FINAL

Site Inspection Report

Benedict Field

St. Croix, U.S. Virgin Islands

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

FUDS Project No. I02VI056401
Contract: W912DY-04-D-0005
Task Order: 0008

Prepared For:

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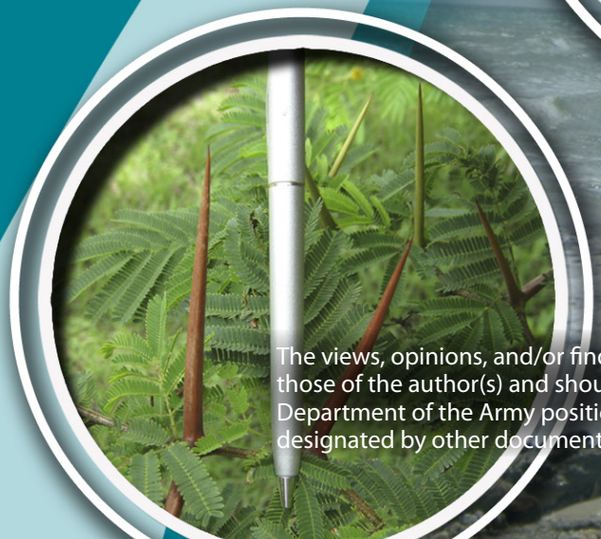

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

March 23, 2011

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Parsons Infrastructure and Technology Group (Parsons) has completed the Final Site Inspection report for Benedict Field, St. Croix, U.S. Virgin Islands. 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, utilizing 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.

Kathleen A. Rowland

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March 23, 2011

Study/Design Team Leader and Team Members

Carol Moore

March 23, 2011

Independent Technical Review Team Leader

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.

Laura Kelly

March 23, 2011

Parsons Program Manager(s)

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March 23, 2011

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Subject: Contract W912DY-04-D-0005, Delivery Order 0008
MMRP SI for SE and Pacific IMA Region – Final SI Report,
Benedict Field, St. Croix, U.S. Virgin Islands

Dear Mr. O'Neal:

Parsons Infrastructure and Technology Group (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). Two copies have been provided for your records.

We have forwarded five copies of the document to Mr. Jose Mendez of the Jacksonville District, Antilles office, for distribution to stakeholders. We have forwarded one copy of the document to Mr. Charles Fales of the Jacksonville District for CESAJ records. We have also submitted a single copy of this Final document to CX-MM. Electronic copies have also been provided, including one to CX-EG and one to CEMVS-EC-P.

If you have any questions or comments, please contact me at (678) 969-2437 or (404) 934-1266 (cell).

Sincerely,

PARSONS

Laura Kelley

Laura Kelley
MMRP SI Program Manager

cc: Charles Fales (CESAJ) – 1 copy/1 CD
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U.S. Army Corps of Engineers
Southeast and Pacific IMA Region

FINAL
Site Inspection Report
Benedict Field
St. Croix, U.S. Virgin Islands

FUDS Project No. I02VI056401
March 23, 2011

In Support of

FUDS MMRP Site Inspections Project

Prepared for:
U.S. Army Corps of Engineers, Jacksonville District
701 San Marco Boulevard
Jacksonville, Florida 32207

and

U.S. Army Engineering and Support Center, Huntsville
4820 University Square
Huntsville, Alabama 35816

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ACRONYMS AND ABBREVIATIONS

APP	Accident Prevention Plan
ARC	Annual Report to Congress
ASR	Archive Search Report
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below Ground Surface
bsl	Below Sea Level
CEMVS	U.S. Army Corps of Engineers, St. Louis District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESAJ	U.S. Army Corps of Engineers, Jacksonville District
CFR	Code of Federal Regulations
CRREL	Cold Regions Research Engineering Laboratory
CSEM	Conceptual Site Exposure Model
CSM	Conceptual Site Model
CWM	Chemical Warfare Material
CZMP	Coastal Zone Management Program
DEP ARC	Defense Environmental Programs Annual Report to Congress
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DPNR	Department of Planning and Natural Resources
DQO	Data Quality Objective
ECOS	Environmental Conservation Online System
EcoSSLs	Ecological Soil Screening Levels
EFH	Essential Fish Habitat
EPP	Environmental Protection Plan
ER	Engineer Regulation
ESVs	Ecological Screening Values
FAC	Florida Administrative Code
FDE	Findings and Determination of Eligibility
FDEP	Florida Department of Environmental Protection
FTL	Field Team Leader
FUDS	Formerly Used Defense Site
GIS	Geographic Information System
GPS	Global Positioning System
HQ	Hazard Quotient
HRS	Hazard Ranking System
HTW	Hazardous Toxic Waste
IGD	Interim Guidance Document
INPR	Inventory Project Report
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
mg/kg	Milligrams Per Kilograms

ACRONYMS AND ABBREVIATIONS (CONTINUED)

MMRP	Military Munitions Response Program
MPA	Marine Protected Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
mya	Millions years ago
NAD	North American Datum
NCP	National Contingency Plan
NDAI	No Department of Defense Action Indicated
NERR	National Estuarine Research Reserve
NHA	National Heritage Areas
NHL	National Historic Landmarks
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRHD	National Register Historic District
NRHP	National Register of Historic Places
NRIS	National Register Information System
NWI	National Wetlands Inventory
NWRS	National Wildlife Refuge System
PA	Preliminary Assessment
Parsons	Parsons Corporation
POP	Period of Performance
PRG	Preliminary Remediation Goal
PSAP	Programmatic Sampling and Analysis Plan
PWP	Programmatic Work Plan
PWS	Performance Work Statement
QC	Quality Control
QR	Qualitative Reconnaissance
RAC	Risk Assessment Code
RI/FS	Remedial Investigation and Feasibility Study
RSL	Regional Screening Levels
SAP	Sampling & Analysis Plan
SCTL	Soil Cleanup Target Levels
SD	Standard Deviation
SI	Site Inspection
SLERA	Screening Level Ecological Risk Assessment
SLRA	Screening Level Risk Assessment
SOP	Standard Operating Procedure
SQAG	Sediment Quality Assessment Guidelines
SS-WP	Site-Specific Work Plan
SVT	Site Visit Team
SWQS	Surface Water Quality Standards

ACRONYMS AND ABBREVIATIONS (CONTINUED)

T&E	Threatened and Endangered
TESS	Threatened and Endangered Species System
TPP	Technical Project Planning
US	United States
USACE	U.S. Army Corps of Engineers
USAESCH	USACE, Engineering and Support Center, Huntsville
USC	United States Code
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USVI	U.S. Virgin Islands
UTM	Universal Transverse Mercator
UXOSO	Unexploded Ordnance Safety Officer

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.).
Inhabited Structure	Permanent or temporary structure, other than military munitions-related structures, routinely occupied by one or more persons for any portion of the day.
Magnetometer	An instrument for measuring the strength of a magnetic field; used to detect buried ferrous 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.

GLOSSARY OF TERMS (CONTINUED)

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 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 The objective of this site inspection (SI) is to determine whether the Bombing Target Munitions Response Site (MRS) and the Rifle Range MRS associated with the former Benedict Field located in St. Croix, U.S. Virgin Islands, warrants further investigation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Benedict Field has been declared a Formerly Used Defense Site (FUDS) and assigned FUDS project # I02VI056401. The work was performed under Contract No. W912DY-04-D-0005, Task Order No. 0008 from the United States Army Corps of Engineers (USACE), Engineering and Support Center, Huntsville (USAESCH). The SI was performed to confirm the range location and to evaluate the potential presence of munitions and explosives of concern (MEC) and munitions constituents (MC) at the site. To accomplish this objective, qualitative reconnaissance (QR) and MC sampling were performed within the land portions of the Bombing Target and Rifle Range MRSs. Figure ES.1 shows the site location of the FUDS and MRSs.

ES.2 The Army acquired the property for Benedict Field via several transactions between August 1940 and September 1943. The site was used as an auxiliary airfield for Borinquen Field in Puerto Rico. According to historical records, Benedict Field housed a fighter squadron and a heavy bomber squadron for aerial defense and submarine tracking in the Caribbean. Structures included a practice bomb target, a known-distance rifle range, ammunition storage facilities, and other buildings associated with a typical Army airfield. The Benedict Field property was declared excess in 1947 and was conveyed to the municipality of St. Croix via a quitclaim deed on November 22, 1948. The majority of the site is now used by the airport and a horse racetrack. The commercial airport is now known as the Henry E. Rohlsen Airport.

ES.3 The Technical Project Planning (TPP) process determined that the collection of ten biased surface soil samples (plus two field duplicates) and a biased surface water/sediment sample couple (plus a field duplicate) as well as the implementation of QR within the land areas of the two MRSs would be sufficient to meet the SI project objectives. Two ambient surface soil samples were also collected.

ES.4 Historical use of groundwater is suspected at the Bombing Target MRS, but anecdotal reported groundwater wells could not be located during the site visit. Per TPP Team concurrence, air samples were not collected during the SI.

ES.5 The site visit team (SVT) completed approximately 5 miles of QR during the site visit between June 21 and 23, 2010. No MEC were observed during the 2010 site visit. One piece of munitions debris (MD), a nose cone from a 100 lb practice bomb (Mk15), was found within the Bombing Target MRS. No evidence of MD or MEC was found within the Rifle Range MRS. No other munitions-related features, such as target remnants, were visually identified. Table ES.1 summarizes the results of the SI for Benedict Field.

Table ES.1
Summary of Site Inspection Results
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Acreage	Munitions and Explosive of Concern and/or Munitions Debris Assessment (1)	Munitions Constituents Assessment (2)	Recommendation
Bombing Target MRS	649	***Yes*** USACE documents issued since site closing and MD found during the June 2010 site visit confirm the use of the site as a bombing range. Munitions known to have been used at the MRS include practice bombs and flares.	***Yes*** Copper, lead, and zinc in surface soils exceed the ecological risk levels, although the copper and zinc levels are only slightly above the related risk value. No MC exceed their respective human health risk screening values.	***RI/FS*** Additional MC sampling may be warranted during a RI/FS
Rifle Range MRS	1259	***No*** This MRS was used with small arms only and MEC Presence is noted as "Evidence of no munitions."	***Yes*** Copper and zinc exceed ecological risk levels for surface soil. Copper and lead exceed ecological risk levels for fresh surface water. Each of these exceedances is only slightly above the risk level. No MC exceeded their respective human health risk screening value.	***NDAI*** There are no MC data that exceed human health risk screening values. MC only slightly exceed the ecological risk values and the concentrations could be within the range of naturally occurring concentrations.

Notes:

(1) "Yes" in this column indicates confirmed MEC or MD presence indicative of potential MEC presence, resulting in a RI/FS recommendation for the MRS. "No" in this column indicates no confirmed MEC or MD indicative of potential MEC presence.

(2) "Yes" in this column indicates the presence of MC presence at levels indicating a potential elevated risk to human health or ecological receptors, resulting in a recommendation for further MC sampling during a RI/FS. "No" in this column of the table indicates the absence of MC at levels indicating a potential risk to human health or ecological receptors, resulting in a recommendation for no further MC sampling for the MRS.

.

ES.6 TestAmerica in Arvada, Colorado analyzed the surface soil samples and the surface water/sediment sample couple for explosives, antimony, copper, lead, and zinc. No site-specific statistical evaluation of background metals concentrations in soil was available, and no regional median background concentration data or U.S. Geological Survey (USGS) average concentration data were available St. Croix. No surface water source suitable for use as a representative ambient sample was located for the SI. The TPP Team agreed to continue the SI study using ambient soil samples (non-statistical) as an indication of site-specific soil conditions. Each analyte was evaluated to verify that it is a potential MC for the site (such as in the munitions known or suspected for the site). Only those analytes detected above the maximum ambient screening level in the surface soil samples and are potential MC were retained for consideration in the screening level risk assessment (SLRA). MC detected in the surface water and sediment samples was carried into the SLRA.

ES.7 No explosives were detected in any sample or sample medium from either MRS. Four MC metals (antimony, copper, lead, and zinc) were detected in the surface soil samples collected from the Bombing Target MRS. The four metals were retained for further evaluation in the SLRA for the Bombing Target MRS. The four MC metals (antimony, copper, lead, and zinc) were detected in both, the surface water sample and the sediment sample, from the Rifle Range MRS and retained for evaluation in the SLRA. Three MC metals (antimony, copper, and zinc) were detected above the ambient maximum in the surface soil samples from the Rifle Range MRS and were retained for evaluation in the SLRA.

ES.8 The human health screening levels for soil and sediment consist of the USEPA RSLs for Chemical Contaminants at Superfund Sites for Residential Soil, updated in November 2010. The surface water screening values consist of the more stringent of the USEPA RSLs for Chemical Contaminants at Superfund Sites for Tap Water and FDEP FAC 62-777 Groundwater and Surface Water Cleanup Target Levels, Freshwater Surface Water Criteria and FAC 62-302 Surface Water Quality Standards (for Class III waters).

ES.9 Using the criteria in the Army Checklist for Important Ecological Places (USACE, 2006), the Bombing Target MRS and the Rifle Range MRS are classified as important ecological places. This classification is made because the MRSs contain marine wetlands that might contain threatened and endangered (T&E) species within the MRS boundaries (Subchapter 5.2.5). Therefore, ecological receptors are potential receptors for exposure pathways at this site. The ecological screening values for surface soil consist of the USEPA ecological soil screening levels (EcoSSLs). The ecological screening values (ESVs) for sediment consist of USEPA Region 4 sediment ESVs. For surface water, the ESVs are the more stringent of the USEPA Region 4 ESVs for fresh surface water and USEPA Region 3 Ecological Screening Benchmarks for surface water. The screening levels used are noted in the Screening Level Ecological Risk Assessment (SLERA) tables below. The ESVs are based on a number of conservative assumptions, including assumptions about the types of receptors present (e.g., insectivores, terrestrial mammals, etc.) and assumptions about exposure parameters such as soil ingestion rate

and receptor range. Site-specific information was not used to develop these screening values. The use of site-specific information typically results in less conservative and higher screening values.

ES.10 *None of the human health screening values for surface soil were exceeded for the retained analytes for the Bombing Target MRS (Table 6.5). None of the human health screening values for fresh surface water, sediment, or surface soil were exceeded for the retained analytes for the Rifle Range MRS (Tables 6.6, 6.7, and 6.8, respectively).* Therefore, based on the analytical results presented in this report, an unacceptable human health risk due to former munitions-related activities ***is not expected*** from exposure to surface soil at the Bombing Target MRS or fresh surface water, sediment or surface soil at the Rifle Range MRS.

ES.11 As shown in Table 5.6, the maximum detected concentrations of copper, lead, and zinc in surface soil at the Bombing Target MRS exceeded the background concentrations. Copper, lead, and zinc were detected at maximum concentrations exceeding the selected ecological screening values, resulting in HQs greater than 1. The HQ for copper was 1.8; for lead was 9.1; and for zinc was 2.4. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities ***may be present*** from exposure to copper, lead, and zinc in the surface soil at the Bombing Target MRS. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 1.2; and zinc by a factor of 1.9; so, based on the limited background data set, these concentrations may be within the range of naturally occurring concentrations. However, the maximum detected concentration of lead in the biased samples exceeded the maximum ambient concentration by a factor of 6.3, and may pose a risk to ecological receptors at the site. Possible other sources, including historic storm water runoff from the airport, of metals contamination are discussed in Chapters 2 and 5.

ES.12 Table 6.10 shows that antimony and zinc were detected in fresh surface water from the Rifle Range MRS at concentrations less than the selected ecological screening values, and the resulting HQ values for antimony and zinc are less than 1. However, the maximum detected concentrations of copper and lead exceeded their respective ecological screening values and the resulting HQ values were 1.5 for copper and 2.2 for lead. Therefore, *based on the analytical results presented in this report, there is a potential risk to ecological receptors due to exposure to copper and lead in fresh surface water at the Rifle Range MRS.* However, as stated earlier (Section 6.3.4), the ecological screening values used are conservative because they are not site-specific and are based on the most sensitive receptors and exposure parameters. Consequently, these marginal exceedances are not expected to present a high potential for ecological risk at this MRS. As shown in Table 6.11, antimony, copper, lead, and zinc were detected in the sediment sample from the Rifle Range MRS at concentrations less than the selected ecological screening values, and the resulting HQ values for antimony, copper, lead, and zinc are less than 1. Therefore, *based on the analytical results presented in this report, an unacceptable ecological risk due to munitions-related activities is not expected due to exposure to sediment at the Rifle Range MRS.* Table 5.9 shows the maximum detected concentrations of copper and zinc in surface soil samples from the Rifle Range MRS

exceeded the background concentrations. Copper and zinc were detected at maximum concentrations exceeding the selected ecological screening values, resulting in HQs greater than 1. The HQ for copper was 2.9 and for zinc was 1.3. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper and zinc in the surface soil at the Rifle Range MRS. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 2; and zinc by a factor of 1.1; so, based on the limited background data set, these concentrations may be within the range of naturally occurring concentrations.

ES.13 An exposure pathway is not considered complete unless all four of the following elements are present (USEPA, 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.14 A MEC Screening Level Risk Assessment was conducted based on the QR conducted in the field and historical data regarding previous site visits and removal actions. Based on the PA (USACE, 2005a) and ASR Supplement (CEMVS, 2008), the munitions known or suspected to have been used at the Bombing Target MRS include the following: Bomb, 3 lb, miniature practice (AN-Mk5 and AN-Mk23); Bomb, 4.5 lb, miniature practice (AN-Mk43); Bomb, 100 lb practice (Mk 15 Mods 1, 2, 3, & 4); Cartridge, signal, bomb Mk 7; cartridge, signal, bomb Mk 4 Mod 0 (also Mod 1, 2, 3, & 4); Flare, Aircraft, Parachute, AN-M26, as detailed in Table 4.1. These munitions contain fuzes or explosives that might present a residual hazard. The munitions known or suspected to have been used at the Rifle Range MRS include only .30 Caliber cartridges.

ES.15 There are hundreds of houses and other inhabited structures within 2 miles of both MRSs. A large portion of the site is on the St. Croix International Airport property and a portion of a horse race track is on the Rifle Range MRS. There are no significant access restrictions. Because MC metals were detected in the surface soil samples collected, the surface soil exposure pathways are complete. Human and ecological receptors may be exposed to MC through direct contact with surface soil (incidental ingestion, dermal contact, and inhalation of fugitive dust). Because there is no fresh water within the Bombing Target MRS, potential receptors would not be exposed to fresh surface water or sediment through ingestion as drinking water, incidental ingestion, or direct dermal contact, so these exposure pathways are incomplete. Because there are anecdotal reports that historic groundwater wells exist within the MRS, receptors could be exposed to groundwater, so these exposure pathways are potentially complete. Marine surface water and marine sediments were not sampled at either MRS, therefore, the marine surface water and sediment exposure pathways (incidental ingestion and dermal contact) were considered potentially complete, but not quantitatively assessed for potential receptors and the potential risks cannot be evaluated for these media. Marine surface water would not be used as drinking water by humans, but could be used as drinking water by ecological receptors. While MC could have been released directly to

marine surface water and sediment as a result of firing activities at the Bombing Range MRS, the large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it ***unlikely that MC in marine surface water and sediment would pose a threat to human or ecological receptors at this site.***

ES.16 Although complete surface soil exposure pathways were identified for the Bombing Target MRS, ***this MRS is not expected to represent a risk to human receptors with regard to MC,*** because the maximum detected concentrations of MC detected in these media did not exceed the human health screening values. The ecological screening values for copper, lead, and zinc in surface soil were exceeded for the Bombing Target MRS. Therefore, based on the analytical results presented in this report, ***an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper, lead, and zinc in the surface soil at the Bombing Target MRS***.

ES.17 Complete surface soil and fresh surface water exposure pathways were identified for the Rifle Range MRS, but ***the Rifle Range MRS is not expected to represent a risk to human receptors with regard to MC,*** because the maximum detected concentrations of MC detected in these media did not exceed the human health screening values. The ecological screening values for copper and lead in fresh surface water; and, for copper and zinc in surface soil were exceeded for the Rifle Range MRS. Therefore, based on the analytical results presented in this report, ***an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper, lead, and zinc in the surface soil and fresh surface water at the Rifle Range MRS***.

ES.18 Based on the findings of the SI, the known use of the MRS for bombing activities, and the potential for MEC to remain within the MRS, ***the MEC exposure pathway for the Bombing Target MRS is complete.*** There is no explosive hazard remaining at the Rifle Range MRS and no explosive safety risk; the only munitions known to have been used at this MRS are small arms. Based on this, ***the MEC exposure pathway for the Rifle Range MRS is not complete.***

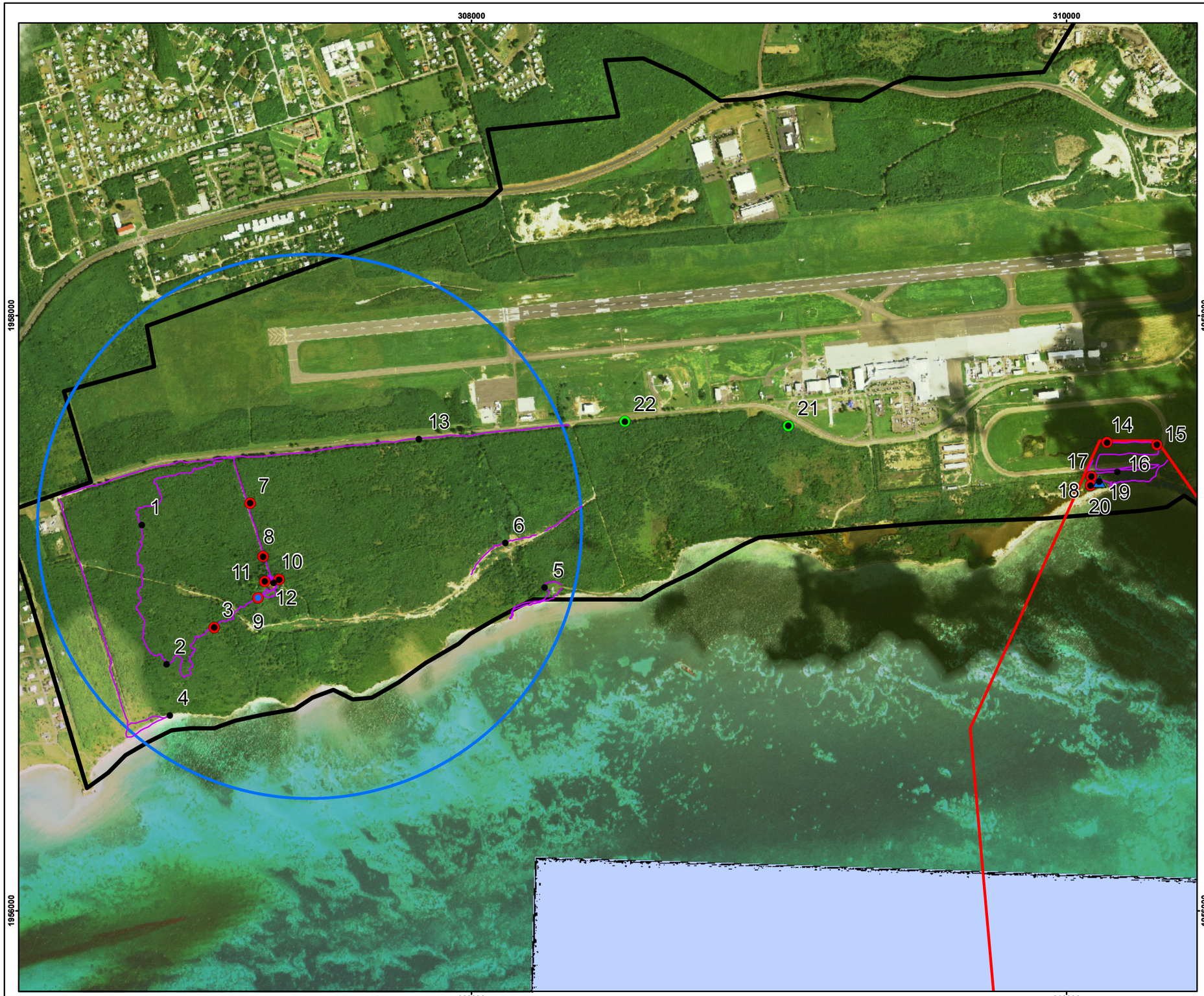
ES.19 The **Bombing Target MRS** at the Benedict Field FUDS, St. Croix, USVI, is recommended for ***RI/FS*** (Table ES.1). ***Immediate munitions removal actions are not warranted at this time.*** Further sampling may be warranted.

ES.20 The **Rifle Range MRS** at the Benedict Field FUDS, St. Croix, USVI, is recommended for **NDAI** (Table ES.1). This MRS was used with small arms only and MEC Presence is noted as "Evidence of no munitions." There are no MC data that exceed human health risk screening values. Some MC (copper, lead, and zinc) only slightly exceed the ecological risk values and the concentrations could be within the range of naturally occurring concentrations.

Figure ES.1

General Site Overview
Saint Croix-Benedict Field
FUDS Project No. I02VI056401

U.S. Virgin Islands



Legend

- 9 Munitions Debris Observation Location
- 1 Field Observation Location
- Soil Sample Location
- Ambient Soil Sample Location
- Surface Water/Sediment Sample Location
- Qualitative Reconnaissance Track
- Bombing Target MRS
- Rifle Range MRS
- FUDS Property Boundary

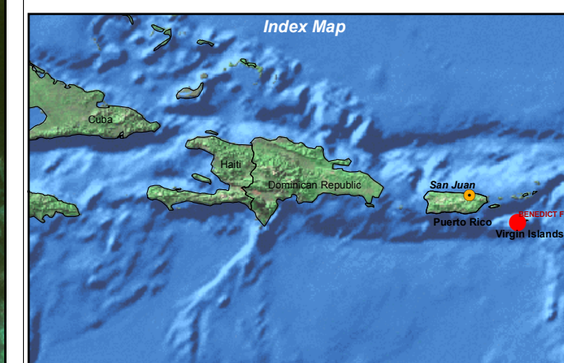


Image Source: 2004 Orthophoto
Projection: UTM Zone 20N NAD83, Map Units in Feet

400 200 0 400 Meters

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DESIGNED BY: BT	General Site Overview		
DRAWN BY: BT			
CHECKED BY: TD	SCALE: As Shown	PROJECT NUMBER: 747140.86135	
SUBMITTED BY: DS	DATE: September 2010	PAGE NUMBER: ES-8	
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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

1.1.1 Parsons Infrastructure and Technology Group (Parsons) received Contract No. W912DY-04-D-0005, Task Order No. 0008, from the United States Army Corps of Engineers (USACE), Engineering and Support Center, Huntsville (USAESCH) to perform a Site Inspection (SI) at the Benedict Field Formerly Used Defense Site (FUDS; project number I02VI056401) located in St. Croix, U.S. Virgin Islands (USVI). The Army acquired the property for Benedict Field via several transactions between August 1940 and September 1943. The site became an auxiliary airfield for Borinquen Field in Puerto Rico. According to historical records, Benedict Field housed a fighter squadron for aerial defense and a heavy bomber squadron for submarine tracking in the Caribbean Sea. Structures on the field included a practice bomb target, a known-distance rifle range, ammunition storage facilities, and buildings associated with the function of a typical Army airfield. The U.S. government declared the Benedict Field property excess in 1947. Benedict Field was conveyed to the municipality of St. Croix via a quitclaim deed on November 22, 1948. Henry E. Rohlsen Airport occupies and owns the majority of the site

1.1.2 The Benedict Field FUDS has two munitions response sites (MRSs): the Bombing Target MRS (649 acres) and the Rifle Range MRS (1,259 acres). Figure 1.1 shows the site location and depicts the FUDS and MRS boundaries for the site. The coordinates for the estimated center points of the MRSs are listed in Table 1.1. The estimated coordinates are in meters (Universal Transverse Mercator [UTM] Zone 20 North American Datum [NAD] 83).

Table 1.1
Benedict Field, St. Croix, U.S. Virgin Islands
Munitions Response Site Center Point Coordinates

Munitions Response Site	Acreage	X-Coordinate (meters)	Y-Coordinate (meters)
Bombing Target MRS	649	307446.41	1957353.00
Rifle Range MRS	1,259	310386.53	1955543.48

1.2 PROJECT OBJECTIVES

1.2.1 The Department of Defense (DoD) 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 USACE is conducting environmental response activities at FUDS for the Army, DoD's Executive Agent for the FUDS program.

1.2.2 Pursuant to USACE's Engineer Regulation (ER) 200-3-1 (USACE, 2004) and the Management Guidance for the Defense Environmental Restoration 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 United States Code [USC] 2701 et seq.), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (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). As such, USACE is conducting remedial SIs, as set forth in the NCP, to evaluate hazardous substance releases or threatened releases from eligible FUDS.

1.2.3 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.

