direct fire; however, the observations made by the field team (lack of MEC and MD) do not support this assertion. Surface water / sediment on MRS 06 is considered either a primary or secondary exposure medium. The small ponds and lagoons may have been contaminated directly during military use of the island or through migration or leaching of MC from surface soil.

5.6.2.3 The points of exposure for surface water / sediment and associated receptor interaction could occur at the lagoons or in the ephemeral gullies during or just after heavy precipitation. According to the 2000 census, there are 27 full-time residents within MRS 06. The surface water / sediment exposure pathway at MRS 06 is considered to be a complete exposure pathway. No sediment or surface water samples were collected within MRS 06; therefore, a SLRA for surface water / sediment was not performed.

However, Sections 6.2.5.3 and 6.3.6.4 further discuss potential risk due to MC in surface water / sediment at MRS 06.

5.6.3 Soil Exposure Pathway

5.6.3.1 MRS 06 is privately owned by many landowners and has scattered private homes. FWS manages the beaches at MRS 06 for sea turtle nesting habitat. At the time of the 2000 census, there were 27 full-time residents within MRS 06 (Figure 5.7). There are no fences or other access barriers at this site; however, vegetation is extremely dense and restricts access to roads, trails, and landscaped yards.

5.6.3.2 No MEC or MD was observed during the QR in MRS 06. Field personnel collected soil samples CUL-06-SS-06-20 and CUL-06-SS-06-21 from the locations shown on Figures 5.1A and 5.2A. These locations were selected based on military use of the area surrounding Mosquito Bay. Historical reports suggest that a 1924 firing point, a 1937 artillery range, and several 1939 range firing points were located in the vicinity of SS-20 and SS-21.

5.6.3.3 As shown in Table 5.1, laboratory analysis of the two soil samples detected several metals. No explosive compounds were detected at MRS 06 or in any of the samples collected at the Culebra Island FUDS. Table 5.10 compares maximum detected concentrations of each analyte to the three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.10, two of the soil analytes (chromium and copper) were retained for consideration in the SLRA that was conducted to further evaluate the soil migration pathway at MRS 06, as presented in Sections 6.2.4.3 and 6.3.5.3.

5.6.4 Air Migration Pathway

5.6.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. The entire Island of Culebra is within 4 miles of MRS 06. The 2000 census reports a population of 1,868 persons within the municipality of Culebra. Figure 5.7 shows the 2000 census tract for MRS 06.

5.6.4.2 The air migration exposure pathway at MRS 06 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.6.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 06.

Table 5.10
MRS 06
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	31000	30000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.33	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	2.2	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	180	270	No	**Yes**	**Yes**	No	Not detected above background
Beryllium	mg/kg	0.82	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.1	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	4500	10000	No	**Yes**	No	No	Not detected above background
Chromium	mg/kg	19	15	**Yes**	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	22	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	130	110	**Yes**	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	61000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	15	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	4800	4900	No	**Yes**	No	No	Not detected above background
Manganese	mg/kg	1300	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.046	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.99	0.63	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Nickel	mg/kg	12	9.4	**Yes**	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	4700	4000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	1.1	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	0.19	0.28	No	No	**Yes**	No	Not detected above background
Sodium	mg/kg	270	640	No	**Yes**	No	No	Not detected above background
Strontium	mg/kg	39	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.061	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	1200	1600	No	**Yes**	No	No	Not detected above background
Vanadium	mg/kg	190	430	No	No	No	No	Not detected above background
Zinc	mg/kg	72	81	No	**Yes**	**Yes**	No	Not detected above background
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

5.7 MRS 07 – CULEBRITA ARTILLERY IMPACT AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 07. The CSEM for MRS 07 is in Appendix J.

5.7.1 Groundwater Migration Pathway

5.7.1.1 The bedrock of Culebrita consists predominantly of andesite lava and lava breccia. Some clay and sand deposits are present on the north beach of Culebrita; however, the soil has not been mapped in this MRS. Four small lagoons are present on Culebrita, and there are no ephemeral streams or gullies. No wells or groundwater withdrawals have been documented on Culebrita; however, the field team did identify one abandoned well near the center of the island.

5.7.1.2 Groundwater at MRS 07 is likely present within valley alluvial deposits, fractures and joints in the volcanic rock, and possibly also in buried weathered zones and/or interflow stream deposits. Groundwater on MRS 07 is considered a secondary exposure medium because it could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking water receptors for groundwater at MRS 07, the groundwater migration pathway is incomplete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 07.

5.7.2 Surface Water Migration Pathway

5.7.2.1 Several lagoons and ponds are present on MRS 07, but there are no ephemeral streams or gullies. Historical records indicate that artillery impact may have occurred on Culebrita in the vicinity of the lagoon; therefore, surface water / sediment on MRS 07 is considered a primary exposure medium due to the potential for munitions debris and MEC in the lagoon. Surface water / sediment is also a secondary exposure medium due to the potential for transport of contaminated surface soil to surface water / sediment through runoff or erosion.

5.7.2.2 The receptor exposure points for surface water / sediment could occur at the lagoon when water is present or in the ephemeral gullies during or just after heavy precipitation. As stated in Section 5.7.3.3, there are no residents within MRS 07; however, visitors frequent the area.

5.7.2.3 The sediment sample collected in MRS 07 (CUL-07-SE-06-02) was collected on the west side of the lagoon (Figures 5.1A and 5.2A). As shown in Table 5.1, laboratory analysis of the samples detected no explosive compound but detected several metals. Table 5.11 compares maximum detected concentrations of each analyte to the SLRA requirements, as stated in Section 5.1.6 paragraph 5.1.6.3. As seen in Table 5.11, five metals (barium, chromium, copper, lead, and zinc) were retained for consideration in the SLRA that was conducted to further evaluate the surface water / sediment migration pathway at MRS 07, as presented in Sections 6.2.5.4 and 6.3.6.5.

Table 5.11
MRS 07
Sediment Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Potential MC? [a]	CERCLA Hazardous? [b]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A						
Aluminum	mg/kg	1700	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.41	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	0.63	No	**Yes**	No	Not a potential MC
Barium	mg/kg	16	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	0.054	No	**Yes**	No	Not a potential MC
Cadmium	mg/kg	0.016	No	**Yes**	No	Not a potential MC
Calcium	mg/kg	370000	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	3	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	1.9	No	**Yes**	No	Not a potential MC
Copper	mg/kg	6.7	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	1900	**Yes**	No	No	Not CERCLA hazardous
Lead	mg/kg	1.9	**Yes**	**Yes**	**Yes**	--
Magnesium	mg/kg	7700	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	36	No	No	No	Not a potential MC
Mercury	mg/kg	< 0.054	**Yes**	**Yes**	No	Not detected at MRS
Molybdenum	mg/kg	0.086	**Yes**	No	No	Not CERCLA hazardous
Nickel	mg/kg	14	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	510	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	0.68	No	**Yes**	No	Not a potential MC
Silver	mg/kg	0.16	No	**Yes**	No	Not a potential MC
Sodium	mg/kg	6300	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	7000	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.0049	No	**Yes**	No	Not a potential MC
Titanium	mg/kg	150	**Yes**	No	No	Not CERCLA hazardous
Vanadium	mg/kg	8.7	No	No	No	Not a potential MC
Zinc	mg/kg	5	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A						
1,3,5-Trinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	ug/kg	< 180	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	ug/kg	< 300	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS

a - Potential MCs as listed in Table 4.1

b - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

5.7.3 Soil Exposure Pathway

5.7.3.1 Culebrita beaches are accessed by the general public regularly via boat. Slightly overgrown, unmaintained trails connect the north, east, and west beaches. There is also a trail to the lighthouse on the south-central portion of Culebrita. Culebrita is managed by the USFWS, and there are no full- or part-time residents on the island. There are no fences or physical barriers to this site, but the restrictive vegetation obstructs travel off established trails.

5.7.3.2 The field team observed MD at one location during the QR on MRS 07. Field personnel collected soil sample CUL-07-SS-06-25 and CUL-07-SS-06-26 from the locations shown on Figures 5.1A and 5.2A. Soil sample locations were selected based on identified impact areas on the west-facing slope of both the northeastern and northwestern lobes of Culebrita. Soil at this MRS is considered a primary exposure medium that may have been contaminated by direct fire.

5.7.3.3 As shown in Table 5.1, laboratory analysis of the sample detected several metals. No explosive compounds were detected at MRS 07 or in any of the samples collected at the Culebra Island FUDS. The maximum detected concentration of each metal was compared to selected background concentrations, the MC list in Table 4.1, and the CERCLA hazardous substance list. Table 5.12 compares maximum detected concentrations of each analyte to these three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.12, three of the soil analytes (barium, copper, and zinc) were retained for consideration in the SLRA that was conducted to further evaluate the soil migration pathway at MRS 07, as presented in Sections 6.2.4.4 and 6.3.5.4.

5.7.4 Air Migration Pathway

5.7.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. At the time of the 2000 census, approximately 663 full-time residents lived within 4 miles of MRS 07 (Figure 5.8).

5.7.4.2 The air migration exposure pathway at MRS 07 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.7.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 07. While the air pathway is believed to be incomplete, based on the previous arguments, the Region 9 residential soil PRGs include an evaluation of inhalation of fugitive dust. Therefore, an evaluation of the air pathway is included in the SLRA for soil.

Table 5.12
MRS 07
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	26000	30000	No	**Yes**	No	No	Not detected above background
Antimony	mg/kg	0.25	<0.32	No	**Yes**	**Yes**	No	Not detected above background
Arsenic	mg/kg	1.7	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	480	270	**Yes**	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	0.93	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.16	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	7600	10000	No	**Yes**	No	No	Not detected above background
Chromium	mg/kg	9.9	15	No	**Yes**	**Yes**	No	Not detected above background
Cobalt	mg/kg	37	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	600	110	**Yes**	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	53000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	72	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	5600	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	1800	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.048	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.31	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	8.9	9.4	No	No	**Yes**	No	Not detected above background
Potassium	mg/kg	3900	4000	No	**Yes**	No	No	Not detected above background
Selenium	mg/kg	1.4	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	0.29	0.28	**Yes**	No	**Yes**	No	Not a potential MC
Sodium	mg/kg	530	640	No	**Yes**	No	No	Not detected above background
Strontium	mg/kg	88	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.029	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	1300	1600	No	**Yes**	No	No	Not detected above background
Vanadium	mg/kg	220	430	No	No	No	No	Not detected above background
Zinc	mg/kg	240	81	**Yes**	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

5.8 MRS 08 – CAYO NORTE IMPACT AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 08. The CSEM for MRS 08 is in Appendix J.

5.8.1 Groundwater Migration Pathway

5.8.1.1 The bedrock of Cayo Norte includes andesite lava, lava breccia, and tuff. The field team did not observe any wells. Three ephemeral gulches are present, and it is likely that groundwater is present in the fractures and joints of the volcanic rock and possibly also in buried weathered zones and/or interflow stream deposits.

5.8.1.2 There are no drinking water receptor exposure points for groundwater on Cayo Norte; however, groundwater discharges to the lagoon on Cayo Norte, providing a potential dermal exposure point. If MC are present in the soil, there is potential that the MC could reach the lagoon via groundwater discharge or surface water flow. The TPP Team agreed that sediment from the lagoon would be the most likely location of MC if present in the lagoon water on Cayo Norte. Groundwater on MRS 08 is considered a secondary exposure medium because it could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking water receptors for groundwater at MRS 08, the groundwater migration pathway is incomplete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 08.

5.8.2 Surface Water Migration Pathway

5.8.2.1 There are several ephemeral streams on Cayo Norte. Two streams drain to a small lagoon on the south-facing slope of the island. The field team observed one stream that was flowing and may be fed by groundwater discharge. Very heavy rains had occurred at Culebra just prior to the site visit, and water levels in lagoons throughout the Culebra Island FUDS were high. The receptor exposure points for surface water / sediment could occur at the lagoon when water is present or in the ephemeral gullies during or just after heavy precipitation. There are two full-time residents within MRS 08.

5.8.2.2 The sediment sample from MRS 08 (CUL-08-SE-06-05) was collected on the northwest side of lagoon (Figures 5.1A and 5.2A). As shown in Table 5.1, laboratory analysis of the samples detected no explosive compounds but detected several metals. Table 5.13 compares maximum detected concentrations of each analyte to the SLRA requirements, as stated in Section 5.1.6 paragraph 5.1.6.3. As seen in Table 5.13, six metals (barium, chromium, copper, lead, mercury, and zinc) were retained for consideration in the SLRA that was conducted to further evaluate the surface water / sediment migration pathway at MRS 08, as presented in Sections 6.2.5.5 and 6.3.6.6.

5.8.3 Soil Exposure Pathway

5.8.3.1 Cayo Norte is privately owned and is not accessible to the public. At the time of the 2000 census, there were two full-time residents on Cayo Norte (Figure 5.9). There are no fences or physical barriers to this site; however, a private security guard is present

Table 5.13
MRS 08
Sediment Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Potential MC? [a]	CERCLA Hazardous? [b]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A						
Aluminum	mg/kg	17000	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.36	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	1.3	No	**Yes**	No	Not a potential MC
Barium	mg/kg	140	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	0.69	No	**Yes**	No	Not a potential MC
Cadmium	mg/kg	0.11	No	**Yes**	No	Not a potential MC
Calcium	mg/kg	4300	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	2.1	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	11	No	**Yes**	No	Not a potential MC
Copper	mg/kg	19	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	39000	**Yes**	No	No	Not CERCLA hazardous
Lead	mg/kg	5.9	**Yes**	**Yes**	**Yes**	--
Magnesium	mg/kg	3700	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	350	No	No	No	Not a potential MC
Mercury	mg/kg	0.011	**Yes**	**Yes**	**Yes**	--
Molybdenum	mg/kg	0.085	**Yes**	No	No	Not CERCLA hazardous
Nickel	mg/kg	0.93	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	2800	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	1.2	No	**Yes**	No	Not a potential MC
Silver	mg/kg	0.13	No	**Yes**	No	Not a potential MC
Sodium	mg/kg	2200	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	30	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.089	No	**Yes**	No	Not a potential MC
Titanium	mg/kg	610	**Yes**	No	No	Not CERCLA hazardous
Vanadium	mg/kg	81	No	No	No	Not a potential MC
Zinc	mg/kg	61	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A						
1,3,5-Trinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	ug/kg	< 180	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	ug/kg	< 300	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	ug/kg	< 120	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	ug/kg	< 500	**Yes**	**Yes**	No	Not detected at MRS

a - Potential MCs as listed in Table 4.1

b - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

on the island and trespassing is prohibited. The restrictive vegetation obstructs travel on the island. The field team did not identify any trails or roads.

5.8.3.2 Field personnel collected soil sample CUL-08-SS-06-23 and CUL-08-SS-06-24 from the locations shown on Figures 5.1A and 5.2A. Soil locations were selected to screen for MC on the south-facing slope of MRS 08, which is within the impact area for the artillery range originating from MRS 06 near Mosquito Bay.

5.8.3.3 As shown in Table 5.1, laboratory analysis of the sample detected several metals. No explosive compounds were detected at MRS 08 or in any of the samples collected at the Culebra Island FUDS. Table 5.14 compares maximum detected concentrations of each analyte to the three SLRA criteria, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.14, only zinc was retained for consideration in the SLRA that was conducted to further evaluate the soil migration pathway at MRS 08, as presented in Sections 6.2.4.5 and 6.3.5.5.

5.8.4 Air Migration Pathway

5.8.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. According to the 2000 census, 1,828 persons live within the Culebra FUDS and all of these residents are within 4 miles of MRS 08.

5.8.4.2 The air migration exposure pathway at MRS 08 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.8.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 08.

5.9 MRS 09 – SOLDADO POINT MORTAR AND BOMBING AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 09. The CSEM for MRS 09 is in Appendix J.

5.9.1 Groundwater Migration Pathway

5.9.1.1 The bedrock at Soldado Point mortar and bombing area is composed of andesite lava and lava breccia. No soil is present in this area except in a very small tidal swamp area at the top of Concha Cove. There are no ephemeral gulches in this area.

5.9.1.2 Groundwater is likely present within fractures and joints in the volcanic rock and also possibly within buried weathered zones and/or interflow stream deposits. One abandoned livestock watering well is present at the north end of Cocha Cove. The well is

Table 5.14
MRS 08
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	30000	30000	No	**Yes**	No	No	Not detected above background
Antimony	mg/kg	< 0.31	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	2.2	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	200	270	No	**Yes**	**Yes**	No	Not detected above background
Beryllium	mg/kg	0.76	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.25	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	21000	10000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	2.5	15	No	**Yes**	**Yes**	No	Not detected above background
Cobalt	mg/kg	17	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	28	110	No	**Yes**	**Yes**	No	Not detected above background
Iron	mg/kg	61000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	7.7	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	6200	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	1900	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.046	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.33	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	1.5	9.4	No	No	**Yes**	No	Not detected above background
Potassium	mg/kg	4600	4000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	0.84	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	0.19	0.28	No	No	**Yes**	No	Not detected above background
Sodium	mg/kg	210	640	No	**Yes**	No	No	Not detected above background
Strontium	mg/kg	51	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.19	0.12	**Yes**	No	**Yes**	No	Not a potential MC
Titanium	mg/kg	1600	1600	No	**Yes**	No	No	Not detected above background
Vanadium	mg/kg	92	430	No	No	No	No	Not detected above background
Zinc	mg/kg	90	81	**Yes**	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

not presently used (Cherry, 1995). Groundwater on MRS 09 is considered a secondary exposure medium; with no direct contact between munitions and the groundwater, this medium could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking water receptors for groundwater at MRS 09, the groundwater migration pathway is incomplete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 09.

5.9.2 Surface Water Migration Pathway

5.9.2.1 There is one ephemeral stream on MRS 09, and one lagoon is present near Cocha Cove. The CSEM for MRS 09 is in Appendix J. Historical records do not indicate direct fire at the lagoon near Cocha Cove; therefore, surface water / sediment on MRS 09 is not considered a primary exposure medium. Surface water / sediment at MRS 09 is a secondary exposure medium due to the potential for contaminated surface soil to be transported to surface water / sediment through runoff or erosion.

5.9.2.2 The points of exposure for surface water / sediment and associated receptor interaction could occur at the lagoons or in the ephemeral gullies during or just after heavy precipitation. According to the 2000 census, there are five full-time residents within MRS 09. The surface water / sediment exposure pathway at MRS 09 is considered to be a complete exposure pathway. No sediment or surface water samples were collected within MRS 09; therefore, a SLRA for surface water / sediment was not performed. However, Sections 6.2.5.6 and 6.3.6.7 further discuss potential risk due to MC in surface water / sediment at MRS 09.

5.9.3 Soil Exposure Pathway

5.9.3.1 All of MRS 09 is managed by the Puerto Rico DNER. A gravel road that runs through this portion of the island provides access to the beach north of Soldado Point. This beach is publicly accessible for recreation, diving, and snorkeling. Squatters have built a small number of shacks at the base of the cliffs along the gravel beach at Sueno Cove. The 2000 census shows that five full-time residents were present on this property at that time. There are no fences or physical barriers to this site. The vegetation is very restrictive and discourages travel off established trails and roads.

5.9.3.2 Field personnel collected soil samples CUL-09-SS-06-09 and CUL-09-SS-06-10 from the locations shown on Figures 5.1B and 5.2B. Soil sample locations were selected based on identified historical training areas, including 1935 Defensive Area No. 1, a 1936 aerial target, and a 1938 mortar boat firing area.

5.9.3.3 As shown in Table 5.1, laboratory analysis of the two soil samples detected several metals. No explosive compounds were detected at MRS 09 or in any of the samples collected at the Culebra Island FUDS. Table 5.15 compares maximum detected concentrations of each analyte to the three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.15, only chromium was retained for consideration in the SLRA that was conducted to further evaluate the soil migration pathway at MRS 09, as presented in Sections 6.2.4.6 and 6.3.5.6.

Table 5.15
MRS 09
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	34000	30000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.34	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	2.4	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	120	270	No	**Yes**	**Yes**	No	Not detected above background
Beryllium	mg/kg	0.53	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.26	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	8200	10000	No	**Yes**	No	No	Not detected above background
Chromium	mg/kg	19	15	**Yes**	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	23	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	98	110	No	**Yes**	**Yes**	No	Not detected above background
Iron	mg/kg	51000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	8.8	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	7700	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	1700	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.035	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.25	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	16	9.4	**Yes**	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	4100	4000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	0.92	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	0.18	0.28	No	No	**Yes**	No	Not detected above background
Sodium	mg/kg	850	640	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	81	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.046	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	2000	1600	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Vanadium	mg/kg	160	430	No	No	No	No	Not detected above background
Zinc	mg/kg	60	81	No	**Yes**	**Yes**	No	Not detected above background
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

5.9.4 Air Migration Pathway

5.9.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. The entire Island of Culebra is within 4 miles of MRS 09. The 2000 census reports a population of 1,868 persons within the municipality of Culebra. Figure 5.10 shows the 2000 census tract for MRS 09.

5.9.4.2 The air migration exposure pathway at MRS 09 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.9.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 09. While the air pathway is believed to be incomplete, based on the previous arguments, the Region 9 residential soil PRGs include an evaluation of inhalation of fugitive dust. Therefore, an evaluation of the air pathway is included in the SLRA for soil.

5.10 MRS 10 – DEFENSIVE FIRING AREA NO. 1

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 10.

5.10.1 Groundwater Migration Pathway

5.10.1.1 The bedrock of MRS 10 includes andesite lava and lava breccia. Most of MRS 10 is exposed bedrock; however, Descalabrado clay loam is also present with patches of Jacana clay. The CSEM for MRS 10 is in Appendix J.

5.10.1.2 Groundwater is likely present within fractures and joints in the volcanic rock at MRS 10, and also possibly within buried weathered zones and interflow stream deposits (that is, between lava flows). Several abandoned livestock watering wells are present surrounding the MRS, and two of the wells near Fulladosa Cove may still be used to water livestock and horses (Cherry, 1995). Groundwater on MRS 10 is considered a secondary exposure medium because it could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking water receptors for groundwater at MRS 10, the groundwater migration pathway is incomplete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 10.

5.10.2 Surface Water Migration Pathway

5.10.2.1 There are no perennial surface water bodies in MRS 10; however, small ephemeral gullies drain storm water west to the ocean and east to Great Harbor only after heavy rain. Based on the absence of surface water on site, the surface water / sediment

migration pathway for human health is incomplete. No human health risk from MC is expected through surface water / sediment at MRS 10.

5.10.2.2 Points of exposure for surface water / sediment and associated ecological receptor interaction could occur in the ephemeral gullies during or just after heavy precipitation. No sediment or surface water samples were collected within MRS 10; therefore, a SLRA for surface water / sediment was not performed. Section 6.3.6.8 further discusses potential ecological risk due to MC in surface water / sediment at MRS 10.

5.10.3 Soil Exposure Pathway

5.10.3.1 At the time of the 2000 census, there were approximately 117 full-time residents in MRS 10. Figure 5.11 shows the 2000 census tract for MRS 10. The town of Dewey is just outside the northern boundary of MRS 10. Much of MRS 10 is accessible to the public via paved and gravel roads through residential areas.

5.10.3.2 Field personnel collected soil samples CUL-10-SS-06-07 and CUL-10-SS-06-08 from the locations shown on Figures 5.1B and 5.2B. Soil sample locations were selected based on identified historical training areas, including 1935 Defensive Area No. 1.

5.10.3.3 As shown in Table 5.1, laboratory analysis of the two soil samples detected several metals. No explosive compounds were detected at MRS 10 or in any of the samples collected at the Culebra Island FUDS. Table 5.16 compares maximum detected concentrations of each analyte to the three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.16, four analytes (barium, chromium, copper, and zinc) were retained for consideration in the SLRA that was conducted to further evaluate the soil migration pathway at MRS 10, as presented in Sections 6.2.4.7 and 6.3.5.7.

5.10.4 Air Migration Pathway

5.10.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. The entire Island of Culebra is within 4 miles of MRS 10. The 2000 census reports a population of 1,868 persons within the municipality of Culebra. Figure 5.11 shows the 2000 census tract for MRS 10.

5.10.4.2 The air migration exposure pathway at MRS 10 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.10.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 10. While the air pathway is believed to be incomplete, based on the previous arguments,

Table 5.16
MRS 10
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	44000	30000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.32	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	3.3	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	1100	270	**Yes**	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	2.4	1.5	**Yes**	No	**Yes**	No	Not a potential MC
Cadmium	mg/kg	0.15	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	19000	10000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	22	15	**Yes**	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	67	38	**Yes**	No	**Yes**	No	Not a potential MC
Copper	mg/kg	230	110	**Yes**	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	84000	78000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Lead	mg/kg	9.5	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	9000	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	3400	2400	**Yes**	No	No	No	Not a potential MC
Mercury	mg/kg	0.023	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.58	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	11	9.4	**Yes**	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	3200	4000	No	**Yes**	No	No	Not detected above background
Selenium	mg/kg	2.8	1.4	**Yes**	No	**Yes**	No	Not a potential MC
Silver	mg/kg	0.26	0.28	No	No	**Yes**	No	Not detected above background
Sodium	mg/kg	520	640	No	**Yes**	No	No	Not detected above background
Strontium	mg/kg	100	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.1	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	1400	1600	No	**Yes**	No	No	Not detected above background
Vanadium	mg/kg	680	430	**Yes**	No	No	No	Not a potential MC
Zinc	mg/kg	130	81	**Yes**	**Yes**	**Yes**	**Yes**	--
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

the Region 9 residential soil PRGs include an evaluation of inhalation of fugitive dust. Therefore, an evaluation of the air pathway is included in the SLRA for soil.

