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Final

Master Sampling and Analysis Plan
East Vieques Terrestrial UXO Sites
Former Vieques Naval Training Range
Vieques, Puerto Rico

Prepared for

Department of the Navy
ATLANTIC

1000

Contract No.
N62470-08-D-1000
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January 2013

Prepared by

CH2MHILL®

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Master Sampling and Analysis Plan
East Vieques Terrestrial UXO Sites

Former Vieques Naval Training Range
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Contract Task Order 037

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Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Under the

LANTDIV CLEAN 1000 Program
Contract N62470-08-D-1000

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Executive Summary

This Sampling and Analysis Plan (SAP) is prepared to support the field sampling activities at 15 individual Munitions Response (MR) Sites, at the former Vieques Naval Training Range (VNTR) located in the eastern portion of Vieques, Puerto Rico (**Figure 1**). Field activities will be implemented through two separate, but related investigations – one focusing on munitions and explosives of concern (MEC) and one focusing on chemical contaminants in the various environmental media associated with each site. This SAP provides a background on the munitions characterization activities currently being implemented under separate work plans and the proposed future munitions activities.

This SAP includes 37 worksheets that detail various aspects of the investigation process and serves as a guideline for the field activities and data assessment. This SAP was developed in general accordance with two guidance documents: 1) U.S. Environmental Protection Agency (USEPA), *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (USEPA, 2002), and 2) USEPA, *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP) (Intergovernmental Data Quality Task Force, 2005).

This SAP was prepared under the United States Navy (Navy) Comprehensive Long-Term Environmental Action (CLEAN) Contract N62470-08-D-1000, Contract Task Order 0037, for submittal to the Naval Facilities Engineering Command (NAVFAC) Atlantic Division, USEPA Region 2, the Commonwealth of Puerto Rico Environmental Quality Board (EQB), and the United States Fish and Wildlife Service (USFWS). The Navy, USEPA, EQB, and USFWS work jointly as the Vieques Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Environmental Restoration Program (ERP) Technical Subcommittee.

The former VNTR comprises approximately 14,573 acres, which provided ground warfare and amphibious training for Marines, naval gunfire support training, and air to ground training. The former VNTR was divided into four separate operational areas, which comprised from west to east: the Eastern Maneuver Area (EMA), the Surface Impact Area (SIA), the Live Impact Area (LIA), and the Eastern Conservation Area (ECA) (**Figure 2**).

In total, there are 18 MR Sites on the former VNTR that include (**Figure 2**):

- UXO 1 (ECA)
- UXO 2 (LIA Beaches)
- UXO 3 (LIA Roads)
- UXO 4 (LIA Interior)
- UXO 5 (SIA Restricted Roads)
- UXO 6 (EMA/SIA Public Roads)
- UXO 7 (EMA/SIA North Beaches)
- UXO 8 (SIA South Beaches)
- UXO 9 (SIA Exterior)
- UXO 10 (SIA Interior)
- UXO 11 (EMA Public Roads)
- UXO 12 (EMA Interior)
- UXO 13 (EMA West)
- UXO 14 (EMA South)
- UXO 15 (Puerto Ferro)
- UXO 16 (Underwater Areas)
- UXO 17 (Other Sites)
- UXO 18 (Cayo la Chiva)

UXOs 1 (ECA), 15 (Puerto Ferro), and 16 (Underwater Areas) have been or are being evaluated separately and are not included in this SAP. In addition, the submunitions area in the LIA is not part of this SAP, but may be included in the future via an addendum.

The environmental investigation will include the characterization of surface and subsurface soil, sediment, surface water, and groundwater. Surface soil sampling will be conducted using the incremental sampling strategy and

approach in general accordance with the guidance document prepared by the US Army Corps of Engineers (USACE) titled *Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program* (USACE, 2009). Due to the large size of the MR Sites within the former VNTR and random distribution of MEC (and associated releases) on the ground surface, incremental sampling of the surface soil will improve the reliability of sampling data by reducing the variability inherent to discrete sampling strategies. Deeper surface soil, subsurface soil, sediment, surface water, and groundwater samples will be collected as discrete samples in accordance with the Master Standard Operating Procedures, Protocols, and Plans (denoted as the Master Plans in this SAP) for the Environmental Restoration Program at Vieques (CH2M HILL, 2010b).

This SAP will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and suitable for the intended uses (i.e., environmental characterization, human health and ecological risk assessments, and path forward). Because this SAP applies to multiple sites that will be investigated over multiple years, this SAP does not identify a specific laboratory but instead includes the protocols that the laboratory selected will be expected to meet. Following the laboratory procurement for a specific site, but prior to mobilization, the applicable laboratory-specific chemistry-related worksheets will be provided to the Vieques Environmental Restoration Subcommittee to show that the laboratory adheres to the protocols or, as applicable, will provide the rationale for any deviation and an explanation for how the SAP objectives can still be met.

Resumen Ejecutivo

Se ha preparado este Plan de Muestreo y Análisis (SAP por sus siglas en inglés) para apoyar las actividades de muestreo de campo en 15 Sitios de Respuesta a Municiones (MR por sus siglas en inglés) individuales, en el antiguo Campo de Adiestramiento Naval de Vieques (VNTR por sus siglas en inglés) ubicados en la porción este de Vieques, Puerto Rico (**Figura 1**). Las actividades de campo serán implementadas a través de dos investigaciones separadas pero relacionadas – la primera para atender las municiones y explosivos de preocupación (MEC por sus siglas en inglés) y la otra para atender los contaminantes químicos en varios medios ambientales relacionados con cada sitio. Este SAP provee los antecedentes de las actividades de caracterización de municiones que actualmente se están implementando siguiendo planes de trabajo individuales y de las actividades relacionadas a municiones futuras propuestas.

Este SAP incluye 37 hojas de trabajo que presentan los detalles de varios aspectos del proceso de investigación y sirve como una guía para las actividades de campo y la evaluación de los datos. Este SAP fue desarrollado siguiendo las pautas generales de dos documentos guía: 1) Agencia de Protección Ambiental de los EE.UU (USEPA por sus siglas en inglés), *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (USEPA, 2002), y 2) USEPA, *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP) (Intergovernmental Data Quality Task Force, 2005).

Este SAP fue preparado bajo el Contrato de la Marina de los Estados Unidos (Marina) de Acción Ambiental a Largo Plazo (CLEAN por sus siglas en inglés) N62470-08-D-1000, Orden de Trabajo 0037, para ser sometido al Comando de Ingeniería de Instalaciones Navales de la División del Atlántico (NAVFAC por sus siglas en inglés), USEPA Región 2, la Junta de Calidad Ambiental de Puerto Rico (JCA), y el Servicio de Pesca y Vida Silvestre de los Estados Unidos (USFWS por sus siglas en inglés). La Marina, USEPA, la JCA, y USFWS trabajan conjuntamente en el Subcomité Técnico del Programa de Restauración Ambiental (ERP por sus siglas en inglés) siguiendo la Ley de Respuesta, Compensación y Responsabilidad Ambiental (CERCLA por sus siglas en inglés).

El antiguo VNTR se compone de aproximadamente 14,573 acres; y fue utilizado para adiestramientos de con armas de guerra y prácticas anfibias de la Infantería de Marina, adiestramiento de apoyo con armas navales, y adiestramiento de aire a tierra. El antiguo VNTR fue dividido en cuatro áreas operativas separadas, que incluyen de oeste a este: Área de Maniobras del Este (EMA por sus siglas en inglés), Área de Impacto de Superficie (SIA por sus siglas en inglés), Área de Impacto con Bala Viva (LIA por sus siglas en inglés), y el Área de Conservación del Este (ECA por sus siglas en inglés) (**Figura 2**).

En total, dentro del VNTR se encuentran 18 sitios MR Sitios que incluyen (**Figure 2**):

- UXO 1 (ECA)
- UXO 2 (Playas del LIA)
- UXO 3 (Caminos del LIA)
- UXO 4 (Interior del LIA)
- UXO 5 (Caminos Restringidos en el SIA)
- UXO 6 (Caminos Públicos en el EMA/SIA)
- UXO 7 (Playas del norte en el EMA/SIA)
- UXO 8 (Playas del sur en el SIA)
- UXO 9 (Exterior del SIA)
- UXO 10 (Interior del SIA)
- UXO 11 (Caminos Públicos en el EMA)
- UXO 12 (Interior del EMA)
- UXO 13 (Oeste del EMA)
- UXO 14 (Sur del EMA)
- UXO 15 (Puerto Ferro)
- UXO 16 (Áreas Bajo el Agua)
- UXO 17 (Otros Sitios)

- UXO 18 (Cayo la Chiva)

Los Sitios UXOs 1 (ECA), 15 (Puerto Ferro), y 16 (Áreas Bajo el Agua) han sido o están siendo evaluadas por separado y no se incluyen en este SAP. El área de sub-municiones en el LIA tampoco es parte de este SAP, pero puede que sea incluida en el futuro a través de un apéndice.

La investigación ambiental incluirá la caracterización de suelo superficial, subsuelos, sedimentos, agua superficial, y agua subterránea. El muestreo de suelo superficial se llevará a cabo usando la estrategia y enfoque de un muestreo en incrementos siguiendo en general un documento guía preparado por el Cuerpo de Ingenieros del Ejército (USACE por sus siglas en inglés) titulado *Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program* (USACE, 2009). Debido al gran tamaño de los sitios MRS dentro del antiguo VNTR y la distribución al azar de los MEC (y derrames relacionados) sobre la superficie, un muestreo en incrementos del suelo superficial aumentará la fidelidad de los datos de muestreo al reducir la variabilidad intrínseca de las estrategias de muestreo discretas. Se obtendrán muestras de suelo superficial a una mayor profundidad, de subsuelos, agua superficial, y agua subterránea como muestras discretas siguiendo los Procedimientos Operativos, Protocolos y Planes Estándares Maestros (denominados Planes Maestros en este SAP) para el Programa de Restauración Ambiental de Vieques (CH2M HILL, 2010b).

Este SAP ayudará a asegurar que los datos obtenidos o recopilados sean científicamente válidos, de calidad conocida y documentada, y adecuado para los usos previstos (como son: caracterización ambiental, evaluación de los riesgos a la salud humana y ecológica, y para los pasos siguientes). Debido a que este SAP aplica a muchos sitios que serán investigados durante varios años, este SAP no identifica un laboratorio específico sino que incluye los protocolos que se espera el laboratorio seleccionado cumpla. Después de que se contrate a un laboratorio para un sitio específico, pero antes de iniciar la movilización, se distribuirán las hojas de trabajo relacionadas a la química del laboratorio específico que apliquen al Subcomité de Restauración Ambiental de Vieques para demostrar que este laboratorio se adhiere a los protocolos, o según aplique, se proveerá el razonamiento que explique cualquier desviación y como todavía es posible alcanzar los objetivos del SAP.

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D Standard Operating Procedures (SOPs)
E Final Responses to EPA, PREQB, and FWS Comments

Acronyms and Abbreviations

AMS	aerial magnetometer survey
AOC	Area of Concern
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
CA	corrective action
CCB	continuing calibration blank
CCP	Comprehensive Conservation Plan
CCV	Continuing Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action—Navy
CLP	Contract Laboratory Program
COC	chain of custody
COPCs	constituents of potential concern
CPC	Central Processing Center
CSM	Conceptual Site Model
CTO	Contract Task Order
DGM	digital geophysical mapping
DLs	detection limits
DMM	discarded military munitions
DO	dissolved oxygen
DoD	U.S. Department of Defense
DOI	Department of the Interior
°C	degrees Celsius
DQE	data quality evaluation
DQI	data quality indicator
DU	depleted uranium
e.g.	exempli gratia (for example)
EADA	elevated anomaly density area
EBS	Environmental Baseline Survey
ECA	Eastern Conservation Area
EIS	Environmental Impact Statement
EMA	Eastern Maneuver Area
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
EQB	Environmental Quality Board
ERA	Ecological Risk Assessment
ERA/SI	Expanded Range Assessment/Site Inspection
ERP	Environmental Restoration Program
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	foot/feet
FTL	Field Team Leader
FWS	Fish and Wildlife Service
GIS	geographic information system
GP	gun position

GPS	Global Positioning System
GW	Groundwater
H&S	Health & Safety
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
i.e.	id est (that is)
ICAL	Initial Calibration
ICP	inductively coupled plasma
ICS	Interference Check Solutions
ICV	initial calibration verification
IDW	investigation-derived waste
IR	Navy Installation Restoration
IS	Internal Standards
IS	incremental sampling
LCS	laboratory control sample
LIA	Live Impact Area
LiDAR	light detection and radar
LIMS	Laboratory Information Management Systems
LOD	limit of detection
LOQ	limit of quantitation
MC	munitions constituent
MCL	maximum contaminant level
MD	munitions debris
MEC	munitions and explosives of concern
MEC HA	munitions and explosives of concern hazard assessment
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL/min	milliliters per minute
µg/kg	micrograms per kilogram
mm	millimeter(s)
MOV	Municipality of Vieques
MPC	Measurement Performance Criteria
MPPEH	Material Potentially Presenting an Explosive Hazard
MR	munitions response
MRP	Munitions Response Program
MSA	method of standard additions
msl	mean sea level
MSOPPPs	Master Standard Operating Procedures, Protocols, and Plans
MS/MSD	matrix spike/matrix spike duplicate
mV	milliVolts
MW	monitoring well
N/A	not applicable
NASD	Naval Ammunition Support Detachment
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NIRIS	Navy Installation Restoration Information System
NOAA	National Oceanic and Atmospheric Administration

NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NTCRA	Non-Time-Critical Removal Action
NTU	Nephelometric Turbidity Unit
OB	open burn
OB/OD	open burn/open detonation
O&M	Operation and Maintenance
OP	observation post
ORP	oxidation-reduction potential
OU	operable unit
PA/SI	Preliminary Assessment/Site Inspection
PAHs	polycyclic aromatic hydrocarbons
PAL	project action limit
PAOC	potential area of concern
PCBs	polychlorinated biphenyls
PDF	portable document format
PDM	project data manager
pH	potential of hydrogen
PI	photo identified
PID	photoionization detector
PM	Project Manager
POC	Point of Contact
PQL	practical quantitation limit
PRA	Preliminary Range Assessment
PRCT	Puerto Rico Conservation Trust
PREQB	Puerto Rico Environmental Quality Board
PRWQS	Puerto Rico Water Quality Standards
QA	quality assurance
QA/QC	quality assurance/quality control
QAMS	Quality Assurance Management Section
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RRD	range-related debris
RRT	relative retention times
RSD	relative standard deviation
RSL	Regional Screening Levels
SAM	surface-to-air missile
SAP	Sampling and Analysis Plan
SAW	squad automatic weapon
SD	sediment

SI	Site Inspection
SIA	Surface Impact Area
SMI	Multi-Incremental Sampling
SMP	Site Management Plan
SOP	standard operating procedure
SSA	site screening area
SSC	Site Safety Coordinator
SUXOS	senior UXO supervisor
SVOC	semivolatile organic compounds
SW	surface water
SWMU	Solid Waste Management Unit
TBD	to be determined
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-Critical Removal Action
TOC	Total organic carbon
U.S.	United States
UCL	upper confidence limit
UFP	Uniform Federal Policy
UFP -QAPP	Uniform Federal Policy-Quality Assurance Project Plans
USACE	US Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UTLs	upper tolerance limits
UXO	Unexploded Ordnance
UXOSO	UXO Safety Officer
VNTR	Vieques Naval Training Range
VOC	volatile organic compound
WCHEM	wet chemistry

SAP Worksheet #1 — Title and Approval Page

Final
Master Sampling and Analysis Plan
East Vieques Terrestrial UXO Sites
Former Vieques Naval Training Range
Vieques, Puerto Rico
January 2013

Prepared for:
Department of the Navy
Naval Facilities Engineering Command
Atlantic Division
6506 Hampton Boulevard
Norfolk, VA 23508-1278

Prepared by:
CH2MHILL
5700 Cleveland Street, Suite 101
Virginia Beach, VA 23462
Office phone # 757-671-6219

Prepared under:
Navy CLEAN Program
Contract N62470-08-D-1000
Contract Task Order – 0037

QA REVIEW SIGNATURE:

G. Brett Doerr
Digitally signed by G. Brett Doerr
DN: cn=G. Brett Doerr, o=CH2M HILL, ou, email=brett.doerr@ch2m.com, c=US
Date: 2013.01.15 09:49:00 -05'00'

Brett Doerr
Vieques Activity Manager

OTHER APPROVAL SIGNATURES:

CLOE.KEVIN.R.1229533947
Digitally signed by CLOE.KEVIN.R.1229533947
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN, cn=CLOE.KEVIN.R.1229533947
Date: 2013.01.15 09:58:47 -05'00'

Kevin Cloe
NAVFAC – Remedial Project Manager

Daniel Rodriguez
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Date: 2013.01.22 11:28:57 -04'00'

Daniel Rodriguez
USEPA Region 2 – Remedial Project Manager

Wilmarie Rivera
Digitally signed by Wilmarie Rivera
DN: cn=Wilmarie Rivera, o, ou=Puerto Rico Environmental Quality Board, email=wilmarierivera@jca.gobierno.pr, c=US
Date: 2013.01.24 09:42:49 -04'00'

Wilmarie Rivera
PREQB – Remedial Project Manager

Richard Henry
Digitally signed by Richard Henry
DN: cn=Richard Henry, o=Department of Interior, ou=US Fish and Wildlife, email=richard_henry@fws.gov, c=US
Date: 2013.01.16 09:10:25 -05'00'

Richard Henry
USFWS – Remedial Project Manager

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SAP Worksheet #2 — SAP Identifying Information

Site Name/Number: East Vieques Terrestrial UXO Sites at the former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico

Operable Unit (OU):

Contractor Name: CH2M HILL

Contract Number: N62470-08-D-1000

Contract Title: Navy Comprehensive Long-term Environmental Action—Navy (CLEAN) Program 1000

Work Assignment Number (optional): Contract Task Order (CTO) 037

1. This SAP was prepared in general accordance with the requirements of the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) (Intergovernmental Data Quality Task Force, 2005) and United States (U.S.) Environmental Protection Agency (USEPA) Guidance for QAPPs, USEPA QA/G-5, Quality Assurance Management Section (QAMS) (USEPA, 2002).
2. Regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
3. This master SAP is for East Vieques Terrestrial UXO sites (UXOs 2 through 14, 17, and 18.
4. Dates of scoping sessions:

Scoping Session	Date
Environmental Technical Subcommittee Meeting—New York, New York	March 10-11, 2010
Environmental Technical Subcommittee Meeting—New York, New York	May 10-12, 2011
Environmental Technical Subcommittee Meeting—New York, New York	August 10-11, 2011
Environmental Technical Subcommittee Meeting—New York, New York	October 25-27, 2011
Vieques Site Visit for Monitoring Well Locations	March 15, 2012
Environmental Technical Subcommittee Meeting—New York, New York	May 7-9, 2012
Environmental Technical Subcommittee Meeting—New York, New York	August 27-29, 2012
Environmental Technical Subcommittee Meeting—New York, New York	October 23, 2012

5. Dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
Master Standard Operating Procedures, Protocols, and Plans	April 2010

6. Organizational partners (stakeholders) and connection with lead organization:
   - **USEPA Region 2 –** Federal regulatory stakeholder overseeing CERCLA Vieques ERP implemented by lead organization.
   - **Puerto Rico Environmental Quality Board (PREQB) –** Commonwealth regulatory stakeholder overseeing CERCLA Vieques ERP implemented by lead organization.
   - **United States Fish and Wildlife Service (USFWS) –** Land owner of land transferred from lead organization and on which ERP activities are conducted.
   - **National Oceanic and Atmospheric Administration (NOAA) –** Marine habitat stakeholder and technical advisor to USEPA.
7. Lead organization (see Worksheet #7 for detailed list of data users):
   - U.S. Department of Navy (Navy).
8. The omitted SAP elements excluded and provide an explanation for their exclusion below:
   - Crosswalk table is excluded as all required information is provided in this SAP.

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SAP Worksheet #3 — Distribution List

Name of SAP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
Kevin Cloe	Vieques Remedial Project Manager (RPM)/Lead Agency Point of Contact (POC)	Navy	757-322-4736	kevin.cloe@navy.mil	A	CL	A
Dan Waddill	Vieques Program Coordinator/No project-specific role	Navy	757-322-4983	dan.waddill@navy.mil	CL	CL	CL
Daniel Hood	Vieques RPM/No project-specific role	Navy	757-322-4630	daniel.r.hood@navy.mil	CL	CL	CL
Madeline Rivera	Vieques Environmental Restoration Program Site Manager /On-island coordination	Navy	757-348-2689 (cell)	llamasmad@gmail.com	A		A
John Noles	Biologist/Technical input	Navy	757-322-4891	john.noles@navy.mil	HC		A
Daniel Rodriguez	Vieques RPM/ Regulatory agency POC	USEPA	787-741-5201 787-671-9879 (cell)	rodriguez.daniel@epa.gov	A	CL	A
Jose Font	Caribbean Environmental Protection Division Director	USEPA	787-977-5814	font.jose@epa.gov	CL		CL
Sergio Lopez	Quality Control (QC) Specialist/Technical input and draft document review	USEPA	732-321-6778	lopez.sergio@epa.gov	A		A
Michael Sivak	Human Health Risk Assessment (HHRA) Lead/Technical input and draft document review	USEPA	212-637-4310	sivak.michael@epa.gov	A		A
Diana Cutt	Geology/Hydrogeology Lead/Technical input and draft document review	USEPA	212-637-4311	cutt.diana@epa.gov	A		A
Mindy Pensak	Ecological Risk Assessment (ERA) Lead/Technical input and draft document review	USEPA	732-321-6705	pensak.mindy@epa.gov	A		A
Pedro J. Nieves, Esq.	President/No project-specific role	PREQB	787-767-8056	pedronieves@jca.gobierno.pr	CL		CL
Wilmarie Rivera	Vieques RPM/ Regulatory agency POC	PREQB	787-767-8181 (x6129) (work) 787-365-8573 (cell)	wilmarierivera@jca.gobierno.pr	A	CL	A
Katarina Rutkowski	Technical Support Consultant for EQB/EQB contractor primary POC	TRC	860-298-6202	krutkowski@trcsolutions.com	A		A
Mike Barandiaran	Refuge Manager/No project-specific role	USFWS	787-741-2138	Mike_barandiaran@fws.gov			A
Susan Silander	Caribbean Islands Refuges Supervisor/No project-specific role	USFWS	787-851-7258 (x38)	susan.silander@fws.gov	CL		CL
Richard Henry	Vieques RPM/ Land management agency POC	USFWS	732-906-6987	richard_henry@fws.gov	A	CL	A
Felix Lopez Arroyo	Environmental Contaminants Specialist/Technical input and draft document review	USFWS	787-851-7297(x226)	felix_lopez@fws.gov	A		A

SAP Worksheet #3 — Distribution List (continued)

Name of SAP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
Diane Wehner	Regional Resource Coordinator/Technical input and draft document review	NOAA	732-872-3030	diane.wehner@noaa.gov	A		A
Brett Doerr	Contractor Environmental Manager/CH2M HILL primary POC/Activity Quality Manager/SAP Quality Reviewer	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	A	A	A
John Swenfurth	Project Manager	CH2M HILL	813-281-7762	john.swenfurth@ch2m.com	A	A	A
Bill Hannah	Senior Technical Consultant	CH2M HILL	757-671-6277	Bill.hannah@ch2m.com			F
To Be Determined (TBD)	Field Team Leader	CH2M HILL					A
TBD	CH2M HILL/Site Safety Coordinator (SSC)/Field Team Member	CH2M HILL					
Monica Marrow	Administrative Record Coordinator	Critigen	757-671-6272	Monica.marrow@ch2m.com			A
Mike Zamboni	Project Chemist	CH2M HILL	709-376-5301	mike.zamboni@ch2m.com			A
Laboratory Point of Contact TBD	Project Manager, POC at primary location.	TBD					HC
TBD	Project UXO support manager	Anomaly avoidance TBD					
Wanda Bermudez	N/A	RAB	787-435-2841	wbromero@yahoo.com		CD	
TBD	Data Validator	TBD					
Colleen McNamara	N/A	RAB	787-380-2545	lacolina@hughes.com		A	
Stacie D. Notine	N/A	RAB	N/A	N/A		HC	
Jorge Fernandez Porto	N/A	RAB	787-726-2839	jfporto@onelinkpr.net		CD	
Lionel Sanchez	N/A	RAB	787-241-0063	sanchezcarambot@yahoo.com		HC	
Lirio Marquez D'Acunti	N/A	RAB	787-726-2839	liriomarquez@gmail.com		None	

A = All DF = Draft Final
CL = Cover Letter F = Final CD = Compact Disc HC = Hard Copy D = Draft

SAP Worksheet #4 — Project Personnel Sign-Off Sheet

Name	Organization/Title/Project Role	Telephone Number (optional)	Signature/email receipt	SAP Section Reviewed	Date SAP Read
Anita Dodson	CH2M HILL/Navy Program Chemist/ SAP review	757-671-6218			
John Swenfurth	CH2M HILL/Contractor Project Manager (PM)/Logistics and administration	813-281-7762			
Bill Hannah	CH2M HILL/Senior Technical Consultant	757-671-6277			
Mark Orman	CH2M HILL/Contractor Health and Safety Lead/Health and Safety officer	414-847-0597			
Hillary Ott	CH2M HILL/ Project Data Manager Data tracking and management	703-376-5165			
Barrie Selcoe	CH2M HILL/Human Health Risk Assessment Lead	281-721-8527 713-392-8707 (cell)			
John Martin	CH2M HILL/Ecological Risk Assessment Lead	352-384-7122			
Brett Doerr	CH2M HILL/Contractor Environmental Manager/CH2M HILL primary POC/Activity Quality Manager/SAP Quality Reviewer	757-671-6219			
TBD	CH2M HILL/ Field Team Leader (FTL)				
Mike Zamboni	CH2M HILL/Project Chemist	709-376-5301			
TBD	TBD/Lab Project Manager				
TBD	TBD/Data Validator				
TBD	TBD/anomaly avoidance project manager				
Bhavana Reddy	Critigen Database Manager	703-462-3784			
TBD	CH2M HILL/Site Safety Coordinator (SSC)/Field Team Member				

Signed versions of Worksheet #4 will be kept on file at CH2M HILL along with other project documents.

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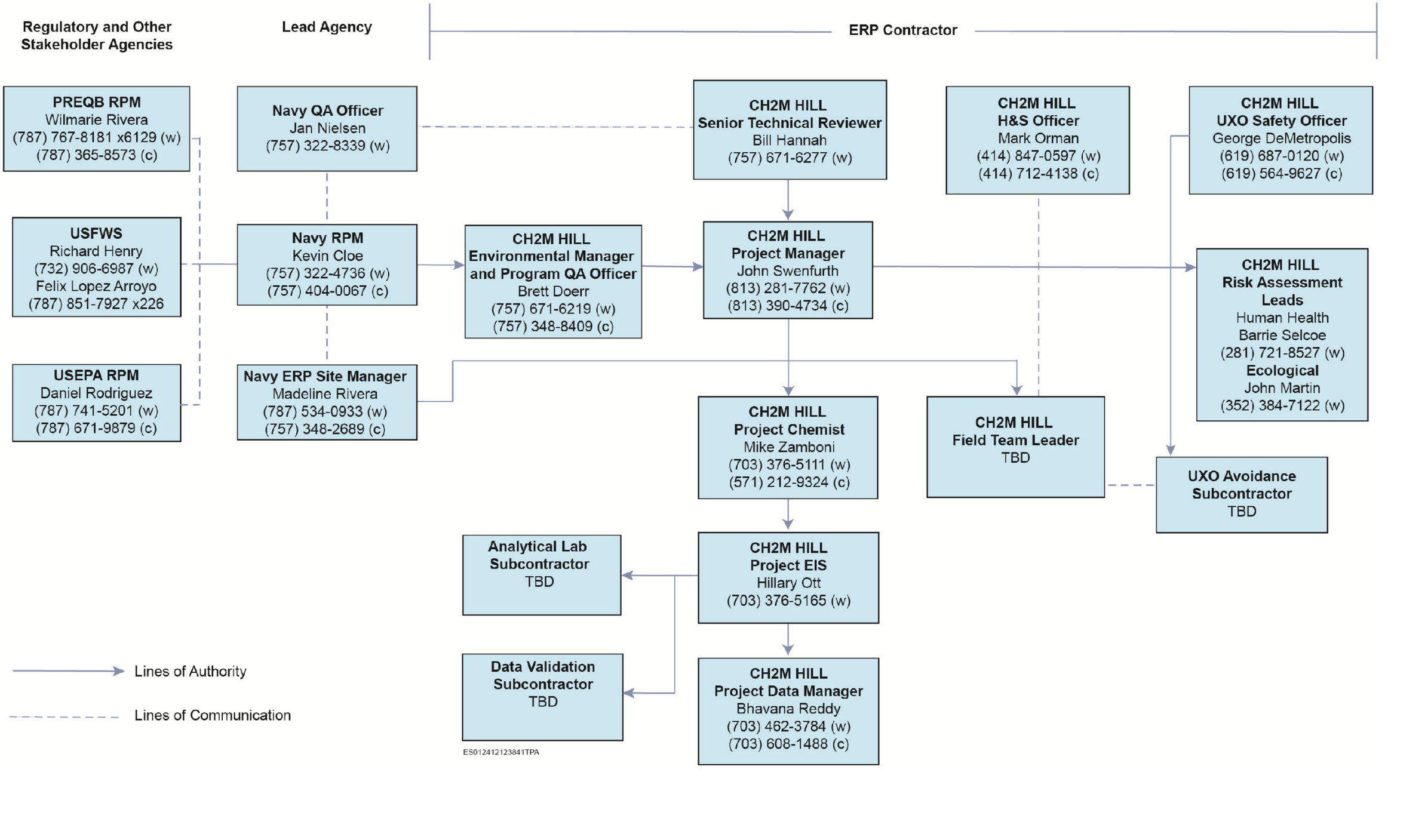
SAP Worksheet #5 — Project Organizational Chart



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SAP Worksheet #6 — Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Communication to/from Navy (e.g., submission of SAP for review; receipt of regulatory comments, etc.)	Navy RPM	Kevin Cloe	757-322-4736	Primary POC for Navy (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact. Stop work notices to regulators, notifying regulators of significant SAP changes or deviations, significant issues and necessary corrective actions by phone or e-mail within 2 weeks of notification of Navy RPM.
Communication to/from USEPA (e.g., receipt of SAP for review; submission of USEPA comments)	USEPA RPM	Daniel Rodriguez	787-741-5201 787-671-9879 (cell)	Primary POC for USEPA (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from PREQB (e.g., receipt of SAP for review; submission of PREQB comments)	PREQB RPM	Wilmarie Rivera	787-767-8181 (x6129)	Primary POC for PREQB (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from USFWS (e.g., receipt of SAP for review; submission of USFWS comments)	USFWS RPM	Richard Henry	732-906-6987	Primary POC for USFWS (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Navy Quality Assurance (QA)/Quality Control (QC) input	Navy Quality Assurance Officer (QAO)	Janice Nielsen	757-322-8339	Provides review comments to CH2M HILL on pre-draft SAP via e-mail through Kevin Cloe. Provides overall Navy guidance via direct communication with CH2M HILL QAO, as warranted.
Communication to/from CH2M HILL (e.g., submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations, etc.)	CH2M HILL Environmental Manager	Brett Doerr	757-671-6219	Primary POC for CH2M HILL (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other contractor staff, as appropriate. Stop work notices to Navy RPM, notifying Navy RPM of significant SAP changes or deviations, significant issues or corrective actions by phone or email within one week of occurrence.
Project administration and logistics	CH2M HILL PM	John Swenfurth	813-281-7762	Direct communication (via e-mail, telephone, hardcopy, or in-person, as warranted) to/from CH2M HILL project staff to ensure appropriate project implementation.
Health and safety expectations and procedures	CH2M HILL Health and Safety Officer	Mark Orman	414-847-0597 414-712-4138 (cell)	Review of Health and Safety Plan (HASP). Direct communication (via e-mail, telephone, hardcopy, or in-person, will be notified within 24 hours of incident) to/from CH2M HILL project staff to ensure implementation of appropriate health and safety procedures.
Implementation of sampling activities; SAP changes in the field	CH2M HILL FTL	TBD	TBD	Documentation of deviations from work plan made in field logbooks and rationale for deviations, made within 24 hours of deviation; assistance in material procurement and delivery; injection oversight and implementation; deviations made only with approval from contractor PM and/or environmental manager. Notifying CH2M HILL EM/AQM of significant SAP changes or deviations, significant issues or corrective actions by phone or email daily.

SAP Worksheet #6 — Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Field corrective actions	CH2M HILL FTL	TBD	TBD	See Worksheet 32 Assessment Findings and Corrective Action (CA) Responses and Worksheet 32-1 CA Form.
Daily Field Progress Reports	CH2M HILL FTL	TBD	TBD	FTL will call to contractor PMs daily
Ensure staff health and safety in the field	CH2M HILL (SSC)	TBD	TBD	Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff.
Data tracking from collection through upload to database	CH2M HILL Project Data Manager (PDM)	Hillary Ott	703-376-5165	PDM will track data from sample collection through upload to database, ensuring QAPP requirements are met by laboratory and field staff. Tracking involves receipt of electronic and hardcopy data from laboratory and data validator. PDM communicates with CH2M HILL project chemist, laboratory PM, and data validator PM, as warranted, to ensure adherence to project analysis and validation requirements. PDM also coordinates data upload with contractor database manager.
Uploading project data and maintaining the database to ensure data are stored properly and can be retrieved by the Environmental Impact Statement (EIS).	Critigen Database Manager	Bhavana Reddy	703-471-1441	Once contractor chemist ensures data are appropriate for upload to database, PDM submits data electronically to contractor database manager, who uploads data to database.
Reporting Lab Data Quality Issues	Laboratory PM (TBD)	TBD	TBD	All QA/QC issues with project field samples will be reported by the lab to the PDM, Project Chemist, and Contractor QAO via e-mail within 2 business days.
Quality Control on Laboratory Data, release of analytical data for upload to database	CH2M HILL Project Chemist	Michael Zamboni	703-376-5301	See Worksheets 24, 25, and 28 for analytical CAs; Upon review of validated data to ensure adherence to project requirements, project chemist communicates via e-mail to PDM that data are ready for release (i.e., upload to database).
Technical Support and Reporting	CH2M HILL Senior Technical Consultant and Technical Leads	John Martin, Barrie Selcoe and Bill Hannah	352-384-7122 281-721-8527 757-671-6277	Risk assessment leads, data evaluation, analysis, and reporting
Validated data	Data Validator PM (TBD)	TBD	TBD	Data validator provides data validation reports (electronic and hardcopy) that provide the data qualifiers and associated explanations.
Anomaly avoidance	Anomaly avoidance subcontractor PM	TBD	TBD	Field avoidance of UXO, UXO safety while conducting field activities.

SAP Worksheet #7 — Personnel Responsibilities Table

Name	Title	Organizational Affiliation	Responsibilities
Kevin Cloe	Vieques RPM	Navy	ERP activities implemented under this SAP.
Jan Nielson	QAO	Navy	Navy review of SAP and QA input.
Madeline Rivera	Vieques ERP Site Manager	Navy	On-island Navy liaison; provides logistical support for implementation of environmental restoration program activities under this SAP
Brett Doerr	Environmental Manager	CH2M HILL	Responsible for ERP at Vieques; primary CH2M HILL POC; assists in data evaluation and interpretation; reviews report.
John Swenfurth	PM	CH2M HILL	Project administration; coordinates staffing; monitors project performance; directs and oversees project staff.
Bill Hannah	Senior Technical Consultant	CH2M HILL	As the technical lead, support human health and ecological risk assessments.
Anita Dodson	Program Chemist	CH2M HILL	Provides program level review and support of the UFP-SAP.
Mike Zamboni	Project Chemist	CH2M HILL	Establishes laboratory scope of work; ensures selected laboratory can meet project-required analytical protocol; primary communications with laboratory and data validator; performs data quality evaluation to determine availability of analytical data.
TBD	FTL	CH2M HILL	Supervises sampling and coordinates field activities; ensures onsite compliance with work plan.
Mark Orman	Health and Safety Officer	CH2M HILL	Responsible for overall Navy CLEAN program health and safety performance; reviews project-specific HASP; interacts with SSC to ensure project-specific safety of field personnel.
TBD	SSC	CH2M HILL	Oversees and ensures safety of onsite personnel; responsible for use and completion of all field work related Health & Safety (H&S) paperwork.
Hillary Ott	Project Data Manager	CH2M HILL	Manages sample tracking; coordinates assimilation of data from field collection through analysis, validation, and upload to environmental database; performs data queries for data evaluation and report writing.
Bhavana Reddy	Database Manager	CH2M HILL	Uploads validated data to environmental database.
Project Manager – Contracted Laboratory	Laboratory Quality Assurance	TBD	Responsible for laboratory QA program and review of QC data.
TBD	Data Validator	TBD	Responsible for validating analytical data in accordance with project-specific UFP-SAP.
TBD	TBD	Investigation-derived Waste (IDW) Subcontractor	Responsible for transport and disposal of IDW deemed necessary for offsite disposal.

[1] Resumes are maintained by the individuals' organizations and are available upon request; upon execution of the project, staff may be removed (if unnecessary to project execution) and other staff may be added or substituted, as necessary and available.

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SAP Worksheet #8 — Special Personnel Training Requirements Table

Project Function	Specialized Training by Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
Field Activities	3R Munitions Training	Various qualified training organizations	Training of CH2M HILL and subcontractors will be verified as current prior to starting field activities by SSC	All field personnel	FTLs, field team members, and SSC (CH2M HILL personnel); IDW subcontractor; and soil removal subcontractor	CH2M HILL Human Resources Department for CH2M HILL personnel; subcontractor organizations for field subcontractors
Field Activities	UXO Tech II or better training	U.S. Department of Defense	Training will be verified as current prior to starting field activities by SSC.	Subcontracted UXO Tech II or better	Subcontracted UXO Tech TBD	Subcontractors records and CH2M HILL field safety files
Field Activities	UXO Technician Training to meet minimum requirements of DDESB TP 18 for the relevant UXO Technician level	• U.S. military EOD school • Canada, Great Britain, Germany, or Australia military EOD school Formal UXO training course of instruction or EOD assistant courses	Training will be verified as current prior to starting field activities by SSC; training will not be provided by CH2M HILL	Subcontracted UXO Tech II or higher	Subcontracted UXO Tech TBD	Subcontractor records and CH2M HILL field safety files. Records to include resume (as demonstrated experience), qualifications, and copies of certifications

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SAP Worksheet #9-1 — Project Scoping Session Participants Sheet

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR	
Projected Date(s) of Sampling: January 2011	**Site Name:** Eastern Conservation Area
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: March 10, 11, 2010 **Scoping Session Purpose:** Concurrence on sampling purpose for the ECA RI. This scoping session provides	

Name	Dates	Title	Affiliation	Phone #	E-mail Address	Project Role
Kevin Cloe	3-10&11	Vieques RPM	Navy	757-322-4736	Kevin.cloe@navy.mil	Primary Navy POC
Daniel Hood	3-10&11	Vieques RPM	Navy	757-322-4630	daniel.r.hood@navy.mil	Navy POC for munitions related items
Stacin Martin	3-10&11	Senior Technical Advisor	Navy	787-322-4780	Stacin.martin@navy.mil	Navy additional POC for munitions related items
Daniel Rodriguez	3-10&11	Vieques RPM	USEPA	787-741-5201 787-671-9879 (cell)	Rodriguez.daniel@epamail.gov	Primary USEPA POC
Michael Sivak	3-10&11	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Technical input and review of human health risk evaluation
Wilmarie Rivera	3-10&11	Vieques RPM	PREQB	787-767-8181 x 6141	wilmarierivera@jca.gobierno.pr	Primary PREQB POC.
Katarina Rutkowski	3-10	Technical Support Contractor to PREQB, Human Health Risk Assessment Lead	TRC	860-298-6202	krutkowski@trcsolutions.com	Technical input and review of human health risk aspects on behalf of EQB; Primary TRC POC
Phil Rury	3-11	Technical Support Contractor to PREQB, Ecological Risk Assessment Lead	TRC	978-656-3590	PRury@trcsolutions.com	Technical input and review of ecological risk aspects on behalf of EQB
Diane Wehner	3-10&11	Ecological Risk Assessor	NOAA	732-872-3030	Diane.wehner@noaa.gov	Technical input and draft document review/No project-specific role.

SAP Worksheet #9-1 — Project Scoping Session Participants Sheet (continued)

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR	
Projected Date(s) of Sampling: November 2010	**Site Name:** Eastern Conservation Area
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: March 10, 11, 2010 **Scoping Session Purpose:** Concurrence on sampling purpose, CSM, samples and analysis to be completed, and data use.	

Name	Date	Title	Affiliation	Phone #	E-mail Address	Project Role
Richard Henry	3-10&11	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC/No project-specific role
Brett Doerr	3-10&11	Environmental Manager	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	Scope development and technical review. Primary CH2M HILL POC.
Bill Hannah	3-10&11	Project Manager	CH2M HILL	757-671-6277	bill.hannah@ch2m.com	Project Management
John Martin	3-10&11	Ecological Risk Assessor	CH2M HILL	352-384-7122	john.martin@ch2m.com	Technical input and review.
Barrie Selcoe	3-10&11	Human Health Risk Assessor	CH2M HILL	281-721-8527	barrie.selcoe@ch2m.com	Technical input and review.
Stan Powell	3-10&11	Ecological Risk Assessor				Technical input and support to USEPA on the ecological risk assessment
Sergio Lopez	3-10&11	EPA Quality Assurance	USEPA			USEPA QA review
Mindy Pensak	3-10&11	EPA Ecological Risk Assessor	USEPA			USEPA ecological risk assessment

Comments/Decisions:.

Action Items: See below.

Consensus Decisions: See below.

SAP Worksheet #9-1 — Project Scoping Session Participants Sheet (continued)

Excerpt from the March 10-11, 2010 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Meeting Minutes (FINAL)

ECA RI Sampling Approach – Scoping Session

Brett Doerr reviews the agenda, discusses the objectives of the scoping session, and walks the team through the updated seed file.

Conceptual Site Model Elements

The team briefly revisited the CSM elements. Brett added the list of explosive constituents analyzed using EPA Method 8330B. A list of potential munitions constituents associated with the items found at the site was passed around.

Sample Media

The team had discussions on characterizing groundwater at the site. Michael Sivak had a discussion with Diana regarding groundwater at the site and the potential for seepage through the cliffs, and whether it was necessary to characterize groundwater in the lowland area. Brett responded that LUCs will be in place for the site because of the potential presence of munitions, which means this site cannot get a no further action with unrestricted use designation. Further, no industrial or residential use of the ECA will be allowed because of legislation (the Congressional Order designating the ECA as a Wilderness Area), and groundwater can only discharge to the ocean or potentially the lagoon. Therefore, no additional institutional control is needed to restrict its use. Michael added the site will require a Five Year Review because it will not get a no further action with unrestricted use designation. He also questioned whether there is an ARAR for groundwater that requires it to be characterized. He noted that it is not the typical case to require institutional controls without having characterized the affected media. Katarina Rutkowski asked if a phased approach could be used, and evaluate groundwater if we find contamination in soil. Brett responded that this scenario was brainstormed (including surface water/sediment), but would like the team to continue to consider the unique circumstances that exist and will continue to exist at the ECA. Michael said that he needs to discuss with the EPA attorney (Jim Doyle) for Vieques regarding the groundwater designation at the ECA. Michael indicated that it is EPA's preference to sample all media in most cases, and the SAP should provide rationale for why groundwater is not being sampled in this round. Brett indicated that we will look at soil data, weathering, and degradation issues for the detected constituents, and a decision tree will be included in the SAP indicating the path to characterizing or not characterizing groundwater. Brett also stated that the cliffs are limestone, and there is Karst terrain; during the ECA site visit, the cliff faces were observed in several areas and no evidence of seeps was observed. Wilmarie Rivera said that she will need site data to receive buy-off from her superiors to not characterize groundwater.

Consensus – Proceed with preparation of the SAP and do not include groundwater as a medium to be characterized (at least in the initial phase of study). The rationale for when/why groundwater will or will not be characterized will be included.

Sampling Method

Brett asked the regulators if they had looked into multi-incremental sampling (MIS) and come to consensus on its applicability. Michael responded that he, Doug Maddox (EPA Federal Facilities Restoration and Reuse Office [FFRO]), Mary Cook (FFRO), and Dina Crumbling (EPA Office of Solid Waste and Emergency Response) had a conference call

SAP Worksheet #9-1 — Project Scoping Session Participants Sheet (continued)

and discussed MIS in detail, and they learned that MIS is typically used for analysis of explosives only, and not for other constituents. Michael added that they know of another sampling approach that could help discrete samples for the other parameters (i.e., metals) may be considered in addition to the MIS for explosives. Michael stated that he couldn't find any other sampling options besides discrete and MIS. Michael indicated that a phased approach to sampling could be conducted: first sampling using MIS for explosives, and then discrete sampling targeting areas for metals if explosives MIS data indicate the need. Rich Henry stated that from his understanding of the guidance documents, MIS could be used for the analysis of metals, and the samples do not need to be ground. He added that the samples could be split for explosives (grinding) and metals (no grinding). If the samples for metals are ground, since the soil sample is ground to a fine-grain, the metals results will provide a more conservative concentration. Katarina followed up with Alaska and Arizona project managers that had implemented MIS. She said that for the project where grinding contaminated the sample with metals (discussed in the January 26, 2010 meeting in San Juan), the lab (TestAmerica) had left the stainless steel grinder operational over the weekend (i.e., longer than appropriate) and chromium had been introduced into the sample. Two other options were discussed: (1) Grinding all samples and excluding those metals from the analysis that could be introduced by the grinder and (2) Grinding all samples, but using a non-metallic grinder, if available. Michael will have follow-up discussions within EPA and provide feedback to the team.

Decision Units

Brett presented a plot size conceptual sampling approach map for the ECA. Five decision units were selected based on receptor type and land cover: upland, lowland, lagoon, lagoon fringe, and beach. Within each decision unit, sampling units were selected based on receptor exposure area, and type and number of MEC items encountered. The team had further discussions on the rationale for selection of the decision units and sampling units, and on how the sampling unit data would be used in the risk assessment evaluation.

Rich stated that the approach presented is a really good starting point on the development of the sampling approach at the site. Danny Rodriguez asked whether the items found were low order, high order, cracked, etc., and if these details were recorded in the database. Stacin answered that only some of this information was included. He also added that the munitions items found were older munitions (pre-1970s), since the site was avoided when it was established as a conservation area. Dan Hood indicated that the lagoon may have historically been used for bomb consolidation. Danny asked about what we would do for the areas that were not covered as part of the ECA removal action. Stacin added that there is only one small area (<1 acre) to the southeast of the turtle nesting area and access to this area is difficult because of the steep cliff in the area. Danny added that it was most likely covered by the aerial magnetometer survey. Dan Hood responded that the aerial magnetometer survey fly-over only evaluates target areas and high density areas, and cannot identify individual items smaller than a drum.

Rich asked for an inventory of items found in each sampling unit to justify why the sampling unit was picked. Rich stated that solely scrap metal locations should not be selected as sampling units. After the team reviewed the sampling approach map, they noted that the map included munitions, munitions-related scrap, and non-munitions-related scrap and that the sampling units were based on the number and location of all three. It was concurred that the map should be reproduced to exclude the non-munitions-related scrap and the sampling units redrawn based solely on munitions items and munitions-related scrap. It was further noted that the sampling

SAP Worksheet #9-1 — Project Scoping Session Participants Sheet (continued)

units will not include the roads, and that a discrete sample will be collected at the "lighthouse" battery disposal area instead of MIS due to its small size (less than 5 square feet). The draft sampling units will be re-evaluated to consider spatial distribution, high density munitions items, the range of munitions items, and munitions-related scrap. It was further determined that the sampling units do not need to be made up of four contiguous grid cells.

The team then discussed the number of soil sample increments that would need to be collected per sampling unit. Michael added that 100 increments are currently being collected at an industrial site in Region 4 (Florida site). Barrie Selcoe asked what size the decision unit for that site was, and Michael said he did not know. Rich added that a range of 30 to 100 increments are mentioned in the Army Corps of Engineers (ACOE) guidance, and that a higher number is selected for highly variable decision units. If there is no knowledge of the variability, 30 to 100 is a good range for energetics. Rich stated that he expects a high degree of variability. Michael added that he would be comfortable if we collected the number of increments near the higher end of that range, such as 70-75 increments, but agreed that we should calculate the target number of increments using the equation in the ACOE guidance (which is dependent on the size of the core sampler and mass needed by the lab). Rich added that since we do not know the chemical variability at the site, he would be comfortable near the higher end of the range as well.

Stacin added that collecting a smaller plug sample (1 cm in diameter) would facilitate collecting more increments. The group discussed that a certain sample mass is needed to pass through a 2 mm size (#10 sieve); Brett stated that the sieving and drying would be performed by the lab. Dan indicated that sticks/rocks/grass from each increment would be included in the sample. Katarina asked if we could identify areas where the sample core method would and would not work. Brett indicated that the field staff will perform a test-run of the proposed sampling methods while the SAP is being prepared so that a feasible sampling approach(es) can be included in the SAP. Rich answered that the key for this sampling approach is to be consistent on the sampling method, but either a trowel or a sample corer can be used. Rich added that the sample mass has to be sufficient to meet the analytical requirements (e.g., 500 grams is 170 increments).

Consensus – The team agreed to attempt to follow the prescriptive approach provided in the ACOE guidance to calculate the appropriate number of increments required.

Action Item - CH2M HILL will attempt to collect core samples during the SAP development to confirm that the core sampling method will work at the site.

The team then went into detailed discussions on the number of QA/QC samples required. Barrie mentioned that the guidance documents say that at least one sampling unit needs to have a triplicate. Sergio Lopez responded that 5 to 10% QA/QC would be required for each decision unit. The team then had detailed discussions on how to analyze replicate results and what to do with the calculation of the standard deviation. Brett added that the target data validation 30% standard deviation may not be applicable in areas with really low concentrations, and as a group we should accept that 30% is not a pass/fail criterion due to the analytical/natural variability, especially at low concentrations. For example, 1 ppm vs 2 ppm can be a 100% difference, but the concentrations are for all intents and purposes the same.

Consensus – Triplicate samples will be collected at a 10% frequency per decision unit. Replicate samples will only be used to evaluate the analytical variability within one sampling unit for QC purposes (not to calculate an upper confidence limit [UCL] on the mean concentration). The maximum concentration of the three samples will be used to represent the analytical results from

SAP Worksheet #9-1 — Project Scoping Session Participants Sheet (continued)

that sampling unit. ProUCL software will be used to calculate the 95% UCL on the mean for MIS results in each decision unit, even when there are only 2 sampling units in the decision unit.

The team then had discussions on background samples. Background soil samples will be collected using MIS in the same lithologic unit as that in the ECA that was sampled during the East Vieques background study. If ECA samples are ground for metals analysis, background samples will need to be ground too.

Brett proposed that since we do not have a background comparison for the lagoon, the team should consider not analyzing for metals at the lagoon. An alternative could be conducting biological community sampling to determine if a natural community exists in this lagoon, considering its unique characteristics of frequent drying and high salt content. We could also consider just looking for explosives initially and then base any future sample analysis on the explosive results. Michael suggested we consider the feasibility of analyzing samples for metals and looking at a ratio comparison. The team then had further discussions on how the metals data could be evaluated. NOAA/EPA/EQB would prefer to analyze the lagoon for metals. Brett continued to point out that if we cannot as a team come up with a certain ability to distinguish metals concentrations present as a result of contamination from metals concentrations present from natural conditions, we should not be analyzing the samples for metals.