1.2.4 This report summarizes the work performed during the SI and presents an accounting of any MEC and MC contamination identified on the site. The SI was limited exclusively to MEC and MC contamination issues requiring collection of a sufficient and appropriate amount of information, but does not consider other unrelated hazardous and toxic waste (HTW) concerns the site may pose. Per ER 200-3-1, guidance for conducting an SI, Section 4-4.1.2:

> *The SI is not intended as a full-scale study of the nature and extent of contamination or explosive hazards. The objectives of the remedial SI are to: (i) Eliminate from further consideration those releases that pose no significant threat to public health or the environment; (ii) Determine the potential need for removal action; (iii) Collect or develop additional data, appropriate for HRS [Hazard Ranking Score] scoring by [US]EPA [United States Environmental Protection Agency]; and (iv) Collect data, as appropriate, to characterize the release for effective and rapid initiation of the RI/FS [Remedial Investigation/Feasibility Study].*

1.2.5 An additional objective of the SI is to collect the additional data necessary to complete the Munitions Response Site Prioritization Protocol (MRSPP).

1.2.6 The SI was performed as a result of findings identified in the 2003 Revised Inventory Project Report (INPR), 2005 Preliminary Assessment (PA) prepared by the USACE - St. Louis District (CEMVS), and the 2008 ASR Supplement prepared by CEMVS. All work adhered to the DERP for FUDS and relevant U.S. Army regulations and guidance for MEC programs. As specified in the task order, this report is prepared to summarize the SI sampling events and presents an accounting of the MEC/MC contamination identified on-site.

1.3 PROJECT SCOPE

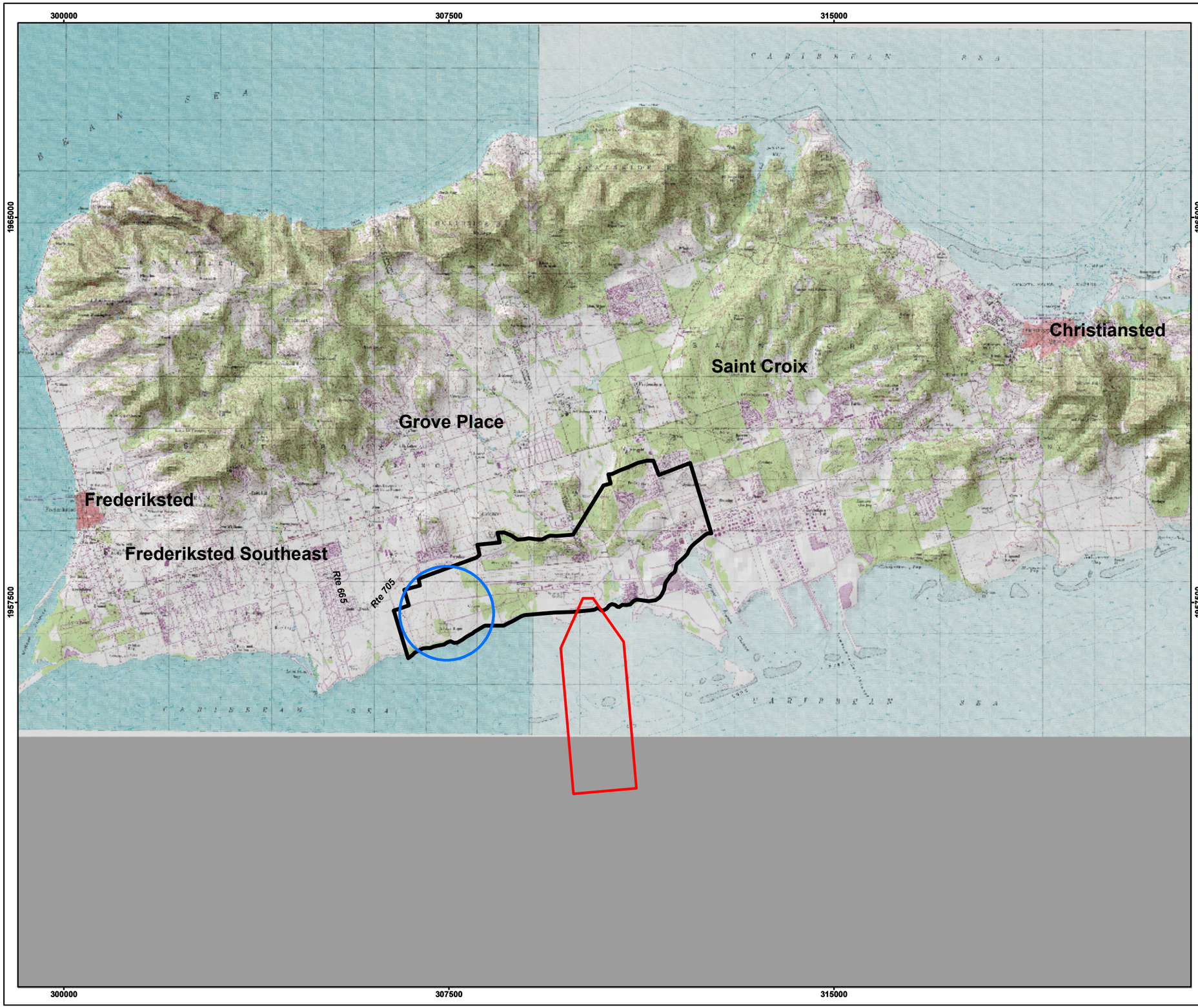
1.3.1 Due to the potential for MEC contamination at the Bombing Target MRS, the Technical Project Planning (TPP) Team concurred that the SI for this MRS would proceed in a manner to support a RI/FS recommendation. Because the Rifle Range MRS was only used for small arms practice and there is no evidence of the former range structures, the TPP Team concurred that the SI for this MRS would proceed in a manner to support a No DoD Action Indicated (NDAI) recommendation.

1.3.2 The TPP Team agreed that the SI data collection efforts would focus on screening for MC in soil. A total of ten biased surface soil samples and a biased surface water/sediment couple along with the appropriate Quality Control (QC) samples and field duplicates were collected at Benedict Field in locations anticipated to reflect biased conditions towards finding residual MC. Two ambient surface soil samples were collected. Ambient surface water and sediment samples were not collected due to lack of acceptable (by the TPP Team) ambient conditions. No groundwater or air samples were planned or collected. There are no groundwater wells or fresh water resources within the MRSs. Each of the samples was analyzed for explosives and selected metals.

1.3.3 The primary project planning documents used to perform the SI include the Site-Specific Work Plan (SS-WP) Addendum for Benedict Field (Parsons, 2010b), the USAESCH Programmatic Work Plan (PWP) (Parsons, 2005), the Programmatic Sampling and Analysis Plan (PSAP) (USACE, 2005b), and the PSAP Addendum (Parsons, 2006). The Performance Work Statement (PWS) for this project is in Appendix A.

Figure 1.1

Site Location Map
Saint Croix-Benedict Field
FUDS Project No. I02VI056401
U.S. Virgin Islands



Legend

- Bombing Target MRS
- Rifle Range MRS
- FUDS Property Boundary

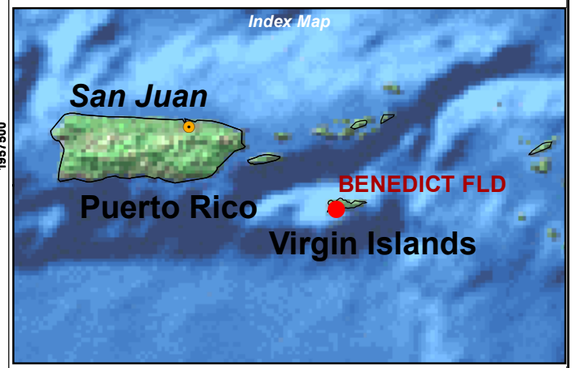


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

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2 1 0 2 Kilometers

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DESIGNED BY: BT	**Site Location Map**		
DRAWN BY: BT			
CHECKED BY: TD	SCALE: As Shown	PROJECT NUMBER: 747140.86135	
SUBMITTED BY: DS	DATE: September 2010	PAGE NUMBER: 1-4	
	FILE: X:\GIS\Site_inspections_ne\Maps\benedict_vi\Fig1_1.mxd		

CHAPTER 2
PROPERTY DESCRIPTION AND HISTORY

2.1 SITE DESCRIPTION

Between August 1940 and September 1943, the army acquired the property for Benedict Field through several transactions. The site was used as an auxiliary airfield for Borinquen Field in Puerto Rico. Structures included a practice bomb target, small arms ranges, ammunition storage facilities, and other buildings associated with an Army airfield. The Benedict Field FUDS has two MRSs: the Bombing Target MRS that is comprised of 649 acres and the Rifle Range MRS comprised of 1,259 acres. The majority of the site is now used by the Henry E. Rohlsen Airport and a horse racetrack.

2.2 SITE LOCATION AND SETTING

2.2.1 Benedict Field is located in St. Croix, one of the U.S.-owned Virgin Islands, and lies about 65 miles southeast of Puerto Rico. Benedict Field was located on the southeasterly shore about 6 miles from Frederiksted and 9 miles from Christiansted (USACE, 2005a). The FUDS and MRS boundaries are shown on Figure 2.2.

2.2.2 Presented below is a summary of site-specific information collected as part of the 2003 INPR (USACE, 2003a), the 2005 PA (USACE, 2005a), and the 2008 Archives Search Report Supplement (CEMVS, 2008). Where appropriate, the information has been revised to reflect data collected during the TPP Meeting and site visit as well as other sources.

2.2.1 Topography and Vegetation

Most of the site is relatively flat with a gentle slope to the south. On-site elevations range from approximately 140 to 180 feet along the north property boundary to sea level along the southern shore of the island. Some steep terrain exists on the extreme northern side of this site. No natural streams occur within the property. The land where Benedict Field lies is highly developed with the Henry E. Rohlsen Airport comprising the majority of the property.

2.2.2 Geology and Soils

2.2.2.1 The Virgin Islands constitute the eastern extremity of the Greater Antilles, a group of islands that also include Cuba, Jamaica, Hispaniola (which includes the nations of the Dominican Republic and Haiti), and Puerto Rico. Structural and Stratigraphic descriptions were obtained from the U.S. Geological Survey (USGS), Professional Paper 1419 (USGS, 2002b).

2.2.2.2 **Structure.** The Island of St. Croix is divided into two distinct physiographic regions: 1) the Central Limestone Plain a structural graben, or downthrown block that lies between two mountain ridges, known as the Northside Range; and, 2) the East End Range interpreted to be horst (up thrown blocks). The Northside and East End Ranges consist of well-lithified Cretaceous rocks of the Mount Eagle Group, including volcani-clastics, tuffaceous sandstone, pelagic (open sea deposit with less than 20 percent terrigenous material) sediments and intrusive gabbros and diorites. The Central Limestone Plain extends from the north central shore of the island down to along most of the western shore and extending to the western two-thirds of the southern shore of St. Croix. The Kingshill Basin comprises the entire Central Limestone Plain and represents a low-lying sedimentary basin where relatively flat-lying rocks of Tertiary age are bounded by the East End and Northside Ranges. Benedict Field lies entirely within the Kingshill Basin.

2.2.2.3 **Stratigraphy.** The uppermost stratigraphic unit in the region surrounding Benedict Field is the Blessing Formation. This unit is comprised of reef and lagoonal carbonate rocks of early Pliocene age that extend across the central southern and western coasts of St. Croix. The Blessing Formation occurs near the land surface along inland portions of Benedict Field where it unconformably overlies the Mannings Bay Member of the Kingsville Limestone. This unconformity shows as a sharp contact between the two units. Throughout the Blessing Formation, mollusk and coral fossils are preserved as moldic porosity with the unit generally classified as bioclastic wackestones (mud-supported limestone with greater than 10 percent sand-sized particle) and occasionally packstone (particle-supported limestone containing some lime mud [Friedman and Sanders, 1978]).

2.2.2.4 The Kingshill Limestone is separated into an upper member (the Mannings Bay Member) and a lower member (the La Reine Member). The formation has a general southerly dip that averages less than 12 degrees.

2.2.2.5 The Mannings Bay Member is composed of well-bedded limestone of late Miocene to early Pliocene age and is the uppermost member of the Kingshill Limestone. The unit is characterized by the presence of foraminifers and shelf-derived debris. The Mannings Bay Member unconformably overlies the La Reine Member of the Kingshill Formation with numerous pinchouts of the coarser grained beds of the Manning Bay Member, possibly indicating channelization within the underlying paleosurface of the La Reine Member. The Mannings Bay Member tends to be more thinly bedded, contains more shelf-derived skeletal clasts versus the La Reine Member, and is dominated by bioclastic wackestones and packstones.

2.2.2.6 The La Reine Member of the Kingsmill Limestone occurs at elevations of 30 feet below sea level (bsl) extending to a depth of approximately 50 feet bsl along central portions of Benedict Field. Rocks of the La Reine Member consist of a variety of lithofacies including packstones, wackestones, and clastic grainstones (particle supported limestone lacking mud).

2.2.2.7 The Jealousy Formation consists of dark, stratified calcitic, sandy clay with intervals of calcareous conglomerate deposits. The age of the formation ranges from early to late Miocene. The percent sand in the formation ranges from less than 10 to almost 25. The type section for this formation is based on cuttings or core from a deep test well. The test well was drilled to a depth of 459 meters below land surface with the lowest 426 meters identified as Jealously Formation sediments. The top of the Jealousy Formation occurs at about 50 feet along northern portions of Benedict Field and dips to the southeast where the top of the formation is at depths of 60 feet or greater.

2.2.2.8 Alluvial deposits are found along steam valleys and are derived from the weathering of the siliclastic rocks found in Northside and East End Ranges. Alluvium in areas immediately overlying the Kingshill Limestone tends to be light colored with carbonate material. Red clay-rich alluvium fills karst cavities in the Blessing Formation and the Mannings Bay Member strata as well.

2.2.2.9 **Soil Type**. There is typically one type of soil found on the Benedict Field site. The surface layer of the soil is dark brown gravelly, silty, clayey sand about 4 inches thick. The subsurface layer is dark brown gravelly, silty, sandy clay to a depth of 10 inches. The subsoil is dark yellowish-brown gravelly, silty, sandy clay and very gravelly, silty, sandy clay to a depth of 27 inches. The substratum is yellowish-brown, very gravelly, sandy clay for 5 inches; light olive-brown very gravelly clay for 9 inches; and light olive-brown very gravelly, sandy clay to a depth of over 60 inches. There are several areas on the site where the soils have been altered for construction of roads, runways, and buildings. In these areas, there is no known soil profile, a random intermixing of the soils has occurred. The soil has a moderate permeability and the available water capacity is moderate. Organic matter content is high. The risk of corrosion to uncoated steel is high and to concrete is low. There is little or no potential for frost development in the soil of the Benedict Field site (USACE, 2005a).

2.2.3 Climate

2.2.3.1 The climate at Benedict Field is sunny and tropical with no significant seasonal changes; therefore, temperatures are consistent year round. June, July, and August tend to be the hottest months with temperatures averaging 85 to 90 degrees Fahrenheit with the cooler months, December through February, averaging in the mid to high 70 degrees Fahrenheit.

2.2.3.2 The Virgin Islands does not have a rainy season; however, there are month-to-month differences. The rainiest months are September, October, and November. Most rain showers are often short and typically occur early in the morning or late at night. The driest months are typically February and March.

2.2.3.3 One of the greatest natural threats in the Virgin Islands is hurricanes. Atlantic hurricane season runs from June 1st to November 30th with the highest occurrences of storms in August and September. During hurricanes, residents secure personal belongings and homes and wait out the winds and rain. Hurricane development is monitored; therefore, watches and warnings are given several days in advance. The last two major hurricanes that affected the islands were Marilyn in September 1995 and Hugo in September 1989 (VINOW, 2010).

2.2.4 Hydrology

All runoff from this site eventually enters the Caribbean Sea through three pathways: overland flow, a stream network, and a natural low-lying area. The majority of this site drains directly into the Caribbean Sea via overland flow, as there are no streams on this portion of the site. Storm water runoff flows towards the coastline in most cases except along the northern property boundary where runoff flows northward into an unnamed stream. This stream flows eastward and then southerly flowing into the Caribbean Sea southeast of the airport. The surface drainage along the northern east-west runway at Benedict Field appears directed into tiled drainage ditches toward the east, into the above-mentioned drainage pattern, and toward the west, following around the western end of the runways ultimately flowing with the natural low-lying topography into the Caribbean Sea. Aerial photographs from 1971 indicate an additional drainage feature may collect water near the center of the north side of the airport runway and funnel the water into a 36-inch diameter drainage culvert running beneath the airport and exiting south of the airport onto open land used for drainage control. Overall, runoff runs generally southward toward natural or man-made low-lying areas.

2.2.5 Groundwater

The Kingshill aquifer, which lies beneath the site at an elevation of 30 feet bsl along the northern site boundary, is a primary aquifer for the island (USGS, 2002a). Groundwater in the area is of poor quality due to salt-water intrusion, high dissolved solids, contamination by wastewater, and petroleum constituents (USACE, 2005a). Groundwater is sparingly used as a potable source in the vicinity of Benedict Field, due to high cost of well installation and low quality of water, producing only about 20 percent of the fresh water supply. On St. Croix, many urban areas use desalinized seawater for their domestic supplies, with rural areas depending on rainwater as a potable source of water (USACE, 2005a).

2.2.6 Significant Structures

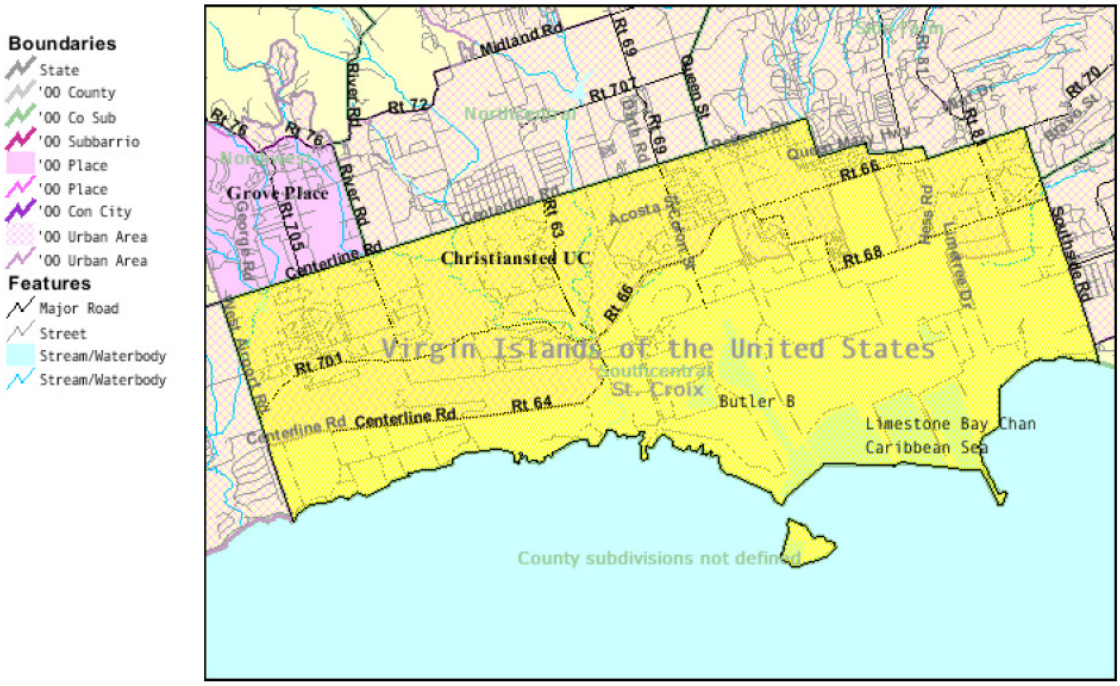
There are hundreds of houses and other inhabited structures within 2 miles of the boundaries of both of the MRSs. A large portion of the site is on the St. Croix International Airport property and a portion of the Rifle Range MRS is on a horse-racing track.

2.2.7 Demographics

2.2.7.1 The Island of St. Croix had a population of approximately 53,234 as of the 2000 census. The Southcentral Subdistrict of St. Croix (as shown on Figure 2.1 below), where the Benedict Field FUDS is located had a population of approximately 8,125 as of the 2000 census. The information was obtained from the American Fact Finder link on the United States Census Bureau website (http://www.census.gov/census2000/usvi.html) (U.S. Census Bureau, 2010). The land area of the Southcentral census area is 12.45 square miles. Based on this information, the population density within the Southcentral census area is approximately 652.6 persons per square mile. The segment of the population under the age of 18 is 35.6 percent, while 6.1 percent are over the age of 65. The median age is 29.3 years. In 2000, there were 2,623 households within the census area with an average household size of 3.0 persons.

Figure 2.1 – Southcentral Subdistrict of St. Croix Island

Southcentral subdistrict, St. Croix Island, Virgin Islands of the United States



2.2.7.2 Approximately 69.6 percent of the Southcentral Subdistrict population classified as one race was Black or African American, 8.8 percent Caucasian, 0.9 percent Asian, 0.7 percent American Indian and Alaska Native, and 15.4 percent "some other race". The estimated occupational breakdown of the Southcentral Subdistrict Census Area as of 2000 was as follows:

- Manufacturing – 531; 18.8 percent of the employed civilian population over the age of 16 (2,819)
- Educational, health, and social services – 386; 13.7 percent
- Construction – 355; 12.6 percent
- Retail Trade – 353; 12.5 percent
- Arts, entertainment, recreation, accommodation and food services – 284; 10.1 percent
- Public administration – 259; 9.2 percent
- Other services (excluding public administration) – 155; 5.5 percent

2.2.7.3 As noted in Table 2.1 and Figure 2.3, 25,538 individuals live within a 4-mile buffer of the Bombing Target MRS and 21,750 individuals live within a 4-mile buffer of the Rifle Range MRS. The estimate was derived from a combination of map examination, 2000 census population information, and information gathered during the SI.

Table 2.1
Population within 4-Mile Buffer of the MRSs at Benedict Field
St. Croix, U.S. Virgin Islands

MRS	On Site	0 to 1/4 Mile	1/4 to 1/2 Mile	1/2 to 1 Mile	1 to 2 Miles	2 to 3 Miles	3 to 4 Miles	Total
Bombing Target	73	141	760	2,583	4,625	8,240	9,116	25,538
Rifle Range	0	0	0	0	3,032	7,700	11,018	21,750

Source: U.S. Census 2000 data. The population within the site, MRS, or within any buffer area is determined using a conservative approach to calculate the population of an area by including the total number of people for any census block that falls within or overlaps the site boundary, MRS boundaries, or buffer line.

2.2.8 Current and Future Land Use

The Municipality of St. Croix owns the majority of the land and currently remains a municipal airport. A private industry (St. Croix Alumina), U.S. Virgin Island Air National Guard, a horse racetrack, and a drag racetrack are also on the former FUDS. Future land use is expected to remain the same.

2.2.9 Site Ownership and History

2.2.9.1 The Army acquired the property for Benedict Field via several transactions between August 1940 and September 1943. The site was used as an auxiliary airfield for Borinquen Field in Puerto Rico. A fighter squadron was also stationed there. Structures included a practice bomb target, a known-distance rifle range, ammunition storage facilities, and other buildings associated with an Army airfield. The Benedict Field property was declared excess in 1947 and was conveyed to the municipality of St. Croix via a quitclaim deed on November 22, 1948.

2.2.9.2 The racetrack within the Rifle Range MRS was present prior to and following World War II. Since site closure, the land within the Bombing Target MRS has experienced significant alteration. The last time the land within the Bombing Target MRS was cleared was in the 1960s. As a result, the vegetation within the Bombing Target MRS is dense, although the understory may be more open further from the edges exposed to light. The northern 40 percent of the MRS has been re-contoured several times since site closure. Prior to USVI Port Authority ownership, the land was used as a cattle farm. Approximately 20 years ago, there was a fresh water spring located within the Bombing Target MRS. There may have also been windmills, groundwater wells, and a greenhouse located within the MRS. The land within the Bombing Target MRS is currently owned by the USVI Post Authority. A gravity sanitary sewer line (fiberglass pipe) was built within the MRS in the late 1960s. Repairs to the line were made prior to 2004.

2.2.10 Cultural and Archeological Resources

2.2.10.1 St. Croix is not listed in the National Register of Historic Places or National Register of Historic Districts databases. According to the National Heritage Areas Program, National Historic Landmarks Program, and National Register Information System websites, no cultural or archeological resources are known on-site. At this time, there are no known culturally significant resources at the site. The Virgin Islands Division of Archaeology and Historic Preservation has been contacted to provide information regarding any cultural resources that may be present within the MRS boundary, and no response has been received. The site visit team (SVT) encountered no cultural resources during the qualitative reconnaissance (QR).

2.2.10.2 According to the PA, an original plantation homestead named "Betty's Hope" lies to the west of the site on airport property. The old plantation was labeled as "ruins" when the DoD purchased the land in 1940. The site contains remains of the home and a concrete block silo for sugar cane storage. The Betty's Hope homestead was in the Bombing Target MRS during World War II and is noted on the USGS topographic quadrangle map (Figure 2.2). The PA site investigation discovered no other archeological sites, cemeteries, or NHLs at the site.

2.3 SITE OPERATIONS AND WASTE CHARACTERISTICS

2.3.1 MRS-Specific Descriptions/Operations

The Bombing Target MRS, consisting of 649 acres (land and tidal water), was used as a practice bombing range from 1940 until 1948 and was possibly used as a night bombing range. The target range consisted of two targets, one 50 feet in diameter and one 200 feet in diameter, and was located southwest of the airstrip. The Rifle Range MRS is composed of 1,259 acres (land and tidal water) and was used as a known distance rifle range from approximately 1940 until 1946. The rifle range was used for weapons familiarization and qualifications, and for function firing of weapons and ammunition.

2.3.2 Regulatory Compliance

The USACE is conducting the SI at the former Benedict Field as part of FUDS response activities pursuant to and in accordance with the guidance, regulations, and legislation listed in Chapter 1.

2.4 PREVIOUS INVESTIGATIONS

2.4.1 2003 Revised Inventory Project Report

The January 2003 Revised INPR confirmed the location and historical use of Benedict Field and determined that the site was eligible for the FUDS program. The INPR recommended a Risk Assessment Code (RAC) score of 4 (on a scale of 1 to 5, 5 indicating no hazard).

2.4.2 2005 Preliminary Assessment

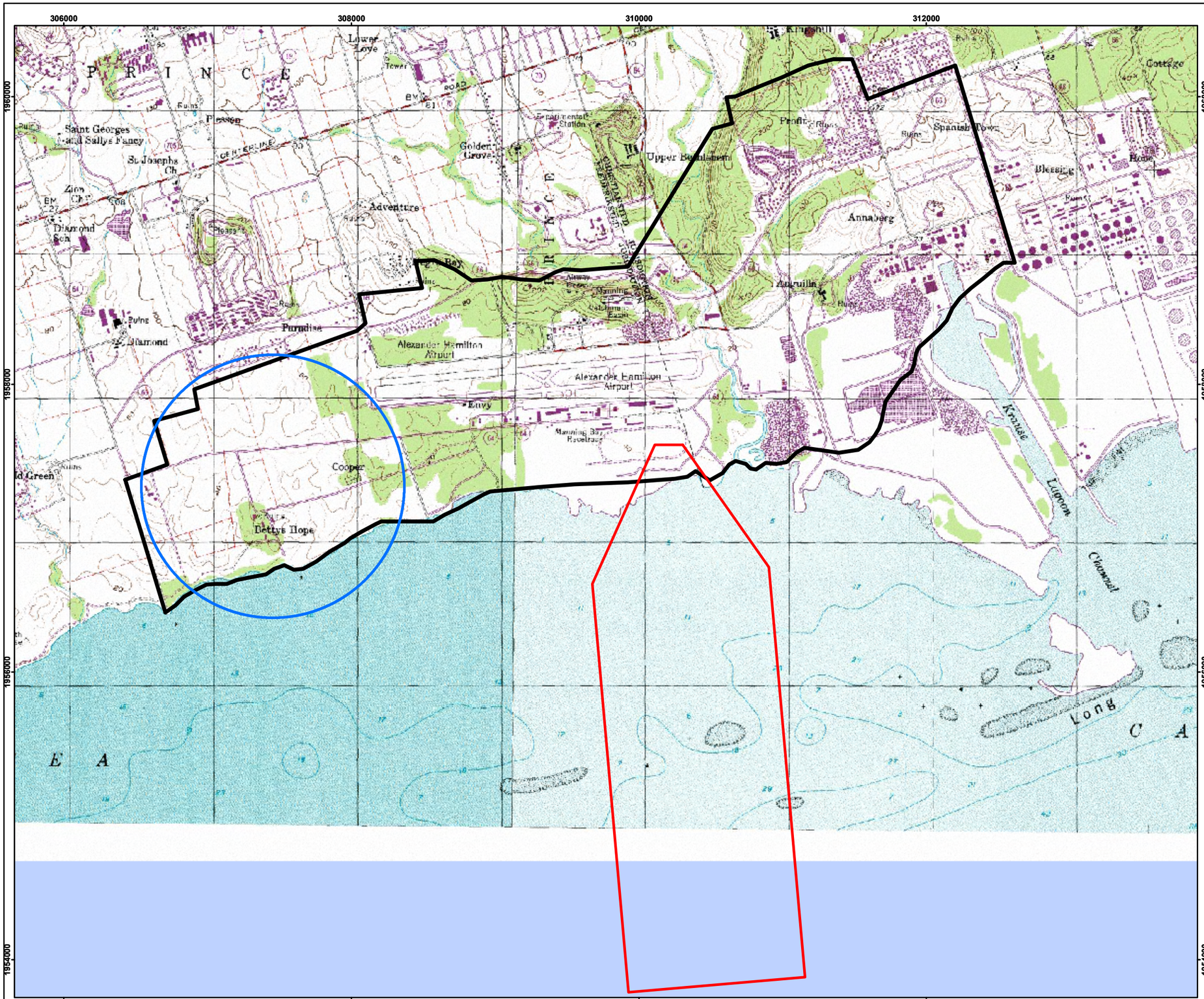
A site visit was conducted during the August 2005 PA. During this visit, the SVT found that the bomb target area was owned and controlled by the airport. The area was undeveloped and covered with dense and overgrown vegetation. A RAC score of 2 was assigned to the bomb target area. A Certificate of Clearance for the bomb target was issued in 1947. The PA team also found no evidence of the former rifle range structures. The range property is now included within the boundaries of the horse racetrack. The team found no evidence of MEC on-site. A RAC score of 5 was assigned for the rifle range area. A Certificate of Decontamination and Neutralization was issued for this site on June 18, 1946. The team did not find evidence of the use of Chemical Warfare Material (CWM) at Benedict Field. The activities at this property did not include the storage, disposal, or use of CWM in training.