5.11 MRS 11 – DEFENSIVE FIRING AREA NO. 2

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 11. The CSEM for MRS 11 is in Appendix J.

5.11.1 Groundwater Migration Pathway

5.11.1.1 The bedrock of MRS 11 is entirely andesite lava and lava breccia. Most of the soil in MRS 11 is Descalabrado clay loam with patches of Jacana clay, Amelia gravelly clay loam, and Fraternidad clay (Figure 2.1). There are a few small tidal swamp deposits as well. Groundwater is likely present within fractures and joints in the volcanic rock at MRS 11 and possibly also in buried weathered zones and interflow stream deposits. Several abandoned livestock watering wells are within the MRS, as well as four observation wells near the landfill on the north end of MRS 11 and a few active domestic wells used for watering plants, flushing toilets, cleaning, and watering livestock and horses (Cherry, 1995).

5.11.1.2 Groundwater at MRS 11 is considered a secondary exposure medium; with no direct contact between munitions and the groundwater. Groundwater could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking water receptors for groundwater at MRS 11, the groundwater migration pathway is incomplete and a SLRA was not performed. No human health or ecological risk from MC is expected through groundwater at MRS 11.

5.11.2 Surface Water Migration Pathway

5.11.2.1 There are several ephemeral streams on MRS 11, and one lagoon is present north of Target Bay. Historical records do not indicate direct fire at the lagoon north of Target Bay; therefore, surface water / sediment at MRS 11 is not considered a primary exposure medium. Surface water / sediment at MRS 11 is a secondary exposure medium due to the potential for contaminated surface soil to be transported to surface water / sediment through runoff or erosion.

5.11.2.2 Points of exposure for surface water / sediment and associated receptor interaction could occur in the ephemeral gullies during or just after heavy precipitation. According to the 2000 census, there are approximately 1,028 full-time residents within MRS 11. No sediment or surface water samples were collected within MRS 11. As discussed in Section 5.11.3, no analytes detected in soil at MRS 11 met the three criteria described in Section 5.1.7 paragraph 5.1.7.5 that designate the need to perform a SLRA for any particular analyte. Because surface water / sediment at MRS 11 is not considered a primary exposure medium, contamination can only occur through transport from soil. Because the soil migration pathway it not complete, the surface water / sediment migration pathway is also incomplete. Therefore, a SLRA is not required for the surface water / sediment migration pathway at MRS 11, and no human health or ecological risk from MC is expected through surface water / sediment at MRS 11.

5.11.3 Soil Exposure Pathway

5.11.3.1 The town of Dewey is at the southern end of MRS 11, and residential development is present in the southeastern portion of this site with 1,028 full time residents reported on this portion of MRS 11. As shown on Figure 5.12, the 2000 census tract shows no full-time residents in the northern portion of MRS 11. There is a hotel near the lagoon on the west side of MRS 11. There are no fences or physical barriers to this site; however, the dense vegetation is very restrictive and discourages travel off established trails and roads.

5.11.3.2 Field personnel collected soil samples CUL-11-SS-06-03, CUL-11-SS-06-04, CUL-11-SS-06-05, and CUL-11-SS-06-06 from the locations shown on Figures 5.1B and 5.2B. These locations were selected based on the locations of the 1938 Defensive Area No. 2 and an area used for infantry and tank direct fire in 1935.

5.11.3.3 As shown in Table 5.1, no explosive compounds were detected at MRS 11 or in any of the samples collected at the Culebra Island FUDS. However, laboratory analysis of the samples detected several metals. The maximum detected concentration of each metal was compared to selected background concentrations, the MC list in Table 4.1, and the CERCLA hazardous substance list. Table 5.17 compares maximum detected concentrations of each analyte to the three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.17, none of the soil analytes were retained for consideration in a SLRA. Therefore, a SLRA is not required for the soil migration pathway at MRS 11, and no human health or ecological risk from MC is expected through soil at MRS 11.

5.11.4 Air Migration Pathway

5.11.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. The entire Island of Culebra is within 4 miles of MRS 11. The 2000 census reports a population of 1,868 persons within the municipality of Culebra. Figure 5.12 shows the 2000 census tract for MRS 11.

5.11.4.2 The air migration exposure pathway at MRS 11 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.11.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 11.

Table 5.17
MRS 11
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	31000	30000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.31	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	4.1	3.4	**Yes**	No	**Yes**	No	Not a potential MC
Barium	mg/kg	120	270	No	**Yes**	**Yes**	No	Not detected above background
Beryllium	mg/kg	0.48	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.16	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	140000	10000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	10	15	No	**Yes**	**Yes**	No	Not detected above background
Cobalt	mg/kg	19	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	72	110	No	**Yes**	**Yes**	No	Not detected above background
Iron	mg/kg	45000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	4.9	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	6900	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	1500	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.035	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.3	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	8.1	9.4	No	No	**Yes**	No	Not detected above background
Potassium	mg/kg	5100	4000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	1	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	0.26	0.28	No	No	**Yes**	No	Not detected above background
Sodium	mg/kg	2000	640	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Strontium	mg/kg	2900	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.1	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	2200	1600	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Vanadium	mg/kg	150	430	No	No	No	No	Not detected above background
Zinc	mg/kg	68	81	No	**Yes**	**Yes**	No	Not detected above background
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

5.12 MRS 12 – LUIS PENA CHANNEL WATER AREAS

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 12. The CSEM for MRS 12 is in Appendix J.

5.12.1 Groundwater Migration Pathway

MRS 12 includes the underwater area along the east side of MRS 11 and most of Northwest Peninsula (MRS 02) in Luis Pena Channel. The geology of this area has not been mapped; however, the surrounding geology indicates that the bedrock is likely composed of andesite lava and lava breccia. The sea floor in this MRS is covered by sand and coral. The area is not in a bay, and there are no tidal restrictions. MRS 12 is completely underwater in Luis Pena Channel. At the time of the 2000 census, there were no full-time residents in MRS 12 (Figure 5.13). Groundwater is not present; therefore, a groundwater migration pathway at MRS 12 is not relevant or complete, and no human health or ecological risk from MC is expected through groundwater at MRS 12.

5.12.2 Surface Water Migration Pathway

MRS 12 is an underwater MRS connected to the Atlantic Ocean. The ocean would dilute MC; therefore, no MC hazard can exist in this area. The surface water / sediment migration pathway is incomplete for MRS 12. Therefore, no human health or ecological risk from MC is expected through surface water / sediment at MRS 12.

5.12.3 Soil Exposure Pathway

5.12.3.1 Soil in MRS 12 consists of sand and coral on the seafloor in Luis Pena Channel. This area is accessible to the general public and is used frequently for recreational swimming, snorkeling, and diving. Contact with the sand would most likely occur at shallow water depths. There are no fences or other restrictions to access.

5.12.3.2 The TPP Team agreed that no soil or sediment sampling would be conducted as part of the SI at MRS 12. The constant movement and exposure of the sand to ocean water greatly reduces the likelihood that MC remains in the soil or sediment at this MRS. Therefore, the soil migration pathway is incomplete for MRS 12. No human health or ecological risk from MC is expected through soil at MRS 12.

5.12.4 Air Exposure Pathway

Air at MRS 12 is not considered to be a medium of concern. Air has not been directly contaminated from military use of the site, and there is no potential for an exposure to MC through inhalation of fugitive dust because MRS 12 is entirely underwater. No human health or ecological risk from MC is expected through air at MRS 12.

5.13 MRS 13 – CAYO LUIS PENA IMPACT AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 13. The CSEM for MRS 13 is in Appendix J.

5.13.1 Groundwater Migration Pathway

5.13.1.1 The bedrock at MRS 13 consists of andesite lava and lava breccia. The soils have not been mapped on Cayo Luis Pena. The hydrology of Cayo Luis Pena is not known; however, it is likely that groundwater is present in fractures and joints in the bedrock, and possibly also in buried weathered zones or interflow stream deposits. There are no known wells, but there are a few ephemeral streams within MRS 13.

5.13.1.2 Groundwater on MRS 13 is considered a secondary exposure medium; with no direct contact between munitions and the groundwater, this medium could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking water receptors for groundwater at MRS 13, the groundwater migration pathway is incomplete and no SLRA was performed. No human health or ecological risk from MC is expected through groundwater at MRS 13.

5.13.2 Surface Water Migration Pathway

5.13.2.1 There are no perennial surface water bodies in MRS 13; however, small ephemeral gullies drain storm water off the cay. Based on the absence of surface water on site, the surface water migration pathway for human health is incomplete. No human health risk from MC is expected through surface water / sediment at MRS 13.

5.13.2.2 Points of exposure for surface water / sediment and associated ecological receptor interaction could occur in the ephemeral gullies during or just after heavy precipitation. No sediment or surface water samples were collected within MRS 13; therefore, a SLRA for surface water / sediment was not performed. Section 6.3.6.9 further discusses potential ecological risk due to MC in surface water / sediment at MRS 13.

5.13.3 Soil Exposure Pathway

5.13.3.1 MRS 13 is undeveloped, and there are no residences on the site. An old jeep road wraps around the center of the island and leads to the old military observation post. There are building foundations, construction debris, and a helicopter pad in this area. There are no fences or physical barriers to this site; however, the vegetation is restrictive and discourages travel on the island. The old road is very overgrown in spots and is difficult to follow even on foot. Cayo Luis Pena is managed by the USFWS.

5.13.3.2 Field personnel collected soil samples CUL-13-SS-06-01 and CUL-13-SS-06-02 from the locations shown on Figures 5.1B and 5.2B. These locations were selected based on the locations of a 1924 target area at the north end of Cayo Luis Pena and a 1939 aircraft bombing and machine gun range encompassing the entire cay.

5.13.3.3 As shown in Table 5.1, laboratory analysis of the two soil samples detected several metals. No explosive compounds were detected at MRS 13 or in any of the samples collected at the Culebra Island FUDS. Table 5.18 compares maximum detected concentrations of each analyte to the three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.18, only chromium was retained for consideration

Table 5.18
MRS 13
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	49000	30000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Antimony	mg/kg	< 0.32	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	1.3	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	110	270	No	**Yes**	**Yes**	No	Not detected above background
Beryllium	mg/kg	0.43	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.25	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	14000	10000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Chromium	mg/kg	17	15	**Yes**	**Yes**	**Yes**	**Yes**	--
Cobalt	mg/kg	26	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	94	110	No	**Yes**	**Yes**	No	Not detected above background
Iron	mg/kg	55000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	6.2	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	15000	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	1900	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.048	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.21	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	12	9.4	**Yes**	No	**Yes**	No	Not a potential MC
Potassium	mg/kg	6100	4000	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Selenium	mg/kg	0.91	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	0.19	0.28	No	No	**Yes**	No	Not detected above background
Sodium	mg/kg	430	640	No	**Yes**	No	No	Not detected above background
Strontium	mg/kg	58	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.052	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	1400	1600	No	**Yes**	No	No	Not detected above background
Vanadium	mg/kg	250	430	No	No	No	No	Not detected above background
Zinc	mg/kg	74	81	No	**Yes**	**Yes**	No	Not detected above background
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

in the SLRA that was conducted to further evaluate the soil migration pathway at MRS 13, as presented in Sections 6.2.4.8 and 6.3.5.8.

5.13.4 Air Migration Pathway

5.13.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. A 4-mile buffer around MRS 13 encompasses nearly the entire Island of Culebra. The 2000 census reports a population of 1,839 persons within the 4-mile buffer. Figure 5.14 shows the 2000 census tract for MRS 13.

5.13.4.2 The air migration exposure pathway at MRS 13 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.13.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 13. While the air pathway is believed to be incomplete, based on the previous arguments, the Region 9 residential soil PRGs include an evaluation of inhalation of fugitive dust. Therefore, an evaluation of the air pathway is included in the SLRA for soil.

5.14 MRS 14 – AIRPORT AND CAMP AREA

Sections 5.1 and 5.2 summarize information on the regional setting, migration pathways, exposure targets, and historical MC information for the former Culebra Island FUDS. This section provides additional details specific to MRS 14. The CSEM for MRS 14 is in Appendix J.

5.14.1 Groundwater Migration Pathway

5.14.1.1 The bedrock at MRS 14 consists of andesite lava and lava breccia with sand and clay deposits in the main valley near the airport. Several wells are present in MRS 14. Most of the wells are abandoned livestock or PRASA wells, and one well was listed as used for domestic purposes such as flushing toilets and watering horses (Cherry, 1995). Of the PRASA wells, most were listed as abandoned; however, three wells near Lower Town were not specified as abandoned and may still be used by PRASA (Cherry, 1995). The specific use of this water is not known; however, the 2000 USGS open file report *Estimated Water Use in Puerto Rico* shows zero groundwater withdrawals on Isla de Vieques and Culebra for public-supply water systems or domestic self-supplied use (Molina, 2000).

5.14.1.2 Groundwater is likely present within fractures and joints in the volcanic rock at MRS 14 and possibly also in buried weathered zones and/or interflow stream deposits. Groundwater at MRS 14 is considered a secondary exposure medium. With no direct contact between munitions and the groundwater, this medium could only be contaminated through migration or leaching of MC from subsurface soil. Because there are no drinking

water receptors for groundwater at MRS 14, the groundwater migration pathway is incomplete and no SLRA was performed. No human health or ecological risk from MC is expected through groundwater at MRS 14.

5.14.2 Surface Water Migration Pathway

5.14.2.1 There are no perennial surface water bodies present in MRS 14; however, small ephemeral gullies drain storm water to Great Harbor.

5.14.2.2 The CSEM for MRS 14 is in Appendix J. There are no perennial surface water bodies within MRS 14; therefore, surface water / sediment is considered a secondary exposure medium due to the potential for contaminated surface soil to be transported to surface water / sediment through runoff or erosion.

5.14.2.3 Receptor exposure points for surface water / sediment could occur in the ephemeral gullies during or just after heavy precipitation. There are approximately 425 residents within MRS 14. Figure 5.15 shows the 2000 census tract for MRS 14. The surface water / sediment exposure pathway at MRS 14 is considered to be a complete exposure pathway. No sediment or surface water samples were collected within MRS 14; therefore, a SLRA for surface water / sediment was not performed. However, Sections 6.2.5.7 and 6.3.6.10 further discuss potential risk due to MC in surface water / sediment at MRS 14.

5.14.3 Soil Exposure Pathway

5.14.3.1 According to the 2000 census, approximately 425 full-time residents reside in MRS 14. The area includes the airport and most of the residential areas on the north end of Great Harbor as well as Lower Town and the USFWS and DNER offices. All of MRS 14 is accessible to the public via paved and gravel roads through residential neighborhoods.

5.14.3.2 No MEC or MD were observed during the QR on MRS 14. Field personnel collected soil sample CUL-14-SS-06-13 near the airport at the location shown on Figures 5.1B and 5.2B. The SS-13 location was selected based on the suspected presence of a small arms range north of the airstrip. SS-13 was collected from a small berm identified in the woods that exhibited an abnormal reading on the magnetometer with many extremely small spotty hits and no visible metal on the surface.

5.14.3.3 As shown in Table 5.1, laboratory analysis of the soil sample detected several metals. No explosive compounds were detected at MRS 14 or in any of the samples collected at the Culebra Island FUDS. Table 5.19 compares maximum detected concentrations of each analyte to the three SLRA requirements, as stated in Section 5.1.7 paragraph 5.1.7.5. As seen in Table 5.19, two of the soil analytes (barium and copper) were retained for consideration in the SLRA that was conducted to further evaluate the soil migration pathway at MRS 14, as presented in Sections 6.2.4.9 and 6.3.5.9.

5.14.4 Air Migration Pathway

5.14.4.1 Target populations potentially impacted by the air migration pathway include people who reside, work, or go to school within the target distance limit of 4 miles around the site. The entire Island of Culebra is within 4 miles of MRS 14. The 2000

Table 5.19
MRS 14
Soil Source Evaluation
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	Background Concentration [a]	Exceeds Background Concentration?	Potential MC? [b]	CERCLA Hazardous? [c]	SLRA Required?	Primary reason for exclusion from SLRA
Total Metals - SW6010B/6020/7470A								
Aluminum	mg/kg	27000	30000	No	**Yes**	No	No	Not detected above background
Antimony	mg/kg	< 0.32	<0.32	No	**Yes**	**Yes**	No	Not detected at MRS
Arsenic	mg/kg	1.1	3.4	No	No	**Yes**	No	Not detected above background
Barium	mg/kg	600	270	**Yes**	**Yes**	**Yes**	**Yes**	--
Beryllium	mg/kg	0.67	1.5	No	No	**Yes**	No	Not detected above background
Cadmium	mg/kg	0.23	0.32	No	No	**Yes**	No	Not detected above background
Calcium	mg/kg	6900	10000	No	**Yes**	No	No	Not detected above background
Chromium	mg/kg	6.1	15	No	**Yes**	**Yes**	No	Not detected above background
Cobalt	mg/kg	21	38	No	No	**Yes**	No	Not detected above background
Copper	mg/kg	120	110	**Yes**	**Yes**	**Yes**	**Yes**	--
Iron	mg/kg	51000	78000	No	**Yes**	No	No	Not detected above background
Lead	mg/kg	10	76	No	**Yes**	**Yes**	No	Not detected above background
Magnesium	mg/kg	5100	4900	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Manganese	mg/kg	920	2400	No	No	No	No	Not detected above background
Mercury	mg/kg	0.039	0.094	No	**Yes**	**Yes**	No	Not detected above background
Molybdenum	mg/kg	0.17	0.63	No	**Yes**	No	No	Not detected above background
Nickel	mg/kg	7.1	9.4	No	No	**Yes**	No	Not detected above background
Potassium	mg/kg	3000	4000	No	**Yes**	No	No	Not detected above background
Selenium	mg/kg	1.1	1.4	No	No	**Yes**	No	Not detected above background
Silver	mg/kg	0.19	0.28	No	No	**Yes**	No	Not detected above background
Sodium	mg/kg	380	640	No	**Yes**	No	No	Not detected above background
Strontium	mg/kg	76	35	**Yes**	**Yes**	No	No	Not CERCLA hazardous
Thallium	mg/kg	0.058	0.12	No	No	**Yes**	No	Not detected above background
Titanium	mg/kg	790	1600	No	**Yes**	No	No	Not detected above background
Vanadium	mg/kg	160	430	No	No	No	No	Not detected above background
Zinc	mg/kg	70	81	No	**Yes**	**Yes**	No	Not detected above background
Explosives - SW8321A								
1,3,5-Trinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
1,3-Dinitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4,6-Trinitrotoluene (TNT)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,4-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Amino-4, 6-dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
2-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
3-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Amino-2,6-Dinitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
4-Nitrotoluene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/kg	< 180	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/kg	< 300	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitrobenzene	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Nitroglycerin	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/kg	< 120	NA	No	**Yes**	**Yes**	No	Not detected at MRS
Pentaerythritol Tetranitrate (PETN)	µg/kg	< 500	NA	No	**Yes**	**Yes**	No	Not detected at MRS

a - Background Concentration as established in Table 5.2

b - Potential MCs as listed in Table 4.1

c - Source: 40 CFR Part 302, Table 302.4--List of Hazardous Substances

NA - Background concentration not available.

census reports a population of 1,868 persons within the municipality of Culebra. Figure 5.15 shows the 2000 census tract for MRS 14.

5.14.4.2 The air migration exposure pathway at MRS 14 is not considered to be a complete exposure pathway, based on the following:

- Air is not a primary exposure medium.
- Air can only be contaminated from soil contamination by way of fugitive dust generation.
- The wet climate and dense vegetation on the island minimize the potential for fugitive dust generation

5.14.4.3 Because the air exposure pathways are incomplete, a SLRA for air is not required. No human health or ecological risk from MC is expected through air at MRS 14. While the air pathway is believed to be incomplete, based on the previous arguments, the Region 9 residential soil PRGs include an evaluation of inhalation of fugitive dust. Therefore, an evaluation of the air pathway is included in the SLRA for soil.

5.15 MC PATHWAYS SUMMARY

Tables 5.20 and 5.21 summarize human health and ecological pathways, respectively.

TABLE 5.20
SUMMARY OF HUMAN HEALTH EXPOSURE PATHWAYS
CULEBRA ISLAND, PUERTO RICO

MRS	Medium	Possible Direct or Secondary Contamination	Transport/ Exposure Medium	Receptor Exposure Point	Likely Route of Exposure	Potentially Completed Exposure Pathway	Analytes Retained for SLRA in Chapter 6
02	Soil	Yes	Yes	Yes	Yes	Yes	Chromium and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	No	No	No	N/A
	Air	Yes	No	Yes	No	No	N/A
03	Soil	No	-	-	-	No	N/A
	Groundwater	No	-	-	-	No	N/A
	Surface Water/ Sediment	Yes	No	No	No	No	N/A
	Air	No	-	-	-	No	N/A
04	Soil	Yes	Yes	Yes	Yes	Yes	None
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, mercury, and zinc
	Air	Yes	No	Yes	No	No	N/A
05	Soil	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, mercury, and zinc
	Air	Yes	No	Yes	No	No	N/A
06	Soil	Yes	Yes	Yes	Yes	Yes	Chromium and copper
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A

TABLE 5.20
SUMMARY OF HUMAN HEALTH EXPOSURE PATHWAYS
CULEBRA ISLAND, PUERTO RICO

MRS	Medium	Possible Direct or Secondary Contamination	Transport/ Exposure Medium	Receptor Exposure Point	Likely Route of Exposure	Potentially Completed Exposure Pathway	Analytes Retained for SLRA in Chapter 6
07	Soil	Yes	Yes	Yes	Yes	Yes	Barium, copper, and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, and zinc
	Air	Yes	No	Yes	No	No	N/A
08	Soil	Yes	Yes	Yes	Yes	Yes	Zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, mercury, and zinc
	Air	Yes	No	Yes	No	No	N/A
09	Soil	Yes	Yes	Yes	Yes	Yes	Chromium
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A
10	Soil	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	No	No	No	N/A
	Air	Yes	No	Yes	No	No	N/A
11	Soil	Yes	Yes	Yes	Yes	Yes	None
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A

TABLE 5.20
SUMMARY OF HUMAN HEALTH EXPOSURE PATHWAYS
CULEBRA ISLAND, PUERTO RICO

MRS	Medium	Possible Direct or Secondary Contamination	Transport/ Exposure Medium	Receptor Exposure Point	Likely Route of Exposure	Potentially Completed Exposure Pathway	Analytes Retained for SLRA in Chapter 6
12	Soil	No	-	-	-	No	N/A
	Groundwater	No	-	-	-	No	N/A
	Surface Water/ Sediment	Yes	No	No	No	No	N/A
	Air	No	-	-	-	No	N/A
13	Soil	Yes	Yes	Yes	Yes	Yes	Chromium
	Groundwater	Yes	Yes	No	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	No	No	N/A
	Air	Yes	No	Yes	No	No	N/A
14	Soil	Yes	Yes	Yes	Yes	Yes	Barium, copper
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A

N/A = Not applicable / medium not sampled

TABLE 5.21
SUMMARY OF ECOLOGICAL EXPOSURE PATHWAYS
CULEBRA ISLAND, PUERTO RICO

MRS	Medium	Possible Direct or Secondary Contamination	Transport/ Exposure Medium	Receptor Exposure Point	Likely Route of Exposure	Potentially Completed Exposure Pathway	Metals Retained for SLRA in Chapter 6
02	Soil	Yes	Yes	Yes	Yes	Yes	Chromium and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A
03	Soil	No	-	-	-	No	N/A
	Groundwater	No	-	-	-	No	N/A
	Surface Water/ Sediment	Yes	No	No	No	No	N/A
	Air	No	-	-	-	No	N/A
04	Soil	Yes	Yes	Yes	Yes	Yes	None
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, mercury, and zinc
	Air	Yes	No	Yes	No	No	N/A
05	Soil	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, mercury, and zinc
	Air	Yes	No	Yes	No	No	N/A
06	Soil	Yes	Yes	Yes	Yes	Yes	Chromium and copper
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A

TABLE 5.21
SUMMARY OF ECOLOGICAL EXPOSURE PATHWAYS
CULEBRA ISLAND, PUERTO RICO

MRS	Medium	Possible Direct or Secondary Contamination	Transport/ Exposure Medium	Receptor Exposure Point	Likely Route of Exposure	Potentially Completed Exposure Pathway	Metals Retained for SLRA in Chapter 6
07	Soil	Yes	Yes	Yes	Yes	Yes	Barium, copper, and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, and zinc
	Air	Yes	No	Yes	No	No	N/A
08	Soil	Yes	Yes	Yes	Yes	Yes	Zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, lead, mercury, and zinc
	Air	Yes	No	Yes	No	No	N/A
09	Soil	Yes	Yes	Yes	Yes	Yes	Chromium
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A
10	Soil	Yes	Yes	Yes	Yes	Yes	Barium, chromium, copper, and zinc
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A
11	Soil	Yes	Yes	Yes	Yes	Yes	None
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A
12	Soil	No	-	-	-	No	N/A