SAP Worksheet #9-2 — Project Scoping Session Participants Sheet

Project Name: East Vieques UXO Sites Master SAP, Former VNTR					
Projected Date(s) of Sampling: TBD				**Site Name:** East Vieques UXO Sites Master SAP	
PM: John Swenfurth				**Site Location:** Vieques, Puerto Rico	
Dates of Session: May 11, 2011 **Scoping Session Purpose:** Sampling purpose, CSM, samples and analysis to be completed, and data use.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
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Dan Waddill	NAVFAC Atlantic	Navy	757-322-4983	dan.waddill@navy.mil	Navy Vieques Coordinator
Daniel Hood	Vieques RPM	Navy	757-322-4630	daniel.r.hood@navy.mil	Navy POC for munitions related items
Pedro Ruiz	Vieques Site Manager	Navy	787-630-9881	pedroruizwork@gmail.com	Navy site coordinator
Stacin Martin	Senior Technical Advisor	Navy	787-322-4780	Stacin.martin@navy.mil	Navy additional POC for munitions related items
Daniel Rodriguez	Vieques RPM	USEPA	787-741-5201 787-671-9879 (cell)	Rodriguez.daniel@epamail.gov	Primary USEPA POC
Michael Sivak	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Technical input and review of human health risk evaluation
Diana Cutt	Geology/Hydrogeology Lead	USEPA	212-637-4311	Cutt.diana@epa.gov	Technical input and review of geology/hydrogeology
Mindy Pensak	Ecological Risk Assessment Lead	USEPA	732-321-6705	Pensak.mindy@epa.gov	Technical input and draft document review
Tom Hall	MEC Support Contractor to EPA	TECHLAW			Technical input and review of munitions related items on behalf of EPA
Wilmarie Rivera	Vieques RPM	PREQB	787-767-8181 x 6129	wilmarierivera@jca.gobierno.pr	Primary PREQB POC
Jim Pastorik	Technical Support Contractor to PREQB,	UXO PRO MEC	703-548-5300	jim@uxopro.com	Technical input and review of munitions related items on behalf of EQB
Katarina Rutkowski	Technical Support Contractor to PREQB, Human Health Risk Assessment Lead	TRC	860-298-6202	krutkowski@trcsolutions.com	Technical input and review of human health risk aspects on behalf of EQB; Primary TRC POC

SAP Worksheet #9-2 — Project Scoping Session Participants Sheet (continued)

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: May 11, 2011 **Scoping Session Purpose:** Explanation of the Master SAP concept for environmental characterization.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Angela Carpenter	Technical Support EPA Special Projects Branch	EPA	212-637-4435	carpenter.angela@epa.gov	Technical support for EPA
Diane Wehner	Ecological Risk Assessor	NOAA	732-872-3030	Diane.wehner@noaa.gov	Technical input and draft document review/No project-specific role.
Richard Henry	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC/No project-specific role
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John Tomik	Activity Manager	CH2M HILL	757-671-6259	john.tomik@ch2m.com	Vieques Activity Manager
Brett Doerr	Environmental Manager	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	CH2M HILL primary POC
Tim Wenk	Vieques MR Site Manager	CH2M HILL	757-671-6265	Tim.Wenk@ch2m.com	CH2M HILL Vieques Site Manager
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Barrie Selcoe	Human Health Risk Assessor	CH2M HILL	281-721-8527	barrie.selcoe@ch2m.com	CH2M HILL lead human health risk assessor
Sandy Martinez	Facilitator	Fulton Communications	702-834-5877	fultoncom@fultoncom.com	Facilitator at meetings
Julio Vazquez	EPA RPM	EPA	212-637-4323	Vazquez.Julio@epamail.epa.gov	RPM, U.S. EPA - Region 2, Special Projects Branch/Federal Facilities Section, New York

Comments/Decisions: See meeting minutes from May 11, 2011 Environmental Restoration Program Technical Subcommittee Meeting below.

SAP Worksheet #9-2 — Project Scoping Session Sheet (continued)

Excerpt from the May 11, 2011 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Meeting Minutes (Final).

Discussion Objective

Agencies concur on use of Master SAP for remaining east Vieques terrestrial UXO sites and hold scoping session for Master SAP.

Key Discussion Points

There are 11 terrestrial UXO SAPs, minus the beaches, that the Navy proposed to be sampled under the cover of one master SAP versus 11 separate SAPs. The Navy gave a brief presentation on the advantages/potential disadvantages of a Master SAP and noted that the advantages greatly outweigh the potential disadvantages. A Master SAP is applicable because all remaining terrestrial UXO sites have the same or similar elements inherent to a SAP. Conceptually, the east Vieques munitions sites could have been investigated as one UXO site; they were broken up geographically to better show progress. Advantages include significant cost and times savings. One potential disadvantage is that it may be several years between the first site being investigated and the last, so the SAP may require addenda or revisions over time.

The Master SAP will generally work like all other SAPs:

- Administrative items such as roles, responsibilities, and personnel and subcontractors will be identified, if known, and detailed in the plan.
- The plan will be built using site-specific worksheets that detail the investigation approach and objectives for each site. These worksheets will include a conceptual site model for each site, environmental questions to be answered, decision process for determining sampling protocol based on what has been found during the munitions site inspection and/or removal activities, data collection procedures, and PALs.
- Analytical and data quality assurance protocols will be contained in the document.

The Navy noted that the sites are in Remedial Investigation (RI) phase because of the presence of munitions, but that it is unknown as to whether there have been releases of munitions-related constituents warranting full nature and extent investigations. Therefore, the investigation approach should start by conducting a munitions constituent release assessment. Additional investigation may be necessary if the release assessment suggests full nature and extent investigation is warranted. The Master SAP will be prepared to handle this contingency and will include a decision process to show how the determination will be made. It was further noted that the release assessment sampling will be biased toward locations that would be conservatively representative of the UXO site. In other words, the sampling will focus on areas with the highest densities of munitions/anomalies, areas representing the types of munitions potentially used at the sites, areas best representing the human and ecological exposure pathways.

It was proposed for consideration that the beaches need not be sampled due to:

- Lack of contamination detected in ECA beach samples
- Inability of contaminants to adhere to sand
- Dynamic nature of the beaches
- Removal actions (which would likely be the ultimate remedy determination based on contaminant data) are already being conducted on all the beaches, so the contaminant sources will be removed, and long-term Operation & Maintenance (O&M) will ensure future source items are removed

SAP Worksheet #9-2 — Project Scoping Session Sheet (continued)

USEPA stated that the public perception of not sampling any of the beaches would be unfavorable and that at least some of the beaches should be sampled to validate the above hypotheses and confirm contamination is not present at levels posing a potentially unacceptable risk. Angela Carpenter/USEPA noted that USEPA has found lead in sand deposits. Richard Henry/USFWS pointed out that that site had a very different conceptual model than that on Vieques; at that site, slag was mixed with the sand deposits.

After a discussion of the necessity for sampling at the beaches, the Navy agreed to collect samples at several representative beaches (i.e., those with the most "finds" and those best representing the exposure scenarios). This information will be included in the Master SAP.

Danny Rodriguez/USEPA asked how depleted uranium in the LIA would be addressed through the sampling. The Navy responded that there is no evidence that the depleted uranium remains. The group discussed the event during which 263 DU rounds were fired at the site. The Navy RASO conducted a full investigation and search after the release and did not identify any concerns. In addition, no penetrators were found during the time critical removal action in the LIA. Information about the DU and related activities will be discussed in the Master SAP.

In a previous sampling effort, NOAA identified a lagoon in the vicinity of Blue Beach with high pesticide concentrations that may be indicative of an isolated dumping. NOAA asked if and how the lagoon will be addressed. The Navy responded that the lagoon is currently not a site but will look into how to best address NOAA's concern.

UXO 15 (PI 9 and PI 13) and UXO 17 (PAOC EE), although included in "UXO" sites, do not contain known MEC. However, investigations will be completed at both UXO sites to verify this assumption. Both UXO sites have existing work plans and, therefore, will not be included in the Master SAP.

Consensus Decisions

The Navy, USEPA, PREQB, and USFWS concurred on the following:

- Prepare a Master SAP for all of the terrestrial UXO sites, including the "worst-case" scenario beaches.

SAP Worksheet #9-3 — Project Scoping Session Participants Sheet

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: August 10, 2011 **Scoping Session Purpose:** Sampling purpose, CSM, samples and analysis to be completed, and data use.	

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Pedro Ruiz	Vieques Site Manager	Navy	787-630-9881	pedroruizwork@gmail.com	Navy site coordinator
Stacin Martin	Senior Technical Advisor	Navy	787-322-4780	Stacin.martin@navy.mil	Navy additional POC for munitions related items
Daniel Rodriguez	Vieques RPM	USEPA	787-741-5201 787-671-9879 (cell)	Rodriguez.daniel@epamail.gov	Primary USEPA POC
Michael Sivak	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Technical input and review of human health risk evaluation
Diana Cutt	Geology/Hydrogeology Lead	USEPA	212-637-4311	Cutt.diana@epa.gov	Technical input and review of geology/hydrogeology
Mindy Pensak	Ecological Risk Assessment Lead	USEPA	732-321-6705	Pensak.mindy@epa.gov	Technical input and draft document review
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SAP Worksheet #9-3 — Project Scoping Session Participants Sheet (continued)

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: August 10, 2011 **Scoping Session Purpose:** Sampling purpose, CSM, samples and analysis to be completed, and data use.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Angela Carpenter	Technical Support EPA Special Projects Branch	EPA	212-637-4435	carpenter.angela@epa.gov	EPA technical support
Diane Wehner	Ecological Risk Assessor	NOAA	732-872-3030	Diane.wehner@noaa.gov	Technical input and draft document review/No project-specific role.
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Richard Henry	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC/No project-specific role
Tim Garretson	Munitions Response Lead	CH2M HILL	757-287-5222	timothy.garretson@ch2m.com	Address munitions related items
John Tomik	Activity Manager	CH2M HILL	757-671-6259	john.tomik@ch2m.com	Vieques Activity Manager
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Comments/Decisions: See meeting minutes from August 10, 2011 Environmental Restoration Program Technical Subcommittee Meeting below.

Action Items: See below

SAP Worksheet #9-3 — Project Scoping Session Participants Sheet (continued)

Excerpt from the August 10, 2011 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Meeting Minutes (Final).

Discussion Objective

Conduct a scoping session related to the East Vieques Master SAP and present to the team the decision process for selection of soil, surface water, sediment, and groundwater sampling locations, the analytical protocol and approach for the chemistry-related worksheets, and the data evaluation/decision-making process.

Key Discussion Points

Brett introduced the concept of the East Vieques Master SAP. He added that because the meeting materials were sent just immediately before the meeting that the Navy is not expecting the regulatory agencies to concur on the approach at this meeting, but instead to initiate discussions of the conceptual approach and schedule a more focused scoping session at a later date. He added that because it is unknown whether the past munitions-related activities caused an identifiable release that warrants further investigation or action, the initial sampling approach will collect data in the areas with the highest potential for contamination (i.e., “worst-case” areas). Those data will then be evaluated in a 7-Step process similar to the release assessment decision process used previously on Vieques. If necessary based on the initial sampling, the investigation of each UXO site will be expanded to further delineate extent of contamination. He added that the MEC investigation approach will also be included in the Master SAP, but this scoping session focuses solely on the characterization of munitions-related constituents.

Bill Hannah/CH2M HILL presented the MEC characterization that has been conducted to date and the sampling decision logic and approach concept. Soil sampling activities will use a combination of an incremental (surface soil) and discrete (deeper surface soil) sampling approach. Groundwater, sediment, and surface water sampling activities will use a discrete sampling approach following the Master Protocols. The team walked through the ranking-based decision approach and how the decision units and sampling units were defined.

Dianna asked if subsurface soil samples would be collected. The Navy responded that monitoring wells will be installed to determine any potential impacts to groundwater and deep surface soil samples will be collected to a depth of 2 feet in some areas. Angela added that subsurface soil samples would be needed to characterize the vertical extent of soil contamination and need to be deeper than the deeper surface soil samples. The Navy responded that monitoring wells will installed in areas with the highest potential for contamination and will provide the most conservative indicator of subsurface contamination and that the risk receptors are at the surface; therefore, no need to conduct subsurface sampling.

Katarina asked if USFWS would be considered a receptor in the LIA. The Navy responded that they are included. Michael added that we need more descriptive terms on the human health receptor exposure summary. Michael added that they would need a refresher on incremental sampling and differences between decision units and sampling units. He would like to see backup information on how the decision units scores were developed, and as an example could show a map of MEC density for each grid or have a table for each grid showing MEC density, receptor, sensitive habitat, etc. Daniel asked that the team be patient because this information will be presented. During the discussion of the targets, EPA asked where the information is from and if the Navy could provide the reference documents.

Danny asked how the islands will be addressed. The Navy responded that the islands are associated with the beach sites and Cayo de la Chiva is its own site. Daniel added that a Time-Critical Removal Action (TCRA) will not be conducted at Cayo de la Chiva based on the biological assessment of the island (extensive transects but no additional MEC identified). Navy Explosive Ordnance Disposal (EOD) divers will be back within the next month to conduct an underwater survey on the deeper water around the island. Stacin Martin/Navy added that there are archeological sites located on the island.

SAP Worksheet #9-3 — Project Scoping Session Participants Sheet (continued)

The Navy noted that the proposed approach for the beaches is similar to the recent investigation at the ECA. Danny added that when sampling units are selected for the road sites to also consider depositional areas. Mindy commented about identifying monitoring wells in areas within ephemeral streams and lagoons. The Navy responded that the rationale for each monitoring well be included in the SAP. The Navy also reminded the team that monitoring wells will need to be installed within bedrock, which makes it difficult for accessibility of large rotary drilling rigs. However, accessibility will not be used as a criterion to limit the location of the wells. Dianna added that there are not any wells located west of the Navy property to verify if there is flow toward the municipality and that additional wells are needed for triangulation. The Navy responded that the 1999 groundwater data shows that groundwater flow is not migrating towards the municipality. Daniel added that the Navy will not install wells on the municipality due to threat of vandalism and the existing data shows that flow is not leaving the site. In addition, explosives were not detected in groundwater in the area.

Katarina asked if the Navy selected sampling units solely based on the type of MEC item, where some items may be more vulnerable to releasing contaminants than other types of MEC. The Navy responded that MEC density, type, and quantity was used and is unaware of any type of documentation on certain type of MEC items being more vulnerable to releasing contaminants.

The Navy asked the regulatory agencies how much time they would need to review and understand the decision logic and would they need longer than 60 days. Danny responded that EPA could review in 60 days provided that there review time is not over the holiday season. The regulatory agencies will get together the first week of October to review the decision logic and approach. An additional scoping session will be needed to review the proposed sampling approach and locations, since the information is too complex to discuss during a conference call.

SAP Worksheet #9-4 — Project Scoping Session Participants Sheet

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: October 27, 2011 **Scoping Session Purpose:** Refine sampling purpose, CSM, samples and analysis to be completed, and data use.	

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SAP Worksheet #9-4 — Project Scoping Session Participants Sheet (continued)

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: October 27, 2011 **Scoping Session Purpose:** Refine sampling purpose, CSM, samples and analysis to be completed, and data use.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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Comments/Decisions: See meeting minutes from October 27, 2011 Environmental Restoration Program Technical Subcommittee Meeting below.

Action Items: See below

SAP Worksheet #9-4 — Project Scoping Session Participants Sheet (continued)

Excerpt from the October 26-27, 2011 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Meeting Minutes (Final).

Discussion Objective

Concur on decision process for selecting soil, surface water, and sediment sampling locations; concur on groundwater characterization approach and locations; concur on analytical protocol and approach for chemistry-related worksheets in Master SAP; concur on data evaluation/decision-making process.

Key Discussion (October 26, 2011)

Bill Hannah/CH2M HILL presented a refresher on the incremental sampling approach and walked the team through the seed file updated based on comments from the last scoping session. The team discussed the differences between background discrete and incremental soil sampling. Michael Sivak/EPA asked if incremental sampling will be conducted within the subsurface. The Navy responded that: incremental sampling is not really designed for subsurface soil sampling; that the incremental soil sampling was designed specifically for surface soil sampling because munitions range studies show the top 2 inches represent the zone with the highest potential for contamination; that the subsurface soil is not an exposure medium based on the potential receptors; and it would be a significant cost and likely technically impractical (due to the potential presence of subsurface anomalies) to conduct subsurface incremental sampling characterization. Michael added that he is aware of a site where subsurface incremental sampling was conducted and has concerns to not evaluate the extent of contamination in the subsurface and to ensure the rationale for not including incremental sampling in the subsurface is included in the Master SAP. It was also pointed out that groundwater characterization will be conducted, which will provide a better indication of the potential leaching of contaminants through soil than what subsurface soil data would indicate. The team then discussed if the current top 2 inches are representative of the top 2 inches at the time of munitions activities. The team discussed evaluating surface soil horizon layer information, and potential erosion and depositional rates for this type of climate and soil. It was also pointed out by the Navy that the current top 2 inches represented the current exposure medium for the ECA RI.

Bill Hannah presented the proposal not to collect additional background incremental data because comparison of the background incremental data and the discrete background data from the same lithologic unit demonstrated the data are comparable. Therefore, it is proposed that the background discrete dataset be used for comparisons with future incremental datasets from the other lithologic units. EPA requested that a statistical comparison of the ECA RI background incremental sample dataset with the East Vieques background discrete sample dataset be included in the Master SAP. Diana Cutt/EPA asked about the potential for groundwater use at the Camp Garcia location and the team discussed that groundwater will not be used in the future at this site because it is designated as a wildlife refuge.

The team walked through the decision logic tables. Michael Sivak requested that under the sampling unit approach and rationale column, to add in the number of sampling units within each decision unit.

Action Item

Navy/CH2M HILL – Proceed forward with completing preparation and submittal of the Draft Master SAP in accordance with the Site Management Plan (SMP) schedule. Include a statistical evaluation of the ECA RI incremental background dataset with the East Vieques discrete background dataset to show that they are comparable; evaluate potential erosional and depositional rates for soil on Vieques; and include the number of sampling units within the decision logic tables. Also, enhance the explanation of column 11 of the matrix table. Include a decision process for selecting the groundwater sampling (well) locations.

EPA (Mindy Pensak) – Send out a technical document she has regarding incremental sampling.

SAP Worksheet #9-4 — Project Scoping Session Participants Sheet (continued)

Key Discussion (October 27, 2011)

The team walked through UXO 4 (LIA) as an example site for the sampling decision approach. The team discussed the logic on how the sampling units and discrete samples were selected. Diana Cutt added that she has concerns with the statement that the 1999 hydrogeologic study shows groundwater does not flow from the VNTR into the municipal area and requested that the Navy soften the language to indicate that groundwater does not likely flow offsite in that direction. Katarina Rutkowski asked for a radionuclide folder to be placed on the Vieques website where all of the various agencies could provide documentation on radiological surveys. The Navy will add the Master Workplan for the TCRA into that folder. Angela Carpenter added that she would like to see the SOPs for the Geiger counter.

The team discussed revising the 7-step process (which was developed for site inspections) to a 6-step process, which is specifically designed for the remedial investigations to be conducted at the terrestrial UXO sites.

Action Item

Navy/CH2M HILL – the rationale for each sampling unit will be included in the SAP; evaluate soil deposition and erosion at the site; remove the "0" values within the grids on the figure at areas where MEC was not cleared; setup a radiological survey folder on the website.

Incremental Sampling Approach Refresher

The team was presented a refresher on the incremental sampling approach and the difference between a decision unit and sampling unit.

- Energetic chemicals on ranges occur as particulates deposited heterogeneously on the soil surface; primarily from propellant residues at firing points, explosive residues near detonations in impact areas, and from controlled detonations; highest concentrations are present near the ground surface with the vast majority in the top 1-inch.
- Incremental sampling is designed to control data variability due to the heterogeneity in contaminant distribution and has a higher likelihood of detecting contaminants than discrete sampling if the location of contamination is unknown; can sample large geographic areas with higher sampling density.
- Various studies have shown that concentrations of energetic chemicals at military ranges measured using an incremental sampling approach were statistically more representative relative to traditional sampling and analytical protocols.
- Obtains a single sample for analysis that has an analyte concentration representative of the decision unit/sampling unit
- The decision unit is site-specific and represents the area in which to base a decision or conclusion; a decision unit may be composed of a single or multiple sampling units that are generally selected to represent a likely contaminant release are or a receptor exposure area; the sampling unit provide an estimate of the mean analyte concentration within that sampling unit.
- Systematic-random sampling conducted within sampling unit with a targeted weight of approximately 1 kg.

SAP Worksheet #9-5 — Project Scoping Session Participants Sheet

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: March 15, 2012 **Scoping Session Purpose:** Concur on monitoring well locations.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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Comments/Decisions: See field visit minutes from the March 15, 2012 Environmental Restoration Program/Munitions Response Program Site Visit below.

Action Items: See below

SAP Worksheet #9-5 — Project Scoping Session Participants Sheet (continued)

Excerpt from the March 15, 2012 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Site Visit Minutes (Final).

Discussion Objective

Concur on monitoring well locations and that installation can take place while the Master SAP is still under review (i.e., before it is finalized).

Key Discussion

The team visited all of the monitoring well locations except for MW-06 and MW-17 because of current site access conditions. Bill Hannah/CH2M HILL provided a general background of each of the sites and the rationale for each of the monitoring wells to the attendees, with particular emphasis on Diana Cutt/EPA hydrogeologist and Mariah Mahoney/TRC hydrogeologist. The team discussed the challenges of mobilizing to some of the locations with a drill rig and also for subsurface UXO safety support during drilling. Diana asked about the spacing of wells between MW-09 and MW-12 to the north of the SIA. Bill responded that the wells are positioned in areas where a higher quantity and diversity of MEC were encountered based on current munitions characterization activities; additional monitoring well(s) may be added if warranted based on future munitions characterization or the findings from the proposed regional monitoring wells.

MW-21 was better positioned in the area of the former targets of the rocket range (Range 4B). Diana added her concern about not having a proposed monitoring well within the western portion of UXO 13 (i.e., near Parcel C) and questioned whether the historical well data provided a control points to sufficiently determine groundwater flow in this area. The Navy will provide Diana further documentation to support that no additional monitoring wells are needed in this area including the groundwater flow maps and historical analytical results via email.

The attendees agreed upon the monitoring well locations as presented in the seed file, with MW-21 being relocated as described above, with the caveat that the need for an additional well in the western portion of UXO 13 is still to be determined. The team also concurred that monitoring well installations can commence following this site visit.

SAP Worksheet #9-6 — Project Scoping Session Participants Sheet

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: May 7, 2012 **Scoping Session Purpose:** Roll-out of the Draft Master SAP; walk through format, key elements, and example sites.	

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SAP Worksheet #9-6 — Project Scoping Session Participants Sheet (continued)

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: May 7, 2012 **Scoping Session Purpose:** Roll-out of the Draft Master SAP; walk through format, key elements, and example sites.	

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Comments/Decisions: See meeting minutes from May 7, 2012 Environmental Restoration Program Technical Subcommittee Meeting below.
Action Items: See below

SAP Worksheet #9-6 — Project Scoping Session Participants Sheet (continued)

Excerpt from the May 7, 2012 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Minutes (Final).

Discussion Objective

Roll out of the Draft Master SAP; walk through the format, key elements, and example sites.

Key Discussion

Bill Hannah/CH2M HILL led the discussion on the Draft Master SAP rollout (issued to the regulators in April) and walked through Worksheets #10 and #17 of the report discussing the overall strategy and using UXO 4 as an example. The team walked through the sample rationale from a regional perspective through the decision unit logic to the actual sampling unit locations.

The team discussed the language that groundwater cannot be developed for use language in the SAP and discussed water sources on Vieques. Danny Rodriguez/EPA noted that Esperanza is able to use the Resolution Aquifer in the event of a water shortage and added that all aquifers on Vieques should be considered to be potable water supplies. The team discussed the land use at the Former VNTR that groundwater is not intended for use. The team discussed the upcoming groundwater monitoring well installations and completion intervals and concurred on longer length well screens (15 ft).

The team discussed collecting additional subsurface soil samples at the OB/OD and SAM site areas and that subsurface soil samples will be collected in accordance with the Vieques Master Protocols. Michael Sivak/EPA noted that the land use restrictions at the ECA are different than at other UXO sites which may warrant more subsurface soil characterization. The team discussed issues with subsurface MEC clearance.

Danny requested that the net explosive weights associated with each demolition event be included with the Master SAP. The team discussed what the next step is to evaluate the extent of contamination. Brett Doerr/CH2M HILL responded that the need for step-out data will be based on the initial findings and the decision process is outlined in Worksheet #11 and the decision tree.

The team discussed the sampling rationale on beaches; discussed Beaches 12 and 13. Daniel Hood/NAVFAC responded that the beaches were surface cleared but not for subsurface removal. These beaches are technically difficult to clear due to submunitions. The team discussed the depleted uranium at the site and the characterization approach.

The team discussed the potential ecological receptors, human health exposure scenarios, and approaches related to decision units and exposure units. Discussion followed on whether the data should be evaluated for residential or wildlife refuge use.

Action Item

Navy/CH2M HILL – provide a plan if the subsurface anomalies prevent collecting a subsurface soil sample in the Draft Final SAP.

Navy/CH2M HILL – provide additional details on how the data evaluation will be extrapolated across the site in the Draft Final SAP.

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SAP Worksheet #9-7 — Project Scoping Session Participants Sheet

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** New York, NY
Dates of Session: August 27 and 29, 2012 **Scoping Session Purpose:** Evaluation of the Navy's responses to Master SAP comments.	

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SAP Worksheet #9-7 — Project Scoping Session Participants Sheet (continued)

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** New York, NY
Dates of Session: August 27 and 29, 2012 **Scoping Session Purpose:** Evaluation of the Master SAP comments.	

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Terry Zdow	Technical Support Contractor to EPA	TechLaw			
Brad Martin	Technical Support Contractor to EPA	TechLaw			

Comments/Decisions: See meeting minutes from August 27-29, 2012 Environmental Restoration Program Technical Subcommittee Meeting below.

Action Items: See below

SAP Worksheet #9-7 — Project Scoping Session Participants Sheet (continued)

Monday, August 27, 2012

The preliminary responses to various EPA comments on the Draft Master SAP were discussed. The following are the key elements/action/revisions made based on the discussion:

EPA Comments 3 and 6 - Reference the UXO 1 scoping session meeting minutes to show how we developed the rationale for 100 sub-samples per incremental sample. We can add another worksheet 9 that has an excerpt from that meeting.

EPA Comment 5 - Beef up response about not analyzing for hexachloroethane degradation products. Add that the deposition would have been surficial (smoke), not buried canisters, that only an insignificant percentage of VOCs could possibly have deposited and that such a small percentage of VOCs would have degraded by now, especially considering how long ago the smoke pots were likely used (WWII timeframe).

EPA Comment 11 – The team discussed different sampling intervals for the surface soil interval. The team discussed potentially collecting incremental samples to 6 inches in order to address potential metals contamination from MEC items in case they had a higher potential for leaching than explosives. EPA responded that they would research this. EQB stated their concern for potentially diluting exposure point concentrations by taking a 6-inch sample if the top 2.5 inches are documented in literature as having the highest potential for contamination. EPA suggested that they were comfortable of the top 6 inches being representative of the exposure interval. Note: Later in the afternoon, Diane Wehner/NOAA discussed with Terry Walker/USACE Environmental and Ammunition Center Risk Assessment technical risk assessor if mobility of metals in soil relative to explosives are different such that different sampling depths should be considered and he said that based on the studies the USACE has conducted, metals associated with explosives tend to not move substantially and have been observed close to the munitions items. He recommended that incremental sampling be selected as the sampling approach for both explosives and metals. He found that even with older ranges the highest concentrations were observed within the uppermost soil interval and recommended that samples be collected from 0-2.5 inches rather than 0-6 inches.

EPA Comment 14 – Diane Wehner/NOAA will provide information on potential screening values that have been used elsewhere. Navy will check internally on comparing constituent concentrations to screening values that have not been widely accepted in the regulated and regulatory communities.

EPA Comment 16 – MEC SOPs/Protocol appendix will be added that includes the standard MEC characterization and related procedures.

EPA Comment 34 – Need to clarify that the additional subsurface soil samples will be in accordance with the modified Vieques protocol (see action item below). Text will be added to the SOP indicating that subsurface soil samples will coincide with depth and location at which MEC or highest anomaly readings are identified.

The preliminary responses to various PREQB comments on the Draft Master SAP were discussed. The following are the key elements/action/revisions made based on the discussion:

PREQB Comment 14 (and all related WS#17s) – Need to articulate MEC DQOs in WS#11 and then in each WS#17, including describing how they have already been met or what the data gaps are and will be done to meet them.

WS#17i, first paragraph – Reference to **Figure 38** should be **Figure 28**.

PREQB Comment 37 – Change response to include reference to the new MEC SOP/Protocol appendix.

SAP Worksheet #9-7 — Project Scoping Session Participants Sheet (continued)

WS#14, under Munitions Characterization Procedures, second paragraph – Revise here and anywhere else, as applicable, what the detonation procedures will be. Now that SOPs will go into an appendix, refer reader to appendix rather than going into detail here. Make clear the differences between detonations before MC characterization is completed vs after it has been completed.

PREQB Comment 4 – Clarify that decision units will not be combined, but evaluated separately. Also, for areas with low potential for MC that are selected as sampling units because of the presence of a unique human health exposure area (such as OP-1), these areas will be evaluated as separate exposure areas or a discussion of why the proposed sampling unit data are appropriate for use in characterizing these unique exposure areas will be provided (such as in the case of OP-1 where the majority of the exposure unit is covered with concrete).

PREQB General Comment 5 – Update response to consider the specific ecological receptors and percent representation of a particular sampling unit to determine whether the mean or max EPC is appropriate to use. For areas that target specific sampling because of human use, make it clear that those sampling units will be evaluated separately rather than be combined with the other sampling units in the decision unit. Make sure there is there text and in the figure showing FWS land use that the locations of proposed land use features are general and may not represent actual locations. In addition, the following will be taken into consideration when updating the Master SAP: That the maximum detected concentrations for a decision unit will be used in Step 3 for those receptors with small home ranges as significant adverse effects to the population may occur from the results obtained from a single sampling unit. Sampling units associated with a specific human receptor (e.g., a proposed observation tower) that may be biased toward low contaminant exposure will not be included in calculating a central tendency estimate for that decision unit for human and ecological receptors and will be evaluated as separate exposure units.

PREQB General Comment 6 – It was agreed that two subsurface soil samples would be collected per sampling unit initially. The data from the subsurface soil samples will be evaluated to determine the need for additional subsurface soil samples or if the subsurface is sufficiently homogeneous as to only require the collection of one subsurface soil sample for adequate characterization.

PREQB Comment 11 – An important point is that USFWS stated that no new trails would be cleared and only current roads would be used for recreational purposes. This information will be added to the Worksheet 11k.
PREQB Comment 55b – PREQB requests that any area selected as a sampling unit that is biased toward receptor exposure but with low potential for MEC would be evaluated as a separate exposure area.

PREQB Comment 60 – The USFWS does not have plans to develop additional trials and the location of proposed future recreational areas, such as hiking trails and scenic areas, are not known at this time. The figure will be footnoted to indicate that the icon placement on the figures is not necessarily representative of the actual location where proposed recreational uses may occur.

PREQB Comment 79 – Add to the response that it is as likely that high quantities of MD represent conservative areas to sample as areas of much lower MD, but more MEC; therefore, adding net explosive weight to the selection criteria would not necessarily result in more conservative sampling. Include in the response why other considerations take care of any uncertainty associated with not including net explosive weight as another selection criterion. Specifically, making sure the MEC items are sufficiently accounted for regarding sampling.

PREQB Comment 23 – Add to this response that once people reach OP-1, they will be mostly on asphalt/concrete areas and in the building, so putting this area in with the roads decision unit is likely conservative.

PREQB Comment 11c and d – Revise response to be that land use feature locations are not specific and not set in stone but instead are general.

SAP Worksheet #9-7 — Project Scoping Session Participants Sheet (continued)

Action Item – Navy/CH2M HILL – include specific protocols for the munitions characterization activities into the Master SAP that are currently referenced in other work plans

Action Item – Navy/CH2M HILL – clarify that subsurface soil sampling will be a modified approach of the Vieques protocol, in that samples will be collected immediately below a subsurface munitions item (MEC and MD) if encountered; otherwise, the normal Vieques protocol will be followed. Text will be added to the SOP indicating that subsurface soil samples will coincide with depth and location at which MEC or highest anomaly readings are identified.

Action Item – EPA –review the 2.5 inch surface sampling interval approach internally.

Wednesday, August 29, 2012

Diane provided feedback again on her discussion with USACE on incremental sampling for members of the subcommittee that were not available yesterday. Michael concurred that he is ok with 0-2.5 inches, but his preference is 0-6 inches. Danny would like to research with EPA further to achieve consensus on 0-2.5 inches.

The team also discussed whether one subsurface soil sample per sampling unit is sufficient. Michael commented that, if possible, the subsurface MEC type should be identified where the subsurface soil sample is collected to see if there is variability amongst the types. Katarina suggested to the team consider collecting two subsurface soil samples per sampling unit initially with the option to decrease or increase the number in the future based on observations of the growing subsurface soil dataset.

Action Item – Navy/CH2M HILL – provide a table of the metals associated with the type of munitions encountered at each site

Consensus – With respect to collecting subsurface soil samples, the Master SAP will be revised to indicate a geophysical instrument-aided technique will be employed to identify the appropriate subsurface sampling location(s) within each sampling unit, which will be proposed in an addendum to the Master SAP for regulatory review concurrence prior to collecting the sample(s). The Navy will start with collecting two subsurface soil samples per sampling unit in the areas of highest anomaly density, but the appropriate number of samples will continue to be evaluated as data are gathered.

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SAP Worksheet #9-8 — Project Scoping Session Participants Sheet

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** New York, NY
Dates of Session: October 23, 2012 **Scoping Session Purpose:** Evaluation of the Navy's responses to Master SAP comments.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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Michael Sivak	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Technical input and review of human health risk evaluation
Tim Garretson	Munitions Response Lead	CH2M HILL	757-287-5222	timothy.garretson@ch2m.com	Address munitions related items
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Wilmarie Rivera	Vieques RPM	PREQB	787-767-8181 x 6129	wilmarierivera@jca.gobierno.pr	Primary PREQB POC.
Jim Pastorik	Technical Support Contractor to PREQB	UXO PRO MEC	703-548-5300	jim@uxopro.com	Technical input and review of munitions related items on behalf of EQB
Katarina Rutkowski	Technical Support Contractor to PREQB, Human Health Risk Assessment Lead	TRC	860-298-6202	krutkowski@trcsolutions.com	Technical input and review of human health risk aspects on behalf of EQB; Primary TRC POC
Tom Hall	Technical Support Contractor to EPA	TechLaw			Technical input on munitions for EPA
Sergio Lopez	Technical Support	EPA	732-321-6778	lopez.sergio@epa.gov	Investigation QC Specialist
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SAP Worksheet #9-8 — Project Scoping Session Participants Sheet (continued)

Project Name: East Vieques UXO Sites Master SAP, Former VNTR	
Projected Date(s) of Sampling: TBD	**Site Name:** East Vieques UXO Sites Master SAP
PM: John Swenfurth	**Site Location:** New York, NY
Dates of Session: October 23, 2012 **Scoping Session Purpose:** Evaluation of the Navy's responses to Master SAP comments.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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Susan Silander	USFWS Caribbean Islands Refuges Supervisor				USFWS representative
Terry Zdow	Technical Support Contractor to EPA	TechLaw			Technical input and review
Jeff Hansen	Technical Support Contractor to EQB	TRC			Technical input and review
Jim Ashworth	Technical Support Contractor to EPA	TechLaw			Technical input and review

Comments/Decisions: See meeting minutes from October 23, 2012 Environmental Restoration Program Technical Subcommittee Meeting below.

Action Items: See below

SAP Worksheet #9-8 — Project Scoping Session Participants Sheet (continued)

The team walked through the evaluation of the Navy's responses to Master SAP comments. Of particular note:

PREQB Comment 5 – The Navy feels that it is likely that more than one round of groundwater samples will be necessary and proposes that sampling all wells using standard methods during the first round is the best way to determine if specialty methods are warranted for particular analytes. The response will be modified to indicate that the first round will be done with the standard methods, but the results will be used to determine if specialty methods are warranted for particular analytes.

PREQB Comment 8 – Transect spacing is selected based on what type of munitions item is likely to be found. Jim Pastorick commented that he would like to see how the MEC DQOs for each individual UXO site have been addressed and where the DQO have not been fully addresses how the data gaps will be resolved. CH2M HILL will send the general DQOs and site-specific DQOs for several sites for Jim to review prior to issuing the draft final.

PREQB Comments on Master SAP Addendum 1 – The Navy will send formal responses; all of the comments appear to be straightforward and did not warrant discussion in the meeting.

EPA Comment 51 – The response will be revised to indicate a sample unit was added within the ephemeral stream.

EPA Comment 57c – The response will be revised to add a description in RAGs Table 1 on vapor intrusion not being an issue. In addition, details for excluding the fish ingestion scenario will be added.

EPA General Comment 1 – Michael Sivak/EPA emailed Brett the suggested language to include in response and, ultimately, the Master SAP to satisfy this comment.

Danny added that the contract for EPA's technical review of documents has not been finalized yet, which will impact the review schedule of the Master SAP Addendum 1, NTCRA status report, Laguna La Chiva SAP, and SWMU 20 SAP. Danny took an action to inform the Navy of the dates when the comments will be submitted on these documents.

Danny also noted that after internal discussion, EPA concurs with the surface soil sample depth interval of 0 – 2.5 inches as being representative of the surface soil interval for human health exposure at the UXO sites.

Consensus – The team concurred that the comments have been adequately addressed (with the above notations) and that the Navy should proceed forward with incorporating the responses and issuing the Draft Final Master SAP to the RAB.

Action Item – CH2M HILL/Navy – provide the general MEC DQOs and a couple site-specific examples of the MEC DQOs to Jim Pastorick for review prior to submittal of the Draft Final Master SAP.

Action Item – CH2M HILL/Navy – provide the Master Ecological Risk Assessment Addendum protocol to the stakeholder agencies

Action Item – Danny/EPA – provide the Navy with the schedule for submitting comments on the Draft Master SAP Addendum 1, NTCRA status report, Draft Laguna La Chiva SAP, and Draft SWMU 20 SAP.

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SAP Worksheet #10 — Problem Definition

This worksheet provides a summary of the background information and key elements of the conceptual site model (CSM) in common to all sites, followed by a narrative description of the general objectives and environmental questions to be answered during the field activities. Following this, individual sub-worksheets (Worksheets #10a through 10o) provide site-specific descriptions pertinent to developing site-specific characterization approaches. In addition, these sub-worksheets provide the status of the munitions investigations/interim actions at each site. For sites where munitions investigations have not been completed and additional data are needed to facilitate the environmental investigations, the planned munitions activities are provided in Worksheet #17, along with the environmental investigation sampling design.

The Master SAP provides for environmental characterization of the various terrestrial sites based on existing information and historical activities, upon which the CSMs are developed. In most cases, that information is sufficient to detail the characterization activities in the Master SAP. However, in some cases, as noted above, supplemental information may be gathered before the characterization activities are conducted (e.g., from ongoing munitions response activities) that may warrant a modification to the planned characterization activities. In other cases, insufficient information about a site currently exists to provide the details of the characterization approach; the planned characterization activities for these sites are more conceptual in the Master SAP. For sites where either of the two situations above apply, site-specific addenda will be prepared that update the CSM (as applicable) and provide the modifications/details of the characterization approach.

Background

Figure 1 illustrates the location of Vieques, Puerto Rico, in the Caribbean Sea, approximately 7 miles southeast across Vieques Passage from the eastern tip of the main island of Puerto Rico. The former VNTR consists of approximately 14,600 acres and is divided into four separate operational areas that from west to east comprise: the 11,000-acre EMA; the 2,500-acre SIA; the 900-acre Live Impact Area (LIA); and the 200-acre Eastern Conservation Area (**Figure 2**). The former VNTR is bound by the Caribbean Sea to the north, east, and south, and the Municipality of Vieques (MOV) to the west.

Former military operations at the former VNTR included ground warfare and amphibious training for Marines, naval gunfire support training, and air to ground training. The former military operations including the ranges, targets, and gun positions at each operational area are shown in **Figure 3**. Following cessation of military operations on the former VNTR, the Navy subdivided the former operational areas into smaller parcels based on considerations such as historic use, geographic features, and land use. The parcels, referred to as UXO sites, were delineated in such a way to make them more manageable for the purposes of prioritization, munitions removal, site characterization, and decision making. It should be noted that "UXO" in the site names is simply convenient nomenclature; it does not indicate the presence or potential presence of UXO. Background information for each of the terrestrial UXO sites is discussed below by former operational area.

Eastern Maneuver Area

The EMA was first established in 1947 and provided military maneuvering areas and ranges for the training in amphibious landings, small arms fire, artillery and tank fire, shore fire control, and combat engineering tasks (CH2M HILL, 2010e). The EMA contains all or part of nine UXO sites (**Figure 3**); two of the sites extend into the adjacent SIA:

- UXO 6 (EMA/SIA Public Roads) – roadway anticipated for public use along the southern portion of the EMA, currently used by personnel for range access (also extends into the SIA)
- UXO 7 (EMA/SIA North Beaches) – sandy beaches and potential turtle nesting areas located along the northern shore (also extends into the SIA)
- UXO 11 (EMA Public Roads) – roadways anticipated for public use along the northern and interior portion of the EMA, currently used by personnel for range access

SAP Worksheet #10 — Problem Definition (continued)

- UXO 12 (EMA Interior) – area where multiple large-scale artillery gun positions fired toward targets located within the SIA and LIA
- UXO 13 (EMA West) - multiple training ranges used for small arms, rifles, submachine guns, rifle and hand grenades, rocket launchers, and shape charges
- UXO 14 (EMA South) - two artillery gun positions and a range that was used for frontal assaults using pistols, rifles, machine guns, and demolition charges
- UXO 15 (Puerto Ferro) – offloading for munitions; the site is being investigated separately and not included in this SAP
- UXO 17 (Other Sites) – includes four Site Screening Areas (SSAs); a former munitions storage area at Potential Area of Concern (PAOC) EE; a former gun position at Photo-Identified (PI) 21 that is being investigated separately and not included in this SAP; a former munitions storage area at PI-14 that is no further action; and a former gun position at PAOC FF that is no further action
- UXO 18 (Cayo la Chiva) – small island where five munitions rocket items were identified

Surface Impact Area

The SIA was established in the 1950s when several Marine artillery targets were constructed. In 1969, two bulls-eye targets were constructed and used for inert bombing; one of which is located within the SIA (CH2M HILL, 2010e). The SIA consists of four UXO sites, plus portions of the two UXO sites previously described (UXO 6, UXO 7) that extends into the SIA (**Figure 3**):

- UXO 5 (SIA Restricted Roads) – roadway anticipated for public use located along the northern and eastern portion of the site, currently used by personnel for range access
- UXO 8 (SIA South Beaches) – sandy beaches located along the southern shore
- UXO 9 (SIA Exterior) – target areas for marine artillery and air-to-ground bombing of practice munitions
- UXO 10 (SIA Interior) – target areas for marine artillery and air-to-ground bombing of practice munitions

Live Impact Area

The LIA was established in 1965 where several targets were maintained for aerial bombing including old tanks and vehicles, a simulated railroad tunnel, simulated ammunition dump, simulated fuel farm, and simulated airstrip, two simulated surface-to-air missile (SAM) sites, and a strafing target (CH2M HILL, 2010e). In addition, several point and area targets were used for ships to practice naval gunfire support. One bulls-eye target was used for inert bombing. The LIA consists of three UXO sites (**Figure 3**):

- UXO 2 (LIA Beaches) – sandy beaches and potential turtle nesting areas located along the northern and southern shores
- UXO 3 (LIA Roads) – roadways within the LIA, restricted to personnel for range access
- UXO 4 (LIA Interior) – formerly contained numerous targets for aerial bombing and naval gunfire, open burn/open detonation (OB/OD) for treatment of retrograde ordnance and open burning of propellants and pyrotechnics. The targets were removed as a part of the TCRA.

The former Central Processing Center (CPC) was established in 2007 for staging and processing of inert metallic items collected during the munitions response activities at the former VNTR (Figure 3). Equipment in the CPC was used to demilitarize inert items and to thermally treat all munitions debris for off-island recycling. The CPC was taken out of full-time service in 2011 because the amount of metal/debris being recovered during ongoing investigations and munitions response activities is significantly less than that recovered during past TCRA and NTCRA activities. However, once the volume of material reaches the point that makes processing viable, processing equipment will be mobilized to the CPC to process and ship the explosive-free metals.

SAP Worksheet #10 — Problem Definition (continued)

Eastern Conservation Area

The ECA, which was wholly designated UXO 1, was established as a conservation area and not used as an operational area for munitions; however, the site is located adjacent to the LIA, where MEC and other munitions-related material identified in the ECA were most likely from munitions directed toward the LIA that missed their intended target.

VNTR Investigation and Interim Action History

On April 30, 2003, the former VNTR was transferred to the Department of Interior (DOI) to be operated and managed by the USFWS as a National Wildlife Refuge and, in some places, a Wilderness Area. Although the DOI is directed to protect and conserve the transferred land as a wildlife refuge, the Navy retains the responsibility for conducting the environmental investigations and clean-up of the property, as warranted.

In 2005, the former VNTR was placed on the National Priorities List (NPL). The NPL required all subsequent environmental restoration activities for Navy Installation Restoration (IR) sites on Vieques to be conducted under CERCLA unless and until removed from CERCLA authority.

The Navy, EPA, PREQB, and the DOI entered into a Federal Facility Agreement (FFA) for the former VNTR in 2007, as a result of the NPL listing and pursuant to CERCLA. The FFA establishes the procedural framework and schedule for implementing the CERCLA response actions for Vieques environmental and munitions sites. SSAs, including PI, PAOC, and Solid Waste Management Units (SWMUs) were also identified as requiring further investigation as part of the FFA. SSAs located within UXO sites and associated with past munitions activities are shown in **Figure 4**.

Below is a list of previous munitions investigations/interim actions (i.e., those focused solely or primarily on the physical presence of munitions) and environmental investigations (i.e., those focused solely or primarily on chemical constituents or hydrogeologic information pertinent to past munitions-related activities) have been conducted at the former VNTR:

- Hydrogeologic Investigation (1999) - groundwater sampling and surface soil sampling conducted along the western boundary of the EMA to determine if explosive constituents were migrating offsite (Baker, 1999) (**Figure 5**).
- Live Impact Area Soil Sampling and Analysis (2000) - 37 surface soil samples analyzed for explosives and inorganic constituents within the LIA (CH2M HILL, 2000) (**Figure 5**).
- Environmental Baseline Survey (2003) (NAVFAC, 2003) –4 soil samples collected from beneath drums and low-lying areas at PI-22 (located within UXO 9); analyzed for Appendix IX Resource Conservation and Recovery Act (RCRA) constituents and total petroleum hydrocarbon (**Figure 5**).
- Preliminary Range Assessment (PRA) (2003) – interviews, records searches, and field inspection of sites using a hand held magnetometer (CH2M HILL, 2003).
- Expanded Range Assessment/ Site Inspection (ERA/SI) (2005-2010) (CH2M HILL, 2007a and 2010e)
  - Initial site investigations – select areas within the former VNTR were inspected to locate, catalog, and remove munitions items at the surface and to locate and qualitatively catalog subsurface metallic anomalies detected using a handheld magnetometer. Information from this investigation is provided in **Attachment A**.
  - Transect inspections and magnetometer survey (mag and flag) – ground-based detector aided visual inspections of munitions items and determination of relative densities of subsurface metallic anomalies along transects within the inland UXO sites (UXOs 4, 9, 10, 12, and 13). Transect inspection paths are shown on **Figure 6**.
  - Light detection and radar (LiDAR) and high resolution orthophotography – aerial survey and photography of the former VNTR to identify ordnance-related ground features such as bomb craters and target areas, as shown in **Figure 3**.

SAP Worksheet #10 — Problem Definition (continued)

  - Aerial magnetometer survey (AMS) – helicopter equipped with an array of magnetometers identified elevated anomaly density areas (EADAs) based on high densities of ferrous metallic objects (or ferrous iron, such as in iron-bearing rock) on the surface and/or subsurface (**Figure 7**).

- TCRA (2005 to present) – interim removal action for munitions located on the surface at the LIA and ECA (**Figure 6)**.
- Non-time critical removal action (NTRCA) (2008 to present) – interim removal action for munitions located in the subsurface of the roads and beaches at the ECA, LIA, and EMA. Digital geophysical mapping (DGM) was conducted along the roads and beaches, as shown in **Figure 6**.
- Preliminary Assessment/Site Inspection (2008) – five surface soil samples were collected from environmental site SWMU 12 located immediately north of OP-1.
- Non-Time-Critical Removal Action (NTCRA) (2009 to present) – interim removal action for munitions located on the surface at UXOs 9 and 10 (SIA) (**Figure 6)**.
- Preliminary Site Inspections of Cayo la Chiva (UXO 18) (2011) and PAOC EE (UXO 17) (2011) - ground-based detector aided visual inspections of UXOs 17 and 18.
- Preliminary Assessment/Site Inspection at Playa La Plata and Secret Beaches (2011) – conducted DGM and anomaly investigation/removal of beach areas that are currently open to the public at UXO 17 (PAOC EE) (**Figure 6**).

As part of the ERA/SI activities, the past use of biological, chemical, and radiological weapons on Vieques was summarized. In May 1969, a test was conducted for four days on non-identified beaches of the former VNTR to determine the operational effects of a persistent, toxic, chemical agent spray attack on US amphibious forces and to evaluate performance of protective clothing worn by troops in the exercise. An aircraft equipped with spray tanks was utilized for the dispersal of tris(2-ethylhexyl)phosphate (U.S. Department of Defense (DoD), 2002). Since the activities were conducted almost 40 years ago and for only a few days on the beaches, which are a dynamic environment, and based on what is known about the persistence of this chemical in the environment, tris(2-ethylhexyl)phosphate is not expected to be present.

In February 1999, a one-time accidental use of armor piercing incendiary depleted uranium (DU) ammunition occurred within the LIA (CH2M HILL, 2010e). Records indicate that ground teams surveyed parts of the LIA in the vicinity of the convoy target area and recovered 116 of the 263 projectiles. Additional details related to the findings of this study are included in Worksheet #10c (UXO 4).

Release History

The primary release mechanisms associated with the former VNTR are particulate deposition as a result of detonations at impact areas and controlled detonations, and from corrosion of the munitions-related items. A less significant release mechanism is propellant detonation from the firing at gun positions. Other potential release mechanisms are site-specific and are therefore discussed in more detail in Worksheets #10a through #10o.

Munitions-related items identified within the former VNTR are generally classified as MEC, Material Potentially Presenting an Explosive Hazard (MPPEH), Munitions Debris (MD) or Range-Related Debris (RRD). MEC is further subcategorized into UXO, Discarded Military Munitions (DMM), and Munitions Constituents (MC). A brief definition of each is summarized below:

- MEC – distinguishes specific categories of military munitions that may pose unique explosive safety risks
- UXO - munitions that have been primed, fused, and armed, or otherwise prepared for action; have been placed in such a manner as to constitute a safety hazard; and remain unexploded
- DMM – munitions that have been abandoned or removed from storage without proper disposal

SAP Worksheet #10 — Problem Definition (continued)

- MC – any materials originating from UXO, discarded military munitions, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such munitions
- MPPEH – material that, prior to determination of its explosives safety status, potentially contains explosives or munitions, or potentially contains a high enough concentration of explosives that the material presents an explosive hazard
- MD – Remnants of munitions remaining after munitions use, demilitarization, or disposal
- RRD – Debris, other than munitions debris, collected from ranges (such as targets and fragments of metal).

MEC found at each site and the potential chemical constituents associated with these items are summarized **Table 19**.

Physical Characteristics

The former VNTR is characterized by gentle to steep rolling hills and valleys with dense vegetation, with the eastern side exhibiting a more rugged terrain. The topography ranges from an elevation of approximately 420 feet (ft) above mean sea level (msl) within the SIA to 0 ft above msl at the beaches. In some areas, large cliff faces separate the ocean from the land. There are two major watersheds within the former VNTR; one to the north and one to the south that are generally divided along the east-west center of the island (**Figure 8**). Surface runoff in the northern watershed generally runs to the north and surface runoff in the southern watershed generally runs to the south.

Surface water on the former VNTR occurs primarily in coastal lagoons and ephemeral streams (**Figure 8)**. Thirty lagoons occur within the former VNTR and are generally not tidally influenced. The ephemeral streams generally only contain water during major precipitation events.

Soil overburden is generally thin and ranges from well-drained soils within the alluvial deposits to fine-grained with a high clay content from the weathering of the bedrock. Bedrock is characterized by volcanic rocks (primarily granodiorite and diorite) generally overlain by alluvial deposits, with limestone and dolomite exposed on the eastern end (**Figure 9**). The alluvial deposits (sand, silt, and clay) are found in valleys and coastal areas and have been found to range up to 50 feet thick (Baker, 1999).

Groundwater is derived from percolating rainwater that infiltrates downward into the alluvial deposits and fractures of the bedrock. The Esperanza aquifer occurs within the alluvial deposits generally within the southwestern portion of the former VNTR (**Figure 10**). Groundwater within the remainder of the former VNTR likely occurs within the bedrock. In areas near the coast, groundwater is tidally influenced and likely brackish to saline. Groundwater discharge is primarily to the ocean, with some minor discharge to the lagoons that are not periodically dry.

The vast majority of east Vieques is undeveloped and supports a variety of habitat types (**Figure 11**). These include bare ground, beach, salt/sand flat, lagoon, mangrove, evergreen scrub, forest scrub, forested, sparse thorn scrub, thick thorn scrub, and grassland. Typical plant species in bare ground areas consist of scattered milkweeds (*Calotropis procera*), low scattered mesquite (*Prosopis juliflora*), and low herbaceous vervain (*Stachytarpheta jamaicensis*). Open sandy beach and beach scrub communities typically include the beach creeper (*Ipomoea pes-caprae*), sand spur (*Cenchrus* spp.), and seagrapes (*Coccoloba uvifera*). Mangrove communities are typically associated with open-water lagoons and shallow salt/sand flats or tidal mudflats, and include red mangrove (*Rhizophora mangle*), white mangrove (*Laguncularia racemosa*), black mangrove (*Avicennia germinans*), and button mangrove (*Conocarpus erectus*) (Geo-Marine, 2003).