2.4.3 2008 Archives Search Report Supplement

The 2008 ASR Supplement, a supplement to the PA, identified two MRSs at the Benedict Field FUDS: the Bombing Target MRS and the Rifle Range MRS. The bomb target consisted of two targets, one 50 feet in diameter and one 200 feet in diameter, and was located southwest of the airstrip. A RAC score of 2 was assigned to the bomb target area. The rifle range was used for weapons familiarization and qualifications, and for function firing of weapons and ammunition. A RAC score of 5 was assigned to the rifle range area.

Figure 2.2

Site Setting
Saint Croix-Benedict Field
FUDS Project No. I02VI056401
U.S. Virgin Islands



Legend

- Bombing Target MRS
- Rifle Range MRS
- FUDS Property Boundary

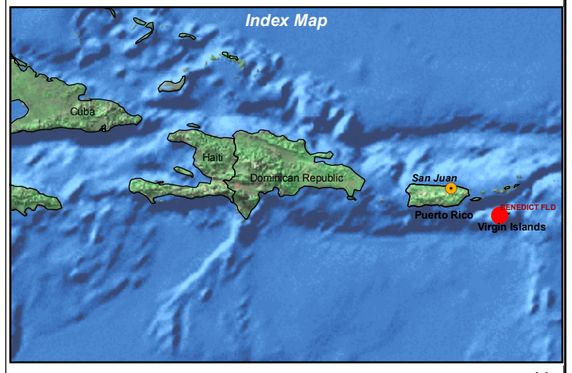


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

N

500 250 0 500 Meters

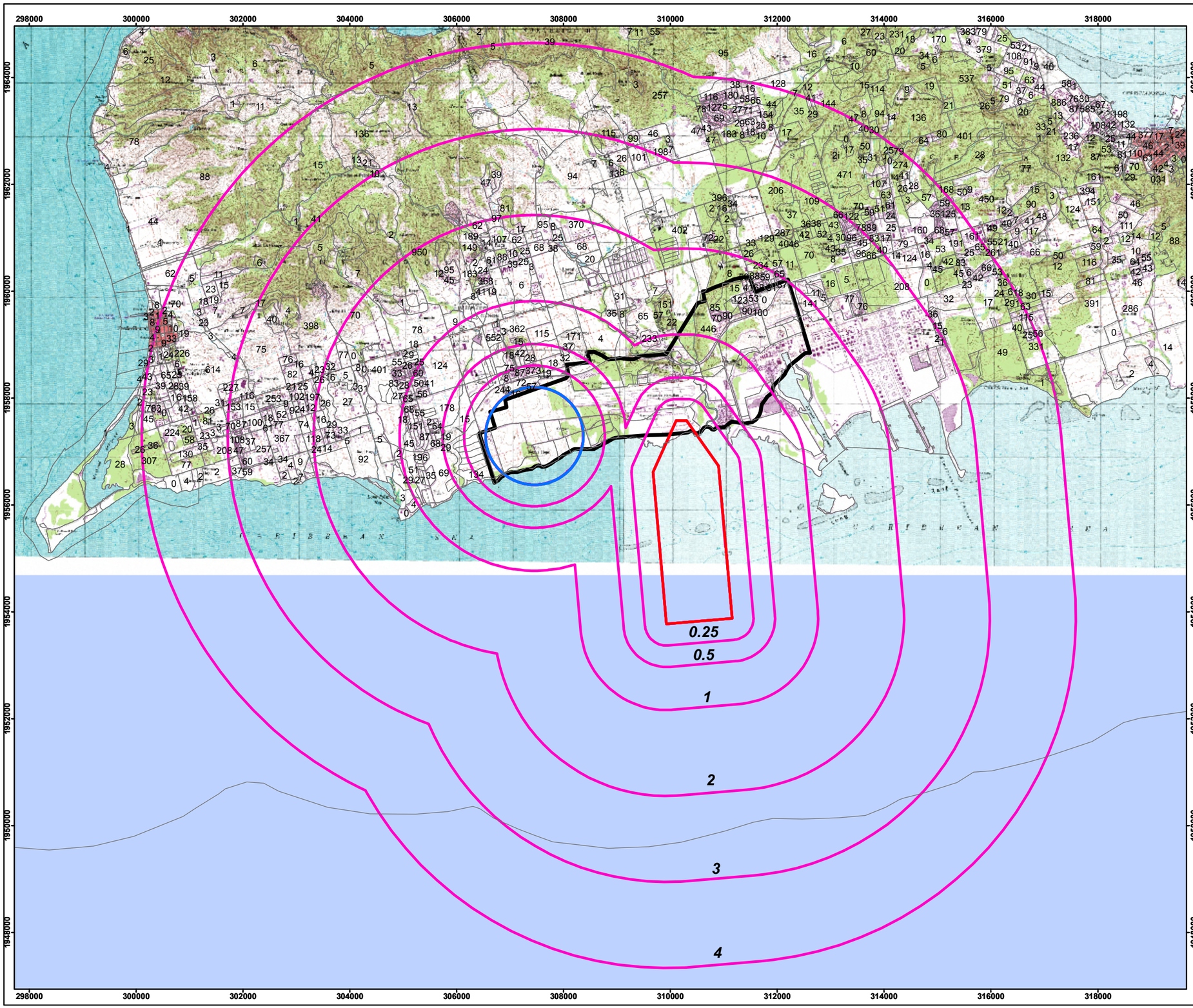
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Site Setting**	
DRAWN BY: BT	SCALE: As Shown	PROJECT NUMBER: 747140.86135
CHECKED BY: TD	DATE: September 2010	PAGE NUMBER: 2-9
SUBMITTED BY: DS	FILE: X:\GIS\Site_inspections_ne\Maps\benedict_vi\Fig2_2.mxd	

Figure 2.3

2000 Census Data
Saint Croix-Benedict Field
FUDS Project No. I02VI056401

U.S. Virgin Islands



Legend

- 4 — 2000 Census Block Boundary with Total Population
- Bombing Target MRS
- Rifle Range MRS
- FUDS Property Boundary
- Buffer (Mile)

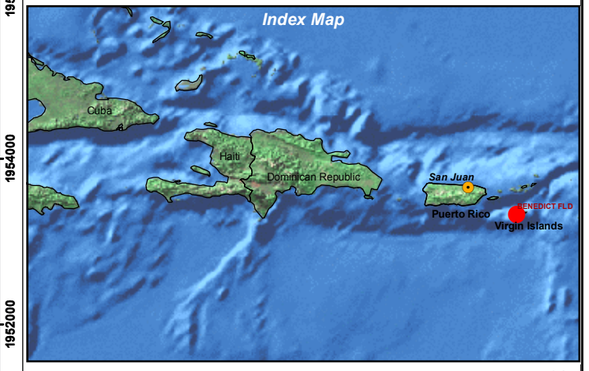


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

N

2 1 0 2 Kilometers

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

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

2000 Census Data

SCALE:	As Shown
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PROJECT NUMBER:	747140.86135
PAGE NUMBER:	2-10

CHAPTER 3
SITE INSPECTION TASKS

3.1 HISTORICAL RECORD REVIEW

The existing body of information pertinent to Benedict Field was thoroughly reviewed in advance of the TPP Meeting held on December 8, 2009, and summarized to the TPP Team as part of the development and acceptance of the selected Technical Approach for the site. Sampling locations and QR planning were the direct result of this review process and follow-on TPP Team discussions. This information has been augmented with institutional knowledge and additional documentation provided by CESAJ or obtained by Parsons during coordination of the field effort.

3.2 TECHNICAL PROJECT PLANNING SUMMARY

Benedict Field falls under the purview of the USACE Jacksonville District (CESAJ). A TPP Meeting was facilitated by CESAJ on December 8, 2009, and included representatives of CESAJ, USAESCH, Parsons, the USVI Port Authority, USVI Department of Planning and Natural Resources (DPNR), and the St. Croix Renaissance Group. Unanimous TPP Team concurrence with the Technical Approach presented in the Final TPP Memorandum issued on March 19, 2010, was achieved (see Appendix B). Key TPP facts and decisions are summarized below:

- The TPP Team concurred with the Technical Approach (supporting an anticipated RI/FS recommendation for the Bombing Target MRS and a potential NDAI recommendation for the Rifle Range MRS) as presented and refined at the TPP Meeting on December 8, 2009, inclusive of number, type, and location of samples as well as sampling methodology.

- Surface soil is the primary exposure media at the Bombing Target MRS and thus, would be the only medium sampled at that MRS during the SI. Six biased surface soil samples were planned for collection within the Bombing Target MRS and six were collected. Surface soil, surface water, and sediment are the primary exposure media at the Rifle Range MRS. Four biased surface soil samples and one surface water/sediment sample couple were planned for collection within the Rifle Range MRS. Two ambient surface soil samples were planned and collected within the FUDS but outside the MRS boundaries. Two discretionary groundwater samples were planned for collection, if existing groundwater wells were identified within the MRSs. However, no water wells were located for sampling. A well may be located between surface soil samples BFVI-MRS01-SS-02-02 and BFVI-MRS01-SS-02-06. This well could not be located during the field effort. MC analyses during this SI would include explosives and selected MC metals based on the munitions used at each MRS. For the Bombing Target

MRS, samples would be analyzed for explosives and selected indicator metals (copper, lead, and zinc); they were also analyzed for antimony. At the Rifle Range MRS, the samples would be analyzed for small arms indicator metals (antimony, copper, and lead [zinc was added]) and samples collected at the probable firing point would additionally be analyzed for explosives.

- *Follow up telephone conversation between Parsons and Mr. Doward (DPNR) indicates the possibility that groundwater wells may exist on the Bombing Target MRS. The SVT, with the assistance of DPNR, would attempt to locate and collect samples from the wells, if possible. If the wells cannot be found, or cannot be accessed to collect samples, the SVT would attempt to locate a reported spring on the property and collect a water sample from the spring. Neither a well nor the spring were located.*

- The biased surface water/sediment sample couple location (BFVI-MRS02-SW-01/ BFVI-MRS02-SD-01) was adjacent to a salt-water pond. However, the location was adjusted to be within a fresh water marsh. The ambient surface water/sediment sample couple location (Fair Plain Gut) identified in the Advance Packet documentation contains raw sewage. Therefore, an ambient sample would not be collected during the SI from this location. According to the USVI PA, there is not an ambient surface water/sediment sample couple location within the FUDS with similar characteristics/conditions to the location where the biased sample couple is planned. As a result, an ambient surface water/sediment sample couple was not planned for collection.

- The SVT would sample in accordance with the PSAP for composite soil samples (using the Cold Regions Research Engineering Laboratory [CRREL] seven-point wheel method) and sample depths of up to 2 inches.

- The TPP Team agreed to allow flexibility for the SVT to move samples or QR paths due to unknown physical or natural obstacles or munitions debris (MD) findings. The QR path and several of the samples were moved because of vegetation, wasps, and other physical obstacles. If MEC were found during the field visit, the USVI Port Authority would be contacted; however, no MEC was found.

- Representatives of the USVI Port Authority and DPNR, specifically Mr. Alexis Dowand might accompany the SVT. The field effort would be coordinated with the USVI Port Authority.

  - *The field team leader (FTL) would contact Mr. Doward and arrange for his meeting with the team prior to the site visit. The SVT met with Mr. Doward on the morning of June 21st.*

- At the date of the SSWP, no additional water well information had been received by Parsons. Efforts would continue during the site visit to obtain any relevant water well information for inclusion in the SI report.

- *See response above. Mr. Doward would accompany the SVT and assist with attempting to locate known water wells on the Bombing Target MRS. However, Mr. Doward did not accompany the SVT into the field. He only met with them the morning of the first day of the field effort. Consequently, the location of the wells is unknown.*

- Since site closure, the land within the Bombing Target MRS has experienced significant alteration. The last time the land within the Bombing Target MRS was cleared was in the 1960s. As a result, the vegetation within the Bombing Target MRS is dense, although the understory may be more open further from the edges exposed to light. The northern 40 percent of the MRS has been re-contoured several times since site closure. Prior to USVI Port Authority ownership, the land was used as a cattle farm. Approximately 20 years ago, there was a fresh water spring located within the Bombing Target MRS. There may have also been windmills, groundwater wells, and a greenhouse located within the MRS. The land within the Bombing Target MRS is currently owned by the USVI Post Authority. A gravity sanitary sewer line (fiberglass pipe) was built within the MRS in the late 1960s. Repairs to the line were made prior to 2004, the date of the aerial photography used in Figure 5.1. The cleared area is evident in these figures. There is a residential area immediately to the west of the Bombing Target MRS. A slit trench well located east of the Bombing Target MRS is used illegally.

  - *Parsons discussed with USVI Ports Authority personnel the groundwater at the MRSs. There does not appear to be groundwater use to any extent at or near Benedict Field due to other contamination issues (petroleum and salt water). Therefore, groundwater may not be relevant to the SI decision. Parsons attempted to locate reported historic water wells on the Bombing Target MRS and collect samples. However, the heavy vegetative undergrowth prevented locating the reported water wells. No groundwater samples were collected during the SI.*

- The USVI Port Authority owns the horse racetrack within the Rifle Range MRS. The racetrack was present prior to and following World War II. An escort by USVI Port Authority personnel within the racetrack area would not be necessary during the field visit. The field effort for the Rifle Range MRS would be focused on the land areas. Although the overshoot area is within the water, the water portion cannot be evaluated at this time. The water portion of the MRS may be recommended for evaluation pending.

- Since the date of the topographic image used in the SS-WP Addendum figures, the shoreline within the Rifle Range MRS has receded northward. Surface water/sediment sample BFVI-MRS02-SW-01/BFVI-MRS02-SED-01 would be collected from a drainage ditch leading to a salt-water pond located immediately west of the Rifle Range MRS. This pond may receive storm water runoff from upland areas. However, the location was adjusted to be within a fresh water marsh down gradient of the Rifle Range firing point.

- There is a quicksand area within the Rifle Range MRS along the shoreline. However, the SVT avoided this area because of the hazard.

- Much of the site falls within the Coastal Zone Management Area.

- The wet season for St. Croix is from September to November.

- The USEPA may have well data for St. Croix. Weston Solutions, Inc. performed the sampling for the USEPA survey of St. Croix. The focus of the survey was on registered residential wells.

  - *Parsons contacted the USEPA for any available well data from St. Croix. To date no response has been received from federal sources.*

- The TPP Team agreed that only those analytes that are potential MC would be retained for consideration in the Screening Level Risk Assessment (SLRA). The maximum MC metal concentration in the biased surface soil samples will be compared to the maximum MC metal concentration in the ambient soil samples. The maximum detected concentration of explosives, if detected, will be retained in the SLRA. In absence of ambient surface water, sediment, and groundwater data, the maximum detections of metals and explosives will be retained for consideration in the SLRA.

- The human health screening values for surface soil and sediment consist of the USEPA Regional Screening Levels (RSLs) for Residential Soil (updated in November 2010); for marine surface water, the more stringent of the Florida Department of Environmental Protection (FDEP) Florida Administrative Code (FAC) 62-777 Groundwater and Surface Water Cleanup Target Levels, Marine Surface Water (February 2005) and the FAC 62-302 Surface Water Quality Standards (SWQS) for Class III Waters (April 2008); and groundwater, the USEPA RSLs for Tap Water (updated in November 2010). The ecological screening values for surface soil consist of the USEPA ecological soil screening levels (EcoSSLs). In the absence of EcoSSLs, the primary references provided in the 2006 PSAP Addendum were used to obtain ecological screening values. The ecological screening values for sediment and surface water consist of the updated values from the primary references provided in the 2006 PSAP Addendum. Alternate screening values were used when screening values were not available from the primary source. Screening values are provided in Chapter 6.

  - *Note: Florida risk values were selected for their Marine water protection. USEPA risk values pertain only to surface water or groundwater. Based on information collected during the SI, the fresh surface water criteria are more applicable to the collected surface water sample. The revised risk will compare to fresh water criteria.*

- Any findings of an archeological nature or ecological nature would be recorded, Global Positioning System (GPS) points collected and reported to USVI Port Authority. However, there were no findings of this nature during the June 2010 field effort.

- The TPP Team did not identify any site-specific issues requiring an expedited project schedule or document reviews for this site.

3.3 NONMEASUREMENT DATA COLLECTION

The following sources were consulted for identifying biological and cultural resources at Benedict Field:

- Topographic Map – U.S. Geological Survey (USGS)
- Wetlands Online Mapper – National Wetlands Inventory (NWI), USFWS
- Threatened and Endangered Species System (TESS) – Endangered Species Program- Virgin Islands, USFWS
- Environmental Conservation Online System (ECOS) – Endangered Species Program- St. Croix, Virgin Islands, USFWS
- National Wildlife Refuge System (NWRS) – USFWS
- Caribbean Endangered Species Map, Species in Puerto Rico and U.S. Virgin Islands – USFWS
- Critical Habitat Portal Database and Mapper, St. Croix, Virgin Islands – USFWS
- VI Department of Planning and Natural Resources (DPNR)- Division of Fish and Wildlife
- Historic Places in Puerto Rico and the Virgin Islands Database – National Park Service (NPS)
- National Register Information System (NRIS)
- National Register of Historic Places (NRHP)
- National Register of Historic Districts (NRHD)
- National Historic Landmarks (NHL)
- National Heritage Areas (NHA)
- National Oceanic and Atmospheric Administration (NOAA) - Coastal Zone Management Program (CZMP): National Marine Sanctuaries (NMS), National Estuarine Research Reserves (NERR), National Marine Fisheries (NMFS), and Marine Protected Areas (MPA)
- PA Benedict Field, Saint Croix, U.S. Virgin Islands, 2005
- USACE 2006c - (Attachment 2) Army Checklist for Important Ecological Places
- Coastal Zone Management Act (CZMA)
- NatureServe Explorer Database

3.4 SITE-SPECIFIC WORK PLAN ADDENDUM

3.4.1 The SS-WP Addendum (Parsons, 2010b) augments the PWP and PSAP, as warranted, to present pertinent site-specific information and procedural adjustments that could not be readily captured in the programmatic documents or that resulted from TPP Team agreements that required modifying the preliminary SI Technical Approach.

3.4.2 The PWP and PSAP are intended to be umbrella documents that set overall programmatic objectives and approaches, whereas the SS-WP Addendum provides site-specific details and action plans. The PWP, PSAP, and SS-WP Addendum were taken to the site for reference by the SVT during SI field activities.

3.4.3 The SS-WP Addendum included the project description, the field investigation plan, the sampling and analysis plan (SAP), the environmental protection plan (EPP), and the health and safety plan specific to the Benedict Field SI. The field investigation plan presented the approved Technical Approach to guide sample documentation of MEC/MD as well as collection and analysis for MC to ensure that the results were sufficient to meet the project Data Quality Objectives (DQOs).

3.4.4 The Bombing Target MRS was anticipated to proceed to a RI/FS status based on the potential for MEC. The Rifle Range MRS was anticipated to be recommended for NDAI. QR conducted as part of this SI was focused to refine and direct the MEC field investigation. The SS-WP Addendum included a sampling rationale for each planned sample location and the latitude and longitude of the planned samples. The sampling rationale has been updated to include the location coordinates for the actual sample locations and is included in this report as Table 3.1.

3.4.5 The SAP discusses procedures for surface soil sample acquisition from locations biased toward the highest potential for MC contamination; QC for the sampling process; sample shipment to an approved, independent laboratory; and analysis of the samples by the laboratory. The EPP evaluates compliance with Army Regulation 200-2 by presenting procedures for avoiding, minimizing, and mitigating potential impacts to environmental and cultural resources during site field activities. The accident prevention plan (APP) supplements the programmatic accident prevention plan with site-specific emergency contact information and directions to the nearest hospital.

3.4.6 Ten biased surface soil samples and one biased surface water/sediment sample couple were collected during the 2010 SI. Sample results are discussed in Chapter 5 of this report.

3.5 DEPARTURES FROM PLANNING DOCUMENTS

The following departure from planning documents occurred during the SI:

- The QR path within the Bombing Target MRS was adjusted due to unforeseen hazardous vegetation. The vegetation was anywhere from 2 to 20 feet tall and more than half of the vegetation had some sort of thorn on it. The SVT talked with the Parsons Geographic Lead after the first day of the field effort and it was decided that the QR and soil samples for the Bombing Target MRS would be moved to the trails and open areas within the MRS.

- Soil samples BFVI-MRS01-SS-02-02, -03, -04, -05, and -06 were moved due to the vegetation. Samples BFVI-MRS01-SS-02-03 and -04 were moved west to just off the trail that leads to just off the center of the site. Samples BFVI-MRS01-SS-02-02, -05 and -06 were moved to open areas around the abandoned house that sits near the center of the Bombing Target MRS. Soil sample BFVI-MRS01-SS-02-02 was collected next to a nose cone for a Mk15 practice bomb.
- Some of the QR within the Rifle Range MRS, but outside the racetrack had to be adjusted from the proposed location because of fences and vegetation.
- The SSWP discussed using marine water ecological screening values (ESVs) because it was uncertain whether the surface water adjacent to the shore on the rifle range MRS was marine or fresh. The SVT determined the water was fresh; therefore, the ESVs for surface water are the more stringent of the USEPA Region 4 ESVs for fresh surface water and USEPA Region 3 Ecological Screening Benchmarks for surface water. Complete references are shown in the risk tables associated with Chapters 5 and 6 of this document.
- There were no other departures from planning documents.

Table 3.1
Sampling Rationale – Benedict Field, St. Croix, U.S. Virgin Islands

Sample ID	Sample Coordinates		Media	Analysis*	Historical Use of Munitions in Area	Rationale
	Latitude	Longitude				
BFVI-MRS01-SS-02-01	17.691202667	-64.818448019	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	Bomb, 3-lb miniature practice, Type AN-Mk 5; Bomb, 3-lb miniature practice, Type AN-Mk 23; Bomb, 4.5-lb miniature practice, Type AN-Mk 43; Bomb, 100-lb practice, Type Mk 15 mods 1 and 2; Bomb, 100-lb practice, Mk 15 mod 3; Cartridge, signal, bomb, Type Mk 7; Fuze, bomb, tail, practice, Type Mk 247; Bomb, 100-lb practice, Type Mk 15 mod 4; Cartridge, signal, bomb, Type Mk4 mods 0, 1, 2, 3, and 4; Flare, Aircraft, Parachute, AN-M26	Collected from within the Bombing Target MRS.
BFVI-MRS01-SS-02-02	17.692115693	-64.817068	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	See Above	Collected next to a nose cone for a Mk15 practice bomb.
BFVI-MRS01-SS-02-03	17.693363788	-64.816923146	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	See Above	Collected as close to the bomb target center that the SVT could access given the extreme vegetation.
BFVI-MRS01-SS-02-04	17.694984696	-64.817346531	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	See Above	Collected from within the Bombing Target MRS.
BFVI-MRS01-SS-02-05	17.692663218	-64.816407262	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	See Above	Collected as close to the bomb target center that the SVT could access given the extreme vegetation.
BFVI-MRS01-SS-02-06	17.692607931	-64.816865223	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	See Above	Collected from within the Bombing Target MRS.
BFVI-AMB-SS-02-07	17.697572028	-64.805505893	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	None	Collected outside of the MRSs and is considered representative of native or non-munitions impacted media.
BFVI-AMB-SS-02-08	17.697488803	-64.800323393	Surface Soil	Explosives, select metals (antimony, copper, lead, and zinc)	None	Collected outside of the MRSs and is considered representative of native or non-munitions impacted media.
BFVI-MRS02-SS-02-09	17.697074224	-64.790218448	Surface Soil	Explosives, select metals (antimony, copper, lead)	Cartridge, .30 Caliber, Small Arms	Collected near the firing point of the Rifle Range MRS.
BFVI-MRS02-SS-02-10	17.697019585	-64.788640186	Surface Soil	Explosives, select metals (antimony, copper, lead)	See Above	Collected near the firing point of the Rifle Range MRS.
BFVI-MRS02-SS-02-11	17.696036747	-64.790704332	Surface Soil	select metals (antimony, copper, lead)	See Above	Collected southwest of the firing point of the Rifle Range MRS.
BFVI-MRS02-SS-02-12	17.695763289	-64.790727065	Surface Soil	select metals (antimony, copper, lead)	See Above	Collected southwest of the firing point of the Rifle Range MRS.
BFVI-MRS02-SW-01	17.695888069	-64.790457257	Surface Water	Explosives, select metals (antimony, copper, lead)	See Above	Collected from fresh water marsh adjacent to the coast that appeared to be down gradient from the Rifle Range MRS firing points.
BFVI-MRS02-SD-01	17.695888069	-64.790457257	Sediment	Explosives, select metals (antimony, copper, lead)	See Above	Collected from fresh water marsh adjacent to the coast that appeared to be down gradient from the Rifle Range MRS firing points.

*See Chapter 5.

CHAPTER 4
MUNITIONS AND EXPLOSIVES OF CONCERN FINDINGS

4.1 GENERAL INFORMATION

4.1.1 Qualitative Reconnaissance

4.1.1.1 The primary task of the SI is to assess the presence or absence of MEC and MC. To assess the presence or absence of MEC, the SVT conducted the QR by walking a meandering path, vegetative growth permitting, of approximately 5 miles throughout the land portions of the Bombing Target MRS and the Rifle Range MRS between June 21, and 23, 2010.

4.1.1.2 Site QR consisted of visual reconnaissance of the site surface to identify visual indicators of suspect munitions use areas including earthen berms, distressed vegetation, stained soil, ground scars or craters, target remnants, and visible metallic debris.

4.1.1.3 The QR involved a three-person SVT walking single file at a nominal 3- to 5-foot separation distance along the QR track shown on Figure 4.1. An Unexploded Ordnance Safety Officer (UXOSO) Technician walked in front of the FTL using a Schonstedt GA-92XTd magnetometer primarily for anomaly avoidance. The SVT stopped occasionally to note field observations and/or to collect surface soil samples. Sampling results are presented in Chapter 5.

4.1.1.4 Figure 4.1 shows the QR paths and observation locations. When MD was observed along the path, the SVT stopped to note an observation. The SVT randomly stopped at other locations to take photographs and to note field conditions, vegetation, or other features of interest. As discussed in the SS-WP Addendum (Parsons, 2010b), the QR route was not limited to the proposed path, but was determined in the field by the FTL based on the baseline QC procedures described in Chapter 3 of the PWP, visual observations, areas of predetermined focus, and by physical barriers such as vegetative undergrowth. The biased samples were collected in tandem with the QR. Table 4.1 presents the potential MEC anticipated to be present at the site based on the 2005 PA and 2008 ASR Supplement. The MEC Conceptual Site Model (CSM) and MC Conceptual Site Exposure Model (CSEM) are included in Appendix J.