TABLE 5.21
SUMMARY OF ECOLOGICAL EXPOSURE PATHWAYS
CULEBRA ISLAND, PUERTO RICO

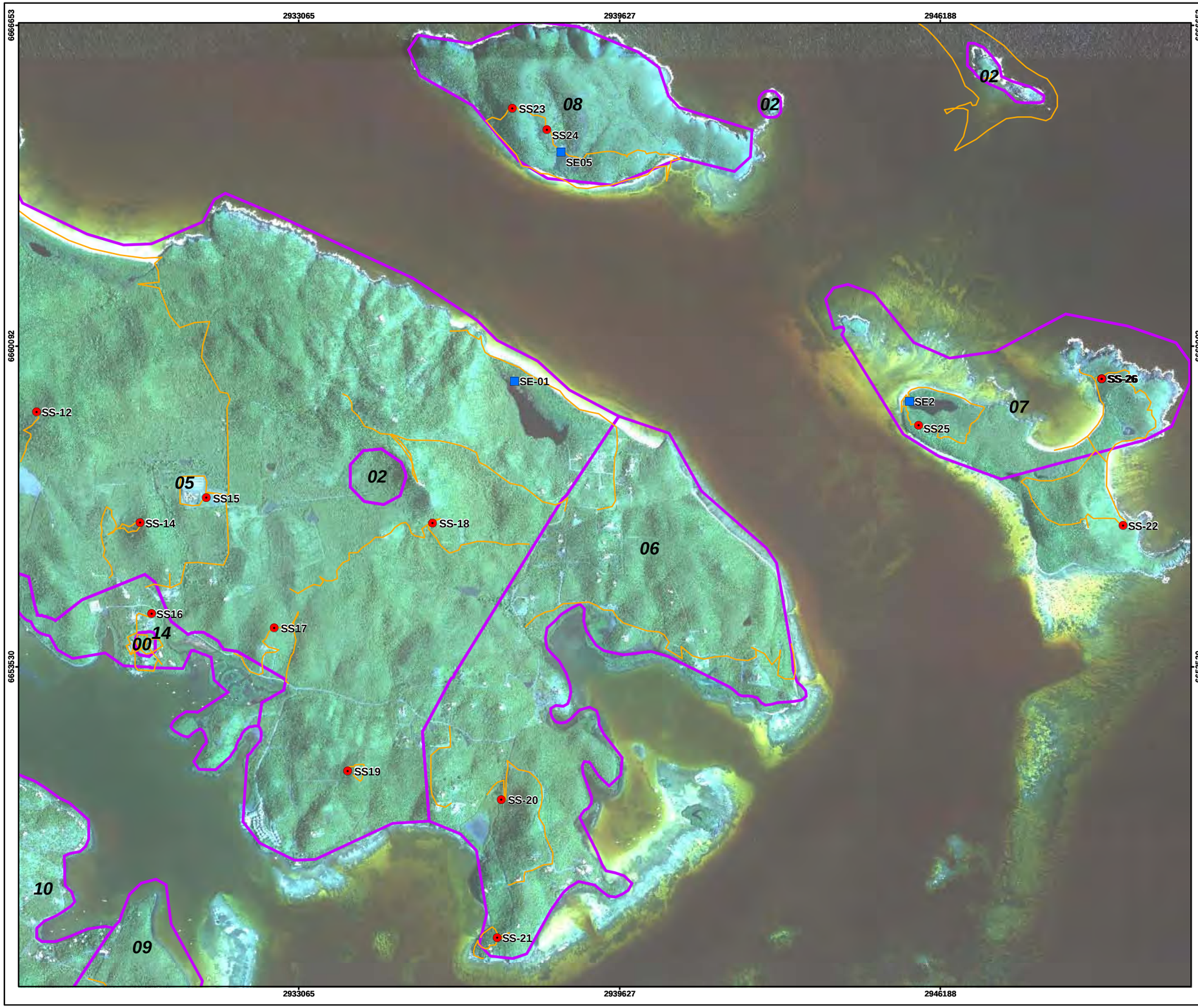
MRS	Medium	Possible Direct or Secondary Contamination	Transport/ Exposure Medium	Receptor Exposure Point	Likely Route of Exposure	Potentially Completed Exposure Pathway	Metals Retained for SLRA in Chapter 6
12	Soil	No	-	-	-	No	N/A
	Groundwater	No	-	-	-	No	N/A
	Surface Water/ Sediment	Yes	No	No	No	No	N/A
	Air	No	-	-	-	No	N/A
13	Soil	Yes	Yes	Yes	Yes	Yes	Chromium
	Groundwater	Yes	Yes	No	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A
14	Soil	Yes	Yes	Yes	Yes	Yes	Barium, copper
	Groundwater	Yes	Yes	Yes	No	No	N/A
	Surface Water/ Sediment	Yes	Yes	Yes	Yes	Yes	N/A
	Air	Yes	No	Yes	No	No	N/A

N/A = Not applicable / medium not sampled

Figure 5.1A

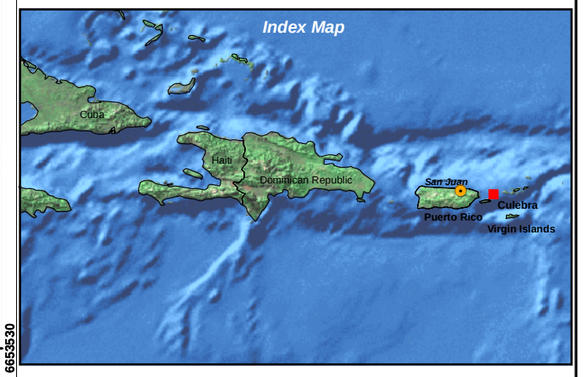
Sample Locations
Culebra Island

Puerto Rico



Legend

- SOIL SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK



N

Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

2,000 1,000 0 2,000 Feet

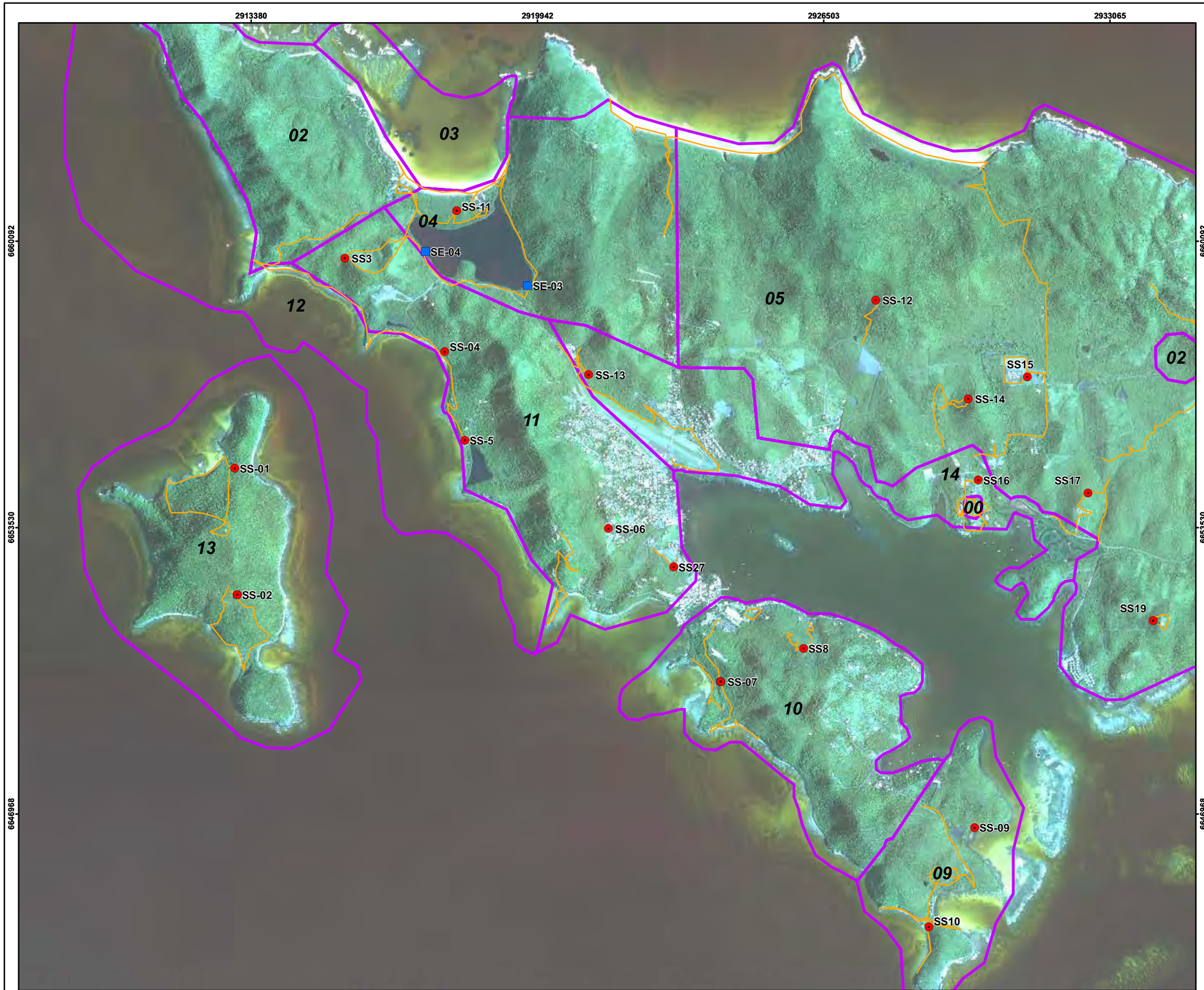
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	Sample Locations		
DRAWN BY: BT			
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000	
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 5-57	
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_1a.mxd		

Figure 5.1B

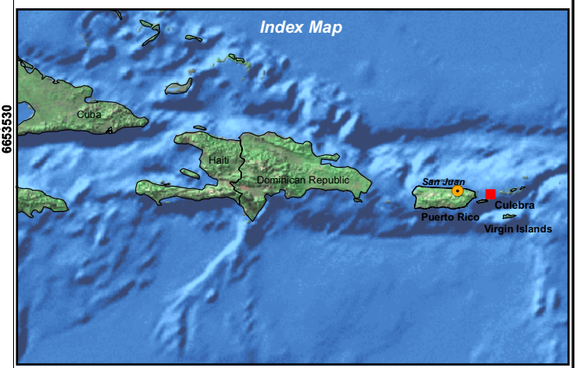
Sample Locations
Culebra Island

Puerto Rico



Legend

- SOIL SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK



N

Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

2,000 1,000 0 2,000 Feet

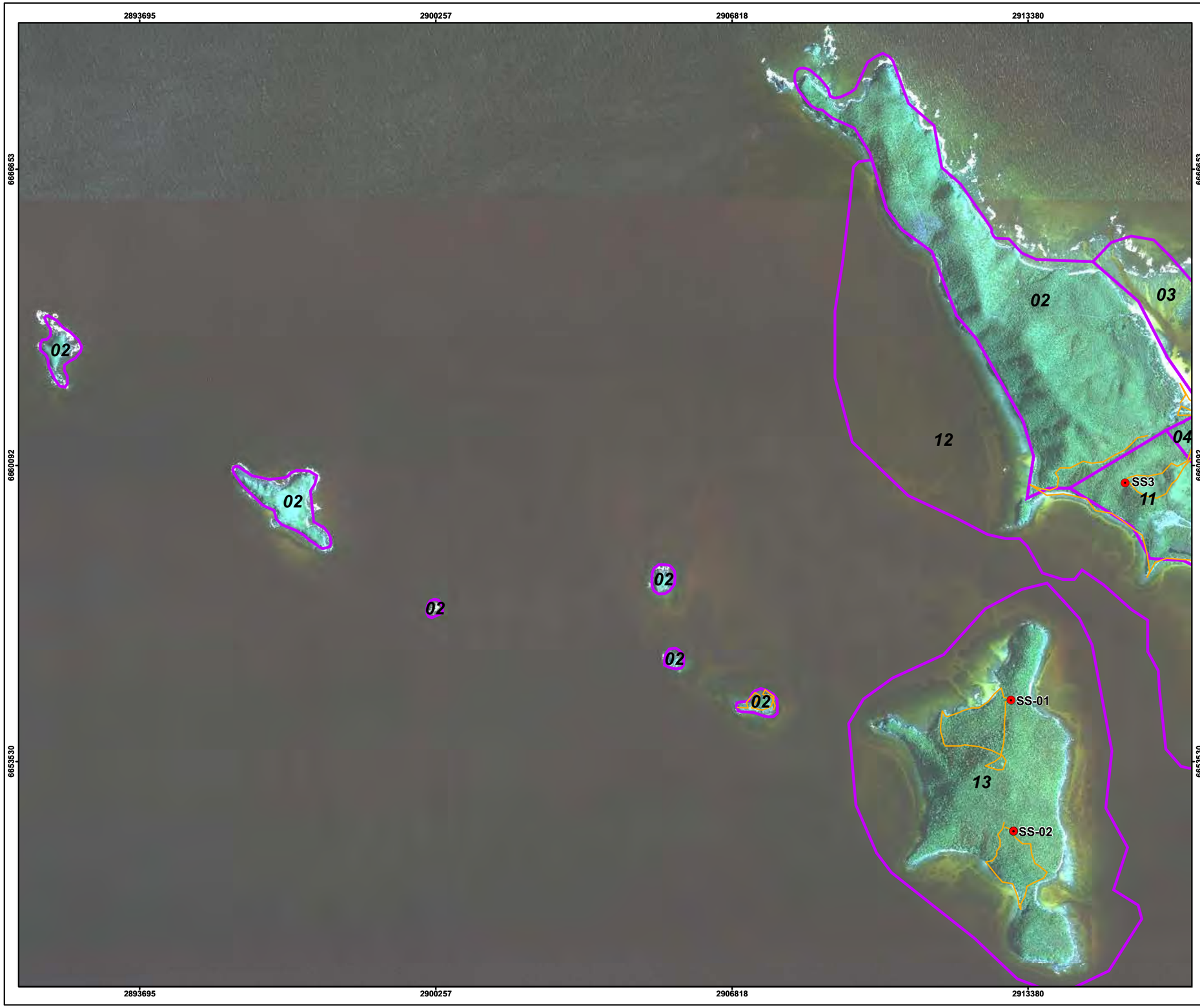
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Sample Locations**	
DRAWN BY: BT	SCALE: As Shown	PROJECT NUMBER: 744647.17000
CHECKED BY: NH	DATE: September 2007	PAGE NUMBER: 5-58
SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_1b.mxd	

Figure 5.1C

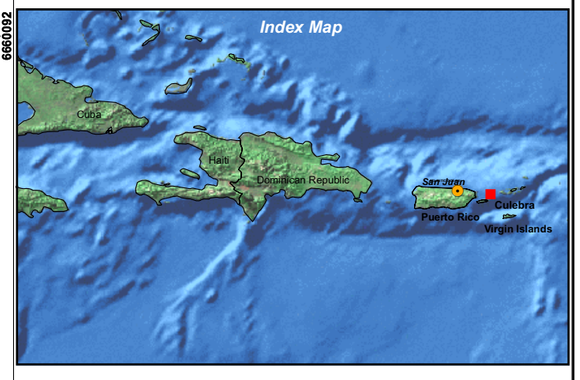
Sample Locations
Culebra Island

Puerto Rico



Legend

- SOIL SAMPLE LOCATION
- MRS BOUNDARY
- QUALITATIVE RECONNAISSANCE TRACK



N

Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

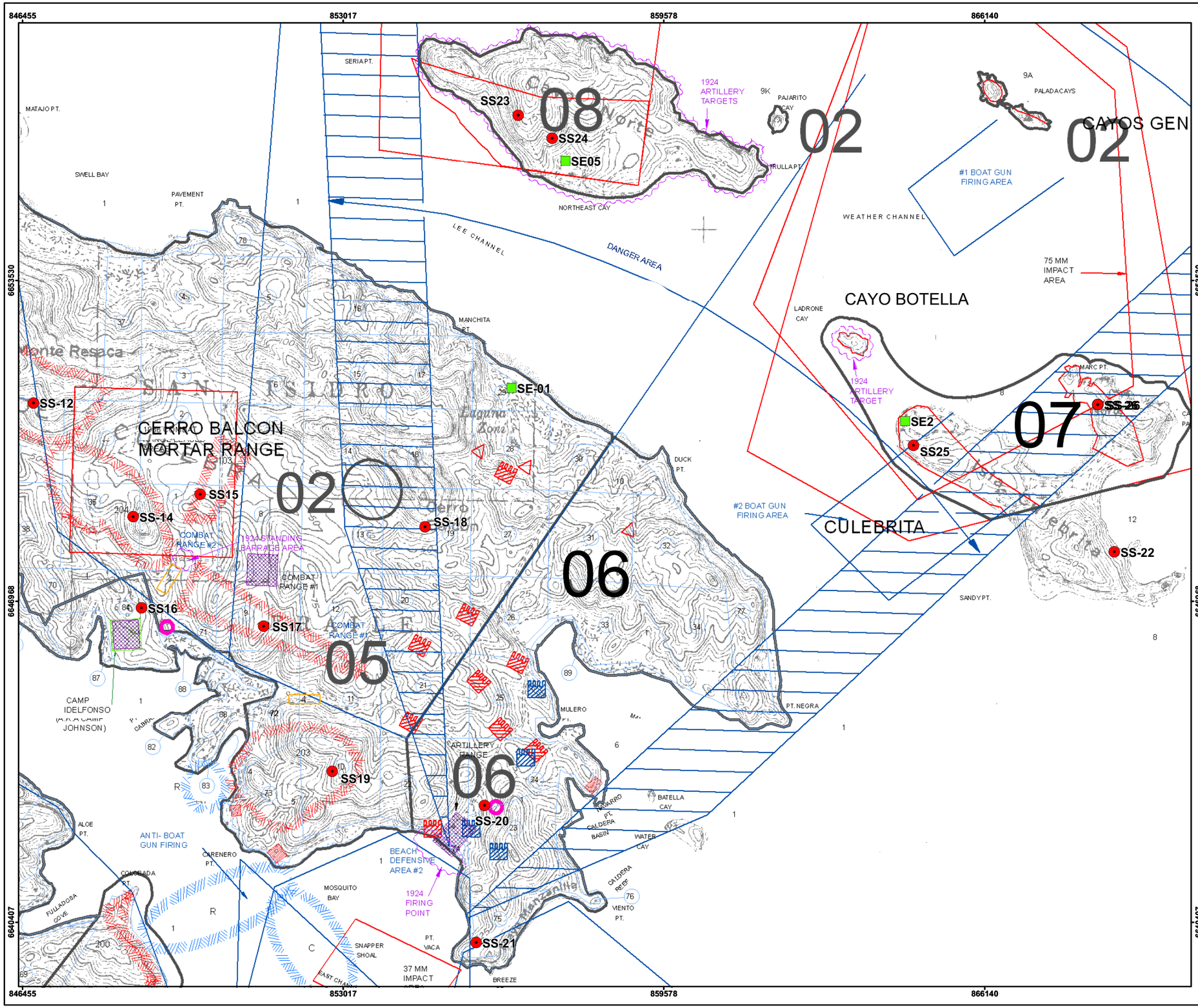
2,000 1,000 0 2,000 Feet

PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Sample Locations**	
DRAWN BY: BT		
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 5-59
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_1c.mxd	

Figure 5.2A

Sample Locations
Culebra Island
Puerto Rico



Legend

- SOIL SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- 1924 OUTPOST AND AMMUNITION STORAGE LOCATIONS
- 1887 PROPERTY LOT
- 1902-1903 GUN POSITION
- 1924 MILITARY AREA
- AREA FOR DIRECT FIRE INFANTRY AND TANKS - 1935 (POSSIBLY 1924)
- WATER AREA FOR DIRECT FIRE AT BOATS - 1935 (POSSIBLY 1924)
- STANDING BARRAGE PREVIOUSLY REGISTERED 1935 (POSSIBLY 1924)
- 1936 ARTILERY AREA AND AERIAL TARGET
- FEATURE TAKEN FROM 1937 MAP TITLED "U.S. FLEET LANDING EXCERCISE #4"
- 1938 MILITARY AREA
- 1939 MILITARY EXCERCISE
- FEATURE TAKEN FROM 1936-1949 OBLIQUE PHOTO
- MRS BOUNDARY

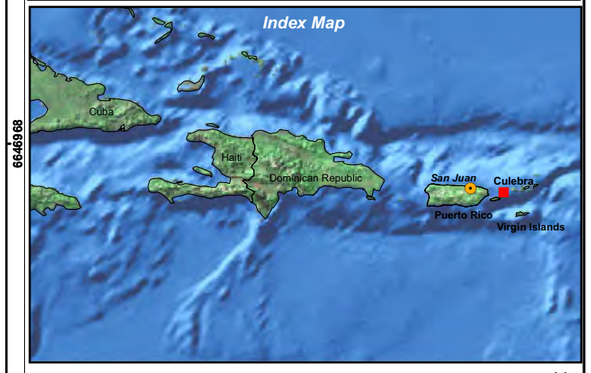


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

2,000 1,000 0 2,000 Feet

N

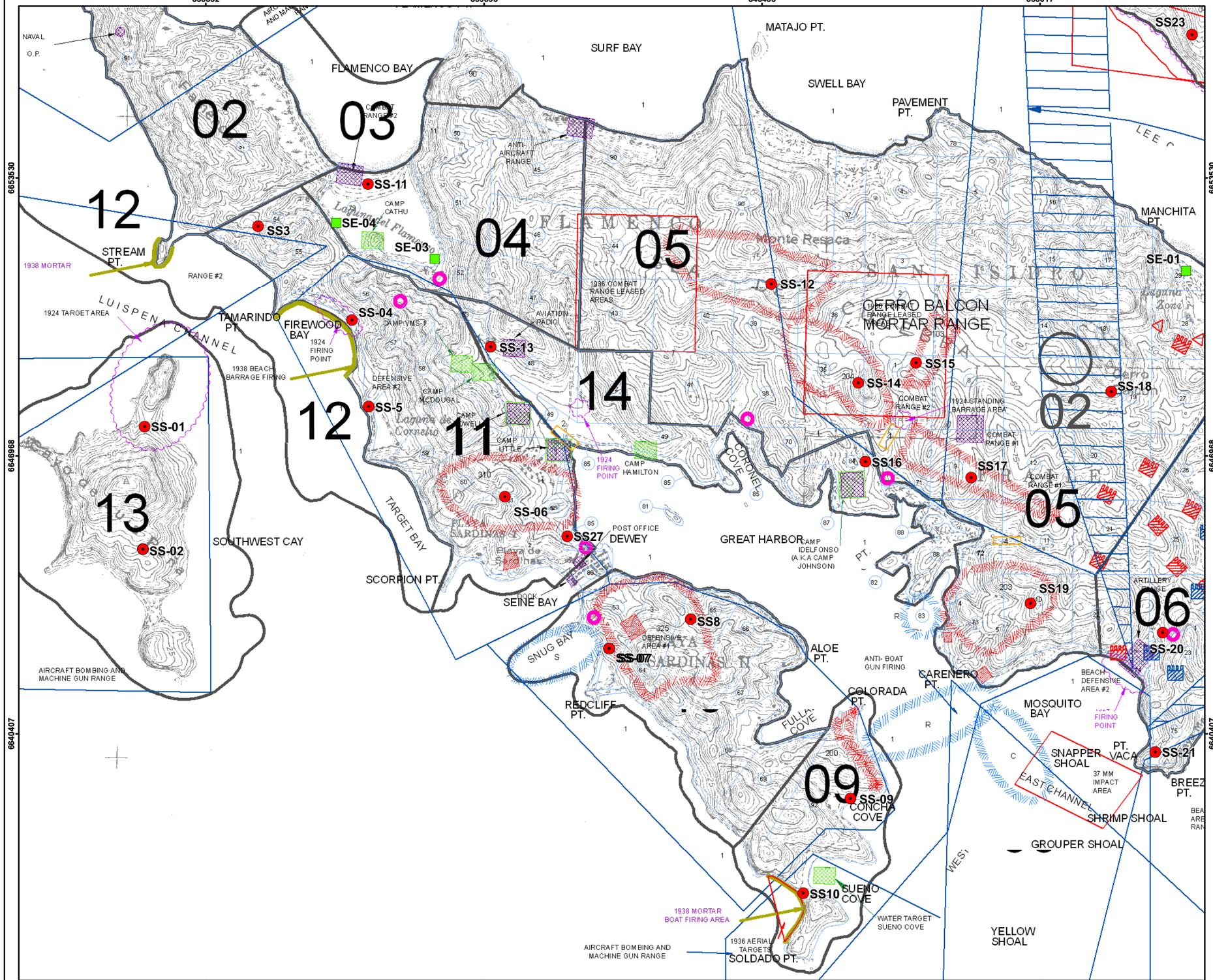
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Sample Locations**		
DRAWN BY: BT	SCALE: As Shown	PROJECT NUMBER: 744647.17000	
CHECKED BY: NH	DATE: September 2007	PAGE NUMBER: 5-60	
SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_2A.mxd		

Figure 5.2B

Sample Locations
Culebra Island

Puerto Rico



Legend

- SOIL SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- 1924 OUTPOST AND AMMUNITION STORAGE LOCATIONS
- 1887 PROPERTY LOT
- 1902-1903 GUN POSITION
- 1924 MILITARY AREA
- AREA FOR DIRECT FIRE INFANTRY AND TANKS - 1935 (POSSIBLY 1924)
- WATER AREA FOR DIRECT FIRE AT BOATS - 1935 (POSSIBLY 1924)
- STANDING BARRAGE PREVIOUSLY REGISTERED 1935 (POSSIBLY 1924)
- 1936 ARTILERY AREA AND AERIAL TARGET
- FEATURE TAKEN FROM 1937 MAP TITLED "U.S. FLEET LANDING EXCERCISE #4"
- 1938 MILITARY AREA
- 1939 MILITARY EXCERCISE
- FEATURE TAKEN FROM 1936-1949 OBLIQUE PHOTO
- MRS BOUNDARY