Thorn scrub is the predominant habitat type, occurring over approximately 80 percent of the area. Common species include Acacia spp., mesquite, *Leucaena glauca*, box-briar (*Randia aculeata*), goatbush (*Pithecellobium unguis-cati*), sage (*Lantana involucrate*), and Croton spp. The forest scrub and forested communities are limited within the area,

SAP Worksheet #10 — Problem Definition (continued)

typically occurring along quebradas and low areas near the coastline where the water table is high or periodically high, such as along the inland borders of mangrove forests. Common species include oxhorn bucida (*Bucida buceras*), box-briar, tachuelo (*Pictetia aculeate*), goatbush, and Jamaican caper (*Capparis cynophallophora*). Evergreen scrub consists mainly of drought-resistant shrubs with leathery leaves and occurs on rocky coasts and limestone formations that are exposed to sea breezes. Dominant species in this community include spoon tree (*Cassine xylocarpa*), uverillo (*Coccoloba microstachya*), Alelí (*Plumeria alba*), palmetto (*Thrinax morrissi*), crabwood (*Coccoloba krugii*), and black torch (*Erithalis fruticosa*). The grassland plant community is dominated by short bunch grasses and sod grasses, including pitted bluestem (*Bothriochloa pertusa*), southern crabgrass (*Digitaria ciliaris*), bermuda grass (*Cynodon dactylon*), Dutch grass (*Eleusine indica*), smutgrass (*Sporobulus indicus*), and sandbur (*Cenchrus brownii*) (Geo-Marine, 2003).

Land Use

The former VNTR was transferred to the DOI in 2003 to be managed by USFWS as a National Wildlife Refuge and, in some places, a Wilderness Area, pursuant to Section 1049 of the National Defense Authorization Act for Fiscal Year 2002 (Public Law 107-107). A provision of this law states that the LIA must be managed as a wilderness area and public access is to be prohibited (Public Laws 106-398 and 107-107). Therefore, no lawful public access is allowed on the LIA and groundwater is not intended for use at this time. The existing legal land use controls accompanying the Congressional transfer of the LIA to the USFWS as a wilderness area render future residential land use unrealistic without a subsequent Congressional act.

Based on the available plans from the USFWS (landowner), no building construction is anticipated at any of the subject sites, with the exception of the observation tower at UXO 6, and there are no existing buildings. It should be noted that, for the sites addressed in this SAP, an SVOC is potentially present at only one site (i.e., hexachloroethane at Cayo La Chiva – UXO 18). Therefore, vapor intrusion is not an issue.

A Comprehensive Conservation Plan (CCP) for the Vieques National Wildlife Refuge was completed by USFWS that outlines the land use plan for managing the former VNTR as a wildlife refuge (DOI, 2007). The land use plan includes areas desired for public use (i.e., picnic areas, beaches, road access, etc.) within the SIA and EMA (**Figure 12**). The exact location of the proposed future recreational areas, such as hiking trails and scenic areas, are not known at this time, USFWS does not have plans to develop additional recreational areas and trails than what is shown in the CCP. The existing legal land use controls accompanying the Congressional transfer of the SIA and EMA to the USFWS as a wildlife refuge render future residential land use unrealistic without a subsequent Congressional act. An exception is a small parcel of land located within the northwest portion of UXO 13 (denoted as Parcel C), which is being considered for transfer by DOI to the Puerto Rico Conservation Trust (PRCT) or Municipality of Vieques (MOV) for unrestricted public use.

In addition, the eastern end of Vieques houses a variety of natural resources in the form of wide-ranging plant and wildlife species. A number of conservation zones have been established in the former VNTR to help protect these resources (Geo-Marine, 2003) (**Figure 12**). The Conservation Zones include:

- The Punta Este Conservation Zone located on the southeastern end of the LIA, consisting primarily of drought-resistant scrub that no longer can be found elsewhere in Puerto Rico.
- The Cayo Conejo Conservation Zone is a small island located southwest of the LIA in Bahia Salina del Sur area. This area is an important nesting habitat for the endangered brown pelican and one of the last nesting areas for this species in Puerto Rico.
- The Ensenada Honda Conservation Zone lies between Blue and Yellow Beaches on the southern coast of Vieques. This area has the best example of lowland forest growth on Vieques and is also home to a variety of extensive mangrove populations that appear to be healthy and expanding.
- The South Coast Bays Conservation zone is located on the southern coastline of Vieques directly south of the Camp Garcia area and western portions of the EMA. Two bays at this location, Bahia Tapon and Puerto Mosquito, have bioluminescent properties and are a valuable tourism resource for the island.

SAP Worksheet #10 — Problem Definition (continued)

Sea turtle nesting occurs primarily from February through August. The sea turtles that have been observed on Vieques are the green, leatherback, and hawksbill sea turtles (Geo-Marine, 2003). The locations of sea turtle nesting are shown on **Figure 12.**

Potential Receptors

Potential receptors at the former VNTR include both human and ecological. While receptor types are broadly similar across the former VNTR, receptor types are discussed on a site-specific basis because they are influenced by habitat and proposed actual/future land use. The site-specific receptor details are provided in Worksheets #10a through 10o. Subsurface soil receptors may be present at a few sites (e.g., reforestation areas, Parcel C, and UXO 9), and will be identified in consultation with USFWS. At sites where subsurface soil activities are reasonably foreseeable, subsurface exposures will be evaluated for site-specific subsurface receptors (e.g., USFWS workers and/or construction workers). Residential receptors will not be evaluated in the HHRAs, with the exception of Parcel C; residential exposures will be evaluated using two separate EPCs (i.e., surface soil and total soil). Subsurface soil exposures will also be evaluated for construction workers and industrial workers at Parcel C.

It is important to note that if, prior to or during the human health and ecological risk assessments, data gaps are identified that warrant additional sampling, additional sampling will be proposed/conducted prior to completing the risk assessments and RI Reports. The additional sampling will be conducted in accordance with this SAP, an addendum to this SAP, or other mechanism that demonstrates formal concurrence by the Navy and regulatory agencies.

Objectives and General Characterization Approach

The ERP/MRP Technical Subcommittee met in May, August, and October 2011 and March, August, and October 2012 to jointly scope the rationale, sampling approach, and analysis for the investigation of the east Vieques UXO sites. The investigation objectives are to:

- sufficiently characterize the nature and extent of MEC at each UXO site such that:
  - final remedy determinations can be made regarding MEC
  - environmental media can be appropriately characterized
- determine if there has been a release of chemical constituents related to the former munitions-related activities at each UXO site, and, if so:
  - whether the data sufficiently represent the nature and extent of contamination
  - whether site-related contamination, if present, poses unacceptable human health and or ecological risks
  - determine whether site-related contamination, if present, warrants action to achieve the proposed land use goals

Characterizing potential contamination within soil at sites on the former VNTR is challenging due to the large size of the sites (14,600 acres) and the widespread distribution of MEC and related scrap. Various studies have shown that concentrations of energetic residues at military ranges measured using an incremental sampling approach were statistically more representative than those from traditional sampling protocols (USACE, 2009). Desirable levels of statistical confidence and decision uncertainty can be obtained using fewer incremental samples than multiple discrete analyses. Incremental sampling reduces the impacts of soil heterogeneity on laboratory analytical results by providing an average concentration over an exposure area rather than at a discrete point (i.e., reduces field sampling and laboratory processing errors), has a higher likelihood of detecting contamination than discrete sampling if the location of contamination is unknown, and includes particle reduction by grinding or milling and mixing. Quality Assurance/Quality Control (QA/QC) field triplicate samples will also be performed to confirm the

SAP Worksheet #10 — Problem Definition (continued)

representativeness of the analytical results. The highest concentrations among the field triplicate samples will be used to represent the particular sampling unit. On site-specific and objective-specific cases, discrete samples are warranted and will be collected. This is further discussed in Worksheet #17.

Incremental sampling provides a single result (per chemical) for a decision unit or from one or more sampling units within that decision unit. A decision unit and associated sampling units are generally selected based on the exposure domain for human or ecological exposure, by an area influenced by a specific activity, and/or by an area influenced by a single event. Decision unit and sampling unit size and shape are controlled by the environmental concerns posed by the contaminants present and the intended use of the site.

To distinguish inorganic constituent concentrations attributable to site-related releases from those attributable to other sources, soil data collected will be compared to the background data set for soil on Eastern Vieques, documented in the report entitled East Vieques Background Soil Inorganics Investigation Report (CH2M HILL, 2007b). Background incremental soil samples collected as part of the ECA RI were determined to be statistically comparable to the background discrete soil samples collected as part of the background study (**Attachment B**). Since soil background data are not available for the beaches, a multiple lines of evidence approach will be used, such as comparing to the adjacent terrestrial lithologic unit background data. If necessary, background data would be collected from a representative background beach(es), if identified. If a representative background beach(es) is identified, it will be included in an addendum to the Master SAP for regulatory review.

Surface water and sediment samples collected from lagoons will be compared to background data collected from a similar lagoon or in the absence of a representative background dataset, a weight of evidence evaluation will be used, as was done for the ECA lagoon (CH2M HILL, 2011a).

MEC and Environmental Questions to be Answered for Each UXO Site

1. What is nature and extent of MEC?

This question will be answered by having conducted or conducting sufficient MEC investigations/interim actions at the UXO sites, as applicable, for facilitating environmental characterization and for making MEC remedy evaluations and determinations consistent with historical munitions activities and future land use.

2. What is the explosive safety hazard associated with the munitions?

A MEC explosive risk evaluation will be conducted for each site using the MEC Hazard Assessment (MEC HA).

3. Has there been a release of chemical constituents to environmental media related to former site activities and, if so, do the data sufficiently represent the nature and extent of contamination?

Details of the sampling design and rationale for each UXO site are presented in Worksheet #17. Sample data will be evaluated using the 6-Step Decision Process depicted in the decision analysis tree (**Figure 13**).

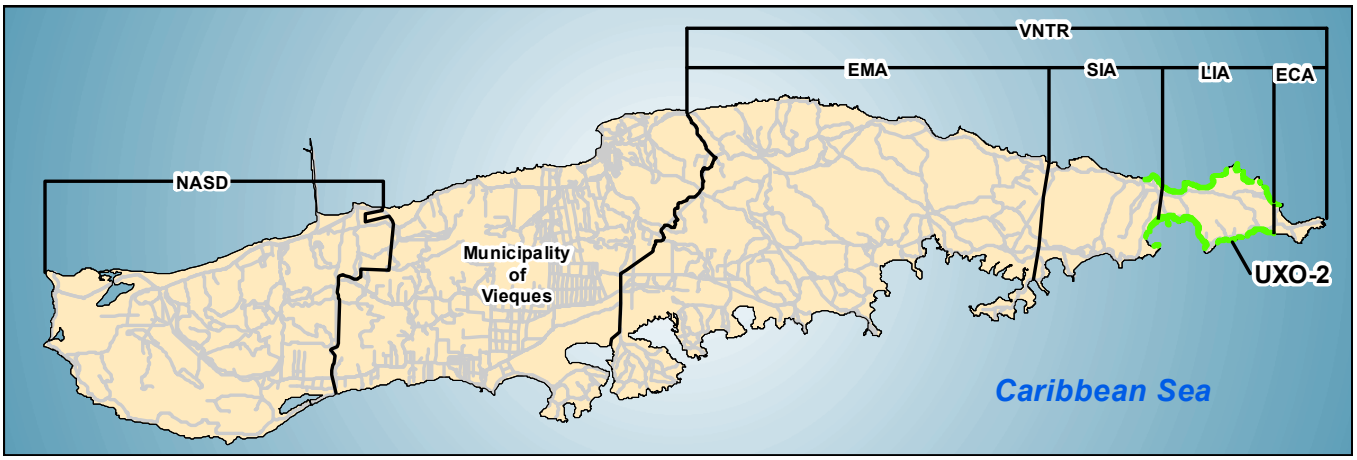
4. What are the potential human health and ecological risks posed by contamination attributable to former site activities?

Results from the environmental media characterization will be evaluated in site-specific HHRAs and ecological risk assessments (ERAs).

5. Based on the data collected during the remedial investigation (including supplemental sampling if additional data needs are identified), what is the appropriate path forward for the site?

The results of the HHRA and ERA will be used, in conjunction with risk management considerations (e.g., land uses, control mechanisms, remedy feasibility), to determine: (1) if additional data are warranted to make site-specific determinations, or (2) if remedy/removal actions are warranted, or (3) if no further action other than land use controls is warranted.

SAP Worksheet #10a — UXO 2 (LIA Beaches)



Site Background

UXO 2 (LIA Beaches) consists of 15 sandy beaches and totals approximately 71 acres in size, located along the perimeter of the LIA (**Figure 14**). Each beach is bounded by the Caribbean Sea and UXO 4 (LIA Interior). Named beaches include Playa Salinas Del Sur (Beach 3), Playa Carucho/Turtle Beach, Icacos/Playa Yallis, Playa Salinas del Norte/Fossil Beach, Playa Brava (Beach 14), and Playa Barco (Beach 13). The designated area of each beach includes not only the proper sandy, unvegetated area, but also potential turtle nesting areas from the beach vegetation line to 60 feet inland. Details of the former operations at the LIA are provided in Worksheet #10c (UXO 4).

Investigation and Release History

- ERA/SI (2005), TCRA – surface removal of MEC (2005 through present), and NTCRA – subsurface removal of MEC (2009 through present)
- No environmental investigations have been conducted at UXO 2

The LIA beaches were surface cleared of munitions located on or protruding from the ground surface as part of the ERA/SI and TCRA. Through October 2012, DGM has been conducted at approximately 13 of the 71 acres, as part of the NTCRA (**Figure 6**). The DGM anomalies were investigated to a maximum depth of 4 ft bgs; the investigation of the anomalies was abandoned if the water table or refusal was encountered prior to reaching 4 ft bgs.

Approximately 8,275 subsurface metallic anomalies have been identified, and removed; however, the NTCRA is currently ongoing. Munitions-related items found at the site in the surface and subsurface (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	106	553	0	108,401	22,585
Subsurface	256	424	0	24,110	43,654

Through the end of October 2012, the highest densities of munitions items found at beaches within the former VNTR were identified at UXO 2; the density of munitions items recovered was greatest at Playa Carucho/Turtle Beach and Playa Salinas del Norte/Fossil Beach. Munitions items are primarily from naval gunfire and aerial bombing at targets within the LIA Interior. There are no ranges, gun positions, or SSAs located on the LIA beaches (**Figure 14**). Intact and detonated MEC items and munitions debris and the historical detonations had the potential to release chemical contaminants to the environmental media at the beaches. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17a.

SAP Worksheet #10a — UXO 2 (LIA Beaches) (continued)

Conceptual Site Model

Figure 15 presents the generalized conceptual site model of UXO 2.

Physical Characteristics and Transport Pathways

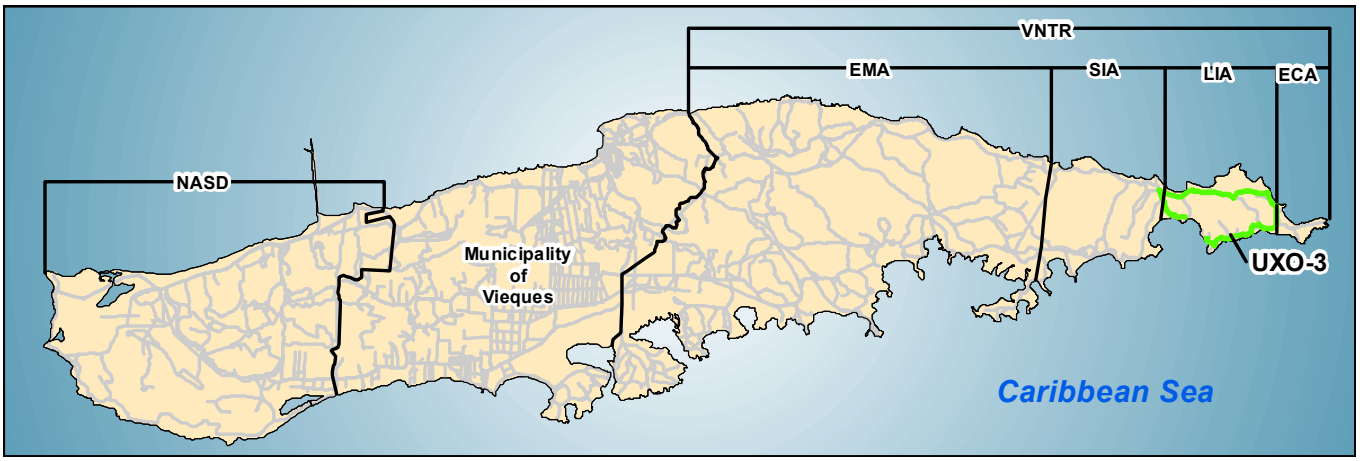
UXO 2 is predominantly sand beaches and dunes that extend from the waterline (low tide waterline during munitions characterization) to the vegetation extent. It also includes vegetated areas that extend approximately 60 feet inland to account for potential turtle nesting areas. The topography slopes toward the ocean and potentially receives runoff from the LIA interior. The beaches are a dynamic environment in that they are prone to tidal, wave, and storm action. Groundwater is shallow and saline due to seawater intrusion. The primary potential migration pathways at UXO 2 are associated with reworking of the beach sands by storm surges, tides, and waves. Constituents could also migrate via leaching to groundwater and wind dispersion.

Future Land Use and Potential Receptors

The LIA is managed as a Wilderness Area and future land use at the LIA beaches is prohibited to the public and is to continue as a wilderness area (Public Laws 106-398 and 107-107). The majority of the beaches are classified as turtle nesting grounds (**Figure 14**), with 14 beaches identified as restricted turtle nesting areas (Geo-Marine, 2003). Eight beaches are identified as major restrictions (where four or more historical sea turtle nesting events have occurred) and six beaches as minor restrictions (one to three historical sea turtle nesting events).

USFWS workers (for turtle monitoring) and trespassers (adults, adolescents, and children) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC. Historical trespassing activities have been observed at Icacos/Playa Yallis Beach. The primary potential ecological receptors are the eggs of hawksbill, green, and leatherback sea turtles exposed to deeper surface soil (18 to 36 inches). Other potential terrestrial receptors for surface soil (upper 2 inches) are terrestrial plants, terrestrial invertebrates, reptiles, Norway rat, Indian mongoose, common ground dove, and pearly-eyed thrasher.

SAP Worksheet #10b — UXO 3 (LIA Roads)



Site Background

UXO 3 (LIA Roads) consists of approximately 39 acres of roadways within the LIA, including a 25-foot buffer zone along each side of the roads (**Figure 14**). The roadways are dirt roads used for range access and generally occur within the lower lying areas of the LIA. Details of the former operations at the LIA are provided in Worksheet #10c.

Investigation and Release History

- ERA/SI (2005), TCRA – surface removal of MEC (2005 through 2009), and NTCRA – subsurface removal of MEC (2009 through present)
- No environmental investigations have been conducted at UXO 3

The LIA roads were surface cleared of munitions as part of the TCRA. Through October 2012, DGM has been conducted at approximately 14 of the 39 acres, as part of the NTCRA (**Figure 6**). Approximately 0.3 acres have been subsurface investigated; however, the NTCRA is currently ongoing. The DGM anomalies were investigated to a maximum depth of 2 ft bgs; the investigation of the anomalies was abandoned if the water table or refusal was encountered prior to reaching 2 ft bgs. The items found at the at the ground surface through October 2012 are summarized below. Due to the evaluation of the Metal Mapper System for potential use in future munitions response activities, the items recovered from the subsurface at UXO 3 have not been made available at the time of this SAP in order to maintain the integrity of the evaluation and not potentially impact the data evaluation.

Munitions related items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	403	1,776	0	102,627	79,723
Subsurface	0	0	0	11	0

Through the end of October 2012, the density of munitions items recovered was greatest within the northwestern and north-central portion of the site. Munitions items identified are primarily from naval gunfire, artillery, and aerial bombing at targets within the LIA Interior. The roadways pass through the former Naval Gunfire Support target areas, but no specific targets were placed on the roads. There are no ranges, gun positions, or SSAs on the LIA roads. Intact and detonated MEC items and munitions debris and the historical detonations had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17b.

SAP Worksheet #10b — UXO 3 (LIA Roads) (continued)

Conceptual Site Model

Figure 15 presents the generalized conceptual site model of UXO 3.

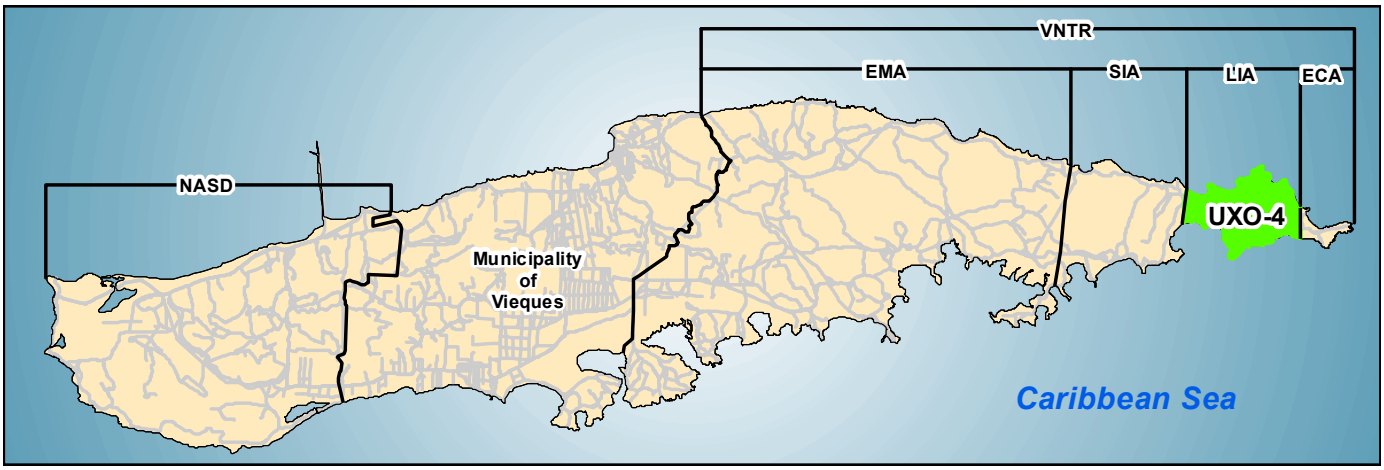
Physical Characteristics and Transport Pathways

UXO 3 is a dirt roadway that overlies limestone and dolomite bedrock. The roadways may act as a preferentially pathway for surface runoff during precipitation events and may also receive runoff from the LIA interior. Constituents could also migrate via leaching to groundwater and wind dispersion.

Future Land Use and Potential Receptors

The LIA is managed as a wilderness area and future land use at the LIA roads is prohibited to the public and will be used primarily by USFWS personnel for beach access as part of land management. Potential human receptors comprise USFWS workers and trespassers (adolescent and adult) exposed to soil and potentially exposed to the explosive hazard associated with MEC. Potentially complete exposure pathways for terrestrial ecological receptors exposed to surface soil include plants, soil invertebrates, birds, mammals, and reptiles. Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.

SAP Worksheet #10c — UXO 4 (LIA Interior)



Site Background

UXO 4 (LIA Interior) is approximately 855 acres in size, located in the eastern portion of the former VNTR. The site is bounded to the east by the ECA, to the west by the SIA, and to the north and south by UXO 2. In 1965, air-to-ground training activity began, where targets such as old tanks and vehicles were used for aerial bombing. Beginning in the mid-1970s, naval gunfire was practiced, where several point and area targets for ships were constructed. Former range features are shown on **Figure 14** and summarized below.

- Numerous former targets including a strafing target near the border with the SIA, two mock surface to air missile sites (SAM East and SAM West), a mock convoy, mock railroad tunnel, mock ammunition dump, mock fuel farm, mock airstrip, and Bull's eye target #1 used for inert bombing. The LIA was formerly designated as Solid Waste Management Unit (SWMU) 9 - Explosive Ordnance Firing Range (LIA bombing range).The CPC was also located within UXO 4, encompassing the area immediately around Bulls eye target #1.
- A former OB/OD area for treatment of unserviceable ordnance; the OB was designated for open burning of waste propellants and pyrotechnics; the OD was used for the destruction of retrograde munitions with high explosives in excavated earthen pits. Solvents were reportedly not used at the site. The OB/OD area was formerly designated as SWMU 3 – Waste Explosive Ordnance Detonation Area (LIA OB/OD).

MEC clearance and target refurbishment was conducted semi-annually at the LIA starting in 1983. Approximately 30 percent of the LIA was cleared of surface MEC during each of the semi-annual events, which included individual targets and a 100-foot radius around the target complexes, roads, beaches, and other designated points on the range where personnel would access the area. Recovered items were demilitarized at the OB/OD pit.

In 1999, a total of 263 depleted uranium (DU) armor-penetrating projectiles were accidentally fired at the simulated convoy targets in the LIA (**Figure 14**). In 2000, the Navy and NRC conducted two phases of a DU survey and completed an environmental survey, which included the collection of 84 soil, 17 vegetation, 7 surface water, and 6 sediment samples (also included areas outside of the LIA) (**Figure 15**) (NRC, 2000b). In total, 116 of the 263 penetrators were recovered. The penetrators were identified and recovered at the ground surface or within a few inches from the ground surface. The 2000 NRC Environmental Survey concluded that radiation levels were associated with background, except within the immediate vicinity of each individual penetrator (NRC, 2000b). Since 2000, only 6 casings and no penetrators have been recovered. In addition, the 2003 Agency for Toxic Substances and Disease Registry (ATSDR 2003) Final Health Assessment (ATSDR, 2003) concluded that residents are not exposed to levels of radiological contamination that could present a public health hazard. The Draft 2011 ATSDR Evaluation of Data Report confirmed the findings of the 2003 Health Assessment (ATSDR, 2011). However, a confirmation study will be conducted within the depleted uranium area as part of the environmental characterization activities, which is detailed in Worksheet #17c.

SAP Worksheet #10c — UXO 4 (LIA Interior) (continued)

Investigation and Release History

- Soil Sampling (2000), PRA (2002 through early 2003), ERA/SI (2005 through 2010), and TCRA - surface removal of MEC (2005 through present).
- Thirty-seven surface soil samples (0 – 6 inches below ground surface (bgs)) were collected previously throughout the LIA **(Figure 5**) (CH2M HILL, 2000). Two explosives were detected above current screening levels (nitroglycerine and 2,4,6-trinitrotoluene [TNT]) at only one location. Since the data are more than 10 year old and were collected before the TCRA was initiated, the results are used primarily for informational purposes and will not be included in the dataset used for this site once the new data are collected.

Transect inspections were conducted in 2005 over approximately 8 percent of UXO 4 to assess the number of MEC items present on the ground surface. The LIA Interior was surface cleared of munitions as part of the TCRA; approximately 99 acres were not cleared due to lagoon areas inundated with standing water (22 acres), area of steep slopes (9 acres), and the submunitions area (68 acres). Approximately 2.5 acres within the former mock runway of UXO 4 were surveyed via DGM and 1,488 anomalies were identified; however, none of the anomalies have been investigated to date. Munitions-related items found at the site (recovered through October 2012) are summarized below:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	6,402	44,864	84	3,175,755	2,190,525
Subsurface	0	0	0	0	0

Through the end of October 2012, the density of munitions items recovered within UXO 4 was greatest within the central portion of the site. Munitions items are primarily from naval gunfire and aerial bombing at the targets and also from OB/OD activities. Two SWMUs (SWMU 3 and SWMU 9) occur within UXO 4. Intact and detonated MEC items and munitions debris, historical detonations, and OB/OD operations had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17c.

Conceptual Site Model

Figure 15 presents the generalized conceptual site model of UXO 4.

Physical Characteristics and Transport Pathways

The LIA comprises primarily limestone and dolomite exposed at the ground surface with low-growing dense vegetation (**Figure 9**). Vegetation was also present during the time of military operations. The western portion of the LIA transitions to sandstone/siltstone/tuff. The topography ranges from over 160 ft msl in the south-central portion of the site to 0 ft msl at the beaches. Numerous craters exist within the site, but are most prominent in the central portion of the site.

Three lagoons (Laguna Anones, Laguna Gato, and Laguna Icacos) occur within the western portion of the site (**Figure 14**). These lagoons are not tidally influenced and the temporal presence of surface water is believed to be wholly or primarily the result of precipitation. Standing water has also been observed in some of the craters at the site.

The soil overburden is expected to be thin (non-existent where the bedrock outcrops), fine-grained and to have a high clay content from the weathering of the bedrock. Percolating rainwater infiltrates downward into the fractures of the bedrock. Groundwater within the LIA likely occurs within the bedrock, and near the beaches and lagoons the water table is likely encountered near sea level and tidally influenced. Groundwater discharge is to the ocean and believed to temporally discharge to the lagoons since the lagoons are periodically dry.

SAP Worksheet #10c — UXO 4 (LIA Interior) (continued)

Contaminated surface soils may be transported by surface runoff (overland flow) with topography. The central portion of the site generally slopes toward Laguna Anones, the northern portion slopes to the north, and the southern portion slopes to the south. Contaminants at and beneath the ground surface may migrate downward through the unsaturated zone by leaching from precipitation infiltration. Contaminants could then migrate within groundwater and discharge to the ocean and lagoons. Wind dispersion is another potential migration pathway; however, the vegetation onsite likely limits this mode of transport.

Future Land Use and Potential Receptors

The LIA is managed as a wilderness area by law and public access is prohibited. Therefore, no lawful public access is allowed on the LIA and groundwater is not intended for use at this time. The northeastern portion of UXO 4 is also considered a conservation zone (**Figure 12**).

USFWS workers and trespassers (adolescents and adults) may be exposed to soil, surface water, and sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue. Potentially complete exposure pathways exist for terrestrial ecological receptors exposed to surface soil and deeper surface soil around lagoons, and aquatic ecological receptors exposed to surface water and sediment in the lagoon. Potential ecological receptors include:

- Terrestrial – plants, soil invertebrates, birds, mammals, and reptiles exposed to surface soil; land crabs within the lagoon fringe exposed to deeper surface soil (0 to 2 feet). Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.
- Aquatic – fish, benthic invertebrates (including crabs), aquatic plants, birds, and mammals exposed to surface water and sediment in the lagoons. Potential birds and mammals consuming fish, invertebrates, or plants include the Fishing Bat, Velvet Free-tailed Bat, Cave Swallow, Green Heron, Spotted Sandpiper, and White-cheeked Pintail.

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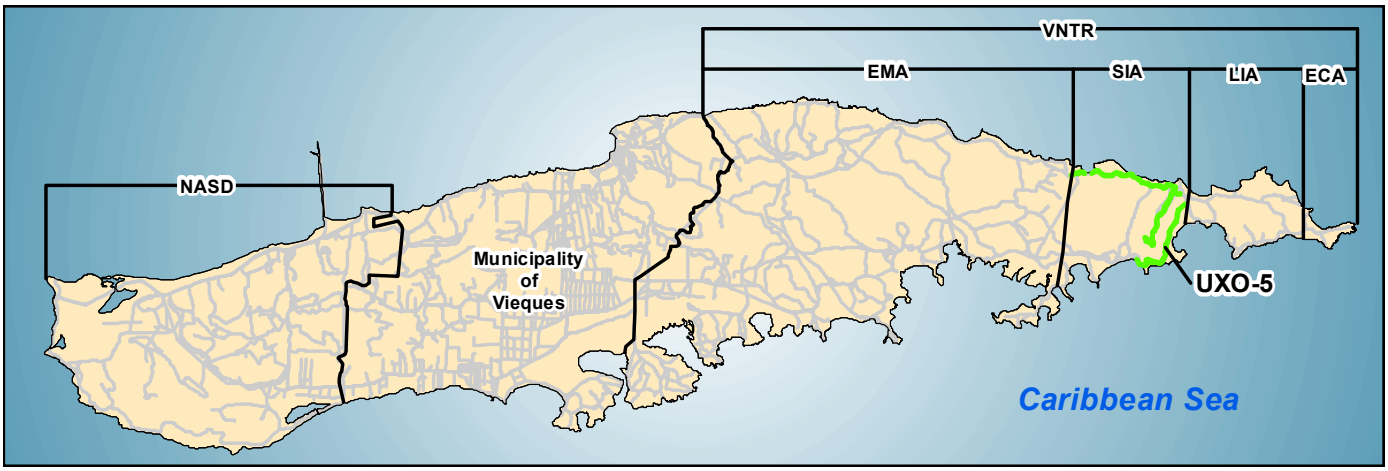
SAP Worksheet #10d — UXO 5 (SIA Restricted Roads)



Site Background

UXO 5 (SIA Restricted Roads) consists of approximately 38 acres of roadways within the SIA, including a 25-foot buffer zone along each side of the roads (**Figure 17**). The roadways are dirt roads currently used for range access. One SSA (PI-22) overlaps a portion of UXO 5; however, this site is addressed as part of UXO 9 (SIA Exterior). Details of the former operations at the SIA are provided in Worksheets #10i and #10j.

Investigation and Release History

- ERA/SI (2005 through 2010) and NTCRA – surface and subsurface (2009 through present)
- No environmental investigations have been conducted at UXO 5

Transect inspections were conducted in 2008 to assess MEC on the ground surface and covered approximately 8 percent of the SIA. The SIA roads were surface cleared of munitions as part of the surface NTCRA. Through October 2011, DGM has been conducted at approximately 22 of the 38 acres, as part of the NTCRA (**Figure 6**). A total of 13,908 subsurface metallic anomalies have been identified and 2,445 have been intrusively investigated; however, the NTCRA is currently ongoing and investigation results are subject to change. The DGM anomalies were investigated to a maximum depth of 2 ft bgs; the investigation of the anomalies was abandoned if the water table or refusal was encountered prior to reaching 2 ft bgs.

MEC items identified within UXO 5 are primarily a result of artillery fire and air to ground bombing at the SIA and potential target misses from the LIA. The items found at the site in the surface and subsurface (through October 2012) are summarized below:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	62	174	17	4,900	6,946
Subsurface	26	14	0	10,911	3,518

Through the end of October 2012, the density of munitions items recovered was greatest at within the northwestern and northeastern portions of the site adjacent to the former bulls-eye targets. No gun positions occur within the site. Intact and detonated MEC items and munitions debris, historical detonations, and particulates from artillery fire at the former gun position had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17d.

SAP Worksheet #10d — UXO 5 (SIA Restricted Roads) (continued)

Conceptual Site Model

Figure 18 presents the generalized conceptual site model of UXO 5.

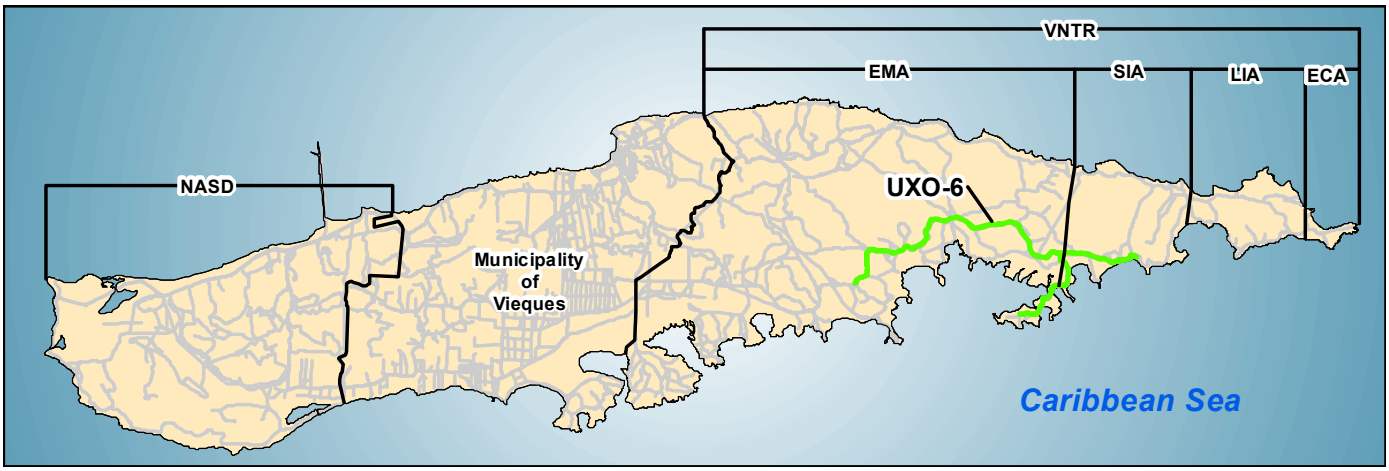
Physical Characteristics and Transport Pathways

UXO 5 is a dirt roadway that overlies marine sedimentary, lava, and tuff bedrock in both topographically high and low areas within the site. The majority of the roadway runs close to the coast; however, the roadway provides access to an observation post (OP-1) at an elevation of over 420 ft msl. The roadways may act as a preferential pathway for surface runoff during precipitation events and may also receive runoff from the SIA exterior and interior (UXOs 9 and 10). Constituents could also migrate via leaching to groundwater and wind dispersion.

Future Land Use and Potential Receptors

In the CCP, the SIA roads are shown as desired for future public use with a lookout area, scenic view, and access to an historic site. However, the SIA as a whole is to be managed as a wildlife refuge. Potential receptors at the site include both human and ecological. USFWS workers, public recreators, and trespassers (adults and adolescents) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC. Potentially complete exposure pathways for terrestrial ecological receptors exposed to surface soil include plants, soil invertebrates, birds, mammals, and reptiles. Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.

SAP Worksheet #10e — UXO 6 (EMA/SIA Public Roads)



Site Background

UXO 6 (EMA/SIA Public Roads) consists of approximately 62 acres of roadways throughout the EMA and SIA, including a 25-foot buffer zone along each side of the road (**Figures 18 and 19**). The western portion of UXO 6 lies in the former EMA and the eastern portion lies in the former SIA. The roadways are dirt roads currently used for range access. Details of the former operations at the EMA and SIA adjacent to UXO 6 are provided in Worksheets #10i, #10j, #10k, and #10m.

Investigation and Release History

- ERA/SI (2005 through 2010) and NTCRA – surface and subsurface removal of MEC (2009 through present)
- No environmental investigations have been conducted at UXO 6

Transect inspections conducted over approximately 10 percent of UXO 6 during the ERA/SI did not identify munitions on the ground surface. These roads were regularly used and maintained by the Navy during the operation of the former VNTR. Through October 2012, DGM has been conducted at approximately 17 of the 62 acres, as part of the NTCRA (**Figure 6**). A total of 5,753 subsurface metallic anomalies were identified and removed; however, the NTCRA is currently ongoing and the results are subject to change. The DGM anomalies were investigated to a maximum depth of 2 ft bgs; the investigation of the anomalies was abandoned if the water table or refusal was encountered prior to reaching 2 ft bgs.

MEC items identified within UXO 6 are likely a result of artillery fire and air to ground bombing at the SIA. Munitions items recovered from UXO 6 were only within the SIA portion along the eastern portion of the roads. Munitions items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	11	13	200	3,303	14,675
Subsurface	17	3	0	15,766	2,798

The roadway also runs through a portion of four gun positions; however, these gun positions are addressed as part of UXOs 12 and 14. There are no SSAs within UXO 6. Intact and detonated MEC items and munitions debris, historical detonations, and particulates from artillery fire at the former gun positions had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17e.

SAP Worksheet #10e — UXO 6 (EMA/SIA Public Roads) (continued)

Conceptual Site Model

Figure 18 presents the generalized conceptual site model of UXO 6.

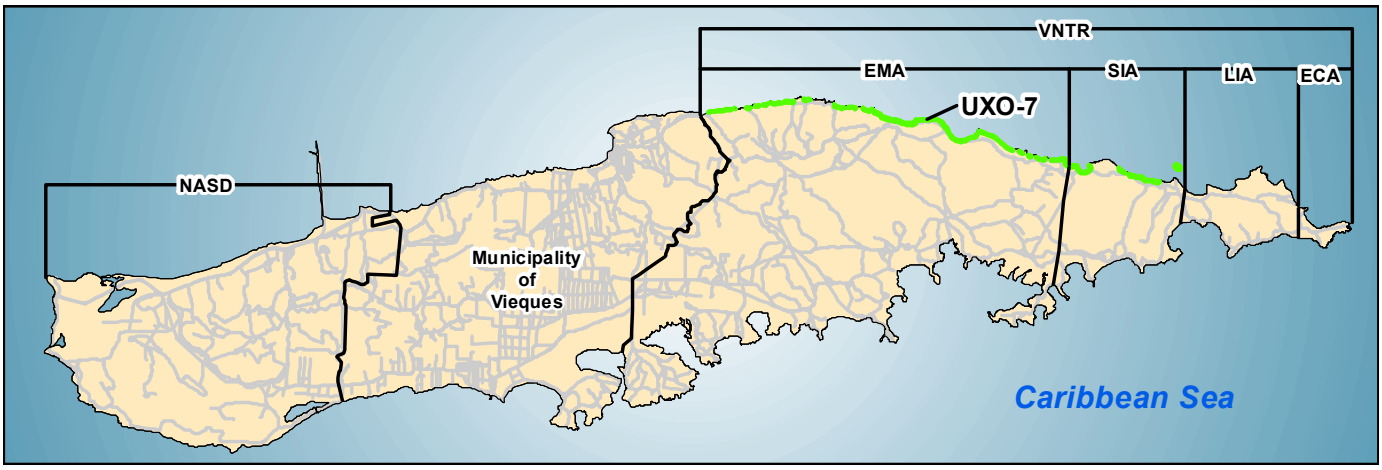
Physical Characteristics and Transport Pathways

UXO 6 is a dirt roadway that overlies primarily volcanic bedrock within lower lying topographically areas along the southern coast. The roadways may act as a preferential pathway for surface runoff during precipitation events and may also receive runoff the EMA and SIA Interior. Constituents may also migrate via leaching to groundwater and wind dispersion.

Future Land Use and Potential Receptors

In the CCP, the EMA/SIA roads shown as desired for public use; however, the SIA and EMA as a whole are to be managed as a wildlife refuge, with the potential construction of an observation tower. Potential human receptors comprise USFWS workers and public recreators/hikers (adolescent and adult only) exposed to soil and potentially exposed to the explosive hazard associated with MEC. Potentially complete exposure pathways for terrestrial ecological receptors exposed to surface soil include plants, soil invertebrates, birds, mammals, and reptiles. Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.

SAP Worksheet #10f — UXO 7 (EMA/SIA North Beaches)



Site Background

UXO 7 (EMA/SIA North Beaches) consists of 14 sandy beaches, including a small island offshore (Isla Yallis). UXO 7 is approximately 54 acres in size, located along the northern perimeter of the EMA and SIA (**Figures 17 and 19**). Named beaches include Puerto Diablo Beach (Beach 22), Puerto Negro (Beach 23), Puerto Brigadier (Beach 30), Playa Campana/Purple Beach (Beach 24), and Isla Yallis. The beaches are bound by the Caribbean Sea and UXOs 10, 12, and 13 (EMA and SIA). The designated area of each beach includes not only the proper sandy, unvegetated area, but also potential turtle nesting areas from the beach vegetation line up to 60 feet inland. Details of the former operations at the EMA and SIA are provided in Worksheet #10i, #10j, #10k, and #10l.

Investigation and Release History

- ERA/SI (2005 through 2010) and NTCRA – surface and subsurface removal of MEC (2009 through present)
- No environmental investigations have been conducted at UXO 7

Transect inspections and a qualitative handheld magnetometer survey was first conducted at UXO 7. Through October 2012, DGM has been conducted at approximately 40 of the 54 acres, as part of the NTCRA (**Figure 6**); however, all of the sandy beaches have been mapped and intrusively investigated. A total of 4,025 subsurface metallic anomalies have been identified and removed from these beaches. The DGM anomalies were investigated to a maximum depth of 4 ft bgs; the investigation of the anomalies was abandoned if the water table or refusal was encountered prior to reaching 4 ft bgs.

MEC items identified within UXO 7 are primarily a result of artillery fire and air to ground bombing at the SIA, potential misfires at the LIA, and from range activities at UXO 13. Munitions-related items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	4	96	0	688	718
Subsurface	30	255	375	13,418	15,806

Through the end of October 2012, the density of munitions items recovered was greatest at unnamed Beach 33 (within the SIA) and Playa Compania/Purple Beach (within a portion of a UXO 13 range). Four ranges associated with UXO 13 overlap into UXO 7 (**Figure 19).** There are no gun positions or SSAs within UXO 7. Intact and detonated MEC items and munitions debris and the historical detonations had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17f.

SAP Worksheet #10f — UXO 7 (EMA/SIA North Beaches) (continued)

Conceptual Site Model

Figures 18 and 20 present the generalized conceptual site model of UXO 7.

Physical Characteristics and Transport Pathways

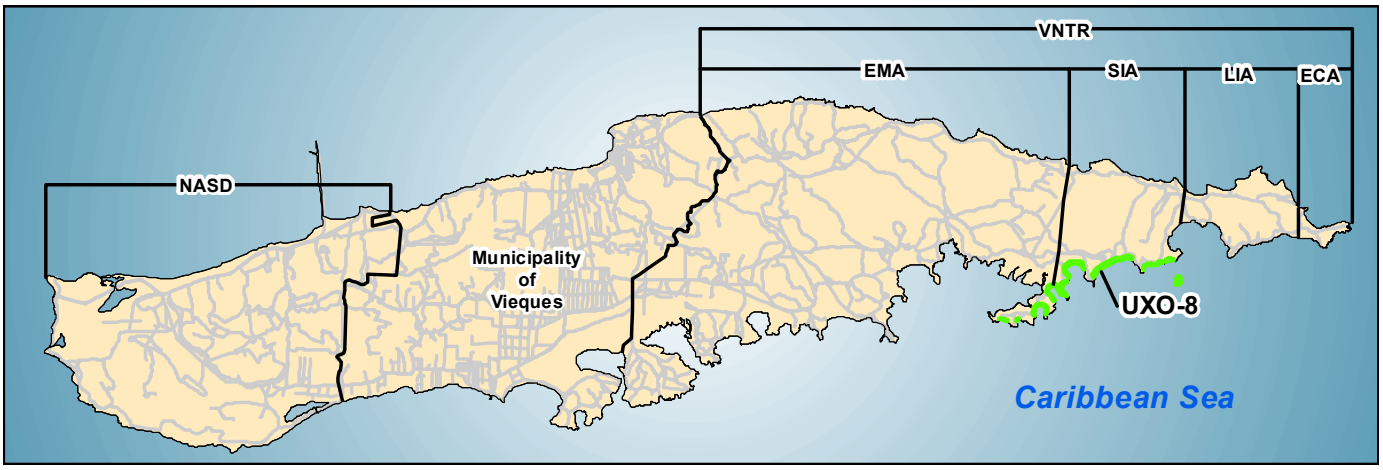
UXO 7 is predominantly sand beaches and dunes that extend from the waterline (low tide waterline during munitions characterization) to the vegetation extent. It also includes vegetated areas that extend approximately 60 feet inland to account for potential turtle nesting areas. The topography slopes toward the ocean and receives runoff from both the EMA and SIA, although most runoff from the EMA and SIA interior is directed into drainage features such as ephemeral streams. The beaches are a dynamic environment in that they are prone to tidal, wave, and storm action. Groundwater is shallow and saline due to seawater intrusion. The primary potential migration pathways at UXO 7 are associated with reworking of beach sands by storm surges, tides, and waves. Constituents could also migrate via leaching to groundwater and wind dispersion.

Future Land Use and Potential Receptors

UXO 7 will continue to be managed as a wildlife refuge. In the CCP, four beaches within UXO 7 are shown as desirable for public access, comprising Beach 33, Puerto Diablo Beach, Puerto Negro, and Playa Compania/Purple Beach. The majority of the beaches in UXO 7 are classified as turtle nesting grounds, with eight beaches identified as restricted turtle nesting areas. Three beaches are identified as major restrictions (four or more historical sea turtle nesting events have occurred) and five beaches as minor restrictions (one to three historical sea turtle nesting events).

Potential human receptors comprise USFWS workers (turtle monitoring), trespassers (adolescent and adult), and public recreators (adolescent and adult and at only four beaches) exposed to soil and potentially exposed to the explosive hazard associated with MEC. The primary potential ecological receptors are the eggs of hawksbill, green, and leatherback sea turtles exposed to deeper surface soil (18 to 36 inches). Other potential terrestrial receptors for surface soil (upper 2 inches) are terrestrial plants, terrestrial invertebrates, reptiles, Norway rat, Indian mongoose, common ground dove, and pearly-eyed thrasher.

SAP Worksheet #10g — UXO 8 (SIA South Beaches)



Site Background

UXO 8 (SIA South Beaches) consists of nine sandy beaches and a small island to the southeast (Cayo Canejo) (**Figure 17**). UXO 8 is approximately 45 acres in size, located along the southern perimeter of the SIA. Named beaches include Playa Matias/Yellow Beach, Playa Jalova, Playa Jalovita, Playa Yoye, Playa Fanduca, Punta Caranera, and Cayo Conejo (a small island to the southeast). The beaches are bound by the Caribbean Sea and UXO 10 (SIA). The designated area of each beach includes not only the proper sandy, unvegetated area, but also potential turtle nesting areas from the beach vegetation line to 60 feet inland. Details of the former operations at the SIA are provided in Worksheets #10h and #10i.

Investigation and Release History

- ERA/SI (2008), NTCRA – surface and subsurface removal of MEC (2009 through present)
- No environmental investigations have been conducted at UXO 8

The beaches were surface cleared of munitions as part of the NTCRA. Through June 2012, DGM has been conducted at approximately 31 of the 45 acres, as part of the NTCRA (**Figure 6**); however, all of the sandy beaches have been mapped and intrusively investigated. A total of 6,128 subsurface metallic anomalies were identified and removed; however, the NTCRA is currently ongoing. The DGM anomalies were investigated to a maximum depth of 4 ft bgs; the investigation of the anomalies was abandoned if the water table or refusal was encountered prior to reaching 4 ft bgs.

MEC items identified within UXO 8 are primarily a result of artillery fire and air to ground bombing at the SIA and from marine amphibious training. Munitions-related items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	7	4	0	222	741
Subsurface	479	168	0	17,419	14,823

Through the end of October 2012, the density of munitions items recovered was greatest at Playa Jalova, Playa Jalovita, and Beach 36. There are no gun positions or SSAs at UXO8. Intact and detonated MEC items and munitions debris and the historical detonations had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17g.

SAP Worksheet #10g — UXO 8 (SIA South Beaches) (continued)

Conceptual Site Model

Figure 18 presents the generalized conceptual site model of UXO 8.

Physical Characteristics and Transport Pathways

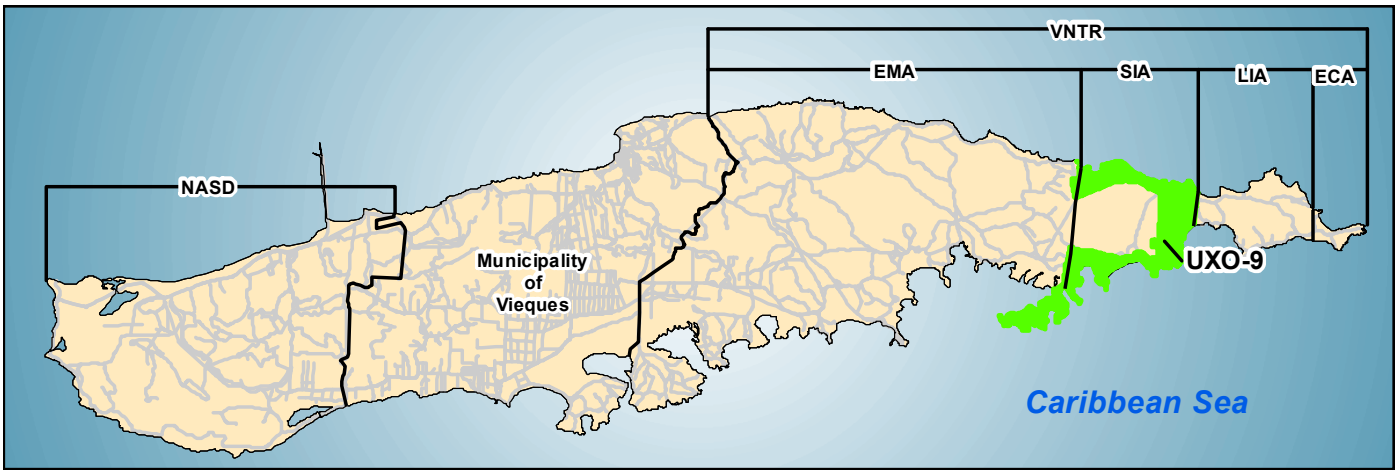
UXO 8 is predominantly sand beaches and dunes that extend from the waterline (low tide waterline during munitions characterization) to the vegetation extent. It also includes vegetated areas that extend approximately 60 feet inland to account for potential turtle nesting areas. The topography slopes toward the ocean and receives runoff from the SIA interior, although most runoff from the EMA and SIA interior is directed into drainage features such as ephemeral streams. The beaches are a dynamic environment in that they are prone to tidal, wave, and storm action. Groundwater is shallow and saline due to seawater intrusion. The primary potential migration pathways at UXO 8 are associated with reworking of beach sands by storm surges, tides, and waves. Constituents could also migrate via leaching to groundwater and wind dispersion.