Table 4.1
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Munitions Type/Model	Composition (Case and Filler)(2)	MC Analysis(1)
Bombing Target MRS	**Bomb, 3 lb, Miniature Practice, Mk5**	**Body: Zinc Alloy** - Aluminum, Cadmium, Copper, Iron, Lead, Magnesium, Tin, Zinc **Filler:** Solid with Mk4 and Mk5 signals	**Metals** Copper, Zinc **Explosives** See Cartridge, Signal, Bomb, Mk4 Mods 1 through 4
	Bomb, 3 lb, Miniature Practice, Mk23	**Body: Iron Alloy** - Aluminum, Carbon, Chromium, Cobalt, Copper, Iron, Manganese, Molybdenum, Nickel, Phosphorus, Silicon, Sulfur, Vanadium, Zinc **Filler:** Solid with Mk4 and Mk5 signals	**Metals** Copper, Zinc **Explosives** See Cartridge, Signal, Bomb, Mk4 Mods 1 through 4
	Bomb, 4.5 lb, Miniature Practice, Mk43	**Body: Lead Alloy** - Antimony, Lead **Filler:** Solid with Mk4 and Mk5 signals	**Metals** Antimony, Lead **Explosives** See Cartridge, Signal, Bomb, Mk4 Mods 1 through 4
	Bomb, 100 lb, Practice, Mk15 Mods 1 and 2	**Munition Case: Steel -** Carbon, Iron, Manganese, Phosphorus, Sulfur **Filler: Sand and/or Water** (7)	**Metals** N/A **Explosives** N/A

Table 4.1 (Continued)
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Munitions Type/Model	Composition (Case and Filler)[2]	MC Analysis[1]
Bombing Target MRS	**Bomb, 100 lb, Practice, Mk15 Mod 3**	**Munition Case: Steel -** Carbon, Iron, Manganese, Phosphorus, Sulfur **Munition Filler: Sand and/or Water** **Fuze: Fuze, Bomb, Tail, Practice, Mk247** (inert) **Steel -** Carbon, Iron, Manganese, Phosphorus, Sulfur **Cartridge, Signal, Bomb, Mk7: Steel, Brass -** Carbon, Copper, Iron, Manganese, Phosphorus, Sulfur, Zinc **Signal Filler: Black Powder -** Potassium Nitrate or Sodium Nitrate, Sulfur **Signal Primer[9]:** Antimony Sulfide, Barium Nitrate, Lead Styphnate, Tetrazene	**Metals** Copper, Zinc **Explosives** As a conservative measure, a full explosives panel will be analyzed for media collected at this MRS.
	Bomb, 100 lb, Practice, Mk15 Mod 4	**Munition Case: Steel -** Carbon, Iron, Manganese, Phosphorus, Sulfur **Munition Filler: Sand and/or Water** and Mk4 and Mk5 signals	**Metals** N/A **Explosives** See Cartridge, Signal, Bomb, Mk4 Mods 1 through 4

Table 4.1 (Continued)
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Munitions Type/Model	Composition (Case and Filler)[2]	MC Analysis[1]
Bombing Target MRS	**Cartridge, Signal, Bomb, Mk4 Mod 0**	**Cartridge: Cardboard, Steel** - Carbon, Iron, Manganese, Phosphorus, Sulfur **Filler: Black Powder, Red Phosphorus** - Potassium Nitrate, Red Phosphorus[8], Sodium Nitrate, Sulfur **Primer[9]:** Antimony Sulfide, Barium Nitrate, Copper, Lead Azide, Lead Thiocyanate, Pentaerythritol Tetranitrate (PETN), Potassium Chlorate, Trinitrotoluene (TNT), Zinc	**Metals** N/A **Explosives** As a conservative measure, a full explosives panel will be analyzed from media collected at this MRS.
	Cartridge, Signal, Bomb, Mk4 Mod 1	**Cartridge: Cardboard, Steel** - Carbon, Iron, Manganese, Phosphorus, Sulfur **Filler: Black Powder, Zinc Oxide** - Potassium Nitrate, Sodium Nitrate, Sulfur, Zinc Oxide **Primer[9]:** Antimony Sulfide, Barium Nitrate, Copper, Lead Azide, Lead Thiocyanate, PETN, Potassium Chlorate, TNT, Zinc	**Metals** Zinc **Explosives** As a conservative measure, a full explosives panel will be analyzed from media collected at this MRS.

Table 4.1 (Continued)
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Munitions Type/Model	Composition (Case and Filler)[2]	MC Analysis[1]
Bombing Target MRS	**Cartridge, Signal, Bomb, Mk4 Mod 2**	**Cartridge: Cardboard, Steel** - Carbon, Iron, Manganese, Phosphorus, Sulfur **Filler: Black Powder, Zinc Oxide** - Potassium Nitrate, Sodium Nitrate, Sulfur, Zinc Oxide **Primer[9]:** Antimony Sulfide, Barium Nitrate, Copper, Lead Azide, Lead Thiocyanate, PETN, Potassium Chlorate, TNT	**Metals** Zinc **Explosives** As a conservative measure, a full explosives panel will be analyzed from media collected at this MRS.
	Cartridge, Signal, Bomb, Mk4 Mod 3	**Cartridge: Aluminum Alloy** - Aluminum, Copper, Iron, Manganese, Silicon, Zinc **Filler: Smokeless Powder, Red Phosphorus** - Dibutylphthalate, Dinitrotoluene[6], Diphenylamine, Nitrocellulose[5], Red Phosphorus[8] **Primer[9]:** Boron, Carbon, Copper, Iron, Lead Styphnate, Manganese, Zinc	**Metals** Zinc **Explosives** As a conservative measure, a full explosives panel will be analyzed from media collected at this MRS.

Table 4.1 (Continued)
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Munitions Type/Model	Composition (Case and Filler)[2]	MC Analysis[1]
Bombing Target MRS	**Cartridge, Signal, Bomb, Mk4 Mod 4**	**Cartridge: Aluminum Alloy** - Aluminum, Copper, Iron, Manganese, Silicon, Zinc **Filler: Smokeless Powder, Zinc Oxide** - Dibutylphthalate, Dinitrotoluene[6], Diphenylamine, Nitrocellulose[5], Zinc Oxide **Primer[9]:** Boron, Carbon, Copper, Iron, Lead Styphnate, Manganese, Zinc	**Metals** Zinc **Explosives** As a conservative measure, a full explosives panel will be analyzed from media collected at this MRS.
	Cartridge, Signal, Bomb, Mk5	**Cartridge: Plastic** **Filler: Fluorescein Dye**	**Metals** N/A **Explosives** N/A

Table 4.1 (Continued)
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Munitions Type/Model	Composition (Case and Filler)[2]	MC Analysis[1]
Bombing Target MRS	**Flare, Aircraft, Parachute, AN-M26**	**Case: Sheet Steel** - Carbon, Iron, Manganese, Phosphorus, Sulfur **Filler:** Aluminum, Barium Nitrate, Magnesium, Potassium Nitrate, Red Phosphorus[8], Sodium Oxalate **Fuze:** Carbon, Iron, Manganese, Phosphorus, Potassium Nitrate, Sulfur **Primer[9]:** Antimony Sulfide, Carborundum, Copper, Iron, Lead Azide, Potassium Chlorate, Zinc	**Metals** N/A **Explosives** As a conservative measure, a full explosives panel will be analyzed from media collected at this MRS.

Table 4.1 (Continued)
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Munitions Type/Model	Composition (Case and Filler)(2)	MC Analysis(1)
Rifle Range MRS	Small Arms General: **Cartridge, .30 Caliber (includes carbine)**	**Cartridge case: Copper Alloy –** Copper, Iron, Lead, Zinc **Propellant:** Calcium Carbonate, Copper, Dibutylphthalate, Diphenylamine, Dinitrotoluene(6), Ethyl Centralite, Lead, Iron, Nitrocellulose(5), Nitroglycerin, Potassium Nitrate, Sodium Sulfate, Zinc **Primer:** Aluminum Powder, Antimony Sulfide, Barium Nitrate, Copper, Iron, Lead, Lead Styphnate, PETN, Tetrazene, Zinc **Projectile**: Antimony, Carbon, Copper, Iron, Lead, Manganese, Silicon, Sulfur, Zinc **Tracer:** Barium Peroxide, Calcium Resinate, Magnesium Powder, Polyvinyl Chloride, Strontium Nitrate, Strontium Oxalate, Strontium Peroxide, Zinc Stearate	**Metals(3)** Antimony, Copper, Lead **Explosives (4)** A full explosives panel will be analyzed from media collected at the firing lines of this MRS.

Table 4.1 Notes
Chemical Composition of Munitions and Explosives of Concern and Potential Munitions Constituents
Benedict Field, St. Croix, U.S. Virgin Islands

(1) MC selected for analysis are typically CERCLA-Hazardous substances and indicative of known or suspected DOD munitions used at this MRS.
(2) MC not selected for analysis are non-CERCLA substances, Semi-Volatile Organic Compounds (SVOCs) or materials that represent a very small percentage of the munitions weight.
(3) As a Programmatic determination, antimony, copper, and lead will be considered indicator metals for small arms ranges.
(4) A full Explosives panel will be analyzed from media collected at known firing points of small arms ranges and ambient samples.
(5) Nitrocellulose is not considered toxic, has no risk-based screening values and there are no chemical analysis techniques that quantify nitrocellulose separately from the natural common essential nutrient nitrate. Based on this, nitrocellulose analysis will not be conducted during this SI.
(6) Dinitrotoluene degradation products include: 2,4-and 2,6-dinitrotoluene; 2-Amino-4,6-dinitrotoluene; 2-and 3-nitrotoluene; 4-Amino-2,6-dinitrotoluene; 4-nitrotoluene.
(7) The Mk15 Mods 1 and 2 100 lb Practice Bombs did not contain any type of spotting charge or signal and therefore did not contain any energetic materials.
(8) Although Red Phosphorus is a potential constituent, there is no chemical analysis technique for Red Phosphorus. Based on this rational, no analysis for Red Phosphorus will be conducted for this MRS.
(9) Primer materials represent a very small percentage of the munitions weight, therefore, primer constituents will not be analyzed for at this MRS (if a primer constituent is associated with a larger component of the munition it may be analyzed for).

Source: **Munitions information was supplied by the 2003 Revised INPR, 2005 PA and 2008 ASR Supplement, Munitions Items Disposition Action System (MIDAS) database, and USACE Range Operations Reports RO-21.**

4.1.1.5 As shown in Appendix E, the SVT recorded discrete field observations throughout the course of the SI including detail on topography, soil color, drainage features, the presence of any barriers, and indications of surface MD and subsurface metal anomalies using the Schonstedt magnetometer. Pertinent field observations are summarized in Table 4.2 and are described in Subchapter 4.3. Appendix D includes related field forms.

Table 4.2
Summary of Qualitative Reconnaissance Observations
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	MEC	MD	Munitions-Related Features
Bombing Target MRS	None	Nose cone from a Mk 15 100-lb practice bomb	None
Rifle Range MRS	None	None	None

4.2 DATA QUALITY OBJECTIVES

4.2.1 Introduction

4.2.1.1 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*, USEPA QA/G-4, USEPA/240/B-06/001 (USEPA, 2006).

4.2.1.2 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 discussed the Benedict Field DQOs at the TPP Meeting held on December 8, 2009. Appendix B of this SI Report presents the TPP documentation. Tables 4.3 through 4.6 present the DQO worksheets. *All the DQOs for both MRSs have been met*.

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

4.2.1.4 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.

4.2.2 Munitions and Explosives of Concern Data Quality Objective

The MEC DQO was achieved by evaluating potential presence of MEC at the Bombing Target and Rifle Range MRSs. The SVT searched for visual evidence of MEC and MD during the QR at the MRSs. One piece of MD, a nose cone from a 100 lb practice bombs (Mk15), was found within the Bombing Target MRS (Figure 4.1, Point_ID 9). No evidence of MD or MEC was found within the Rifle Range MRS. No other munitions-related features, such as target remnants, were visually identified. A summary of these findings is included in Table 4.2.

4.2.3 Munitions Constituents Data Quality Objective

4.2.3.1 The MC DQO was achieved by evaluating the potential presence of MC at the Bombing Target and Rifle Range MRSs. Air and ambient surface water and sediment samples were not planned or collected. Groundwater samples were planned, but viable sources were not identified before, during, or since the field effort. Due to heavy, vegetative undergrowth, the anecdotally reported water wells could not be located by the SVT. Ten biased surface soil samples and one biased surface water/sediment sample couple was collected during the SI (plus appropriate field duplicates and QC samples). Chapter 5 presents the MC sampling results.

4.2.3.2 Several types of munitions were potentially used at the Bombing Target MRS, but only .30 Caliber cartridges were used at the Rifle Range MRS. The TPP Team evaluated the composition of the munitions (and fillers) potentially used at Benedict Field and developed a list of compounds/analytes for sample analysis. The complete list of munitions potentially used at the Bombing Target and Rifle Range MRSs and their chemical composition is provided in Table 4.1.

4.2.3.3 Factors considered for selecting specific MC metals for screening at a site include: focusing on MC metals that comprise over two percent of the weight of the munitions potentially used at this site; and, determining whether the MC metal(s) is a CERCLA hazardous substance (Agency for Toxic Substances and Disease Registry [ATSDR], 2007; USACE cannot respond to non-CERCLA hazardous substances under the FUDS program). MC metals considered "essential nutrients," such as iron and magnesium, are not expected to pose an unacceptable risk to human or ecological receptors, so these metals are not typically included in the MC metal analyses. The TPP Team agreed to analyze the MC samples for explosives, antimony, copper, lead, and zinc. Although antimony and lead do not compose greater than two percent of the weight of potential munitions at this site, these metals were included in the screening process due to their presence in the munitions, cumulative properties in the environment over time, and their toxicity to humans and ecological receptors.

4.2.4 Munitions Response Site Prioritization Protocol Data Quality Objective

The MRSPP DQO was achieved by obtaining sufficient information to complete the MRSPP scoring sheets for the Bombing Target Range MRS and Rifle Range MRS. Specific input data were collected, and the three modules for the MRSPP were populated as part of the SI. The scoring sheets for the MRSPP are included in Appendix K.

4.2.5 Hazard Ranking System Data Quality Objective

The HRS DQO was achieved by including information in the SI report necessary for the USEPA to populate the HRS score sheets. Source documents for the HRS information include the INPR, PA 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.

4.3 BOMBING TARGET MUNITIONS RESPONSE SITE

4.3.1 Historical Munitions and Explosives of Concern

The Bombing Target MRS, consisting of 649 acres (land and tidal water), was used as a practice bombing range from 1940 until 1948 and possibly used as a night bombing range. The target range consisted of two targets, one 50 feet in diameter and one 200 feet in diameter located southwest of the airstrip. Munitions potentially used at this MRS include the following: Bomb, 3 lb, miniature practice (AN-Mk5 and AN-Mk23); Bomb, 4.5 lb, miniature practice (AN-Mk43); Bomb, 100 lb practice (Mk 15 Mods 1, 2, 3, & 4); Cartridge, signal, bomb Mk 7; cartridge, signal, bomb Mk 4 Mod 0 (also Mod 1, 2, 3, & 4); Flare, Aircraft, Parachute, AN-M26. No MD or MEC had been found on the site prior to this SI.

4.3.2 Inspection Activities

The SI field effort for the Bombing Target MRS was conducted between June 21, and 23, 2010. The SVT collected six surface soil samples, along with appropriate field duplicate and QC samples. The SVT also conducted QR over a 4.1-mile path (Figure 4.1). One piece of MD, a nose cone from a 100 lb practice bombs (Mk15), was found within the Bombing Target MRS (Figure 4.1, Point_ID 9). No other munitions-related features, such as target remnants, were visually identified. Photographs and site observations collected are included in Appendix E.

4.4 RIFLE RANGE MUNITIONS RESPONSE SITE

4.4.1 Historical Munitions and Explosives of Concern

The Rifle Range MRS is composed of 1,259 acres (land and tidal water) and was used as a known distance rifle range from approximately 1940 until 1946. The rifle range was used for weapons familiarization and qualifications, and for function firing of weapons and ammunition. The only munitions associated with this MRS are .30 Caliber cartridges. No MD or MEC had been found on the site prior to this SI.

4.4.2 Inspection Activities

The SI field effort for the Rifle Range MRS was conducted between June 21, and 23, 2010. The SVT collected four surface soil samples and one surface water/sediment sample couple, along with appropriate field duplicate and QC samples. The SVT also conducted QR over a 0.9-mile path (Figure 4.1). Neither MD nor MEC was located within this MRS. No other munitions-related features, such as target remnants, were visually identified. Photographs and site observations collected are included in Appendix E.

Table 4.3 - MEC Data Quality Objective Worksheet

SITE: **Benedict Field, St. Croix, USVI**
PROJECT: **MMRP Site Inspection / FUDS No. I02VI056401**

DQO Element Number (*)	DQO Element Description (*)	Site-Specific DQO Statement	Objective Met? Yes (Y)/No (N)
Intended Data Use(s):			
1	Project Objective(s) Satisfied	Evaluate presence/lack of MEC	Y
Intended Need Requirements:			
2	Data User Perspective(s)	Risk, Remedy	Y
3	Contaminant or Characteristic of Interest	MEC, MD	Y
4	Media of Interest	N/A	N/A
5	Required Sampling Locations or Areas and Depths	Bombing Target MRS and Rifle Range MRS	Y
6	Number of Samples Required	QR path (total length) to be determined	Y
7	Reference Concentration of Interest or Other Performance Criteria	Any indication of residual MEC/MD will be evaluated. Based on the indications of type, degree and quantity of MEC/MD, a recommendation will be made regarding subsequent actions at the site. If the presence of MEC is confirmed or physical evidence of a potential explosive hazard is identified, a RI/FS may be recommended. If there are no anomalies detected and a potential explosive hazard is not identified, an NDAI recommendation may be warranted.	Y
Appropriate Sampling and Analysis Methods:			
8	Sampling Method	Qualitative Reconnaissance with magnetometer (Schonstedt GA 92 XTi)	Y
9	Analytical Method	N/A	N/A

(*) Refer to EM 200-1-2, Paragraph 4.2.1

Table 4.4 - MC Data Quality Objective Worksheet

SITE: **Benedict Field, St. Croix, USVI**
PROJECT: **MMRP Site Inspection / FUDS No. I02VI056401**

DQO Element Number(*)	DQO Element Description(*)	Site-Specific DQO Statement	Objective Met? Yes (Y)/No (N)
Intended Data Use(s):			
1	Project Objective(s) Satisfied	Evaluate presence/lack of MC	Y
Intended Need Requirements:			
2	Data User Perspective(s)	Risk, Remedy	Y
3	Contaminant or Characteristic of Interest	Explosives and specific metals (see Chapter 5)	Y
4	Media of Interest	Surface Soil, Surface Water, Sediment and possibly groundwater	Y - a viable groundwater source was not found.
5	Required Sampling Locations or Areas and Depths	As determined by the TPP Team, see Figures 3.1 and 3.2 of the SSWP Addendum. Biased locations based on locations of the various areas of concern. Depth is 0 to 2 inches for surface soil.	Y - Final sample locations were determined in the field.
6	Number of Samples Required	10 biased surface soil samples and 2 ambient surface soil samples. One biased surface water/ sediment sample couple. Two discretionary groundwater samples, if sample location is found within FUDS. Plus associated QA/QC samples.	Y- a viable groundwater source was not found.

Table 4.4 - MC Data Quality Objective Worksheet (Continued)

SITE: **Benedict Field, St. Croix, USVI**
PROJECT: **MMRP Site Inspection / FUDS No. I02VI056401**

DQO Element Number(*)	DQO Element Description(*)	Site-Specific DQO Statement	Objective Met? Yes (Y)/No (N)
7	Reference Concentration of Interest or Other Performance Criteria	The human health screening values for surface soil and sediment consist of the USEPA Regional Screening Levels (RSLs) for Residential Soil; and for marine surface water, the more stringent of the Florida Department of Environmental Protection (FDEP) Florida Administrative Code (FAC) 62-777 Groundwater and Surface Water Cleanup Target Levels, Marine Surface Water Criteria, April 2005 and FAC 62-302 Surface Water Quality Standards (SWQS; for Class III waters), July 1, 2008; for groundwater, the USEPA RSLs for Tap Water. The ecological screening values for surface soil consist of the USEPA ecological soil screening levels (EcoSSLs). In the absence of EcoSSLs, the primary references provided in the 2006 PSAP Addendum were used to obtain ecological screening values. The ecological screening values for sediment consist of the updated values from the primary references provided in the 2006 PSAP Addendum. The ecological screening values for marine surface water consist of the more stringent of the USEPA Region 4 Ecological Screening Values, November 30, 2001 and USEPA Region 3 Ecological Screening Benchmarks for marine surface water. Alternate screening values were used when screening values were not available from the primary source.	Y
Appropriate Sampling and Analysis Methods:			
8	Sampling Method	Composite samples in accordance with the CRREL sample wheel and TPP Team concurrence.	Y
9	Analytical Method	SW6020 -- metals, SW8321A-Explosives.	Y

(*) Refer to EM 200-1-2, Paragraph 4.2.

Table 4.5 - MRSPP Data Quality Objective Worksheet

Site:	Benedict Field, St. Croix, USVI				
Project:	MMRP Site Inspection / FUDS No. I02VI056401				
Module	**Table #**	**Table Description**	**Known Data**	**Current Data Gap**	**Data Source**
Explosive Hazard Evaluation (EHE)	1	Munitions Type	X		Historical Records/Findings
	2	Source of Hazard	X		Historical Maps
	3	Location of Munitions	X		Historical or Field Findings
	4	Ease of Access	X		Field Findings
	5	Status of Property	X		Historical Records
	6	Population Density	X		U.S. Census Bureau
	7	Population Near Hazard	X		Field Findings
	8	Types of Activities/Structures	X		Regional Zoning
	9	Ecological and/or Cultural Resources	X		State Historic Preservation Office
	10	Determining the EHE	X		Scores from Tables 1 through 9
Chemical Warfare Materiel (CWM) Hazard Evaluation (CHE)	11	CWM Configuration	X		Historical Records/Findings
	12	Sources of CWM	X		Historical Records/Findings
	13	Location of CWM	X		Historical or Field Findings
	14	Ease of Access	X		Field Findings
	15	Status of Property	X		Historical Records
	16	Population Density	X		U.S. Census Bureau
	17	Population Near Hazard	X		Field Findings
	18	Types of Activities/Structures	X		Regional Zoning
	19	Ecological and/or Cultural Resources	X		State Historic Preservation Office
	20	Determining the CHE	X		Scores from Tables 11 through 19
Health Hazard Evaluation (HHE)	21	Groundwater Data	X		Historical Records/Field Findings
	22	Surface Water - Human Endpoint	X		Historical Records/Field Findings
	23	Sediment - Human Endpoint	X		Historical Records/Field Findings
	24	Surface Water - Ecological Endpoint	X		Historical Records/Field Findings
	25	Sediment - Ecological Endpoint	X		Historical Records/Field Findings
	26	Surface Soil	X		Surface Soil Sampling Results
	27	Supplemental Contaminant Hazard Factor	X		All MC Sampling Results
	28	Determining the HHE	X		Scores from Tables 21 through 27
	29	MRS Priority	X		Scores from Tables 10, 20, and 28
	A	MRS Background Information	X		DoD Databases

Table 4.6 - HRS Data Quality Objective Worksheet

Site: Benedict Field, St. Croix, USVI
Project: MMRP Site Inspection / FUDS No. I02VI056401
DQO Statement Number: 4 of 4

Data Description	Known Data	Current Data Gap	Data Source
Source Type	X		Historical Records/Findings
Estimated Volume or Area	X		Field Findings
Hazardous Substance	X		Constituents of Suspected Munitions
Groundwater Sample Concentration	X		Not applicable. No groundwater resources
Groundwater Use	X		Well Records/Municipal Data
Surface Water Sample Concentration	X		Sample results.
Surface Water Pathways	X		Field Findings and municipal data
Soil Sample Concentration	X		Soil Sample Results
Soil Pathways	X		Municipal Data
Sensitive Environments	X		State Historic Preservation Office, US Fish and Wildlife Service, various government agencies
Attractiveness/Accessibility	X		Field Findings/Land Use Records

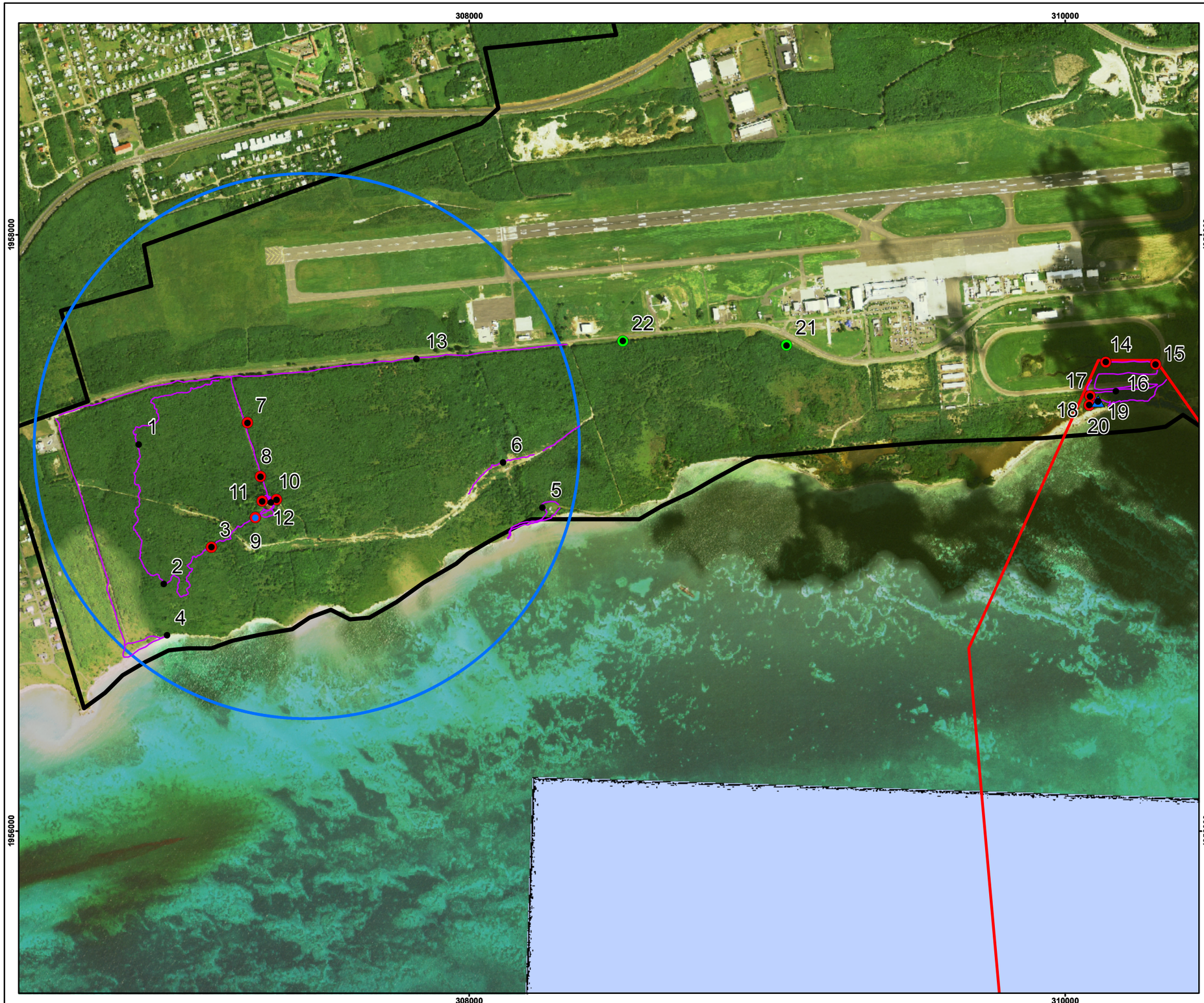

Figure 4.1

Qualitative Reconnaissance and Field Observation Locations Saint Croix-Benedict Field FUDS Project No. I02VI056401

U.S. Virgin Islands

Legend

- Munitions Debris Observation Location
- Field Observation Location
- Soil Sample Location
- Ambient Soil Sample Location
- Surface Water/Sediment Sample Location
- Qualitative Reconnaissance Track
- Bombing Target MRS
- Rifle Range MRS
- FUDS Property Boundary

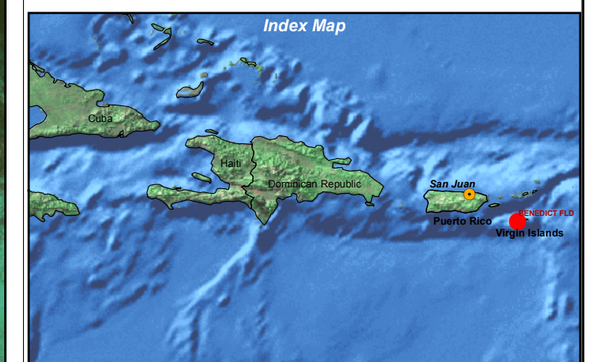

Image Source: 2004 Orthophoto
Projection: UTM Zone 20N NAD83, Map Units in Feet

N

400 200 0 400 Meters

PARSONS

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Qualitative Reconnaissance and Field Observation Locations**
DRAWN BY: BT	
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CHAPTER 5
EXPOSURE PATHWAYS AND RECEPTORS

5.1 INTRODUCTION

5.1.1 This chapter of the SI report evaluates the potential for release of MC to the environment based on site-specific conditions. It is necessary to evaluate site-specific conditions and land use to evaluate risks posed to potential receptors under current and future land use scenarios for the MRS. This chapter of the SI report evaluates exposure pathways for groundwater, surface water, sediment, soil, and air. The CSEM for the Benedict Field (Appendix J) summarizes which potential receptor exposure pathways are (or may be) complete and which are (and are likely to remain) incomplete for the MRS. For an exposure pathway to be considered complete, all four of the following factors (in *italics*) must be present (USEPA, 1989). An example regarding a hypothetical groundwater exposure pathway accompanies each pathway element.