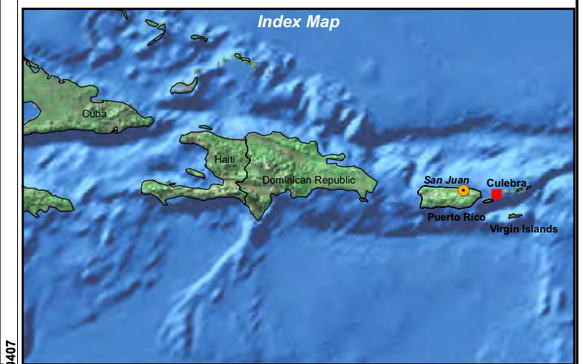


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

2,000 1,000 0 2,000 Feet

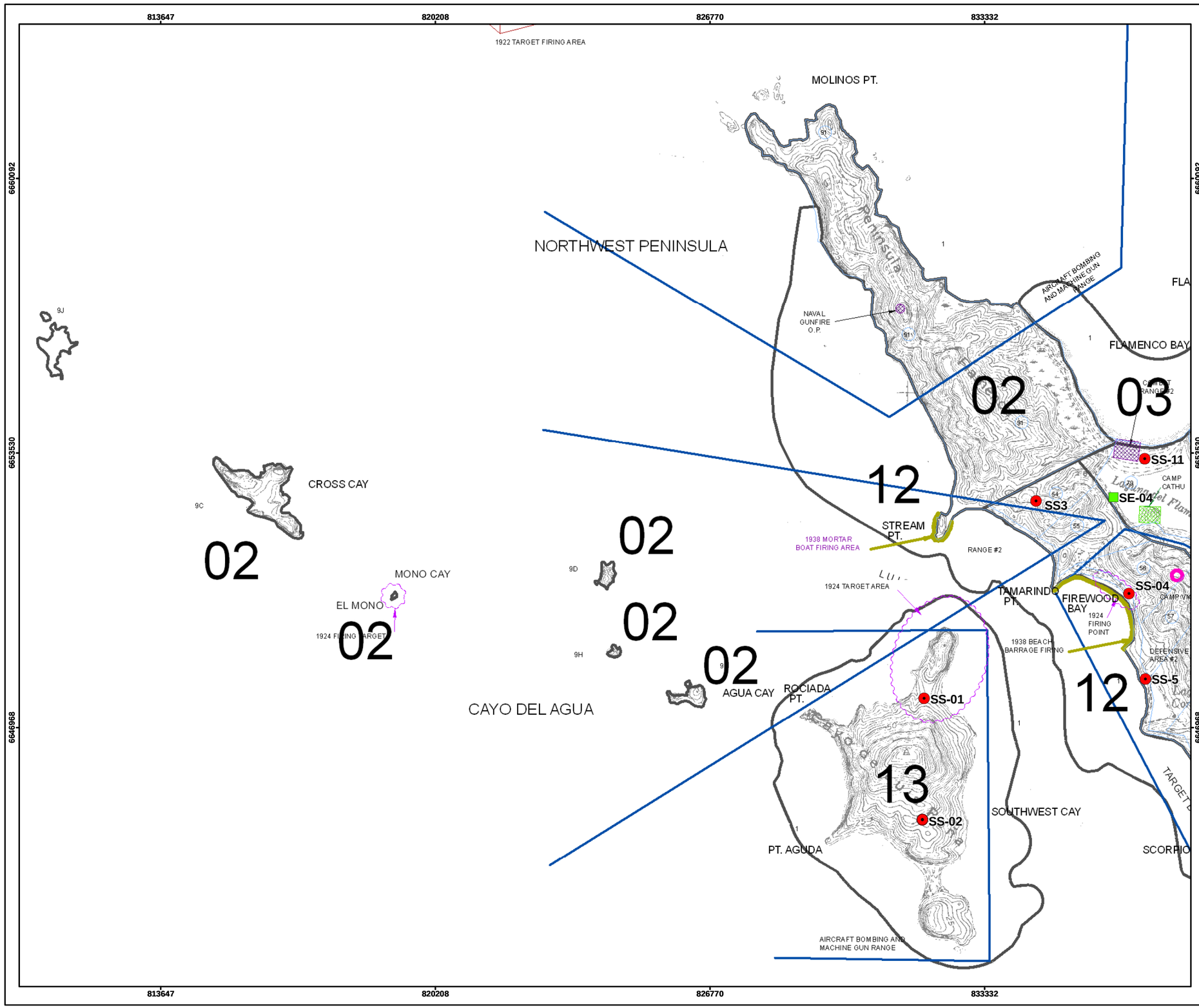
N

PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Soil Sample Locations**		
DRAWN BY: BT			
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000	
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 5-61	
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_2B.mxd		

Figure 5.2C

Sample Locations
Culebra Island
Puerto Rico



Legend

- SOIL SAMPLE LOCATION
- SEDIMENT SAMPLE LOCATION
- 1924 OUTPOST AND AMMUNITION STORAGE LOCATIONS
- 1887 PROPERTY LOT
- 1902-1903 GUN POSITION
- 1924 MILITARY AREA
- AREA FOR DIRECT FIRE INFANTRY AND TANKS - 1935 (POSSIBLY 1924)
- WATER AREA FOR DIRECT FIRE AT BOATS - 1935 (POSSIBLY 1924)
- STANDING BARRAGE PREVIOUSLY REGISTERED 1935 (POSSIBLY 1924)
- 1936 ARTILERY AREA AND AERIAL TARGET
- FEATURE TAKEN FROM 1937 MAP TITLED "U.S. FLEET LANDING EXCERCISE #4"
- 1938 MILITARY AREA
- 1939 MILITARY EXCERCISE
- FEATURE TAKEN FROM 1936-1949 OBLIQUE PHOTO
- MRS BOUNDARY

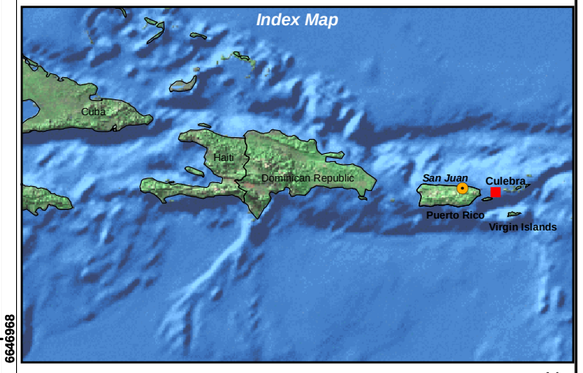


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

2,000 1,000 0 2,000 Feet

N

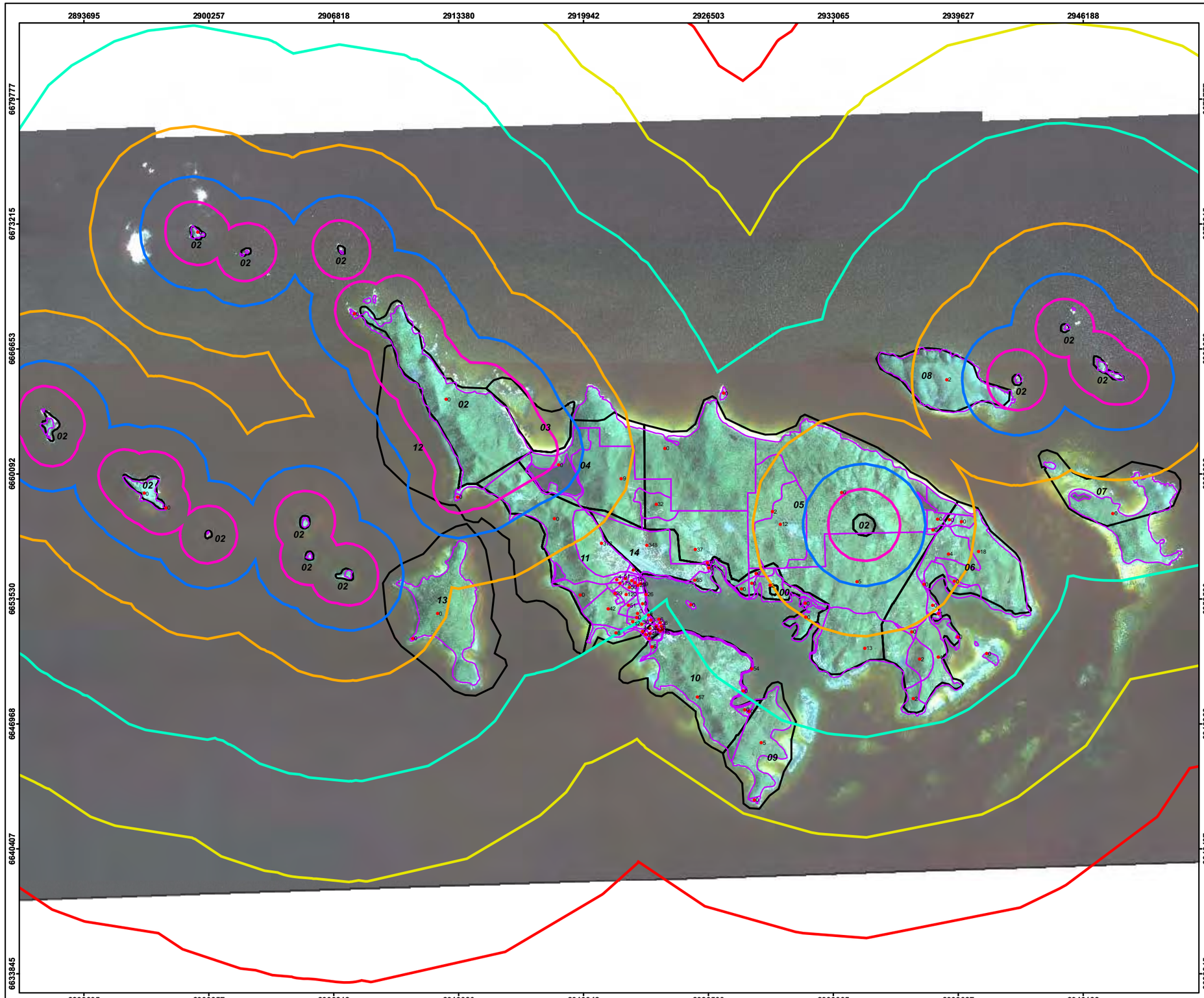
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	Soil Sample Locations	
DRAWN BY: BT	SCALE: As Shown	PROJECT NUMBER: 744647.17000
CHECKED BY: NH	DATE: September 2007	PAGE NUMBER: 5-62
SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_2C.mxd	

Figure 5.3

2000 Census Data
MRS 02
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

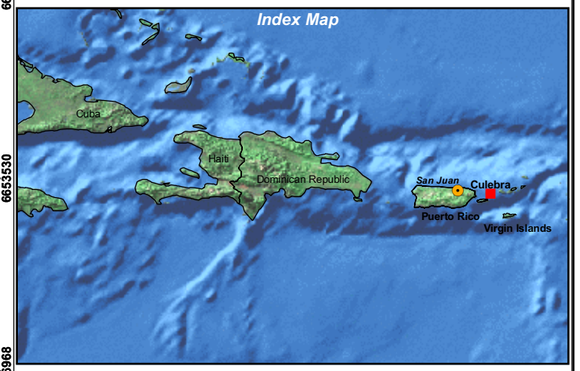


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

1 0.5 0 1 Miles

N

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 02**
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 5-63
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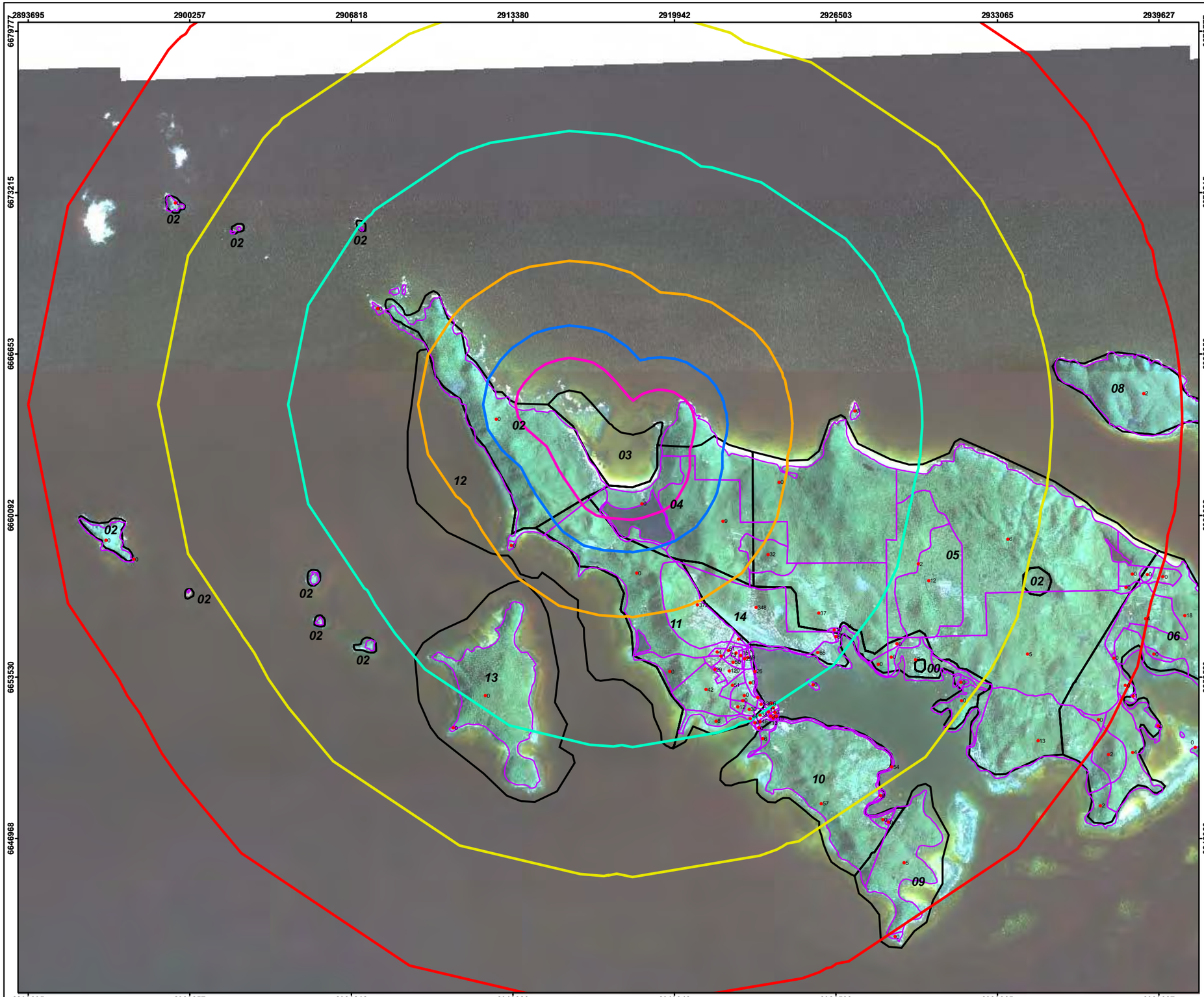
Figure 5.4

2000 Census Data
MRS 03
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

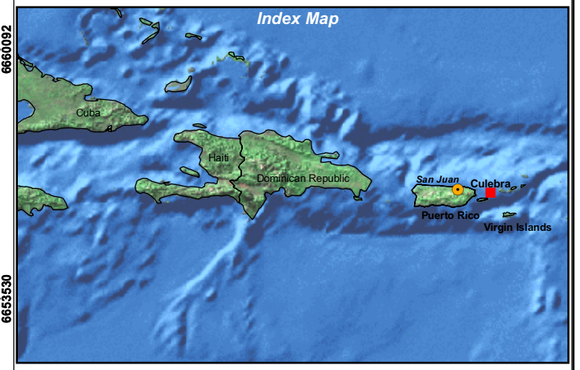


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

N

1 0.5 0 1 Miles

PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 03**	
DRAWN BY: BT		
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 5-64
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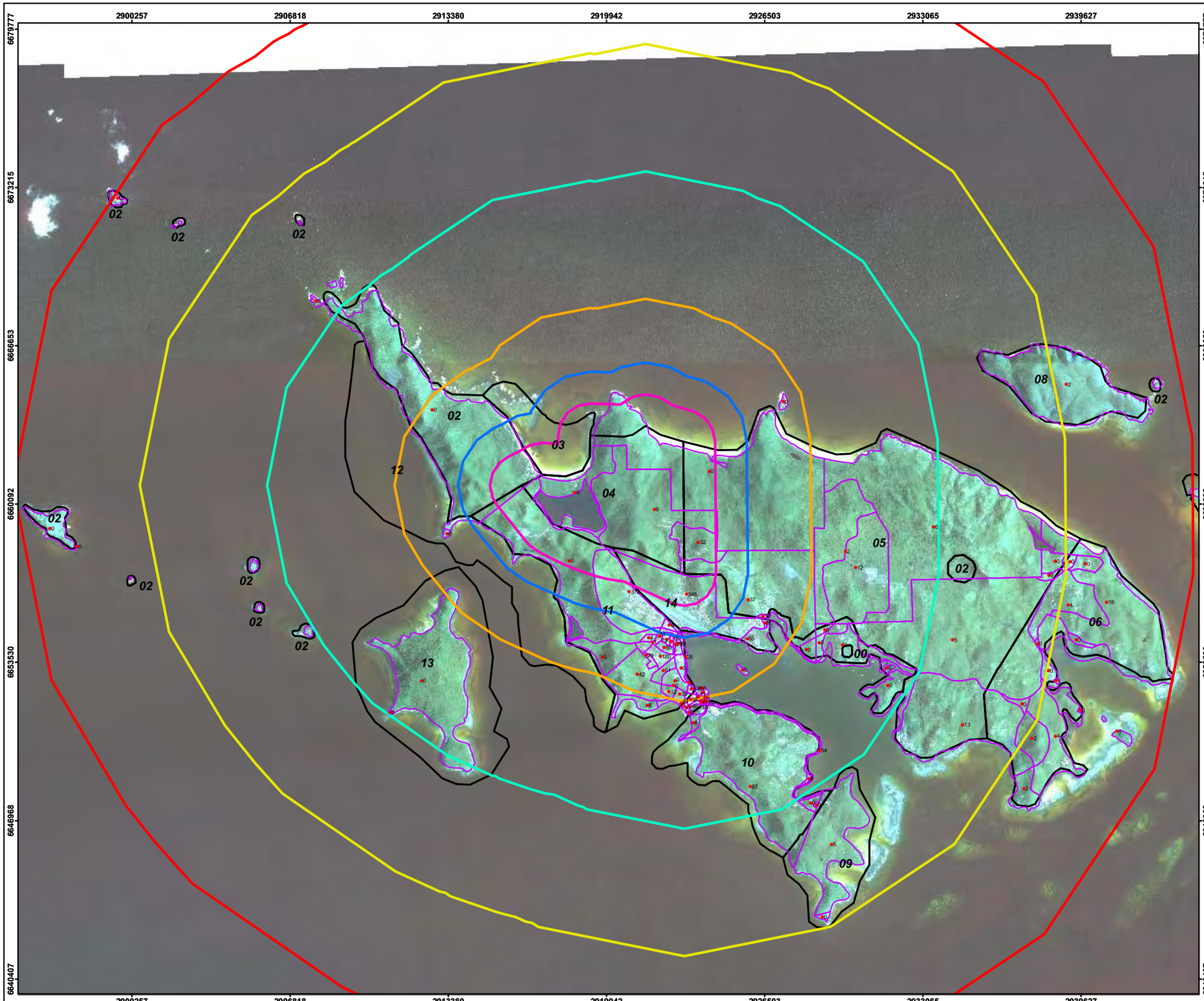
Figure 5.5

2000 Census Data
MRS 04
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

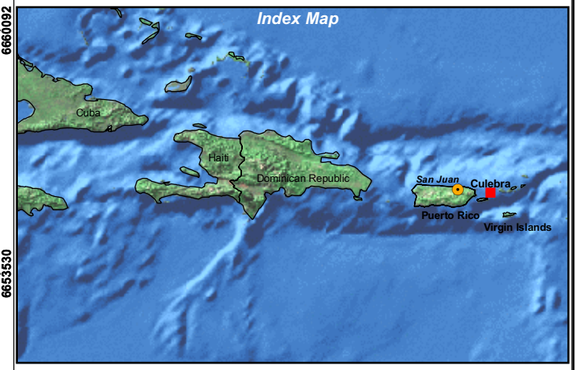


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

N

1 0.5 0 1 Miles

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 04**
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 5-65
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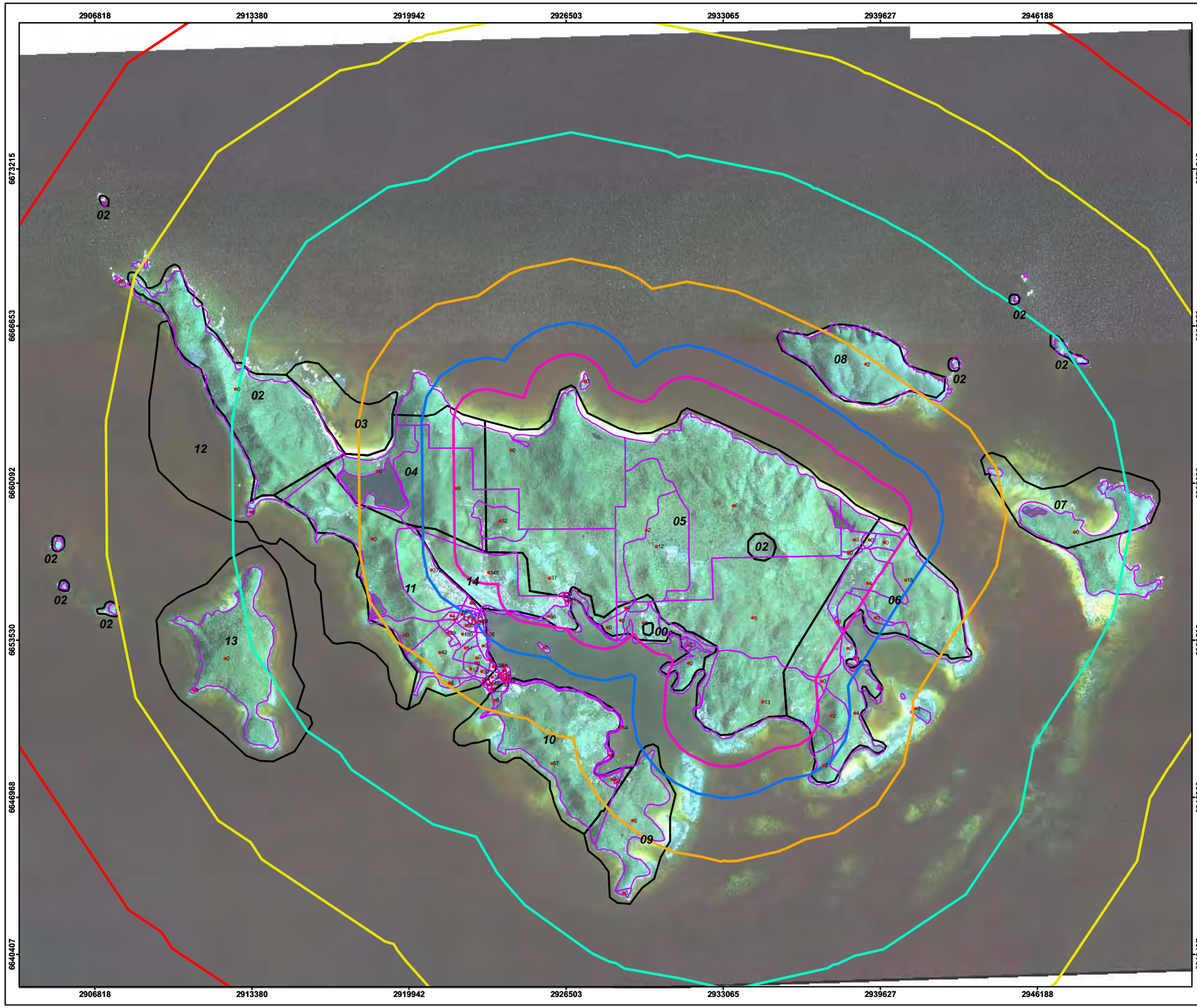
Figure 5.6