Future Land Use and Potential Receptors

UXO 8 will continue to be managed as a wildlife refuge. In the CCP, one beach (Playa Matias/Yellow Beach) is shown as desirable for seasonal public use (to minimize wildlife impacts). Five beaches in UXO 8 are classified as turtle nesting grounds. Three beaches are identified as major restrictions (four or more historical sea turtle nesting events have occurred) and two beaches as minor restrictions (one to three historical sea turtle nesting events. Cayo Conejo is a small island associated with UXO 8 that is a conservation zone and is a habitat for the endangered Brown Pelican (**Figure 12**).

Potential human receptors comprise USFWS workers (turtle monitoring), trespassers (adolescent and adult), and public recreators (adolescent and adult and at only one beach) exposed to soil and potentially exposed to the explosive hazard associated with MEC. The primary potential ecological receptors are the eggs of hawksbill, green, and leatherback sea turtles exposed to deeper surface soil (18 to 36 inches), as well as terrestrial ecological receptors (plants, soil invertebrates, birds [including Common Ground Dove and Pearly-eyed Thrasher], mammals [including the Norway Rat and Indian Mongoose], and reptiles) exposed to surface soil at Cayo Conejo.

SAP Worksheet #10h — UXO 9 (SIA Exterior)



Site Background

UXO 9 (SIA Exterior) is approximately 953 acres in size, which includes the exterior (northern, southern, and eastern) portions of the SIA (excluding the roads and beaches) (**Figure 17**). The site is bounded to the east by the LIA and to the north and south by the Caribbean Sea. The western portion of the site is bound by either UXO 10 (SIA Interior) or the EMA.

In the 1950s, the Navy constructed marine artillery targets within the SIA for 76mm to 175 millimeters (mm) artillery projectiles fired from gun positions in the EMA. In 1969, Bulls-eye target #2 was established within the western portion of the SIA, which was used for inert bombing. Aerial photographic analysis identified craters within the northwestern portion of the site that were potentially caused by aerial bombing associated with Bulls-eye target #2 (CH2M HILL, 2010e). Range features are shown in **Figure 17** and summarized below.

- A former gun position (GP-1) located in a leveled area on a hilltop adjacent to Observation Post 1 (OP-1); a light-toned, I-shaped marker on the ground may indicate the point at which the gun was positioned.
- A former gun position (GP-5/OP-5) located in a leveled area on a hilltop on the east-central side of the SIA; an I-shaped marker, similar to GP-1, is on the ground in this area.
- A former gun position (G-21) identified by aerial photographs, which was a mortar site with three revetted weapon positions.
- Former gun positions (OP-12 and OP-13) identified by aerial photographs as potential gun positions only prior to 1967.

Three SSA sites are located within UXO 9 and include:

- PI-1 is the former location of an aircraft strafing target and water production well for residents prior to Navy activities.
- PI-17 is a former target and possibly used for landing exercises and as a munitions storage area based on interviews and records.
- PI-22 is a potential target area and formerly used for landing exercises and for loading and unloading of range support materials and equipment.

SAP Worksheet #10h — UXO 9 (SIA Exterior) (continued)

Investigation and Release History

- EIS (1979), PRA (2002 through early 2003), Environmental Baseline Survey (EBS) (2003), ERA/SI (2008), and NTCRA – surface removal of MEC (2009 through present).
- Four soil samples were collected at PI-22 in 2003 as part of the EBS and analyzed for Appendix IX RCRA constituents and total petroleum hydrocarbons (**Figure 5**). Because all detected constituents were below the Region III Residential Soil RBCs, the site was recommended for no further action. The results were included in the Draft Phase I RFI Report (CH2M HILL, 2004). The RFI Report was not finalized at the time Vieques was placed on the NPL and the former VNTR became regulated under CERCLA. Therefore, additional characterization of PI-22 will be conducted as part of this SAP, and the previous results are used primarily for information purposes and will not be included in the dataset used for this site once the new data are collected.
- Three environmental sites (SWMUs 5 and 8 and Area of Concern (AOC) A) are located within UXO 9, adjacent to OP-1 (**Figure 3**). Environmental data collected from these sites were presented in the Final Preliminary Assessment/Site Inspection (PA/SI) Report (CH2M HILL, 2008a). Four and five surface soil samples were collected from SWMUs 5 and 8, respectively, and analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), inorganic constituents, herbicides, pesticides, polychlorinated biphenyls (PCBs), and explosives including perchlorate. Perchlorate was the only explosive detected, but at concentrations below screening criteria and at only one location at SWMU 8. Soil samples collected from 10 locations at AOC A were analyzed for petroleum compounds and lead. Based on the findings in the PA/SI Report, a No Action Decision Document (CH2M HILL, 2009a) was issued for these sites. Therefore, these sites are excluded from further investigation at UXO 9.

In order to get an assessment of MEC within the SIA, transects were walked across approximately 5 percent of the entire SIA in 2008. A relatively significant amount of MEC on the ground surface was identified during the transect inspections in the SIA. Therefore, a NTCRA was initiated in February 2009 to remove MEC from the ground surface throughout the entire SIA. The NTCRA at UXO 9 is currently on going.

In addition to the NTCRA surface clearance, approximately 79 acres along the eastern boundary of UXO 9 was surface cleared during the TCRA for UXOs 1, 2, 3, and 4. This work was conducted to remove MEC consistent with the air-to-ground bombing and marine artillery firing activities that took place in the adjacent LIA areas.

MEC items identified at the surface within UXO 9 are primarily a result of artillery fire and air to ground bombing at the SIA and potential misfires from the LIA. No subsurface MEC removal has occurred to date. Munitions-related items found at the site include (recovered through October 2012):

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	6,551	8,888	565	110,268	91,005
Subsurface	0	0	0	0	0

Through the end of October 2012, the density of munitions items recovered was greatest at the northeastern and southeastern portions of the site. There are also five gun positions (located in eight areas that were moved over time) and three SSA sites within UXO 9. Intact and detonated MEC items and munitions debris, and historical detonations had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17h.

Conceptual Site Model

Figure 18 presents the generalized conceptual site model of UXO 9.

SAP Worksheet #10h — UXO 9 (SIA Exterior) (continued)

Physical Characteristics and Transport Pathways

UXO 9 comprises primarily marine sedimentary, lava, and tuff bedrock with low-growing dense vegetation and forested areas (**Figure 9**). UXO 9 includes the low lying exterior of the SIA, which ranges in ground elevation from over 160 ft msl to near 0 ft msl at the coast. Craters exist within the site and are most prominent in the northwestern portion adjacent to Bulls-eye target #2. Surface runoff follows the general topography, which flows to the north, east, and south toward the ocean in the northern, eastern, and southern portions of the site, respectively. Contaminated surface soils may be transported by surface runoff in the direction of the sloping ground surface.

Six lagoons (Laguna Puerto Diablo, Laguna Matias, and three unnamed lagoons) occur within the site (**Figure 17**). These lagoons are not tidally influenced and the temporal presence of surface water is believed to be wholly or primarily the result of precipitation. A number of ephemeral streams occur within UXO 9, most of which originate and drain from UXO 10 (SIA interior) (**Figure 17**). The ephemeral streams generally only contain water during major precipitation events.

The soil overburden is expected to be thin (non-existent where the bedrock outcrops), fine-grained and to have a high clay content from the weathering of the bedrock. Percolating rainwater infiltrates downward into the fractures of the bedrock. Groundwater within the SIA likely occurs within the bedrock, and near the beaches and lagoons the water table is likely encountered near sea level and tidally influenced. Groundwater discharge is to the ocean and believed to temporally discharge to the lagoons since the lagoons are periodically dry. Contaminants at and below the ground surface may migrate downward through the unsaturated zone by leaching from precipitation infiltration. Contaminants could then migrate within groundwater and discharge to the ocean and lagoons.

Contaminants also may be transported by wind erosion; however, the vegetation onsite likely limits this mode of transport.

Future Land Use and Potential Receptors

UXO 9 will continue to be managed as a wildlife refuge. Interpretive trails are intended for public use in the northern portion, as stated in the CCP. Conservation zones exist along the northern and southern shorelines (**Figure 12**). Although the northern portion of UXO 9 is identified in the CCP as having land use intended for interpretive trails, USFWS has since identified this area as having sensitive vegetation and, therefore, it will not be intended for public use. USFWS workers, trespassers (adolescents and adults), hikers (adolescents and adults only along interpretive trails within the northern portion of the site), and construction workers (during construction of a future observation tower) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue. Potential ecological receptors include:

- Terrestrial – plants, soil invertebrates, birds, mammals, and reptiles exposed to surface soil; land crabs within the ephemeral streams and lagoon fringe exposed to deeper surface soil (0 to 2 feet). Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.
- Aquatic – fish, benthic invertebrates (including crabs), aquatic plants, birds, and mammals exposed to surface water and sediment in the lagoons. Potential birds and mammals consuming fish, invertebrates, or plants include the Fishing Bat, Velvet Free-tailed Bat, Cave Swallow, Green Heron, Spotted Sandpiper, and White-cheeked Pintail.

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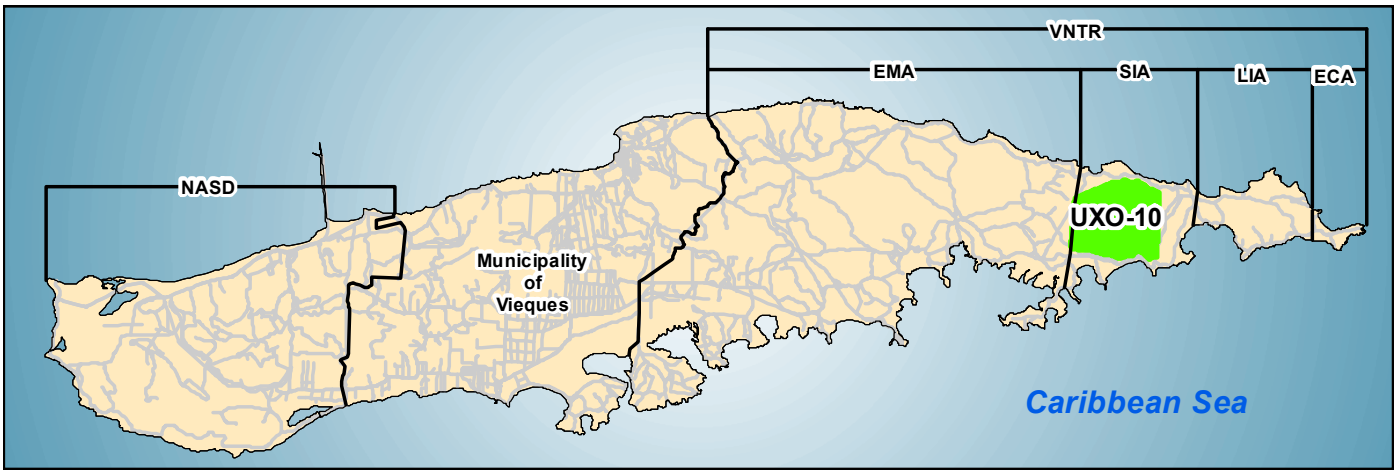
SAP Worksheet #10i — UXO 10 (SIA Interior)



Site Background

UXO 10 (SIA Interior) is approximately 890 acres in size located within the interior portion of the SIA. The site is bounded to the east, north, and south by UXO 9 and to the west by the EMA. In the 1950s, the Navy constructed marine artillery targets within the SIA for artillery fire of 76mm to 175 mm projectiles firing from gun positions in the EMA.

The SIA was formerly designated as SWMU 11 – Surface Impact Target Area. Therefore, although **Figure 17** identifies this SWMU to be within UXO 10 (based on historical documentation), the SWMU boundaries are, in actuality, synonymous with the SIA boundaries. In addition, the SSA PAOC Y, which was identified as a large metal object on the east side of the roadway, is located within UXO 10. Range features at UXO 10 are shown in **Figure 17**.

Investigation and Release History

- EIS (1979), PRA (2002 through early 2003), ERA/SI (2005 through 2010), and NTCRA – surface removal of MEC (2009 through present).
- One environmental site (SWMU 12) is located within UXO 10, to the north of OP-1. Environmental data collected from this site were presented in the Final PA/SI Report (CH2M HILL, 2008a). Five surface soil samples were collected from SWMU 12 for analysis of VOCs, SVOCs, inorganic constituents, herbicides, pesticides, PCBs, and explosives including perchlorate. No explosives were detected. Based on the findings in the PA/SI Report, a No Action Decision Document (CH2M HILL, 2009a) was issued for this site. Therefore, this site is excluded from further investigation at UXO 10.

Transects were initially conducted across approximately seven percent of UXO 10 in 2008. Since a significant amount of MEC was identified, a NTCRA was initiated in 2009 to remove MEC from the ground surface at the SIA, and is currently ongoing.

MEC items identified at the surface within UXO 10 are primarily a result of artillery fire and air to ground bombing at the SIA and potential misfires from the LIA. No subsurface MEC removal has occurred to date. Munitions-related items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	1,063	1,102	70	125,242	15,861
Subsurface	0	0	0	0	0

SAP Worksheet #10i — UXO 10 (SIA Interior) (continued)

There are no gun positions within UXO 10. PAOC Y (large metal object), and SWMU 11 (the former designation of the SIA) occur within UXO 10. Intact and detonated MEC items and munitions debris and historical detonations had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17i.

Conceptual Site Model

Figure 18 presents the generalized conceptual site model of UXO 10.

Physical Characteristics and Transport Pathways

UXO 10 is characterized as a forested area and is the topographically higher areas of the SIA. The topography ranges in elevation from over 420 ft msl to below 20 ft msl (near the ephemeral stream drainage areas). The bedrock consists primarily of marine sedimentary, lava, and tuff bedrock, which is exposed at the ground surface within the eastern portion of the site. The east-to-west drainage divide runs along the southern portion of the site, where surface runoff flows to the north in the northern portion and to the south in the southern portion of the site, toward UXO 9. Contaminated surface soils may be transported by surface runoff in the direction of the sloping ground surface.

No lagoons occur within the site. A number of ephemeral streams occur within UXO 10 that drain to UXO 9 and further to downstream lagoons and the ocean (**Figure 17**). The ephemeral streams generally only contain water during major precipitation events.

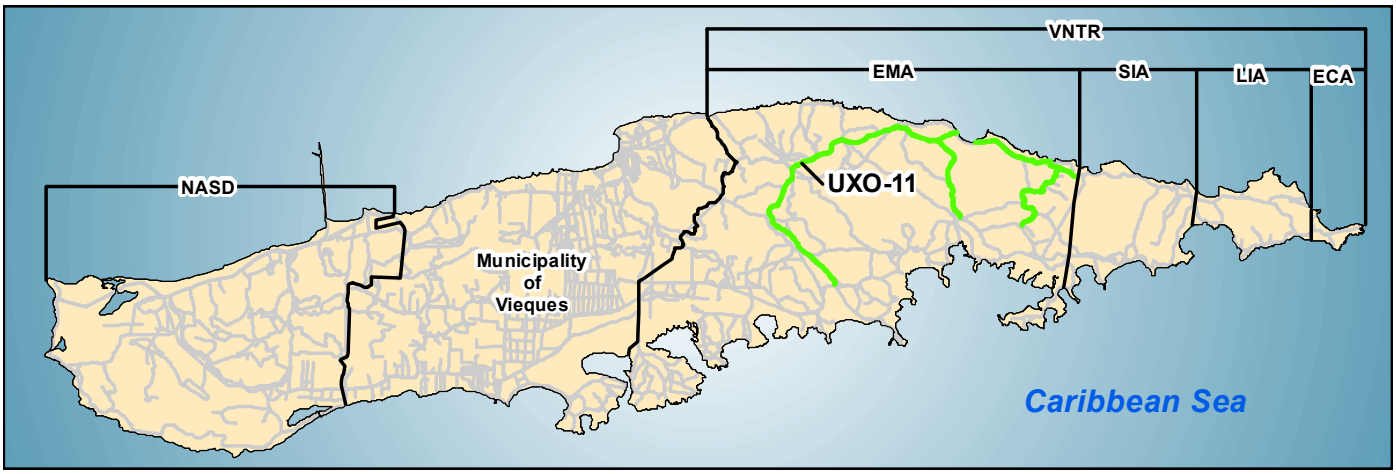
The soil overburden is expected to be thin (non-existent where the bedrock outcrops), fine-grained and to have a high clay content from the weathering of the bedrock. Percolating rainwater infiltrates downward into the fractures of the bedrock. Groundwater within UXO 10 likely occurs within the bedrock and may be fresh. Contaminants at and below the ground surface may migrate downward through the unsaturated zone by leaching from precipitation infiltration. Contaminants could then migrate within groundwater and discharge to the ocean. Contaminants also may be transported by wind erosion; however, the vegetation onsite likely limits the mode of transport.

Future Land Use and Potential Receptors

UXO 10 will continue to be managed as a wildlife refuge. USFWS workers and trespassers (adolescents and adults) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue. However, the relatively steep slopes and dense vegetation likely limit and/or discourage access to much of the area. Potential ecological receptors include:

- Terrestrial – plants, soil invertebrates, birds, mammals, and reptiles exposed to surface soil; land crabs within the ephemeral stream areas exposed to deeper surface soil (0 to 2 feet). Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.

SAP Worksheet #10j — UXO 11 (EMA Public Roads)



Site Background

UXO 11 (EMA Public Roads) consists of approximately 86 acres of roadways throughout the EMA, including a 25-foot buffer zone along each side of the roads (**Figure 19**). The roadways are dirt roads currently used for range access. One SSA (PAOC Z) occurs within the site, which was a former target (an observed overturned tractor trailer). Details of the former operations at the EMA adjacent to the site are provided in Worksheets #10k and #10l.

Investigation and Release History

- ERA/SI (2008) and NTCRA – surface and subsurface removal of MEC (2009 through present)
- No environmental investigations have been conducted at UXO 11

UXO 11 was included in the transect inspections of the EMA. Transects inspections were conducted across approximately 5 percent of the EMA in 2008 to identify MEC on the ground surface. A NTCRA was initiated in 2009 to address surface and subsurface MEC. Through October 2012, DGM has been conducted at approximately 31 of the 86 acres, as part of the NTCRA (**Figure 6**). A total of 950 subsurface metallic anomalies were identified and removed; however, the NTCRA is currently ongoing.

MEC items identified within UXO 11 are primarily a result of potential target misses from the SIA and range activities within UXO 13. The density of munitions items recovered was greatest within the eastern portion of the site, adjacent to the SIA. Munitions-related items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	289	915	359	7,610	22,781
Subsurface	4	17	16	2,144	3,901

The roadway also passes through several gun positions and two small arms ranges, which are being addressed as part of UXO 13. One SSA, PAOC Z, designated as a former target, also occurs within the eastern portion of the site. Intact and detonated MEC items and munitions debris, historical detonations, and particulates from the gunfire within the gun positions had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17j.

SAP Worksheet #10j — UXO 11 (EMA Public Roads) (continued)

Conceptual Site Model

Figures 20 and 21 present the generalized conceptual site model of UXO 11.

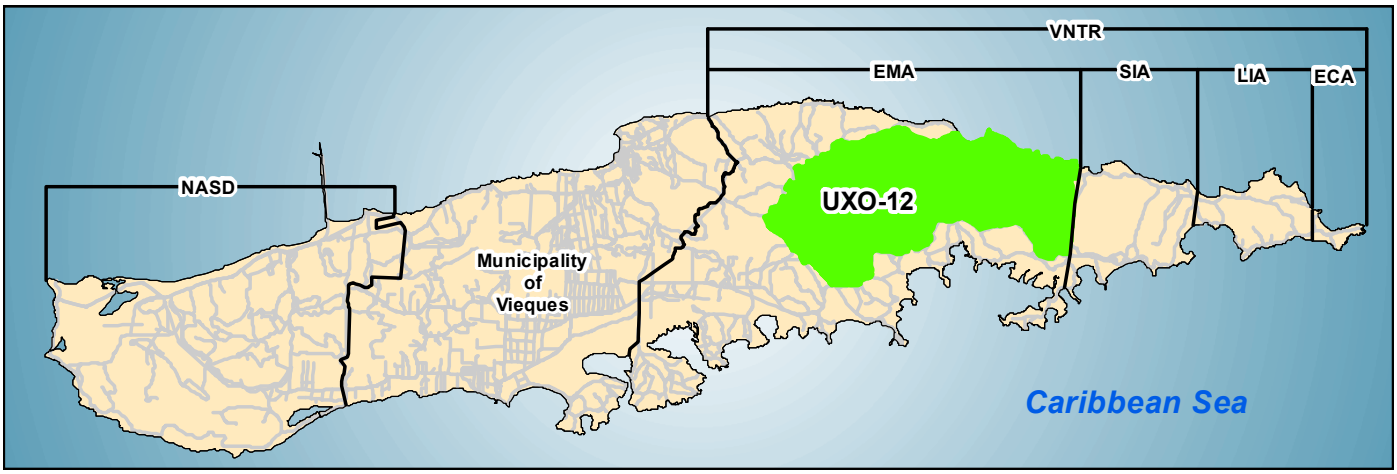
Physical Characteristics and Transport Pathways

UXO 11 is a dirt roadway that overlies primarily volcanic bedrock and generally runs along low lying drainage areas within the EMA, except where the road runs north-south and crosses the main east-west trending drainage divide. The roadways may act as a preferential pathway for surface runoff during precipitation events and may also receive runoff from the EMA interior. Constituents could also migrate via leaching to groundwater and wind dispersion.

Future Land Use and Potential Receptors

In the CCP, UXO 11 is shown as desired for public use and also includes an observation tower, picnic areas, and parking area, but managed as part of the wildlife refuge. The specific details regarding these activities are not known at this time, and the locations of these areas shown on the figures are not necessarily representative of the actual location where proposed recreational uses may occur. Potential human receptors comprise USFWS workers, public recreators, and construction workers (during construction of a future observation tower) exposed to soil and potentially exposed to the explosive hazard associated with MEC. Potentially complete exposure pathways for terrestrial ecological receptors exposed to surface soil include plants, soil invertebrates, birds, mammals, and reptiles. Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.

SAP Worksheet #10k — UXO 12 (EMA Interior)



Site Background

UXO 12 encompasses approximately 4,465 acres and is comprised of interior portions of the former EMA (**Figure 19**). The former EMA was established in 1947 to provide areas and ranges for the training of Marine amphibious units and battalion landing teams in exercises that included amphibious landings, small-arms fire, artillery and tank fire, shore fire control, and combat engineering tasks. The 1979 EIS Report (Tippetts et al., 1979) provides a detailed description of historical training trends and indicates that the heaviest training occurred from the mid-1950s until early 1960s.

Large-scale artillery exercises were completed in the EMA using live marine artillery including 76mm, 81mm, 90mm, 105mm, 106mm, and 175mm rounds. The artillery was fired from gun positions primarily, located throughout the EMA, toward targets located within the SIA and LIA. The exercises included Marine amphibious unit (1,200 to 1,500 Marines) and battalion landing team (1,200 to 1,500 Marines) (Tippetts et al., 1979).

Over the years, Range 11, the only range located in UXO 12, was an established range with all firing from a single point. This range was used by tanks, 106 recoilless rifles, artillery and 50 caliber machine guns. The firing was in an eastward direction (NAVFAC, 1972), as shown in **Figure 19**.

A total of 33 gun positions used for either mortar or artillery gunfire were identified at the site. G-1 through G-7 and G-9 were known artillery gun positions that were approved to fire 300 rounds of 155mm per day. All other gun positions were identified from historical aerial photographs (G-10 through G-20, G-22, G-24 through G-26, G-28 through G-32, G-34, G-35, and OP-10 through OP-12). Operational data indicates that several types of munitions were fired from the artillery gun positions including: 175mm, 155mm, 106mm, 105mm and 90mm rounds (CH2M HILL, 2010e). Although the available documentation provides general locations of the gun position firing points, the documentation does not provide details on the specific types or quantities of munitions fired from each gun position or the direction in which the firing occurred. As a result, an accurate assessment of the impact area from each gun position cannot be completed. However, the inspection of the known firing points did not identify MEC at any of the firing points. Based on this information, the MEC data from the ERA/SI do not differentiate the extent of the MEC from each individual gun position, or identify the source from which the identified MEC items originated.

The results of the Phase I ERA/SI (**Attachment A** – Area H) and the Phase II ERA/SI (**Figure 6**) (CH2MHILL, 2010e) show that over 2,100 munitions-related items were identified throughout UXO 12. The items identified were predominantly 81mm mortars, 105mm projectiles, 155mm projectiles, and 4.2 inch illumination projectiles, which are expected based on site use. However, following a 215-acre brush fire in the northeast portion of UXO 12 (**Figure 19**), the area was inspected and five 5-inch rockets and one 500-pound bomb were found, indicating this part of the site was used for air to ground bombing.

SAP Worksheet #10k — UXO 12 (EMA Interior) (continued)

Seven SSAs occur within UXO 12:

- PI-2 – A former water production well and former small arms range. ERA/SI transects observed fence posts, barbed wire, and metal banding
- PI-3 - A former small arms range and former water production well. ERA/SI transects observed fence posts, barbed wire, and metal banding
- PI-12 - Water production well used prior to 1970s, private residence prior to 1940s
- PI-15 - Possible small arms range or observation post. One discarded compressor cylinder and a practice bomb were observed, but no other indications of disposal activities. ERA/SI transects observed scrap portions of a tank target, MD, and a 3.5 inch rocket classified as MPPEH
- PI-16 - Potential disposal area for munitions. ERA/SI transects observed 100 pounds (lbs) of RRD and 10 MD items
- PI-18 - Potential small arms range. ERA/SI transects observed 150 lbs of RRD
- PI-19 – Possible former gun position. ERA/SI transects observed 3,000 lbs of RRD, one hand grenade, and one 40 mm projectile (MD).

Investigation and Release History

- ERA/SI (2005 through 2010), NTCRA – surface removal of MEC (2009 through present)
- No environmental investigations have been conducted at UXO 12

Transect inspections covering approximately five percent of the entire EMA were conducted in 2008 to assess potential MEC on the ground surface. A total of 71 MEC items were identified, with the highest quantity of items located in the eastern portion of UXO 12 in close proximity to the SIA. In addition, PIs 2, 3, 15, 16, 18, and 19 were investigated. The NTCRA was initiated in 2009 to remove surface munitions from the site. To date, the only area addressed by the NTCRA is the eastern border of UXO 12 in the immediate vicinity of the former bulls-eye target in UXO 9. In addition, areas have been investigated following fires UXO12 to take advantage of the vegetation being removed/thinned (the fires were not due to munitions response activities) and during the NTCRA activities at UXO 11 a portion of UXO 12 has been incidentally surface cleared to accommodate the DGM activities. Approximately 184 acres have been surface cleared through the October 2012 as a result of these activities.

Munitions items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	831	1,601	1,118	26,362	17,890
Subsurface	0	0	0	0	0

The site also contains numerous gun positions, a rifle and artillery range (former target areas are unknown) and potential small arms ranges, and multiple SSAs. PI-16 is designated as a potential disposal site for munitions. Intact and detonated MEC items and munitions debris, particulates from the gunfire within the gun positions, and the potential disposal of munitions had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17k.

Conceptual Site Model

Figures 20 and 21 present the generalized conceptual site model of UXO 12.

Physical Characteristics and Transport Pathways

UXO 12 is characterized as a forested area with marine sedimentary, lava, tuff, and granodiorite bedrock hills and valleys (**Figure 9**). The topography ranges from over 320 ft msl in the central-western portion of the site to just above sea level near the coast. The east-to-west drainage divide runs along the central portion of the site, where

SAP Worksheet #10k — UXO 12 (EMA Interior) (continued)

surface runoff flows to the north toward the ocean and UXO 13 in the northern portion of the site and to the south toward UXO 14 in the southern portion of the site. Contaminated surface soils may be transported by surface runoff in the direction of the sloping ground surface.

Two lagoons (Laguna Monte Largo and an unnamed adjacent lagoon) occur within the northern portion of the site (**Figure 19**). These lagoons are not tidally influenced and the temporal presence of surface water is believed to be wholly or primarily the result of precipitation. A number of ephemeral streams occur within UXO 12 that drain to the ocean, lagoons, and UXOs 13 and 14. The ephemeral streams generally only contain water during major precipitation events.

The soil overburden is expected to be thin (non-existent where the bedrock outcrops), fine-grained and to have a high clay content from the weathering of the bedrock. Percolating rainwater infiltrates downward into the fractures of the bedrock. Groundwater within UXO 12 likely occurs within the bedrock and may be fresh in the central portion of the site, and tidally influenced and brackish to saline near the coast. Groundwater discharge is to the ocean and believed to temporally discharge to the lagoons since the lagoons are periodically dry. Contaminants at and beneath the ground surface may migrate downward through the unsaturated zone by leaching from precipitation infiltration. Contaminants could then migrate within groundwater and discharge to the ocean. Contaminants may also be transported by wind erosion; however, the vegetation onsite likely limits this mode of transport.

Future Land Use and Potential Receptors

UXO 12 will continue to be managed as a wildlife refuge. A conservation zones exist along the ephemeral streams within the western portion of the site (**Figure 12**). USFWS workers and trespassers (adolescents and adults) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue. Potential ecological receptors include:

- Terrestrial – plants, soil invertebrates, birds, mammals, and reptiles exposed to surface soil; land crabs within the lagoon fringe and ephemeral stream areas exposed to deeper surface soil (0 to 2 feet). Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.
- Aquatic – fish, benthic invertebrates (including crabs), aquatic plants, birds, and mammals exposed to surface water and sediment in the lagoons. Potential birds and mammals consuming fish, invertebrates, or plants include the Fishing Bat, Velvet Free-tailed Bat, Cave Swallow, Green Heron, Spotted Sandpiper, and White-cheeked Pintail.

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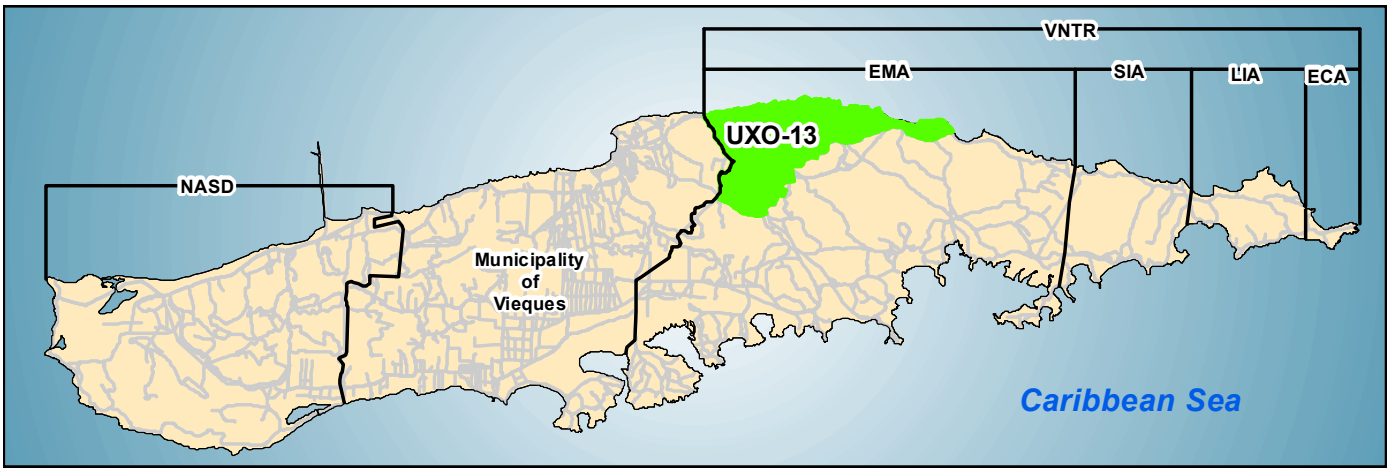
SAP Worksheet #10I — UXO 13 (EMA West)



Site Background

UXO 13 is approximately 1,871 acres in size, located in the northwest corner of the former EMA. The site is bound by the Municipality of Vieques (MOV) to the west, UXO 12 to the east, and UXO 7 and the Caribbean Sea to the north. UXO 13 consists of 11 ranges, five artillery gun positions, and five SSAs (four PAOC sites and one PI site) (**Figure 19**). Nine of the ranges were operational from 1962 to 1999 and the other two were identified from aerial photographs (**Figure 22**) (CH2M HILL, 2010e). A description of the ranges is provided below:

Ranges

- Range 1 – Small Arms Range
  - Target area in northwestern portion (as identified in 1962 aerial photograph). No MPPEH or MEC identified within range; however, one MPPEH item found 500 meters west of range (unknown type, 3-inch length flare) (CH2M HILL, 2010e).
- Range 2 – Combat Rifle Range
  - A squad fire and maneuver range with different target areas (identified in each year of aerial photography) and generally fired from south to north. M-16 service rifles, pistols, M-249 squad automatic weapon (SAW), M-60 and M-240G submachine guns, practice grenades, and pyrotechnics were authorized for use at this range. An 8-ft earthen berm surrounds the area on the north, east, and west. Results of the metal detector survey (15% of area) only identified a few targets, although the northern berm area did exhibit significant amounts of small arms ammunition fragments. Approximately 12 small arms ammunition items, expended small arm cartridges, and one grenade clip were noted. No MPPEH or MEC was identified (CH2M HILL, 2010e).
- Range 3 – Hand Grenade Range
  - Fragmentation hand grenades were fired from a control pit to the target area. The target area was a trench like opening in the ground with some empty steel drums imbedded into the sides of the trench. The target area was approximately 100 feet in length and at a lower elevation than the firing pit. Results of a perimeter walk identified a number of grenade clips. No small arms ammunition was noted. Low subsurface anomaly density, and no scrap metal or MEC was identified during a metal detector survey (25% of area). One MPPEH was identified (grenade) (CH2M HILL, 2010e).
- Range 4 – M-79 Grenade Launcher/Rifle Grenade Range
  - 40mm rifle grenades were fired in a seaward direction into an area adjacent to the beach. Multiple target areas were identified in the aerial photography in various years. Four MPPEH (3.5-inch rocket, 105mm projectile, 40 mm projectiles) and one MEC (40mm projected grenade) were identified (CH2M HILL, 2010e).

SAP Worksheet #10I — UXO 13 (EMA West) (continued)

- Range 4A – Flame Range
  - Flame thrower equipment was authorized for use but was apparently seldom used. Range firing was to the north. One MEC (LAW M72 66mm rocket) was identified (CH2M HILL, 2010e).
- Range 4B – 3.5-inch Rocket Launcher Range
  - 3.5-inch rockets were fired in a seaward direction into a dune area adjacent to the beach. Pieces of aircraft and one 75 mm gun were set up as targets at distances ranging from 300 to 350 meters from firing points. Earthen berms exist on three sides of the range. Field of fire is from the berm at the firing line to a 10-meter high cliff that forms the center of the target area. Relatively moderate to high anomalies were detected in the northern portion of the area and low in the southern portion near the observation tower (15% or the range was covered). Numerous expended rocket motors and rocket motor parts, along with other MD, were identified throughout the range especially along the northern perimeter. Two MPPEH (3.5-inch rocket) and one MEC (3.5-inch rocket) were located between Ranges 4 and 4B (CH2M HILL, 2010e).
- Range 5 – Pistol Range
  - Pistols fired at targets located 15 and 25 yards from the firing point to the north. Some random targets were encountered on site. Allowable weapons were recorded as M-16 service rifles, pistols, M-249 SAW, M-60 and M-240G submachine guns, practice grenades, and pyrotechnics. Very little evidence remains of past operations. Low anomaly densities were found with the metal detector (10% of area). No MPPEH or MEC was identified (CH2M HILL, 2010e).
- Range 6 – Shape Charges
  - Shape charges were exploded at the beach. The size of the charges did not exceed 40 pounds. Remnants of a concrete bunker and four pits were observed. Pits exhibited evidence of being training areas for open detonation. Evidence of small arms ammunition and a small berm. Relatively moderate anomaly density was observed with metal detector (15% of area). M-60 fuze lighter and expended 5.56mm and 7.62mm cartridge cases were noted. One MEC was identified 100 meters south of range (CH2M HILL, 2010e).
- Range 7 – M-60 Caliber Machine Gun Range
  - Firing of machine guns and Browning automatic rifles at fixed targets to the north consisting of old military vehicles and rock out-croppings. Allowable weapons on this range were recorded as M-16 service rifles, pistols, M-249 SAW, M-60 and M-240G submachine guns, practice grenades, and pyrotechnics. Very little evidence remains of past operations. Low anomaly densities were observed (10% of area). A number of small arms ammunition items were encountered on the surface during field reconnaissance activities. Five MEC (3.5-inch rockets, 60mm mortar, projected grenades, and unknown rocket 55mm x 210mm) were identified. One MPPEH (MK1 flare) was identified 140 meters east of range, and one MPPEH (3.5-inch rockets) was identified northeast of range (CH2M HILL, 2010e).
- Range 8
  - Aerial photograph identified the area as a possible range, likely a small arms range. No MPPEH or MEC was identified (CH2M HILL, 2010e).
- Range 9
  - Aerial photograph identified the area as a possible range, likely a small arms range. No MPPEH or MEC was identified (CH2M HILL, 2010e).

Gun Positions

- G-7 – The area is bermed on all four sides and oriented for howitzer artillery/mortar fire to the SIA. Was approved for firing of 300 rounds of 155 mm per day. No MEC items or evidence of burial pits were identified.

SAP Worksheet #10l — UXO 13 (EMA West) (continued)

- G-8 – The area is surrounded by a 10 ft high earthen berm on its northern, southern, and eastern sides. Was approved for firing of 300 rounds of 155 mm per day. Five pieces of expended small arms ammunition and two expended tear gas canisters were the only surface items encountered during reconnaissance efforts. No MEC items or evidence of burial pits or were identified.
- G-9 - Field artillery site identified by aerial photographs. Not inspected.
- G-23 - Field artillery/mortar sites identified by aerial photographs. Not inspected.
- G-27 - Field artillery site identified by aerial photographs. Not inspected.

PAOC Sites

- PAOCs AA, BB, CC, and DD are Ranges 2, 7, 4 and 4B, respectively. The range terminology is now used.

PI Site

- PI-23 - Identified in the EBS as "Water production well, possibly observation point," which is not correct. PI-23 is hydrologic investigation well P-1, installed as a 2-inch piezometer and discussed in the Results of the Hydrogeologic Investigation Report (Baker, 1999).

A small parcel of land located within the northwest portion of UXO 13 (denoted as Parcel C) is being considered for transfer by DOI to the Puerto Rico Conservation Trust (PRCT), which is intended for unrestricted public use (**Figure 19**). Munitions are not expected at Parcel C as the site was not historically used as a range, target, or firing point.

Investigation and Release History

- EIS (1972), Hydrogeologic Investigation (1999), EBS (2003), PRA (2003), and ERA/SI (2005 through 2010)
- Environmental data collected from this site were presented in the report titled Results of the Hydrogeologic Investigation (Baker, 1999). Eighteen surface soil samples were collected and groundwater samples were collected and analyzed from four monitoring wells from Parcel C. No explosives were detected in soil and groundwater.

Transect inspections were conducted across approximately 5 percent of the entire EMA in 2008 to assess munitions items on the ground surface. Over 40 MEC items were identified at UXO 13 during the transect inspection. The majority of the items found were located around Ranges 2 and 4 in the northern portion of UXO 13. Range 7 was also investigated during the transect inspections and 3 MD and 2 RRD items were identified. In addition, during the NTCRA activities at UXO 11 a portion (approximately 38 acres) have been incidentally surface cleared of munitions. This is due to the former VNTR being broken into grids and the munitions clearance activities taking place on a grid by grid basis. Munitions items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	41	106	3	11,291	25,506
Subsurface	0	0	0	0	0

Intact and detonated MEC items and munitions debris, historical detonations, propellant discharge at the firing points and gun positions, and flame throwing activities had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is discussed in more detail in Worksheet #17i.

Conceptual Site Model

Figure 20 presents the generalized conceptual site model of UXO 13.

SAP Worksheet #10l — UXO 13 (EMA West) (continued)

Physical Characteristics and Transport Pathways

UXO 13 is characterized as a forested area and comprises primarily of sandstone, siltstone, conglomerate, lava, tuff, and tuffaceous breccias largely deposited in a marine environment and subject to extensive deep weathering (**Figure 9**). There is a topographic divide that separates the northern and southern portions of the site. A topographic high also occurs along the western boundary between UXO 13 and the MOV.

Two lagoons (Laguna Algodones and an unnamed adjacent lagoon) occur within the eastern portion of the site (**Figure 19**). These lagoons are not tidally influenced and the temporal presence of surface water is believed to be wholly or primarily the result of precipitation. A number of ephemeral streams occur within UXO 13 that drain to the ocean and lagoons; no ephemeral streams drain toward the municipality (**Figure 19**). The ephemeral streams generally only contain water during major precipitation events.

The soil overburden is expected to be thin (non-existent where the bedrock outcrops), fine-grained and to have a high clay content from the weathering of the bedrock. Percolating rainwater infiltrates downward into the fractures of the bedrock. Groundwater within the EMA likely occurs within the bedrock and may be fresh in the central portion of the site, and tidally influenced and brackish to saline near the coast. A groundwater divide occurs within the site, where groundwater flows from a high near the south central portion of the site primarily to the north and south (Baker, 1999). Monitoring wells located along the western boundary of the site show that groundwater does not likely flow offsite to the municipality. Groundwater discharge is to the ocean and believed to temporally discharge to the lagoons since the lagoons are periodically dry. Contaminants at and below the ground surface may migrate downward through the unsaturated zone by leaching from precipitation infiltration. Contaminants could then migrate within groundwater and discharge to the ocean. Contaminants may also be transported by wind erosion; however, the vegetation onsite likely limits this mode of transport.

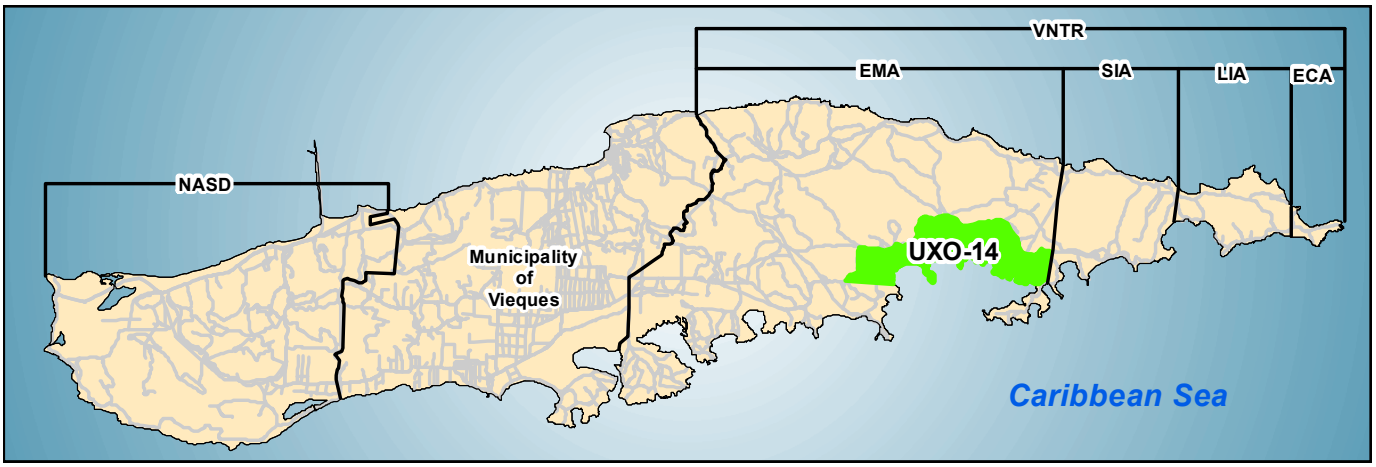
Future Land Use and Potential Receptors

UXO 13 will continue to be managed as a wildlife refuge; however, the western portion of UXO 13 (Parcel C) is intended for unrestricted land use. In the CCP, Fish and Wildlife Service (FWS) identify portions of UXO 13 desirable for reforestation; however, the exact location and size of the area is not known at this time. The ephemeral streams and eastern portion of UXO 13 are considered conservation zones (**Figure 12**).

USFWS workers and trespassers (adolescents and adults) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC, while land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue; at Parcel C only, residential receptors will also be evaluated in the HHRA. Potential ecological receptors include:

- Terrestrial – plants, soil invertebrates, birds, mammals, and reptiles exposed to surface soil; land crabs within the lagoon fringe and ephemeral stream areas exposed to deeper surface soil (0 to 2 feet). Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.
- Aquatic – fish, benthic invertebrates (including crabs), aquatic plants, birds, and mammals exposed to surface water and sediment in the lagoons. Potential birds and mammals consuming fish, invertebrates, or plants include the Fishing Bat, Velvet Free-tailed Bat, Cave Swallow, Green Heron, Spotted Sandpiper, and White-cheeked Pintail.

SAP Worksheet #10m — UXO 14 (EMA South)



Site Background

UXO 14 encompasses 1,050 acres and is located in the southern portion of the former EMA (**Figure 19**); the site is south of UXO 11 and UXO 12 and adjacent to Ensenada Honda. Range 10, located adjacent to Ensenada Honda, was established as a fixed, static range with all firing from a single point using M-1, M-14 rifles; M-2 carbines, Browning Automatic rifles, service pistols, and 45 caliber machine guns. Demolition charges up to a quarter pound were detonated to simulate combat. Two gun positions also occur within UXO 14.

Investigation and Release History

- ERA/SI (2008)
- No environmental investigations have been conducted at UXO 14

Transect inspections were conducted at approximately five percent of the entire EMA in 2008 to assess the amount of MEC present. The majority of the munitions items were located in the eastern portion of the site. In addition, during the NTCRA activities at UXO 11, a portion (approximately 30 acres) was incidentally surface cleared of munitions. This is due to the former VNTR being broken into grids and the munitions clearance activities taking place on a grid by grid basis. Munitions items found at the site (recovered through October 2012) include:

Number of items recovered	UXO	MPPEH	DMM	MD	RRD
Surface	8	7	0	819	3,020
Subsurface	0	0	0	0	0

The site contains two artillery gun positions (G-33 and G-36) that were identified by aerial photograph and the aforementioned range (target areas are unknown). No SSAs occur within UXO 14. Intact and detonated MEC items and munitions debris, historical detonations, and propellant discharge at the firing points and gun positions had the potential to release chemical contaminants to the environmental media. The distribution of MEC and other munitions-related items is shown in more detail in Worksheet #17m.

Conceptual Site Model

Figure 21 presents the generalized conceptual site model of UXO 14.

Physical Characteristics and Transport Pathways

UXO 14 is characterized as a forested area with alluvial deposits, marine sedimentary, lava, tuff, and granodiorite bedrock (**Figure 9**). The site is generally low-lying adjacent to the southern coastline (near sea level), but has some hills that reach an elevation of over 220 ft msl. Surface runoff follows the sloping topography to the south toward the southern lagoons and the ocean. Contaminated surface soils may be transported by surface runoff in the direction of the sloping ground surface.

SAP Worksheet #10m — UXO 14 (EMA South) (continued)

Eight lagoons occur within the site (Laguna Yanuel and seven unnamed) (**Figure 19**). The majority of the lagoons are tidally influenced and surface water is present at all times. However, a couple lagoons are not tidally influenced and the temporal presence of surface water is likely wholly or primarily the result of precipitation. A number of ephemeral streams occur within UXO 14 (originate in UXO 12) that drain to the lagoons and the ocean (**Figure 19**). The ephemeral streams generally only contain water during major precipitation events.

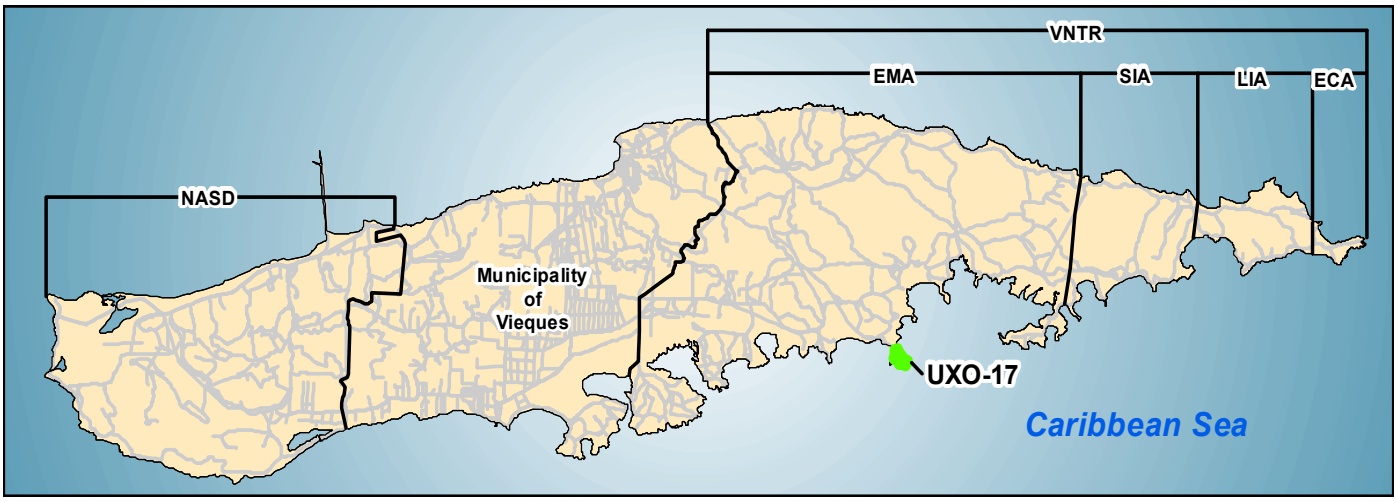
The soil overburden is likely thickest in areas where alluvial deposits occur. Percolating rainwater infiltrates downwards, where groundwater within UXO 14 may occur within the alluvial deposits or within the fractures of the bedrock. Contaminants at the ground surface may migrate downward through the unsaturated zone by leaching from precipitation infiltration. Groundwater discharge is to the ocean and believed to temporarily discharge to the lagoons since the lagoons are potentially dry. Contaminants also may be transported by wind erosion; however, the vegetation onsite likely limits this mode of transport.

Future Land Use and Potential Receptors

UXO 14 will continue to be managed as a wildlife refuge. In the CCP, USFWS identifies some portions of the site as desirable for public hiking and biking trails. All of UXO 14 is a conservation zone, which includes the Ensenda Honda Conservation Zone (**Figure 12**). USFWS workers, trespassers (adolescents and adults), and hikers (adolescent and adult) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue. Potential ecological receptors include:

- Terrestrial – plants, soil invertebrates, birds, mammals, and reptiles exposed to surface soil; land crabs within the lagoon fringe and ephemeral stream areas exposed to deeper surface soil (0 to 2 feet). Potential birds and mammals consuming invertebrates, plants, and small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.
- Aquatic – fish, benthic invertebrates (including crabs), aquatic plants, birds, and mammals exposed to surface water and sediment in the lagoons. Potential birds and mammals consuming fish, invertebrates, or plants include the Fishing Bat, Velvet Free-tailed Bat, Cave Swallow, Green Heron, Spotted Sandpiper, and White-cheeked Pintail.

SAP Worksheet #10n — UXO 17 (EMA Other Sites)



Site Background

UXO 17 is located to the south of the EMA and consists of one SSA, PAOC EE (**Figure 23**). PAOC EE encompasses approximately 18 acres and is located on Punta Conejo, where matting, metallic debris, small arms blanks, a flare, and a canister of propellant were identified.

Other sites associated with UXO 17 include PI-21, PI-14 and PAOC FF. PI-21 is being investigated and addressed separately from this SAP. Investigations at PI-14 and PAOC FF led to no further action, as documented in the report entitled Final No Action Decision Document (CH2M HILL, 2010g). Therefore, PI-14 and PAOC FF are excluded from further investigation at UXO 17.

Investigation and Release History

- EIS (1979), EBS (2002), PRA (2003), ERA/SI (2009), Preliminary Assessment/Site Inspection (PA/SI) for PAOC EE (2011)
- In 2011, a PA/SI was completed at PAOC EE to assess if the site was a munitions response site. The inspection consisted of conducting vegetation clearance and a DGM survey across all 18 acres and excavating selected DGM anomalies to assess if MEC was present at the site. The DGM survey identified 2,542 anomalies (2,190 discrete anomalies and 352 polygon anomaly areas); 458 of the anomalies (18%) were excavated, which provided a 98% confidence level as to whether or not MEC was present. The inspection identified two items classified as DMM, consisting of a 40mm flare and a canister containing propellant. In addition, 20 small arms blank ammunition were identified at one location. All other items recovered from the investigated anomalies consisted of RRD and cultural debris.