- *A source of contamination*. For example, a site has known MEC from which MC have leached and contaminated surface soil.
- *An environmental transport and/or exposure medium*. In the example, the MC in soil is mobile and can contaminate groundwater.
- *A point of exposure at which the contaminant can interact with a receptor*. A drinking water well drawing from the contaminated aquifer is at the site.
- *A receptor and a likely route of exposure at the exposure point*. An on-site resident uses groundwater as a source of drinking water.

5.1.2 In the hypothetical example of the resident, all four factors are present and, therefore, the groundwater exposure pathway is complete. If any single factor was not present (for example, MC were not present in soil or the resident used drinking water from another source), the pathway would be incomplete.

5.2 GENERAL INFORMATION

5.2.1 Regional Geologic Setting

5.2.1.1 **Structure.** The Island of St. Croix is divided into two distinct physiographic regions: 1) the Central Limestone Plain, a structural graben, or downthrown block that lies in between two mountain ridges, known as the Northside Range; and, 2) the East End Range interpreted to be horst (up thrown blocks). The Northside and East End Ranges consist of well-lithified Cretaceous rocks of the Mount Eagle Group, including volcani-clastics, tuffaceous sandstone, pelagic (open sea deposit with less than 20 percent terrigenous material) sediments and intrusive gabbros and diorites. The Central Limestone Plain extends from the north central shore of the island

down to along most of the western shore and extending to the western two-thirds of the southern shore of St. Croix. The Kingshill Basin comprises the entire Central Limestone Plain and represents a low-lying sedimentary basin where relatively flat lying rocks of Tertiary age are bounded by the East End and Northside Ranges. Benedict Field lies entirely within the Kingshill Basin.

5.2.1.2 **Stratigraphy.** The uppermost stratigraphic unit in the region surrounding Benedict Field is the Blessing Formation. This unit is comprised of reef and lagoonal carbonate rocks of early Pliocene age that extend across the central southern and western coasts of St. Croix. The Blessing Formation occurs near the land surface along inland portions of Benedict Field where it unconformably overlies the Mannings Bay Member of the Kingsville Limestone. This unconformity shows as a sharp contact between the two units. Throughout the Blessing Formation, mollusk and coral fossils are preserved as moldic porosity with the unit generally classified as bioclastic wackestones (mud supported limestone with greater than 10 percent sand sized particle) and occasionally packstone (particle supported limestone containing some lime mud [Friedman and Sanders, 1978]).

5.2.1.3 The Kingshill Limestone is separated into an upper member (the Mannings Bay Member) and a lower member (the La Reine Member). The formation has a general southerly dip that averages less than 12 degrees.

5.2.1.4 The Mannings Bay Member is made up of well-bedded limestone of late Miocene to early Pliocene age and is the uppermost member of the Kingshill Limestone. The unit is characterized by the presence of foraminifers and shelf-derived debris. The Mannings Bay Member unconformably overlies the La Reine Member of the Kingshill Formation with numerous pinchouts of the coarser grained beds of the Manning Bay Member, possibly indicating channelization within the underlying paleosurface of the La Reine Member. The Mannings Bay Member tends to be more thinly bedded, contains more shelf-derived skeletal clasts versus the La Reine Member, and is dominated by bioclastic wackestones and packstones.

5.2.1.5 The La Reine Member of the Kingshill Limestone occurs at elevations of 30 feet bsl extending to a depth of approximately 50 feet bsl along central portions of Benedict Field. Rocks of the La Reine Member consist of a variety of lithofacies including packstones, wackestones, and clastic grainstones (particle supported limestone lacking mud).

5.2.1.6 The Jealousy Formation consists of dark, stratified calcitic, sandy, clay with intervals of calcareous conglomerate deposits. The age of the formation ranges from early to late Miocene. The percent sand in the formation ranges from less than 10 percent to almost 25 percent. The type section for this formation is based on cuttings or core from a deep test well. The test well was drilled to a depth of 459 meters below land surface with the lowest 426 meters identified as Jealously Formation sediments. The top of the Jealousy Formation occurs at about 50 feet along northern portions of Benedict Field and dips to the southeast where the top of the formation is at depths of 60 feet or greater.

5.2.1.7 Alluvial deposits are found along steam valleys and are derived from the weathering of the siliclastic rocks found in Northside and East End Ranges. Alluvium in areas immediately overlying the Kingshill Limestone tends to be light colored with carbonate material. Red clay-rich alluvium fills karst cavities in the Blessing Formation and the Mannings Bay Member strata as well.

5.2.1.8 **Soil Type**. There is typically one type of soil found on the Benedict Field site. The surface layer of the soil is dark brown gravelly, silty, clayey sand about 4 inches thick. The subsurface layer is dark brown gravelly silty, sandy clay to a depth of 10 inches. The subsoil is dark yellowish brown gravelly, silty, sandy clay and very gravelly, silty, sandy clay to a depth of 27 inches. The substratum is yellowish-brown, very gravelly, sandy clay for 5 inches; light olive brown very gravelly clay for 9 inches; and light olive brown very gravelly sandy clay to a depth of over 60 inches. There are several areas on the site where the soils have been altered for construction of roads, runways, and buildings. In these areas, there is no known soil profile, a random intermixing of the soils has occurred. The soil has a moderate permeability and the available water capacity is moderate. Organic matter content is high. The risk of corrosion to uncoated steel is high and to concrete is low. There is little or no potential for frost development in the soil of the Benedict Field site (USACE, 2005a).

5.2.2 Regional Hydrogeologic Setting and Groundwater Use

The Kingshill aquifer, which lies beneath the site at an elevation of 30 feet bsl along the northern site boundary, is a primary aquifer for the island (USGS, 2002a). Groundwater in the area is of poor quality due to salt-water intrusion, high dissolved solids, contamination by wastewater, and petroleum constituents (USACE, 2005a). Groundwater is sparingly used as a potable source in the vicinity of Benedict Field, due to high cost of well installation and low quality of water, producing only about 20 percent of the fresh water supply. On St. Croix, many urban areas use desalinized seawater for their domestic supplies, with rural areas depending on rainwater as a potable source of water (USACE, 2005a). According to the DPNR, approximately 20 years ago, there was a fresh water spring located within the Bombing Target MRS. Additionally, there may have been windmills, groundwater wells, and a greenhouse located within the Bombing Target MRS. DPNR personnel were to accompany the SVT to assist in locating any groundwater well remnants on the Bombing Target MRS property, but were unable to accompany the team during the site visit. Due to the heavy undergrowth and uncertainty of the well location(s), the SVT did not observe any groundwater source on the property. In addition, the SVT did not observe a reported slit trench well located east of the Bombing Target MRS as it is reportedly outside of the MRS and likely upgradient. The illegally constructed slit trench well is reportedly used by some nearby residents. There was no information readily available to confirm, locate, or map any nearby groundwater wells within either MRS.

5.2.3 Regional Hydrologic Setting

5.2.3.1 All runoff from this site eventually enters the Caribbean Sea through three pathways: overland flow, a stream network, and a natural low-lying area. The majority of this site drains via overland flow into drainage features that empty into the Caribbean Sea. There are no natural streams on this portion of the site. Runoff runs generally southward toward low-lying areas. A gravity sanitary sewer line (fiberglass pipe) was built within the MRS in the late 1960s. Repairs to the line were made prior to 2004, the date of the aerial photography used in Figures 4.1, 5.1, and ES.1; the cleared area is evident in these figures.

5.2.3.2 Runoff from the steep terrain on the extreme northern side of the site, which is a very small portion of this site, flows generally northward into an unnamed intermittent stream. Runoff from part of the northeastern portion of this site, and from a very small part of the southeastern portion, flows generally southeastward. Runoff from both the extreme western and the extreme northwestern portions of this site flows generally southwest toward a natural low-lying area. See Figure 5.2 for topographic and wetland features of the Benedict Field area. Additional detail of localized storm water runoff controls and flows are included in subchapter 2.2.4.

5.2.4 Regional Sensitive Ecological Resources

5.2.4.1 The Virgin Islands support 16 federally listed Threatened and Endangered (T&E) species consisting of 12 animals and 4 plants. According to the ECOS database for the island of St. Croix, the U.S. Fish and Wildlife Service (USFWS) records list nine federally listed T&E species (one bird [now delisted, in recovery], two plants, one mammal, and five reptiles) on the island of St. Croix. Due to the site development, mix of current site usages, and habitat preferences of species, only five of the listed T&E species may be located on-site or within the coastal waters in and around the FUDS and MRSs. NOAA NMFS indicates that two federally listed coral species, elkhorn coral (*Acropora palmata*) and staghorn coral (*Acropora cervicornis*) may be within the water portions of the MRSs. According to NOAA NMFS, the surrounding waters of St. Croix are also an Essential Fish Habitat (EFH) for corals, (, queen conch, reef fish, and spiny lobster. The seven federally listed T&E species potentially within or around the MRS boundaries are shown in Table 5.1. The 2010 SVT did not observe any T&E species during the field effort.

5.2.4.2 According to the PA, the surrounding land of the FUDS includes Manning Bay wetlands that consist of salt ponds, salt flats, and mangrove wetlands. Manning Bay wetlands, while rather small, are one of the more important mangrove wetlands on St. Croix. Mangrove wetlands are a vital coastal ecosystem since they provide habitat for juvenile fish, foraging, roosting and nesting areas for birds, help control coastal erosion, and provide a natural water filtration for surface water runoff. The recently de-listed brown pelican is known to forage and roost in the Manning Bay mangroves and multiple regionally T&E bird species are known to roost and breed in the Manning Bay mangroves. Three species of sea turtles (green, hawksbill, and leatherback) are known to

occur in Manning Bay. Manning Bay shoreline has potential for turtle nesting although it is not considered a major nesting site.

5.2.4.3 The USFWS Wetlands Online Mapper, through the NWI, was used to identify wetlands within the Benedict Field site. Wetlands are land areas that are transitional between terrestrial and deep-water habitats in which the water table usually is at or near the surface or in which the land is covered by shallow water. Currently, according to the NWI database, there are four predominant wetland systems (Palustrine, Estuarine, Marine, and Lacustrine) with varying subsystems, classes, and subclasses within the FUDS and MRSs. According to the NWI, the predominant wetland types within the FUDS and two MRSs are:

- M1AB3L- Marine, sub-tidal, aquatic bed, rooted vascular, sub-tidal
- PEM1C- Palustrine, emergent, persistent, seasonally flooded
- E2FO3N- Estuarine, intertidal, forested, broad-leaved evergreen, regularly flooded
- E2US2N- Estuarine, intertidal, unconsolidated shore, sand, regularly flooded
- L2USKx- Lacustrine, littoral, unconsolidated shore, artificially flooded, excavated

5.2.4.4 Using the criteria in the Army Checklist for Important Ecological Places (USACE, 2006b), the FUDS and MRSs are classified as important ecological places since they supports wetland areas, are within a coastal zone management area, provide preferred habitat for T&E species, and the water portions are within an EFH. The determinations regarding important ecological places pertain to whether or not ecological receptors are considered present at the site. Therefore, ecological receptors are potential receptors for exposure pathways at this site.

Table 5.1
Federally and State-Listed Threatened and Endangered Species Potentially Within the Benedict Field Formerly Used Defense Site

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat (NatureServe, 2010)	Habitat Present on-site?
Antillean Manatee	*Trichechus manatus manatus*	Endangered	Endangered	Habitat includes shallow coastal waters, estuaries, bays, rivers, and lakes; throughout most of the range, manatees appear to prefer rivers and estuaries over marine habitats. Manatees are not averse to traveling through dredged canals or using quiet marinas. In Puerto Rico, manatees are primarily marine but appear to depend on access to fresh water, and seagrass beds provide the primary foraging habitat.	No

Table 5.1 (Continued)
Federally and State-Listed Threatened and Endangered Species Potentially Within the Benedict Field Formerly Used Defense Site

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat (NatureServe, 2009)	Habitat Present on-site?
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered	Endangered	Shallow coastal waters with rocky bottoms, coral reefs, and mangrove-bordered bays and estuaries; infrequently reported from shallow coastal systems with soft bottoms and high turbidity. Hatchlings probably float in masses of sea plants (*Sargassum* rafts) in the open ocean. Juveniles never range far from the shallowest coral reefs. Adults do not travel beyond the tropics. Nests on undisturbed, deep-sand beaches, from high energy ocean beaches to tiny pocket beaches several meters wide contained in crevices of cliff walls; typically a low-energy sand beach with woody vegetation, such as sea grape or saltshrub, near the water line. Successive nestings usually are in the same general area. Beach development and illumination may make beaches unsuitable for successful nesting.	Yes

Table 5.1
Federally and State-Listed Threatened and Endangered Species Potentially Within the Benedict Field Formerly Used Defense Site

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat (NatureServe, 2010)	Habitat Present on-site?
Loggerhead Sea Turtle	*Caretta caretta*	Threatened	Threatened	Open sea to more than 500 miles from shore, mostly over continental shelf, and in bays, estuaries, lagoons, creeks, and mouths of rivers; mainly warm temperate and subtropical regions not far from shorelines. Adults occupy various habitats, from turbid bays to clear waters of reefs. Sub-adults occur mainly in near shore and estuarine waters. Hatchlings move directly to sea after hatching, often float in masses of sea plants (*Sargassum*); may remain associated with *Sargassum* rafts perhaps for 3-5 years.	No

Table 5.1 (Continued)
Federally and State-Listed Threatened and Endangered Species Potentially Within the Benedict Field Formerly Used Defense Site

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat (NatureServe, 2010)	Habitat Present on-site?
Green Sea Turtle	*Chelonia mydas*	Endangered	Endangered	Most commonly feeds in shallow, low-energy waters with abundant submerged vegetation. Migrates across open seas. Adults are tropical in distribution, whereas juveniles range into temperate waters. Hatchlings often float in masses of sea plants (e.g., *Sargassum*) in convergence zones. Coral reefs and rocky outcrops near feeding pastures often are used as resting areas.	Yes

Table 5.1 (Continued)
Federally and State-Listed Threatened and Endangered Species Potentially Within the Benedict Field Formerly Used Defense Site

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat (NatureServe, 2010)	Habitat Present on-site?
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Endangered	Marine; open ocean, often near edge of continental shelf; also seas, gulfs, bays, and estuaries. Mainly pelagic, seldom approaching land except for nesting. Dives almost continuously to depths of up to at least several thousand meters; may linger at the surface at midday but spends most of time submerged.	Yes

Table 5.1 (Continued)
Federally and State-Listed Threatened and Endangered Species Potentially Within the Benedict Field Formerly Used Defense Site

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat (NatureServe, 2010)	Habitat Present on-site?
Elkhorn Coral	*Acropora palmata*	Threatened	Threatened	Saltwater; warm regions, occupies depth range from 0-17 meters, but typically occurs between 1-5 meters.	Yes

Table 5.1 (Continued)
Federally and State-Listed Threatened and Endangered Species Potentially Within the Benedict Field Formerly Used Defense Site

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat (NatureServe, 2010)	Habitat Present on-site?
Staghorn Coral	*Acropora cervicornis*	Threatened	Threatened	Saltwater; warm regions, occupies depth range from 0-50 meters, but typically occurs between 15-30 meters on fore-reef communities on bank reefs and fringing reefs.	Yes

5.2.5 Sample Locations and Methods

5.2.5.1 The Benedict Field site visit, including QR and MC sampling, was conducted June 21, and 23, 2010. No intrusive MEC investigations, explosives handling, or MEC detonations were conducted. Extensive QR of the parcels was not performed beyond a visual assessment to evaluate the condition of the site. Preliminary QR routes were identified by the TPP Team with the understanding that the SVT could determine alternate routes to accommodate conditions on the ground. These routes were modified as needed based on hazardous and extreme vegetation and fences. The QR path is shown on Figure 5.1.

5.2.5.2 Surface soil, sediment, and surface water sampling was conducted during the Benedict Field site visit. Ten surface soil locations were sampled at the Benedict Field site (Figure 5.1). Of the ten surface soil samples, six of the samples (BFVI-MRS01-SS-02-01 through BFVI-MRS01-SS-02-06 and one field duplicate sample [BFVI-MRS01-SS-02-13]) were collected within the Bombing Target MRS and four samples (BFVI-MRS02-SS-02-09 through BFVI-MRS02-SS-02-12 and one field duplicate sample [BFVI-MRS02-SS-02-14]) were collected within the Rifle Range MRS and were positioned to represent areas with the highest likelihood for the presence of MEC or MC. Two ambient surface soil samples (BFVI-AMB-SS-02-07 and BFVI-AMB-SS-02-08) were selected to obtain metals concentrations from areas outside of the MRSs and in areas not anticipated to have been affected by munitions training. One surface water/sediment sample couple (BFVI-MRS02-SW-01 / BFVI-MRS02-SD-01) and one field duplicate surface water/sediment sample couple (BFVI-MRS02-SW-02 / BFVI-MRS02-SD-02) was collected from within the Rifle Range MRS. No ambient surface water and sediment samples were collected due to absence of a representative source for background. No groundwater or air samples were collected.

5.2.5.3 The samples were collected from 0 to 2 inches below ground surface (bgs) using a plastic hand trowel. Each of the sampling locations was recorded with a GPS unit for later reference. The surface soil sample locations were screened for potential subsurface anomalies using a Schonstedt GA-92XTd magnetometer and approved by the UXO Technician III prior to final location selection and sample collection. In accordance with the PWP, the CRREL seven point wheel sampling technique was employed for the surface soil samples. The actual GPS coordinates for each sample location were recorded and updated in the geographic information system (GIS) database.

5.2.5.4 The collected samples were packaged and shipped to TestAmerica Laboratories in Arvada, Colorado for analysis. The samples were analyzed for explosives (Method SW8321A and SW8330B), select metals (antimony, copper, lead, and zinc; Method SW6020), and percent moisture of soil and sediment samples. The sample results are presented in Table 5.2 (surface water), Table 5.3 (sediment), and Table 5.4 (surface soil).

5.2.5.5 The sample collection procedures presented in the Final PSAP (USACE, 2005) and the Parsons Final PSAP Addendum (Parsons, 2006) were followed.

Table 5.2
Summary Of Validated Analytical Results For Benedict Field MMRP Water Samples Collected In June 2010

SAMPLE ID:		BFVI-MRS02-SW-01		BFVI-MRS02-SW-02*	
DATE SAMPLED:		06/23/10		06/23/10	
LAB SAMPLE ID:		280-4830-8		280-4830-9	
	Units				
Explosives - SW8321A					
1,3,5-Trinitrobenzene	µg/L	0.11	UJ	0.11	U
2,4,6-Trinitrotoluene (TNT)	µg/L	0.11	UJ	0.11	U
2,4-Dinitrotoluene	µg/L	0.11	UJ	0.11	U
2,6-Dinitrotoluene	µg/L	0.11	UJ	0.11	U
2-Amino-4,6-dinitrotoluene	µg/L	0.11	UJ	0.11	U
2-Nitrotoluene	µg/L	0.19	UJ	0.19	U
3-Nitrotoluene	µg/L	0.19	UJ	0.19	U
4-Amino-2,6-dinitrotoluene	µg/L	0.11	UJ	0.11	U
4-Nitrotoluene	µg/L	0.19	UJ	0.19	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	µg/L	2.3	UJ	2.3	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	µg/L	0.11	UJ	0.11	U
Nitrobenzene	µg/L	0.11	UJ	0.11	U
Nitroglycerin	µg/L	0.14	UJ	0.14	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	µg/L	2.3	UJ	2.3	U
Pentaerythritol Tetranitrate (PETN)	µg/L	0.11	UJ	0.11	U
Explosives - SW8330B					
1,3-Dinitrobenzene	µg/L	1.0	UJ	1.0	UJ
Total Metals - SW6020					
Antimony	µg/L	**1.1**	J	**0.14**	J
Copper	µg/L	**9.9**	J	**5.3**	J
Lead	µg/L	**1.2**	J	**2.8**	J
Zinc	µg/L	100	U	**12**	J

QA NOTES AND DATA QUALIFIERS:
(NO CODE) - Confirmed identification.
U - Analyte was analyzed for but not detected above the sample specific practical quantitation limit (PQL_sa).
UJ - Analyte not detected, reported PQL_sa may be inaccurate or imprecise.
J - Analyte detected, estimated concentration.
* - Field duplicate of sample on left.
Detections are bolded.

Table 5.3
Summary Of Validated Analytical Results For Benedict Field MMRP Sediment Samples Collected In June 2010

SAMPLE ID:		BFVI-MRS02-SD-01		BFVI-MRS02-SD-02*	
DATE SAMPLED:		06/23/10		06/23/10	
LAB SAMPLE ID:		280-4830-10		280-4830-11	
	Units				
Explosives - SW8321A					
1,3,5-Trinitrobenzene	mg/kg	0.099	U	0.10	U
1,3-Dinitrobenzene	mg/kg	0.099	U	0.10	U
2,4,6-Trinitrotoluene (TNT)	mg/kg	0.099	U	0.10	U
2,4-Dinitrotoluene	mg/kg	0.099	U	0.10	U
2,6-Dinitrotoluene	mg/kg	0.099	U	0.10	U
2-Amino-4,6-dinitrotoluene	mg/kg	0.099	U	0.10	U
2-Nitrotoluene	mg/kg	0.099	U	0.10	U
3-Nitrotoluene	mg/kg	0.099	U	0.10	U
4-Amino-2,6-dinitrotoluene	mg/kg	0.099	U	0.10	U
4-Nitrotoluene	mg/kg	0.099	U	0.10	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	mg/kg	0.099	U	0.10	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	mg/kg	0.099	U	0.10	U
Nitrobenzene	mg/kg	0.099	U	0.10	U
Nitroglycerin	mg/kg	0.099	U	0.10	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	mg/kg	0.099	U	0.10	U
Pentaerythritol Tetranitrate (PETN)	mg/kg	0.099	U	0.10	U
Metals - SW6020					
Antimony	mg/kg	0.36	UJ	**0.084**	J
Copper	mg/kg	**14**		**13**	
Lead	mg/kg	**3.7**		**4.1**	
Zinc	mg/kg	**20**		**22**	
Percent Moisture					
Moisture, percent	%	**33**		**35**	

QA NOTES AND DATA QUALIFIERS:
(NO CODE) - Confirmed identification.
U - Analyte was analyzed for but not detected above the sample specific practical quantitation limit (PQL_sa).
UJ - Analyte not detected, reported PQL_sa may be inaccurate or imprecise.
J - Analyte detected, estimated concentration.
* - Field duplicate of sample on left.
Detections are bolded.

Table 5.4
Summary Of Validated Analytical Results For Benedict Field MMRP Soil Samples Collected In June 2010

SAMPLE ID:		BFVI-AMB-SS-02-07*		BFVI-AMB-SS-02-08*		BFVI-MRS01-SS-02-01		BFVI-MRS01-SS-02-02		BFVI-MRS01-SS-02-03		BFVI-MRS01-SS-02-04		BFVI-MRS01-SS-02-13**		BFVI-MRS01-SS-02-05		BFVI-MRS01-SS-02-06		BFVI-MRS02-SS-02-09		BFVI-MRS02-SS-02-10		BFVI-MRS02-SS-02-14**		BFVI-MRS02-SS-02-11		BFVI-MRS02-SS-02-12	
DATE SAMPLED:		06/23/10		06/23/10		06/21/10		06/22/10		06/22/10		06/22/10		06/22/10		06/22/10		06/22/10		06/23/10		06/23/10		06/23/10		06/23/10		06/23/10	
LAB SAMPLE ID:		280-4830-6		280-4830-7		280-4757-1		280-4757-2		280-4757-3		280-4757-4		280-4757-7		280-4757-5		280-4757-6		280-4830-1		280-4830-2		280-4830-3		280-4830-4		280-4830-5	
	Units																												
Explosives - SW8321A																													
1,3,5-Trinitrobenzene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
1,3-Dinitrobenzene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
2,4,6-Trinitrotoluene (TNT)	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U			0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
2,4-Dinitrotoluene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
2,6-Dinitrotoluene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
2-Amino-4,6-dinitrotoluene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
2-Nitrotoluene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
3-Nitrotoluene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
4-Amino-2,6-dinitrotoluene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
4-Nitrotoluene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
Nitrobenzene	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
Nitroglycerin	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
Pentaerythritol Tetranitrate (PETN)	mg/kg	0.098	U	0.098	U	0.097	U	0.10	U	0.097	U	0.099	U	0.10	U	0.098	U	0.097	U	0.10	U	0.098	U	0.099	U	0.098	U	0.10	U
Explosives - SW8330B																													
2,4,6-Trinitrotoluene (TNT)	mg/kg													0.10	UJ														
Metals - SW6020																													
Antimony	mg/kg	0.37	U	**0.037**	J	0.34	U	0.32	U	0.30	U	0.34	UJ	0.35	U	**0.17**	J	0.30	U	**0.042**	J	**0.020**	J	0.36	U	0.28	U	0.32	U
Copper	mg/kg	**36**		**41**		**51**		**38**		**31**		**47**	J	**43**		**43**		**29**		**62**		**70**		**82**		**31**		**12**	
Lead	mg/kg	**16**		**15**		**16**		**35**		**35**		**18**		**17**		**17**		**100**		**7.2**		**3.3**		**3.0**		**4.2**		**3.8**	
Zinc	mg/kg	**51**		**56**		**55**		**51**		**42**		**42**		**40**		**40**		**110**		**60**		**31**		**31**		**35**		**21**	
Percent Moisture																													
Moisture, percent	%	**33**		**27**		**29**		**27**		**23**		**30**		**29**		**26**		**19**		**34**		**25**		**36**		**13**		**29**	

QA NOTES AND DATA QUALIFIERS:

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

5.2.6 Background Concentrations

5.2.6.1 No site-specific statistical evaluation of background metals concentrations is available. Due to the limited scope of the SI, conducting a site-specific statistical background evaluation of metals concentrations (which typically requires collection of at least 10 background samples) was not considered practical or warranted at this stage of investigation. Therefore, analytical results of ambient surface soil samples collected during the 2010 SI field activities that are not expected to be affected by munitions activities will be used to determine background concentrations.

5.2.6.2 Two ambient surface soil samples (BFVI-AMB-SS-02-07 and BFVI-AMB-SS-02-08), as shown on Figure 5.1, were collected during the SI. No MEC or MD was observed in the vicinity of the remaining sample locations, which suggests that these samples are likely representative of the naturally occurring soil in the area. No explosives were detected in the ambient surface soil samples. The maximum detected metals concentrations in the biased surface soil samples collected from the Bombing Target MRS and the Rifle Range MRS will be compared to the maximum metals concentrations detected in the ambient surface soil samples. For surface soil, the maximum concentrations from ambient samples collected in association with this SI will be used as the selected background concentrations (Table 5.5).

5.2.6.3 No ambient surface water and sediment samples were collected due to lack of a representative source for background. Therefore, any detection of explosives or MC metals in surface water or sediment samples will be considered in the SLRA (Chapter 6). No explosives were detected in surface water and sediment samples.

Table 5.5
Surface Soil Background Concentrations
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	BFVI-AMB-SS-02-07*	BFVI-AMB-SS-02-08*	Selected Background Concentration (1)
Metals				
Antimony	mg/kg	0.37 U	0.037 J	0.037 J
Copper	mg/kg	36	41	41
Lead	mg/kg	16	15	16
Zinc	mg/kg	51	56	56

(1) - Selected background concentration is the maximum detected concentration of the ambient field samples collected.
Notes:
(NO CODE) - Confirmed identification.
U - Analyte was analyzed for but not detected above the sample specific practical quantitation limit (PQL_sa).
J - Analyte detected, estimated concentration.
* - Ambient sample.
mg/kg - milligrams/kilogram

5.2.7 Munitions Constituents Source Evaluation

5.2.7.1 As explained earlier in this chapter, an exposure pathway is not considered complete unless there is MC contamination present. To make this determination, analytical results for MC are screened against several criteria to evaluate whether or not potential MC have been released to environmental media. For a chemical to be considered MC contamination that is related to a release from munitions-related activities at the MRS, it is necessary for the following conditions to be true:

- The chemical is detected in the sample medium; AND
- The chemical is present above the selected background concentration (see Subchapter 5.2.7); AND
- The chemical is a potential constituent of the munitions formerly used at the range (Table 4.1).