2000 Census Data
MRS 05
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

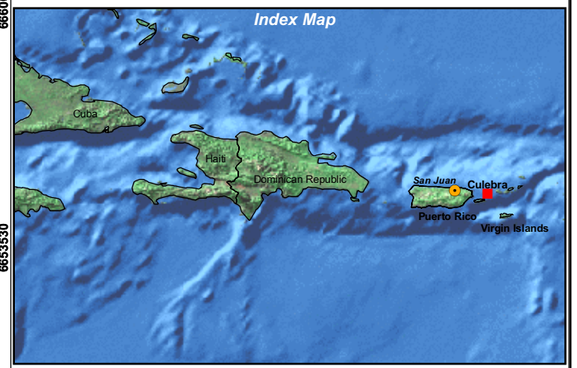


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

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1 0.5 0 1 Miles

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	2000 Census Data MRS 05
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 5-66
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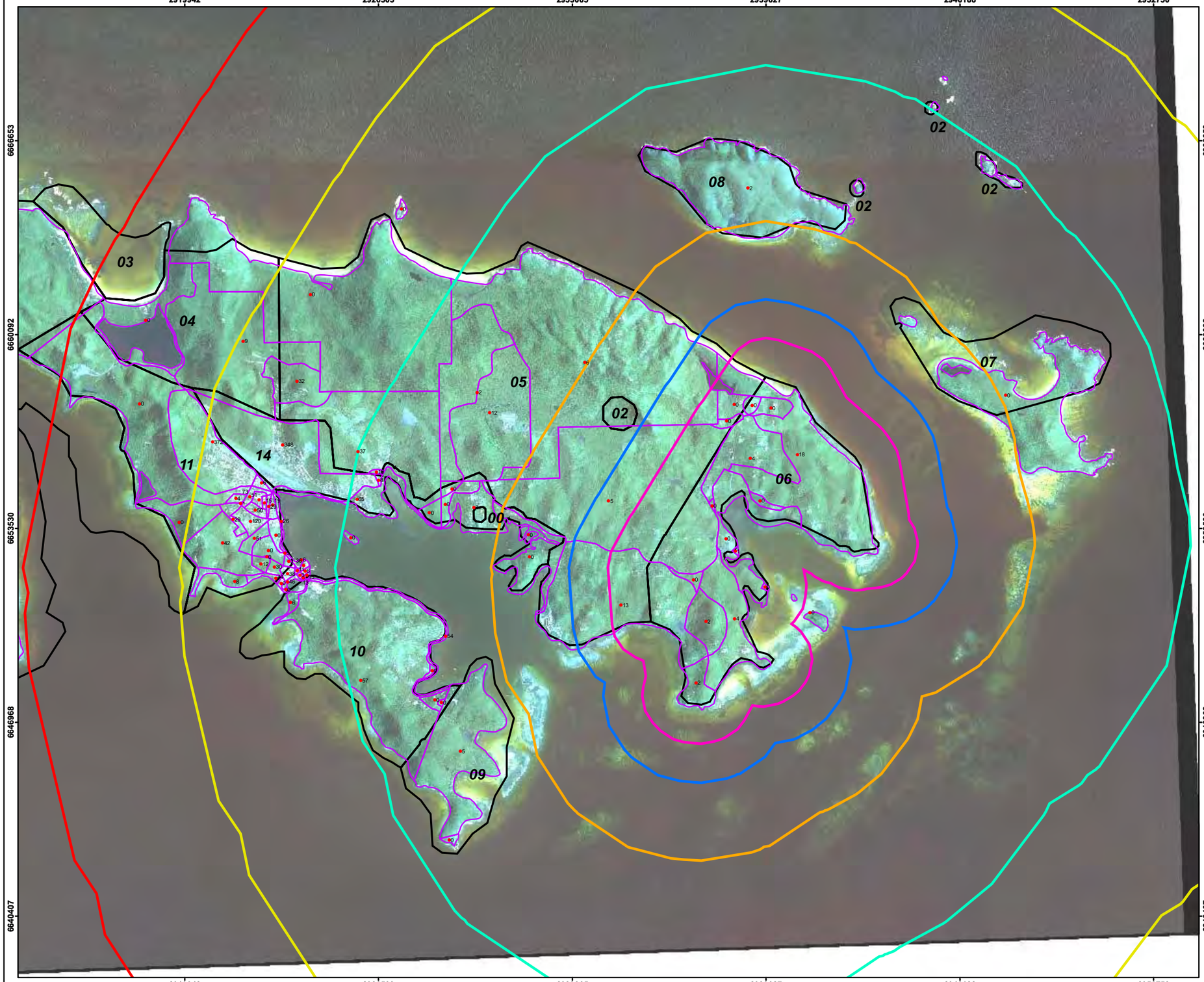
Figure 5.7

2000 Census Data
MRS 06
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

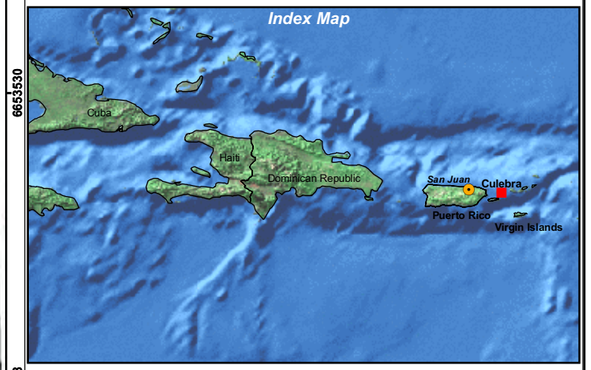


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

N

1 0.5 0 1 Miles

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 06**
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown; PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007; PAGE NUMBER: 5-67
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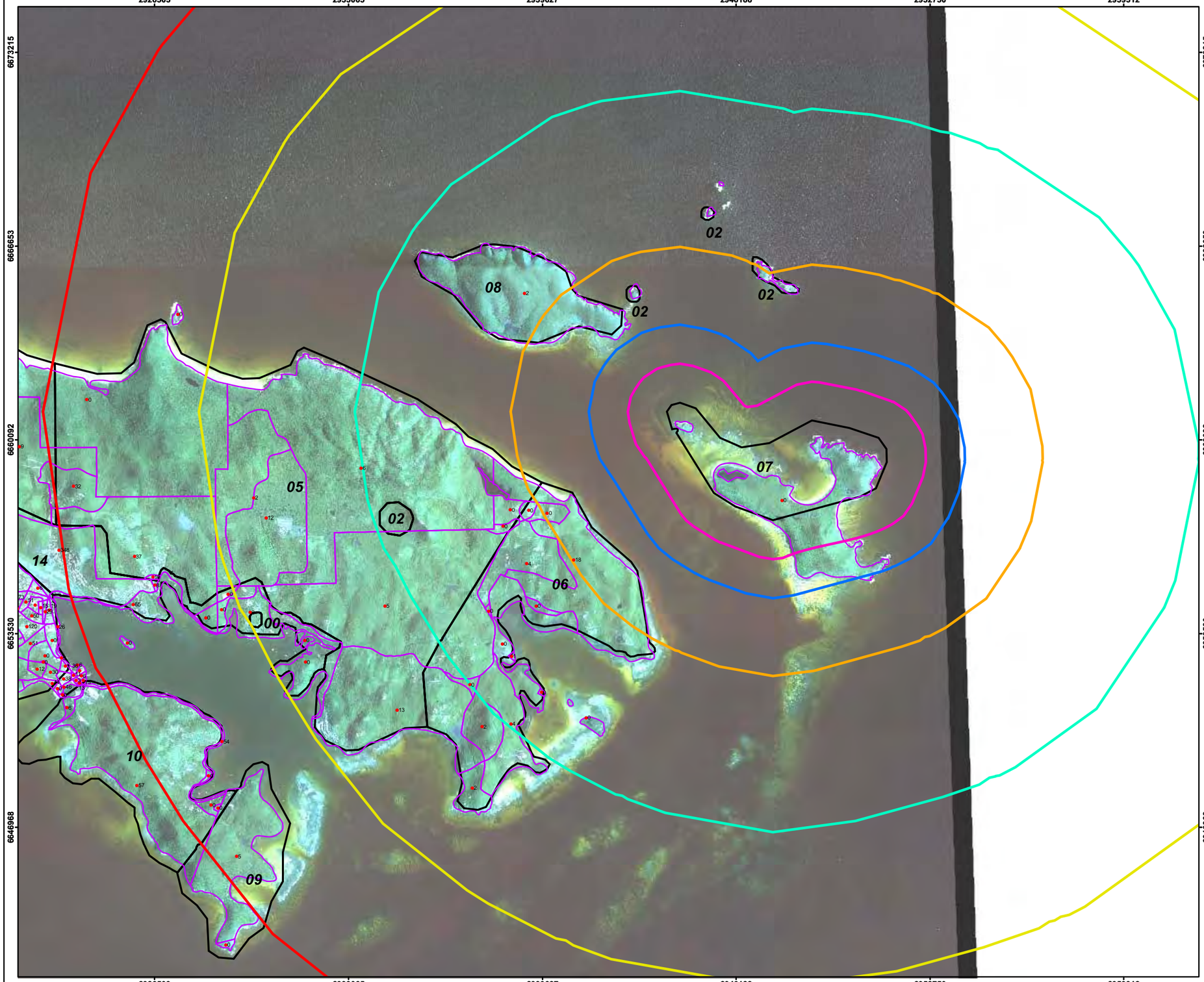
Figure 5.8

2000 Census Data
MRS 07
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

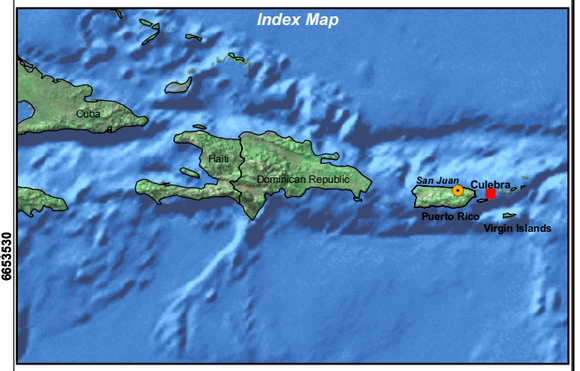


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

N

1 0.5 0 1 Miles

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 07**
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 5-68
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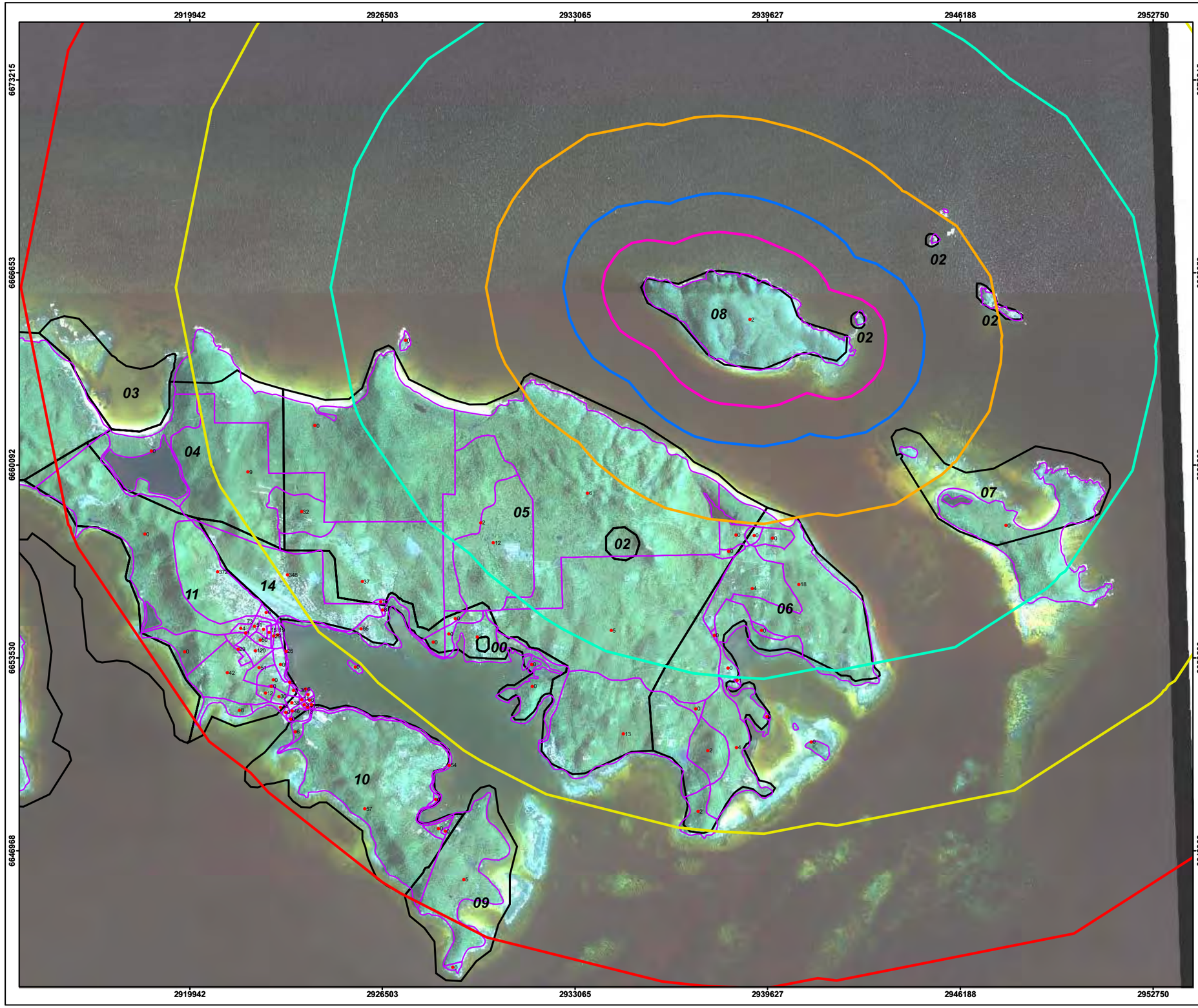
Figure 5.9

2000 Census Data
MRS 08
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

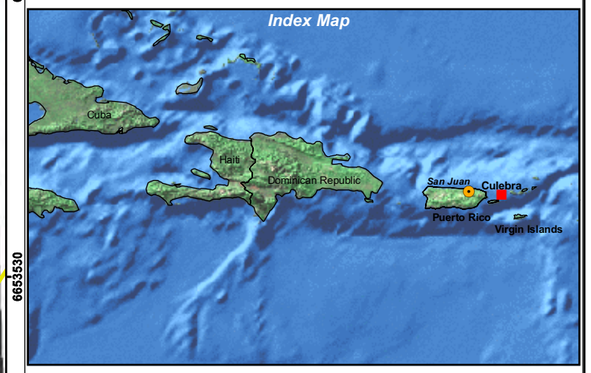


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

N

1 0.5 0 1 Miles

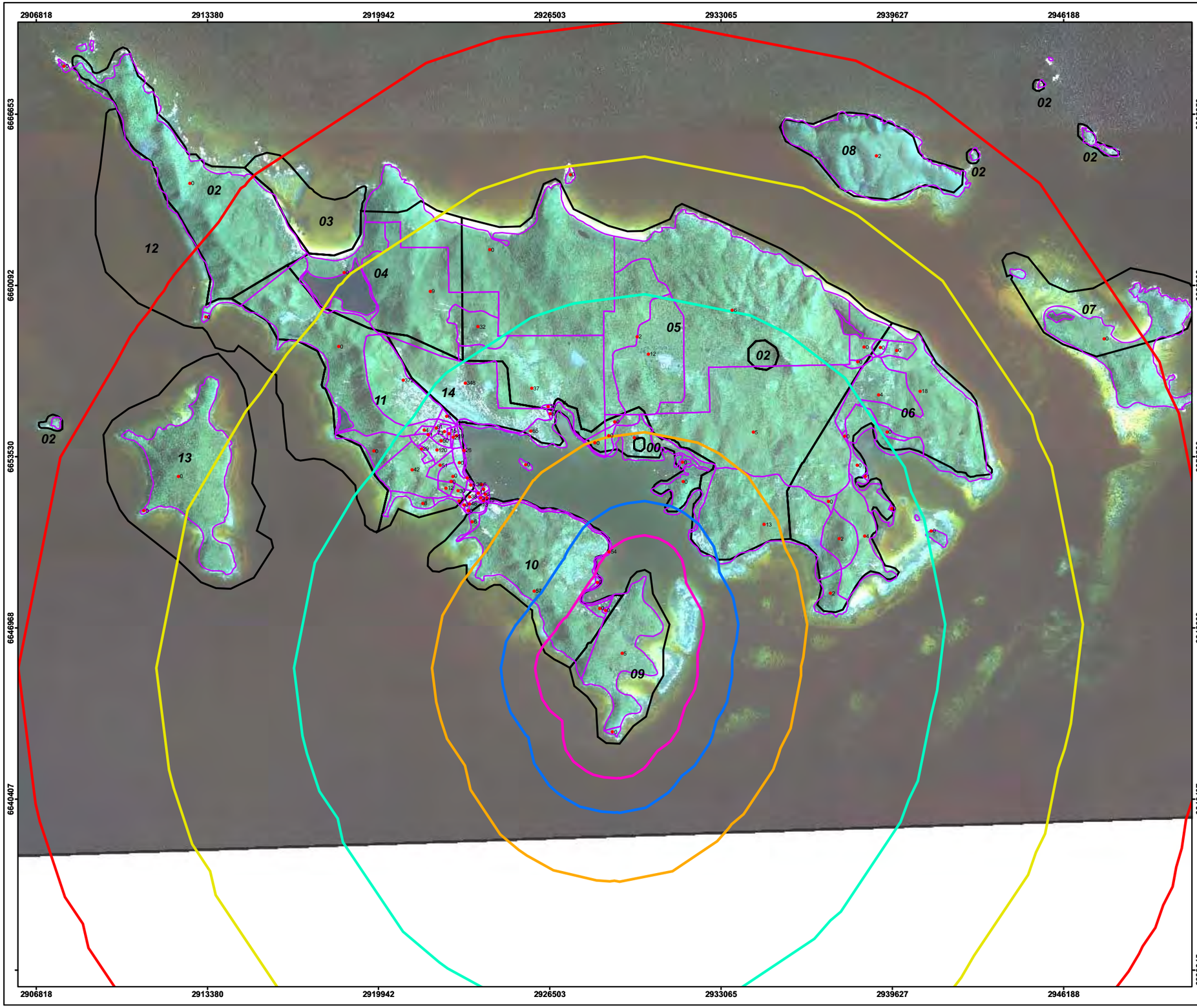
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 08**		
DRAWN BY: BT			
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000	
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 5-69	
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_9.mxd		

Figure 5.10

2000 Census Data
MRS 09
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

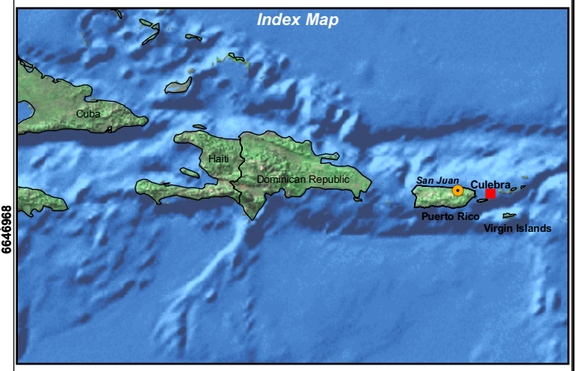


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

N

1 0.5 0 1 Miles

PARSONS

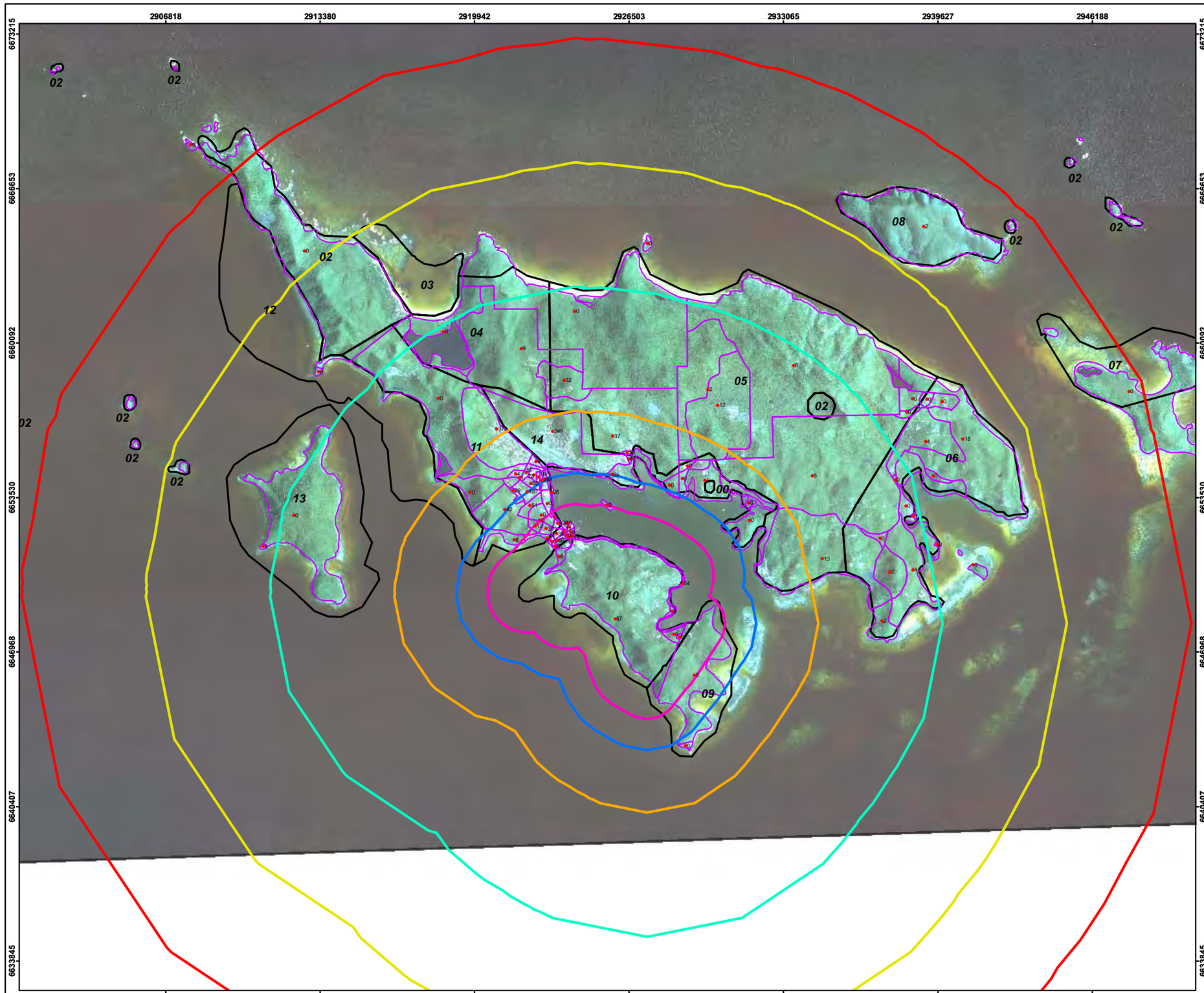
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 09**
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 5-70
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_9.mxd

Figure 5.11

2000 Census Data
MRS 10
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

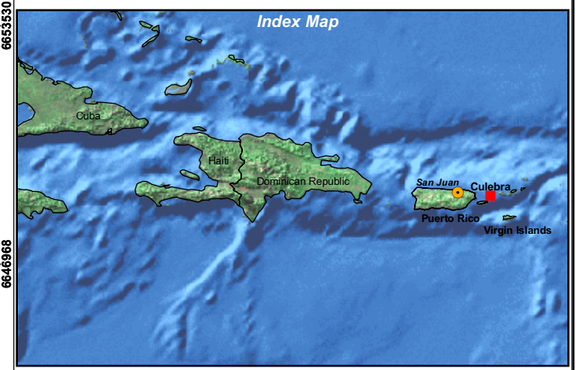


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

1 0.5 0 1 Miles

N

PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 10**		
DRAWN BY: BT			
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000	
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 5-71	
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_10.mxd		

Figure 5.12

2000 Census Data
MRS 11
Culebra Island

Puerto Rico

Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

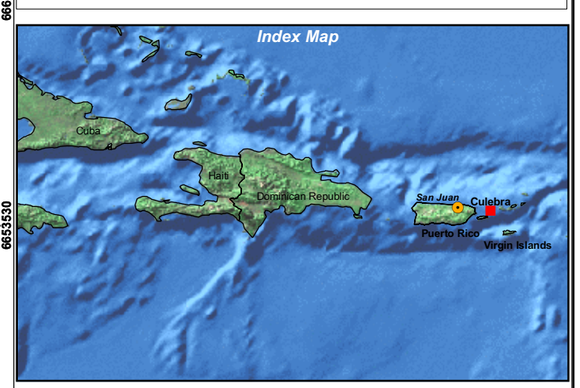


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

1 0.5 0 1 Miles

N

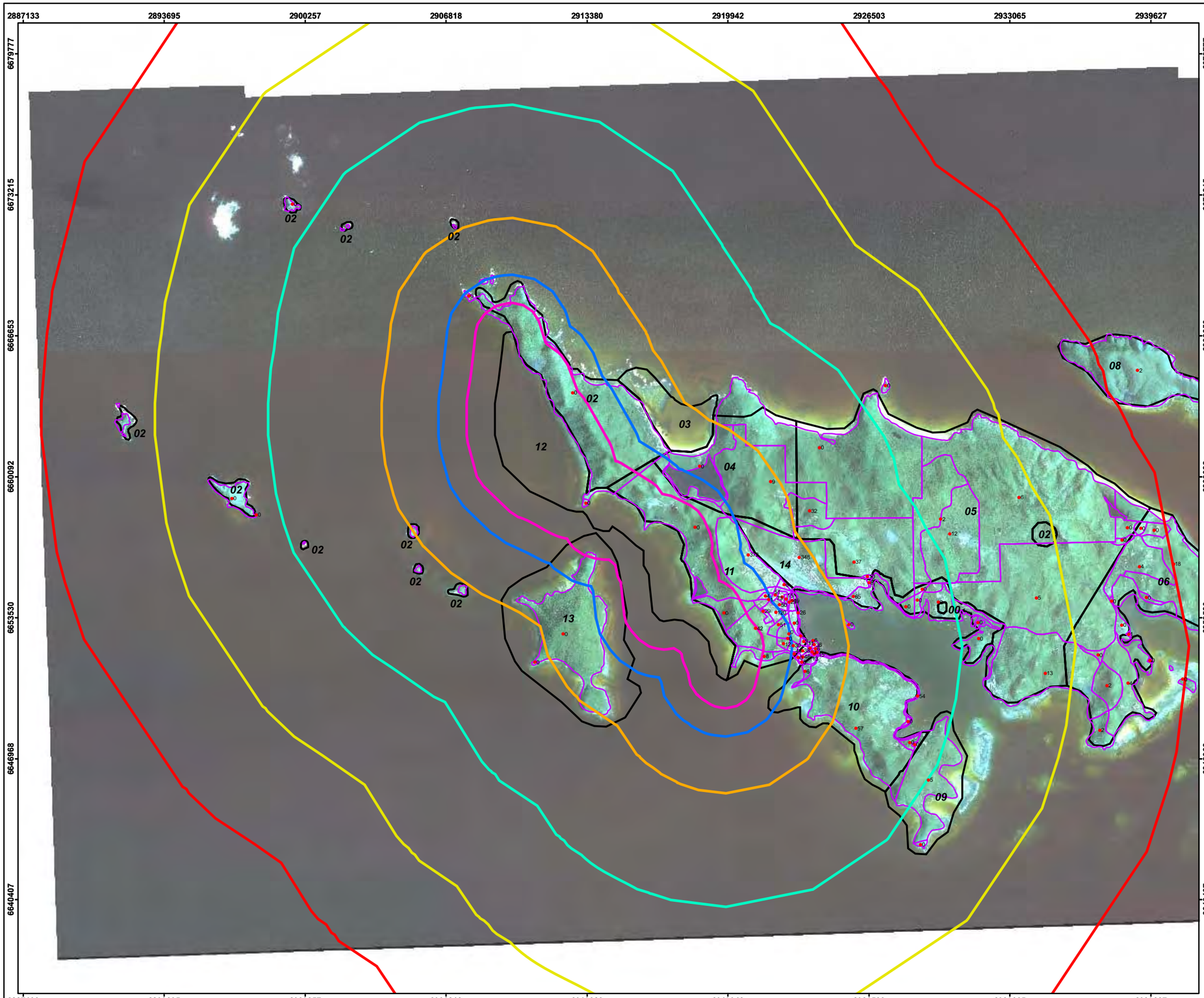
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 11**		
DRAWN BY: BT			
CHECKED BY: NH	SCALE: As Shown	PROJECT NUMBER: 744647.17000	
SUBMITTED BY: DS	DATE: September 2007	PAGE NUMBER: 5-72	
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_11.mxd		