Conceptual Site Model

Physical Characteristics and Transport Pathways

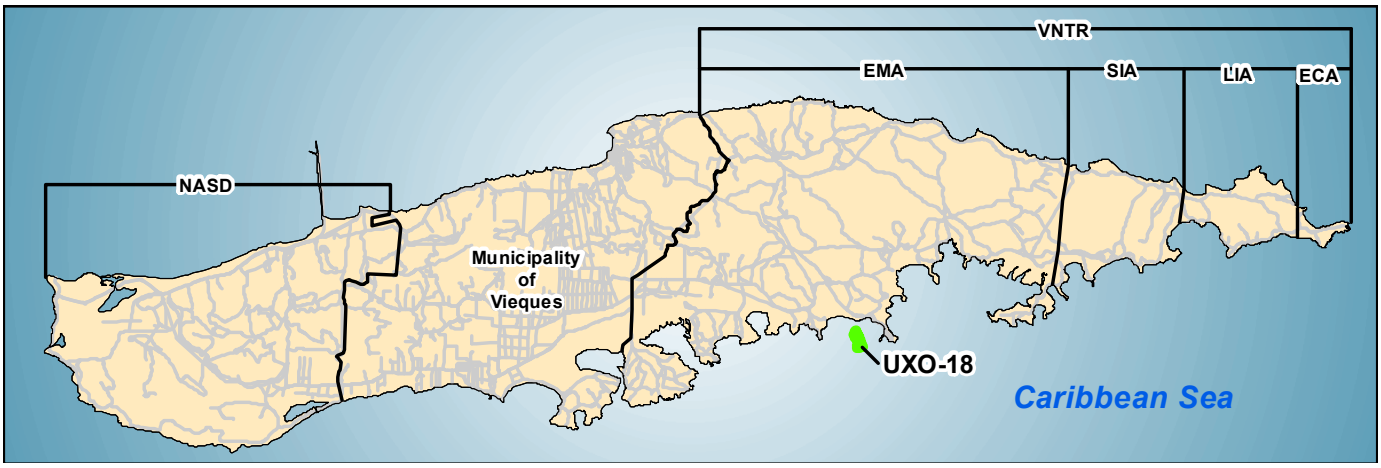
UXO 17 comprises primarily sandstone, some limestone, siltstone, conglomerate, lava, tuff, and tuffaceous breccias largely deposited in a marine environment and extensive deep weathering. The two SSAs within the site are generally low-lying adjacent to the southern coastline (near sea level). Due to the close proximity to the ocean, groundwater is likely shallow and saline from seawater intrusion.

SAP Worksheet #10n — UXO 17 (EMA Other Sites) (continued)

Future Land Use and Potential Receptors

PAOC EE will continue to be managed as part of the wildlife refuge. However, in the CCP, USFWS identifies a public boat ramp as desirable. Potential receptors at the site include both human and ecological. Potential human receptors comprise USFWS workers, trespassers (adolescent and adult), and recreators (adolescent and adult) exposed to soil. Because all anomalies at PAOC EE will be removed, the associated potential explosive hazard will be mitigated. Potentially complete exposure pathways for terrestrial ecological receptors exposed to surface soil include plants, soil invertebrates, birds, mammals, and reptiles. Potential birds and mammals consuming invertebrates, plants, and/or small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.

SAP Worksheet #10o — UXO 18 (Cayo La Chiva)



Site Background

UXO 18 (Cayo La Chiva) consists of a 12-acre small island south of the EMA (**Figure 24**). The island is surrounded by the Caribbean Sea and is within swimming distance from a public beach, Blue Beach. Munitions items were identified on the island. Details of the former operations at the EMA are provided in Worksheets #10k, #10l, and #10m.

Investigation and Release History

- Transect inspections (2011)
- No environmental investigations have been conducted at UXO 18

Transect inspections were conducted across UXO 18 in January 2011 to determine if MEC is present on the ground surface of the island (**Figure 25**). The transects were walked across approximately 5 percent of the island. Five MEC items (5-inch rockets) were discovered along the western portion of the island (**Figure 25**). The items were destroyed through open detonation in March 2011. In addition to the MEC items, RRD (smoke canisters [HC 30 lbs ABC-M5]) were observed on the ground surface. The smoke canisters were expended, but at time of operation the HC smoke mixture contained 47% hexachloroethane (a SVOC), 47% zinc oxide, and 6% grained aluminum. The MEC and RRD items and the detonation had the potential to release chemical contaminants to the environmental media. During June 2011, a Biological Assessment was completed at Cayo La Chiva. The Assessment included transects that were walked across 3% of the area (**Figure 25**). The transects were escorted by a UXO Technician who inspected the transects but did not identify any additional MEC items. In addition, the Navy conducted several visual surveys using Navy EOD divers/snorkelers to identify locations of underwater munitions off Cayo La Chiva. The Navy EOD divers identified several MEC items west of the island, including 5-in Zuni rockets. While these items will not be addressed as part of UXO 18, they do provide another line of evidence that Cayo La Chiva may have been used for training activities.

Conceptual Site Model

Physical Characteristics and Transport Pathways

UXO 18 comprises primarily of limestone and dolomite exposed at the ground surface. The shoreline is not sandy and not a suitable turtle nesting area. Groundwater is likely within bedrock and saline due to seawater intrusion.

SAP Worksheet #10o — UXO 18 (Cayo La Chiva) (continued)

Future Land Use and Potential Receptors

UXO 18 will continue to be managed as part of the wildlife refuge; however, the site has known trespassing activities. Cayo La Chiva is designated as a conservation zone (TEC, 2002). Potential receptors at the site include both human and ecological. USFWS workers and trespassers (adults, adolescents, and children) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC. Potentially complete exposure pathways for terrestrial ecological receptors exposed to surface soil include plants, soil invertebrates, birds, mammals, and reptiles. Potential birds and mammals consuming invertebrates, plants, and/or small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements

1. Who will use the data and what will the data be used for?

The Navy, USEPA, EQB, and USFWS will use the data collected during RIs to assess the nature and extent of MEC and whether releases to the environment have occurred as result of munitions-related activities conducted within the former VNTR, and evaluate if there are potentially unacceptable risks to human health and the environment in order to determine what further action is warranted for each site.

2. What are the Project Action Limits (PALs)?

The PALs are defined in the Master Standard Operating Procedures, Protocols, and Plans (CH2M HILL, 2010b) and are listed, by constituent group and medium, in Worksheet #15. In general, the PALs are:

- Vieques human health screening values for soil, sediment, and surface water are the current (as of the time the HHRA is being conducted) Regional Screening Levels (RSLs) (adjusted for a hazard quotient [HQ] of 0.1 for non-carcinogens) provided by USEPA. Adjusted residential RSLs are used for areas where unrestricted use is a potential (i.e., Parcel C of UXO 13), which are the only areas where the residential scenario will be considered, and for areas where recreational use by a child receptor is a potential. In addition, surface water screening values include the Puerto Rico Water Quality Standards (PRWQS) Regulation, Class SB (March 2010). The selected PAL is the lowest of applicable screening levels.
- Vieques human health screening values for groundwater are the current (as of the time the HHRA is being conducted) Tap-Water RSLs (adjusted for an HQ of 0.1 for non-carcinogens) provided by USEPA, the federal drinking water maximum contaminant levels (MCLs), and the PRWQS Regulation, Class SG standards (March 2010). The selected PAL is the lowest of applicable screening levels.
- Vieques ecological screening values for soil, sediment, and surface water are derived from multiple sources, which are listed in the Vieques Master Ecological Risk Assessment Protocol (CH2M HILL, 2010c).
- Vieques soil-to-groundwater leaching screening values provided by USEPA.
- Incremental background sampling was completed as part of the ECA RI. No statistically significant difference in results from the ECA incremental samples and discrete background samples collected as part of the East Vieques background soil study (CH2M HILL, 2007b) was determined. The results of this assessment are provided in **Attachment B** of this SAP. Therefore, the East Vieques background soil inorganics upper tolerance limits (UTLs) (CH2M HILL, 2007b) will be used to compare to incremental and discrete soil samples collected under the Master SAP. Since soil background data are not available for the beaches, soil from the beaches will be evaluated using a multiple lines of evidence approach, such as comparing to the adjacent terrestrial lithologic unit background surface and subsurface soil data. If necessary, background data could be collected from a representative background beach(es), if identified. If a representative background beach(es) is identified, it will be included in an addendum to the Master SAP for regulatory review..
- Screening levels for protection of human health and ecological receptors from radionuclides (i.e., U-234, U-235, and U-238) are discussed in **Attachment C**.
- Results for screening data (i.e., general chemistry parameters such as total organic carbon [TOC], potential of hydrogen (pH), etc.) collected to support the interpretation of potential contaminant data and human and/or ecological risk results will not be compared to strictly-defined PALs, but will be evaluated qualitatively. These parameters are identified in Worksheet #15.
- Each incremental sampling unit sample and discrete sample will be compared to the applicable PALs.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. Once the laboratory is identified, an update to WS#15 containing laboratory specific reporting limits, as well as any impact on the resulting data and why alternative analytical methods are not used, will be provided in a site-specific SAP addendum. If there are instances where the laboratory-specific DL is greater than the screening level, then the resulting uncertainty will be discussed in the data quality evaluation.

3. **What types of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)?**
   - Soil, sediment, surface water, and groundwater samples, as applicable to each UXO site, will be submitted to an offsite laboratory for analysis (each laboratory will be selected prior to mobilization)
   - Chemicals of interest consist, as applicable to each UXO site, of explosives constituents (USEPA Method 8330B list and perchlorate), elemental and radiological uranium, PAHs, and inorganic constituents, as shown in Worksheets #15 and #18.
   - Worksheets #10, #15, and #18 define the matrices, analytical groups, and, where applicable, specific target analytes for East Vieques UXO Sites.
   - The classification, quantity, and distribution of MEC, MPPEH, MD, RRD, and cultural debris observed during removal actions and or transect inspections, as applicable to each UXO site and recorded by UXO qualified personnel.
4. **How "good" do the data need to be in order to support the environmental decision?**
   - The data will be of the quantity and quality necessary to provide technically sound and defensible assessments of potential releases and associated human and ecological risks at each UXO site within the former VNTR. Laboratory methods will meet CERCLA, USEPA Region 2, and Navy guidance and the data will be validated per Region 2 guidelines, methodology, and laboratory SOPs as described in Worksheet #36
   - The laboratory will follow the Measurement Performance Criteria (MPC) in Worksheet #12 for field QC samples and Worksheet #28 for laboratory QC samples. These MPC are consistent with the DoD Quality Systems Manual (QSM) as applicable and laboratory in-house limits where the QSM does not apply.
   - The MEC, MPPEH, MD, RD, and cultural debri data will be identified by qualified UXO Technicians to provide technically sound and defensible assessments regarding the nature and distribution of MEC across each UXO site within the former VNTR.
5. **How much data should be collected (number of samples for each analytical group, matrix, and concentration)?**
   - Worksheet #18 contains the number of samples per matrix per analytical group per UXO site. Worksheets #15 contain the particular analytes and PALs. Worksheet #17 provides the rationale for the particular sampling at each UXO site.
   - The basis and rationale for determining the number of groundwater, surface water, sediment, incremental soil, and discrete soil samples is provided on WS# 10 and #17.
   - Field measurements of the groundwater and surface water salinity, conductivity, dissolved oxygen (DO), pH, oxidation-reduction potential (ORP), temperature, and turbidity will be made.
   - During removal actions and investigations;, the MEC classification, type, quantity, and grid location for the MEC, MPPEH, MD, RRD, or cultural debris found should be documented.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

- Transect inspections fairly uniformly spaced over each UXO site to identify classification and quantity of MEC, MPPEH, MD, RRD, and cultural debris present. The spacing of transects will depend on the nature and size of each UXO site.

- Where, when, and how should the data be collected/generated?
  - Samples will be collected during multiple field mobilizations based on the progress of MEC investigation activities and resource allocation.
  - Data will be collected and generated in accordance with the procedures outlined in the UFP-SAP. Specifically, see the SOPs in Attachment A for more details.
  - MEC, MPPEH, MD, RRD, and cultural debris classifications, quantities, and locations will be recorded during removal actions and or transect inspections. The data collection methods are described in SOP MR-3.
- Who will collect and generate the data? How will the data be reported?
  - CH2M HILL field staff will collect the samples.
  - Laboratory analysis will be performed by a laboratory that meets Navy, USEPA and Puerto Rico laboratory specific requirements. The laboratory will be selected and approved by the Navy. USEPA and PREQB will have an opportunity to review laboratory-specific information in site-specific SAP addenda prior to conducting the sampling.
  - The Navy's munitions response contractors will collect MEC data related to the munitions response activities. The data recorded through each activity will be reported in the munitions response data management system and will be incorporated into the RI report for each UXO site.
- How will the data be archived?
  - The data will be archived in accordance to procedures dictated in the Navy CLEAN program/contract. At the end of the project, archived data will be returned to the Navy. It is anticipated that the Navy will not dispose of project documents.
- List the PQOs in the form of if/then qualitative and quantitative statements
  - The general objectives of the decision analysis process are:
    - To sufficiently characterize the nature and extent of MEC at each UXO site such that: (1) the final remedy determinations can be made regarding MEC based on the explosive safety risk for the intended land use, and (2) environmental media can be appropriately characterized
    - To determine if there has been a release of chemical constituents related to the former munitions-related activities at each UXO site and, if so: (1) whether the data sufficiently represent the nature and extent of contamination, (2) whether site-related contamination, if present, poses unacceptable human health and/or ecological risks, and (3) determine whether site-related contamination, if present, warrants action to achieve the proposed land use goals

The decision analysis process shown in **Figure 13** represents the general PQOs for all sites included in this Master SAP. The 6-step decision analysis and associated PQOs are described below.

Step 1(MC and MEC) —MEC Nature and Extent Determination to Facilitate MC Nature and Extent Determination

As noted above, determination of the nature and extent of MEC has two purposes. The first is to make explosive safety risk and associated remedy determinations for MEC itself. The second is to provide sufficient information on the distribution of MEC such that MC characterization can be performed in areas that can conservatively represent the site as a whole.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

Based on these objectives, the following are the PQOs for this step:

- If the MEC nature and extent have been sufficiently delineated to adequately assess the associated explosive safety risk consistent with the planned land use, make final MEC remedy determinations for the site (via the feasibility study, proposed plan, record of decision process); otherwise, conduct additional MEC delineation activities until sufficiently delineated.
- If the MEC nature and extent have been sufficiently delineated to assess the nature and extent of MC, perform the MC RI; otherwise, conduct additional MEC delineation until sufficiently delineated to perform the MC RI.

It is important to note that it is not necessary to delineate the nature and extent of MEC throughout 100 percent of each site. It is necessary only to delineate the nature and extent of MEC until MEC remedy decisions for the site and conservative MC characterization determinations can be made with confidence. In other words, MEC will have been sufficiently delineated once the remedial actions necessary to protect human health from potential explosive safety risk posed by MEC for the intended land use can be appropriately evaluated and selected. Similarly, with respect to MC characterization, MEC will have been sufficiently delineated once MC sampling locations in areas deemed conservatively representative of the site as a whole can be appropriately selected.

As discussed and shown in each of the site-specific worksheets, the site-specific sampling proposed in the SAP is based on the cumulative information available for the site, including the current understanding of the nature and extent of MEC (the potential contaminant source), which includes not only actual identification of MEC, but also other elements of the CSM, such as historical site use, release mechanisms, fate and transport, and potential exposure pathways. This cumulative information has been deemed sufficient for each site contained in this SAP to identify conservative sampling locations. However, the SAP provides for continual scrutiny of this conclusion in that as additional MEC data are gathered at any particular site (e.g., via NTCRAs) following issuance of this SAP, the data are evaluated to determine if they suggest the understanding of the nature and extent of MEC has been altered such that the MC characterization and/or MEC remedial determinations could be affected. If the former occurs, modifications to the sampling approach at the affected site will be proposed in a site-specific addendum. Ultimately, the conclusions drawn that the nature and extent of MC and MEC have been sufficiently delineated will be subject to review by the regulatory agencies in the corresponding report.

Step 2 (MEC)—Determination of Additional MC Data Needs based on Additional MEC Delineation

The purpose of this step is to determine if any additional MEC delineation data collected after planning or initiation of the MC characterization changes the CSM such that additional environmental media samples should be collected. Since the objective of MC characterization, at least initially, is to collect samples in areas that can conservatively represent the site as a whole, if additional MEC delineation data are gathered that suggest the areas where MC data were (or are planned to be) collected no longer conservatively represent the site as a whole, for example, due to information that would suggest other areas potentially represent higher levels of site-related contamination or the potential release from MEC, additional environmental media samples will be collected in accordance with a Master SAP Addendum (provided for review and approval by the regulatory agencies) in order to achieve the MC characterization objective.

The associated PQO statement for this step is:

- If additional MEC delineation indicates the planned or executed MC RI did not conservatively represent the site as a whole, collect additional environmental media samples to achieve this objective.

Step 2 (MC)—Data Quality Evaluation

The purpose of this step is to determine if the data quality evaluation indicates the dataset as a whole is available and useful for its intended purpose. The data quality evaluation (DQE) assesses the effect of the overall analytical process on the “availability” of the analytical data. “Availability” in this context refers to whether results can be used by the project team based on their analytical soundness. If a result is analytically sound, it is available for use for evaluating potential releases and whether further investigation or action is warranted. However, a particular result or group of results may not be “usable” for these purposes if other conditions apply.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

The three major categories of data availability evaluation are laboratory performance, field collection performance (i.e. blank contamination), and matrix interferences. The data evaluation and validation is a multi-tiered approach. The process begins with an internal laboratory review, continues with an independent review by a third-party validator, and ends with an overall review by the CH2M HILL project chemistry team. While only the data validator is allowed to apply qualifiers to the data, the process provides a medium for essential communication between the laboratory, validator, and project team, and allows for data quality to be thoroughly evaluated.

The data usability evaluation comprises critical assessment of the data with respect to the project objective. Given that the primary objective of the MC RI is to determine the nature and extent of contamination and associated risks, the comprehensive dataset will be reviewed to determine if it is adequate for making the project-specific

determinations. Another aspect of the data usability evaluation is whether PALs were met for non-detect results and, if not, what the effects are on the project-specific determinations. Not achieving PALs does not necessarily mean project-specific determinations cannot be made; it may lend some uncertainty to those decisions and may mean additional lines of evidence are necessary to make the decisions conclusively, which will be discussed in the data usability evaluation.
The associated PQO statement for this step is:

- If the DQE indicates the data are available and useful for the intended purpose, evaluate the nature and extent of contamination and assess potential risks; otherwise, collect sufficient additional samples to achieve an available and useful data set.

Step 3 (MC)—Release, Nature and Extent, and Risk Assessments

The purpose of this step is to determine if there has been a potential CERCLA-related release at a particular site and, if so, a conservative representation of the nature and extent of contamination. A “CERCLA-related release” is a release of hazardous substances, pollutants, and contaminants eligible for CERCLA response as defined in CERCLA Sections 101(14) and 101(33).

A potential release is suspected if any inorganic constituents inconsistent with background (including use of background UTLs, where present, and multiple lines of evidence, such as potential presence based on historic use and/or components of contaminant sources) are detected or if any non-inorganic constituents (e.g., explosives) are detected.

It is important here to emphasize the distinction between the use of background in a “release assessment” versus a “risk assessment.” In determining whether there has been a CERCLA-related release, it is critical that background be considered upon initial evaluation of site-specific data. In other words, whether a potential release occurred can be determined only if site-specific data are evaluated relative to background (and potentially other lines of evidence as indicated above). On the other hand, when a risk assessment is performed, a release has already been determined to have occurred and the risk assessment is performed to evaluate the potential risks based on the nature and extent of the contaminant release. In that circumstance, background is considered only after the potential risks posed by all constituents of potential concern (COPCs) are evaluated, in accordance with EPA policy.

The associated PQO statement for this step is:

If any inorganics not attributable to background or non-inorganics (e.g., explosives) are detected, use the data to conservatively evaluate the nature and extent of contamination and assess potential human health and ecological risks; otherwise, make a final evaluation of the adequacy of the data set (see Step 5) prior to preparation of the RI Report. Inorganics detected within background will be addressed in the human health risk assessment; however, if the only chemicals exceeding RSLs are inorganic constituents within background levels, a human health risk assessment will not be prepared.

SAP Worksheet #11 — Project Quality Objectives/Systematic Planning Process Statements (continued)

Step 4 (MC)—Whole-Site Applicability Determination

Once the initial data set has been used to conservatively assess the nature and extent of contamination and associated risks, an assessment will be made as to whether those findings are appropriate to apply to the site as a whole. This step is performed to ensure scaling up the conservative results does not potentially result in unintentional or unnecessary remedial action for areas of the site where it may not be warranted. In this case, additional sampling may be performed to refine the understanding of the nature and extent of contamination and associated risks in order to better evaluate and ultimately select any necessary remedial action.

The associated PQO statement for this step is:

- If the results of the conservative nature and extent of contamination determination and associated risk assessments suggest they are not appropriate to apply to the site as a whole because, for example, they do not reflect actual site conditions, are determined to be too conservative, or may result in unintentional or unnecessary remedial actions at the site, collect additional samples in accordance with a Master SAP Addendum (provided for review and approval by the regulatory agencies) to refine the findings; otherwise, make a final evaluation of the adequacy of the data set (see Step 5) prior to preparation of the RI Report.

Step 5 (MC)—Evaluation of Historical Site Information and Spatial Distribution

As a final check before preparing the RI Report, the historical site information, spatial distribution of constituents and constituent concentrations, and risk assessments are collectively evaluated to ensure the site has been sufficiently characterized to make remedy determinations for MC.

The associated PQO statement for this step is:

- If the historical information, nature and extent of contamination determination, and associated risk assessments suggest the site has been sufficiently characterized to make remedy determinations, prepare the RI Report; otherwise, collect additional samples and return to Step 2 (MC).

Step 6 (MC and MEC)—RI Report and FS Report Preparation

Once it has been determined that the nature and extent of MEC and MC have been sufficiently characterized and the associated risks assessed appropriately for the intended land use, the RI and Feasibility Study (FS). Reports will be prepared.

The associated PQO statement for this step is:

- If the RI Report concludes: (1) there is an explosive safety risk associated with the intended land use, or (2) a CERCLA-related release occurred that poses an unacceptable human health and/or ecological risk, prepare an FS Report that evaluates remedial alternatives to address the explosive safety and/or MC exposure risks, as applicable. The explosive safety risk will be calculated using the MEC HA.

As shown above, the 6-step decision process is potentially iterative, whereby the findings based on a particular data set may result in collection of additional data. For efficiency, it is anticipated that concurrence will be reached by the Navy, USEPA, PREQB, and USFWS at critical steps in the decision process (i.e., data grouping, determining if a data set is adequate for its intended purpose, determining the scale-up applicability) and at iterative junctures (i.e., selection of additional data collection media and locations). Concurrence will be accomplished via conference calls, Technical Subcommittee meetings, and SAP addenda, as warranted.

SAP Worksheet #12 — Field Quality Control Samples

Refer to Worksheet #28 for field QC samples.

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SAP Worksheet #13 — Secondary Data Criteria and Limitations Table

The table below provides general information on how secondary data will be used in meeting the current project objectives and the limitations on their use in developing the SAP. Secondary data criteria and limitations tables are presented for each site where historical analytical data exist (applicable to the scope of work covered by this SAP), specifically to address the use and limitations of the historical analytical data.

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use
MEC Items	Expanded Range Assessment/Site Inspection Report, Former Vieques Naval Training Range, Vieques, Puerto Rico (CH2M HILL, 2010e), Final Draft Preliminary Range Assessment Report, Vieques Naval Training Range, Vieques Island, Puerto Rico (CH2M HILL, 2003) Non-Time Critical Removal Action Work Plan, Surface Munitions and Explosives of Concern at Munitions Response Area-Surface Impact Area, Munitions Response Sites 1 through 7, former VNTR, Vieques, Puerto Rico (CH2MHILL, 2009) Preliminary Inspection of Cayo la Chiva, Former Vieques Naval Training Range, Vieques, Puerto Rico (CH2M HILL, 2010) Preliminary Assessment/Site Inspection for the Playa La Plata and Secret Beaches, Former Vieques Naval Training Range, Vieques, Puerto Rico (CH2M HILL, 2010) Status Report, Time Critical Removal Action, Interim Action for the Removal of Surface Munitions and Explosives of Concern at Munitions Response Areas-Live Impact Area, and Eastern Conservation Area, Former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico (CH2M HILL, 2010) Non-Time Critical Removal Action Work Plan Munitions Response Site UXO 13, Former Vieques Naval Training Range, Vieques, Puerto Rico (CH2M HILL, 2012) Technical Memorandum, PAOC EE PA/SI Results, Former Vieques Naval Training Range, Vieques, Puerto Rico (CH2M HILL, 2012)	MEC and MD items located and disposed of during surface clearance of EMA, SIA, and LIA	Locations, varieties, and concentrations of MEC/MD items have been used to locate systematic incremental sampling.	Locations of items limited to the accuracy of the personal digital assistant (PDA) used to collect the data. In some cases MD scrap was relocated to a central position on each site prior to marking the location.
Environmental Media	Results of the Hydrogeologic Investigation Vieques, Island, Puerto Rico (Baker, 1999) Live Impact Area Soil Sampling Report, U.S. Naval Facility, Vieques Island, Puerto Rico (CH2M HILL, 2000) Draft Final Environmental Baseline Survey Vieques Naval Training Range, Vieques Island, Puerto Rico (NAVFAC, 2003)	Determine if explosive constituents were detected in soil and groundwater.	Locations and depth of monitoring wells and soil samples.	Locations of items limited to the accuracy of the sampling methods used to collect the data.

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SAP Worksheet #14 — Summary of Project Tasks

The Master Standard Operating Procedures, Protocols, and Plans (MSOPPPs) (CH2M HILL, 2010b) in conjunction with the Random Incremental Sampling SOP A-7 (**Attachment A**) address the protocols SOPs to be used for this sampling approach, in accordance with the Vieques Environmental Master Health and Safety Plan (CH2M HILL, 2010). The proposed field activities for the UXO sites are discussed below. The technical approach and sample design for the proposed field activities are discussed in Worksheet #17. SOP A-7 has been incorporated into the MSOPPPs.

Mobilization

Prior to mobilization, NAVFAC Atlantic, USEPA, PREQB, and USFWS will be notified to allow for appropriate oversight and coordination.

As part of the field mobilization, CH2M HILL will procure the following subcontractors to support investigation activities:

- Analytical laboratory
- Data validation
- IDW disposal contractor
- Anomaly avoidance support

Mobilization for the field effort includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the CH2M HILL field team mobilizes for field activities.

Anomaly Avoidance

An anomaly avoidance subcontractor will be present at all times during field activities. Any anomaly detected will be avoided with an exclusion zone of a distance specified by the UXO safety officer, but not less than 2 feet in diameter. Very detailed anomaly avoidance will be conducted in the areas where submunitions were identified and removed. Anomaly avoidance will be followed in accordance with the Vieques Master Environmental Health & Safety Plan (CH2MHILL, 2010a).

Sample Location Mark-out

The sampling unit boundaries will be established with survey tape and pin flags or stakes at each corner using Global Positioning System (GPS) coordinates. Each sampling unit area and discrete sampling point will be walked by anomaly avoidance subcontractors prior to staking and sampling for anomaly avoidance.

Soil Sampling

Incremental Sample Collection

Each sampling unit will be sampled for the specified analytes in accordance with the sampling decision in Worksheet #17 and following the incremental sampling SOP (**Attachment C**). The sampling device used to collect the subsample soil plugs will be the MISTTM 02 or equivalent (**Attachment C**), using the 0.5-inch diameter 2.5-inch (nominal 2-inch) core bit. Samples will be collected to approximately 2.5-inches or to refusal if bedrock/sample tool refusal is shallower than 2.5-inches. If the environmental conditions do not allow for the incremental sampling device to collect samples (i.e., bedrock depth shallower than 2.5-inches), a stainless steel spoon may be used. Due to the quantity of soil needed for analysis (approximately 1,000 grams) and sampling device size, each sampling unit will have a target of 100 subsample soil plugs collected in approximately even distribution over the entire sampling unit area. Each 1-acre sampling unit consists of four quarter-acre grids that were used for munitions characterization. The coordinates of each quadrant are located in the field using a GPS. In general, 25 subsamples will be collected along four transects within the quarter-acre grids. This approach is consistent with what is recommended in the US Army Corps of Engineer guidance on incremental sampling (USACE, 2009). Some vegetation clearing may be required to approximately evenly distribute subsample locations. More subsamples may be required if the soil layer is particularly thin, or poor recovery is obtained from the subsample coring device, so that the target 1,000-gram sample mass is achieved. Vegetation will not be intentionally included in the soil samples. Where vegetation is present at the ground surface, it will be pushed aside before collecting the soil sample.

SAP Worksheet #14 — Summary of Project Tasks (continued)

Discrete Soil Sample Collection

Discrete surface soil samples from the beaches (18 to 36 inches), lagoon fringes (2.5 to 24 inches), depleted uranium area at UXO 4 (0 to 12 inches), Parcel C at UXO 13 (0 to 12 inches), UXO 17 (0 to 12 inches), and UXO 18 (0 to 12 inches) will be collected with a hand auger or similar sampling device in accordance with the modified Master Protocols (detailed more in Worksheet #17). Discrete subsurface soil samples will also be collected at a depth interval and sampling device in accordance with the modified Master Protocols. In addition, discrete subsurface soil samples (4 to 6 feet) will be collected using split spoons during borehole drilling at each of the 23 monitoring wells, in accordance with the Master Protocols.

Surface Water and Sediment Sampling

Surface water sampling will follow Vieques Master Protocols SOP G-1 (Surface Water Sampling) to the extent practicable (based on quantity and depth of water present). Surface water samples will be collected prior to sediment samples. Sediment will be sampled following Vieques Master Protocols SOP G-2 (Sediment Sampling). Depending on the depth of the water, sediments will either be sampled from a canoe or from waders. For UXO safety purposes, the preferred method of sampling is from a canoe. Waders will only be used if the sampler sinks into the sediment less than the safe resolution depth of anomaly avoidance Schonstadts. Detailed anomaly avoidance will be conducted prior to sampling.

Field surface water quality parameters to be measured and logged in the field comprise temperature, pH, DO, ORP, conductivity, salinity, and turbidity.

Monitoring Well Installation and Development

The well borehole will be advanced with post-hole diggers to a depth of at least 4 feet bgs to provide clearance of underground utilities (if necessary), then drilled with hollow-stem augers or air rotary rigs to the appropriate depth. Continuous soil samples will be collected using a 2-foot split spoon sampler or comparable method during installation prior to reaching bedrock. These samples will be logged in the field in accordance with the Unified Soils Classification System (USCS). Specifically, sample descriptions included soil type, USCS symbols, predominate and secondary grain sizes with relative proportions (Modified Wentworth Scale), color (Munsell Color System), and lithologic boundaries.

Twenty-three monitoring wells (**Figure 26**) will be installed in each of the 23 borings. The total depth and well screen intervals of 23 new monitoring wells will be at the first encountered water within the saturated zone. Each monitoring well will be screened at the first encountered groundwater using a screen length appropriate for providing sufficient water to facilitate sampling. This will be a judgment call made in the field based on water production observed during drilling and may include screen lengths up to 15 feet. The field personnel will make appropriate adjustment of total depth and screen intervals based on observed geologic and depth-to-water conditions. Each monitoring well will be installed in general accordance with the Master Standard Operating Procedures, Protocols, and Plans, SOPs D-1 and D-2 (CH2M HILL, 2010b).

Following installation of all wells, a round of groundwater-level measurements will be collected to verify the groundwater flow direction. Monitoring wells will be developed no sooner than 24 hours after the well has been installed in order to give the grout time to cure. Additionally, the wells will be sampled no sooner than 48 hours after development, in order to give the wells time to re-equilibrate after development. Development water will be containerized in 55-gallon drums for IDW disposal. The groundwater levels from the monitoring wells along with other physical characteristics (such as elevations of dry lagoons, etc.) may be used to evaluate the regional groundwater flow direction.

SAP Worksheet #14 — Summary of Project Tasks (continued)

Groundwater Sampling

The groundwater monitoring event will include the sampling of 23 new monitoring wells (**Figure 26**). Prior to purging, the field team will measure and record the depth to water, sampling depth, and total well depth in the log book. Purging and sampling will be done either using a peristaltic pump or a submersible pump at a flow rate of approximately 100 – 500 milliliters per minute (mL/min). Purging will continue until water quality parameters stabilized for three consecutive readings. Water quality parameters will be obtained using a Horiba U-22, or equivalent, water quality meter and flow-through cell. Groundwater samples will be collected following SOP B-1, Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling (CH2M HILL, 2010b).:

Groundwater samples will be collected by placing the sample tubing intake in the middle of the screened interval.

The groundwater samples will be analyzed for inorganics and explosives that will be contained in laboratory-prepared, pre-preserved sample bottles and packed on ice. Quality assurance/quality control (QA/QC) samples included field duplicates, matrix spike/matrix spike duplicates (MS/MSDs), , and equipment blanks.

All non-disposable sampling equipment was decontaminated immediately after each use in accordance with the applicable SOPs.

Sample Analysis

Incremental samples will not be homogenized or ground in the field, but will be sent to the laboratory in appropriate sample containers for explosives, inorganic constituents, pH, and TOC. The laboratory will sieve the samples to remove debris and in the process homogenize the sample. A subsample will be collected in the laboratory from the main sample to analyze for inorganics and ground with a non-metallic device (i.e., ceramic) by hand. Another subsample will be collected from the main sample for pH and TOC (general chemistry parameters). Following removal of the inorganics and general chemistry sample fractions, the main sample will be ground and further homogenized for analysis for explosives. Details of the laboratory analysis are included in Worksheet #28 and Attachment B.

The laboratory will maintain, test, inspect, and calibrate analytical instruments (Worksheets #24 and #25). The laboratory will analyze groundwater, soil, sediment, and surface water samples for various groups of parameters as shown on Worksheets # 15 and #18.

Radiological Survey

The radiological survey will be conducted to measure radiation levels in the area within UXO 4 where depleted uranium was deployed. A Ludlum Model 19 Micro R Meter (model 19) or equivalent will be used to measure radiation levels in microroentgens (microR) per hour in accordance with SOP C-4. The model 19 can be used to determine area radiation levels ranging from typical background values to 5,000 microR per hour except where significant quantities of fission and/or activation products are present. Radiation readings detected by the model 19 will be recorded in the field note book along with the GPS coordinates of the location. Background radiation levels will be established on-site from an unaffected area. Any detected penetrators/fragments will be recovered. Operators of the meter will be trained in calibration and operation of the meter prior to use. Details of the radiological survey and associated sampling are discussed in Worksheet #17.

Equipment Decontamination

Equipment decontamination will follow the Master Protocols SOP E-1.

Investigation-Derived Waste Management

IDW will be managed and disposed of in accordance with the Master Protocols. Liquid and solid IDW will be sampled for Toxicity Characteristic Leaching Procedure (TCLP) and RCI to determine the disposal options. The disposal subcontractor will determine the necessary parameters.

SAP Worksheet #14 — Summary of Project Tasks (continued)

Shipments

All offsite analytical samples will be delivered to the laboratory by FedEx. All samples will be shipped in accordance with the Master SOP H-9 "Packaging and Shipping Procedures for Low-Concentration Samples."

Quality Control

All quality control samples are listed on Worksheet #20. In reference to the field tasks, field work will be overseen by a field team leader, or his delegate, who is responsible for the quality control of the sampling and make sure the proper SOPs are followed for each task.

All munitions response activities will take place in general accordance with the procedures described in the SOPs (see Worksheet #21 and Appendix D) for the tasks performed. The UXO team leader, UXOQCS, and or QA officer will be responsible ensuring the quality control processes identified in the SOPs are implemented, as appropriate, and the quality control metrics identified in MR contractor's site specific work plan are achieved.

Data Management

The Project EIS, Hillary Ott, is responsible for data tracking and storage. In addition a third party data validator will receive all analytical data from the laboratory and the data will be validated prior to its use by the Navy. All validated analytical data will be loaded into the (Navy Installation Restoration Information System (NIRIS) database.

Procedures for Recording and Correcting Data

- Field data will be recorded in field logbooks.
- Project Assessment/Audit: Worksheets #31 and #32
- Data Validation: Worksheets #35 and #36
- Data Usability Assessment: Worksheet #37.

Munitions Characterization Procedures

The areas selected for subsurface MEC characterization will be investigated in accordance with the equipment and practices currently being employed at the Former VNTR as part of the subsurface NTCRA. The details about the equipment, work approaches, and quality control requirements that will be employed during these investigations are provided in the SOPs listed in Worksheet 21, which are included in Attachment D. The SOPs for these work elements have been developed based on the approved work approaches presented in *Final Work Plan for Munitions and Explosives of Concern, Subsurface Interim Removal Action Beaches and Select Roadways, Former Vieques Naval Training Range (VNTR) and Former Naval Ammunition Support Detachment (NASD), Solid Waste Management Unit 4, Vieques, Puerto Rico* (CH2M HILL, 2008c). When the investigations take place at the sites, the SOPs will be supplemented by site-specific work plans by the munitions response contractor executing the work.

SAP Worksheet #15-1 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: SB, SD, SMI, SS
Analytical Group: EXPLO

Analyte[1]	CAS No.	RSLs Residential Soil Adjusted[2] (µg /kg)	RSLs Industrial Soil Adjusted[2] (µg /kg)	Ecological Soil ESVs[3] (µg /kg)	Marine Sediment ESVs[4] (µg /kg)	SSL[5] (µg/kg)	Project QL Goal[6] (µg /kg)	Laboratory Specific Limits[7] (µg/kg)			A/P Limits[8] (%)		
								LOQs	LODs	DLs	LCL	UCL	%RPD
HMX	2691-41-0	380000	4900000	10000	115000	990	495	TBD	TBD	TBD	TBD	TBD	20
RDX	121-82-4	5600	24000	10000	891000	0.23	0.115	TBD	TBD	TBD	TBD	TBD	20
1,3,5-Trinitrobenzene	99-35-4	220000	2700000		7000	1700	850	TBD	TBD	TBD	TBD	TBD	20
1,3-Dinitrobenzene	99-65-0	610	6200			1.4	0.7	TBD	TBD	TBD	TBD	TBD	20
Tetryl	479-45-8	24000	250000	10000	72	580	36	TBD	TBD	TBD	TBD	TBD	20
Nitrobenzene	98-95-3	4800	24000	2260	21	0.079	0.0395	TBD	TBD	TBD	TBD	TBD	20
2,4,6-Trinitrotoluene	118-96-7	3600	42000	10000	20000	13	6.5	TBD	TBD	TBD	TBD	TBD	20
4-Amino-2,6-dinitrotoluene	19406-51-0	15000	190000			23	11.5	TBD	TBD	TBD	TBD	TBD	20
2-Amino-4,6-dinitrotoluene	35572-78-2	15000	200000	80000		23	11.5	TBD	TBD	TBD	TBD	TBD	20
2,4-Dinitrotoluene	121-14-2	1600	5500	11000		0.28	0.14	TBD	TBD	TBD	TBD	TBD	20
2,6-Dinitrotoluene	606-20-2	6100	62000	8500	549	20	10	TBD	TBD	TBD	TBD	TBD	20
2-Nitrotoluene	88-72-2	2900	13000			0.25	0.125	TBD	TBD	TBD	TBD	TBD	20
3-Nitrotoluene	99-08-1	610	6200			1.2	0.6	TBD	TBD	TBD	TBD	TBD	20
4-Nitrotoluene	99-99-0	24000	110000			3.4	1.7	TBD	TBD	TBD	TBD	TBD	20
Nitroglycerin	55-63-0	610	6200			0.66	0.33	TBD	TBD	TBD	TBD	TBD	20
PETN	78-11-5	12000	120000			24	12	TBD	TBD	TBD	TBD	TBD	20
Perchlorate	14797-73-0	5500	72000	1000			500	TBD	TBD	TBD	80	120	15
Picric Acid	88-89-1						N/A	TBD	TBD	TBD	TBD	TBD	20

Notes:

1. Full 8330B-list & Perchlorate & Picric Acid
2. RSLs presented are current as of November, 2012
3. Ecological Soil ESVs are current as of August, 2010.
4. Marine Sediment ESVs are current as of August, 2010.
5. Risk-based SSL if no MCL-based SSL, current as of November, 2012
6. The PQL Goal is 1/2 the lesser of applicable screening levels.
7. The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. There may be instances where DL > screening level (refer to Worksheet #11).
8. DoD QSM v. 4.1 does not provide accuracy or precision limits for 8330B compounds. In-house limits must be used.
9. Results for non-aqueous samples are reported on a dry-weight basis. For fractions which have been dried prior to analysis, results are reported on an as-received basis (for the dried fraction).

SAP Worksheet #15-2 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: SB, SD, SMI, SS
Analytical Group: METAL

Analyte[1]	CAS No.	Intended Analysis Method[7]	RSLs Residential Adjusted[2] (mg/kg)	RSLs Industrial Soil Adjusted[2] (mg/kg)	Ecological Soil ESVs[3] (mg/kg)	Marine Sediment ESVs[4] (mg/kg)	SSL[5] (mg/kg)	Project QL Goal[6] (mg/kg)	Laboratory Specific Limits[6] (mg/kg) (6010 or 7196)			Laboratory Specific Limits[6] (mg/kg) (6020)			A/P Limits (%)		
									LOQs	LODs	DLs	LOQs	LODs	DLs	LCL	UCL	%RPD
Aluminum	7429-90-5	6010 or 6020	7700	99000		18000	23000	3850	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Antimony	7440-36-0	6010 or 6020	3.1	41	0.27	2	0.27	0.135	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Arsenic	7440-38-2	6010 or 6020	0.39	1.6	18	8.2	0.29	0.145	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Barium	7440-39-3	6010 or 6020	1500	19000	330	48	82	24	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Beryllium	7440-41-7	6010 or 6020	16	200	21		3.2	1.6	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Cadmium	7440-43-9	6010 or 6020	7	80	0.36	1.2	0.38	0.18	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Calcium	7440-70-2	6010 or 6020						N/A	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Chromium	7440-47-3	6010 or 6020	0.29	5.6	26	81	180000	0.145	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Chromium (hexavalent)	18540-29-9	7196	0.29	5.6			0.00059	0.000295	TBD	TBD	TBD	N/A	N/A	N/A	85	115	30
Cobalt	7440-48-4	6010 or 6020	2.3	30	13	10	0.21	0.105	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Copper	7440-50-8	6010 or 6020	310	4100	28	34	46	14	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Iron	7439-89-6	6010 or 6020	5500	72000		220000	270	135	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Lead	7439-92-1	6010 or 6020	400	800	11	46.7	14	5.5	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Magnesium	7439-95-4	6010 or 6020						0	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Manganese	7439-96-5	6010 or 6020	180	2300	220	260	21	10.5	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Nickel	7440-02-0	6010 or 6020	150	2000	38	20.9	20	10	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Potassium	7440-09-7	6010 or 6020						N/A	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Selenium	7782-49-2	6010 or 6020	39	510	0.52	1	0.26	0.13	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Silver	7440-22-4	6010 or 6020	39	510	4.2	1	0.6	0.3	TBD	TBD	TBD	TBD	TBD	TBD	75	120	20
Sodium	7440-23-5	6010 or 6020						N/A	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Thallium	7440-28-0	6010 or 6020	0.078	1	1		0.14	0.039	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Uranium	7440-61-1	6010 or 6020	23	310	TBD	TBD	21	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	20
Vanadium	7440-62-2	6010 or 6020	39	520	7.8	57	78	3.9	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Zinc	7440-66-6	6010 or 6020	2300	31000	46	150	290	23	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20

Notes:

1. ILM05-list (no Hg, no CN) & HexCr. Uranium is not part of the TAL and is shown only for samples which require analysis for Uranium.
2. RSLs presented are current as of November, 2012.
3. Ecological Soil ESVs are current as of August, 2010; the lowest of the Eco-SSLs was used as the PAL. The chromium value of 26 mg/kg represents chromium (III)
4. Marine Sediment ESVs are current as of August, 2010.
5. Risk-based SSL if no MCL-based SSL, current as of November, 2012
6. The PQL Goal is 1/2 the lesser of applicable screening levels.
7. The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. There may be instances where DL > screening level (refer to Worksheet #11).
8. The intended analysis method will be assigned in this fashion: For any given 6010/6020 analyte, if the laboratory-specific LOQ > PQL Goal, then that analyte will be assigned to 6020 if the laboratory-specific LOQ is lower via 6020 and the laboratory is DoD-ELAP accredited for that analyte via that method. However, the laboratory may report any 6010/6020 analyte by 6010 or 6020 if that provides "better data" (i.e. lower laboratory specific limits at elevated dilution factor) as determined by the laboratory and project chemist.
9. Results for non-aqueous samples are reported on a dry-weight basis. For fractions which have been dried prior to analysis, results are reported on an as-received basis (for the dried fraction).

SAP Worksheet #15-3 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix:	SB, SMI, SS																	
Analytical Group:	SVOC																	
Analyte[1]	**CAS No.**	**Intended Analysis Method[7]**	**RSLs Residential Soil Adjusted[2] (µg /kg)**	**RSLs Industrial Soil Adjusted[2] (µg /kg)**	**Ecological Soil ESVs[3] (µg /kg)**	**Marine Sediment ESVs[4] (µg /kg)**	**SSL[5] (µg/kg)**	**Project QL Goal[6] (µg /kg)**	**Laboratory Specific Limits[7] (µg /kg) (8270)**			**Laboratory Specific Limits[8] (µg /kg) (8270_SIM)**			**A/P Limits (%)[9]**		
									LOQs	**LODs**	**DLs**	**LOQs**	**LODs**	**DLs**	**LCL**	**UCL**	**%RPD**
Hexachloroethane	67-72-1	8270 or 8270_SIM	4300	43000		73	0.48	0.24	TBD	TBD	TBD	TBD	TBD	TBD	30	100	30
Naphthalene	91-20-3	8270 or 8270_SIM	3600	18000		160	0.47	0.235	TBD	TBD	TBD	TBD	TBD	TBD	40	105	30
2-Methylnaphthalene	91-57-6	8270 or 8270_SIM	23000	220000		70	140	35	TBD	TBD	TBD	TBD	TBD	TBD	45	105	30
2-Chloronaphthalene	91-58-7	8270 or 8270_SIM	630000	8200000			2900	1450	TBD	TBD	TBD	TBD	TBD	TBD	45	105	30
Acenaphthylene	208-96-8	8270 or 8270_SIM	340000	3300000		44	4100	22	TBD	TBD	TBD	TBD	TBD	TBD	45	105	30
Acenaphthene	83-32-9	8270 or 8270_SIM	340000	3300000		16	4100	8	TBD	TBD	TBD	TBD	TBD	TBD	45	110	30
Fluorene	86-73-7	8270 or 8270_SIM	230000	2200000		19	4000	9.5	TBD	TBD	TBD	TBD	TBD	TBD	50	110	30
Phenanthrene	85-01-8	8270 or 8270_SIM	1700000	17000000		240	42000	120	TBD	TBD	TBD	TBD	TBD	TBD	50	110	30
Anthracene	120-12-7	8270 or 8270_SIM	1700000	17000000		85.3	42000	42.65	TBD	TBD	TBD	TBD	TBD	TBD	55	105	30
Fluoranthene	206-44-0	8270 or 8270_SIM	230000	2200000		600	70000	300	TBD	TBD	TBD	TBD	TBD	TBD	45	125	30
Pyrene	129-00-0	8270 or 8270_SIM	170000	1700000		665	9500	332.5	TBD	TBD	TBD	TBD	TBD	TBD	45	125	30
Benzo(a)anthracene	56-55-3	8270 or 8270_SIM	150	2100		261	10	5	TBD	TBD	TBD	TBD	TBD	TBD	50	110	30
Chrysene	218-01-9	8270 or 8270_SIM	15000	210000		384	1100	192	TBD	TBD	TBD	TBD	TBD	TBD	55	110	30
Benzo(b)fluoranthene	205-99-2	8270 or 8270_SIM	150	2100		1800	35	17.5	TBD	TBD	TBD	TBD	TBD	TBD	45	115	30
Benzo(k)fluoranthene	207-08-9	8270 or 8270_SIM	1500	21000		1800	350	175	TBD	TBD	TBD	TBD	TBD	TBD	45	125	30
Benzo(a)pyrene	50-32-8	8270 or 8270_SIM	15	210		430	240	7.5	TBD	TBD	TBD	TBD	TBD	TBD	50	110	30
Indeno(1,2,3-cd)pyrene	193-39-5	8270 or 8270_SIM	150	2100		600	200	75	TBD	TBD	TBD	TBD	TBD	TBD	40	120	30
Dibenz(a,h)anthracene	53-70-3	8270 or 8270_SIM	15	210		63.4	11	5.5	TBD	TBD	TBD	TBD	TBD	TBD	40	125	30
Benzo(g,h,i)perylene	191-24-2	8270 or 8270_SIM	170000	1700000		670	9500	335	TBD	TBD	TBD	TBD	TBD	TBD	40	125	30

Notes:

1. Samples are analyzed either for Hexachloroethane or for PAHs from SOM01.
2. RSLs presented are current as of November, 2012.
3. Ecological Soil ESVs are current as of August, 2010.
4. Marine Sediment ESVs are current as of August, 2010.
5. Risk-based SSL if no MCL-based SSL, current as of November, 2012.
6. The PQL Goal is 1/2 the lesser of applicable screening levels.
7. The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. There may be instances where DL > screening level (refer to Worksheet #11).
8. The intended analysis method will be assigned in this fashion: For any given SVOC analyte, if the laboratory-specific LOQ > PQL Goal, then that analyte will be assigned to 8270_SIM if the laboratory-specific LOQ is lower via 8270_SIM and the laboratory is DoD-ELAP accredited for that analyte via that method. However, the laboratory may report any SVOC analyte by 8270 or 8270_SIM if that provides "better data" (i.e. lower laboratory specific limits at elevated dilution factor) as determined by the laboratory and project chemist.
9. Results for non-aqueous samples are reported on a dry-weight basis. For fractions which have been dried prior to analysis, results are reported on an as-received basis (for the dried fraction).

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SAP Worksheet #15-4 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: SD **Analytical Group:** GRAINSIZE		
Analyte[1]	**CAS No.**[2]	**Project Indicator Limit**[3] **(% Passing or %)**
GS03 Sieve 3" (75 mm)	SIEVE75.0	N/A
GS05 Sieve 2" (50 mm)	SIEVE50.0	N/A
GS06 Sieve 1.5" (37.5 mm)	SIEVE37.5	N/A
GS07 Sieve 1" (25.0 mm)	SIEVE25.0	N/A
GS08 Sieve 0.75" (19.0 mm)	SIEVE19.0	N/A
GS10 Sieve 0.375" (9.5 mm)	SIEVE9.5	N/A
Sieve No. 004 (4.75 mm)	SIEVE4.75	N/A
Sieve No. 010 (2.00 mm)	SIEVE2.0	N/A
Sieve No. 020 (850 um)	SIEVE850	N/A
Sieve No. 040 (425 um)	SIEVE425	N/A
Sieve No. 060 (250 um)	SIEVE250	N/A
Sieve No. 140 (106 um)	SIEVE106	N/A
Sieve No. 200 (75um)	SIEVE75	N/A
Gravel (%)	GRAVEL	N/A
Sand (%)	14808-60-7	N/A
Coarse Sand (%)	COARSESAND	N/A
Medium Sand (%)	MEDIUMSAND	N/A
Fine Sand (%)	FINESAND	N/A
Fines (%)	FINES	N/A

Notes:
1. A similar sieve set is OK.
2. Some CAS numbers are contractor-specific.
3. There are no project indicator limits for GRAINSIZE data.

SAP Worksheet #15-5 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix:	SB, SD, SMI, SS					
Analytical Group:	WCHEM					
Analyte	**CAS No.[1]**	**Project Indicator Limit[2] (mg/kg)**	**Project QL Goal (mg/kg)**	**Laboratory Specific Limits (mg/kg)**		
				LOQs	**LODs**	**DLs**
pH	PH	N/A	N/A	N/A	N/A	N/A
Total Organic Carbon (TOC)	TOC	N/A	N/A	TBD	TBD	TBD

Notes:

1. Some CAS numbers are contractor-specific.
2. There are no project indicator limits for these WCHEM data.

SAP Worksheet #15-6 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: GW, SW
Analytical Group: EXPLO

Analyte[1]	CAS No.	RSLs Tap Water Adjusted[2] (µg /L)	Marine Surface Water ESVs[3] (µg /L)	PRWQ Class SB & SC (marine for SW)[4] (µg /L)	PRWQ Class SG (for GW)[4] (µg /L)	MCLs (µg /L)	Project QL Goal[5] (µg /L)	Laboratory Specific Limits[6] (µg /L)			A/P Limits (%)[7]		
								LOQs	LODs	DLs	LCL	UCL	%RPD
HMX	2691-41-0	78					39	TBD	TBD	TBD	80	115	20
RDX	121-82-4	0.61	5000				0.305	TBD	TBD	TBD	50	160	20
1,3,5-Trinitrobenzene	99-35-4	46	15				7.5	TBD	TBD	TBD	65	140	20
1,3-Dinitrobenzene	99-65-0	0.15	180				0.075	TBD	TBD	TBD	45	160	20
Tetryl	479-45-8	6.1	8				3.05	TBD	TBD	TBD	20	175	20
Nitrobenzene	98-95-3	0.12	66.8	690	17		0.06	TBD	TBD	TBD	50	140	20
2,4,6-Trinitrotoluene	118-96-7	0.76	100				0.38	TBD	TBD	TBD	50	145	20
4-Amino-2,6-dinitrotoluene	19406-51-0	3					1.5	TBD	TBD	TBD	55	155	20
2-Amino-4,6-dinitrotoluene	35572-78-2	3					1.5	TBD	TBD	TBD	50	155	20
2,4-Dinitrotoluene	121-14-2	0.2	480	34	1.1		0.1	TBD	TBD	TBD	60	135	20
2,6-Dinitrotoluene	606-20-2	1.5	1000				0.75	TBD	TBD	TBD	60	135	20
2-Nitrotoluene	88-72-2	0.27					0.135	TBD	TBD	TBD	45	135	20
3-Nitrotoluene	99-08-1	0.13					0.065	TBD	TBD	TBD	50	130	20
4-Nitrotoluene	99-99-0	3.7					1.85	TBD	TBD	TBD	50	130	20
Nitroglycerin	55-63-0	0.15					0.075	TBD	TBD	TBD	TBD	TBD	20
PETN	78-11-5	3					1.5	TBD	TBD	TBD	TBD	TBD	20
Perchlorate	14797-73-0	1.1					0.55	TBD	TBD	TBD	80	120	15
Picric Acid	88-89-1						NA	TBD	TBD	TBD	TBD	TBD	20

Notes:
1. Full 8330B-list & Perchlorate & Picric Acid
2. RSLs presented are current as of November, 2012.
3. Marine Surface Water ESVs are current as of August, 2010.
4. PRWQs are current as of August, 2011.
5. The PQL Goal is 1/2 the lesser of applicable screening levels.
6. The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. There may be instances where DL > screening level (refer to Worksheet #11).
7. DoD QSM v. 4.1 does not provide accuracy or precision limits for some compounds. In-house limits must be used and are to be determined.