5.2.7.2 Each of the MC analyzed in surface soil at the site were evaluated using these criteria to determine whether a release of MC has occurred at the MRS. Only detections of metals in surface soil that meet the conditions above are evaluated further in the SLRA in Chapter 6. Any detection of explosives in the surface soil at the MRS would be considered potential contamination and would be evaluated in the SLRA.

5.2.7.3 Because background concentrations for surface water and sediment could not be established at the site, any detection of explosives or metals in the surface water or sediment at either MRS would be considered potential contamination and would be evaluated in the SLRA.

5.3 BOMBING TARGET MUNITIONS RESPONSE SITE

This section of the SI Report evaluates exposure pathways for the Bombing Target MRS. The analysis of each pathway is described in detail. The related CSEM for this MRS is provided in Appendix J.

5.3.1 Historical Munitions Constituents Information

To date, no historical MC-related groundwater, surface water, soil, sediment, or air sampling has been documented at this MRS.

5.3.2 Groundwater Exposure Pathway

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

5.3.2.1 Geologic and Hydrogeologic Setting

The geologic setting of Benedict Field is described in detail in Subchapter 5.2.1. St. Croix is comprised of limestone and some upthrown rocks of volcanic origin. There is a thin layer of soils on the island with some limited agricultural activities. Groundwater sources do exist on the island but are of limited value due to low quality of the water. Almost 80 percent of the island receives water from desalinization or capture of rainwater into cisterns.

5.3.2.2 Releases and Potential Releases to Groundwater

There are no known releases of MC to groundwater at the Bombing Target MRS. If MC were detected in the surface soil, the MC may have migrated to shallow groundwater in the MRS.

5.3.2.3 Groundwater Exposure Pathways and Receptors

St. Croix Island is inhabited with just over 53,000 people according to the 2000 Census (http://www.census.gov/census2000/usvi.html accessed 10/22/2010). There are reported historic water wells on the MRS, however, confirmation of location could not be made by the SVT. Based on the undergrowth covering the area, it is unlikely that such wells remain in use at this time. Groundwater is sparingly used as a potable source in the vicinity of Benedict Field (Subchapter 5.2.2). Based on the current and future land use of the Bombing Target MRS, potential human receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, and future construction workers. Groundwater is not directly accessible to most ecological receptors so this pathway is not present at this MRS. There is reported use of a shallow slit trench well near the MRS and reported historic sources of groundwater through wells, but these features could not be located during the site visit.

5.3.2.4 Groundwater Sample Locations and Methods

Groundwater samples were not collected because the SVT could not locate the reported groundwater wells within the MRS.

5.3.2.5 Groundwater Analytical Results

Not applicable. Groundwater samples were not collected at this MRS.

5.3.2.6 Groundwater Exposure Pathway Conclusions

Groundwater sampling was not performed at the Bombing Target MRS during the SI. Although there are reported wells within the MRS, these wells could not be located during the site visit. MC metals were detected in the surface soil above the selected background values (Subchapter 5.3.4), and MC may have migrated to shallow groundwater in the MRS. Therefore, the groundwater exposure pathways are potentially complete but not quantitatively assessed for future construction workers at the Bombing Target MRS.

5.3.3 Surface Water and Sediment Exposure Pathways

Surface water can serve as a contaminant transport mechanism that may affect surface water bodies, sediment, drinking water supplies, vegetation, and sensitive environmental areas such as wetlands. The likelihood of exposure is influenced by such factors as the mass and concentration of MC in soil at the ground surface that can be transported to the marine surface water and sediment through runoff and erosion.

5.3.3.1 Hydrologic Setting

The hydrologic setting of Benedict Field is described in Subchapter 5.2.3 and in Subchapter 2.2.4. The area is generally flat with a slight slope south toward the ocean. Most surface water runs off into man-made drainage features that collect runoff from nearby roadways, the airport, and airport runway system. From viewing topographic maps and Benedict Field construction update figures, most of the surface runoff would not flow over the entirety of the Bombing Range MRS due to the natural low-lying topographic features directing flow around the MRS. All surface water runoff from the island empties into the surrounding marine waters. There are no fresh water streams or other bodies of fresh surface water at this MRS.

5.3.3.2 Releases and Potential Releases to Surface Water and Sediment

There are no known sources of fresh surface water or sediment at this MRS. Munitions-related activities could have lead to direct releases of MC to marine surface water and sediment at this MRS. It is also possible that MC in surface soil could migrate to surface water and sediment via runoff and erosion. Other possible sources of impact to surface water and sediments include the current and historic airport operations.

5.3.3.3 Surface Water and Sediment Exposure Pathways and Receptors

Because there is no fresh surface water within the MRS, potential receptors would not be exposed to fresh surface water or sediment through ingestion as drinking water, incidental ingestion, or direct dermal contact. However, receptors could be exposed to marine surface water and marine sediment. Based on the current and future land use of

the Bombing Range MRS, potential human receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, future construction workers, and ecological receptors. These receptors may be exposed to MC in marine surface water or sediment via incidental ingestion or dermal exposure. The drinking water exposure pathway is not complete for human receptors, as the surface water is not used as a drinking water source. Ecological receptors could be exposed to MC in surface water through ingestion as a drinking water source, incidental ingestion, dermal contact, and ingestion of other biota that have been exposed to MC in surface water or sediment.

5.3.3.4 Surface Water and Sediment Sample Locations and Methods

No surface water or sediment samples were collected within the Bombing Target MRS during the SI.

5.3.3.5 Surface Water and Sediment Analytical Results

Not applicable.

5.3.3.6 Surface Water and Sediment Exposure Pathway Conclusions

The fresh surface water and sediment exposure pathway is incomplete for all potential receptors because there is no fresh surface water within the MRS. The marine surface water would not be used as drinking water by humans, but could be used by marine species. Potential human and ecological receptors could be exposed to MC in the marine surface water and marine sediment through incidental ingestion, dermal contact, and ingestion of wetlands biota that have been exposed to MC. Because no marine surface water, or marine sediment, samples were collected during the SI, the marine water and marine sediment pathways are considered potentially complete, but not quantitatively assessed for potential receptors. While MC could have been released directly to marine surface water and sediment as a result of munitions activities, the large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it unlikely that MC in surface water and sediment would pose a threat to human or ecological receptors at this site.

5.3.4 Soil Exposure Pathway

Potential soil exposure pathways include incidental ingestion, dermal contact, and inhalation of resuspended particulates by both human and ecological receptors, as well as runoff and erosion to marine surface water and sediment. The likelihood of exposure is influenced by such factors as the mass and concentration of MC in the soil exposed at the ground surface, site-specific geology, climate, and expected future land use.

5.3.4.1 Physical Source Access Conditions

There are hundreds of houses and other inhabited structures within 2 miles of the Bombing Target MRS. A large portion of the site is on the St. Croix International Airport property. There are no known restrictions to access. The land use is not expected to change.

5.3.4.2 Actual or Potential Contamination Areas

Prior to the SI, there were no known soil contamination areas within the Bombing Target MRS. However, munitions-related activities could have directly affected soil. The Bombing Target MRS was used as a practice bombing range from 1940 until 1948 and was possibly used as a night bombing range. Based on the PA (USACE, 2005a) and ASR Supplement (CEMVS, 2008), the munitions known or suspected to have been used at the Bombing Target MRS include the following: Bomb, 3-lb, miniature practice (AN-Mk5 and AN-Mk23); Bomb, 4.5-lb, miniature practice (AN-Mk43); Bomb, 100 lb practice (Mk 15 Mods 1, 2, 3, & 4); Cartridge, signal, bomb Mk 7; cartridge, signal, bomb Mk 4 Mod 0 (also Mod 1, 2, 3, & 4); Flare, Aircraft, Parachute, AN-M26, as detailed in Table 4.1. No MD or MEC had been found on the site prior to this SI. The 2010 SVT found a nose cone from a 100 lb practice bomb (Mk15). No other MEC or MD was found.

5.3.4.3 Soil Exposure Pathways and Receptors

The soil exposure pathway accounts for the potential threat to human and ecological receptors on or near the Bombing Target MRS who may be exposed to MC in surface soil via dermal contact, incidental ingestion, or inhalation of resuspended soil particulates. Inhalation of resuspended soil particulates is addressed in Subchapter 5.3.5. Based on the current and future land use of the Bombing Target MRS, potential human receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, future construction workers, and ecological receptors.

5.3.4.4 Soil Sample Locations and Methods

Six biased surface soil samples (plus QC samples and one field duplicate) were collected within the Bombing Target MRS. Sample BFVI-MRS01-SS-02-02 was collected next to a nose cone for a Mk15 practice bomb. Samples BFVI-MRS01-SS-02-03 and -05 were collected as close to the bomb target center that the SVT could access given the dense vegetative growth on the MRS. Samples BFVI-MRS01-SS-02-01, -04, and -06 and field duplicate BFVI-MRS01-SS-02-13 were collected from within the Bombing Target MRS, but not at the target center. The soil samples were analyzed for explosives (Method SW8321A and SW8330B); antimony, copper, lead, and zinc (Method SW6020). The sample results for surface soil are presented in Table 5.4. Figure 5.1 shows the actual QR paths and sample locations.

5.3.4.5 Soil Analytical Results

The analytical results for the surface soil samples collected from the Bombing Target MRS during the SI are presented in Table 5.4. These results were evaluated using the criteria described in Subchapter 5.2.7. No explosives were detected in the surface soil samples, so this evaluation was performed for metals only. As shown in Table 5.6, antimony, copper, lead, and zinc were detected at concentrations greater than background concentrations in soil samples collected from this MRS. These analytes will be retained for further evaluation in the SLRA.

5.3.4.6 Soil Exposure Pathway Conclusions

No explosives were detected in surface soil samples from the Bombing Target MRS. As shown in the soil source evaluation (Table 5.6), the maximum detected concentrations of antimony, copper, lead, and zinc in the surface soil were detected above the selected background concentrations. Therefore, based on the analytical results presented in this report, there is potential MC contamination present, which is a necessary element for a complete exposure pathway. The surface soil pathways are considered complete for all potential receptors at this MRS. These four MC metals are further evaluated in the SLRA (Chapter 6).

Table 5.6
Bombing Target Munitions Response Site
Soil Source Evaluation
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration	Background Concentration (1)	Exceeds Background Concentration?	Potential MC? (2)	SLRA Required?	Primary reason for exclusion from SLRA
Metals							
Antimony	mg/kg	0.17 J	0.037 J	**Yes**	**Yes**	**Yes**	--
Copper	mg/kg	51	41	**Yes**	**Yes**	**Yes**	--
Lead	mg/kg	100	16	**Yes**	**Yes**	**Yes**	--
Zinc	mg/kg	110	56	**Yes**	**Yes**	**Yes**	--

(1) - Background Concentrations as established in Table 5.5
(2) - Potential MC as listed in Table 4.1

Notes:
(NO CODE) - Confirmed identification.
J - Analyte detected, estimated concentration.
mg/kg - milligrams/kilogram

5.3.5 Air Exposure Pathway

The air exposure pathway accounts for hazardous substance exposure in gaseous or particulate form through the air. Inhalation of a contaminant can be a potential exposure pathway for human and ecological receptors. No air sampling has been performed at this site, and the TPP Team agreed that air sampling would not be performed as part of this SI.

5.3.5.1 Climate

The climate at the site is described in Subchapter 2.2.3.

5.3.5.2 Releases and Potential Releases to Air

There are no known direct releases of MC to air at the Bombing Target MRS.

5.3.5.3 Air Exposure Pathway and Receptors

Because there are no known volatile MC associated with the munitions used at the site, the only remaining air exposure pathway evaluated during the SI would be via the inhalation of resuspended soil particulates. Based on the current and future land use of the Bombing Target MRS, potential human receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, future construction workers, and ecological receptors. These receptors could be exposed to MC in air through inhalation of resuspended soil particulates.

5.3.5.4 Air Sample/Monitoring Locations and Methods

No air sampling is known to have been previously performed at the Bombing Target MRS and the TPP Team agreed that air sampling would not be conducted as part of this SI.

5.3.5.5 Air Analytical Results

Not applicable.

5.3.5.6 Air Exposure Pathway Conclusions

As discussed in Subchapter 5.3.4.5, four MC metals (antimony, copper, lead, and zinc) were detected in surface soil at concentrations above the selected background concentrations. Based on these results, the air exposure pathway is complete for all receptors present at the Bombing Target MRS. The air exposure pathway for human receptors is assessed through the soil exposure pathway, as the screening values for human receptors include inhalation. While the inhalation exposure pathway is indirectly evaluated through the human health screening values for soil, the ecological screening values for soil do not evaluate this pathway, and the air exposure pathway is considered potentially complete, but not quantitatively assessed for ecological receptors at this MRS.

5.4 RIFLE RANGE MRS

This section of the SI Report evaluates exposure pathways for the Rifle Range MRS. The analysis of each pathway is described in detail. The related CSEM for this MRS is provided in Appendix J.

5.4.1 Historical Munitions Constituents Information

To date, no historical MC-related groundwater, surface water, soil, sediment, or air sampling has been documented at this MRS.

5.4.2 Groundwater Exposure Pathway

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

5.4.2.1 Geologic and Hydrogeologic Setting

The geologic setting of Benedict Field is described in detail in Subchapter 5.2.1. St. Croix is comprised of limestone and some upthrown rocks of volcanic origin. There is a thin layer of soils on the island with some limited agricultural activities. Groundwater sources do exist on the island but are of limited value due to low quality of the water. Almost 80 percent of the island receives water from desalinization or capture of rainwater into cisterns.

5.4.2.2 Releases and Potential Releases to Groundwater

There are no known releases of MC to groundwater at the Rifle Range MRS. Groundwater would not have been directly affected by firing activities, and there are no known wells within the MRS.

5.4.2.3 Groundwater Exposure Pathways and Receptors

St. Croix Island is inhabited with just over 53,000 people according to the 2000 Census (http://www.census.gov/census2000/usvi.html accessed 10/22/2010). There are no known water wells on the MRS. Groundwater is sparingly used as a potable source in the vicinity of Benedict Field (Subchapter 5.2.2). Based on the current and future land use of the Rifle Range MRS, potential human receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, and future construction workers. However, it is unlikely that human receptors would be exposed to groundwater via ingestion as drinking water, incidental ingestion, or dermal contact since there are no wells located within this MRS. Groundwater is not directly accessible to most ecological receptors so this pathway is not present at this MRS.

5.4.2.4 Groundwater Sample Locations and Methods

Groundwater samples were not collected due to the absence of groundwater wells within the MRS.

5.4.2.5 Groundwater Analytical Results

Not applicable. Groundwater was not sampled.

5.4.2.6 Groundwater Exposure Pathway Conclusions

There are no groundwater wells at the Rifle Range MRS, and exposure to the groundwater underlying the MRS is considered unlikely. Therefore, the groundwater exposure pathways are incomplete for all human receptors present at the MRS. Ecological receptors are not generally exposed to groundwater; therefore, the groundwater exposure pathway is incomplete for ecological receptors.

5.4.3 Surface Water and Sediment Exposure Pathways

Surface water can serve as a contaminant transport mechanism that may affect surface water bodies, sediment, drinking water supplies, vegetation, and sensitive environmental areas such as wetlands. The likelihood of exposure is influenced by such factors as the mass and concentration of MC in soil at the ground surface that can be transported to the marine surface water and sediment through runoff and erosion.

5.4.3.1 Hydrologic Setting

The hydrologic setting of Benedict Field is described in Subchapter 5.2.4. The area is generally flat with a slight slope south toward the ocean. Most surface water runs off into man-made drainage features. All surface water runoff from the island empties into the surrounding marine waters. An apparent man-made surface water drainage feature crosses the eastern MRS boundary and drains into a wetland area adjacent to the coast and thence into the ocean.

5.4.3.2 Releases and Potential Releases to Surface Water and Sediment

5.4.3.2.1 There are no known releases of MC to fresh surface water or sediment at the Rifle Range MRS. There is a man-made surface water drainage feature within the MRS, and it is possible that MC in surface soil could migrate to fresh surface water and sediment via runoff and erosion.

5.4.3.2.2 Munitions-related activities could have lead to direct releases of MC to marine surface water and sediment at this MRS. It is also possible that MC in surface soil could migrate to marine surface water and sediment via runoff and erosion, through overland flow or through the man-made drainage structure.

5.4.3.3 Surface Water and Sediment Exposure Pathways and Receptors

5.4.3.3.1 There is a drainage ditch leading to a fresh water pond located immediately west and south of the Rifle Range MRS. This pond may receive storm water runoff from upland areas. Based on the current and future land use of the Rifle Range MRS, potential receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, future construction workers, and ecological receptors. The fresh surface water at the MRS is not used as drinking water; however, human receptors could be exposed to MC in fresh surface water or sediment through incidental ingestion and dermal contact. Ecological receptors could be exposed to MC in fresh surface water or sediment through ingestion as drinking water, incidental ingestion, dermal contact, and ingestion of biota that have been exposed to MC.

5.4.3.3.2 A large portion of the Rifle Range MRS extends into the Caribbean Sea, and receptors could be exposed to marine surface water and marine sediment. Based on the current and future land use of the Bombing Range MRS, potential receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, future construction workers, and ecological receptors. Human receptors do not use the marine waters as drinking water, but may be exposed to MC in marine surface water or sediment through incidental ingestion or dermal exposure. Ecological receptors may be exposed to MC in marine surface water or sediment through ingestion as drinking water, incidental ingestion, dermal contact, and ingestion of biota that have been exposed to MC.

5.4.3.4 Surface Water and Sediment Sample Locations and Methods

One biased surface water/sediment sample couple (BFVI-MRS02-SW-01 / BFVI-MRS02-SD-01) plus QC samples and one field duplicate sample (BFVI-MRS02-SW-02 / BFVI-MRS02-SD-02) were collected within the Rifle Range MRS from an apparently man-made drainage feature within the Rifle Range MRS. Based on the low conductivity readings (Daily Reports, Appendix D), this is considered fresh surface water and sediment. The fresh surface water and sediment samples were analyzed for explosives (SW8321A and SW8330B [surface water only]); antimony, copper, lead, and zinc (Method SW6020). The analytical sample results are presented in Tables 5.2 (surface water) and 5.3 (sediment). Figure 5.1 shows the actual QR paths and sample locations. No marine surface water or sediment samples were collected during the SI.

5.4.3.5 Surface Water and Sediment Analytical Results

5.4.3.5.1 The analytical results for fresh surface water samples and sediment samples are presented in Tables 5.2 and 5.3, respectively. No explosives were detected in the fresh surface water or sediment samples, so this evaluation as performed for metals only.

5.4.3.5.2 Four MC metals (antimony, copper, lead, and zinc) were detected in the surface water samples collected (Table 5.2). No background concentrations were available for surface water, and as shown in Table 5.7, the MC metals antimony, copper, lead, and zinc were detected, and will be retained for further evaluation in the SLRA (Chapter 6).

5.4.3.5.3 Four MC metals (antimony, copper, lead, and zinc) were detected in the sediment samples collected (Table 5.3). No background concentrations were available for sediment, and as shown in Table 5.8, the MC metals antimony, copper, lead, and zinc were detected, and will be retained for further evaluation in the SLRA (Chapter 6).

Table 5.7
Rifle Range Munitions Response Site
Surface Water Source Evaluation
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration		Potential MC? (1)	SLRA Required?	Primary reason for exclusion from SLRA
Metals						
Antimony	µg/L	1.1	J	**Yes**	**Yes**	--
Copper	µg/L	9.9	J	**Yes**	**Yes**	--
Lead	µg/L	2.8	J	**Yes**	**Yes**	--
Zinc	µg/L	12	J	**Yes**	**Yes**	--

(1) - Potential MC as listed in Table 4.1
Notes:
(NO CODE) - Confirmed identification.
J - Analyte detected, estimated concentration.
mg/kg - milligrams/kilogram

Table 5.8
Rifle Range Munitions Response Site
Sediment Source Evaluation
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration	Potential MC? (1)	SLRA Required?	Primary reason for exclusion from SLRA
Metals					
Antimony	mg/kg	0.084 J	**Yes**	**Yes**	--
Copper	mg/kg	14	**Yes**	**Yes**	--
Lead	mg/kg	4.1	**Yes**	**Yes**	--
Zinc	mg/kg	22	**Yes**	**Yes**	--

(1) - Potential MC as listed in Table 4.1
Notes:
(NO CODE) - Confirmed identification.
J - Analyte detected, estimated concentration.
mg/kg - milligrams/kilogram

5.4.3.6 Surface Water and Sediment Exposure Pathway Conclusions

5.4.3.6.1 Fresh surface water and sediment are present within the Rifle Range MRS, and human and ecological receptors could be exposed to MC in fresh surface water or sediment. Antimony, copper, lead, and zinc were detected in fresh surface water and sediment, and therefore, based on the analytical results presented in this report, there is potential MC contamination present in fresh surface water and sediment. Human receptors may be exposed to MC in fresh surface water and sediment through incidental ingestion and dermal contact. Ecological receptors may be exposed to MC in fresh surface water through incidental ingestion, dermal contact, ingestion as drinking water, and ingestion of biota that have been exposed to MC. The four MC metals (antimony, copper, lead, and zinc) will be evaluated in the SLRA.

5.4.3.6.2 Marine surface water and sediment are also present within the Rifle Range MRS. Potential human receptors could be exposed to MC in the marine surface water and marine sediment through incidental ingestion and dermal contact, and ecological receptors could be exposed to MC in the marine surface water and marine sediment through incidental ingestion, dermal contact, ingestion as drinking water, and ingestion of biota that have been exposed to MC. Because no marine surface water or marine sediment samples were collected during the SI, the marine water and marine sediment pathways are considered potentially complete, but not quantitatively assessed for potential receptors. While MC could have been released directly to marine surface water

and sediment as a result of munitions activities, the large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it unlikely that MC in surface water and sediment would pose a threat to human and ecological receptors at this site.

5.4.4 Soil Exposure Pathway

Potential soil exposure pathways include incidental ingestion, dermal contact, and inhalation of resuspended particulates by both human and ecological receptors, as well as runoff and erosion to fresh and marine surface water and sediment. The likelihood of exposure is influenced by such factors as the mass and concentration of MC in the soil exposed at the ground surface, site-specific geology, climate, and expected future land.

5.4.4.1 Physical Source Access Conditions

There are hundreds of houses and other inhabited structures within 2 miles of the Rifle Range MRS. A large portion of the site is on the St. Croix International Airport property and a portion of the MRS is on a horseracing track. There are no known restrictions to access. The land use is not expected to change.

5.4.4.2 Actual or Potential Contamination Areas

Prior to the SI, there were no known soil contamination areas within the Rifle Range MRS. However, munitions-related activities could have directly affected soil. The Rifle Range MRS was used as a known distance rifle range from approximately 1940 until 1946. Based on the PA (USACE, 2005a) and ASR Supplement (CEMVS, 2008), the munitions known or suspected to have been used at the Rifle Range MRS include only .30-caliber cartridges, as detailed in Table 4.1. No MD or MEC had been found on the site prior to this SI. The 2010 SVT found no MD, MEC, or evidence of the former range.

5.4.4.3 Soil Exposure Pathways and Receptors

The soil exposure pathway accounts for the potential threat to human and ecological receptors on or near the Rifle Range MRS who may be exposed to MC in surface soil via dermal contact, incidental ingestion, or inhalation of resuspended soil particulates. Inhalation is addressed in Subchapter 5.3.5. Based on the current and future land use of the Rifle Range MRS, potential human receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, future construction workers, and ecological receptors.

5.4.4.4 Soil Sample Locations and Methods

Four biased surface soil samples (plus QC samples and one field duplicate) were collected within the Rifle Range MRS. Samples BFVI-MRS02-SS-02-09 and -10 and field duplicate BFVI-MRS02-SS-02-14 were collected near the firing point of the Rifle Range MRS. Samples BFVI-MRS02-SS-02-11 and -12 were collected southwest of the firing point. The soil samples were analyzed for explosives (Method SW8321A); antimony, copper, lead, and zinc (Method SW6020). The analytical data are presented in Table 5.4. Figure 5.1 shows the actual QR paths and sample locations.

5.4.4.5 Soil Analytical Results

The analytical results for the surface soil samples collected from the Rifle Range MRS during the SI are presented in Table 5.4. These results were evaluated using the criteria described in Subchapter 5.2.7. No explosives were detected in the surface soil samples, so this evaluation was performed for metals only. As shown in Table 5.9, antimony, copper, and zinc were detected at concentrations greater than background concentrations in soil samples collected from this MRS. These analytes will be retained for further evaluation in the SLRA.

5.4.4.6 Soil Exposure Pathway Conclusions

No explosives were detected in surface soil samples from the Rifle Range MRS. As shown in the soil source evaluation (Table 5.9), the maximum detected concentrations of antimony, copper, and zinc in the surface soil were detected above the selected background concentrations. Therefore, based on the analytical results presented in this report, there is potential MC contamination present, which is a necessary element for a complete exposure pathway. The surface soil pathways are considered complete for all potential receptors at this MRS. These three MC metals are further evaluated in the SLRA (Chapter 6).

Table 5.9
Rifle Range Munitions Response Site
Soil Source Evaluation
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration	Background Concentration (1)	Exceeds Background Concentration?	Potential MC? (2)	SLRA Required?	Primary reason for exclusion from SLRA
Metals							
Antimony	mg/kg	0.042 J	0.037 J	**Yes**	**Yes**	**Yes**	--
Copper	mg/kg	82	41	**Yes**	**Yes**	**Yes**	--
Lead	mg/kg	7.2	16	No	**Yes**	No	Not detected above background
Zinc	mg/kg	60	56	**Yes**	**Yes**	**Yes**	--

(1) - Background Concentrations as established in Table 5.5
(2) - Potential MC as listed in Table 4.1
Notes:
(NO CODE) - Confirmed identification.
J - Analyte detected, estimated concentration.
mg/kg - milligrams/kilogram

5.4.5 Air Exposure Pathway

The air exposure pathway accounts for hazardous substance exposure in gaseous or particulate form through the air. Inhalation of a contaminant can be a potential exposure pathway for human and ecological receptors. No air sampling has been performed at this site, and the TPP Team agreed that air sampling would not be performed as part of this SI.

5.4.5.1 Climate

The climate at the site is described in Subchapter 2.2.3.

5.4.5.2 Releases and Potential Releases to Air

There are no known direct releases of MC to air at the Rifle Range MRS.

5.4.5.3 Air Exposure Pathway and Receptors

Because there are no known volatile MC associated with the munitions used at the site, the only remaining air exposure pathway evaluated during the SI would be via the inhalation of resuspended soil particulates. Based on the current and future land use of the Rifle Range MRS, potential human receptors in this MRS include commercial/industrial workers (for example, airport personnel), site visitors, future construction workers, and ecological receptors. These receptors could be exposed to MC in air through inhalation of resuspended soil particulates.

5.4.5.4 Air Sample/Monitoring Locations and Methods

No air sampling is known to have been previously performed at the Rifle Range MRS and the TPP Team agreed that air sampling would not be conducted as part of this SI.

5.4.5.5 Air Analytical Results

Not applicable.

5.4.5.6 Air Exposure Pathway Conclusions

As discussed in Subchapter 5.4.4.5, three MC metals (antimony, copper, and zinc) were detected in surface soil at concentrations above the selected background concentrations. Based on these results, the air exposure pathway is complete for all receptors present at the Rifle Range MRS. The air exposure pathway for human receptors is assessed through the soil exposure pathway, as the screening values for human receptors include inhalation. While the inhalation exposure pathway is indirectly evaluated through the human health screening values for soil, the ecological screening values for soil do not evaluate this pathway, and the air exposure pathway is considered potentially complete, but not quantitatively assessed for ecological receptors at this MRS.