Figure 5.13

2000 Census Data
MRS 12
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

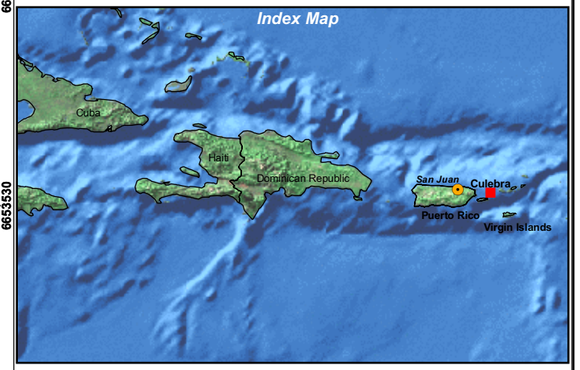


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

1 0.5 0 1 Miles

N

PARSONS

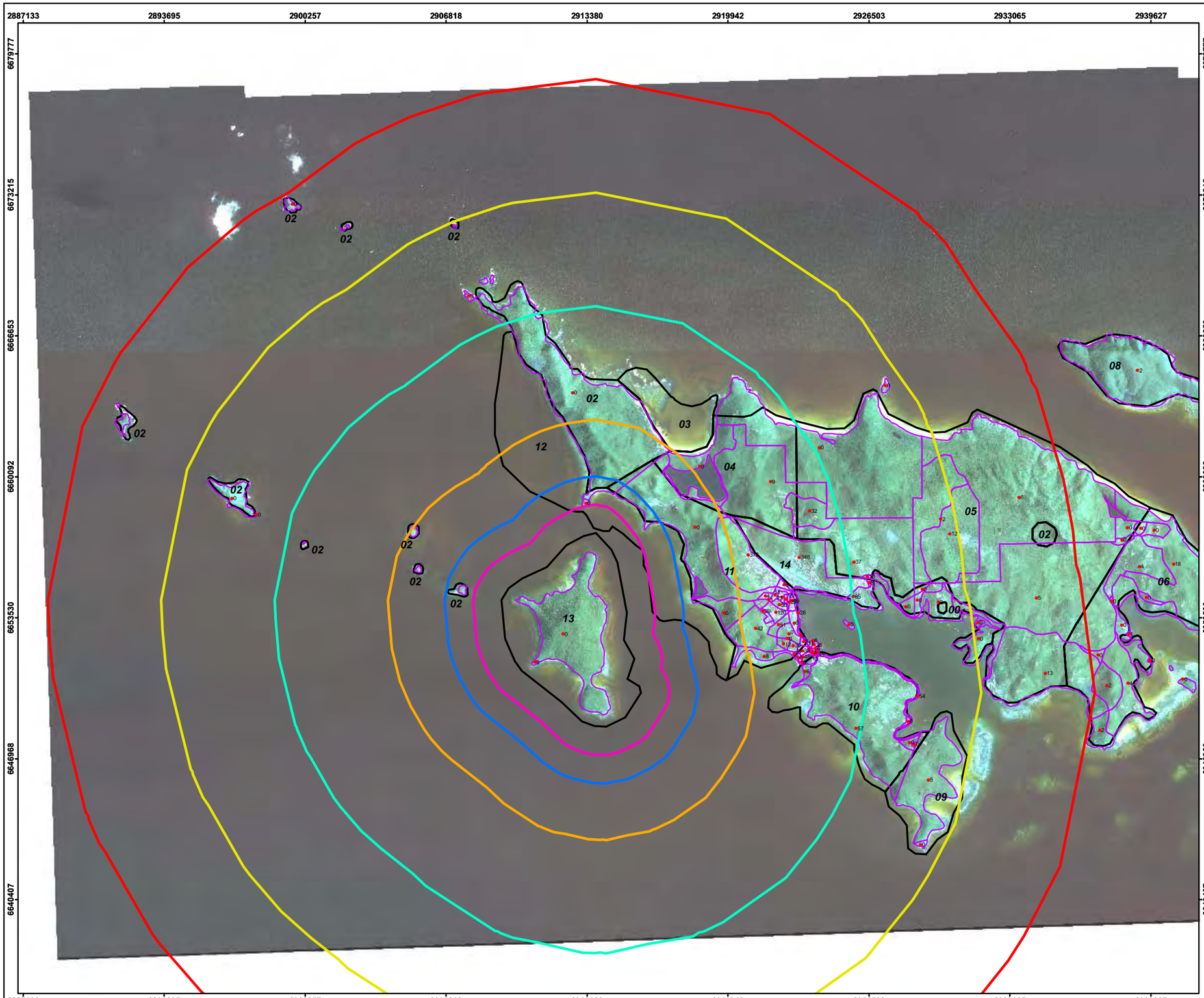
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 12**
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 5-73
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_12.mxd

Figure 5.14

2000 Census Data
MRS 13
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

1 0.5 0 1 Miles

N

PARSONS

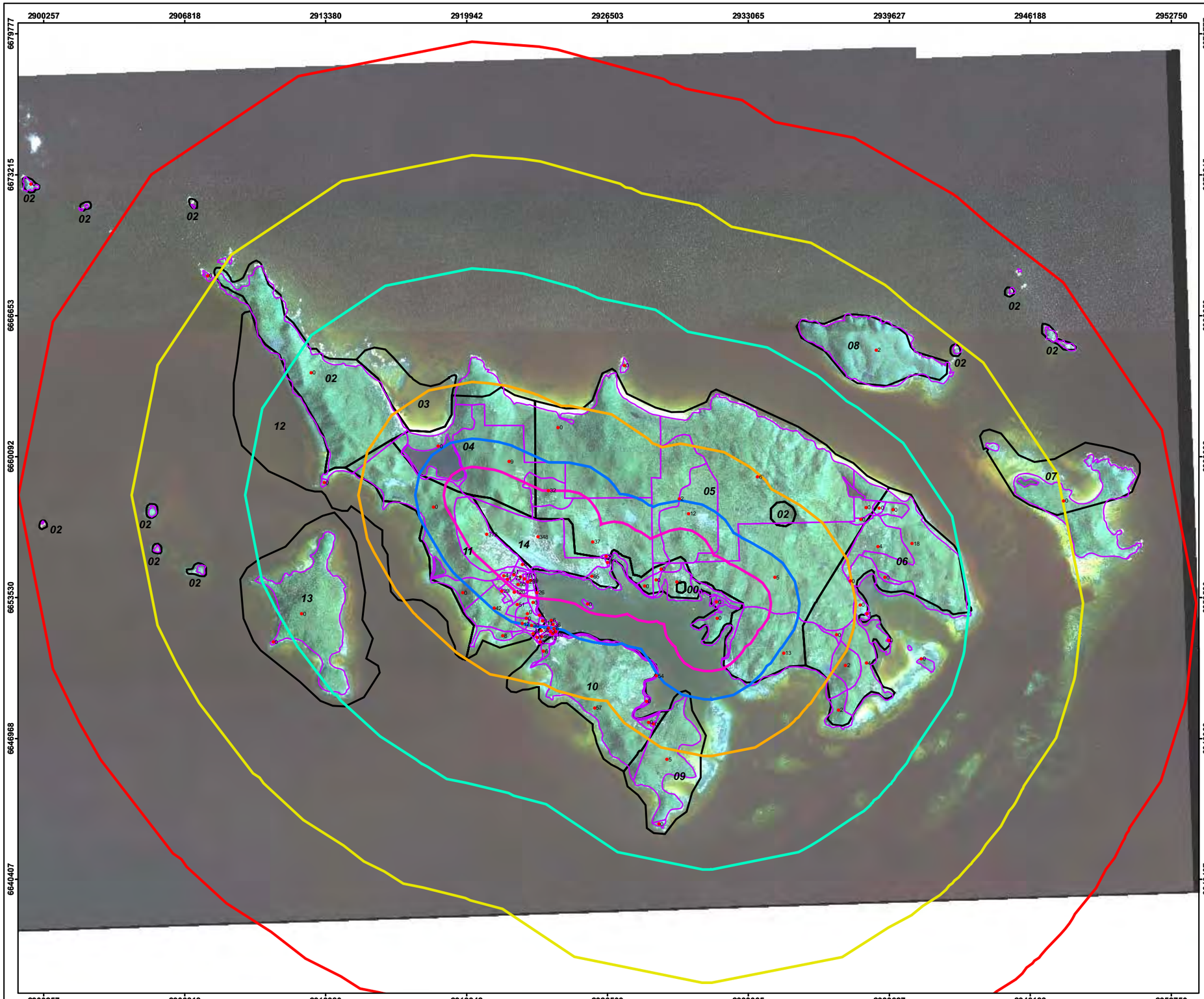
U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**2000 Census Data MRS 13**
DRAWN BY: BT	
CHECKED BY: NH	SCALE: As Shown — PROJECT NUMBER: 744647.17000
SUBMITTED BY: DS	DATE: September 2007 — PAGE NUMBER: 5-74
	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_14.mxd

Figure 5.15

2000 Census Data
MRS 14
Culebra Island

Puerto Rico



Legend

- 2000 Census Block Center Point & Population Number
- 2000 Census Block Boundary
- MRS Boundary

Buffer around MRS (Mile):

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4

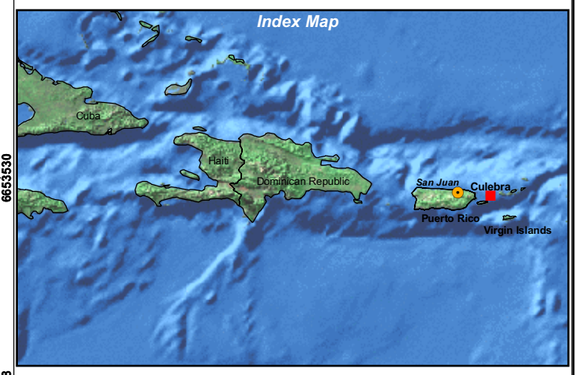


Image Source: 2004 Orthophotos
Projection: UTM Zone 19N NAD27, Map Units in Feet

1 0.5 0 1 Miles

N

PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	2000 Census Data MRS 14	
DRAWN BY: BT	SCALE: As Shown	PROJECT NUMBER: 744647.17000
CHECKED BY: NH	DATE: September 2007	PAGE NUMBER: 5-75
SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\Culebra_PR\Fig5_15.mxd	

CHAPTER 6

SCREENING-LEVEL RISK ASSESSMENT

6.1 MUNITIONS AND EXPLOSIVES OF CONCERN SCREENING-LEVEL RISK ASSESSMENT

6.1.1 A qualitative risk evaluation was conducted to assess potential explosive safety risk to the public at the Culebra Island FUDS and to qualitatively communicate the magnitude of the risk at the site and the primary causes of that risk. The risk evaluation presented below was developed using the interim guidance for ordnance and explosive risk impact assessment (USACE, 2001) and is based on the historical information presented in prior studies noted in Chapter 2 and on the QR observations for the MRSs.

6.1.2 An explosive safety risk is the possibility for MEC to detonate as a result of human activities and potentially cause harm. An explosive safety risk exists if a person can come near or into contact with MEC and act on that item to cause a detonation. The potential for an explosive safety risk depends on the presence of three critical elements: a source (presence of MEC), a receptor or person, and interaction between the source and receptor (such as picking up or disturbing the item). There is no risk if any one element is missing. Each of the three elements provides a basis for implementing effective risk-management response actions.

6.1.3 The exposure route for MEC receptors is primarily direct contact as a result of some human activity. Agricultural or construction activities involving subsurface intrusion are examples of human activities that will increase the likelihood for direct contact with buried MEC. MEC will tend to remain in place unless disturbed by human or natural forces, such as erosion. Movement of MEC may increase the possibility for direct human contact but will not necessarily result in direct contact or exposure.

6.1.1 Munitions and Explosives of Concern Conceptual Site Model

CSMs can help identify risks to human health and the environment by identifying complete exposure pathways between physical media affected by site-related contamination and potential human or ecological receptors. Appendix J includes the MEC CSM at the Culebra Island FUDS.

6.1.2 Definition of Risk Evaluation Factors, Categories, and Subcategories

The potential risk posed by MEC was characterized qualitatively by evaluating three primary risk factors: 1) presence and nature of MEC sources, 2) site characteristics that affect the accessibility or pathway between sources and human receptors, and 3) human factors that define the receptors and types of activities that may result in direct contact between receptors and MEC sources. By performing a qualitative analysis of these three

factors, an overall assessment of the safety risk posed by MEC may be evaluated. The following sections describe the components of each primary risk factor.

6.1.2.1 Presence of Munitions and Explosives of Concern

6.1.2.1.1 Four categories are used to evaluate the presence of MEC: MEC type, MEC sensitivity, MEC density, and MEC depth distribution. At the SI stage, MEC density and MEC depth are generally unknown; they are evaluated during the RI/FS stage.

6.1.2.1.2 **MEC type** affects the likelihood of injury and the severity of exposure. If multiple MEC are identified in an area, the item posing the greatest risk to public health is selected for risk evaluation. Table 6.1 shows the four subcategories of MEC type, in order of severity from highest to lowest risk.

TABLE 6.1
MUNITIONS AND EXPLOSIVES OF CONCERN TYPE SUBCATEGORIES
CULEBRA ISLAND, PUERTO RICO

Subcategory	MEC Type Description
Most severe	MEC that may be lethal if detonated by an individual's activities
Moderately severe	MEC that may cause major injury to an individual if detonated by an individual's activities
Least severe	MEC that may cause minor injury to an individual if detonated by an individual's activities
No injury	Munitions debris (inert) that will cause no injury

6.1.2.1.3 **MEC sensitivity** affects the likelihood of detonation and the severity of exposure. Factors considered in evaluating sensitivity include fuzing and environmental factors such as weathering. The category of sensitivity is based on the results of the SI field QR and archival studies. When multiple subcategories of MEC sensitivity types are discovered in an area, the highest risk subcategory is used in the risk evaluation. Table 6.2 defines the four subcategories of sensitivity, in order from highest to lowest.

6.1.2.1.4 **MEC density** directly affects the likelihood that an individual will be exposed to and negatively impacted by MEC: The more ordnance per acre, the greater the likelihood of exposure to MEC and opportunity to create an incident. Due to the absence of reliable and confirmed subsurface data at the SI stage, MEC density is not evaluated during the SI.

TABLE 6.2
MUNITIONS AND EXPLOSIVES OF CONCERN
SENSITIVITY SUBCATEGORIES
CULEBRA ISLAND, PUERTO RICO

Subcategory	MEC Sensitivity
Very sensitive	MEC that is very sensitive, that is, electronic fuzing, land mines, booby traps
Less sensitive	MEC that has standard fuzing
Insensitive	MEC that may have functioned correctly or is unfuzed but has a residual risk
Inert	Munitions debris (inert) that will cause no injury

6.1.2.1.5 **MEC depth distribution** refers to the vertical location of MEC in the subsurface. There is an inverse relationship between the depth of MEC and the likelihood of exposure to the MEC: the greater the depth of the MEC, the lower the risk of exposure. The two subcategories within the MEC depth distribution category are surface and subsurface MEC. The surface subcategory includes those items on the ground surface, protruding from the ground surface, or beneath the leaf litter. All other MEC are considered subsurface. Due to the absence of reliable and confirmed subsurface data at the SI stage, the MEC depth distribution category is not evaluated during the SI.

6.1.2.2 Site Characteristics

6.1.2.2.1 The two categories evaluated in the site characteristics risk factor are site accessibility and site stability.

6.1.2.2.2 **Site accessibility** affects the likelihood of encountering MEC. Natural or physical barriers can limit the accessibility. Natural barriers can include the site's terrain or topography as well as the vegetation. Physical barriers can include walls and fences that control, limit, or prevent access to the site. The physical and natural barriers at a site are both considered when evaluating this category. Site accessibility has three subcategories, presented in Table 6.3.

TABLE 6.3
SITE ACCESSIBILITY SUBCATEGORIES
CULEBRA ISLAND, PUERTO RICO

Subcategory	Accessibility Description
No restriction to site access	No man-made barriers, gently sloping terrain, no vegetation that restricts access, no water that restricts access
Limited restriction to access	Man-made barriers, vegetation, water, snow or ice cover, remote location, and/or terrain restrict access
Complete restriction to access	All points of entry are controlled

6.1.2.2.3 **Site stability** relates to the probability of exposure to MEC by natural processes, including recurring natural events (for example, erosion and frost heave) or extreme natural events (for example, severe wind and flash floods). The local soil type,

topography, climate, and vegetation affect stability of the site. The soil type and climate primarily affect the depth of penetration of the MEC. Over time, the soil type and climate will also affect the degree of erosion that occurs at a site. Topography and vegetation in the area will also affect the rate of erosion that takes place in an area. Site stability has three subcategories, described in Table 6.4.

TABLE 6.4
SITE STABILITY SUBCATEGORIES
CULEBRA ISLAND, PUERTO RICO

Subcategory	Accessibility Description
Stable site	MEC should not be exposed by natural events
Moderately stable site	MEC may be exposed by natural events
Unstable site	MEC most likely will be exposed by natural events

6.1.2.3 Human Factors

6.1.2.3.1 Two categories are used to evaluate the human risk factors: site activities and population.

6.1.2.3.2 **Types of activities** conducted at a site affect the likelihood of encountering MEC. Activities may be classified as recreational and occupational. This category examines whether the impact from an activity on MEC is significant, moderate, or low. To assign such a score, the general guidelines presented in Table 6.5 are considered. First, the type of activity is identified. Second, the depth of the activity is considered. For example, at a site where MEC is at the surface, all activities that can impact MEC at the surface are considered activities that have significant impact or contact level. Conversely, if all MEC is located at depths greater than 1 foot and only surface impact activities are being performed, then the activities are considered as moderate or low impact. Third, a score of significant, moderate, or low may be assigned. Due to the absence of reliable and confirmed subsurface data at the SI stage, the subsurface category cannot be evaluated during the SI.

TABLE 6.5
MUNITIONS AND EXPLOSIVES OF CONCERN
CONTACT PROBABILITY LEVELS
CULEBRA ISLAND, PUERTO RICO

Examples of Activities	Actual Depth of MEC	Contact Level
Child play, picnic, short cuts, hunting, hiking, jogging, surveying, off-road driving	Surface Below surface to 12 inches >12 inches	Significant Low Low
Camping, campfires, metal detecting	Surface Below surface to 12 inches >12 inches	Significant Moderate Low
Intrusive work	Surface Below surface to 12 inches >12 inches	Significant Significant Moderate

6.1.2.3.3 **Population** refers to the number of people that potentially access the MRS on a daily basis. A direct relationship exists between the number of people and the risk of exposure. An estimate of the number of people accessing the MEC on a daily basis was made using best professional judgment based on knowledge of the type of site, land use, and site accessibility.

6.1.3 Application of Risk Evaluation Factors, Categories, and Subcategories

An evaluation of MEC risk was performed for each identified MRS at the Culebra Island FUDS site.

6.1.3.1 Presence of Munitions and Explosives of Concern

6.1.3.1.1 No MEC were observed during the SI field work in October 2006; however, MD was observed, and both MD and MEC have been identified on several MRS within the Culebra Island FUDS during previous investigations (INPR, ASR, EE/CA, TCRA, clearance, and ongoing removal actions). Many types of munitions were used on Culebra Island FUDS, including aerial bombs, projectiles, rockets, and mortars; the munitions include practice rounds and HE rounds. Table 6.6 summarizes the MEC types at each MRS.

6.1.3.1.2 In accordance with Table 6.2, an MEC sensitivity subcategory of "less sensitive" was assigned to all of the MRSs based on the assumed use of standard fuzing. Table 6.6 indicates the MEC sensitivity assigned to each MRS.

6.1.3.1.3 Due to the absence of reliable and confirmed subsurface data at the SI stage, the MEC density and depth subcategories are not evaluated during the SI.

6.1.3.2 Site Characteristics

6.1.3.2.1 All areas within the Culebra Island FUDS are open with unrestricted public access; however, vegetation and terrain are very restrictive in most MRSs. Additionally, two MRSs (MRS 03 and MRS 12) are underwater. Each MRS was assigned a subcategory of "limited restriction to access" due to the extremely restrictive vegetation, difficult terrain, or being underwater.

6.1.3.2.2 Most of the MRSs are characterized as having moderate topography, with all slopes covered with low to high shrubs or forest. The SI field team noted evidence of erosion while conducting QR. The site stability is assigned a subcategory of "moderately stable" for the entire site. MRS 03 and MRS 12, which are both underwater, were assigned a stability subcategory of "unstable" due to the extensive sea floor movement resulting from tidal and wave action.

6.1.3.3 Human Factors

6.1.3.3.1 The types of activities conducted at the Culebra Island FUDS in combination with the potential presence of MEC determine the likelihood of individuals encountering MEC. Table 6.6 describes the activity types expected for the MRSs based on the current land use.

TABLE 6.6
SITE INSPECTION MUNITIONS AND EXPLOSIVES OF CONCERN RISK EVALUATION
CULEBRA ISLAND, PUERTO RICO

MRS	Presence of MEC Factors					Site Characteristics Factors		Human Factors	
	Type		Sensitivity	MEC Density	MEC Depth Distribution	Accessibility	Stability	Contact Level / Activities	Population (Daily)
02	General Purpose Bomb: Mk 81; Mk 82; Mk 83; Mk 84 GP Practice Bomb: MK 76, 100-pound bomb Rocket: 5-inch Zuni; 5-inch; Tiny Tim 11.75-inch Mk 1 mod 0; general rockets Practice Rocket: Mk 8, 2.75-inch HEI Projectile: 20mm; 76mm; 105mm HE Projectile: M1; 155mm; 75mm; 37mm Mortar: 81mm HE and practice; 3-inch, HE MK1; 4.2-inch HE M329A1 AP: 8-inch Mk 21; 16-inch Mk 5; 7-inch; 8-inch; 3-inch; 6-inch; 12-inch shell; 3-inch shell 5-inch Flat Nose; 5-inch common; 5-inch HE; 5-inch Naval ; 6-inch; 4-inch shrapnel; 3-inch HE; 3-inch shrapnel; 14-inch projectile; 12-inch Torpedo: General Navy Aircraft flare	Highest severity	Less sensitive	≥1 to unknown	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational	<10

TABLE 6.6
SITE INSPECTION MUNITIONS AND EXPLOSIVES OF CONCERN RISK EVALUATION
CULEBRA ISLAND, PUERTO RICO

MRS	Presence of MEC Factors					Site Characteristics Factors		Human Factors	
	Type		Sensitivity	MEC Density	MEC Depth Distribution	Accessibility	Stability	Contact Level / Activities	Population (Daily)
03	75mm shrapnel	Highest severity	Less sensitive	≥1 to unknown	Not applicable in SI	Limited restriction to access	Unstable site	Significant/ recreational	>9
04	Mortar: 81mm HE and practice; 75mm shrapnel	Highest severity	Less sensitive	None	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational	>15
05	Mortar: 81mm HE and practice; 75mm possible	Highest severity	Less sensitive	≥1 to unknown	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational and construction	>100
06	3-inch; 37mm	Highest severity	Less sensitive	None, only MD	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational	>27
07	General Purpose Bomb: Mk 82, 500-pound Rocket: 5-inch Zuni; 75mm; 20mm HEI MkI; 75mm	Highest severity	Less sensitive	59 items identified, density unknown	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational	>10
08	Unknown	Highest severity	Less sensitive	None, ≥1 in water off site.	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational	>2
09	Projectile: 5-inch; 37mm; 75mm; 155mm; 3-inch.; Bomb: 30-pound fragmentation; 100-pound HE; 1000-pound HE	Highest severity	Less sensitive	None, only MD	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational	>5

TABLE 6.6
SITE INSPECTION MUNITIONS AND EXPLOSIVES OF CONCERN RISK EVALUATION
CULEBRA ISLAND, PUERTO RICO

MRS	Presence of MEC Factors					Site Characteristics Factors		Human Factors	
	Type		Sensitivity	MEC Density	MEC Depth Distribution	Accessibility	Stability	Contact Level / Activities	Population (Daily)
10	Unknown mortars and artillery	Highest severity	Less sensitive	None confirmed	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational and construction	>125
11	Projectile: 155mm; 5-inch anti-aircraft; 6-inch flat nose	Highest severity	Less sensitive	None, only MD	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational and construction	~1,800
12	Unknown	Highest severity	Less sensitive	≥1 to unknown	Not applicable in SI	Limited restriction to access	Unstable site	Significant/ recreational	<10
13	Projectile: 155mm; 75mm anti-aircraft; 37mm; 8-inch and 6-inch naval; napalm	Highest severity	Less sensitive	None, only MD	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational	<5
14	Possible Small Arms	No Injury	Not applicable	None confirmed	Not applicable in SI	Limited restriction to access	Moderately stable site	Significant/ recreational and construction	~1,800

6.1.3.3.2 Intrusive activities include recreational activities such as hiking, camping, and off-road driving as well as construction and development of new housing. The likelihood of occurrence for MEC on the surface and in the subsurface in combination with the site activities results in an overall "significant" contact level rating for most of the MRSs

6.1.4 Hazards Assessment

Each of the primary risk factors identified above was evaluated using the data collected during the SI field investigation and the historical data available from other studies. Table 6.6 summarizes the MEC risk evaluation for the Culebra Island FUDS.