SAP Worksheet #15-7 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: GW, SW
Analytical Group: METAL, FMETAL

Analyte[1]	CAS No.	Intended Analysis Method[7]	RSLs Tap Water Adjusted[2] (µg /L)	Marine Surface Water ESVs[3] (µg/L)	PRWQ Class SB & SC (marine for SW)[4] (µg/L)	PRWQ Class SG (for GW)[4] (µg/L)	MCLs (µg/L)	Project QL Goal[5] (µg/L)	Laboratory Specific Limits[6] (µg/L) (6010 or 7196)			Laboratory Specific Limits[5] (µg/L) (6020)			A/P Limits[8] (%)		
									LOQs	LODs	DLs	LOQs	LODs	DLs	LCL	UCL	%RPD
Aluminum	7429-90-5	6010 or 6020	1600					800	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Antimony	7440-36-0	6010 or 6020	0.6	500	640	5.6	6	0.3	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Arsenic	7440-38-2	6010 or 6020	0.045	36	36	10	10	0.0225	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Barium	7440-39-3	6010 or 6020	290	200			2000	100	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Beryllium	7440-41-7	6010 or 6020	1.6	100			4	0.8	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Cadmium	7440-43-9	6010 or 6020	0.69	8.85	8.85	5	5	0.345	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Calcium	7440-70-2	6010 or 6020						N/A	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Chromium	7440-47-3	6010 or 6020	0.031	50	50.35	100	100	0.0155	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Chromium (hexavalent)	18540-29-9	7196	0.031	50.4	50.35			0.0155	TBD	TBD	TBD	N/A	N/A	N/A	85	115	30
Cobalt	7440-48-4	6010 or 6020	0.47					0.235	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Copper	7440-50-8	6010 or 6020	62	3.73	3.73	1300	1300	1.865	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Iron	7439-89-6	6010 or 6020	1100	50				25	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Lead	7439-92-1	6010 or 6020	15	8.52	8.52	15	15	4.26	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Magnesium	7439-95-4	6010 or 6020						N/A	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Manganese	7439-96-5	6010 or 6020	32	100				16	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Nickel	7440-02-0	6010 or 6020	30	8.28	8.28	610		4.14	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Potassium	7440-09-7	6010 or 6020						N/A	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Selenium	7782-49-2	6010 or 6020	7.8	71.1	71.14	50	50	3.9	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Silver	7440-22-4	6010 or 6020	7.1	2.24	2.24			1.12	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Sodium	7440-23-5	6010 or 6020						N/A	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Thallium	7440-28-0	6010 or 6020	0.016	21.3	0.47	0.24	2	0.008	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Uranium	7440-61-1	6010 or 6020	4.7	TBD	TBD	TBD		TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	20
Vanadium	7440-62-2	6010 or 6020	7.8	50				3.9	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20
Zinc	7440-66-6	6010 or 6020	470	85.6	85.62			42.8	TBD	TBD	TBD	TBD	TBD	TBD	80	120	20

Notes:

1. ILM05-list (no Hg, no CN) & HexCr
2. RSLs presented are current as of November, 2012.
3. Marine Surface Water ESVs are current as of August, 2010.
4. PRWQs are current as of August, 2011.
5. The PQL Goal is 1/2 the lesser of applicable screening levels.
6. The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. There may be instances where DL > screening level (refer to Worksheet #11).
7. The intended analysis method will be assigned in this fashion: For any given 6010/6020 analyte, if the laboratory-specific LOQ > PQL Goal, then that analyte will be assigned to 6020 if the laboratory-specific LOQ is lower via 6020 and the laboratory is DoD-ELAP accredited for that analyte via that method. However, the laboratory may report any 6010/6020 analyte by 6010 or 6020 if that provides "better data" (i.e. lower laboratory specific limits at elevated dilution factor) as determined by the laboratory and project chemist.
8. DoD QSM v. 4.1 does not provide accuracy or precision limits for Uranium. In-house limits must be used and are to be determined.

SAP Worksheet #15-8 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: SB, SD, SMI **Analytical Group:** RAD								
Analyte[1]	**CAS No.**	**Worker Scenario Soil PRGs[2] (pCi/g)**	**Ecological Soil BSVs[3,4] (pCi/g)**	**Ecological Sediment BSVs[3,4] (pCi/g)**	**Project QL Goal[5] (pCi/g)**	**Laboratory Specific Limits[6,7] (pCi/g)**		
						LOQs	**LODs**	**DLs**
Uranium-234	13966-29-5	29.1	5000	5000	14.55	TBD	TBD	TBD
Uranium-235	15117-96-1	30.9	3000	4000	15.45	TBD	TBD	TBD
Uranium-238	TBD	1.5	2000	2000	0.75	TBD	TBD	TBD

Notes:

1. Ratios of 234/238 and 235/238 are compared to determine whether Uranium is depleted or naturally-occurring. If uranium is determined to be depleted, the U-238 screening criteria will be used as described in Attachment C.
2. Values for protection of human health are based on EPA's Radionuclide PRGs http://epa-prgs.ornl.gov/radionuclides/
3. BSV – Biota Screening Value
4. Values for protection of ecological receptors are based on DOE's Biota Concentration Guides (BCGs), http://www.hss.doe.gov/nuclearsafety/techstds/docs/standard/1153.htm
5. The PQL Goal is 1/2 the lesser of applicable screening levels.
6. LOQ/LOD/DL may not be applicable to RAD analysis. Some form of reporting limit and lower-limit of detection are applicable.
7. The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. There may be instances where DL > screening level (refer to Worksheet #11).

SAP Worksheet #15-9 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: GW, SW
Analytical Group: RAD, FRAD

Analyte[1]	CAS No.	Residential Scenario GW PRGs[2] (pCi/L)	Residential Scenario SW PRGs[2] (pCi/L)	Ecological Water BSVs[3,4] (pCi/L)	Project QL Goal[5] (pCi/L)	Laboratory Specific Limits[6,7] (pCi/L)		
						LOQs	LODs	DLs
Uranium-234	13966-29-5	0.7	0.7	200	0.35	TBD	TBD	TBD
Uranium-235	15117-96-1	0.7	0.7	200	0.35	TBD	TBD	TBD
Uranium-238	TBD	0.6	0.6	200	0.3	TBD	TBD	TBD

Notes:

1. Ratios of 234/238 and 235/238 are compared to determine whether Uranium is depleted or naturally-occurring. If uranium is determined to be depleted, the U-238 screening criteria will be used as described in Attachment C.
2. Values for protection of human health are based on EPA's Radionuclide PRGs http://epa-prgs.ornl.gov/radionuclides/
3. Values for protection of ecological receptors are based on DOE's Biota Concentration Guides (BCGs), http://www.hss.doe.gov/nuclearsafety/techstds/docs/standard/1153.htm
4. BSV – Biota Screening Value
5. The PQL Goal is 1/2 the lesser of applicable screening levels.
6. LOQ/LOD/DL may not be applicable to RAD and FRAD analysis. Some form of reporting limit and lower-limit of detection are applicable.
7. The laboratory-specific LOQ should be less than the PQL Goal. If that is not possible, the laboratory-specific LOD should be less than the screening level (exceedances of LOD v. screening level shall be highlighted). If that is not possible, then the DL should be less than the screening level. There may be instances where DL > screening level (refer to Worksheet #11).

SAP Worksheet #16 — Project Schedule / Timeline

The official schedule for each UXO site is the SMP schedule that is distributed and updated separately.

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SAP Worksheet #17 — Sampling Design and Rationale

Sampling activities will focus on areas with the highest potential for contamination to provide the most conservative evaluation of releases and nature and extent of contamination. Field activities at each UXO site will comprise environmental characterization of soil (surface and subsurface), sediment, and surface water, as applicable, and regional characterization of groundwater. In addition, the planned future munitions activities at each UXO site are also provided in this worksheet.

Due to the size of the UXO sites, a ranking-based decision approach (in conjunction with a CSM for each site) is used. The approach assesses both common elements and distinguishing features of each site, to focus sampling in areas that best represent potential releases, potential contaminant types, highest contaminant concentrations, key transport pathways, and key exposure areas for potential receptors. The decision analysis to determine the proposed sample areas is provided in **Tables 1 and 2**. Note that an explanation table of each of the category descriptions used in **Tables 1 and 2** is provided in **Table 1**, due to the complexity of the CSM for each site and number of categories used to evaluate where to focus sampling. In general, the tables provide a mechanism to evaluate:

- Potential release and transport areas by using the UXO and Decision Unit categories
- Potential contaminant types and potential areas with the highest contaminant concentrations by using the Site Screening Areas, Range/Target Areas/Gun Positions, Former Activity Features, MEC Type, MEC Scoring, and MEC investigation status categories (based on the CSM summarized in Worksheet #10)
- Potential receptor exposure by using the Biological Assessment and Receptor Exposure Summary (based on the CSM summarized in Worksheet #10)

The decision analysis is described in detail for each specific site summarized in the sampling approach in Worksheets #17a through #17o. The foundation for the overall sampling method and approach is described below.

Figures 29 through 46 provide the munitions characterization data as of the end of June 2012. Each quadrant provides the number of MEC and munitions debris identified during surface clearance activities. In addition, each quadrant has a color code that represents the number of DGM anomalies identified in the subsurface (where investigated); the orange outline represents areas where the anomalies have been investigated and provide the general quantity of MEC and munitions debris identified in the subsurface. The circles within the quadrants indicate the type of MEC and munitions debris identified in both the surface and/or subsurface and the location of the consolidation point within the quadrant.

Sampling Method and Approach

Surface soil sampling will be conducted using the incremental sampling strategy and approach, in general accordance with guidance document prepared by the US Army Corps of Engineers (USACE) titled Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program (USACE, 2009) and the approach used for UXO 1 (ECA) (CH2M HILL, 2011a). Discrete deeper surface soil and subsurface soil, sediment, surface water, and groundwater will be collected in accordance with the applicable Vieques SOPs (CH2M HILL, 2010b).

Incremental sampling is planned for all of the UXO sites, except for UXO-17 (PAOC EE). A discrete soil sampling approach will be used at UXO 17 since the presence of munitions is related to isolated munitions storage and/or discarding and not from range impact or firing activities. This is further discussed in Worksheet #17n.

Incremental Soil Sampling Design

The majority of sampling will be performed using the incremental sampling approach. Incremental sampling is designed to control data variability due to the heterogeneity in contaminant distribution commonly associated with munitions ranges, and has a higher likelihood of detecting contaminants than discrete sampling if the location of contamination is unknown. It allows for sampling large geographic areas with higher sampling density and improves the reliability of sampling data. It also simulates more realistic receptors exposures to potential contaminants at the

SAP Worksheet #17 — Sampling Design and Rationale (continued)

ground surface than discrete samples. For incremental sampling, a single sample is obtained that has an analyte concentration representative of the area in which to base a decision or conclusion (i.e., a decision unit). The decision unit is site-specific and selected to represent a likely contaminant release area or a receptor exposure area. The decision unit may be composed of a single or multiple sampling units. A systematic-random sampling approach is conducted within each sampling unit.

Energetic and inorganic chemicals associated with munitions releases on ranges primarily occur as particulates deposited heterogeneously on the soil surface, primarily from propellant residues at firing points, explosive residues near detonations in impact areas, and from controlled detonations. The highest concentrations are present near the ground surface with the vast majority in the top inch or two. Therefore, incremental sampling at ranges focuses on the top 2.5 inches of soil and represents the most conservative exposure depth interval for human health and terrestrial ecological receptors. However, if the soil or contaminant distribution has been significantly reworked since the former range activities, contamination could be encountered within potential migration pathways from erosion. As a result, sampling will also be conducted in potential transport pathways (such as ephemeral streams), within depositional environments (such as lagoons), and discrete subsurface soil samples will be collected from depths in accordance with the modified Master Protocols to evaluate the vertical extent of contamination, as discussed further below.

Decision Units

Decision units within each UXO site were identified in accordance with the USACE guidance (USACE, 2009). The initial consideration for defining decision units for the UXO sites (specifically the Inland UXO sites) was to design them around watershed areas (**Figure 8**), which capture not only release areas, but the associated transport areas as well. The three major watersheds within eastern Vieques were further refined to smaller watersheds based on the topography and localized drainage. Since the Beach and Road UXO sites generally act as drainage areas, each Beach and Road UXO site is its own decision unit.

Decision units were further refined to represent potential receptor exposure pathways that are unique from other areas (e.g., lagoon fringe areas, potential unrestricted land use, etc.). Potential ecological receptors (based on habitat [**Figure 11**]) and human health receptors (based on proposed land use [**Figure 12**]) were also considered in defining decision units. The term decision unit is synonymous with exposure unit.

In total, 52 decision units (including lagoons and lagoon fringes) were selected for the Inland UXO sites (UXOs 4, 9, 10, 12, 13, 14, and 18) (**Figure 27**). Three decision units were selected for the Beach UXO sites (UXOs 2, 7, and 8) and four decision units were selected for the Roads UXO sites (UXOs 3, 5, 6, and 11).

Sampling Units

Within each decision unit, sampling units were focused in areas with the highest potential for contamination by evaluating the following: site features including former targets, ranges, and gun positions (**Figure 3**); SSAs identified for further investigation (i.e., PAOCs, PIs, AOCs, and SWMUs) (**Figure 4**); quantity, frequency, and type of MEC and munitions scrap items (see site-specific Worksheets below), and subsurface DGM anomaly data (**Figure 28**). In addition, sampling units were also located in potential transport pathways, such as ephemeral streams. Note that ephemeral streams will be sampled during dry conditions. In total, 202 sampling units are planned across the Former VNTR (excluding QA/QC samples) (**Figure 27**).

Sampling units were selected to be representative of the concentrations within a particular exposure area. The proposed sampling units are generally approximately 1 acre in size to account for ecological receptors with smaller exposure areas; since larger exposure areas are typically applicable for human receptors, data from multiple sampling units will be grouped as appropriate for use in the HHRAs. Within each sampling unit, approximately 100 subsamples (increments) will be collected using a 0.5-inch diameter coring device (to a depth of approximately 2.5-inches) to achieve an adequate total sample mass of at least 1,000 grams (in accordance with the approach in the USACE guidance and SOPs in **Attachment D**). Each subsample will include approximately 11 grams of soil (see coring specifications for the incremental sampling tool in **Attachment D**). Subsamples will be collected in a systematic

SAP Worksheet #17 — Sampling Design and Rationale (continued)

random sampling approach, where the subsamples are collected in a general uniform grid across the sampling unit.

It is noted that MEC characterization/removal activities are still being conducted on some UXO sites, so the site-specific evaluation approach conducted under this SAP will be updated, if the newly-acquired information from the ongoing MEC characterization/removal activities necessitates a revision to the sampling approach. In these cases, Master SAP addenda will be submitted to convey the new information and the associated modifications to the characterization approach.

Discrete Soil Sampling Design and Regional Groundwater Characterization

In some cases (e.g., in areas of land crab habitat), discrete surface soil samples are warranted. Discrete surface soil samples will be collected in accordance with the applicable Vieques Master Plans and Protocols (CH2M HILL, 2010b). Depth intervals are site-specific and based on receptor exposure scenarios, as detailed in the site-specific Worksheets #17a through #17o. In addition, subsurface soil samples will be collected from depth intervals in accordance with the modified Master Protocols from each incremental sampling unit (except at the lagoon fringe and beach) and at each of the monitoring well locations, to evaluate the vertical extent of contamination and will not be used in the risk assessment evaluation. Each subsurface soil sample from each incremental sampling unit will be collected in areas with the highest potential for a subsurface release using a geophysical instrument-aided technique if deemed safe. One subsurface soil sample will still be collected if a subsurface munitions item is not identified. Two subsurface soil samples are initially proposed within each sampling unit, and as the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. Discrete sediment samples and co-located surface water samples will be collected in depositional areas of lagoons, provided munitions safety concerns can be mitigated and allow sample collection. In addition, discrete surface water samples will be collected from sampling unit locations within ephemeral streams, if surface water is present during the time of sampling.

In addition to discrete surface soil, surface water, and sediment sampling, groundwater will be evaluated on a regional scale. A total of 23 regional monitoring wells will be installed to determine if a release to groundwater has occurred (**Figure 26**). Each monitoring well will be screened at the first encountered groundwater using a screen length appropriate for providing sufficient water to facilitate sampling. This will be a judgment call made in the field based on water production observed during drilling and may include screen lengths up to 15 feet. Monitoring wells are conservatively focused in areas with the highest potential for contamination and downgradient of potential release areas (to evaluate migration). The majority of the monitoring wells are located within the LIA, since this area likely has the highest potential for a release to groundwater. The rationale for each monitoring well is summarized in **Table 3**. Monitoring well locations may be adjusted in the field based on site conditions and munitions safety at the time of mobilization. Regional groundwater characterization will follow the 6-step decision analysis and the need for additional future groundwater assessment will be determined by the results of the monitoring well sampling and reviewing soil data to determine the potential for contaminants to leach to groundwater (i.e., fate and transport mechanisms).

Implementing subsurface incremental soil sampling is not technically and economically practical due to subsurface munitions safety concerns. For every incremental subsample, the boreholes would have to be checked and cleared (deemed absent) of magnetic anomalies to the depth of the borehole. Since each incremental sample is composed of approximately 100 subsamples and subsurface metallic anomalies are known to be present, it would not be practical to perform subsurface incremental sampling. In addition, as discussed above, incremental sampling focuses on the area with the highest potential for contamination near the ground surface.

Background Dataset

Soil background data collected during the East Vieques Background Study (CH2M HILL 2007b) will be used for comparison with incremental and discrete soil samples. Background values measured during the UXO 1 RI incremental sampling show that they are comparable with the discrete sampling conducted during the East Vieques

SAP Worksheet #17 — Sampling Design and Rationale (continued)

Background study (**Attachment B**). Since background data are not available for the beaches, a multiple lines of evidence approach will be used to evaluate potential inorganic releases at the beaches, such as using the adjacent terrestrial lithologic unit surface and subsurface soil from the background study. If necessary, background data could be collected from a representative background beach(es), if identified. If a representative background beach(es) is identified, it will be included in an addendum to the Master SAP for regulatory review. Surface water and sediment samples will be compared to background data collected from a similar lagoon (if one is identified) or, in the absence of a representative background dataset, a weight-of-evidence evaluation will be used, as was done for the UXO 1 RI. If appropriate background lagoons are identified, they will be proposed to the regulatory agencies in a SAP addendum prior to sampling activities.

Inorganics data for regional groundwater samples will be compared to existing data from background monitoring wells (such as MW-13 at SWMU 1, MW-02 at SWMU 10, and other non-impacted monitoring wells) identified during historical investigations such as the SI/ESI (CH2M HILL, 2010d) (**Figure 26**). Because the data from these background wells will not be contemporaneous with the regional groundwater data nor necessarily from the same lithologic units, the background data will be used in conjunction with a weight-of-evidence approach for interpreting the regional groundwater data.

Risk Evaluation

Each decision unit is evaluated separately from one another and is not combined. For areas with a low potential for munitions constituents but were selected as a sampling unit because of the presence of a unique human health exposure area, will generally be evaluated as separate exposure areas. However, in some cases, the proposed sampling unit data are appropriate for use in characterizing these unique exposure areas and the details are provided in the site-specific discussions in Worksheet #17. The data groupings will be determined after the site-specific data are available and reviewed. As indicated in the HHRA Protocol, data must be evaluated spatially prior to determination of data groupings for the HHRA. This step will be performed and documented in the HHRA Pre-Interim Deliverable and discussed with the agencies prior to preparation of the HHRA Interim Deliverable, consistent with the HHRA Protocol.

The approach, methods, and assumption used for the ERA will be based upon the final ERA protocol presented in the *Master Standard Operating Procedures, Protocols, and Plans* (CH2M HILL, 2010) and the *Master Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program – Update 1 (Addendum)* (CH2M HILL, 2010).

For the ERA, the data groupings will also be determined after the site-specific data are available and will consider factors such as habitat type. The data groupings will be documented as part of the ERA Interim Deliverable and may differ from the groupings used in the HHRA.

In accordance with the ERA protocol, the exposure point concentration (EPC) at the screening level (SERA; Step 2) will be the maximum detected concentration, while at the baseline level (BERA; Step 3) the EPC will be a central tendency estimate (arithmetic mean and the 95 percent upper confidence limit [UCL] of the arithmetic mean). Therefore, the ERA will be conducted per the protocol, which includes evaluations of both maximum and mean exposure concentrations, and uncertainties related to the sizes of decision units versus the number of sampling units will be addressed in the risk characterization. Also, please note that the placement of sampling units is biased toward worst-case exposures so that central tendency estimates for particular receptor populations will still include a substantial level of conservatism. Where an individual sampling unit associated with a specific human receptor is biased towards low contaminant concentrations, the sampling unit will not be included in the central tendency estimate for other receptors in the larger decision unit.

In Step 3 of the BERA, the area represented by each sampling unit relative to the area of the associated decision unit will be considered with respect to the home range size of each target wildlife receptor. For receptors with small home ranges such that their entire range is less than that of a sampling unit, maximum detected sampling unit concentrations would be considered representative of decision unit exposure. For wider ranging receptors

SAP Worksheet #17 — Sampling Design and Rationale (continued)

with home ranges greater than the area of a sampling unit, central tendency estimates (arithmetic mean and the 95 percent UCL) would be considered representative of decision unit exposure. For each decision unit a description of the decisions made for identifying Step 3 wildlife exposure concentrations will be included in the BERA, along with any potential deviations required based on site specific conditions.

Risk assessment elements presented in the HHRA and ERA pre-interim and/or interim deliverables, such as grouping of decision unit data, will be subject to additional regulatory review and comment, as will any site-specific modifications to the procedures and methods outlined in the final HHRA and ERA protocols that may be included in the HHRA and ERA pre-interim and/or interim deliverables. Decision unit central tendency estimates will be the same for the HHRA and ERA.

Laboratory Analysis

Details regarding laboratory analyses for each site are discussed in Worksheets #17a through #17o and in Worksheet #28.

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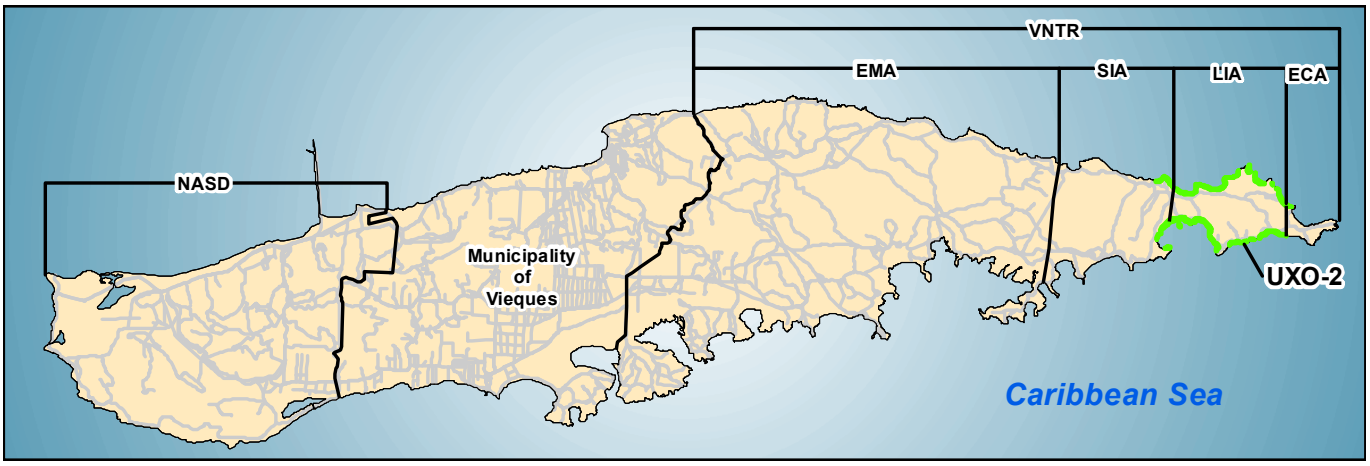
SAP Worksheet #17a — UXO 2 (LIA Beaches)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 2:

1. Conduct a characterization of MEC identified within each of the sandy beaches and vegetation buffer areas to sufficiently delineate the location, type, and spatial extent of munitions-related items along the surface, and to evaluate the explosive safety hazard at the site.
2. Conduct DGM and subsequent intrusive investigation of anomalies to a depth of 4 ft bgs within each of the sandy beaches and vegetation buffer areas to sufficiently delineate the location, type, and vertical extent of munitions-related items within the subsurface.
3. Characterize the munitions-related information collected as part of these activities to sufficiently evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address site-specific PQO #1, the TCRA for surface removal of MEC (CH2M HILL, 2010f) has been completed for the entire site. The surface clearance cleared nearly 100 percent of UXO 2 and nearly 100 percent of the data is adequate to determine the lateral extent of MEC. As a result, the evaluation of the data from the surface clearance will meet this PQO.

To address site-specific PQO # 2, the NTCRA for the subsurface removal of MEC at UXO 2 has been ongoing. Through October 2012, over 60,000 munitions related items (RRD, MD, UXO, MEC, MPPEH) have been recovered from the subsurface at UXO 2. It is estimated that at least 57 acres of DGM remains to be completed. Therefore, the data from the NTCRA, and the remaining DGM data should provide sufficient information to characterize the vertical nature and extent of MEC at UXO 2.

To address PQO #3, the NTCRA depth of investigation (4 ft bgs) was a depth that was determined to be protective of human health and the environment during the development of the NTCRA. The NTCRA removal depth was selected based on the known USFWS turtle monitoring activities at the sandy beaches, where personnel could be exposed to MEC up to a depth of 3 ft bgs. The beaches are part of the LIA which is designated as a wilderness area and the anticipated future land use scenarios and MEC exposure routes will remain consistent with the current uses/exposure routes. Therefore, the MEC removal depth applied during the NTCRA is conservatively protective of future receptors at the site. The available data and remaining DGM date should provide sufficient information to meet PQO #3.

Based on this information, there are no additional MEC removal actions anticipated at UXO 2 prior to making final remedy determinations for the site. However, if information gathered during the TCRA and NTCRA or other site-related investigations or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

SAP Worksheet #17a — UXO 2 (LIA Beaches) (continued)

An investigation to study the dynamics at several beaches within UXOs 2, 7, and 8 is being conducted in support of the RI investigations. The intent of the beach dynamics investigation is to augment the current understanding of the dynamic nature of the beach environment at the former VNTR and its impact on the potential distribution and removal /deposition of MEC. As part of the beach dynamics investigation, the selected beaches will be surveyed using DGM several times throughout a 1-year period and the resulting anomalies with a reading above 2.5 mV will be intrusively investigated following each DGM survey. Data from the investigation will be included in the RI, as appropriate, to help assess the nature, extent, and mobility of MEC contamination at the beaches.

Sampling Approach

It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 2 beaches. However, the soil characterization approach developed in this SAP is based on existing munitions information. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 2 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the beach(e)s selected for sampling herein are still the most conservatively representative of all UXO 2 beaches, characterization will proceed as described in this SAP.

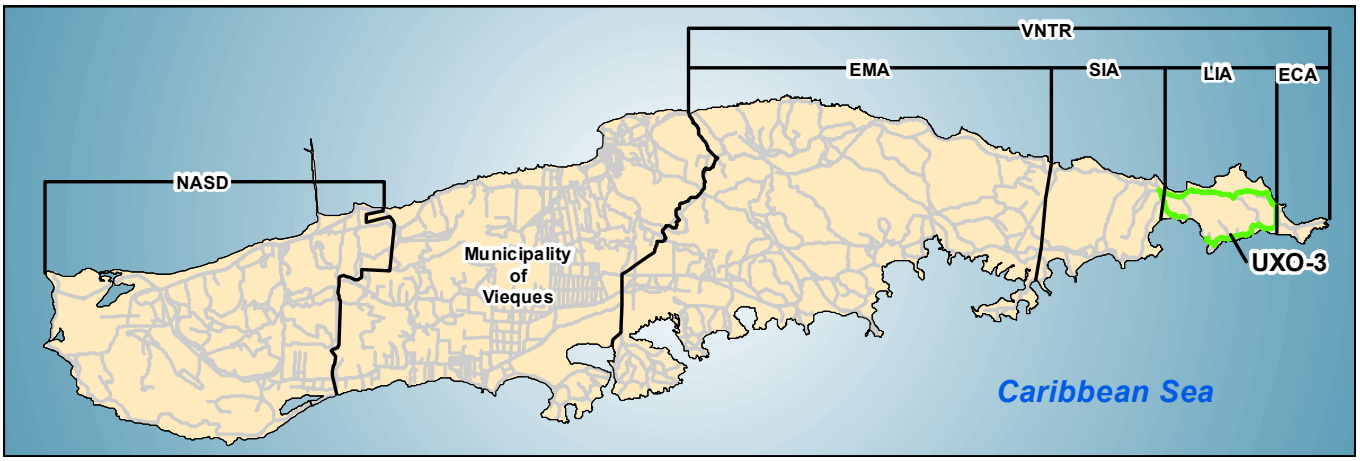
UXO 2 is considered its own decision unit since the beach generally acts as a drainage area; therefore, UXO 2 consists of one decision unit. Each of the 15 beaches within UXO 2 was evaluated as a potential beach to be sampled using the ranking-based decision approach (**Table 2**). Four beaches (Playa Salinas del Sur [Beach 3], Turtle Beach, Icacos/Playa Yallis, and Playa Salinas del Norte/Fossil Beach) were selected for sampling as they have the most conservative contaminant release potential and receptor exposure scenarios of all the UXO 2 beaches (**Figure 29**). Each of these beaches has the highest quantity and diversity of MEC and munitions scrap, and three of the beaches are designated as a major turtle nesting habitat. Although Icacos/Playa Yallis is not a major turtle nesting beach, trespassing activities have historically been observed at this beach. In addition, each beach selected for sampling potentially receives surface runoff from the areas with the highest potential for contamination within UXO 4 (see Worksheet 17c). Additional rationale as to why these beaches are conservatively representative of the other beaches is summarized in **Table 2**.

Each sampling unit is approximately 1 acre in size. Since each beach is different in size, the number of sampling units was biased toward diversity and quantity of MEC and munitions scrap on the surface and within the subsurface, DGM density, and potential depositional area for surrounding drainage on each beach (**Figure 29**). In total, eight incremental surface soil samples (0 to approximately 2.5 inches) and eight discrete deeper surface soil samples (18 to 36 inches) will be collected at the four beaches; two of each at Playa Salinas del Sur; three of each at Turtle Beach; two of each at

Icacos/Playa Yallis; and one of each at Playa Salinas del Norte/Fossil Beach. **Table 4** summarizes the MEC and munitions scrap items historically found and removed within each UXO 2 sampling unit and the rationale for why each sampling unit was selected. The discrete deeper surface soil samples will be collected to best represent the depth of turtle egg nests. The discrete sample locations will be located where historical turtle nests have occurred, and as close as possible to where relatively higher frequencies of MEC have been identified.

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. Explosive D (picric acid) will also be analyzed since the types of armaments likely used on Vieques contained this constituent. Although there are no widely accepted human health or ecological screening levels for this analyte, the laboratory will report the results at its reporting limit. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the surface soil data will be compared to the adjusted RSLs, ecological screening value, and background data. Potential risks to human health at the beach will be evaluated using both the surface and deeper surface soil samples. The incremental and discrete soil samples will be evaluated as separate exposure media in the ecological risk assessment: surface soil to terrestrial receptors, and deeper surface soil to turtle eggs only.

SAP Worksheet #17b – UXO 3 (LIA Roads)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 3:

1. Characterize the MEC identified within each of the roads and 25-ft road buffer areas to sufficiently delineate the location, type, and spatial extent of munitions-related items along the surface, and evaluate the explosive safety hazard at the site.
2. Conduct DGM and subsequent intrusive investigation of anomalies to a depth of 2 ft bgs within each of the roads and 25-ft buffer areas to sufficiently delineate the location, type, and vertical extent of munitions-related items within the subsurface.
3. Assess munitions-related information collected as part of these activities to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11 .

To address site-specific PQO #1, the surface clearance of MEC has been completed as part of the TCRA at UXO 3. The clearance is 100 percent complete and over 184,000 munitions related items have been characterized, therefore, site-specific PQO #1 has been met for the RI.

To address site specific PQO #2, the data from the NTCRA for subsurface removal of MEC at UXO 3 will be evaluated. The NTCRA, which will provide an assessment of the density and lateral extent of subsurface MEC at the site, is currently ongoing; it is estimated that approximately 25 acres of DGM remain to be completed. Due the very high anomaly densities at the site, 100 percent of the subsurface removal of MEC at the site will not be completed; however, for the RI 100 percent removal is not necessary. It is anticipated that upon completion of the DGM, enough information will have been collected to sufficiently characterize the nature and extent of MEC. Remedial alternatives for this site may include capping or paving and, therefore, complete site characterization of these areas is not needed.

To address PQO #3, the NTCRA depth of investigation (2 ft bgs) was determined to be protective of the known current and potential future use of the roads by USFWS refuge management personnel and trespassers accessing the areas surrounding UXO 3 and the potential for future road repairs to a maximum depth of 1 ft bgs. The roads are part of the LIA which is designated as a wilderness area and the anticipated future land use scenarios and MEC exposure routes will remain consistent with the current uses/exposure routes. Therefore, the MEC removal depth applied during the NTCRA is conservatively protective of future receptors at the site.

Based on this information, there are no additional MEC investigations or removal actions anticipated at UXO 3 (beyond the ongoing NTCRA) prior to making final remedy determinations for the site. However, if information

SAP Worksheet #17b – UXO 3 (LIA Roads) (continued)

gathered during the NTCRA or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

The sampling at UXO 3 may be initiated prior to completion of the NTCRA, but after DGM has been conducted along the remaining 25 acres of LIA roads. However, much of the MEC will have been removed to a depth of 2 ft. Because of the significant amount of munitions-related activities conducted at UXO 3, available information will likely be adequate to support RI/FS decision making. However, if additional information is gathered during the NTCRA that warrants a modification to the sampling approach, the modification will be made via an addendum to this SAP, or other mechanism that demonstrates formal concurrence by the Navy and regulatory agencies.

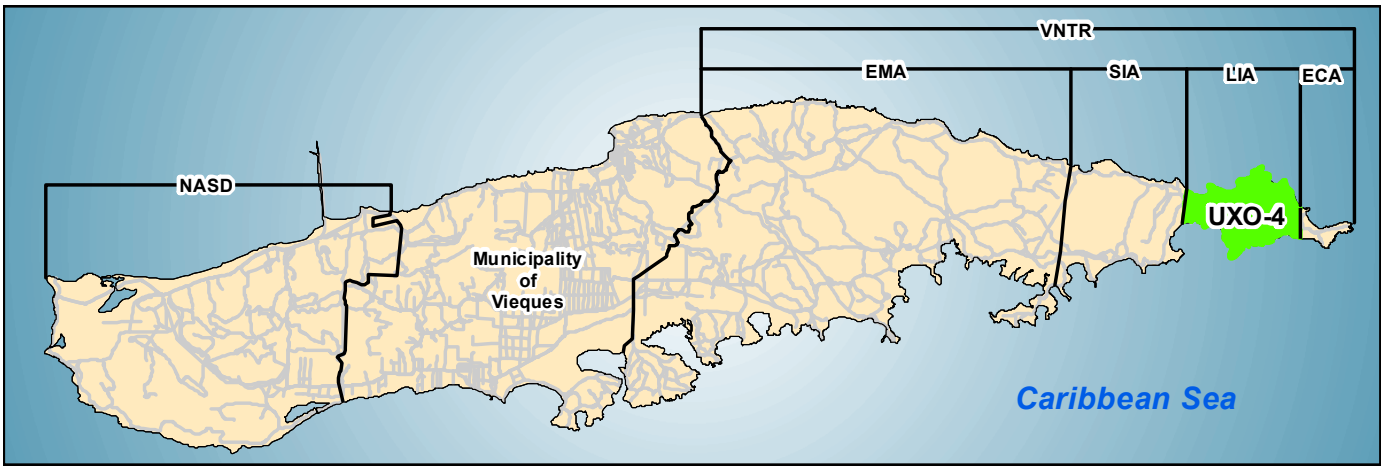
Sampling Approach

It is important to note that, as shown in **Figure 6** munitions removal activities are still ongoing at some of the UXO 3 road areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. Further, at a minimum, geophysics will have been completed along all UXO 3 roads prior to performing soil characterization activities. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 3 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 3 road areas, characterization will proceed as described in this SAP. Further, please note that no sampling units are proposed within the submunitions area due to safety concerns.

UXO 3 comprises one decision unit since the road generally acts as a drainage area. Eight sampling units at UXO 3 were designed to focus on areas with high densities of munitions items, to account for each type of munitions item and munitions related scrap identified on the surface and within the subsurface, DGM density, and in potential depositional areas along the roads that receive surface runoff from UXO 4 (**Figure 30**). The potential human health and ecological receptor exposure scenarios are consistent across this site; therefore, any area along the roads is representative of potential exposures. Each sampling unit is approximately 1 acre in size and includes both the road and a 25-ft buffer on each side of the road. **Table 5** summarizes the MEC and munitions scrap items historically found and removed within the roads decision units and the rationale for why each sampling unit was selected (in order of importance).

One incremental surface soil sample (0 to approximately 2.5 inches) and two discrete subsurface soil sample will be collected at each of the eight sampling units (note that the number of subsurface soil samples may be adjusted in the future as the data collected from the sites are evaluated on a continuing basis, as warranted, with consensus from the ERP Technical Subcommittee). Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background data. The incremental soil samples will be evaluated to assess potential risks to human health and the environment.

SAP Worksheet #17c – UXO 4 (LIA Interior)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 4:

1. Characterize the MEC identified across the site to determine the location, type, and spatial extent of munitions-related items along the surface, and to evaluate the explosive safety hazard at the site.
2. Evaluate the vertical extent of munitions related items based on the subsurface MEC characterization through the intrusive investigation of anomalies identified using DGM.
3. Assess munitions-related information collected as part of these activities to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address PQO #1, the surface MEC data from the TCRA will be evaluated. Through October 2012, the surface clearance of over 90 percent of UXO 4 has characterized the types and lateral distribution of over 50,000 MEC items. Therefore, PQO #1 has been met. The TCRA activities are complete for the 9 acres of the steep slope areas since this area is inaccessible and for the 22 acres of Laguna Anones since this area is perennially submerged. The types of munitions identified adjacent to the steep slope and inundated areas are likely representative of what would be found within these areas; therefore, no additional investigations are needed to make risk-based decisions for these portions of the site. Additionally, the future surface clearance of the high density submunitions area is awaiting approval by the regulators of a vegetation burn plan. However, the previous removal of numerous submunitions from around the perimeter of the high density submunitions area (greater than 200 items/acre) can similarly provide the characterization of the types of munitions anticipated to be present within the high density submunitions area.

To address the site-specific PQO #2, DGM anomalies will be investigated to 2 ft bgs at eight of the environmental sampling units within UXO 4, as identified further below (one-acre in size) (**Figure 28**). In addition, MEC data from adjacent beaches (UXO 2) and roads (UXO 3) will be evaluated to assess the nature of MEC present. The sampling unit locations are focused in areas with the highest quantity of MEC identified on the ground surface, in the OD area, and at multiple target locations. The eight environmental sampling units are designed such that they are located in areas of the highest MEC contamination, thereby providing a conservative estimate of the MEC depth profile.

To address site-specific PQO #3, the vertical depth of investigation to 2 ft bgs will conservatively evaluate deeper than the anticipated exposure depths for USFWS personnel and trespassers accessing the area, as no intrusive activities are intended for the site.

SAP Worksheet #17c – UXO 4 (LIA Interior) (continued)

Given the future use of UXO 4 as a wilderness area, the data collected to date are sufficient to be able to identify the nature and lateral extent of MEC at the site while considering the potential exposure pathways for USFWS personnel and trespassers accessing the site. Upon completion of the subsurface MEC characterization within the sampling units, supplemented with subsurface characterization data from the adjacent beaches and roads, sufficient information will have been collected to characterize the nature and vertical extent of MEC at UXO 4. Therefore, there are no additional MEC investigations or removal actions anticipated at UXO 4 prior to making final remedy determinations for the site. However, if information gathered during the TCRA activities in the high density submunition area or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

Because of the significant amount of munitions-related activities conducted at UXO 4, available information is sufficient to plan the sampling approach. However, if additional information is gathered during the TCRA activities in the high density submunition area that warrants a modification to the sampling approach, the modification will be made via an addendum to this SAP, or other mechanism that demonstrates formal concurrence by the Navy and regulatory agencies.

Sampling Approach

UXO 4 is approximately 855 acres in size. Eleven decision units (including three lagoons) were established for the site using the ranking-based decision approach (**Table 1** and **Figure 31**). Each decision unit was generally defined based on the topography and localized drainage; however, three decision units were defined based on the fringes of Lagunas Anones, Gato, and Icacos, which may be potential land crab habitats. A higher quantity of sampling units was placed in the terrestrial decision units representing the most significant release potential to the environment, since the potential human health and ecological receptor exposure scenarios are similar amongst all of the decision units.

The preliminary sampling approach may be modified based on the collection of additional munitions-related data prior to sampling. In these instances, the additional sampling will be provided in a site-specific SAP addendum provided for regulatory review prior to collecting the samples.

Sampling in the submunitions area is dependent on the timing of vegetation clearance approval. If approval is not received prior to initiating the sampling, it is possible that this area could be designated as its own site or operable unit so that it does not affect the decision making process for the remainder of UXO 4.

UXO 4 will be the first site investigated as part of the Master SAP. Initially, two subsurface soil samples will be collected within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

Table 6 summarizes the MEC and munitions scrap items historically found and removed within each of the sampling units and the rationale for why each sampling unit was selected (in order of importance). In total, 46 incremental samples (one in each of 46 sampling units), 9 discrete deeper surface soil samples, and 81 discrete subsurface soil samples will be collected (**Figure 31**). Each sampling unit is approximately 1 acre in size. The discrete subsurface soil samples will be collected in accordance with the modified Vieques protocol. The number of incremental samples (sampling units) and discrete soil samples per decision unit is as follows:

- Central UXO 4 - 16 sampling units (0 to 2.5 inches) and 39 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, target areas, craters, the OB/OD, and potential depositional area for surrounding drainage (**Figure 31a**). Two sampling units (1DU02 and 1DU07) and seven discrete subsurface soil samples are located over the former OB and OD areas, which were formerly designated as SWMU 3.

SAP Worksheet #17c – UXO 4 (LIA Interior) (continued)

- North UXO 4 – 8 sampling units (0 to 2.5 inches) and 16 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, target areas, craters, and potential depositional area for surrounding drainage (**Figure 31b**).
- Northwest UXO 4 – 5 sampling units (0 to 2.5 inches) and 10 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, craters, target areas, and potential depositional area for surrounding drainage (**Figure 31c**).
- Southwest UXO 4 – 5 sampling units (0 to 2.5 inches) and 10 discrete subsurface soil samples biased toward drainage, target areas, and diversity and quantity of MEC and munitions items (**Figure 31d**).
- East UXO 4 – 3 sampling units (0 to 2.5 inches) and 6 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, craters, target areas, and potential depositional area for surrounding drainage (**Figure 31e**).
- Lagoon Anones Fringe – 5 sampling units (0 to 2.5 inches) equally spaced and 5 discrete deeper surface soil samples (2.5 to 24 inches). The lagoon fringe boundary is from the high water mark of the lagoon to 30 ft inland. Discrete samples will be biased toward areas where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest (secondarily) (**Figure 31f**).
- Laguna Gato Fringe – 2 sampling units (0 to 2.5 inches) and 2 discrete deeper surface soil samples (2.5 to 24 inches). The lagoon fringe boundary is from the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest (secondarily) (**Figure 31g**).
- Laguna Icacos Fringe – 2 sampling units (0 to 2.5 inches) and 2 discrete deeper surface soil samples (2.5 to 24 inches). The lagoon fringe boundary is from the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest (secondarily) (**Figure 31h**).

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. While explosives and inorganics are the primary potential contaminants, PAHs may be present due to former OB activities. Therefore, one sample at the OB area (1DU07) will be analyzed for SVOCs (PAHs only). Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background data. Potential risks to human health will be evaluated using the surface soil samples site-wide, and at the lagoon fringe using both the surface and deeper surface soil samples. For the ecological risk assessment, the incremental and discrete soil samples will be merged and evaluated together for land crabs only. All other ecological receptors will be evaluated using only incremental soil samples.

Surface Water and Sediment

The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. Since Laguna Anones is the largest lagoon at UXO 4 and located adjacent to multiple former activity features and high quantities of MEC and munitions scrap, this lagoon contains the highest quantity of samples.

SAP Worksheet #17c – UXO 4 (LIA Interior) (continued)

Sediment and surface water samples were located for broad spatial distribution, while ensuring areas with the highest frequencies of MEC identified were included. The number of samples per lagoon is as follows:

- Laguna Anones – 15 sediment samples (0 to 6 inches) and 6 surface water samples (at mid-depth) (**Figure 31f**).
- Laguna Gato – 3 sediment (0 to 6 inches) and 3 surface water samples (at mid-depth) (**Figure 31g**).
- Laguna Icacos – 3 sediment (0 to 6 inches) and 3 surface water samples (at mid-depth) (**Figure 31h**).

In addition, one sediment (0 to 6 inches) and one surface water sample (mid-depth) will be collected from three field identified craters, which act as potential habitat for waterfowl and shorebirds.

Each surface water and sediment sample will be analyzed for explosives and inorganic constituents. Sediment samples will also be analyzed for pH, TOC, and grain size. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to the nature and extent evaluation, the data will be compared to the adjusted RSLs, ecological screening value, and background data collected from a similar lagoon or a weight of evidence evaluation. Potential risks to human health and ecological receptors will be evaluated using the surface water and sediment samples.

Groundwater

Eight monitoring wells will be installed within UXO 4 (**Figure 26**). The rationale for the locations of each of the monitoring wells is provided in **Table 3**. The monitoring wells are conservatively focused in areas with the highest potential for contamination, such as at or adjacent to targets with high densities of munitions, in the vicinity of the OB and OD area, and/or in the CPC, and downgradient of potential release areas to evaluate migration.

Depleted Uranium Area

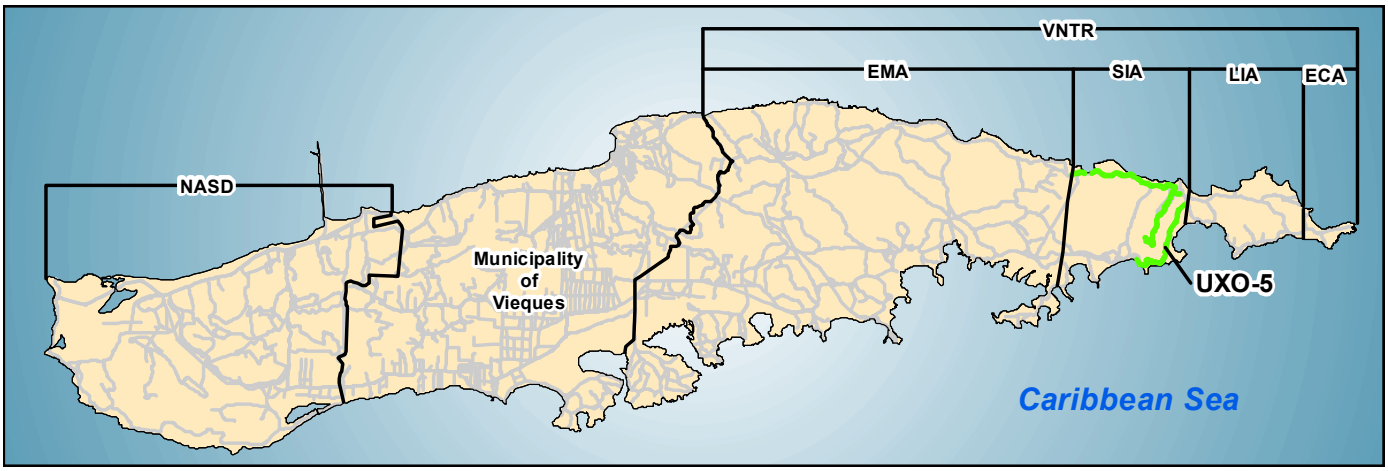
Since only 116 of the 263 depleted uranium armor-penetrating projectiles were recovered previously from the LIA, a discrete soil sampling approach will be conducted within the area where the projectiles potentially struck. A radiological survey will first be conducted within the former Nuclear Regulatory Commission (NRC) study area by collecting radiological measurements along the ground surface using a sodium iodide detector over the study area and comparing to background measurements.

Twelve discrete surface (0 to 12 inches bgs) and subsurface soil samples will be collected and analyzed for uranium (as an inorganic constituent) for non-carcinogenic effects and for radiological uranium for carcinogenic effects (**Figure 32**). Four soil sample locations are located where penetrators were previously identified as part of the 2000 NRC Environmental Survey (NRC, 2000b). If during the radiological survey radiological measurements above background are observed (greater than 2-times the average background), discrete surface and subsurface soil samples will be focused in the areas with radiological measurements above background.

Radiological uranium will include the analysis of U-234, U-235, and U-238. The ratios of U-234/U-238 and U-235/U-238 will be used to distinguish between natural and depleted uranium at the site. Since the depleted uranium projectiles are composed primarily of U-238, only U-238 will be compared to screening criteria if determined to be depleted uranium. Screening criteria for radionuclides are included in **Attachment C**.

Groundwater from the one monitoring well located within the depleted uranium study area will also be analyzed for uranium as noted above. Since Laguna Anones is topographically downgradient of the depleted uranium area, the samples from that lagoon also will be analyzed for uranium as noted above. A subset of the other monitoring wells and lagoons sampled as part of the SAP, but away from the area potentially affected by the depleted uranium, will be analyzed for uranium to serve as background.

SAP Worksheet #17d – UXO 5 (SIA Restricted Roads)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 5:

1. Characterize the MEC identified within each of the roads and 25-ft road buffer areas to sufficiently delineate the location, type, and spatial extent of munitions-related items along the surface, and to evaluate the explosive safety hazard at the site.
2. Conduct DGM and subsequent intrusive investigation of anomalies to a depth of 2 ft bgs within each of the roads and 25-ft buffer areas to sufficiently delineate the location, type, and vertical extent of munitions-related items within the subsurface.
3. Assess munitions-related information collected as part of these activities to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11 .

To address site specific PQO #1, the surface removal of MEC has been completed throughout the entirety of UXO 5 and data have been collected for over 16,000 munitions-related items. This information is sufficient to meet PQO #1.

To address site-specific PQO #2, the subsurface data collected during the NTCRA at UXO 5 will be evaluated; it is estimated that 16 additional acres of DGM remain to be completed. It is anticipated that upon completion of the DGM and subsequent intrusive investigation of anomalies, information will have been collected to sufficiently characterize the nature and vertical extent of MEC.

To address PQO #3, the NTCRA depth of investigation (2 ft bgs) was a depth determined to be protective the known current and potential future use of the roads by USFWS refuge management personnel and trespassers accessing the areas surrounding UXO 5 and the potential for future road repairs to a maximum depth of 1 ft bgs. It is anticipated that the future use of the roads will be restricted to USFWS personnel conducting refuge management activities with MEC exposure routes that will remain consistent with the current exposure routes. Therefore, the MEC removal depth applied during the NTCRA is conservatively protective of future receptors at the site.

Based on this information, there are no additional MEC investigations or removal actions anticipated at UXO 5 following the completion of the current NTCRA prior to making final remedy determinations for the site. However, if information gathered during the NTCRA or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

SAP Worksheet #17d – UXO 5 (SIA Restricted Roads) (continued)

The sampling at UXO 5 may be initiated prior to completion of the subsurface NTCRA. Sufficient information to develop the sampling approach is based on historical information and munitions data available through October 2012 (DGM and surface and subsurface munitions information). However, if additional information is gathered during the NTCRA that warrants a modification to the sampling approach, the modification will be made via an addendum to this SAP, or other mechanism that demonstrates formal concurrence by the Navy and regulatory agencies.