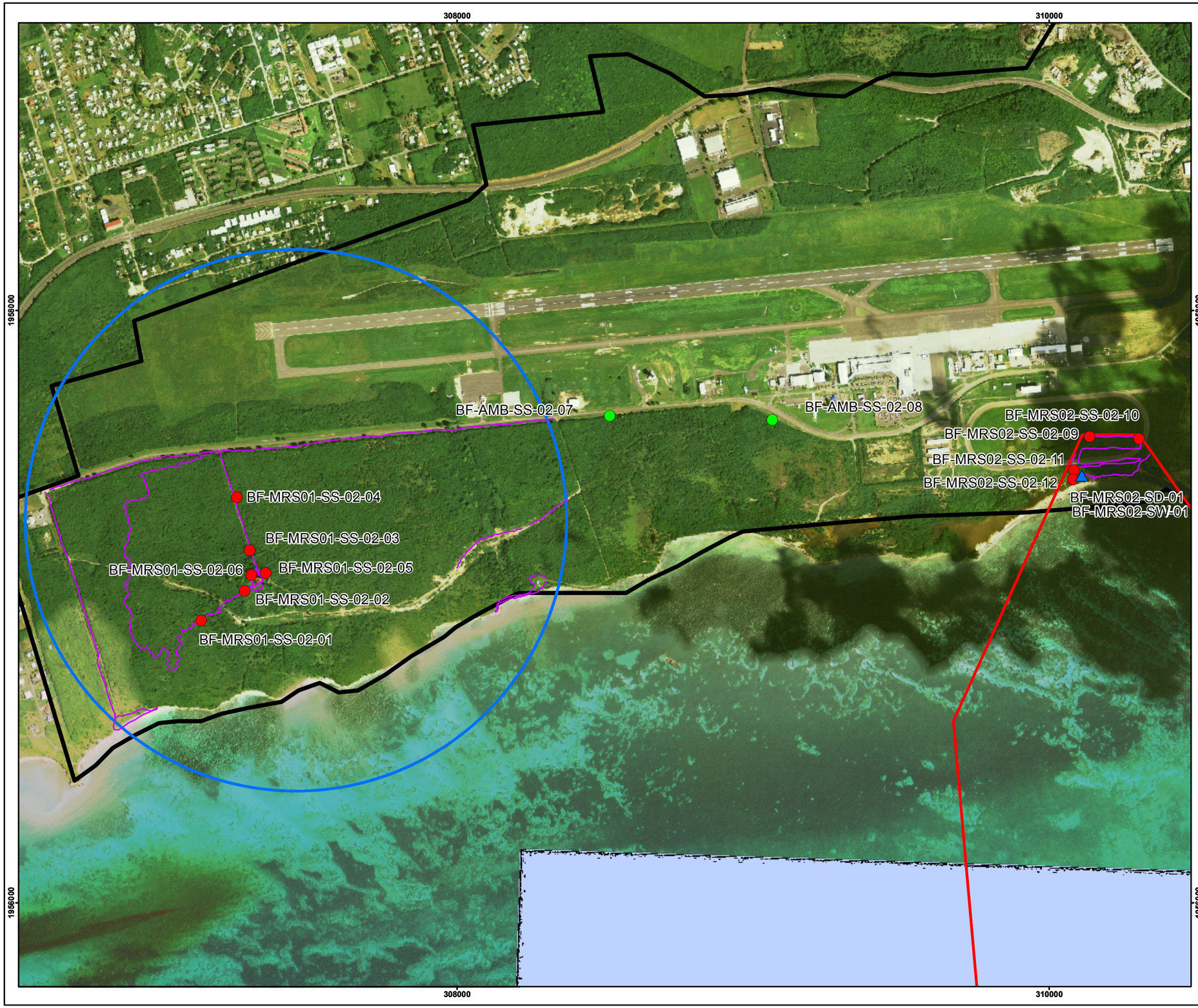


Figure 5.1

Qualitative Reconnaissance and Sample Locations
Saint Croix-Benedict Field
FUDS Project No. I02VI056401

U.S. Virgin Islands

Legend

- Soil Sample Location
- Ambient Soil Sample Location
- Surface Water/Sediment Sample Location
- Qualitative Reconnaissance Track
- Bombing Target MRS
- Rifle Range MRS
- FUDS Property Boundary

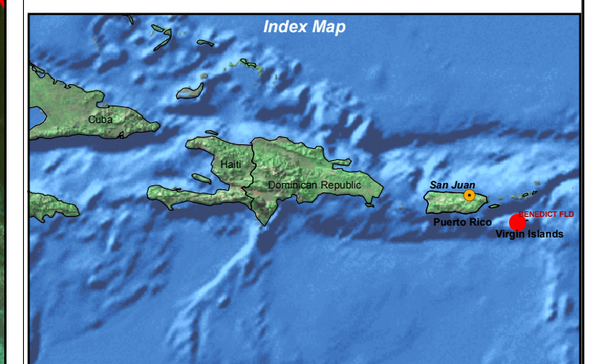


Image Source: 2004 Orthophoto
Projection: UTM Zone 20N NAD83, Map Units in Feet

400 200 0 400 Meters

N

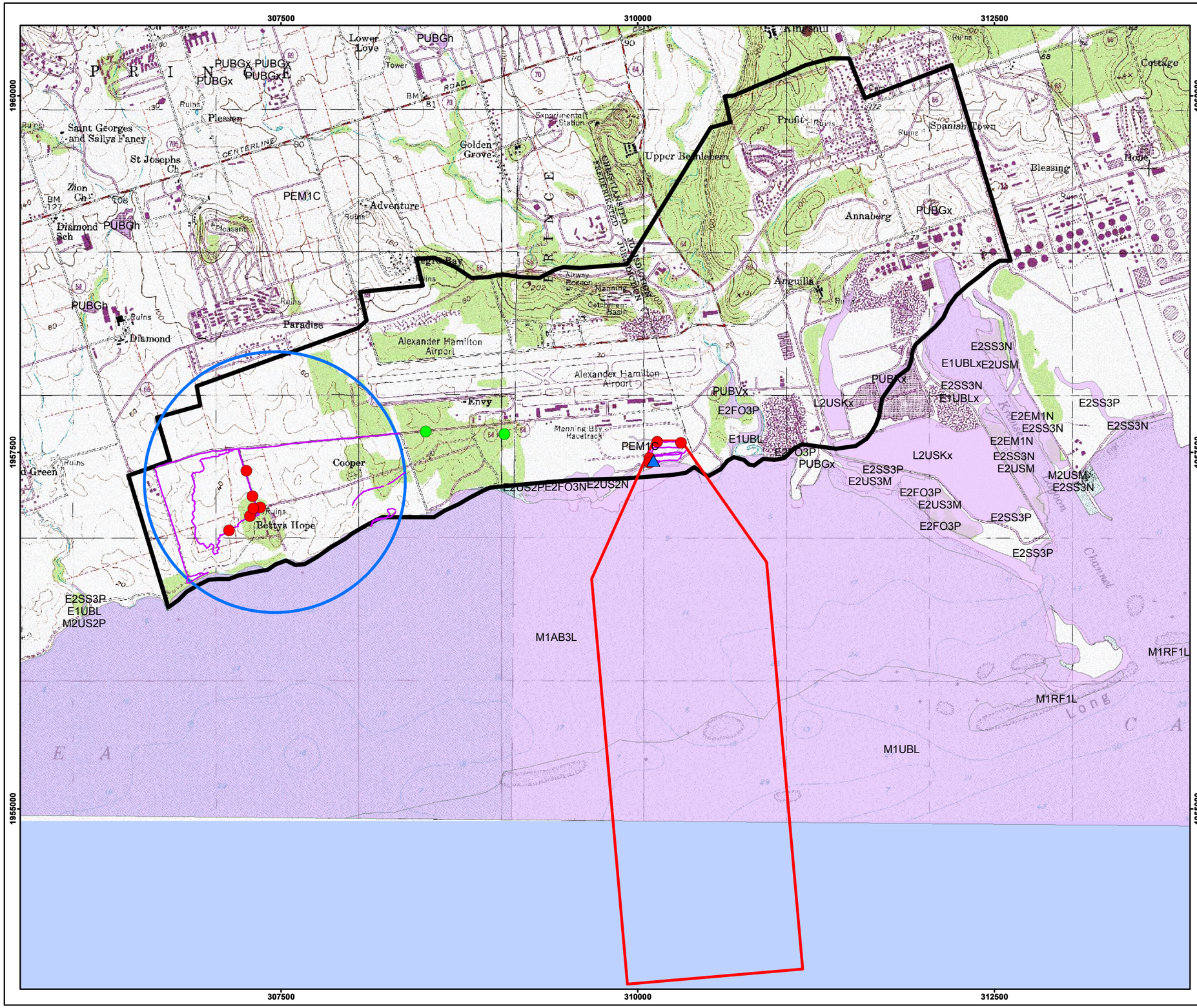
PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	**Qualitative Reconnaissance and Sample Locations**		
DRAWN BY: BT			
CHECKED BY: TD	SCALE: As Shown	PROJECT NUMBER: 747140.86135	
SUBMITTED BY: DS	DATE: September 2010	PAGE NUMBER: 5-35	
	FILE: X:\GIS\Site_inspections_ne\Maps\benedict_vi\Fig5_1.mxd		

Figure 5.2

Wetlands
Saint Croix-Benedict Field
FUDS Project No. I02VI056401

U.S. Virgin Islands



Legend

- Soil Sample Location
- Ambient Soil Sample Location
- Surface Water/Sediment Sample Location
- Qualitative Reconnaissance Track
- Bombing Target MRS
- Rifle Range MRS
- FUDS Property Boundary
- Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Types:

E2FO3N- Estuarine, intertidal, forested, broad-leaved evergreen, regularly flooded
PEM1C- Palustrine, emergent, persistent, seasonally flooded
L2USKx- Lacustrine, littoral, unconsolidated shore, artificially flooded, excavated
E2US2N- Estuarine, intertidal, unconsolidated shore, sand, regularly flooded

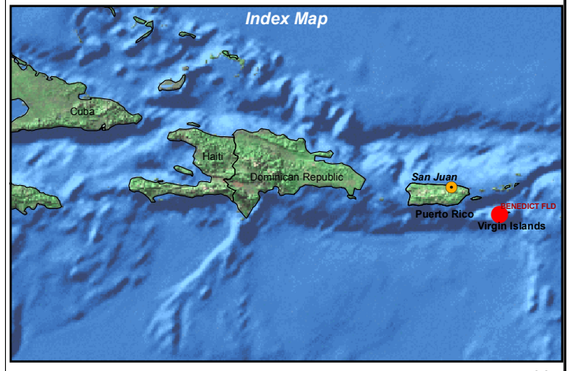


Image Source: USGS Topo Maps
Projection: UTM Zone 20N NAD83, Map Units in Feet

500 250 0 500 Meters

N

PARSONS	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	Wetlands	
DRAWN BY: BT		
CHECKED BY: TD	SCALE: As Shown	PROJECT NUMBER: 747140.86135
SUBMITTED BY: DS	DATE: September 2010	PAGE NUMBER: 5-36
	FILE: X:\GIS\Site_inspections_ne\Maps\benedict_vi\Fig5_2.mxd	

CHAPTER 6
SCREENING-LEVEL RISK ASSESSMENT

6.1 MUNITIONS AND EXPLOSIVES OF CONCERN SCREENING-LEVEL RISK ASSESSMENT

6.1.1 Conceptual Site Model

The CSM for Benedict Field, included in Appendix J, summarizes conditions at the site that could result in human exposure to MEC. It describes the types of MEC potentially present at the Bombing Target and Rifle Range MRSs, past MEC and MD findings, and current and projected future land use and receptors.

6.1.2 Introduction

6.1.2.1 A qualitative risk evaluation was conducted to assess the potential explosive safety risk to the public at Benedict Field. The purpose of this risk evaluation is to qualitatively communicate whether a potential risk is present at the site and the primary causes of that potential risk. The risk evaluation presented here is based on historical information presented in prior studies (for example, INPR and PA) and observations made during the SI QR.

6.1.2.2 An explosive safety risk exists if a person can come near or into contact with a MEC item and interact with it in a manner that results in a detonation. The potential for an explosive safety risk depends on the presence of three critical elements:

- a source (*such as,* presence of MEC), AND
- a human receptor (*such as,* a person), AND
- the potential for interaction between the source and receptor (such as, the possibility the item might be picked up or disturbed by the receptor).

6.1.2.3 All three of these elements must be present for there to be an explosive safety risk. There is no risk if any one element is missing. Each of these three elements provides a basis for implementing effective risk-management response actions.

6.1.3 Qualitative Risk Evaluation

6.1.3.1 The potential risk posed by MEC was characterized qualitatively by evaluating three primary risk factors for each MRS at the site. These factors are related to the three critical elements listed above and are:

1) MEC Presence: whether there is the potential for MEC to be present at the MRS;

2) MEC Type: the type(s) of MEC that might be present at the MRS and the related potential explosive hazards; and

3) Site Accessibility: the potential receptors at the MRS and how they might interact with the MEC.

6.1.3.2 The known or suspected presence of an explosive hazard and any potential human receptors at a MRS will typically be considered sufficient justification for a RI/FS. The following paragraphs describe each of the primary risk factors.

6.1.3.3 **MEC Presence**: this factor describes whether MEC either has been confirmed or is suspected to be present at the MRS, either at the surface or in the subsurface, and is based on historical information presented in prior studies (for example, INPR, ASR, and ASR Supplement) and observations made during the SI QR. Note that if there is historical evidence of potential MEC presence at a site, lack of confirmation of MEC presence during the SI QR will not be considered as evidence of MEC absence for this qualitative risk evaluation. Table 6.1 lists the three possible categories used to describe MEC Presence for this evaluation.

Table 6.1
Categories of MEC Presence

MEC Presence	Description
Confirmed or suspected	There is physical or confirmed historical evidence of MEC presence at the MRS, or there is physical or historical evidence indicating that MEC may be present at the MRS.
Small arms only(1)	The presence of small arms ammunition is confirmed or suspected, and there is evidence that no other types of munitions were used or are present at the MRS.
Evidence of no munitions	Following investigation of the MRS, there is physical or historical evidence that there are no Unexploded Ordnance (UXO) or discarded military munitions (DMM) present.

(1) Small arms ammunition is defined as "ammunition, without projectiles that contain explosives (other than tracers), that is .50 Caliber or smaller or for shotguns" (Department of the Army, 2005).

6.1.3.4 **MEC Type**: this factor describes whether the MEC potentially present at the MRS might be detonated, resulting in injury to one or more human receptors. If multiple MEC items are potentially present at a MRS, the item that poses the greatest risk to public health is selected for purposes of this qualitative risk evaluation. This determination is based on historical information presented in prior studies (for example, INPR, ASR, and ASR Supplement) and observations made during the SI QR. Table 6.2 lists the three possible categories used to describe MEC Type for this evaluation.

Table 6.2
Categories of MEC Type

MEC Type	Description
Potentially Hazardous	Fuzed or unfuzed MEC that may result in physical injury to an individual if detonated by an individual's activities.
Small arms only(1)	Small arms ammunition is confirmed or suspected, and there is evidence that no other types of munitions were used or are present at the MRS.
Inert	Munitions debris or other items that will cause no injury (for example, training ordnance containing no explosives, fuzes, spotting charges, etc.).

(1) Small arms ammunition is defined as "ammunition, without projectiles that contain explosives (other than tracers), that is .50 Caliber or smaller or for shotguns" (Department of the Army, 2005).

6.1.3.5 **Site Accessibility**: this factor describes whether human receptors have any access to the MRS and, therefore, may interact with any MEC present at the surface or in the subsurface. For purposes of this qualitative risk evaluation, if MEC is confirmed or suspected to be present at the MRS, it is assumed that human receptors might come into contact with that MEC unless there is "Complete Restriction to Access." A description of the potential receptors will also be given with this assessment. Table 6.3 lists the two possible categories used to describe Site Accessibility for this evaluation.

Table 6.3
Categories of Site Accessibility

Site Accessibility	Description
Accessible	Access control is not complete: residents, site workers, visitors, or trespassers can gain access to all or part of the MRS.
Complete restriction to access	Human receptors are completely prevented from gaining access to the MRS.

6.1.3.6 With regard to this qualitative risk evaluation, further evaluation (such as, RI/FS) for the MRS will typically be justified if the following conditions are true:

- MEC is confirmed or suspected to be present, AND
- The MEC confirmed or suspected to be present is potentially hazardous, AND
- The MRS is accessible.

6.1.3.7 The primary risk factors identified above were evaluated for the Bombing Target and Rifle Range MRSs at Benedict Field using data collected during the SI field investigation and the historical data available from other studies. The following sections discuss the qualitative risk evaluation by each primary risk factor to determine whether further evaluation is justified at the site.

6.1.4 Munitions and Explosives of Concern Risk Assessment – Bombing Target Munitions Response Site

6.1.4.1 The Bombing Target MRS, consisting of 649 acres (land and tidal water), was used as a practice bombing range from 1940 until 1948 and was possibly used as a night bombing range. The target range consisted of two targets, one 50 feet in diameter and one 200 feet in diameter, and was located southwest of the airstrip. No MD or MEC had been found on the site prior to this SI. The 2010 SVT found a nose cone from a 100 lb practice bomb (Mk15). No other MEC or MD was found. Based on this information and Table 6.1, the presence of MEC at the Bombing Target MRS is assessed to be "Confirmed or suspected."

6.1.4.2 Based on the PA (USACE, 2005a) and ASR Supplement (CEMVS, 2008), the munitions known or suspected to have been used at the Bombing Target MRS include the following: Bomb, 3 lb, miniature practice (AN-Mk5 and AN-Mk23); Bomb, 4.5 lb, miniature practice (AN-Mk43); Bomb, 100 lb practice (Mk 15 Mods 1, 2, 3, & 4); Cartridge, signal, bomb Mk 7; cartridge, signal, bomb Mk 4 Mod 0 (also Mod 1, 2, 3, & 4); Flare, Aircraft, Parachute, AN-M26, as detailed in Table 4.1. These munitions contain fuzes or explosives that might present a residual hazard. Based on this information and Table 6.2, the MEC Type at the Bombing Target MRS is assessed to be "Potentially Hazardous."

6.1.4.3 There are hundreds of houses and other inhabited structures within 2 miles of the Bombing Target MRS. A large portion of the site is on the St. Croix International Airport property. There are no known restrictions to access. Visitors to the MRS may include airport and airline employees and trespassers. The land use is not expected to change. Potential human receptors within the MRS would include commercial or industrial workers, site visitors, and recreational users. Based on this information, the Bombing Target MRS is considered "Accessible."

6.1.5 Munitions and Explosives of Concern Risk Assessment – Rifle Range Munitions Response Site

6.1.5.1 The Rifle Range MRS is composed of 1,259 acres (land and tidal water) and was used as a known distance rifle range from approximately 1940 until 1946. The rifle range was used for weapons familiarization and qualifications, and for function firing of weapons and ammunition. The only munitions associated with this MRS are .30 Caliber cartridges. No MD or MEC had been found on the site prior to this SI. The 2010 SVT found no MD, MEC, or evidence of the former range. Based on this information and Table 6.1, the presence of MEC at the Rifle Range MRS is assessed as "Small arms only."

6.1.5.2 Based on the PA (USACE, 2005a) and ASR Supplement (CEMVS, 2008), the munitions known or suspected to have been used at the Rifle Range MRS include only .30 Caliber cartridges, as detailed in Table 4.1. Based on this information and Table 6.2, the MEC Type at the Rifle Range MRS is assessed as "Small arms only."

6.1.5.3 There are hundreds of houses and other inhabited structures within 2 miles of the Rifle Range MRS. A large portion of the site is on the St. Croix International Airport property and a portion of the MRS is on a horseracing track. There are no known restrictions to access. Visitors to the MRS may include airport and airline employees, visitors and employees at the racetrack, and trespassers. The land use is not expected to change. Potential human receptors within the MRS would include commercial or industrial workers, site visitors, and recreational users. Based on this information, the Rifle Range MRS is considered "Accessible."

6.1.6 Risk Summary

6.1.6.1 The qualitative MEC risk evaluation for the Bombing Target and Rifle Range MRSs is summarized in Table 6.4.

Table 6.4
MEC Risk Evaluation
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	MEC Presence	MEC Type [1]		Site Accessibility	Further Evaluation?
Bombing Target MRS	Confirmed or Suspected	Flare, Aircraft, Parachute, AN-M26	Potentially Hazardous	Accessible	**Yes**
Rifle Range MRS	Evidence of no munitions	.30 Caliber cartridge	Small Arms Only	Accessible	**No**

[1] Where multiple MEC items were used at a MRS, *only* the item that poses the greatest risk to public health is listed for purposes of this risk assessment.

6.1.6.2 Based on this qualitative MEC risk evaluation, an explosive hazard may remain at the Bombing Target MRS and, therefore, an explosive safety risk is considered present at this range. The munitions known or suspected to have been used at this range contain explosives and fuzes which may present a residual explosive hazard if any remain on-site intact. There is no explosive hazard remaining at the Rifle Range MRS and no explosive safety risk; the only munitions known to have been used at this MRS are small arms.

6.2 MUNITIONS CONSTITUENT HUMAN HEALTH SCREENING LEVEL RISK ASSESSMENT

6.2.1 Conceptual Site Model

6.2.1.1 Based on the current and future land use of the Bombing Target MRS and the Rifle Range MRS, potential human receptors in both MRSs include commercial/industrial workers (for example, airport personnel), site visitors, and future construction workers. The land is owned by the airport, and land use is expected to remain the same. Site access is generally unrestricted. The MC CSEMs for the Bombing Target MRS and the Rifle Range MRS (Appendix J) identify affected media, transport mechanism, exposure routes, and potential receptors.

6.2.1.2 Human receptors at the Bombing Target MRS may be exposed to MC through direct contact with surface soil (incidental ingestion, dermal contact, and inhalation of resuspended soil particulates) or marine surface water and sediment (incidental ingestion and dermal contact). Air is indirectly evaluated using soil RSLs that include the inhalation pathway. Marine surface water and marine sediments were not sampled at the Bombing Target MRS. For this reason, the marine surface water and sediment exposure pathways were considered potentially complete, but not quantitatively assessed for potential human receptors and the potential risks cannot be evaluated for these media. Marine surface water would not be used as drinking water by humans. Because there is no perennial fresh water within the Bombing Target MRS, potential receptors would not be exposed to fresh surface water or sediment through ingestion as drinking water, incidental ingestion, or direct dermal contact. Groundwater use is suspected at the Bombing Target MRS, but groundwater wells could not be located during the site visit. Therefore, the groundwater pathways for human receptors are potentially complete but not quantitatively assessed for human receptors.

6.2.1.3 Human receptors at the Rifle Range MRS may be exposed to MC through direct contact with fresh surface water and sediment (incidental ingestion or dermal contact), or marine surface water and sediment (incidental ingestion and dermal contact) and surface soil (incidental ingestion, dermal contact, and inhalation of resuspended soil particulates). Air is indirectly evaluated using soil RSLs that include the inhalation pathway. Marine surface water and marine sediments were not sampled at the Rifle Range MRS. For this reason, the marine surface water and sediment exposure pathways were considered potentially complete, but not quantitatively assessed for potential human receptors and the potential risks cannot be evaluated for these media. Marine surface

water would not be used as drinking water by humans. There are no known groundwater wells within the MRS; therefore, the groundwater exposure pathways are incomplete for all human receptors.

6.2.2 Affected Media

6.2.2.1 Direct release of MC from munitions would have affected surface soil and marine surface water and sediment at the Bombing Target MRS. In addition to potential direct release of MC to surface soil because of the munitions-related activities, MC in the soil could migrate to groundwater or subsurface soils through leaching. MC in the surface soil can also become airborne in resuspended soil particulates. It is also possible that MC in surface soil could migrate to marine surface water and sediment through runoff and erosion at the Bombing Target MRS. There are no perennial sources of fresh surface water at the Bombing Target MRS. No groundwater, marine surface water, marine sediment, or air samples were collected at the Bombing Target MRS.

6.2.2.2 Direct release of MC from munitions would have affected surface soil and marine surface water and sediment at the Rifle Range MRS. In addition to potential direct release of MC to surface soil because of the munitions-related activities, MC in the soil could migrate to groundwater or subsurface soils through leaching; however, there are no known groundwater wells within this MRS. MC in the surface soil can also become airborne in resuspended soil particulates. It is also possible that MC in surface soil could migrate to fresh or marine surface water and sediment through runoff and erosion at the Rifle Range MRS. Neither groundwater nor air samples were collected at the Rifle Range MRS.

6.2.3 Human Health Screening Levels

The human health screening levels for soil and sediment consist of the USEPA RSLs for Chemical Contaminants at Superfund Sites for Residential Soil, updated in November 2010. The surface water screening values consist of the more stringent of the USEPA RSLs for Chemical Contaminants at Superfund Sites for Tap Water and FDEP FAC 62-777 Groundwater and Surface Water Cleanup Target Levels, Freshwater Surface Water Criteria and FAC 62-302 Surface Water Quality Standards (for Class III waters).

6.2.4 Risk Characterization

As discussed in subchapter 5.2.7, the source evaluation for MC is used to determine which analytes are retained for further consideration in a SLRA. To complete the human health risk characterization for soil, surface water, and sediment at each MRS, the maximum detected concentration of each analyte retained for consideration in Chapter 5 was compared to selected human health screening values as described above. For an analyte to be considered as a possible risk to human health, it would be necessary for the analyte to be present above the risk screening level.

6.2.5 Bombing Target Munitions Response Site

Six surface soil samples (plus one field duplicate sample) were collected from the Bombing Target MRS. As shown in Table 5.6, the maximum detected concentrations of antimony, copper, lead, and zinc exceeded the background concentrations. As shown in Table 6.5, the MC antimony, copper, lead, and zinc were detected at concentrations less than the selected human health screening values and, therefore, are not expected to pose a risk to human health risk.

Table 6.5
Bombing Target Munitions Response Site
Soil Human Health Screening Level Risk Assessment
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration	USEPA Regional Screening Level (RSL) (1)	Exceeds Screening Level?
Metals				
Antimony	mg/kg	0.17 J	31	No
Copper	mg/kg	51	3,100	No
Lead	mg/kg	100	400	No
Zinc	mg/kg	110	23,000	No

(1) - USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, Residential Soil, November 2010 (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_NOVEMBER2010.pdf).

Notes:

(NO CODE) - Confirmed identification.

J - Analyte detected, estimated concentration.

mg/kg - milligrams/kilogram

6.2.6 Rifle Range Munitions Response Site

6.2.6.1 One surface water/sediment couple (and one duplicate sample couple) was collected at the Rifle Range MRS. As shown in Table 5.7 (surface water) and Table 5.8 (sediment), the MC antimony, copper, lead, and zinc were detected. As shown in Table 6.6, antimony, copper, lead, and zinc were detected at concentrations less than their respective human health screening values for surface water. As shown in Table 6.7, antimony, copper, lead, and zinc were detected at concentrations less than their respective human health screening values for sediment.

6.2.6.2 Four surface soil samples (plus one field duplicate sample) were collected at the Rifle Range MRS. As shown in Table 5.9, the maximum detected concentrations of antimony, copper, and zinc exceeded their background concentrations. As shown in Table 6.8, the MC antimony, copper, and zinc were detected at concentrations less than the selected human health screening values and, therefore, are not expected to pose a risk to human health risk.

Table 6.6
Rifle Range Munitions Response Site
Surface Water Human Health Screening Level Risk Assessment
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration		Regional Screening Levels (RSLs) (1)	Exceeds Screening Level?
Metals					
Antimony	µg/L	1.1	J	15 (2)	No
Copper	µg/L	9.9	J	1,500 (2)	No
Lead	µg/L	2.8	J	15 (3)	No
Zinc	µg/L	12	J	11,000 (2)	No

(1) - More stringent of the USEPA RSLs for Chemical Contaminants at Superfund Sites for Tap Water and FDEP FAC 62-777 Groundwater and Surface Water Cleanup Target Levels, Freshwater Surface Water Criteria and FAC 62-302 Surface Water Quality Standards (for Class III waters).
(2) USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, November 2010 (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_NOVEMBER2010.pdf).
(3) - USEPA MCLs, National Primary Drinking Water Standards, 2006 (http://www.epa.gov/safewater/contaminants/index.html).

Notes:

(NO CODE) - Confirmed identification.

J - Analyte detected, estimated concentration.

µg/L - micrograms/liter

Table 6.7

Rifle Range Munitions Response Site

Sediment Human Health Screening Level Risk Assessment

Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration		USEPA Regional Screening Level (RSL) (1)	Exceeds Screening Level?
Metals					
Antimony	mg/kg	0.084	J	31	No
Copper	mg/kg	14		3,100	No
Lead	mg/kg	4.1		400	No
Zinc	mg/kg	22		23,000	No

(1) - USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, Residential Soil, November 2010 (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_NOVEMBER2010.pdf).

Notes:

(NO CODE) - Confirmed identification.

J - Analyte detected, estimated concentration.

mg/kg - milligrams/kilogram

Table 6.8

Rifle Range Munitions Response Site

Soil Human Health Screening Level Risk Assessment

Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration		USEPA Regional Screening Level (RSL) (1)	Exceeds Screening Level?
Metals					
Antimony	mg/kg	0.042	J	31	No
Copper	mg/kg	82		3,100	No
Zinc	mg/kg	60		23,000	No

(1) - USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, Residential Soil, November 2010 (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_NOVEMBER2010.pdf).

Notes:

(NO CODE) – Confirmed identification.