6.1.5 Munitions and Explosives of Concern Risk Summary

6.1.5.1 The risk to public safety associated with the presence of MEC was evaluated for the Culebra Island FUDS. The MEC safety risk results from a combination of the primary risk factors presented above.

6.1.5.2 No MEC were observed during the SI field work in October 2006. However, various types of munitions debris were observed during the SI site visit, and MEC was confirmed during previous site visits in several MRSs. Only a small percentage of the area covered by MRSs was traversed during the SI; therefore, it is possible that MEC are present in MRS containing munitions debris and were beyond the observation range of the SI field team. The MEC CSM in Appendix J shows MEC pathway determination for each MRS. Based on observations of munitions debris during the SI visit and MEC and munitions debris during previous site visits, MEC may be present, and the MEC exposure pathway is complete (that is, there is potential MEC risk) at MRSs 02 through 09, 11, and 12. Based on the historical use of mortars and artillery at MRS 10 and limited QR due to lack of ROE, the MEC pathway at MRS 10 is potentially complete, and there is potential MEC risk at MRS 10. The MEC pathway is incomplete at MRS 14, because no source of MEC is present; therefore, there is no potential MEC risk at MRS 14.

6.2 MUNITIONS CONSTITUENTS SCREENING-LEVEL HUMAN HEALTH RISK ASSESSMENT

6.2.1 Conceptual Site Model

Potential human receptors for Culebra Island FUDS include current and future residents, site workers, and visitors. The site consists of 8,430 acres of land primarily privately owned with portions managed by the USFWS and DNER. There are physical barrier to access at many of the MRSs due to dense vegetation. Much of the island is accessed regularly by the 1,800-plus local residents and many yearly visitors. The MC CSEM identifies impacted media, transport mechanism, exposure routes, and potential receptors. CSEMs developed for each MRS are included in Appendix J.

6.2.2 Affected Media

Direct release of MC from munitions activities at the site would have been to surface soil. Migration of MC to groundwater and surface water is possible. Based on decisions made at the TPP meeting, 27 soil samples (including three ambient samples) and five

sediment samples were collected during the SI at the Culebra Island FUDS. Surface soil is expected to be an indicator of potential contamination. Because activities at the site would be expected to release MC directly to surface soil and result in the highest concentrations there, the absence of MC in surface soil would indicate an absence of contamination in other media.

6.2.3 Screening Values

The soil and sediment screening values for human health comparison are the EPA Region 9 residential soil PRGs. The use of soil PRGs to evaluate sediment is a conservative approach as the soil PRGs are based on soil exposure frequencies of 350 days/year. Actual sediment exposure frequencies are considerably less, often in the range of 35-40 days/year. Therefore, the soil screening values are lower than would be calculated using expected sediment exposure parameters.

6.2.4 Risk Characterization for Soil

To complete the risk characterization for this site, the maximum detected concentration of each analyte retained for consideration in the SLRA in Section 5 was compared to the screening levels selected during the TPP process (that is, EPA Region 9 residential soil PRGs).

6.2.4.1 MRS 02 – Northwest Peninsula, Cerro Balcon, and Adjacent Cayos

Ten soil samples were collected by Ellis Environmental at MRS 02. As described in Section 5.2.4.6, two analytes (chromium and zinc) were retained for risk characterization. Table 6.7 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to soil at MRS 02.

TABLE 6.7
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 02
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Chromium	mg/kg	110	210	No
Zinc	mg/kg	97	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.4.2 MRS 05 – Mortar and Combat Range Area

Six soil samples were collected from MRS 05. As described in Section 5.5.3, four analytes (barium, chromium, copper, and zinc) were retained for risk characterization. Table 6.8 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these

results, no unacceptable human health risk from MC is expected through exposure to soil at MRS 05.

TABLE 6.8
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 05
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	1300	5400	No
Chromium	mg/kg	150	210	No
Copper	mg/kg	170	3100	No
Zinc	mg/kg	120	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.4.3 MRS 06 – Artillery Firing Area

Two soil samples were collected from MRS 06. As described in Section 5.6.3, two analytes (chromium and copper) were retained for risk characterization. Table 6.9 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to soil at MRS 06.

TABLE 6.9
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 06
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Chromium	mg/kg	19	210	No
Copper	mg/kg	130	3100	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.4.4 MRS 07 – Culebrita Artillery Impact Area

Two soil samples were collected from MRS 07. As described in Section 5.7.3, three analytes (barium, copper, and zinc) were retained for risk characterization. Table 6.10 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to soil at MRS 07.

TABLE 6.10
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 07
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	480	5400	No
Copper	mg/kg	600	3100	No
Zinc	mg/kg	240	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.4.5 MRS 08 – Cayo Norte Impact Area

Two soil samples were collected from MRS 08. As described in Section 5.8.3, one analyte (zinc) was retained for risk characterization. Table 6.11 presents the SLRA results for this analyte and indicates that the maximum detected concentration is less than the risk-based screening value. Based on this result, no unacceptable human health risk from MC is expected through exposure to soil at MRS 08.

TABLE 6.11
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 08
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Zinc	mg/kg	90	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.4.6 MRS 09 – Soldado Point Mortar and Bombing Areas

Two soil samples were collected from MRS 09. As described in Section 5.9.3, one analyte (chromium) was retained for risk characterization. Table 6.12 presents the SLRA results for this analyte and indicates that the maximum detected concentration is less than the risk-based screening value. Based on this result, no unacceptable human health risk from MC is expected through exposure to soil at MRS 09.

TABLE 6.12
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 09
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Chromium	mg/kg	19	210	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.4.7 MRS 10 – Defensive Firing Area No. 1

Two soil samples were collected from MRS 10. As described in Section 5.10.3, four analytes (barium, chromium, copper, and zinc) were retained for risk characterization. Table 6.13 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to soil at MRS 10.

6.2.4.8 MRS 13 – Cayo Luis Pena Impact Area

Two soil samples were collected from MRS 13. As described in Section 5.13.3, one analyte (chromium) was retained for risk characterization. Table 6.14 presents the SLRA results for this analyte and indicates that the maximum detected concentration is less than the risk-based screening value. Based on this result, no unacceptable human health risk from MC is expected through exposure to soil at MRS 13.

TABLE 6.13
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 10
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	1100	5400	No
Chromium	mg/kg	22	210	No
Copper	mg/kg	230	3100	No
Zinc	mg/kg	130	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

TABLE 6.14
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 13
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Chromium	mg/kg	17	210	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.4.9 MRS 14 – Airport and Camp Area

One soil sample was collected from MRS 14. As described in Section 5.14.3, two analytes (barium and copper) were retained for risk characterization. Table 6.15 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to soil at MRS 14.

TABLE 6.15
SOIL HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 14
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	600	5400	No
Copper	mg/kg	120	3100	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.5 Risk Characterization for Surface Water / Sediment

To complete the risk characterization for this site, the maximum detected concentration of each sediment analyte retained for consideration in the SLRA in Section 5 was compared to the screening levels selected during the TPP process (that is, EPA Region 9 residential soil PRGs).

6.2.5.1 MRS 04 – Flamenco Lagoon Maneuver Area

Two sediment samples were collected from MRS 04. As described in Section 5.4.2, six analytes (barium, chromium, copper, lead, mercury, and zinc) were retained for risk characterization. Table 6.16 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to surface water / sediment at MRS 04.

TABLE 6.16
SEDIMENT HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 04
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	81	5400	No
Chromium	mg/kg	9.9	210	No
Copper	mg/kg	93	3100	No
Lead	mg/kg	12	400	No
Mercury	mg/kg	0.04	23	No
Zinc	mg/kg	74	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.5.2 MRS 05 – Mortar and Combat Range Area

One sediment sample was collected from MRS 05. As described in Section 5.5.2, six analytes (barium, chromium, copper, lead, mercury, and zinc) were retained for risk characterization. Table 6.17 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to surface water / sediment at MRS 05.

6.2.5.3 MRS 06 – Artillery Firing Area

As determined in Section 5.6.2, a complete surface water / sediment exposure pathway does exist at MRS 06; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would most likely have been directly to surface soil; however, migration of MC to surface water / sediment is possible, and the site history shows that there is potential for direct release to surface water / sediment. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the human health SLRA for soil at MRS 06, presented in Section 6.2.4.3 (there is no unacceptable human health risk due to exposure to soil), no unacceptable human health risk from MC migration via soil is expected through exposure to surface water / sediment at MRS 06. However, due to munitions activities at the lagoon near Mosquito Bay, there is a potential for direct release to surface water / sediment; therefore, risk to human health due to MC in sediment at MRS 06 cannot be ruled out.

TABLE 6.17
SEDIMENT HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 05
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	29	5400	No
Chromium	mg/kg	7.7	210	No
Copper	mg/kg	22	3100	No
Lead	mg/kg	2.5	400	No
Mercury	mg/kg	0.013	23	No
Zinc	mg/kg	32	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.5.4 MRS 07 – Culebrita Artillery Impact Area

One sediment sample was collected from MRS 07. As described in Section 5.7.2, five analytes (barium, chromium, copper, lead, and zinc) were retained for risk characterization. Table 6.18 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable human health risk from MC is expected through exposure to surface water / sediment at MRS 07.

TABLE 6.18
SEDIMENT HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 07
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	16	5400	No
Chromium	mg/kg	3	210	No
Copper	mg/kg	6.7	3100	No
Lead	mg/kg	1.9	400	No
Zinc	mg/kg	5	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.5.5 MRS 08 – Cayo Norte Impact Area

One sediment sample was collected from MRS 08. As described in Section 5.8.2, six analytes (barium, chromium, copper, lead, mercury, and zinc) were retained for risk characterization. Table 6.19 presents the SLRA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values.

Based on these results, no unacceptable human health risk from MC is expected through exposure to surface water / sediment at MRS 08.

TABLE 6.19
SEDIMENT HUMAN HEALTH SCREENING RISK ASSESSMENT FOR MRS 08
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Concentration	Site Specific Region 9 Residential Soil PRG [a]	Exceeds Screening Level?
Metals				
Barium	mg/kg	140	5400	No
Chromium	mg/kg	2.1	210	No
Copper	mg/kg	19	3100	No
Lead	mg/kg	5.9	400	No
Mercury	mg/kg	0.011	23	No
Zinc	mg/kg	61	23000	No

[a] USEPA Region 9 residential soil Preliminary Remediation Goal (PRG) (December 28, 2004) (EPA, 2004)

6.2.5.6 MRS 09 – Soldado Point Mortar and Bombing Area

As determined in Section 5.9.2, a complete surface water / sediment exposure pathway exists at MRS 09; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the human health SLRA for soil at MRS 09, presented in Section 6.2.4.6 (there is no unacceptable human health risk due to exposure to soil), no unacceptable human health risk from MC is expected through exposure to surface water / sediment at MRS 09.

6.2.5.7 MRS 14 – Airport and Camp Area

As determined in Section 5.14.2, a complete surface water / sediment exposure pathway exists at MRS 14; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the human health SLRA for soil at MRS 14, presented in Section 6.2.4.9 (there is no unacceptable human health risk due to exposure to soil), no unacceptable human health risk from MC is expected through exposure to surface water / sediment at MRS 14.

6.2.6 Discussion

Of the analytes that met the three criteria to perform a SLRA (analyte exceeded background concentrations, was a potential constituents of munitions known or suspected of being used on site, and was listed as a hazardous substance in 40CFR Part 302 of

CERCLA), none were detected above the screening criteria selected by the TPP team (EPA Region 9 residential soil PRGs). No unacceptable human health risk is expected due to MC in groundwater, surface water / sediment, soil, or air at any of the Culebra Island FUDS MRSs. However, while not expected, there is potential for human health risk due to MC in surface water / sediment at MRS 06. Sediment at this MRS was not sampled, and there is historical evidence of an artillery range at the lagoon near Mosquito Bay.

6.3 MUNITIONS CONSTITUENTS SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

The Island of Culebra and 22 of the associated cays are a National Wildlife Refuge area consisting of diverse sensitive habitats including wetlands, mangrove area, coral reefs, seagrass beds, boulder forests, seabird rookeries, and sea turtle nesting sites. Additionally, the PRDNR lists 12 conservation priority areas, discussed along with the ecologically important places at the Culebra Island FUDS in Section 2.2.5. Because protected species and habitats are likely present, the site is considered an important ecological place, and therefore a screening-level ecological risk assessment (SLERA) is required.

6.3.1 Conceptual Site Model

Nine federally listed and 13 state-listed species are known or suspected to occupy Culebra Island. The plant species were not evaluated separately or considered further in the SLERA. Exposure of wildlife to MC could occur through direct exposure to contaminated soil, surface water, and sediment, as well as through ingestion of deeply rooted plants. The MC CSEM identified impacted media, transport mechanisms, exposure routes, and potential ecological receptors. Appendix J includes CSEMs for each MRS at the Culebra Island FUDS.

6.3.2 Management Goals

6.3.2.1 Management goals are general statements about the desired condition of ecological values of concern. The goals vary based on the objectives of the property owner, current and reasonable future land use, regulatory requirements, the ecosystem, and the environmental needs of the community or other stakeholders (USACE, 2006). All site-specific management goals should be consistent with the Army's over-arching management goal for ecological risk assessments (ERAs):

Protect valuable biological resources from unreasonable adverse effects due to the release of hazardous substances associated with Army operations, including past Department of Defense operations for FUDS (Department of the Army, 2005).

6.3.2.2 As discussed above, protected species and habitats are known to be present within each MRS at the Culebra Island FUDS. Therefore, for this SLERA, the entire site is considered an ecologically important place. Various valuable ecological resources are present or expected to be present within the site, potentially including 26 federally listed animal species. Based on these ecological resources, the primary ERA management goal is to sustain the populations of any listed species that occur at the site.

6.3.3 Affected Media

Direct release of MC from munitions activities at the site would have been to soil. Migration of MC to surface water / sediment through erosion and contaminant migration is also possible. Based on decisions made at the TPP meeting, soil and sediment were the only media sampled during the SI at the Culebra Island FUDS. Surface soil is expected to act as an indicator of potential contamination. Because activities at the site would be expected to release MC directly to surface soil and result in the highest concentrations in the surface soil, the potential absence of MC in surface soil would indicate the absence of contamination in other media.

6.3.4 Screening Values

The criteria used for ecological screening-level comparison are the EPA Region 4 ESVs.

6.3.5 Ecological Risk Characterization for Soil

6.3.5.1 Section 5.1.7 describes how the soil data for each of the MRSs were screened to determine whether analytes were both MC and present above ambient levels. Only those soil analytes that exceeded background concentrations, are potential MC, and are CERCLA hazardous substances were retained for risk characterization in this chapter.

6.3.5.2 To complete the ecological risk characterization for this site, the maximum detected concentration of each selected analyte was evaluated against the screening values (Section 6.3.4). This comparison resulted in the calculation of hazard quotients (HQs) for each analyte. The HQ was calculated by determining the ratio of the maximum detected site concentration to the screening value (in this case, the EPA Region 4 ESVs). If the HQ was equal to or less than one, the potential for ecological risk for that receptor group was considered to be negligible. If the HQ was greater than one, then unacceptable ecological risks generally cannot be ruled out based on the screening comparison alone. Additional evaluation and consideration of the conservative nature of the screening evaluation may be appropriate when the HQ is close to but greater than one.

6.3.5.1 MRS 02 – Northwest Peninsula, Cerro Balcon, and Adjacent Cayos

Ten soil samples were collected by Ellis Environmental at MRS 02. As described in Section 5.2.3.6, two analytes (chromium and zinc) were retained for risk characterization. Table 6.20 presents the SLERA results for these analytes and indicates that the maximum detected concentrations exceed the risk-based screening values. Based on these results, there is a potential for ecological risk due to chromium and zinc in soil at MRS 02.

6.3.5.2 MRS 05 – Mortar and Combat Range Area

Six soil samples were collected from MRS 05. As described in Section 5.5.3, four analytes (barium, chromium, copper, and zinc) were retained for risk characterization. Table 6.21 presents the SLERA results for these analytes and indicates that the maximum detected concentrations exceed the risk-based screening values. Based on these results, there is a potential for ecological risk due to barium, chromium, copper, and zinc in soil at MRS 05.

TABLE 6.20
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 02
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Chromium	mg/kg	110	0.4	Yes	275
Zinc	mg/kg	150	50	Yes	3

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

TABLE 6.21
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 05
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	1300	165	Yes	7.9
Chromium	mg/kg	150	0.4	Yes	375
Copper	mg/kg	170	40	Yes	4.3
Zinc	mg/kg	120	50	Yes	2.4

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.5.3 MRS 06 – Artillery Firing Area

Two soil samples were collected from MRS 06. As described in Section 5.6.3, two analytes (chromium and copper) were retained for risk characterization. Table 6.22 presents the SLERA results for these analytes and indicates that the maximum detected concentrations exceed the risk-based screening values. Based on these results, there is a potential for ecological risk due to chromium and copper in soil at MRS 06.

TABLE 6.22
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 06
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Chromium	mg/kg	19	0.4	Yes	48
Copper	mg/kg	130	40	Yes	3.3

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.5.4 MRS 07 – Culebrita Artillery Impact Area

Two soil samples were collected from MRS 07. As described in Section 5.7.3, three analytes (barium, copper, and zinc) were retained for risk characterization. Table 6.23 presents the SLERA results for these analytes and indicates that the maximum detected concentrations exceed the risk-based screening values. Based on these results, there is a potential for ecological risk due to barium, copper, and zinc in soil at MRS 07.

TABLE 6.23
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 07
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	480	165	Yes	2.9
Copper	mg/kg	600	40	Yes	15
Zinc	mg/kg	240	50	Yes	4.8

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.5.5 MRS 08 – Cayo Norte Impact Area

Two soil samples were collected from MRS 08. As described in Section 5.8.3, one analyte (zinc) was retained for risk characterization. Table 6.24 presents the SLERA results for this analyte and indicates that the maximum detected concentration exceeds the risk-based screening value. Based on this result, there is a potential for ecological risk due to zinc in soil at MRS 08; however, due to the low HQ of 1.8 and the conservative approach used to determine the HQ (comparison to maximum concentration detected), it is reasonable to say that ecological risk due to zinc is unlikely.

TABLE 6.24
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 08
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Zinc	mg/kg	90	50	Yes	1.8

a USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.5.6 MRS 09 – Soldado Point Mortar and Bombing Areas

Two soil samples were collected from MRS 09. As described in Section 5.9.3, one analyte (chromium) was retained for risk characterization. Table 6.25 presents the SLERA results for this analyte and indicates that the maximum detected concentration exceeds the risk-based screening value. Based on this result, there is a potential for ecological risk due to chromium in soil at MRS 09.

TABLE 6.25
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 09
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Chromium	mg/kg	19	0.4	Yes	48

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.5.7 MRS 10 – Defensive Firing Area No. 1

Two soil samples were collected from MRS 10. As described in Section 5.10.3, four analytes (barium, chromium, copper, and zinc) were retained for risk characterization. Table 6.26 presents the SLERA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, there is a potential for ecological risk due to barium, chromium, copper, and zinc in soil at MRS 10.

TABLE 6.26
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 10
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	1100	165	Yes	6.7
Chromium	mg/kg	22	0.4	Yes	55
Copper	mg/kg	230	40	Yes	5.8
Zinc	mg/kg	130	50	Yes	2.6

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.5.8 MRS 13 – Cayo Luis Pena Impact Area

Two soil samples were collected from MRS 13. As described in Section 5.13.3, one analyte (chromium) was retained for risk characterization. Table 6.27 presents the SLERA results for this analyte and indicates that the maximum detected concentration exceeds the risk-based screening value. Based on this result, there is a potential for ecological risk due to chromium in soil at MRS 13.

TABLE 6.27
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 13
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Chromium	mg/kg	17	0.4	Yes	42.5

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.5.9 MRS 14 – Airport and Camp Area

One soil sample was collected from MRS 14. As described in Section 5.14.3, two analytes (barium and copper) were retained for risk characterization. Table 6.28 presents the SLERA results for these analytes and indicates that the maximum detected concentrations exceed the risk-based screening values. Based on these results, there is a potential for ecological risk due to barium and copper in soil at MRS 14.

TABLE 6.28
SOIL ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 14
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	600	165	Yes	3.6
Copper	mg/kg	120	40	Yes	3.0

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
HQ = Hazard Quotient
*** Screening levels based on the Culebra Island Site-Specific SAP.

6.3.6 Risk Characterization for Surface Water / Sediment

To complete the risk characterization for this site, the maximum detected concentration of each sediment analyte retained for consideration in the SLRA in Section 5 was compared to the ecological screening levels (that is, EPA Region 4 ESVs).

6.3.6.1 MRS 02 – Northwest Peninsula, Cerro Balcon, and Adjacent Cayos

As determined in Section 5.2.3, a complete surface water / sediment exposure pathway exists at MRS 02 for ecological receptors; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the SLERA for soil at MRS 02, presented in Section 6.3.5.1 (there is a potential for ecological risk due to chromium,

and zinc in soil at MRS 02), ecological risk from MC is possible through exposure to surface water / sediment at MRS 02 due to potential contamination migration from soil.

6.3.6.2 MRS 04 – Flamenco Lagoon Maneuver Area

Two sediment samples were collected from MRS 04. As described in Section 5.4.2, six analytes (barium, chromium, copper, lead, mercury, and zinc) were retained for risk characterization. Table 6.29 presents the SLERA results for these analytes and indicates that the maximum detected concentration of one analyte (copper) exceeds the risk-based screening value. Based on these results, there is a potential for ecological risk due to copper in sediment at MRS 04. There is no ecological screening value for barium in sediment; therefore, the results of the SLERA for barium in sediment at MRS 04 are inconclusive.

TABLE 6.29
SEDIMENT ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 04
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	81	--[b]	No	N/A
Chromium	mg/kg	9.9	52.3	No	<1
Copper	mg/kg	93	18.7	Yes	5.0
Lead	mg/kg	12	30.2	No	<1
Mercury	mg/kg	0.04	0.13	No	<1
Zinc	mg/kg	74	124	No	<1

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)

[b] "--" = no ESV sediment value available for comparison.

HQ = Hazard Quotient

N/A Not applicable

6.3.6.3 MRS 05 – Mortar and Combat Range Area

One sediment sample was collected from MRS 05. As described in Section 5.5.2, six analytes (barium, chromium, copper, lead, mercury, and zinc) were retained for risk characterization. Table 6.30 presents the SLERA results for these analytes and indicates that the maximum detected concentrations of one analyte (copper) exceeded the risk-based screening value. Based on these results, there is a potential for ecological risk due to copper in sediment at MRS 05; however, due to the low HQ of 1.2 and the conservative approach used to determine the HQ (comparison to maximum concentration detected), it is reasonable to say that ecological risk due to copper is unlikely. There is no ecological screening value for barium in sediment; therefore, the result of the SLERA for barium in sediment at MRS 05 is inconclusive.

TABLE 6.30
SEDIMENT ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 05
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	29	--[b]	No	N/A
Chromium	mg/kg	7.7	52.3	No	<1
Copper	mg/kg	22	18.7	Yes	1.2
Lead	mg/kg	2.5	30.2	No	<1
Mercury	mg/kg	0.013	0.13	No	<1
Zinc	mg/kg	32	124	No	<1

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)

[b] "--" = no ESV value available for comparison.

HQ = Hazard Quotient

N/A Not applicable

6.3.6.4 MRS 06 – Artillery Firing Area

As determined in Section 5.6.2, a complete surface water / sediment exposure pathway exists at MRS 06; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the SLERA for soil at MRS 06, presented in Section 6.3.5.3 (there is a potential for ecological risk due to chromium and copper in soil at MRS 06), exposure to surface water / sediment at MRS 06 is possible due to potential contamination migration from soil. Additionally, at MRS 06, ecological risk from MC is possible through direct release of MC to surface water / sediment.

6.3.6.5 MRS 07 – Culebrita Artillery Impact Area

One sediment sample was collected from MRS 07. As described in Section 5.7.2, five analytes (barium, chromium, copper, lead, and zinc) were retained for risk characterization. Table 6.31 presents the SLERA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable ecological risk from MC is expected through exposure to surface water / sediment at MRS 07. There is no ecological screening value for barium in sediment; therefore, the results of the SLERA for barium in sediment at MRS 07 are inconclusive.