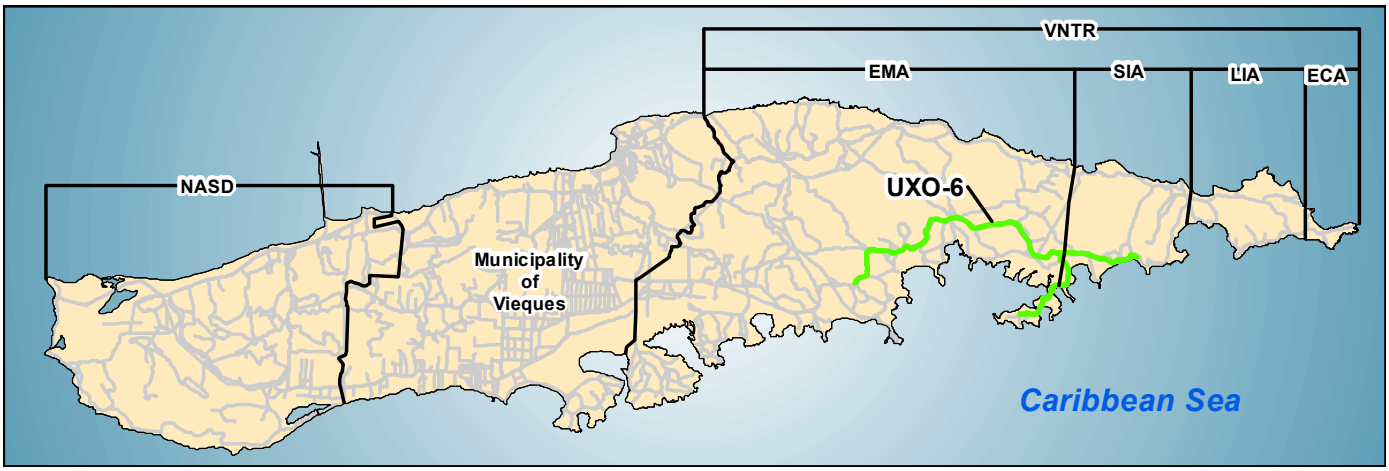
Sampling Approach

It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 5 road areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. Further, at a minimum, geophysics will have been completed along all UXO 5 roads prior to performing soil characterization activities. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 5 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 5 road areas, characterization will proceed as described in this SAP.

UXO 5 comprises one decision unit since the road generally acts as a drainage area. Eight sampling units at UXO 5 were designed to focus on areas with high densities of munitions items, to account for each type of munitions item and munitions related scrap identified on the surface and within the subsurface, DGM anomalies, and in potential depositional areas along the roads that receive surface runoff from UXO 9 (**Figure 33**). The potential human health and ecological receptor exposure scenarios are similar across the entire site; therefore, any area along the roads is representative of potential exposures. One area along the road is unique in that a scenic overlook and historical site (assumed to be in the vicinity of OP-1) is being considered for public use. Each sampling unit is approximately 1 acre in size and includes both the road and a 25-ft buffer on each side of the road. **Table 7** summarizes the MEC and munitions scrap items historically found and removed within the roads decision units and the rationale for why each sampling unit was selected.

One incremental surface soil sample (0 to approximately 2.5 inches) and two discrete subsurface soil samples will be collected at each of the eight sampling units (note that the number of subsurface soil samples may be adjusted in the future as the data collected from the sites are evaluated on a continuing basis, as warranted, with consensus from the ERP Technical Subcommittee). Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to the nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background data. The incremental soil samples will be evaluated to assess potential risks to human health and the environment.

SAP Worksheet #17e – UXO 6 (EMA/SIA Public Roads)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 6:

1. Characterize the MEC identified within each of the roads and 25-ft road buffer areas to sufficiently delineate the location, type, and spatial extent of munitions-related items along the surface, and to evaluate the explosive safety hazard at the site.
2. Conduct DGM and subsequent intrusive investigation of anomalies to a depth of 2 ft bgs within each of the roads and 25-ft buffer areas to sufficiently delineate the location, type, and vertical extent of munitions-related items within the subsurface.
3. Assess munitions-related information collected as part of these activities to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11 .

To address site-specific PQO # 1, the entirety of the EMA and SIA roads have been surface cleared of munitions a part of the NTCRA, where over 18,000 munitions-related items have been removed. Therefore, the data from this effort will meet the PQO #1.

To address PQO #2, the subsurface removal of MEC at UXO 6 has provided information on over 18,500 munitions-related items that supplements the DGM data collected throughout the entire site. Based on this information, sufficient data has been collected to sufficiently characterize the vertical nature and extent of MEC.

To address PQO #3, the NTCRA depth of investigation (2 ft bgs) was a depth determined to be protective of the known use of the roads by USFWS refuge management personnel and trespassers accessing the areas surrounding UXO 6 and the potential for future road repairs to a maximum depth of 1 ft bgs. It is anticipated that in the future, the roads will be used by USFWS personnel conducting wildlife management activities, authorized recreational users, and trespassers to gain access to other parts of the refuge and the areas open for recreational use; no intrusive activities are associated with this. The roads will also require periodic maintenance, with a maximum anticipated intrusive depth of 1 ft bgs. Therefore, the MEC removal depth applied during the NTCRA is conservatively protective of future receptors at the site.

Based on this information, there are no additional MEC investigations or removal actions following completion of the current NTCRA anticipated at UXO 6 prior to making final remedy determinations for the site. However, if information gathered during NTCRA or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

SAP Worksheet #17e – UXO 6 (EMA/SIA Public Roads) (continued)

Based on historical information and munitions data available through October 2012 (DGM and surface and subsurface munitions information), the sampling approach has been defined. However, the approach may be modified based on the collection of additional munitions-related data prior to sampling.

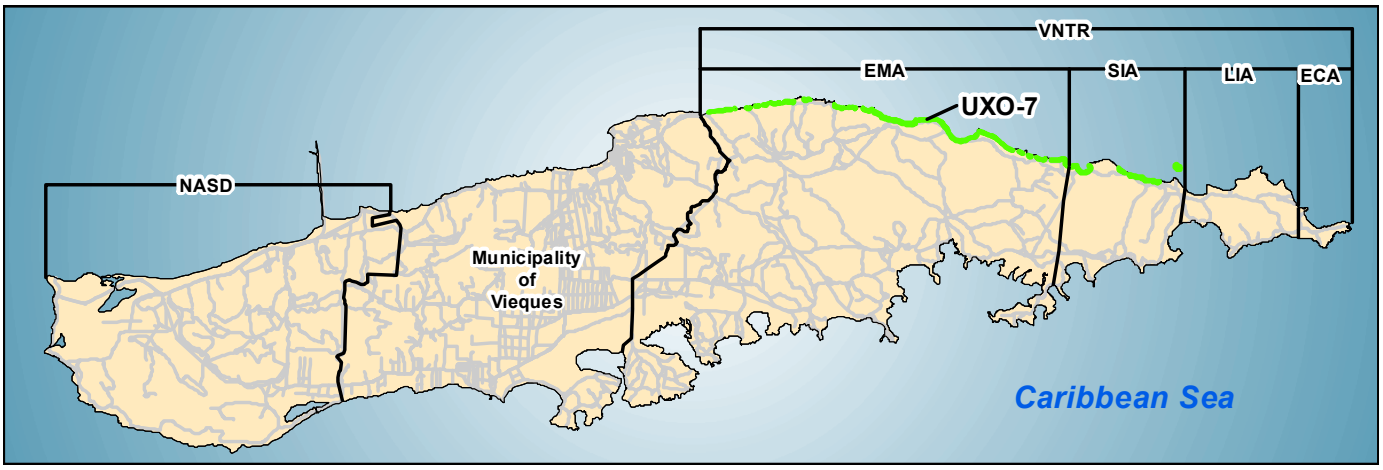
Sampling Approach

It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 6 road areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. Further, at a minimum, geophysics will have been completed along all UXO 6 roads prior to performing soil characterization activities. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 6 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 6 road areas, characterization will proceed as described in this SAP.

UXO 6 comprises one decision unit since the road generally acts as a drainage area. Four sampling units at UXO 6 were designed to focus on areas with high densities of munitions items, to account for each type of munitions item and munitions related scrap identified in the surface and subsurface, DGM anomalies, and in potential depositional areas along the roads (**Figures 34a and 34b**). The potential human health and ecological receptor exposure scenarios are similar across the entire site; therefore, any area along the roads is representative of potential exposures. Each sampling unit is approximately 1 acre in size and includes both the road and a 25-ft buffer on each side of the road. **Table 8** summarizes the MEC and munitions scrap items historically found and removed within the roads decision units and the rationale for why each sampling unit was selected. Note that only one munitions item was identified within the western portion of the site.

One incremental surface soil sample (0 to approximately 2.5 inches) and two discrete subsurface soil samples will be collected at each of the four sampling units (note that the number of subsurface soil samples may be adjusted in the future as the data collected from the sites are evaluated on a continuing basis, as warranted, with consensus from the ERP Technical Subcommittee). Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background data. The incremental soil samples will be evaluated to assess potential risks to human health and the environment.

SAP Worksheet #17f – UXO 7 (EMA/SIA North Beaches)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 7:

1. Characterize the MEC identified within each of the sandy beaches and associated buffer areas to sufficiently delineate the location, type, and spatial extent of munitions-related items along the surface, and to evaluate the explosive safety hazard at the site.
2. Conduct DGM and subsequent intrusive investigation of anomalies to a depth of 4 ft bgs within each of the sandy beaches and associated buffer areas to sufficiently delineate the location, type, and vertical extent of munitions-related items within the subsurface.
3. Assess the munitions-related information as part of these activities that will be sufficient to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11 .

To address site-specific PQO # 1, the surface removal of MEC has been completed for the sandy beaches at UXO 7, providing data on over 1,500 munitions related items. Therefore, the available data is sufficient to meet PQO # 1.

To address site-specific PQO #2, the subsurface MEC removal has been completed at UXO 7, providing data on over 29,000 munitions items from all of the sandy beaches.

To address PQO #3, the NTCRA depth of investigation (4 ft bgs) was a depth that was determined to be protective the known USFWS turtle monitoring activities at the sandy beaches, where personnel could be exposed to MEC up to a depth of 3 ft bgs. The future use of the UXO 7 sandy beaches will be by USFWS personnel conducting refuge management and turtle monitoring activities, authorized recreations users at select beaches, and trespassers. It is anticipated that the continued turtle monitoring activities will result in the maximum potential MEC exposure depth (3 ft bgs), with a majority of authorized recreational users only being exposed to items on the ground surface and a relative few conducting shallow intrusive activities to a depth of less than 3 ft bgs.

Based on this information, there are no additional MEC investigations or removal actions anticipated at UXO 7 prior to making final remedy determinations for the site. However, a step-down plan detailing USFWS's intended use of the area indicates additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

The DGM and MEC data currently available will provide sufficient data to select sample locations. Based on historical information and data available through October 2012, the sampling approach has been preliminarily defined.

SAP Worksheet #17f – UXO 7 (EMA/SIA North Beaches) (continued)

An investigation to study the dynamics at several beaches within UXOs 2, 7, and 8 is being conducted in support of the RI investigations. The intent of the beach dynamics investigation is to augment the current understanding of the dynamic nature of the beach environment at the former VNTR and its impact on the potential distribution and removal /deposition of MEC. As part of the beach dynamics investigation, the selected beaches will be surveyed using DGM several times throughout a 1-year period and the resulting anomalies with a reading above 2.5 mV will be intrusively investigated following each DGM survey. Data from the investigation will be included in the RI, as appropriate, to help assess the nature, extent, and mobility of MEC contamination at the beaches.

Sampling Approach

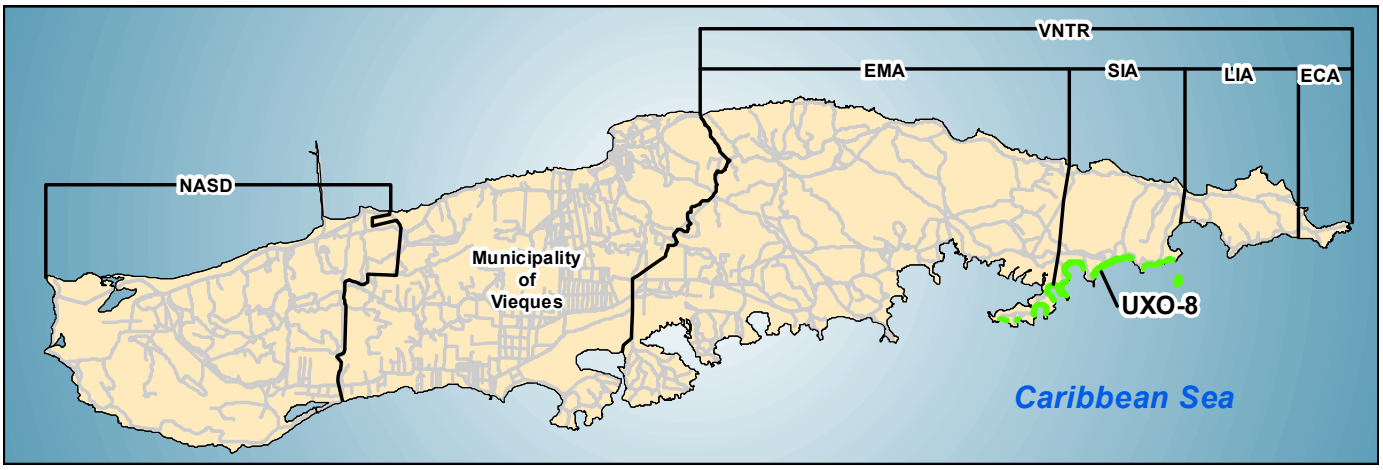
It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 7 beaches. However, the soil characterization approach developed in this SAP is based on existing munitions information. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 7 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the beach(e)s selected for sampling herein are still the most conservatively representative of all UXO 7 beaches, characterization will proceed as described in this SAP.

UXO 7 is considered its own decision unit since the beach generally acts as a drainage area. Each of the 14 beaches within UXO 7 was evaluated as a potential sampling unit using the ranking-based decision approach (**Table 2**). Three beaches (Diablo, Purple Beach, and Beach 33 [unnamed]) were selected for sampling as they have the most conservatively representative contaminant release potential and receptor exposure scenarios of all the UXO 7 beaches (**Figures 35a through 35c**). Each of these beaches has the highest quantity and diversity of MEC and munitions scrap and are the only UXO 7 beaches being considered as recreational beaches for the public. In addition, the beaches likely receive surface runoff from UXOs 9 and 13. Additional rationale as to why these beaches are representative of the other UXO 7 beaches is summarized in **Table 2**.

Each sampling unit is approximately 1 acre in size. Since each beach is different in size, the number of sampling units was biased toward diversity and quantity of MEC and munitions scrap, DGM anomalies, and potential depositional area for surrounding drainage on each beach (**Figures 35a through 35c**). In total, five incremental surface soil samples (0 to approximately 2.5 inches) and four discrete deeper surface soil samples (18 to 36 inches) will be collected at the three beaches; two of each at Diablo; two of each at Purple Beach; and one incremental surface soil sample at Beach 33 (a discrete deeper surface soil sample will not be collected since the beach is not a major turtle nesting habitat). **Table 9** summarizes the MEC and munitions scrap items historically found and removed within each UXO 7 sampling unit and the rationale for why each sampling unit was selected. The discrete deeper surface soil samples will be collected to best represent the depth of turtle egg nests. The discrete sample locations will be located where historical turtle nests have occurred, and as close to possible where higher frequencies of MEC have been identified.

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and background data. Potential risks to human health at the beach will be evaluated using both the surface and deeper surface soil samples. The incremental and discrete soil samples will be evaluated as separate exposure media in the ecological risk assessment; surface soil to terrestrial receptors, and deeper surface soil to turtle eggs only.

SAP Worksheet #17g – UXO 8 (EMA/SIA South Beaches)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 8:

1. Characterize MEC identified within each of the sandy beaches and associated buffer areas to sufficiently delineate the location, type, and spatial extent of munitions-related items along the surface.
2. Conduct DGM and subsequent intrusive investigation of anomalies to a depth of 4 ft bgs within each of the sandy beaches and associated buffer areas to sufficiently delineate the location, type, and vertical extent of munitions-related items within the subsurface.
3. Assess munitions-related information collected as part of these activities to sufficiently evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11 .

To address site-specific PQO #1 the surface clearance of UXO 8 was completed as part of the ERA/SI and NTCRA, providing data on over 970 munitions related items. Therefore, the available data is sufficient to meet PQO #1.

The subsurface clearance of MEC at UXO 8 has also been completed as part of the NTCRA, providing data on over 32,800 munitions related items from the sandy beaches. Therefore, information has been collected to sufficiently characterize the nature and vertical extent of MEC to meet specific PQO # 2.

To address PQO #3, the NTCRA depth of investigation (4 ft bgs) was a depth that was determined to be protective the known USFWS turtle monitoring activities at the sandy beaches, where personnel could be exposed to MEC up to a depth of 3 ft bgs. The future use of the UXO 8 sandy beaches will be by USFWS personnel conducting refuge management and turtle monitoring activities, authorized recreations users at select beaches, and trespassers. It is anticipated that the continued turtle monitoring activities will result in the maximum potential MEC exposure depth (3 ft bgs), with a majority of authorized recreational users only being exposed to items on the ground surface and a relative few conducting shallow intrusive activities to a depth of less than 3 ft bgs.

Based on this information, there are no additional MEC investigations or removal actions anticipated at UXO 8 prior to making final remedy determinations for the site. However, if a step-down plan detailing USFWS's intended use of the area indicates additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

The sampling at UXO 8 is currently planned to occur following completion of the DGM and intrusive investigation of the anomalies. The DGM and MEC data available at that time will provide sufficient data to select sample locations. Based on historical information and data available through October 2012, the sampling approach has been preliminarily defined.

SAP Worksheet #17g – UXO 8 (EMA/SIA South Beaches) (continued)

An investigation to study the dynamics at several beaches within UXOs 2, 7, and 8 is being conducted in support of the RI investigations. The intent of the beach dynamics investigation is to augment the current understanding of the dynamic nature of the beach environment at the former VNTR and its impact on the potential distribution and removal /deposition of MEC. As part of the beach dynamics investigation, the selected beaches will be surveyed using DGM several times throughout a 1-year period and the resulting anomalies with a reading above 2.5 mV will be intrusively investigated following each DGM survey. Data from the investigation will be included in the RI, as appropriate, to help assess the nature, extent, and mobility of MEC contamination at the beaches.

Sampling Approach

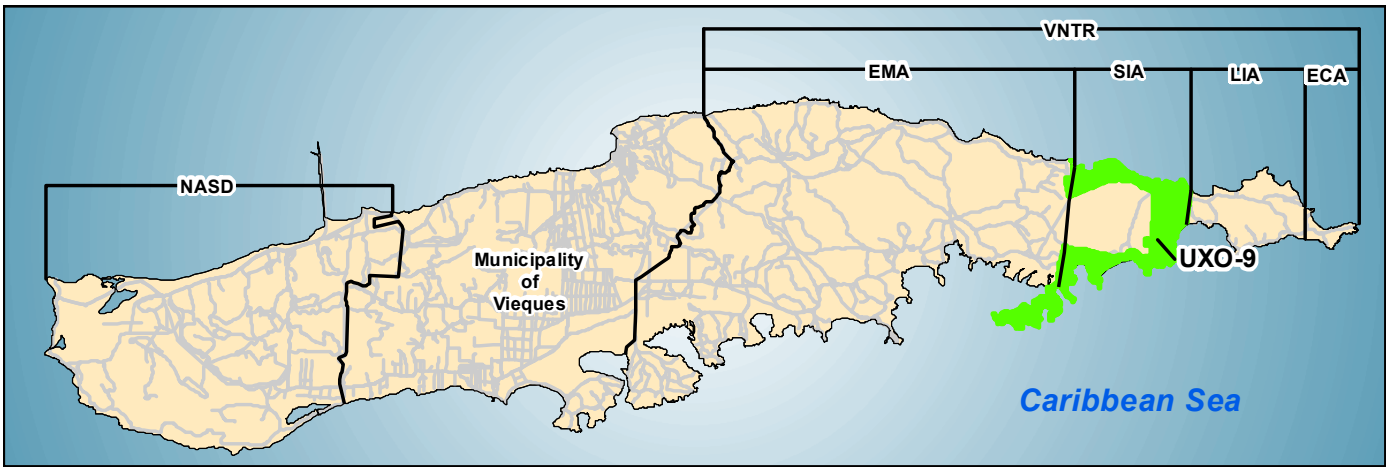
It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 8 beaches. However, the soil characterization approach developed in this SAP is based on existing munitions information. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 8 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the beach(e)s selected for sampling herein are still the most conservatively representative of all UXO 8 beaches, characterization will proceed as described in this SAP.

UXO 8 is considered its own decision unit since the beach generally acts as a drainage area; therefore, UXO 8 consists of one decision unit. Each of the nine beaches within UXO 8 was evaluated as a potential sampling unit using the ranking-based decision approach (**Table 2**). Five beaches (Playa Jolova, Playa Jolovita, Playa Matias/Yellow Beach, and Cayo Conejo) were selected for sampling as they have the most conservatively representative contaminant release potential and receptor exposure scenarios of all the UXO 8 beaches **(Figure 36**). Playa Jolova and Playa Jolovita have the highest quantity and diversity of MEC and are major turtle nesting beaches. Although a low quantity of munitions was identified at Playa Matias/Yellow Beach, it is selected for sampling since it is being considered as a recreational beach for the public and is a major turtle nesting beach. Although Cayo Conejo is not a sandy beach or turtle nesting area and also had a low quantity of munitions items identified, it was selected for surface soil sampling to evaluate potential exposure to terrestrial plants and animals. Additional rationale as to why these beaches are representative of the other UXO 8 beaches is summarized in **Table 2**.

Each sampling unit is approximately 1 acre in size. Since each beach is different in size, the number of sampling units was biased toward diversity and quantity of MEC and munitions scrap on the surface and within the subsurface, DGM anomalies, and potential depositional area for surrounding drainage on each beach (**Figure 36**). In total, five incremental surface soil samples (0 to approximately 2.5 inches) and four discrete deeper surface soil samples (18 to 36 inches) will be collected at the four beaches; two of each at Playa Matias/Yellow Beach; one of each at Playa Jolova; one of each at Playa Jolovita; and one incremental surface soil sample at Cayo Conejo (a discrete deeper surface soil sample will not be collected since the beach is not a major turtle nesting habitat). **Table 10** summarizes the MEC and munitions scrap items historically found and removed within each UXO 8 sampling unit and the rationale for why each sampling unit was selected. The discrete deeper surface soil samples will be collected from 18 to 36 inches to best represent the depth of turtle egg nests. The discrete sample locations will be located where historical turtle nests have occurred, and as close to possible where higher frequencies of MEC have been identified.

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the surface soil data will be compared to the adjusted RSLs, ecological screening value, and background data. Potential risks to human health at the beach will be evaluated using both the surface and deeper surface soil samples. The incremental and discrete soil samples will be evaluated as separate exposure media in the ecological risk assessment; surface soil to terrestrial receptors, and deeper surface soil to turtle eggs only.

SAP Worksheet #17h – UXO 9 (SIA Exterior)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 9:

1. Characterize MEC to sufficiently delineate the location, type, and spatial extent of munitions-related items along the ground surface, and to assess the explosive safety hazard at the site.
2. Evaluate the vertical extent and type of munitions related items based on the subsurface MEC characterization through the intrusive investigation of anomalies identified using DGM.
3. The munitions-related information collected as part of these activities will be sufficient to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address site specific PQO #1, the MEC data from approximately 570 acres of UXO 9 that have been surface cleared during the NTCRA , providing data on over 217,000 munitions items. Therefore sufficient data is available to meet PQO #1. In addition, information collected from transects on over five percent of the entire site during the ERA/SI transect inspections will be used to supplement the NTCRA data in these areas.

To address site-specific PQO # 2, a DGM survey and intrusive investigation to 2 ft bgs will be conducted at three environmental sampling units identified further below (one-acre in size) (**Figure 28**). The three environmental sampling units are designed such that they are located in an area with the highest MEC contamination on the ground surface, at a target location, and at one SSA (PI-17), thereby providing a conservative estimate of the MEC depth profile. In addition, subsurface MEC data from the adjacent beaches (UXO 2) and roads (UXO 3) will supplement the subsurface MEC characterization from the sampling units.

To address site-specific PQO #3, the vertical extent of munitions-related items will be evaluated to a depth of 2 ft bags at the environmental sampling units, which will conservatively evaluate deeper than the anticipated exposure depths for USFWS personnel and trespassers accessing the area as no intrusive activities are intended for the site.

The data collected to date at UXO 9 has sufficiently characterized the nature and extent of MEC on the surface of the site. Upon completion of the subsurface MEC characterization, it is anticipated that sufficient information will have been collected to characterize the nature and extent of MEC. Therefore, there are no additional MEC investigations or removal actions anticipated at UXO 9, beyond the planned subsurface evaluation in the three environmental sampling units, prior to making final remedy determinations for the site. However, if information gathered during the NTCRA or other site-related investigations or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

SAP Worksheet #17h – UXO 9 (SIA Exterior) (continued)

Based on historical information and munitions data available through October 2012 (surface munitions), the sampling approach has been defined. The preliminary approach may be modified based on the collection of additional munitions-related data prior to sampling.

Sampling Approach

UXO 9 is approximately 953 acres in size. Twelve decision units were established for the site and each were evaluated using the ranking-based decision approach (**Table 1 and Figure 37**). Three decision units were established for the six lagoons onsite designated as Laguna Matias, Northwestern UXO 9 Lagoons (comprising the two Puerto Diablo lagoons), and the Southwestern UXO 9 Lagoons (comprising Lagoon 11). All other decision units were generally defined based on the topography and localized drainage; however, three decision units were defined based on the fringes of Laguna Matias, the two Puerto Diablo lagoons, and Lagoon 11, which may be potential land crab habitats.

Three decision units (Northeast UXO 9, Northwest UXO 9, and Southeast UXO 9) represent the most conservative scenarios for a potential release to the environment based on the diversity and quantity of MEC. It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 9 areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 9 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 9 areas, characterization will proceed as described in this SAP.

Soil

For the initial sites investigated, two subsurface soil samples will be collected within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. Two subsurface soil samples within each sampling unit are noted below but may be modified at a later date.

Table 11 summarizes the MEC and munitions scrap items historically found and removed within each of the sampling units and the rationale for each sampling unit. In total, 30 sampling units, 4 discrete deeper surface soil samples, and 46 discrete subsurface soil samples will be collected (**Figure 37**). Each sampling unit is approximately 1 acre in size. The number of sampling units per decision unit is as follows:

- Northeast UXO 9 – 8 sampling units (0 to 2.5 inches) and 16 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, drainage and transport pathways (such as ephemeral streams), PI-1 (former aircraft strafing target and water production well), and PI-22 (former target area) (**Figure 37a**). One sampling unit (1DU08) covers the extent of PI-1 and one sampling unit (1DU03) covers the extent of PI-22. Two sampling units (1DU01 and 1DU02) will also characterize potential contamination transport along two ephemeral streams originating from UXO 10.
- South UXO 9 - 5 sampling units (0 to 2.5 inches) and 10 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, transport pathways (such as ephemeral streams), and PI-17 (possible former target area) (**Figure 37b**). One sampling unit (4DU04) covers the extent of PI-17. One sampling unit (4DU03) will also characterize potential contamination along the confluence of two ephemeral streams originating from UXO 10.

Northwest UXO 9 – 4 sampling units (0 to 2.5 inches) and 8 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, the former bulls-eye target, and potential depositional area for surrounding drainage (**Figure 37c**).

SAP Worksheet #17h – UXO 9 (SIA Exterior) (continued)

- Southeast UXO 9 - 3 sampling units (0 to 2.5 inches) and 6 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, a gun position, and transport pathways (ephemeral stream) (**Figure 37d**).
- North UXO 9 - 2 sampling units (0 to 2.5 inches) and 4 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap (**Figure 37e**).
- Southwest UXO 9 - 1 sampling unit (0 to 2.5 inches) and 2 discrete subsurface soil sample in the only area where MEC and munitions scrap was previously identified (**Figure 37f**).
- Laguna Matias Fringe - 1 sampling unit (0 to 2.5 inches) and 1 discrete deeper surface soil sample (2.5 to 24 inches). The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest (secondarily) (**Figure 37g**).
- Northwestern UXO 9 Lagoon Fringes – 4 sampling units (0 to 2.5 inches) and 4 discrete deeper surface soil samples (2.5 to 24 inches). The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete samples will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest (secondarily) (**Figure 37h**).
- Southwestern UXO 9 Lagoon Fringes - 2 sampling units (0 to 2.5 inches) and 2 discrete deeper surface soil samples (2.5 to 24 inches) at the largest of the three lagoons (Lagoon 11 only). The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest (secondarily) (**Figure 37i**).

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background concentrations.

Potential risks to human health will be evaluated using the surface soil samples site-wide, and at the lagoon fringe using both the surface and deeper surface soil samples. The incremental and discrete soil samples will be merged and evaluated together for land crabs only. All other ecological receptors will be evaluated using incremental soil samples.

Surface Water and Sediment

Sediment and surface water samples were located for broad spatial distribution, while ensuring areas with the highest frequencies of MEC identified were included. The number of samples per lagoon is as follows:

- Laguna Matias – 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) (**Figure 37g**).
- Northwestern UXO 9 Lagoons - 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) from each of the two lagoons; 6 sediment and 6 surface water samples total (**Figure 37h**). Multiple ephemeral streams originating from UXO 10 drain into these lagoons.
- Southwestern UXO 9 Lagoons – 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) from the largest of the three lagoons (Lagoon 11 only) (**Figure 37i**).

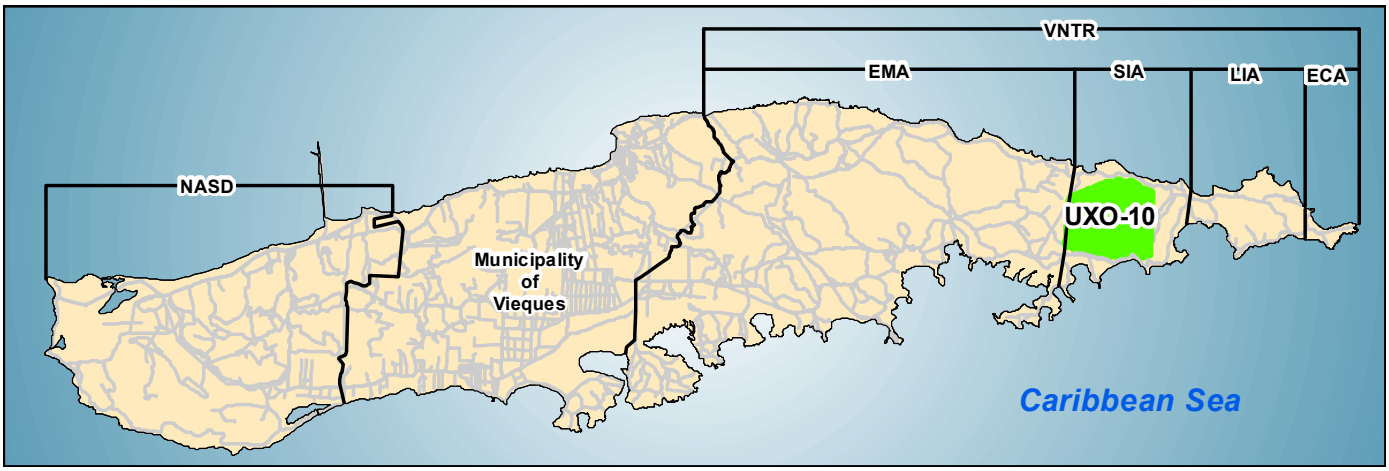
Each surface water and sediment sample will be analyzed for explosives and inorganic constituents. Sediment samples will also be analyzed for pH, TOC, and grain size. The data will be compared to the adjusted RSLs, ecological screening value, and background data collected from a similar lagoon or a weight of evidence evaluation. Potential risks to human health and ecological receptors will be evaluated using the surface water and sediment samples.

SAP Worksheet #17h – UXO 9 (SIA Exterior) (continued)

Groundwater

Six monitoring wells will be installed within UXO 9 (**Figure 26**). The rationale for the locations of each of the monitoring wells is provided in **Table 3**. The monitoring wells are conservatively focused in areas with the highest potential for contamination, such as adjacent to targets with high densities of munitions, and also downgradient of potential release areas to evaluate migration.

SAP Worksheet #17i – UXO 10 (SIA Interior)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 10:

1. Characterize MEC identified across the entire site to sufficiently delineate the location, type, and spatial extent of munitions-related items along the ground surface, and evaluate the explosive safety hazard at the site.
2. Evaluate the vertical extent and type of munitions related items through the intrusive investigation of anomalies identified using DGM.
3. Assess munitions-related information as part of these activities w to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address site-specific PQO # 1, the MEC data from the surface clearing of approximately 210 acres at UXO 10 provided information on over 143,000 munitions related items. In addition, MEC data collected from uniformly spaced transect across five percent of the entire site inspected during the ERA/SI will also be evaluated to supplement the NTCRA data in these areas. Therefore, the data are sufficient to address PQO #1.

To address site-specific PQO # 2, a DGM survey and subsequent intrusive investigation to 2 ft bgs will be conducted at three of the environmental sampling units identified further below (one-acre in size) (**Figure 28**). The three environmental sampling units are designed such that they are located in the areas with the highest identified MEC contamination on the ground surface, thereby providing a conservative estimate of the MEC depth profile. In addition, the subsurface MEC data from the nearby roads (UXO 5) will be evaluated to supplement the subsurface MEC characterization.

To address site-specific PQO #3 the vertical extent of munitions-related items will be evaluated to 2 ft at the three environmental sampling units. The sampling units are focused in areas with the highest quantity of MEC identified on the ground surface and at one SSA (PAOC Y). The depth range investigated will conservatively evaluate deeper than the anticipated exposure depths for USFWS personnel and trespassers accessing the area, as no intrusive activities are intended for the site.

The data collected to date at UXO 10 has sufficiently characterized the nature and extent of MEC on the surface of the site. Upon completion of the subsurface MEC characterization, it is anticipated that sufficient information will have been collected to characterize the nature and extent of MEC. Therefore, there are no additional MEC investigations or removal actions anticipated at UXO 10, beyond the planned subsurface evaluation in the three

SAP Worksheet #17i – UXO 10 (SIA Interior) (continued)

environmental sampling units, prior to making final remedy determinations for the site. However, if information gathered during the intrusive investigation of the sampling units or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

Based on historical information and munitions data available through October 2012 (surface munitions), the sampling approach has been preliminarily defined. The preliminary approach may be modified based on the collection of additional munitions-related data prior to sampling.

Sampling Approach

UXO 10 is approximately 900 acres in size. Five decision units were established for the site and each were evaluated using the ranking-based decision approach (**Table 1 and Figure 38**). All decision units were generally defined based on the topography and localized drainage; A higher quantity of sampling units were focused in the decision units with the most conservative release potential to the environment, since the potential human health and ecological receptor scenarios were similar amongst all of the decision units. It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 10 areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 10 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 10 areas, characterization will proceed as described in this SAP.

Soil

For the initial sites investigated, two subsurface soil samples will be collected within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. Two subsurface soil samples within each sampling unit are noted below but may be modified at a later date.

Table 12 summarizes the MEC and munitions scrap items historically found and removed within each of the sampling units and provides the rationale for each sampling unit. In total, 15 sampling units and 30 discrete subsurface soil samples will be collected (**Figure 38**). Each sampling unit is approximately 1 acre in size. The number of sampling units per decision unit is as follows:

- Southwest UXO 10 – 3 sampling units (0 to 2.5 inches) and 6 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, PAOC Y (identified as a large metal object), and transport pathways (ephemeral stream) (**Figure 38a**). One sampling unit (1DU01) covers the general extent of PAOC Y and the potential for contamination to migrate along an ephemeral stream that originates at the site. One sampling unit (1DU03) will characterize potential contamination along the ephemeral stream at the site boundary.
- Southeast UXO 10 - 4 sampling units (0 to 2.5 inches) and 8 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap and the primary transport pathway (ephemeral stream) within the decision unit (**Figure 38b**).
- Central UXO 10 - 3 sampling units (0 to 2.5 inches) and 6 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, craters, and transport pathways (ephemeral streams) (**Figure 38c**). Two sampling units (4DU01 and 4DU03) will characterize potential contamination along three ephemeral streams at the site boundary.

Northeast UXO 10 - 3 sampling units (0 to 2.5 inches) and 6 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap and the primary transport pathways (ephemeral stream) within the decision unit (**Figure 38d**).

SAP Worksheet #17i – UXO 10 (SIA Interior) (continued)

- North UXO 10 - 2 sampling (0 to 2.5 inches) and 4 discrete subsurface soil samples biased toward transport pathways (ephemeral streams) (**Figure 38e**).

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background concentrations. Potential risks to human health and ecological receptors will be evaluated using the surface soil samples.

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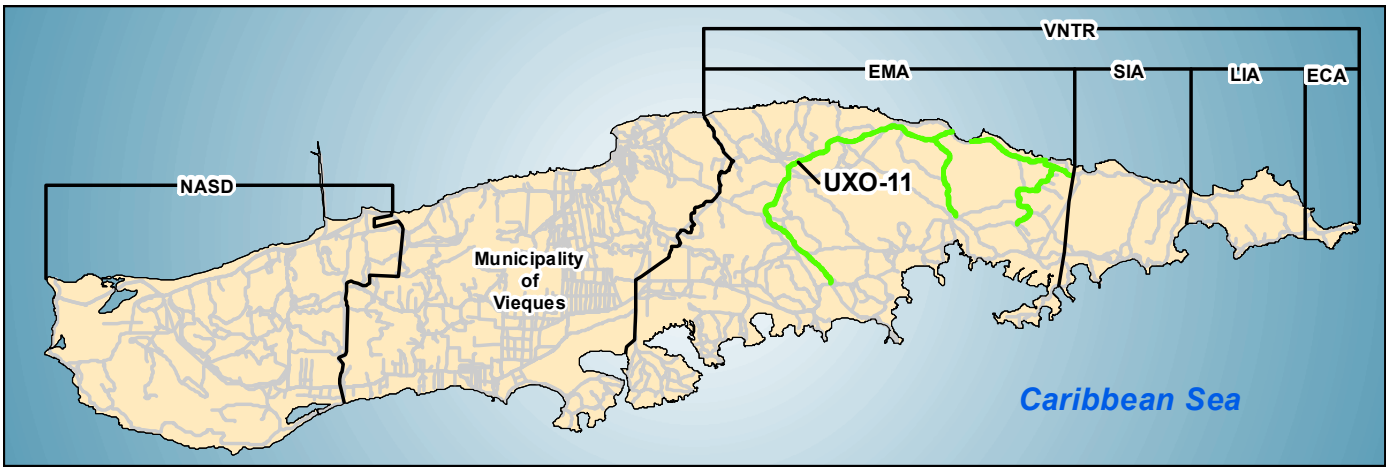
SAP Worksheet #17j – UXO 11 (EMA Public Roads)



Proposed Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 11:

1. Characterize the MEC identified within each of the roads and 25-ft road buffer areas to sufficiently delineate the location, type, and spatial extent of munitions-related items along the surface, and evaluate the explosive safety hazard at the site.
2. Conduct DGM and subsequent intrusive investigation of anomalies to a depth of 2 ft bgs within the roads and 25-ft buffer areas to sufficiently delineate the location, type, and vertical extent of munitions-related items within the subsurface at the site.
3. Assess munitions-related information collected as part of these activities to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11 .

To address site-specific PQO #1, the surface removal of MEC for the entire UXO 11 has been completed providing data on over 31,900 items. Therefore, sufficient data are available to address PQO #1.

To address site-specific PQO #2, over 6,000 subsurface munitions have been removed and approximately 51 acres of DGM remains to be completed. It is anticipated that upon completion of the DGM and subsequent intrusive investigation of anomalies, information will have been collected to sufficiently characterize the nature and extent of subsurface MEC.

To address PQO #3, the NTCRA vertical depth of investigation (2 ft bgs) was a depth that was determined to be protective of the known use of the roads by USFWS refuge management personnel and trespassers accessing the areas surrounding UXO 11 and the potential for future road repairs to a maximum depth of 1 ft bgs. It is anticipated that future use of the roads will be by USFWS personnel conducting wildlife management activities, authorized recreational users, and trespassers to gain access to other parts of the refuge and the areas open for recreational use; no intrusive activities are anticipated for this use. The roads will also require periodic maintenance, with a maximum anticipated intrusive depth of 1 ft bgs. Therefore, the MEC removal depth applied during the NTCRA is conservatively protective of future receptors at the site.

Based on this information, there are no additional MEC investigations or removal actions anticipated at UXO 11 following completion of the current NTCRA prior to making final remedy determinations for the site. However, if information gathered during the NTCRA or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

SAP Worksheet #17j – UXO 11 (EMA Public Roads) (continued)

The sampling at UXO 11 is currently planned to be initiated upon completion of the DGM. The DGM and MEC data available at that time will provide sufficient data to select sample locations. Based on historical information and munitions data available through October 2012 (DGM, surface, and subsurface munitions information), the sampling approach has been preliminarily defined. The preliminary approach may be modified based on the collection of additional munitions-related data prior to sampling.

Sampling Approach

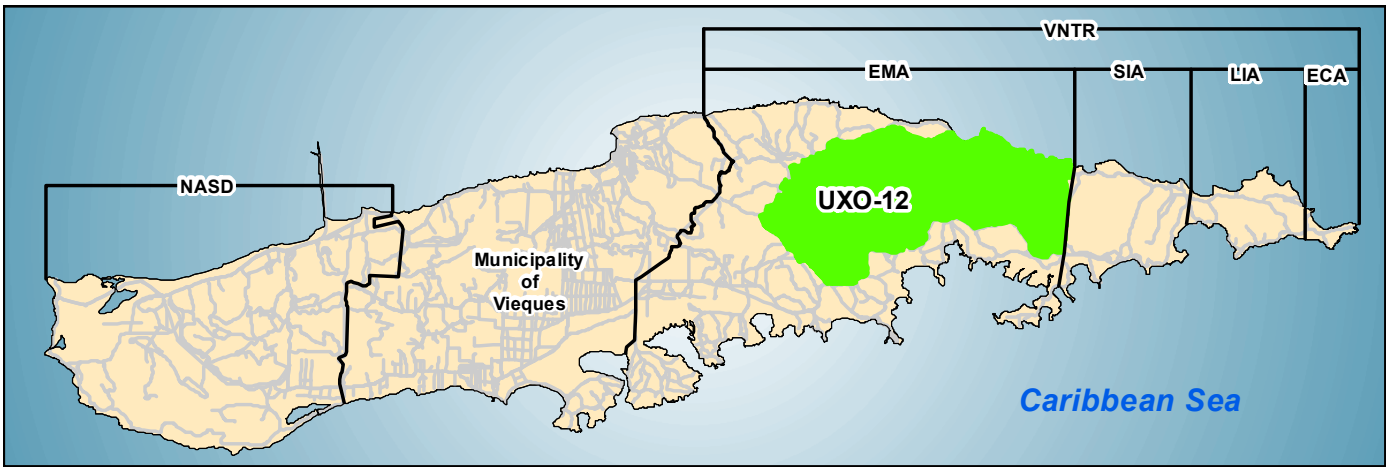
UXO 11 is considered its own decision unit since the beach generally acts as a drainage area. Five sampling units at UXO 11 were designed to target areas with high density munitions items, to account for each type of munitions item and munitions related scrap identified, DGM anomalies, in potential depositional areas along the road, and at PAOC Z (former target) since the SSA lies within the extent of the site (**Figures 39a through 39c**). The potential human health and ecological receptor exposure scenarios are similar across the entire site. Each sampling unit is approximately 1 acre in size to account for the receptors with smaller exposure areas and includes both the road and a 25-ft buffer on each side of the road. **Table 13** summarizes the MEC and munitions scrap items historically found and removed within the roads decision units and the rationale for each sampling unit.

It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 11 road areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. Further, at a minimum, geophysics will have been completed along all UXO 11 roads prior to performing soil characterization activities. As discussed previously, if information gathered during future munitions-related activities necessitates a modification to the UXO 11 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 11 road areas, characterization will proceed as described in this SAP. In addition, one incremental surface soil sample.

One incremental surface soil sample (0 to approximately 2.5 inches) and two discrete subsurface soil sample will be collected at each of the five sampling units (note that the number of subsurface soil samples may be adjusted in the future as the data collected from the sites are evaluated on a continuing basis, as warranted, with consensus from the ERP Technical Subcommittee). Each soil sample will be analyzed for explosives,

inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the surface soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background data. The incremental soil samples will be evaluated to assess potential risks to human health and the environment.

SAP Worksheet #17k – UXO 12 (EMA Interior)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 12:

1. Characterize MEC data to sufficiently delineate the location, type, and spatial extent of munitions-related items and to evaluate the explosive safety hazard for the site.
2. Evaluate the vertical extent of munitions-related items based on the subsurface MEC characterization through the intrusive investigation of anomalies identified using DGM.
3. Asses the munitions-related information collected as part of these activities to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address site-specific PQO # 1, surface removal of over 47,800 munitions items from the NTCRA activities in eastern UXO 12 has been completed. The data obtained during the NTCRA combined with the data from the ERA/SI transect investigation provide the type and lateral extent of MEC at the site, thereby meeting PQO #1. The NTCRA addressed the area with highest potential to contain MEC based on the historical use of the site and the known presence of potential MEC. The ERA/SI transects were conducted across the remainder of the site and did not identify areas with concentrations of MEC or any additional areas that were indicative of former training activities that would have resulted in potential MEC being present.

To address site-specific PQO # 2, a DGM survey and subsequent subsurface MEC investigations to 2 ft bgs will be completed within five of the environmental sampling units identified further below (one-acre in size) (**Figure 28**). The five environmental sampling units are designed such that they are focused in areas with the highest quantity of MEC identified on the ground surface, at one SSA (PI-16), and at gun positions, thereby providing a conservative estimate of the MEC depth profile. Subsurface MEC characterization will not be conducted at SSAs PI-2, PI-3, PI-15, and PI-18 since these ranges are potential small arms ranges. In addition, subsurface MEC data from the adjacent roads (UXOs 6 and 11) and beaches (portions of UXO 7) will supplement the subsurface MEC characterization.

To address site specific PQO # 3, the vertical extent of munitions-related items will be evaluated to a depth of 2 ft bgs at the five environmental sampling units, which will conservatively evaluate deeper than the anticipated exposure depths for USFWS personnel and trespassers accessing the area as no intrusive activities are intended for the site.

Based on this information, there are no additional MEC investigations or removal actions anticipated at UXO 12, beyond the planned subsurface evaluation in the five environmental sampling units, prior to making final remedy

SAP Worksheet #17k – UXO 12 (EMA Interior) (continued)

determinations for the site. However, if a step-down plan detailing USFWS's intended use of the area indicates additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

The sampling approach at UXO 12 is based on historical information and munitions data available through October 2012.

Sampling Approach

UXO 12 is approximately 4,465 acres in size. Eight decision units (including two lagoons) were established for the site and each were evaluated using the ranking-based decision approach (**Table 1 and Figure 40**). One decision unit was established for the two lagoons onsite and designated as Laguna Monte Largo. All other decision units were generally defined based on the topography and localized drainage; however, the lagoon fringe of Laguna Monte Large was based on the potential of it being a land crab habitat. A higher quantity of sampling units were focused in the decision units with the most conservative release potential to the environment, since the potential human health and ecological receptor exposure scenarios were similar across all of the decision units (excluding the lagoons).

It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 12 areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. As discussed previously, if information gathered during future munitions-related activities necessitates

a modification to the UXO 12 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 12 areas, characterization will proceed as described in this SAP.

Soil

For the initial sites investigated, two subsurface soil samples will be collected within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. Two subsurface soil samples within each sampling unit are noted below but may be modified at a later date.

Table 14 summarizes the MEC and munitions scrap items historically found and removed within each of the sampling units and provides the rationale for each sampling unit. In total, 23 sampling units, 1 discrete deeper surface soil sample, and 38 discrete subsurface soil samples will be collected (**Figure 40**). Each sampling unit is one acre in size. The number of sampling units per decision unit is as follows:

- Northeast UXO 12 - 6 sampling units (0 to 2.5 inches) and 12 discrete subsurface soil samples biased toward diversity and quantity of MEC and munitions scrap, gun positions, PI-15 (possible former range), PI-16 (potential disposal area for munitions), and transport pathways (ephemeral streams) (**Figure 40a**).
- South-central UXO 12 - 5 sampling units (0 to 2.5 inches) and 10 discrete subsurface soil samples biased toward the location of multiple gun positions, transport pathways (ephemeral streams) from the gun positions, and PI-2 and PI-3 (both former small arms range and water production wells) (**Figure 40b**).
- South UXO 12 - 2 sampling units (0 to 2.5 inches) and 4 discrete subsurface soil samples biased toward gun positions and transport pathways (ephemeral streams) (**Figure 40c**).
- Southeast UXO 12 - 2 sampling units (0 to 2.5 inches) and 4 discrete subsurface soil samples biased toward diversity and quantity of MEC, gun positions, potential target area within Range 11, and transport pathways (ephemeral streams) (**Figure 40d**).

SAP Worksheet #17k – UXO 12 (EMA Interior) (continued)

- Southwest UXO 12 - 2 sampling units (0 to 2.5 inches) and 4 discrete subsurface soil samples biased toward PI-18 (potential small arms range) and PI-19 (possible gun position) (**Figure 40e**).
- North UXO 12 – 1 sampling unit (0 to 2.5 inches) and 2 discrete subsurface soil sample biased toward a gun position and transport pathways (ephemeral stream) (**Figure 40f**).
- North-central UXO 12 - 1 sampling unit (0 to 2.5 inches) and 2 discrete subsurface soil sample biased toward gun position and transport pathways (ephemeral streams) (**Figure 40g**). A sampling unit is not proposed at PI-12, since this site is only a former water production well and private residence. In addition, only one sampling unit is proposed due to the lack of munitions identified within this decision unit.
- Laguna Monte Largo Fringe - 4 sampling unit (0 to 2.5 inches) and 4 discrete deeper surface soil samples (2.5 to 24 inches) at the largest of the two lagoons (Laguna Monte Largo) (**Figure 40h**). Since no munitions were identified adjacent to the lagoon, the discrete sample will be biased toward the highest land crab burrow density.

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background concentrations. Potential risks to human health will be evaluated using the surface soil samples site-wide, and at the lagoon fringe using both the surface and deeper surface soil samples. The incremental and discrete soil samples will be merged and evaluated together for land crabs only. All other ecological receptors will be evaluated using incremental soil samples.

Surface Water and Sediment

Sediment and surface water samples were located for broad spatial distribution, while ensuring areas with the highest frequencies of MEC identified were included. The number of samples per lagoon is as follows:

- Laguna Monte Largo – 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) from the largest of the two lagoons (Laguna Monte Largo) (**Figure 40h**).

Each surface water and sediment sample will be analyzed for explosives and inorganic constituents. Sediment samples will also be analyzed for pH, TOC, and grain size. The data will be compared to the adjusted RSLs, ecological screening value, and background data collected from a similar lagoon or a weight of evidence evaluation. Potential risks to human health and ecological receptors will be evaluated using the surface water and sediment samples.

Groundwater

Six monitoring wells will be installed within UXO 12 (**Figure 26**). The rationale for the locations of each of the monitoring wells is provided in **Table 3**. The monitoring wells are conservatively focused in areas with the highest potential for contamination, such as located adjacent to gun positions, and also downgradient of potential release areas to evaluate migration.