J - Analyte detected, estimated concentration.

mg/kg - milligrams/kilogram

6.2.7 Discussion

6.2.7.1 None of the human health screening values for surface soil were exceeded for the retained analytes for the Bombing Target MRS (Table 6.5). None of the human health screening values for fresh surface water, sediment, or surface soil were exceeded for the retained analytes for the Rifle Range MRS (Tables 6.6, 6.7, and 6.8, respectively). Therefore, based on the analytical results presented in this report, an unacceptable human health risk due to former munitions-related activities is not expected from exposure to surface soil at the Bombing Target MRS or exposure to fresh surface water, sediment or surface soil at the Rifle Range MRS.

6.2.7.2 Marine surface water and marine sediments were not sampled at the Bombing Target MRS or the Rifle Range MRS. For this reason, the marine surface water and sediment exposure pathways were considered potentially complete, but not quantitatively assessed for potential human receptors and the potential risks cannot be evaluated for these media. Potential human receptors could be exposed to MC in marine surface water and marine sediment through incidental ingestion and dermal contact. Marine surface water would not be used as drinking water by humans. While MC could have been released directly to marine surface water and sediment as a result of firing activities at the Bombing Target MRS and the Rifle Range MRS and indirectly via erosion and runoff at the two MRSs, the large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it unlikely that MC in marine surface water and sediment would pose a threat to human receptors at this site.

6.3 MUNITIONS CONSTITUENT SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

Using the criteria in the Army Checklist for Important Ecological Places (USACE, 2006), the Bombing Target MRS and the Rifle Range MRS are classified as important ecological places. This classification is made due to the MRSs containing marine wetlands and potentially containing T&E species within the MRS boundaries (Subchapter 5.2.5). Therefore, ecological receptors are potential receptors for exposure pathways at this site.

6.3.1 Conceptual Site Model

Because the MRSs are considered important ecological places, exposure of wildlife to MC could occur through direct exposure to contaminated soil at the Bombing Target MRS and the Rifle Range MRS through direct dermal contact, incidental ingestion, inhalation of particulates, and as well as through ingestion of other biota that have been exposed to MC. Wildlife may be exposed to MC through direct exposure to fresh surface water and sediment (Rifle Range MRS only) through ingestion as drinking water, incidental ingestion, or dermal contact. Further, wildlife may be exposed to MC through direct exposure to contaminated marine surface water and marine sediment at the Bombing Target MRS and the Rifle Range MRS. Marine surface water and marine sediments were not sampled at the site. For this reason, the marine surface water and

sediment exposure pathways were considered potentially complete, but not quantitatively assessed for potential ecological receptors and the potential ecological risks cannot be evaluated for these media. Because groundwater is not typically accessible to ecological receptors, the groundwater exposure pathways are incomplete for ecological receptors. The MC CSEM identifies affected media, transport mechanisms, exposure routes, and potential receptors. Individual CSEMs have been developed for the Bombing Target MRS and the Rifle Range MRS and are included in Appendix J.

6.3.2 Affected Media

6.3.2.1 Direct release of MC from munitions activities within the Bombing Target MRS would be primarily to surface soil and marine surface water and sediment. If releases of MC to surface soil because of munitions-related activities occur, MC could migrate to marine surface water and sediment through runoff and erosion. MC in the surface soil can also become airborne as resuspended soil particulates. No groundwater, marine surface water, marine sediment, or air samples were collected at the Bombing Target MRS.

6.3.2.2 Direct release of MC from munitions activities within the Rifle Range MRS would be to surface soil and marine surface water and marine sediment, and indirect release of MC at the Rifle Range MRS to fresh and marine surface water and sediment through erosion and runoff. MC in the surface soil can also become airborne as resuspended soil particulates. Neither groundwater nor air samples were collected at the Rifle Range MRS.

6.3.3 Ecological Screening Levels

6.3.3.1 The ecological screening values for surface soil consist of the USEPA EcoSSLs. The ESVs for sediment consist of USEPA Region 4 sediment ESVs. For surface water, the ESVs are the more stringent of the USEPA Region 4 ESVs for fresh surface water and USEPA Region 3 Ecological Screening Benchmarks for surface water. The screening levels used are noted in the Screening Level Ecological Risk Assessment (SLERA) tables below.

6.3.3.2 The ESVs are based on a number of conservative assumptions, including assumptions about the types of receptors present (e.g., insectivores, terrestrial mammals, etc.) and assumptions about exposure parameters such as soil ingestion rate and receptor range. Site-specific information was not used to develop these screening values. The use of site-specific information typically results in less conservative and higher screening values.

6.3.4 Ecological Risk Characterization

Subchapter 5.2.7 describes how the sample data for soil samples at the Benedict Field site were evaluated to determine whether analytes were present above background concentrations. Subchapter 5.2.7 also describes how the sample data for fresh surface water and sediment were evaluated to determine if MC metals were present. Only those

analytes retained for consideration in the SLRA following the source evaluation are evaluated in this chapter. To complete the ecological risk characterization for this site, the maximum detected concentration of each retained analyte was evaluated using the agreed upon screening levels (Subchapter 6.3.3). This comparison resulted in the calculation of a Hazard Quotient (HQ) for each analyte. The HQ was calculated by determining the ratio of the maximum detected site concentration to the screening value. If the HQ is equal to or less than 1, the potential for ecological risk for that receptor group is considered negligible. If the HQ is greater than 1, unacceptable ecological risks cannot be ruled out based on the screening comparison alone. HQs that are greater than 1 should be further evaluated to determine their significance.

6.3.5 Bombing Target Munitions Response Site

6.3.5.1 Six biased surface soil samples (plus one field duplicate sample) were collected from within the Bombing Target MRS. Antimony, copper, lead, and zinc were detected above background concentrations (Table 5.6) in surface soil. As shown in Table 6.9, antimony was detected at a concentration less than the selected ecological screening value, and the resulting HQ value for antimony is less than 1.

6.3.5.2 As shown in Table 5.6, the maximum detected concentrations of copper, lead, and zinc in surface soil exceeded the background concentrations. Copper, lead, and zinc were detected at maximum concentrations exceeding the selected ecological screening values, resulting in HQs greater than 1. The HQ for copper was 1.8; for lead was 9.1; and for zinc was 2.4. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper, lead, and zinc in the surface soil at the Bombing Target MRS. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 1.2; and zinc by a factor of 1.9; so, based on the limited background data set, these concentrations may be within the range of naturally occurring concentrations. However, the maximum detected concentration of lead in the biased samples exceeded the maximum ambient concentration by a factor of 6.3, and may pose a risk to ecological receptors at the site.

Table 6.9
Bombing Target Munitions Response Site
Soil Screening Level Ecological Risk Assessment
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration	USEPA Ecological Screening Values (ESVs) (1)	HQ
Metals				
Antimony	mg/kg	0.17 J	0.27	≤1
Copper	mg/kg	51	28	1.8
Lead	mg/kg	100	11	9.1
Zinc	mg/kg	110	46	2.4

(1) - USEPA Ecological Soil Screening Levels, May 2008 (http://www.epa.gov/ecotox/ecossl/).
Notes:
(NO CODE) - Confirmed identification.
J - Analyte detected, estimated concentration.
mg/kg - milligrams/kilogram

6.3.6 Rifle Range Munitions Response Site

6.3.6.1 One surface water/sediment couple (and one duplicate sample couple) was collected at the Rifle Range MRS. Antimony, copper, lead, and zinc were detected in fresh surface water and sediment samples (Tables 5.7 and 5.8, respectively).

6.3.6.2 As shown in Table 6.10, antimony and zinc were detected in fresh surface water at concentrations less than the selected ecological screening values, and the resulting HQ values for antimony and zinc are less than 1. However, the maximum detected concentrations of copper and lead exceeded their respective ecological screening values and the resulting HQ values were 1.5 for copper and 2.2 for lead. Therefore, based on the analytical results presented in this report, there is a potential risk to ecological receptors due to exposure to copper and lead in fresh surface water at the Rifle Range MRS. However, as stated earlier (Section 6.3.4), the ecological screening values used are conservative because they are not site-specific and are based on the most sensitive receptors and exposure parameters. Consequently, these marginal exceedances are not expected to present a high potential for ecological risk at this MRS.

6.3.6.3 As shown in Table 6.11, antimony, copper, lead, and zinc were detected in sediment samples at concentrations less than the selected ecological screening values, and the resulting HQ values for antimony, copper, lead, and zinc are less than 1. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to munitions-related activities is not expected due to exposure to sediment at the Rifle Range MRS.

Table 6.10
Rifle Range Munitions Response Site
Surface Water Screening Level Ecological Risk Assessment
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration		Ecological Screening Values (ESVs) (1)	HQ
Metals					
Antimony	µg/L	1.1	J	30 (2)	≤1
Copper	µg/L	9.9	J	6.5 (3)	1.5
Lead	µg/L	2.8	J	1.3 (3)	2.2
Zinc	µg/L	12	J	59 (3)	≤1

(1) The more stringent of the USEPA Region 4 Ecological Screening Values, November 30, 2001 (http://www.epa.gov/region04/waste/ots/ecolbul.htm#tbl2) and USEPA Region 3 Ecological Screening Benchmarks for Surface water, March 19, 2010 (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm)(http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/marine/screenbench.htm).

(2) USEPA Region 3 Ecological Screening Benchmarks for Surface water, March 19, 2010 (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm)

(3) USEPA Region 4 Ecological Screening Values, November 30, 2001 (http://www.epa.gov/region04/waste/ots/ecolbul.html#tbl1).

Notes:

(NO CODE) - Confirmed identification.

J - Analyte detected, estimated concentration.

µg/L - micrograms/liter

Table 6.11
Rifle Range Munitions Response Site
Sediment Screening Level Ecological Risk Assessment
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration	Ecological Screening Values (ESVs) (1)	HQ
Metals				
Antimony	mg/kg	0.084 J	12	≤1
Copper	mg/kg	14	19	≤1
Lead	mg/kg	4.1	30	≤1
Zinc	mg/kg	22	120	≤1

(1) - USEPA Region 4 Ecological Screening Values, November 30, 2001 (http://www.epa.gov/region04/waste/ots/ecolbul.html#tbl3).

Notes:
(NO CODE) - Confirmed identification.
J - Analyte detected, estimated concentration.
mg/kg - milligrams/kilogram

6.3.6.4 Four biased surface soil samples (plus one field duplicate sample) were collected from within the Rifle Range MRS. Antimony, copper, and zinc were detected above background concentrations (Table 5.9) in surface soil. As shown in Table 6.12, antimony was detected at a concentration less than the selected ecological screening value, and the resulting HQ value for antimony is less than 1.

6.3.6.5 As shown in Table 5.9, the maximum detected concentrations of copper and zinc in surface soil exceeded the background concentrations. Copper and zinc were detected at maximum concentrations exceeding the selected ecological screening values, resulting in HQs greater than 1. The HQ for copper was 2.9 and for zinc was 1.3. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper and zinc in the surface soil at the Rifle Range MRS. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 2; and zinc by a factor of 1.1; so, based on the limited background data set, these concentrations may be within the range of naturally occurring concentrations.

Table 6.12
Rifle Range Munitions Response Site
Soil Screening Level Ecological Risk Assessment
Benedict Field, St. Croix, U.S. Virgin Islands

Analyte	Units	Maximum Detected Site Concentration	Ecological Screening Values (ESVs) (1)	HQ
Metals				
Antimony	mg/kg	0.042 J	0.27	≤1
Copper	mg/kg	82	28	2.9
Zinc	mg/kg	60	46	1.3

(1) - USEPA Ecological Soil Screening Levels, May 2008 (http://www.epa.gov/ecotox/ecossl/).

Notes:
(NO CODE) - Confirmed identification.
J - Analyte detected, estimated concentration.
mg/kg - milligrams/kilogram

6.3.7 Discussion

6.3.7.1 The ecological screening values for copper, lead, and zinc in surface soil were exceeded for the Bombing Target MRS (Table 6.9), resulting in HQs of 1.8, 9.1, and 2.4, respectively. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper, lead, and zinc in the surface soil at the Bombing Target MRS. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 1.2; and zinc by a factor of 1.9; so, based on the limited background data set, these concentrations may be within the range of naturally occurring concentrations. However, the maximum detected concentration of lead in the biased samples exceeded the maximum ambient concentration by a factor of 6.25, and may pose a risk to ecological receptors at the site.

6.3.7.2 Copper and lead were detected in fresh surface water at the Rifle Range MRS at concentrations exceeding the selected ecological screening values (Table 6.10), resulting in HQ values of 1.5 and 2.2, respectively. Based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper and lead in the fresh surface water at the Rifle Range MRS. However, as stated earlier (Section 6.3.4), the ecological screening values used are conservative because they are not site-specific and are based on the most sensitive receptors and exposure parameters. Consequently, these marginal exceedances are not expected to present a high potential for ecological risk at this MRS.

6.3.7.3 Antimony, copper, lead, and zinc were detected in surface water/sediment sample couples at concentrations less than their ecological screening values (Table 6.11), resulting in HQ values of less than 1. Based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities is not expected for exposure of ecological receptors to surface water and sediment at the Rifle Range MRS.

6.3.7.4 For the surface soil samples, the ecological screening values for copper and zinc were exceeded for the Rifle Range MRS (Table 6.12), resulting in HQ values of 2.9 and 1.3, respectively. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper and zinc in the surface soil at the Rifle Range MRS. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 2; and zinc by a factor of 1.1; so, based on the limited background data set, these concentrations may be within the range of naturally occurring concentrations.

6.3.7.5 No groundwater, marine surface water, marine sediment, or air samples were collected during this SI at the Bombing Target MRS or the Rifle Range MRS. Therefore, these pathways are considered potentially complete but not quantitatively assessed and were not directly evaluated in the SLERA. Marine surface water could be used as drinking water by marine species. Potential ecological receptors could also be exposed to MC in the marine surface water and marine sediment through incidental ingestion and dermal contact. While MC could have been released directly to marine surface water and sediment as a result of munitions activities at the Bombing Target MRS and the Rifle Range MRS and indirectly via runoff or erosion at the two MRSs, the large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it unlikely that MC in marine surface water and sediment would pose a threat to ecological receptors at this site.

CHAPTER 7
SUMMARY AND CONCLUSIONS

7.1 SUMMARY

7.1.1 The Bombing Target and Rifle Range MRSs at the Benedict Field FUDS were identified and evaluated to determine if historic military training use had affected the FUDS and subsequently presented a potential to cause significant contamination to the environment or adversely affect human and ecological receptors. The evaluation included the collection of surface soil, surface fresh water and sediment samples, as well as the implementation of QR within the accessible land areas of the Bombing Target and Rifle Range MRSs. The SI Team did not collect groundwater, marine surface water, marine sediment, and air samples during the SI.

7.1.2 The SVT completed approximately 5 miles of QR during the site visit conducted between June 21 and 23, 2010. No UXO was found; however, a nose cone from an Mk 15 100 lb practice bomb was found within the Bombing Target MRS. No other munitions-related features, such as target remnants, were visually identified; however, vegetative growth was dense resulting in alteration of the QR path during the site visit.

7.1.3 Surface soil samples were collected from six locations within the Bombing Target MRS and four locations within the Rifle Range MRS, selected to represent areas with the highest likelihood for the presence of MEC or MC that were accessible by the SVT. Two field duplicate surface soil samples and two ambient surface soil samples were also collected. One surface fresh water/sediment sample couple and an associated field duplicate were collected from downrange land within the Rifle Range MRS. No surface water sources were identified that would serve as an ambient surface water/sediment source. The samples were analyzed for explosives, antimony, copper, lead, and zinc.

7.1.4 No explosives were detected in any sample medium from either MRS. The analytical results for the surface soil samples collected from the Bombing Target MRS during the SI are presented in Table 5.4. These results were evaluated using the criteria described in Subchapter 5.2.7. No explosives were detected in the surface soil samples, so this evaluation was performed for metals only. As shown in Table 5.6, antimony, copper, lead, and zinc were detected at concentrations greater than background concentrations in soil samples collected from this MRS. These analytes were retained for further evaluation in the SLRA. The analytical results for the surface soil samples collected from the Rifle Range MRS during the SI are presented in Table 5.4. These results were evaluated using the criteria described in Subchapter 5.2.7. No explosives were detected in the surface soil samples, so this evaluation was performed for metals

only. As shown in Table 5.9, antimony, copper, and zinc were detected at concentrations greater than background concentrations in soil samples collected from this MRS. These analytes were retained for further evaluation in the SLRA.

7.2 CONCLUSIONS REGARDING POTENTIAL MUNITIONS AND EXPLOSIVES OF CONCERN EXPOSURE PATHWAYS

7.2.1 An MEC Screening Level Risk Assessment was conducted based on the QR conducted in the field and historical data regarding previous site visits and removal actions (Chapter 6). No MEC was found at either MRS during the 2010 SI field effort; however, a nose cone from an Mk 15 100 lb practice bomb was found within the Bombing Target MRS. No MD or other range features were identified within the Rifle Range MRS. Based on the PA (USACE, 2005a) and ASR Supplement (CEMVS, 2008), the munitions known or suspected to have been used at the Bombing Target MRS include the following: Bomb, 3-lb, miniature practice (AN-Mk5 and AN-Mk23); Bomb, 4.5-lb, miniature practice (AN-Mk43); Bomb, 100-lb practice (Mk 15 Mods 1, 2, 3, & 4); Cartridge, signal, bomb Mk 7; cartridge, signal, bomb Mk 4 Mod 0 (also Mod 1, 2, 3, & 4); Flare, Aircraft, Parachute, AN-M26, as detailed in Table 4.1. These munitions contain fuzes or explosives that might present a residual hazard if any remain on-site. The munitions known or suspected to have been used at the Rifle Range MRS include only .30 Caliber cartridges.

7.2.2 There are hundreds of houses and other inhabited structures within 2 miles of both MRSs. A large portion of the site is on the St. Croix International Airport property and a portion of a horse race track is on the Rifle Range MRS. There are no significant access restrictions. Based on these findings, the known use of the MRS for bombing activities, and the potential for MEC to remain within the MRS, ***the MEC exposure pathway for the Bombing Target MRS is complete.*** There is no explosive hazard remaining at the Rifle Range MRS and no explosive safety risk; the only munitions known to have been used at this MRS are small arms. Based on this, ***the MEC exposure pathway for the Rifle Range MRS is not complete.***

7.3 CONCLUSIONS REGARDING POTENTIAL MUNITIONS CONSTITUENTS EXPOSURE PATHWAYS

7.3.1 An exposure pathway is not completed unless all four of the following elements are present (USEPA, 1989):

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

7.3.2 Bombing Target MRS. Groundwater sampling was not performed at the Bombing Target MRS during the SI because reported water wells could not be located due to the dense undergrowth. Due to reported historic groundwater use within the MRS, the groundwater exposure pathways for humans are potentially complete but not quantitatively assessed for future construction workers at the Bombing Target MRS. There is no groundwater exposure pathway for ecological receptors. The marine surface

water and sediments were not sampled at the Bombing Target MRS during this SI; therefore, the marine surface water and sediment pathways are potentially complete, but not quantitatively assessed. While MC could have been released directly to marine surface water and sediment as a result of firing activities at the Bombing Target MRS and indirectly via erosion and runoff at the MRS, the large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it unlikely that MC in marine surface water and sediment would pose a threat to human receptors at this site. The MC metals antimony, copper, lead, and zinc were detected in surface soils above their selected background levels. The human health and ecological exposure pathways for surface soils are complete at this MRS, with the exception of the ecological inhalation pathway that is considered potentially complete, but not quantitatively assessed. As shown in Table 6.5, the MC metals antimony, copper, lead, and zinc were detected at concentrations less than the selected human health screening values and, therefore, are not expected to pose a risk to human health risk. ***An unacceptable human health risk is not expected from exposure to MC in the surface soil at the Bombing Target MRS.***

7.3.3 Surface soil samples collected at the Bombing Target MRS have copper, lead, and zinc detected with maximum concentrations of each exceeding the selected ecological screening values, resulting in HQs greater than one. As shown in Table 6.9, the HQ for copper was 1.8; for lead was 9.1; and for zinc was 2.4. Therefore, based on the analytical results presented in this report, an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper, lead, and zinc in the surface soil at the Bombing Target MRS. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 1.2 and zinc by a factor of 1.9; so, based on the limited background data set, *these concentrations may be within the range of naturally occurring concentrations.* However, the maximum detected concentration of *lead in the biased samples exceeded the maximum ambient concentration by a factor of 6.3, and may pose a risk to ecological receptors* at the site. ***An unacceptable ecological risk is possible from exposure to lead in the surface soil at the Bombing Target MRS***. ***An unacceptable ecological risk from exposure to copper and zinc may exist, but may also be within the range of naturally occurring concentrations of each MC metal at the Bombing Target MRS.***

7.3.4 Rifle Range MRS. Groundwater sampling was not performed at the Rifle Range MRS during the SI. No known groundwater wells are reported to exist within the Rifle Range MRS. The groundwater exposure pathways for humans are incomplete for construction workers, visitors, ecological receptors, and future construction workers at the Rifle Range MRS. The marine surface water and sediments were not sampled at the Rifle Range MRS during this SI; therefore, the marine surface water and sediment pathways are potentially complete, but not quantitatively assessed. While MC could have been released directly to marine surface water and sediment as a result of firing activities at the Rifle Range MRS and indirectly via erosion and runoff at the MRS, the large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it unlikely that MC in marine surface water and sediment would pose a

threat to human receptors at this site. Fresh water surface water, fresh water sediment, and surface soil samples were collected from the Rifle Range MRS during the SI. As shown in Table 6.6, antimony, copper, lead, and zinc were detected at concentrations less than their respective human health screening values for surface water. As shown in Table 6.7, antimony, copper, lead, and zinc were detected at concentrations less than their respective human health screening values for sediment. As shown in Table 6.8, the MC antimony, copper, and zinc (lead was detected below its selected background level for soil) were detected at concentrations less than the selected human health screening values for soil, therefore, are not expected to pose a risk to human health risk. ***An unacceptable human health risk is not expected from exposure to MC in the surface soil at the Rifle Range MRS.***

7.3.5 Copper and lead were detected in fresh surface water at the Rifle Range MRS at concentrations exceeding the selected ecological screening values (Table 6.10), resulting in HQ values of 1.5 and 2.2, respectively. Based on the analytical results presented in this report, ***an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper and lead in the fresh surface water at the Rifle Range MRS.*** However, *these marginal exceedances are not expected to present a high potential for ecological risk at this MRS.* Antimony, copper, lead, and zinc were detected in sediment samples at concentrations less than their ecological screening values (Table 6.11), resulting in HQ values of less than 1. Based on the analytical results presented in this report, ***an unacceptable ecological risk due to former munitions-related activities is not expected from exposure of ecological receptors to fresh water sediment at the Rifle Range MRS***. The ecological screening values for copper and zinc in soil were exceeded for the Rifle Range MRS (Table 6.12), resulting in HQ values of 2.9 and 1.3, respectively. Therefore, based on the analytical results presented in this report, ***an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper and zinc in the surface soil at the Rifle Range MRS***. However, the maximum detected concentration of copper in the biased samples only exceeded the maximum ambient concentration by a factor of 2; and zinc by a factor of 1.1; so, based on the limited background data set, these concentrations may be within the range of naturally occurring concentrations.

7.4 OVERALL CONCLUSIONS

7.4.1 The munitions known or suspected to have been fired at the Bombing Target MRS contain fuzes and explosives that might present a residual explosive hazard. MD was found on-site during the 2010 SI field visit. ***The MEC exposure pathway is considered complete at the Bombing Target MRS because an explosive safety hazard may remain at this MRS. The MEC exposure pathway for the Rifle Range MRS is not complete because of a lack of an explosive hazard.***

7.4.2 Bombing Target MRS. Although a complete surface soil exposure pathway was identified for the Bombing Target MRS, ***this MRS is not expected to represent a risk to human receptors with regard to MC,*** because the maximum detected concentrations of MC detected in soil did not exceed the human health screening values. The ecological screening values for copper, lead, and zinc in surface soil were exceeded for the Bombing Target MRS. Therefore, based on the analytical results presented in this

report, ***an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper, lead, and zinc in the surface soil at the Bombing Target MRS***.

7.4.3 Rifle Range MRS. Although complete the surface soil and the surface fresh water and sediment exposure pathways were identified for the Rifle Range MRS, ***this MRS is not expected to represent a risk to human receptors with regard to MC,*** because the maximum detected concentrations of MC detected in these media did not exceed the human health screening values. The ecological screening values for copper and lead in fresh water surface water; and, for copper and zinc in surface soil were exceeded for the Rifle Range MRS. Therefore, based on the analytical results presented in this report, ***an unacceptable ecological risk due to former munitions-related activities may be present from exposure to copper, lead, and zinc in the surface soil and fresh water surface water at the Rifle Range MRS***.

7.4.4 Although the marine surface water and sediment exposure pathways are potentially complete, but not quantitatively assessed for the both MRSs, ***neither MRS is expected to represent a risk to human or ecological receptors with regard to MC in marine waters.*** The large volume of marine water compared to the mass of MC that could have been released, as well as the amount of time that has passed since munitions activities were conducted at this site, make it unlikely that MC in marine surface water or sediment would pose a threat to human or ecological receptors at this site. However, this was not quantitatively assessed during the SI and there may be localized areas of MEC/MD within the marine water areas of the MRS that could release MC to the surface water and sediment via degradation or leaching of remaining munitions, if present.

Table 7.1
Risk Summary

Receptor/Media	Bombing Target MRS Possible Risk (Yes/No)	Rifle Range MRS Possible Risk (Yes/No)
Human		
Marine Surface Water	Not expected	Not expected
Marine Sediment	Not expected	Not expected
Fresh Surface Water	N/A	No
Fresh water Sediment	N/A	No
Soil	No	No
Ecological		
Marine Surface Water	Not expected	Not expected
Marine Sediment	Not expected	Not expected
Fresh Surface Water	N/A	Yes (Copper, Lead)
Fresh water Sediment	N/A	No
Soil	Yes (Copper, Lead, Zinc)	Yes (Copper, Zinc)

N/A: Not applicable, no source available.

CHAPTER 8
RECOMMENDATIONS

Based on the June 2010 SI field effort, the analytical results, and the historical record review, the Bombing Target MRS at the Benedict Field FUDS is recommended for RI/FS and the Rifle Range MRS is recommended for NDAI (Table 8.1). ***Immediate munitions removal actions are not warranted at this time.*** Further sampling may be warranted for the Bombing Range MRS. The RI/FS recommendation is based on the following:

- MD indicative of the potential for additional MEC was observed on the Bombing Target MRS during the site visit for the SI in June 2010. Based on the qualitative MEC risk evaluation, there is a possibility that human receptors might come into contact with explosively hazardous MEC at the Bombing Target MRS; therefore, ***there is the potential for an explosive safety risk at this MRS.*** The MRS is accessible to ecological and human receptors.
- ***An unacceptable ecological risk is possible from exposure to lead in the surface soil at the Bombing Target MRS. An unacceptable ecological risk from exposure to copper and zinc may exist, <u>but may also be within the range of naturally occurring concentrations of each MC metal</u>*** at the Bombing Target MRS. Further surface soil sampling may be warranted to confirm and define any potential impact from munitions at this MRS.

Table 8.1
Recommendations
Benedict Field, St. Croix, U.S. Virgin Islands

MRS	Acreage	Munitions and Explosive of Concern and/or Munitions Debris Assessment (1)	Munitions Constituents Assessment (2)	Recommendation
Bombing Target MRS	649	***Yes*** USACE documents issued since site closing and MD found during the June 2010 site visit confirm the use of the site as a bombing range. Munitions known to have been used at the MRS include practice bombs and flares.	***Yes*** Copper, lead, and zinc in surface soils exceed the ecological risk levels, although the copper and zinc levels are only slightly above the related risk value. No MC exceed their respective human health risk screening values.	***RI/FS*** Additional MC sampling may be warranted during a RI/FS
Rifle Range MRS	1259	***No*** This MRS was used with small arms only and MEC Presence is noted as "Evidence of no munitions."	***Yes*** Copper and zinc exceed ecological risk levels for surface soil. Copper and lead exceed ecological risk levels for fresh surface water. Each of these exceedances is only slightly above the risk level. No MC exceeded their respective human health risk screening value.	NDAI There are no MC data that exceed human health risk screening values. MC only slightly exceed the ecological risk values and the concentrations could be within the range of naturally occurring concentrations.

Notes:
(1) "Yes" in this column indicates confirmed MEC or MD presence indicative of potential MEC presence, resulting in a RI/FS recommendation for the MRS. "No" in this column indicates no confirmed MEC or MD indicative of potential MEC presence.
(2) "Yes" in this column indicates the presence of MC presence at levels indicating a potential elevated risk to human health or ecological receptors, resulting in a recommendation for further MC sampling during a RI/FS. "No" in this column of the table indicates the absence of MC at levels indicating a potential risk to human health or ecological receptors, resulting in a recommendation for no further MC sampling for the MRS.

CHAPTER 9
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