TABLE 6.31
SEDIMENT ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 07
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	16	--[b]	No	N/A
Chromium	mg/kg	3	52.3	No	<1
Copper	mg/kg	6.7	18.7	No	<1
Lead	mg/kg	1.9	30.2	No	<1
Zinc	mg/kg	5	124	No	<1

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
[b] "--" = no ESV value available for comparison.
HQ = Hazard Quotient
N/A Not applicable

6.3.6.6 MRS 08 – Cayo Norte Impact Area

One sediment sample was collected from MRS 08. As described in Section 5.8.2, six analytes (barium, chromium, copper, lead, mercury, and zinc) were retained for risk characterization. Table 6.32 presents the SLERA results for these analytes and indicates that the maximum detected concentrations are less than the risk-based screening values. Based on these results, no unacceptable ecological risk from MC is expected through exposure to surface water / sediment at MRS 08. There is no ecological screening value for barium in sediment; therefore, the results of the SLERA for barium in sediment at MRS 08 are inconclusive.

TABLE 6.32
SEDIMENT ECOLOGICAL SCREENING RISK ASSESSMENT FOR MRS 08
CULEBRA ISLAND, PUERTO RICO

Analyte	Units	Maximum Detected Site Concentration	USEPA Region 4 ESV [a]	Exceeds Screening Value	HQ
Metals					
Barium	mg/kg	140	--[b]	No	N/A
Chromium	mg/kg	2.1	52.3	No	<1
Copper	mg/kg	19	18.7	Yes	1.0
Lead	mg/kg	5.9	30.2	No	<1
Mercury	mg/kg	0.011	0.13	No	<1
Zinc	mg/kg	61	124	No	<1

[a] USEPA Region 4 Ecological Screening Values obtained from http://www.epa.gov/region4/wate/ots/ecolbul.htm#tb14 (EPA, 2001)
[b] "--" = no ESV value available for comparison.
HQ = Hazard Quotient
N/A Not applicable

6.3.6.7 MRS 09 – Soldado Point Mortar and Bombing Area

As determined in Section 5.9.2, a complete surface water / sediment exposure pathway exists at MRS 09; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the SLERA for soil at MRS 09, presented in Section 6.3.5.6 (there is a potential for ecological risk due to chromium in soil at MRS 09), ecological risk from MC is possible through exposure to surface water / sediment at MRS 09 due to potential contamination migration from soil.

6.3.6.8 MRS 10 – Defensive Firing Area No. 1

As determined in Section 5.10.2, a complete surface water / sediment exposure pathway exists at MRS 10 for ecological receptors; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the SLERA for soil at MRS 10, presented in Section 6.3.5.7 (there is a potential for ecological risk due to barium, chromium, copper, and zinc in soil at MRS 10), ecological risk from MC is possible through exposure to surface water / sediment at MRS 10 due to potential contamination migration from soil.

6.3.6.9 MRS 13 – Cayo Luis Pena Impact Area

As determined in Section 5.13.2, a complete surface water / sediment exposure pathway exists at MRS 13 for ecological receptors; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the SLERA for soil at MRS 13, presented in Section 6.3.5.8 (there is a potential for ecological risk due to chromium in soil at MRS 13), ecological risk from MC is possible through exposure to surface water / sediment at MRS 13 due to potential contamination migration from soil.

6.3.6.10 MRS 14 – Airport and Camp Area

As determined in Section 5.14.2, a complete surface water / sediment exposure pathway exists at MRS 14; however, no sediment or surface water samples were collected at this MRS. Direct release of MC from munitions activities at the site would have been to surface soil; however, migration of MC to surface water / sediment is possible. As discussed in Section 6.2.2, surface soil is expected to act as an indicator of potential contamination. Based on the results of the SLERA for soil at MRS 14, presented in Section 6.3.5.9 (there is a potential for ecological risk due to barium and copper in soil at MRS 14), ecological risk from MC is possible through exposure to surface water / sediment at MRS 14 due to potential contamination migration from soil.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1.1 The SI performed on the Culebra Island FUDS, Puerto Rico, evaluated site-specific conditions to assess the potential for completed exposure pathways to human and ecological receptors at the site. The project was planned and performed with the goal of satisfying the DQOs set for the project: 1) evaluate potential presence of MEC; 2) evaluate potential presence of MC; 3) collect data needed to complete MRSPP scoring sheets; and 4) collect information for HRS scoring. Successful completion of the DQOs allowed determination of whether this FUDS project warrants further response action under CERCLA.

7.1.2 The SI evaluation included more than 51 miles of QR and the collection of 27 surface soil samples (plus three associated field duplicates) and five sediment samples. Twenty-nine of these samples were collected from biased locations representing areas with the highest likelihood for the presence of MEC or MC contamination. Three samples were collected from adjacent land buffers to provide ambient data.

7.1.3 STL in Arvada, Colorado, analyzed for explosives and metals in the soil and sediment samples. The detected analytes from the soil and sediment sampling were evaluated using the EPA Region 9 residential soil PRGs for human health risk and EPA Region 4 ESVs for ecological risk.

7.1.4 Summaries for each MRS at the Culebra Island FUDS follow.

7.1 MRS-SPECIFIC SUMMARY

7.1.1 MRS 02 –Northwest Peninsula, Cerro Balcon, and Adjacent Cayos

7.1.1.1 Many previous investigations conducted at MRS 02 have confirmed the presence of MEC and MD items. MRS 02 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC. MRS 02 is a very diverse site that includes the smaller cays surrounding Culebra Island, Northwest Peninsula, and portions of Cerro Balcon. As shown in Table 4.3 many MEC items have been identified at MRS 02. Most of the items were found on Northwest Peninsula and Flamenco Beach, but MEC have also been identified on Cayo Del Agua, Cayo Botella, Cayo Lobo, and Cerro Balcon. Of these areas, Cerro Balcon and Northwest Peninsula are more frequented than the small cays surrounding Culebra, and construction is currently underway on the southern slope of Cerro Balcon. As discussed in Sections 2.5 and 4.2, several removal actions have been conducted within this MRS.

7.1.1.2 As discussed in Section 5.2, soil migration pathways are complete for human receptors at MRS 02; however, no unacceptable human health risk from MC is expected

through exposure to soil there. Surface water / sediment, groundwater, and air migration pathways are not complete for human receptors at MRS 02; therefore, no human health risk is expected due to MC exposure through these three migration pathways.

7.1.1.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 02. As discussed in Section 6.3, there is potential for unacceptable ecological risk due to chromium and zinc in soil at MRS 02. Additionally, unacceptable ecological risk through the surface water / sediment migration pathway cannot be ruled out due to MC migration from soil. Groundwater and air migration pathways are not complete for ecological receptors at MRS 02; therefore, unacceptable ecological risk is not expected due to MC exposure through these two migration pathways.

7.1.2 MRS 03 – Flamenco Bay Water Area

7.1.2.1 Due to the limited scope of the SI and the underwater location of this MRS; no field activities or observations were made in this area. No previous investigations have been conducted within MRS 03; however, munitions were confirmed near Flamenco Beach by a local diver. MRS 03 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.2.2 No MC sampling was conducted at MRS 03; however, the constant movement and exposure of the sediment to ocean water in this MRS greatly reduces the likelihood that MC remains in the sediment at concentrations of concern. It is not anticipated that any MC exposure pathways for human or ecological receptors are complete at MRS 03; therefore, no unacceptable human health or ecological risk is expected due to MC exposure through soil, surface water / sediment, groundwater, or air migration pathways.

7.1.3 MRS 04 – Flamenco Lagoon Maneuver Area

7.1.3.1 The SI field team identified no MEC or MD within MRS 04; however, due to its close proximity to portions of MRS 02 (where MEC items have been confirmed), it is possible that MEC are present on site. MRS 04 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.3.2 As discussed in Section 5.2, surface water/sediment migration pathways are complete for human receptors at MRS 04; however, no unacceptable human health risk from MC is expected through exposure to surface water / sediment there. Soil, groundwater, and air migration pathways are not complete for human receptors at MRS 04; therefore, no unacceptable human health risk is expected due to MC exposure through these three migration pathways.

7.1.3.3 Surface water / sediment migration pathways are complete for ecological receptors at MRS 04. As discussed in Section 6.3, there is potential for ecological risk due to copper in sediment at MRS 04, and the results for barium in sediment are inconclusive. Soil, groundwater, and air migration pathways are not complete for ecological receptors at MRS 04; therefore, no ecological risk is expected due to MC exposure through these three migration pathways.

7.1.4 MRS 05 – Mortar and Combat Range Area

7.1.4.1 Many previous investigations conducted on MRS 05 have confirmed the presence of MEC and MD items within this MRS. During the SI, the field team identified MD within MRS 05 near Cerro Balcon. MRS 05 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.4.2 As discussed in Section 5.2, soil migration pathways and surface water / sediment migration pathways are complete for human receptors at MRS 05; however, no unacceptable human health risk from MC is expected through exposure to soil or surface water / sediment there. Groundwater and air migration pathways are not complete for human receptors at MRS 05; therefore, no unacceptable human health risk is expected due to MC exposure through these two migration pathways.

7.1.4.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 05. As discussed in Section 6.3, there is potential for ecological risk due to barium, chromium, copper, and zinc in soil at MRS 05. Additionally, unacceptable ecological risk due to copper in sediment is possible, but unlikely based on the low HQ. Groundwater and air migration pathways are not complete for ecological receptors at MRS 05; therefore, no unacceptable ecological risk is expected due to MC exposure through these two migration pathways.

7.1.5 MRS 06 – Artillery Firing Area

7.1.5.1 The SI field team identified no MEC or MD within MRS 06. However, the ASR states that one MD item has been identified in this area; therefore, it is possible that MEC may be present on site. MRS 06 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.5.2 As discussed in Section 5.2, soil migration pathways and surface water / sediment migration pathways are complete for human receptors at MRS 06; however, no unacceptable human health risk from MC is expected through exposure to soil. Human health risk is not expected through the surface water / sediment migration pathway due to MC migration from soil because no human health risk is present from MC in soil. However, at MRS 06, there is potential for direct release of MC to sediment; therefore, risk to human health from MC in sediment at MRS 06 cannot be ruled out. Groundwater and air migration pathways are not complete for human receptors at MRS 06; therefore, no human health risk is expected due to MC exposure through these two migration pathways.

7.1.5.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 06. As discussed in Section 6.3, there is potential for ecological risk due to chromium and copper in soil at MRS 06. Unacceptable ecological risk through the surface water / sediment migration pathway is possible due to MC migration from soil and through direct release of MC to surface water / sediment. Groundwater and air migration pathways are not complete for ecological receptors at MRS 06; therefore, no ecological risk is expected due to MC exposure through these two migration pathways.

7.1.6 MRS 07 – Culebrita Artillery Impact Area

7.1.6.1 Previous investigations at MRS 07 have confirmed the presence of MEC and MD items within this MRS. During the SI, the field team identified MD within MRS 07 on the northeastern lobe of Culebrita. MRS 07 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.6.2 As discussed in Section 5.2, soil migration pathways and surface water / sediment migration pathways are complete for human receptors at MRS 07; however, no unacceptable human health risk from MC is expected through exposure to soil or surface water / sediment at MRS 07. Groundwater and air migration pathways are not complete for human receptors at MRS 07; therefore, no human health risk is expected due to MC exposure through these two migration pathways.

7.1.6.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 07. As discussed in Section 6.3, there is potential for ecological risk due to barium, copper, and zinc in soil at MRS 07. However, no unacceptable ecological risk from MC is expected through exposure to surface water / sediment at MRS 07 (although the screening results for barium are inconclusive). Groundwater and air migration pathways are not complete for ecological receptors at MRS 07; therefore, no ecological risk is expected due to MC exposure through these two migration pathways.

7.1.7 MRS 08 – Cayo Norte Impact Area

7.1.7.1 The SI field team identified no MEC or MD within MRS 08; however, the ASR states that munitions have been identified in the water near the eastern end of Cayo Norte. Cayo Norte was also within the safety fan for the artillery range in MRS 06. MEC and MD may be present on Cayo Norte. MRS 08 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.7.2 As discussed in Section 5.2, soil migration pathways and surface water / sediment migration pathways are complete for human receptors at MRS 08; however, no unacceptable human health risk from MC is expected through exposure to soil or surface water / sediment there. Groundwater and air migration pathways are not complete for human receptors at MRS 08; therefore, unacceptable human health risk is not expected due to MC exposure through these two migration pathways.

7.1.7.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 08. As discussed in Section 6.3, there is potential for ecological risk due to zinc in soil at MRS 08; however, unacceptable risk posed by zinc is unlikely due to the low HQ. No unacceptable ecological risk from MC is expected through exposure to surface water / sediment at MRS 08 (although the screening results for barium are inconclusive). Groundwater and air migration pathways are not complete for ecological receptors at MRS 08; therefore, unacceptable ecological risk is not expected due to MC exposure through these two migration pathways.

7.1.8 MRS 09 – Soldado Point Mortar and Bombing Area

7.1.8.1 The SI field team identified MD within MRS 09, so MEC may be present on site. MRS 09 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.8.2 As discussed in Section 5.2, soil migration pathways and surface water / sediment migration pathways are complete for human receptors at MRS 09; however, no unacceptable human health risk from MC is expected through exposure to soil or surface water / sediment there. Groundwater and air migration pathways are not complete for human receptors at MRS 09; therefore, unacceptable human health risk is not expected due to MC exposure through these two migration pathways.

7.1.8.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 09. As discussed in Section 6.3, there is potential for ecological risk due to chromium in soil at MRS 09. Additionally, ecological risk through the surface water / sediment migration pathway is possible due to MC migration from soil. Groundwater and air migration pathways are not complete for ecological receptors at MRS 09; therefore, unacceptable ecological risk is not expected due to MC exposure through these two migration pathways.

7.1.9 MRS 10 – Defensive Firing Area #1

7.1.9.1 The SI field team identified no MEC or MD within MRS 10, and historical records showed no cases of MD or MEC identified in this MRS. However, due to the limited source of information for this MRS, historical reference to direct fire with mortars and artillery, and limited QR due to lack of ROE, the MEC exposure pathway is potentially complete and MEC could pose a potential risk to human health.

7.1.9.2 As discussed in Section 5.2, soil migration pathways are complete for human receptors at MRS 10; however, no unacceptable human health risk from MC is expected through exposure to soil there. Groundwater, surface water / sediment and air migration pathways are not complete for human receptors at MRS 10; therefore, unacceptable human health risk is not expected due to MC exposure through these three migration pathways.

7.1.9.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 10. As discussed in Section 6.3, there is potential for ecological risk due to barium, chromium, copper, and zinc in soil at MRS 10. Additionally, unacceptable ecological risk through the surface water / sediment migration pathway is possible due to MC migration from soil. Groundwater and air migration pathways are not complete for ecological receptors at MRS 10; therefore, unacceptable ecological risk is not expected due to MC exposure through these two migration pathways.

7.1.10 MRS 11 – Defensive Firing Area #2

7.1.10.1 The SI field team identified MD within MRS 11, so it is possible that MEC may be present on site. MRS 11 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.10.2 Soil, groundwater, surface water / sediment and air migration pathways are not complete for human or ecological receptors at MRS 11; therefore, unacceptable human health or ecological risk is not expected due to MC exposure.

7.1.11 MRS 12 – Luis Pena Channel Water Areas

7.1.11.1 Due to the limited scope of the SI and the underwater location of this MRS, no field activities were performed and no observations were made in this area. No previous investigations have been conducted within MRS 12; however, munitions were confirmed in Luis Pena Channel by a local diver. MRS 12 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.11.2 No MC sampling was conducted at MRS 12; however, the constant movement and exposure of the sediment to ocean water in this MRS greatly reduces the likelihood that MC remains in the sediment. It is not anticipated that any MC exposure pathways for human health or ecological receptors are complete at MRS 12; therefore, unacceptable human health or ecological risk is not expected due to MC exposure through soil, surface water / sediment, groundwater, or air migration pathways.

7.1.12 MRS 13 – Cayo Luis Pena Impact Area

7.1.12.1 The SI field team identified several pieces of MD within MRS 13; therefore, it is possible that MEC may be present on site. MRS 13 has human receptors present; therefore, the MEC exposure pathway is complete and there is a potential for human health risk due to MEC.

7.1.12.2 As discussed in Section 5.2, soil migration pathways are complete for human receptors at MRS 13; however, unacceptable human health risk from MC is not expected through exposure to soil there. Surface water / sediment, groundwater, and air migration pathways are not complete for human receptors at MRS 13; therefore, unacceptable human health risk is not expected due to MC exposure through these three migration pathways.

7.1.12.3 Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 13. As discussed in Section 6.3, there is potential for ecological risk due to chromium in soil at MRS 13. Additionally, unacceptable ecological risk through the surface water / sediment migration pathway is possible due to MC migration from soil. Groundwater and air migration pathways are not complete for ecological receptors at MRS 13; therefore, unacceptable ecological risk is not expected due to MC exposure through these two migration pathways.

7.1.13 MRS 14 – Airport and Camp Area

7.1.13.1 The SI field team identified no MEC or MD within MRS 14, and historical records showed no cases of munitions debris or MEC identified in this MRS. MRS 14 does not appear to have a source of MEC; therefore, the MEC exposure pathway is incomplete and MEC does not pose a potential risk to human health.

7.1.13.2 As discussed in Section 5.2, soil migration pathways and surface water / sediment migration pathways are complete for human receptors at MRS 14; however,

unacceptable human health risk from MC is not expected through exposure to soil or surface water / sediment there. Groundwater and air migration pathways are not complete for human receptors at MRS 14; therefore, unacceptable human health risk is not expected due to MC exposure through these two migration pathways.

7.1.13.3 Groundwater and air migration pathways are not complete for ecological receptors at MRS 14; therefore, unacceptable ecological risk is not expected due to MC exposure through these two migration pathways. Surface water / sediment migration pathways and soil migration pathways are complete for ecological receptors at MRS 14. As discussed in Section 6.3, there is potential for ecological risk due to barium and copper in soil at MRS 14. Therefore, unacceptable ecological risk through the surface water / sediment migration pathway also cannot be ruled out due to MC migration from soil. However, there is no historical evidence of munitions used at MRS 14 except for possible small arms. Small arms use at MRS 14 would have resulted in high concentrations of lead and antimony; however, antimony was not detected and lead was detected at a concentration much lower than the maximum ambient concentration. Therefore, it is concluded that slightly elevated barium and copper concentration at MRS 14 are not due to munitions use at the Culebra Island FUDS. Rather, it is likely that the barium and copper detected at MRS 14 are due to the variable geology of the site and the resulting variations of soil chemistry.

7.2 OVERALL CONCLUSIONS

7.2.1 The potential for MEC to pose a human health risk is present within 12 of the 13 MRSs. At this time, there is no evidence to indicate that MRS 14 has potential MEC contamination. Though there is potential for MEC to pose a risk at the Culebra Island FUDS, the field team did not identify an imminent threat to the public; therefore, a TCRA is not recommended for any of the 13 MRSs.

7.2.2 The presence of MC has been identified to some degree in 10 of the 13 MRSs investigated during the SI. The human health SLRA concluded that the soil and surface water / sediment migration pathways were complete, but that none of the metals detected resulted in unacceptable risk to human health. In contrast, the SLERA concluded that unacceptable ecological risk could not be ruled out at eight MRSs due to metals in soil (02, 05, 06, 07, 09, 10, 13, and 14), and due to metals in sediment at MRS 04. Surface water / sediment was not sampled at MRS 06, and there is historical evidence that direct fire may have contaminated the lagoon at Mosquito Bay within this MRS; therefore, risk to human health and ecological receptors at MRS 06 cannot be ruled out. Additionally, ecological risk is possible due to metals migration from soil at six MRSs (02, 06, 09, 10, 13, and 14). However, although ecological risk is potentially present due to barium and copper at MRS 14, there is no evidence of MEC at this MRS, and therefore it is concluded that the elevated barium and copper in soil is not related to munitions use of the site.

CHAPTER 8

RECOMMENDATIONS

8.1 Due to the presence of munitions debris and MEC at several areas within the site, 12 of the 13 MRSs at Culebra Island FUDS are recommended to proceed to RI/FS status (See Table 8.1).

8.2 No evidence of MEC or munitions debris has been identified within MRS 10; however, historical evidence indicates mortars and artillery were used at this MRS. Because the portion of the site where munitions debris is expected has not been developed, and since access during the SI was limited due to lack of ROE, it is possible that munitions debris and/or MEC may remain undiscovered within this MRS. Therefore, an RI/FS is also warranted for MRS 10 due to potential for MEC risk.

8.3 Soil samples collected at MRS 14 contained concentrations of barium and copper that are higher than those of the ambient samples. However, as discussed in paragraph 7.1.13.3, this contamination is apparently not due to DoD use of the site; therefore, a status of no DoD action indicated (NDAI) is recommended for MRS 14.

8.4 It is possible that many of the MC analytes detected are within background concentrations. The diversity of soil types (Figure 2.2) and parent rock types (Figure 2.1) indicates that careful planning of soil sample locations will be required to collect a representative and statistically-viable data set for background metals determination in the RI.

8.5 In addition to the recommendations generated though the evaluation of MEC and MC risk during this SI, the following stakeholder recommendations have been made regarding follow on work on the Culebra Island FUDS site.

- The USFWS requests that screening values be evaluated and reconsidered by future TPP teams during the RI/FS.
- NOAA request that after standard operation procedures for protecting important marine and coastal resources are finalized with FWS and the National Marine Fisheries Service, that this information be used to guide decisions regarding which inventory sites, or portions of inventory sites, will undergo an RI/FS.

TABLE 8.1
RECOMMENDATIONS: CULEBRA ISLAND FORMERLY USED DEFENSE SITE

MRS	Recommendation	Rationale
02 – Northwest Peninsula, Cerro Balcon, and Adjacent Cayos	RI/FS	Human health risk due to MEC: MEC identified during previous investigations Munitions debris identified during SI and previous investigations Potential ecological risk due to MC in soil: Chromium (HQ 275) Zinc (HQ 3) Possible migration from soil to surface water / sediment
03 – Flamenco Bay Water Area	RI/FS	Human health risk due to MEC: MEC or munitions debris reported by local diver Risk due to MC unlikely due to dilution and movement/exposure from sea water
04 – Flamenco Lagoon Maneuver Area	RI/FS	Human health risk due to MEC: Historical record of munitions use Munitions debris and MEC in nearby MRS Potential ecological risk due to MC in surface water / sediment: Chromium (HQ 5.0) Barium results are inconclusive
05 – Mortar and Combat Range Area	RI/FS	Human health risk due to MEC: MEC identified during previous investigations Munitions debris identified during SI and previous investigations Potential ecological risk due to MC in soil: Barium (HQ 7.9) Chromium (HQ 375) Copper (HQ 4.3) Zinc (HQ 2.4) Potential, but low likelihood, of ecological risk due to MC in surface water / sediment: Copper (low HQ 1.2) Barium results are inconclusive

TABLE 8.1
RECOMMENDATIONS: CULEBRA ISLAND FORMERLY USED DEFENSE SITE

MRS	Recommendation	Rationale
06 – Artillery Firing Area	RI/FS	Human health risk due to MEC: Historical record of munitions use Potential ecological risk due to MC in soil: Chromium (HQ 48) Copper (HQ 3.3) Potential ecological risk due to MC in surface water / sediment: Possible migration from soil to surface water / sediment Potential for direct release to surface water / sediment Human health risk due to MC in surface water / sediment Potential for direct release to surface water / sediment
07 – Culebrita Artillery Impact Area	RI/FS	Human health risk due to MEC: MEC identified during previous investigations Munitions debris identified during SI and previous investigations Potential ecological risk due to MC in soil: Barium (HQ 2.9) Copper (HQ 15) Zinc (HQ 4.8) Potential ecological risk due to MC in surface water / sediment is only driven by: Inconclusive results for barium No risk due to other analytes
08 – Cayo Norte Impact Area	RI/FS	Human health risk due to MEC: Historical record of munitions use Munitions identified in water nearby Potential, but low likelihood, of ecological risk due to MC in soil: Zinc (low HQ 1.8) Potential ecological risk due to MC in surface water / sediment is only driven by: Inconclusive results for barium No risk due to other analytes
09 – Soldado Point Mortar and Bombing Area	RI/FS	Human health risk due to MEC: Munitions debris identified during SI Potential ecological risk due to MC in soil: Chromium (HQ 48) Possible migration to surface water / sediment

TABLE 8.1
RECOMMENDATIONS: CULEBRA ISLAND FORMERLY USED DEFENSE SITE

MRS	Recommendation	Rationale
10 – Defensive Firing Area No. 1	RI/FS	Human health risk due to MEC: Historical record of munitions use Potential ecological risk due to MC in soil: Barium (HQ 6.7) Chromium (HQ 55) Copper (HQ 5.8) Zinc (HQ 2.6) Potential ecological risk due to MC in surface water / sediment: Possible migration from soil to surface water / sediment
11 – Defensive Firing Area No. 2	RI/FS	Human health risk due to MEC: Munitions debris identified during SI No risk due to MC
12 – Luis Pena Channel Water Areas	RI/FS	Human health risk due to MEC: MEC or munitions debris reported by local diver Risk due to MC unlikely due to dilution and movement/exposure from sea water
13 – Cayo Luis Pena Impact Area	RI/FS	Human health risk due to MEC: Munitions debris identified during SI Potential ecological risk due to MC in soil: Chromium (HQ 42.5) Potential ecological risk due to MC in surface water / sediment: Possible migration from soil to surface water / sediment
14 – Airport and Camp Area	NDAI	No risk due to MEC No risk due to MC: Barium (HQ 3.6) not related to munitions Copper (HQ 3.0) not related to munitions

CHAPTER 9

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