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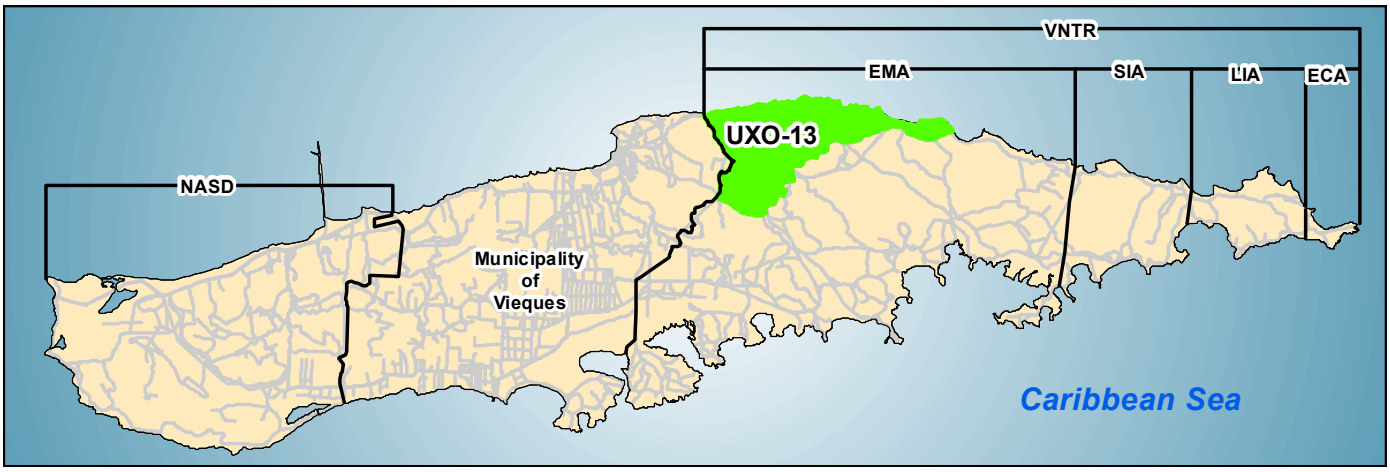
SAP Worksheet #17I – UXO 13 (EMA West)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 13:

1. Characterize MEC to sufficiently delineate the location, type, and spatial extent of munitions-related items along the ground surface, and to evaluate the explosive safety hazard at the site.
2. Evaluate the vertical extent and type of munitions related items through the intrusive investigation of anomalies identified using DGM.
3. Assess munitions-related information to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address site PQO #1, the MEC data from NTCRA for the surface clearance of MEC from approximately 620 acres of eastern UXO 13 will be collected and evaluated. The NTCRA began in September 2012 and is currently ongoing. To address the western portion of the site a transect approach within the remainder of the site will be conducted to assess if munitions potentially presenting an explosive hazard are present. As shown on **Figure 41**, the transects will be oriented in an east-west direction across the entire site. This data, combined with the historical north-south transect data (from the ERA/SI), will provide sufficient coverage of the remainder of UXO 13. Transects are also proposed at Parcel C to sufficiently delineate the location, type, and spatial extent of the munitions-related items using east-west and north-south trending transects. These transects, shown on **Figure 41**, will cover approximately 3 percent of Parcel C. It is anticipated that the transects will provide sufficient coverage to evaluate the potential for MEC to have been released at the site and the locations of the release(s) since no MEC is anticipated. If MEC is found, however, it should be limited to the ground surface since historical information suggests the area was not used for munitions training activities.

To address site PQO #2, a DGM survey and subsequent intrusive investigations to 2 ft bgs will be completed at six environmental sampling units identified further below (one-acre in size) (**Figure 28**). The six environmental sampling units are designed such that are focused in areas with the highest quantity of MEC identified on the ground surface during the ERA/SI and at potential target locations within ranges, thereby providing a conservative estimate of the MEC depth profile. In addition, subsurface MEC data from the adjacent roads (UXO 11) and beaches (portions of UXO 7) will supplement the subsurface MEC characterization. Subsurface MEC characterization will not be conducted at the small arms ranges.

To address site specific PQO # 3, the vertical extent of munitions-related items will be evaluated to a depth of 2 ft bgs at the six environmental sampling units, which will conservatively evaluate deeper than the anticipated

SAP Worksheet #17l – UXO 13 (EMA West) (continued)

exposure depths for USFWS personnel and trespassers accessing the area as no routine intrusive activities are intended for the site. Upon completion of the NTCRA, transect investigation, and intrusive investigation of the sampling units, information will have been collected to sufficiently characterize the nature and extent of MEC.

There will be no additional MEC investigations or removal actions anticipated at UXO 13 following completion of the current NTCRA and intrusive investigation of the sampling units prior to making final remedy determinations for the site. However, if information gathered during the NTCRA, transect investigation, or investigation of the sampling units, or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

Based on historical information and munitions data available through October 2012 (surface munitions information), the sampling approach has been preliminarily defined. The preliminary approach may be modified based on the collection of additional munitions-related data prior to sampling.

Sampling Approach

UXO 13 is approximately 1,871 acres in size. Seven decision units (including two lagoons) were established for the site and each was evaluated using the ranking-based decision approach (**Table 1 and Figure 42**). One decision unit was established for the two lagoons onsite and designated as Laguna Algodones. One decision unit (Parcel C UXO 13) includes proposed land use that is unrestricted for public use. All other decision units were generally defined based on the topography and localized drainage; however, the Laguna Algodones fringe decision unit was defined based on the potential of being a land crab habitat. It is important to note that, as shown in **Figure 6**, munitions removal activities are still ongoing at some of the UXO 13 areas. However, the characterization approach developed in this SAP is based, in part, on existing munitions information. As discussed previously, if information

gathered during future munitions-related activities necessitates a modification to the UXO 13 soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples. However, if the additional information suggests the decision units selected for sampling herein are still the most conservatively representative of all UXO 13 areas, characterization will proceed as described in this SAP.

Soil

For the initial sites investigated, two subsurface soil samples will be collected within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. Two subsurface soil samples within each sampling unit are noted below but may be modified at a later date.

Table 15 summarizes the MEC and munitions scrap items historically found and removed within each of the sampling units and provides the rationale for each sampling unit. In total, 29 sampling units, 2 discrete deeper surface soil samples, and 52 discrete subsurface soil samples will be collected. Each sampling unit is one acre in size. The number of sampling units per decision unit is as follows:

- Northeast UXO 13 - 12 sampling units (0 to 2.5 inches) and 24 discrete subsurface soil samples biased toward the location of former gun positions, and within firing points and former target areas in multiple ranges (Range 3, 4, 4A, 4B, 7, and 9) **(Figure 42a)**.
- Central UXO 13 - 11 sampling units (0 to 2.5 inches) and 22 discrete subsurface soil samples biased toward the location of former gun positions, within firing points and former target areas in multiple ranges (Range 1, 2, 5, and 7), diversity and quantity of MEC and munitions scrap, and transport pathways (ephemeral streams) (**Figure 42b**).

SAP Worksheet #17I – UXO 13 (EMA West) (continued)

- East Northeast UXO 13 – 2 sampling units (0 to 2.5 inches) and 4 discrete subsurface soil samples biased toward former range impact areas, quantity of MEC and munitions scrap (limited quantity identified), and transport pathways (ephemeral stream that originated in UXO 12 and runs through former gun positions) (**Figure 42c**).
- South UXO 13 - 1 sampling unit (0 to 2.5 inches) and 2 discrete subsurface soil samples biased toward the location of a former gun position (**Figure 42d**).
- Parcel C UXO 13 – Samples within this decision unit are dependent on the findings of additional MEC characterization. Eight discrete surface soil (0 to 1 foot) and eight discrete subsurface soil (depth interval is in accordance with Vieques protocols) will be collected randomly within the transects as part of the munitions investigation. However, if munitions items are identified, a sample location will be moved to where the item was identified. If more than eight munitions items are identified, a SAP Addendum will be prepared for this decision unit following the findings of the MEC characterization (**Figure 42e**).
- Laguna Algodones Fringe – 3 sampling units (0 to 2.5 inches) and 3 discrete deeper surface soil samples (2.5 to 24 inches) at the two lagoons (Laguna Algodones) (**Figure 42f**). Since no munitions were identified adjacent to the lagoon, the discrete sample will be biased toward the highest land crab burrow density.

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. Since there is the potential for PAHs within Range 4A from flame throwing activities, sampling units 1DU6 and 1DU10 will include PAHs for analysis. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the surface soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background concentrations. Potential risks to human health will be evaluated using the surface soil samples site-wide, and at the lagoon fringe using both the surface and deeper surface soil samples. The incremental and discrete soil samples will be merged and evaluated together for land crabs only. All other ecological receptors will be evaluated using incremental soil samples.

Surface Water and Sediment

Sediment and surface water samples were located for broad spatial distribution, while ensuring areas with the highest frequencies of MEC identified were included. The number of samples per lagoon is as follows:

- Laguna Algodones – 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) from the two lagoons; total of 6 sediment and 6 surface water samples (**Figure 42f**).

Each surface water and sediment samples will be analyzed for explosives and inorganic constituents. Sediment samples will also be analyzed for pH, TOC, and grain size. The data will be compared to the adjusted RSLs, ecological screening value, and background data collected from a similar lagoon or a weight of evidence evaluation. Potential risks to human health and ecological receptors will be evaluated using the surface water and sediment samples.

Groundwater

Three monitoring wells will be installed within UXO 13 (**Figure 26**). The rationale for the locations of each of the monitoring wells is provided in **Table 3**. The monitoring wells are conservatively focused in areas with the highest potential for contamination, such as located within the rocket range and a small arms range, and also downgradient of potential release areas to evaluate migration.

Groundwater sampling is not proposed within Parcel C as the 1999 hydrogeologic investigation concluded that explosives were not detected in groundwater in this area (Baker, 1999). Three monitoring wells are located at or in close proximity to the Parcel C boundary (**Figure 5**); monitoring wells NW-1, P-2, and RCRA-1 are screened from 124-134, 92-102, and 54-64 ft bgs at first encountered groundwater. Groundwater flow in this area was determined to generally flow to the northeast, from Parcel C to the interior of UXO 13.

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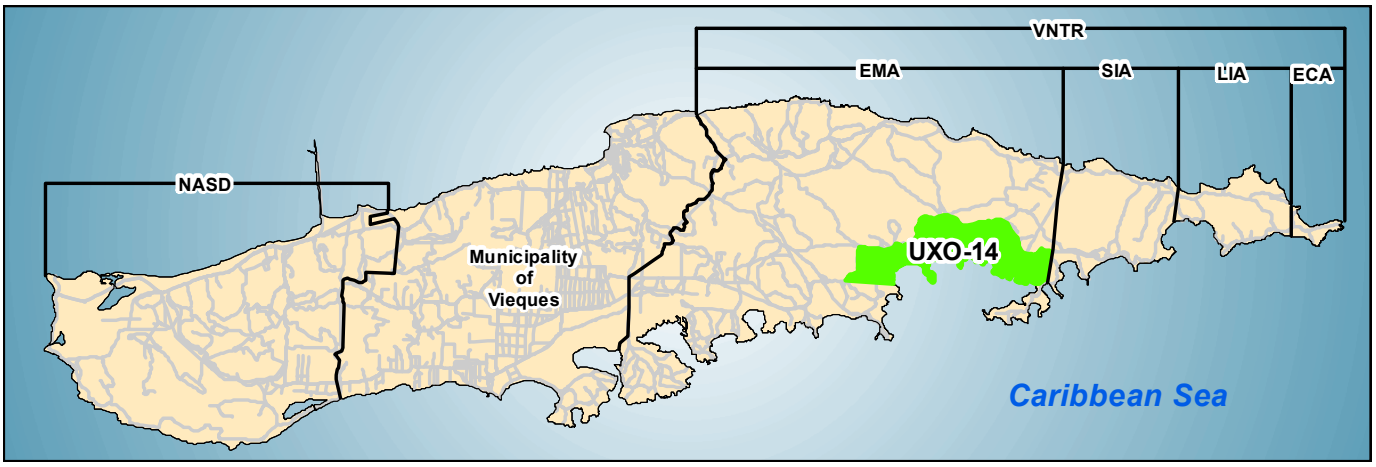
SAP Worksheet #17m – UXO 14 (EMA South)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the approach for UXO 14 is to characterize the nature and lateral extent of MEC within the site that could potentially impact future receptors. The future use of UXO 14 will be limited to maintaining the site as wildlife refuge with some recreational activities, where USFWS personnel accessing the area for general wildlife refuge management activities, authorized recreational users, and trespassers could potentially be exposed to MEC. The objective for the investigation of MEC at UXO 14 will be met through evaluation of the location, type, and spatial extent of the munitions-related items identified during the investigation transects completed during the ERA/SI. The following MEC site-specific PQOs were developed for UXO 14:

1. Characterize the nature and lateral extent of MEC within the site that could potentially impact future receptors. The vertical extent of MEC is limited to the surface due to the former site use, limited number of MEC identified, and surface exposure pathway.
2. Assess munitions-related information to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address site-specific PQO # 1, the data from the over 3,800 munitions-related items identified during the investigation transects completed during the ERA/SI will be evaluated. The transects were uniformly spaced across the entire site and covered approximately four percent of the total area at UXO 14. The data from the transects was consistent with historic documentation about the site and did not identify areas with significant MEC concentrations or occurrences, suggesting that the MEC contamination within the site is sparse and limited.

To address site-specific PQO # 2 the surface MEC data are considered sufficient to sufficiently delineate if there are viable or complete exposure pathways based upon the planned future land use and to evaluate the potential for remaining MEC to pose unacceptable safety risks. The future use of UXO 14 will be limited to maintaining the site as wildlife refuge with some recreational activities, where USFWS personnel accessing the area for general wildlife refuge management activities, authorized recreational users, and trespassers could potentially be exposed to MEC on the ground surface.

Because of the limited use of the site for military activities, the historical MEC investigation activities have provided information to sufficiently characterize the nature and extent of MEC; therefore, there are no additional MEC investigations or removal actions anticipated at UXO 14 prior to making final remedy determinations for the site. However, if information gathered during the environmental investigation or a step-down plan detailing USFWS's intended use of the area indicate additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

SAP Worksheet #17m – UXO 14 (EMA South) (continued)

Sufficient information to develop the sampling approach is based on historical information and munitions data available through October 2012.

Sampling Approach

UXO 14 is approximately 1,050 acres in size. Ten decision units (including eight lagoons) were established for the site and each was evaluated using the ranking-based decision approach (**Table 1 and Figure 43**). Three decision units were established for the six lagoons onsite and designated as West UXO 14 Lagoons (Laguna Yanuel), East Central UXO 14 Lagoons (Lagoons 14, 15, and 16), and East UXO 14 Lagoons (Lagoons 12 and 13). All other decision units were generally defined based on the topography and localized drainage; however, three decision units were defined based on the fringes of the West UXO 14 Lagoons, East Central UXO 14 Lagoons, and East UXO 14 Lagoons based on the potential to be land crab habitats. Two decision units (West UXO 14 and West Central UXO 14) contain intended land use that is open to the public as recreational use for interpretive hiking, and biking trails. One decision unit (East UXO 14) represents the most conservative scenarios for a potential release to the environment.

Soil

For the initial sites investigated, two subsurface soil samples will be collected within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. Two subsurface soil samples within each sampling unit are noted below but may be modified at a later date.

Table 16 summarizes the MEC items historically found and removed within each of the sampling units and provides the rationale for each sampling unit. In total, 13 sampling units, 4 discrete deeper surface soil samples, and 10 discrete subsurface soil samples will be collected. Each sampling unit is one acre in size. The number of sampling units per decision unit is as follows:

- West Central UXO 14 - 2 sampling units (0 to 2.5 inches) and 4 discrete subsurface soil samples biased toward gun positions and transport pathways (ephemeral streams) (**Figure 43a**).
- West UXO 14 – 1 sampling unit (0 to 2.5 inches) and 2 discrete subsurface soil sample biased toward transport pathways (multiple ephemeral streams) (**Figure 43b**).
- East Central UXO 14 - 1 sampling unit (0 to 2.5 inches) and 2 discrete subsurface soil sample biased toward transport pathways (ephemeral stream) (**Figure 43c**).
- East UXO 14 - 1 sampling unit (0 to 2.5 inches) and 2 discrete subsurface soil sample biased toward a gun position (**Figure 43d**).
- West UXO 14 Lagoon Fringes – 4 sampling units (0 to 2.5 inches) and 4 discrete deeper surface soil samples (2.5 to 24 inches) from Laguna Yanuel. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of land crab burrow density is highest since munitions were not identified (**Figure 43e**).
- East Central UXO 14 Lagoon Fringes – 2 sampling units (0 to 2.5 inches) and 2 discrete deeper surface soil samples (2.5 to 24 inches); one of each from Lagoon 14 and Lagoon 15. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of land crab burrow density is highest since munitions were not identified (**Figure 43f**).

East UXO 14 Lagoon Fringes – 2 sampling unit (0 to 2.5 inches) and 2 discrete deeper surface soil samples (2.5 to 24 inches) at both Lagoons 12 and 13; total of 2 sampling units and 2 discrete soil samples. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of land crab burrow density is highest since munitions were not identified (**Figure 43g**).

SAP Worksheet #17m – UXO 14 (EMA South) (continued)

Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background concentrations. Potential risks to human health will be evaluated using the surface soil samples site-wide, and at the lagoon fringe using both the surface and deeper surface soil samples. The incremental and discrete soil samples will be merged and evaluated together for land crabs only. All other ecological receptors will be evaluated using incremental soil samples.

Surface Water and Sediment

Sediment and surface water samples were located for broad spatial distribution, while ensuring areas with the highest frequencies of MEC identified were included. The number of samples per lagoon is as follows:

- West UXO 14 Lagoon – 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) from Laguna Yanuel (**Figure 43e**).
- East Central UXO 14 Lagoons – 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) from Lagoon 15 and 2 sediment samples (0 to 6 inches) and 2 surface water samples (at mid-depth) from Lagoon 14 (**Figure 43f**).
- East UXO 14 Lagoons - 3 sediment samples (0 to 6 inches) and 3 surface water samples (at mid-depth) from both Lagoons 12 and 13; total of 6 sediment and 6 surface water samples (**Figure 43g**).

Each surface water and sediment sample will be analyzed for explosives and inorganic constituents. Sediment samples will also be analyzed for pH, TOC, and grain size. The data will be compared to the adjusted RSLs, ecological screening value, and background data collected from a similar lagoon or a weight of evidence evaluation. Potential risks to human health and ecological receptors will be evaluated using the surface water and sediment samples.

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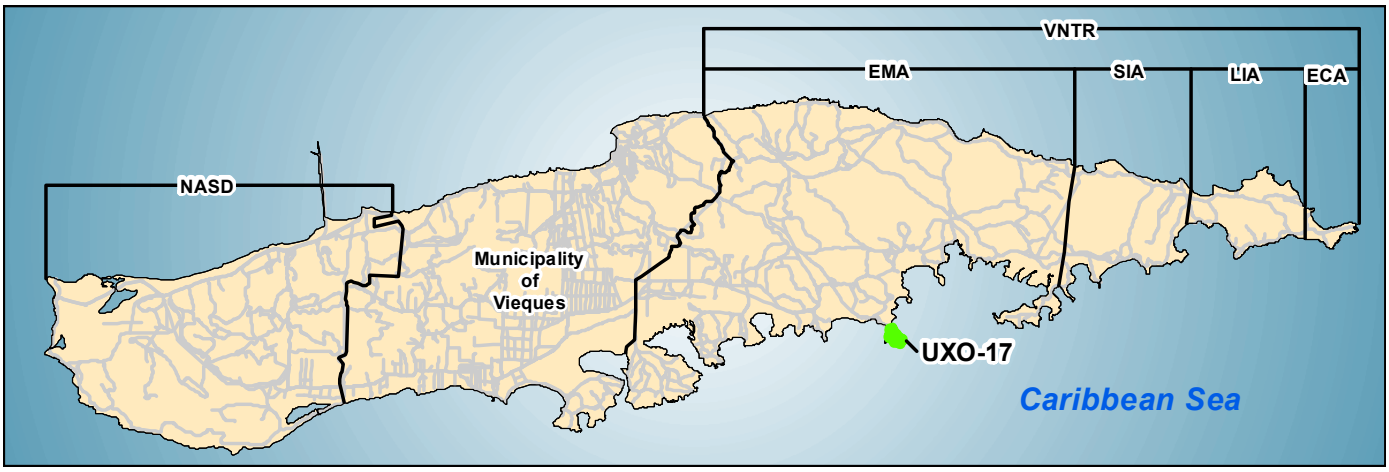
SAP Worksheet #17n – UXO 17 (EMA Other Sites)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 17:

1. Characterize MEC data to sufficiently delineate the location, type, and spatial extent of munitions-related items and to evaluate the explosive safety hazard for the site.
2. Evaluate the vertical extent of munitions-related items based on the subsurface MEC characterization through the intrusive investigation of anomalies identified using DGM.
3. Assess munitions-related information to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs are provided in Worksheet #11.

To address site-specific PQO # 1, surface MEC data from the initial phase of the subsurface MEC clearance at PAOC EE have been evaluated. To address specific PQO# 2, the location and type of subsurface munitions-related items have been evaluated based on the results of the intrusive investigation of anomalies at PAOC EE and the surrounding beach areas. To date, 458 of the DGM anomalies have been investigated at PAOC EE and the PA/SI recommended that the remaining 2,084 anomalies at PAOC EE be investigated to complete the MEC component of the RI; the locations of the anomalies to be investigated are shown on **Figure 44**. In addition, the surrounding beaches were mapped using DGM and all of the anomalies were intrusively investigated. To address site-specific PQO # 3 the vertical extent of munitions-related items will be evaluated to a maximum depth of 2 ft bgs throughout PAOC EE, which will conservatively evaluate deeper than the anticipated exposure depths for USFWS personnel conducting refuge management activities, authorized recreational users accessing the beaches, and trespassers accessing the area as no intrusive activities are anticipated for the site.

The sampling at PAOC EE will be conducted following completion of the anomaly excavation.

Sampling Approach

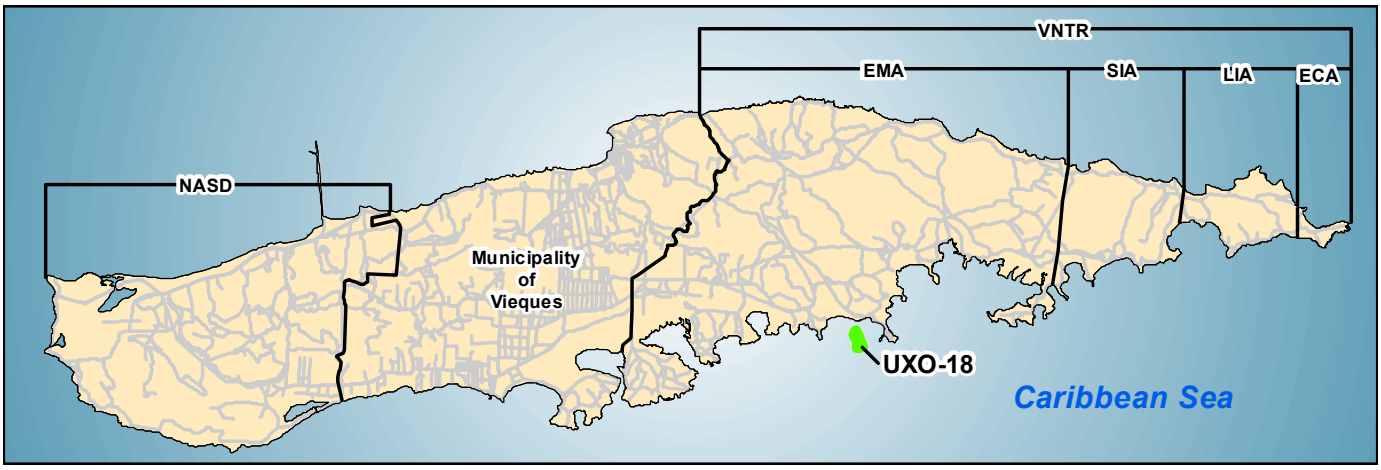
Three discrete surface soil samples will be collected following the removal of the subsurface munitions identified at three locations (**Figure 45**). Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. A discrete sampling approach at UXO 17 will be used since the presence of munitions are related to isolated munitions storage and/or discarding and not from range impact or firing activities. Discrete surface soil samples will be collected from where the munitions-related items were identified at the site, which provides the most conservative evaluation of a potential release.

SAP Worksheet #17n – UXO 17 (EMA Other Sites) (continued)

Explosives and inorganics are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background concentrations. Potential risks to human health and ecological receptors will be evaluated using the surface soil data.

It is important to note that, munitions removal activities are still ongoing at PAOC EE. If information gathered during future munitions-related activities necessitates a modification to the PAOC EE soil characterization approach contained herein, the modification will be presented in an addendum to this SAP provided for regulatory review prior to collecting the samples.

SAP Worksheet #17o – UXO 18 (Cayo La Chiva)



Future Munitions Activities

To meet the general MEC PQOs identified in Worksheet #11, the following site-specific PQOs and approach for the MEC investigations were developed for UXO 18:

1. Characterize the nature and lateral extent of MEC within the site that could potentially impact future receptors. The vertical extent of MEC is limited to the surface due to the shallow/exposed bedrock of the island.
2. Assess munitions-related information to evaluate if there are complete exposure pathways based on the intended future land use and the explosive safety hazard at the site; the general information on the data needs is provided in Worksheet #11.

To address the site-specific PQO #1, the location, type, and spatial extent of the munitions-related items identified during the investigation transects completed on the island were evaluated. The future use of UXO 18 will be limited to maintaining the site as wildlife refuge, where USFWS personnel accessing the area for general wildlife refuge management activities, authorized recreational users, and trespassers could potentially be exposed to MEC on the ground surface. The transects covered the accessible areas on the island and covered approximately five percent of UXO 18. The transects, where the anticipated MEC exposures are anticipated, did not identify areas with significant MEC/MPPEH concentrations or occurrences (i.e., only a few, isolated MEC/MPPEH were found).

To address site PQO # 2 the data collected to date is sufficient to sufficiently delineate if there are viable or complete exposure pathways based upon the planned future land use and to evaluate the potential for remaining MEC to pose unacceptable safety risks.

Based on the data collected from the transects completed at UXO 18, information has been collected to sufficiently characterize the nature and extent of MEC at UXO 18; therefore, there are no additional MEC investigations or removal actions anticipated at UXO 18 prior to initiating the MC RI. However, if information gathered during other site-related investigations indicates additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

Sampling Approach

UXO 18 is composed of a small island southwest of the former SIA (**Figure 46**). It was evaluated as a potential sampling unit using the ranking-based decision approach (**Table 2**). Two sampling units will be collected in the areas where MEC items were identified and three discrete surface soil samples will be collected at the smoke canister locations. **Table 18** summarizes the MEC items historically found and removed within each sampling unit.

SAP Worksheet #17o – UXO 18 (Cayo La Chiva) (continued)

One incremental surface soil sample (0 to approximately 2.5 inches) will be collected within each sampling unit. Discrete surface soil samples will be collected from 0 to 1 ft bgs. Each soil sample will be analyzed for explosives, inorganic constituents, pH, and TOC. In addition, hexachloroethane (a SVOC) will be analyzed for from the three discrete surface soil samples collected at the smoke canister locations. Note that most of the hexachloroethane in a smoke canister is used up by the smoke producing reaction and less than 5% may remain after the smoke has formed. Although hexachloroethane may adsorb to soil, volatilization is expected to be the major transport pathway within shallow soil. Note that chemical hydrolysis is not expected and the biotransformation of hexachlorethane in soil has not been well established (ATSDR, 1997 and Howard, 1989). Therefore, analysis of hexachloroethane breakdown products is not warranted.

Explosives, inorganics, and hexachloroethane are the potential contaminants released at this site from past munitions-related activities. pH and TOC data help interpret the potential contaminant data. With respect to nature and extent evaluation, the surface soil data will be compared to the adjusted RSLs, ecological screening value, and East Vieques background concentrations. Potential risks to human health and ecological receptors will be evaluated using the surface soil samples site-wide.

SAP Worksheet #18 — Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference
Regional Groundwater Sampling					
VE-EAST-MW01 / VE-EAST-GW01-MMYY VE-EAST-MW01 / VE-EAST-GW01P-MMYY	GW	N/A	METAL (incl. U), FMETAL (incl. U), EXPLO, RAD, FRAD	2 (FD)	See Worksheet #21
VE-EAST-MW02 / VE-EAST-GW02-MMYY VE-EAST-MW02 / VE-EAST-GW02-MMYY-MS VE-EAST-MW02 / VE-EAST-GW02-MMYY-MSD			METAL, FMETAL, EXPLO	3 (MS/MSD)	
VE-EAST-MW03 / VE-EAST-GW03-MMYY				1	
VE-EAST-MW04 / VE-EAST-GW04-MMYY				1	
VE-EAST-MW05 / VE-EAST-GW05-MMYY				1	
VE-EAST-MW06 / VE-EAST-GW06-MMYY				1	
VE-EAST-MW07 / VE-EAST-GW07-MMYY				1	
VE-EAST-MW08 / VE-EAST-GW08-MMYY				1	
VE-EAST-MW09 / VE-EAST-GW09-MMYY				1	
VE-EAST-MW10 / VE-EAST-GW10-MMYY VE-EAST-MW10 / VE-EAST-GW10P-MMYY				2 (FD)	
VE-EAST-MW11 / VE-EAST-GW11-MMYY				1	
VE-EAST-MW12 / VE-EAST-GW12-MMYY				1	
VE-EAST-MW13 / VE-EAST-GW13-MMYY				1	
VE-EAST-MW14 / VE-EAST-GW14-MMYY				1	
VE-EAST-MW15 / VE-EAST-GW15-MMYY				1	
VE-EAST-MW16 / VE-EAST-GW16-MMYY				1	
VE-EAST-MW17 / VE-EAST-GW17-MMYY				1	
VE-EAST-MW18 / VE-EAST-GW18-MMYY				1	
VE-EAST-MW19 / VE-EAST-GW19-MMYY VE-EAST-MW19 / VE-EAST-GW19P-MMYY				2 (FD)	
VE-EAST-MW20 / VE-EAST-GW20-MMYY VE-EAST-MW20 / VE-EAST-GW20-MMYY-MS VE-EAST-MW20 / VE-EAST-GW20-MMYY-SD				3 (MS/MSD)	
VE-EAST-MW21 / VE-EAST-GW21-MMYY				1	
VE-EAST-MW22 / VE-EAST-GW22-MMYY				1	
VE-EAST-MW23 / VE-EAST-GW23-MMYY				1	

SAP Worksheet #18 — Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference
Regional Subsurface Soil Sampling					
VE-EAST-MW01 / VE-EAST-SB01-0406 VE-EAST-MW01 / VE-EAST-SB01P-0406	SB	(in accordance with Vieques Protocols) Sample IDs assume 4-6' BGS.	EXPLO, METAL (incl. U), RAD, WCHEM (pH, and ORP)	2 (FD)	See Worksheet #21
VE-EAST-MW02 / VE-EAST-SB02-0406 VE-EAST-MW02 / VE-EAST-SB02-0406-MS VE-EAST-MW02 / VE-EAST-SB02-0406-MSD			METAL, EXPLO, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	
VE-EAST-MW03 / VE-EAST-SB03-0406				1	
VE-EAST-MW04 / VE-EAST-SB04-0406				1	
VE-EAST-MW05 / VE-EAST-SB05-0406				1	
VE-EAST-MW06 / VE-EAST-SB06-0406				1	
VE-EAST-MW07 / VE-EAST-SB07-0406				1	
VE-EAST-MW08 / VE-EAST-SB08-0406				1	
VE-EAST-MW09 / VE-EAST-SB09-0406				1	
VE-EAST-MW10 / VE-EAST-SB10-0406 VE-EAST-MW10 / VE-EAST-SB10P-0406				2 (FD)	
VE-EAST-MW11 / VE-EAST-SB11-0406				1	
VE-EAST-MW12 / VE-EAST-SB12-0406				1	
VE-EAST-MW13 / VE-EAST-SB13-0406				1	
VE-EAST-MW14 / VE-EAST-SB14-0406				1	
VE-EAST-MW15 / VE-EAST-SB15-0406				1	
VE-EAST-MW16 / VE-EAST-SB16-0406				1	
VE-EAST-MW17 / VE-EAST-SB17-0406				1	
VE-EAST-MW18 / VE-EAST-SB18-0406				1	
VE-EAST-MW19 / VE-EAST-SB19-0406 VE-EAST-MW19 / VE-EAST-SB19P-0406				2 (FD)	
VE-EAST-MW20 / VE-EAST-SB20-0406 VE-EAST-MW20 / VE-EAST-SB20-0406-MS VE-EAST-MW20 / VE-EAST-SB20-0406-SD				3 (MS/MSD)	
VE-EAST-MW21 / VE-EAST-SB21-0406				1	
VE-EAST-MW22 / VE-EAST-SB22-0406				1	
VE-EAST-MW23 / VE-EAST-SB23-0406				1	

1. FDs and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18a — UXO 02 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 2					
Decision Unit 1 - Beaches					
Playa Salinas del Sur					
SMI Samples					
VE-UXO02-1DU01 / VE-UXO02-1SMI01-MMYY VE-UXO02-1DU01 / VE-UXO02-1SMI01T-MMYY VE-UXO02-1DU01 / VE-UXO02-1SMI01TT-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO02-1DU02 / VE-UXO02-1SMI02-MMYY				1	
Deep Surface Soil Samples					
VE-UXO02-1SO01 / VE-UXO02-1SS01-1H03 VE-UXO02-1SO01 / VE-UXO02-1SS01P-1H03	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO02-1SO02 / VE-UXO02-1SS02-1H03				1	
Turtle Beach					
SMI Samples					
VE-UXO02-1DU03 / VE-UXO02-1SMI03-MMYY VE-UXO02-1DU03 / VE-UXO02-1SMI03-MMYY-MS VE-UXO02-1DU03 / VE-UXO02-1SMI03-MMYY-MSD	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO02-1DU04 / VE-UXO02-1SMI04-MMYY				1	
VE-UXO02-1DU05 / VE-UXO02-1SMI05-MMYY				1	
Deep Surface Soil Samples					
VE-UXO02-1SO03 / VE-UXO02-1SS03-1H03 VE-UXO02-1SO03 / VE-UXO02-1SS03-1H03-MS VE-UXO02-1SO03 / VE-UXO02-1SS03-1H03-SD	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO02-1SO04 / VE-UXO02-1SS04-1H03				1	
VE-UXO02-1SO05 / VE-UXO02-1SS05-1H03				1	

SAP Worksheet #18a — UXO 02 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 2					
Icacos/Playa Yallis					
SMI Samples					
VE-UXO02-1DU06 / VE-UXO02-1SMI06-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO02-1DU07 / VE-UXO02-1SMI07-MMYY				1	
Deep Surface Soil Samples					
VE-UXO02-1SO06 / VE-UXO02-1SS06-1H03	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO02-1SO07 / VE-UXO02-1SS07-1H03				1	
Playa Salinas del Norte/Fossil Beach					
SMI Samples					
VE-UXO02-1DU08 / VE-UXO02-1SMI08-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Deep Surface Soil Samples					
VE-UXO02-1SO08 / VE-UXO02-1SS08-1H03	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21

[1] FDs, field triplicates, and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18b: UXO 03 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 3					
Decision Unit 1 - UXO 3 LIA Roads					
SMI Samples					
VE-UXO03-1DU01 / VE-UXO03-1SMI01-MMYY VE-UXO03-1DU01 / VE-UXO03-1SMI01T-MMYY VE-UXO03-1DU01 / VE-UXO03-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO03-1DU02 / VE-UXO03-1SMI02-MMYY VE-UXO03-1DU02 / VE-UXO03-1SMI02-MMYY-MS VE-UXO03-1DU02 / VE-UXO03-1SMI02-MMYY-MSD				3 (MS/MSD)	
VE-UXO03-1DU03 / VE-UXO03-1SMI03-MMYY				1	
VE-UXO03-1DU04 / VE-UXO03-1SMI04-MMYY				1	
VE-UXO03-1DU05 / VE-UXO03-1SMI05-MMYY				1	
VE-UXO03-1DU06 / VE-UXO03-1SMI06-MMYY				1	
VE-UXO03-1DU07 / VE-UXO03-1SMI07-MMYY				1	
VE-UXO03-1DU08 / VE-UXO03-1SMI08-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO03-1SO01 / VE-UXO03-1SB01-TDBD VE-UXO03-1SO01 / VE-UXO03-1SB01-TDBD-MS VE-UXO03-1SO01 / VE-UXO03-1SB01-TDBD-MSD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO03-1SO02 / VE-UXO03-1SB02-TDBD VE-UXO03-1SO02 / VE-UXO03-1SB02P-TDBD				2 (FD)	
VE-UXO03-1SO03 / VE-UXO03-1SB03-TDBD				1	
VE-UXO03-1SO04 / VE-UXO03-1SB04-TDBD				1	
VE-UXO03-1SO05 / VE-UXO03-1SB05-TDBD				1	
VE-UXO03-1SO06 / VE-UXO03-1SB06-TDBD				1	
VE-UXO03-1SO07 / VE-UXO03-1SB07-TDBD				1	
VE-UXO03-1SO08 / VE-UXO03-1SB08-TDBD				1	
VE-UXO03-1SO09 / VE-UXO03-1SB09-TDBD				1	
VE-UXO03-1SO10 / VE-UXO03-1SB10-TDBD VE-UXO03-1SO10 / VE-UXO03-1SB10P-TDBD				2 (FD)	
VE-UXO03-1SO11 / VE-UXO03-1SB11-TDBD				1	
VE-UXO03-1SO12 / VE-UXO03-1SB12-TDBD				1	
VE-UXO03-1SO13 / VE-UXO03-1SB13-TDBD				1	
VE-UXO03-1SO14 / VE-UXO03-1SB14-TDBD				1	
VE-UXO03-1SO15 / VE-UXO03-1SB15-TDBD				1	
VE-UXO03-1SO16 / VE-UXO03-1SB16-TDBD				1	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

[1.] FDs, field triplicates, and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Decision Unit 1 - Central UXO 4					
SMI Samples					
VE-UXO04-01DU01 / VE-UXO04-01SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO04-01DU02 / VE-UXO04-01SMI02-MMYY VE-UXO04-01DU02 / VE-UXO04-01SMI02-MMYY-MS VE-UXO04-01DU02 / VE-UXO04-01SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO04-01DU03 / VE-UXO04-01SMI03-MMYY				1	
VE-UXO04-01DU04 / VE-UXO04-01SMI04-MMYY				1	
VE-UXO04-01DU05 / VE-UXO04-01SMI05-MMYY				1	
VE-UXO04-01DU06 / VE-UXO04-01SMI06-MMYY				1	
VE-UXO04-01DU07 / VE-UXO04-01SMI07-MMYY VE-UXO04-01DU07 / VE-UXO04-01SMI07T-MMYY VE-UXO04-01DU07 / VE-UXO04-01SMI07TT-MMYY VE-UXO04-01DU07 / VE-UXO04-01SMI07-MMYY-MS VE-UXO04-01DU07 / VE-UXO04-01SMI07-MMYY-SD			EXPLO, METAL, SVOC (PAHs), WCHEM (pH, TOC, and ORP)	3 (Triplicate) 2 (MS/MSD on SVOCs only)	
VE-UXO04-01DU08 / VE-UXO04-01SMI08-MMYY			EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	
VE-UXO04-01DU09 / VE-UXO04-01SMI09-MMYY				1	
VE-UXO04-01DU10 / VE-UXO04-01SMI10-MMYY VE-UXO04-01DU10 / VE-UXO04-01SMI10T-MMYY VE-UXO04-01DU10 / VE-UXO04-01SMI10TT-MMYY				3 (Triplicate)	
VE-UXO04-01DU11 / VE-UXO04-01SMI11-MMYY				1	
VE-UXO04-01DU12 / VE-UXO04-01SMI12-MMYY				1	
VE-UXO04-01DU13 / VE-UXO04-01SMI13-MMYY				1	
VE-UXO04-01DU14 / VE-UXO04-01SMI14-MMYY				1	
VE-UXO04-01DU15 / VE-UXO04-01SMI15-MMYY				1	
VE-UXO04-01DU16 / VE-UXO04-01SMI16-MMYY				1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Discrete Subsurface Soil Samples					
VE-UXO04-01SO01 / VE-UXO04-01SB01-TDBD VE-UXO04-01SO01 / VE-UXO04-01SB01P-TDBD	SB	(in accordance with modified Vieques protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO04-01SO02 / VE-UXO04-01SB02-TDBD				1	
VE-UXO04-01SO03 / VE-UXO04-01SB03-TDBD				1	
VE-UXO04-01SO04 / VE-UXO04-01SB04-TDBD				1	
VE-UXO04-01SO05 / VE-UXO04-01SB05-TDBD				1	
VE-UXO04-01SO06 / VE-UXO04-01SB06-TDBD				1	
VE-UXO04-01SO07 / VE-UXO04-01SB07-TDBD VE-UXO04-01SO07 / VE-UXO04-01SB07P-TDBD VE-UXO04-01SO07 / VE-UXO04-01SB07-TDBD-MS VE-UXO04-01SO07 / VE-UXO04-01SB07-TDBD-MSD				4 (FD, MS/MSD)	
VE-UXO04-01SO08 / VE-UXO04-01SB08-TDBD				1	
VE-UXO04-01SO09 / VE-UXO04-01SB09-TDBD				1	
VE-UXO04-01SO10 / VE-UXO04-01SB10-TDBD VE-UXO04-01SO10 / VE-UXO04-01SB10P-TDBD				2 (FD)	
VE-UXO04-01SO11 / VE-UXO04-01SB11-TDBD				1	
VE-UXO04-01SO12 / VE-UXO04-01SB12-TDBD				1	
VE-UXO04-01SO13 / VE-UXO04-01SB13-TDBD				1	
VE-UXO04-01SO14 / VE-UXO04-01SB14-TDBD			EXPLO, METAL, SVOC (PAHs), WCHEM (pH, TOC, and ORP)	1	
VE-UXO04-01SO15 / VE-UXO04-01SB15-TDBD				1	
VE-UXO04-01SO16 / VE-UXO04-01SB16-TDBD			EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	
VE-UXO04-01SO17 / VE-UXO04-01SB17-TDBD				2 (FD)	
VE-UXO04-01SO18 / VE-UXO04-01SB18-TDBD VE-UXO04-01SO18 / VE-UXO04-01SB18-TDBD-MS VE-UXO04-01SO18 / VE-UXO04-01SB18-TDBD-SD				3 (MS/MSD)	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
VE-UXO04-01SO19 / VE-UXO04-01SB19-TDBD				1	
VE-UXO04-01SO20 / VE-UXO04-01SB20-TDBD				1	
VE-UXO04-01SO21 / VE-UXO04-01SB21-TDBD				1	
VE-UXO04-01SO22 / VE-UXO04-01SB22-TDBD				1	
VE-UXO04-01SO23 / VE-UXO04-01SB23-TDBD VE-UXO04-01SO23 / VE-UXO04-01SB23-TDBD-MS VE-UXO04-01SO23 / VE-UXO04-01SB23-TDBD-MSD				3 (MS/MSD)	
VE-UXO04-01SO24 / VE-UXO04-01SB24-TDBD				1	
VE-UXO04-01SO25 / VE-UXO04-01SB25-TDBD				1	
VE-UXO04-01SO26 / VE-UXO04-01SB26-TDBD				1	
VE-UXO04-01SO27 / VE-UXO04-01SB27-TDBD				1	
VE-UXO04-01SO28 / VE-UXO04-01SB28-TDBD				1	
VE-UXO04-01SO29 / VE-UXO04-01SB29-TDBD				1	
VE-UXO04-01SO30 / VE-UXO04-01SB30-TDBD				1	
VE-UXO04-01SO31 / VE-UXO04-01SB31-TDBD				1	
VE-UXO04-01SO32 / VE-UXO04-01SB32-TDBD				1	
VE-UXO04-01SO33 / VE-UXO04-01SB33-TDBD			EXPLO, METAL, SVOC (PAHs), WCHEM (pH, TOC, and ORP)	1	
VE-UXO04-01SO34 / VE-UXO04-01SB34-TDBD				1	
VE-UXO04-01SO35 / VE-UXO04-01SB35-TDBD				1	
VE-UXO04-01SO36 / VE-UXO04-01SB36-TDBD				1	
VE-UXO04-01SO37 / VE-UXO04-01SB37-TDBD				1	
VE-UXO04-01SO38 / VE-UXO04-01SB38-TDBD				1	
VE-UXO04-01SO39 / VE-UXO04-01SB39-TDBD				1	
Discrete Surface Soil & Subsurface Soil Samples					
VE-UXO04-01SO40 / VE-UXO04-01SS40-MMYY VE-UXO04-01SO40 / VE-UXO04-01SB40-TDBD	SS SB	(in accordance with modified Vieques protocols)	METAL (U-only), RAD	SS: 1 SB: 1	See Worksheet #21
VE-UXO04-01SO41 / VE-UXO04-01SS41-MMYY VE-UXO04-01SO41 / VE-UXO04-01SB41-TDBD	SS SB			SS: 1 SB: 1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
VE-UXO04-01SO42 / VE-UXO04-01SS42-MMYY	SS			SS: 1	
VE-UXO04-01SO42 / VE-UXO04-01SB42-TDBD	SB			SB: 1	
VE-UXO04-01SO43 / VE-UXO04-01SS43-MMYY	SS			SS: 2 (FD)	
VE-UXO04-01SO43 / VE-UXO04-01SS43P-MMYY	SB			SB: 2 (FD)	
VE-UXO04-01SO43 / VE-UXO04-01SB43-TDBD					
VE-UXO04-01SO43 / VE-UXO04-01SB43P-TDBD					
VE-UXO04-01SO44 / VE-UXO04-01SS44-MMYY	SS			SS: 3 (MS/MSD)	
VE-UXO04-01SO44 / VE-UXO04-01SS44-MMYY-MS	SB			SB: 3 (MS/MSD)	
VE-UXO04-01SO44 / VE-UXO04-01SS44-MMYY-MSD					
VE-UXO04-01SO44 / VE-UXO04-01SB44-TDBD					
VE-UXO04-01SO44 / VE-UXO04-01SB44-TDBD-MS					
VE-UXO04-01SO44 / VE-UXO04-01SB44-TDBD-MSD					
VE-UXO04-01SO45 / VE-UXO04-01SS45-MMYY	SS			SS: 1	
VE-UXO04-01SO45 / VE-UXO04-01SB45-TDBD	SB			SB: 1	
VE-UXO04-01SO46 / VE-UXO04-01SS46-MMYY	SS			SS: 1	
VE-UXO04-01SO46 / VE-UXO04-01SB46-TDBD	SB			SB: 1	
VE-UXO04-01SO47 / VE-UXO04-01SS47-MMYY	SS			SS: 1	
VE-UXO04-01SO47 / VE-UXO04-01SB47-TDBD	SB			SB: 1	
VE-UXO04-01SO48 / VE-UXO04-01SS48-MMYY	SS			SS: 1	
VE-UXO04-01SO48 / VE-UXO04-01SB48-TDBD	SB			SB: 1	
VE-UXO04-01SO49 / VE-UXO04-01SS49-MMYY	SS			SS: 1	
VE-UXO04-01SO49 / VE-UXO04-01SB49-TDBD	SB			SB: 1	
VE-UXO04-01SO50 / VE-UXO04-01SS50-MMYY	SS			SS: 1	
VE-UXO04-01SO50 / VE-UXO04-01SB50-TDBD	SB			SB: 1	
VE-UXO04-01SO51 / VE-UXO04-01SS51-MMYY	SS			SS: 2 (FD)	
VE-UXO04-01SO51 / VE-UXO04-01SS51P-MMYY	SB			SB: 2 (FD)	
VE-UXO04-01SO51 / VE-UXO04-01SB51-TDBD					
VE-UXO04-01SO51 / VE-UXO04-01SB51P-TDBD					

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Decision Unit 2 - North UXO 4					
SMI Samples					
VE-UXO04-02DU01 / VE-UXO04-02SMI01-MMYY VE-UXO04-02DU01 / VE-UXO04-02SMI01T-MMYY VE-UXO04-02DU01 / VE-UXO04-02SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO04-02DU02 / VE-UXO04-02SMI02-MMYY VE-UXO04-02DU02 / VE-UXO04-02SMI02-MMYY-MS VE-UXO04-02DU02 / VE-UXO04-02SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO04-02DU03 / VE-UXO04-02SMI03-MMYY				1	
VE-UXO04-02DU04 / VE-UXO04-02SMI04-MMYY				1	
VE-UXO04-02DU05 / VE-UXO04-02SMI05-MMYY				1	
VE-UXO04-02DU06 / VE-UXO04-02SMI06-MMYY				1	
VE-UXO04-02DU07 / VE-UXO04-02SMI07-MMYY				1	
VE-UXO04-02DU08 / VE-UXO04-02SMI08-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO04-02SO01 / VE-UXO04-02SB01-TDBD VE-UXO04-02SO01 / VE-UXO04-02SB01P-TDBD	SB	(in accordance with modified Vieques protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO04-02SO02 / VE-UXO04-02SB02-TDBD VE-UXO04-02SO02 / VE-UXO04-02SB02-TDBD-MS VE-UXO04-02SO02 / VE-UXO04-02SB02-TDBD-SD				3 (MS/MSD)	
VE-UXO04-02SO03 / VE-UXO04-02SB03-TDBD				1	
VE-UXO04-02SO04 / VE-UXO04-02SB04-TDBD				1	
VE-UXO04-02SO05 / VE-UXO04-02SB05-TDBD				1	
VE-UXO04-02SO06 / VE-UXO04-02SB06-TDBD				1	
VE-UXO04-02SO07 / VE-UXO04-02SB07-TDBD				1	
VE-UXO04-02SO08 / VE-UXO04-02SB08-TDBD				1	
VE-UXO04-02SO09 / VE-UXO04-02SB09-TDBD				1	
VE-UXO04-02SO10 / VE-UXO04-02SB10-TDBD				1	
VE-UXO04-02SO11 / VE-UXO04-02SB11-TDBD				1	
VE-UXO04-02SO12 / VE-UXO04-02SB12-TDBD				1	
VE-UXO04-02SO13 / VE-UXO04-02SB13-TDBD				1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
VE-UXO04-02SO14 / VE-UXO04-02SB14-TDBD				1	
VE-UXO04-02SO15 / VE-UXO04-02SB15-TDBD				1	
VE-UXO04-02SO16 / VE-UXO04-02SB16-TDBD				1	
Decision Unit 3 - Northwest UXO 4					
SMI Samples					
VE-UXO04-03DU01 / VE-UXO04-03SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO04-03DU02 / VE-UXO04-03SMI02-MMYY				1	
VE-UXO04-03DU03 / VE-UXO04-03SMI03-MMYY				1	
VE-UXO04-03DU04 / VE-UXO04-03SMI04-MMYY				1	
VE-UXO04-03DU05 / VE-UXO04-03SMI05-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO04-03SO01 / VE-UXO04-03SB01-TDBD VE-UXO04-03SO01 / VE-UXO04-03SB01P-TDBD	SB	(in accordance with modified Vieques protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO04-03SO02 / VE-UXO04-03SB02-TDBD				1	
VE-UXO04-03SO03 / VE-UXO04-03SB03-TDBD				1	
VE-UXO04-03SO04 / VE-UXO04-03SB04-TDBD				1	
VE-UXO04-03SO05 / VE-UXO04-03SB05-TDBD				1	
VE-UXO04-03SO06 / VE-UXO04-03SB06-TDBD				1	
VE-UXO04-03SO07 / VE-UXO04-03SB07-TDBD				1	
VE-UXO04-03SO08 / VE-UXO04-03SB08-TDBD				1	
VE-UXO04-03SO09 / VE-UXO04-03SB09-TDBD				1	
VE-UXO04-03SO10 / VE-UXO04-03SB10-TDBD				1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Decision Unit 4 - Southwest UXO 4					
SMI Samples					
VE-UXO04-04DU01 / VE-UXO04-04SMI01-MMYY VE-UXO04-04DU01 / VE-UXO04-04SMI01T-MMYY VE-UXO04-04DU01 / VE-UXO04-04SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO04-04DU02 / VE-UXO04-04SMI02-MMYY				1	
VE-UXO04-04DU03 / VE-UXO04-04SMI03-MMYY VE-UXO04-04DU03 / VE-UXO04-04SMI03-MMYY-MS VE-UXO04-04DU03 / VE-UXO04-04SMI03-MMYY-SD				3 (MS/MSD)	
VE-UXO04-04DU04 / VE-UXO04-04SMI04-MMYY				1	
VE-UXO04-04DU05 / VE-UXO04-04SMI05-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO04-04SO01 / VE-UXO04-04SB01-TDBD VE-UXO04-04SO01 / VE-UXO04-04SB01P-TDBD	SB	(in accordance with modified Vieques protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO04-04SO02 / VE-UXO04-04SB02-TDBD				1	
VE-UXO04-04SO03 / VE-UXO04-04SB03-TDBD				1	
VE-UXO04-04SO04 / VE-UXO04-04SB04-TDBD				1	
VE-UXO04-04SO05 / VE-UXO04-04SB05-TDBD				1	
VE-UXO04-04SO06 / VE-UXO04-04SB06-TDBD				1	
VE-UXO04-04SO07 / VE-UXO04-04SB07-TDBD				1	
VE-UXO04-04SO08 / VE-UXO04-04SB08-TDBD				1	
VE-UXO04-04SO09 / VE-UXO04-04SB09-TDBD				1	
VE-UXO04-04SO10 / VE-UXO04-04SB10-TDBD				1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Decision Unit 5 - East UXO 4					
SMI Samples					
VE-UXO04-05DU01 / VE-UXO04-05SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO04-05DU02 / VE-UXO04-05SMI02-MMYY				1	
VE-UXO04-05DU03 / VE-UXO04-05SMI03-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO04-05SO01 / VE-UXO04-05SB01-TDBD	SB	(in accordance with modified Vieques protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO04-05SO02 / VE-UXO04-05SB02-TDBD				1	
VE-UXO04-05SO03 / VE-UXO04-05SB03-TDBD				1	
VE-UXO04-05SO04 / VE-UXO04-05SB04-TDBD				1	
VE-UXO04-05SO05 / VE-UXO04-05SB05-TDBD				1	
VE-UXO04-05SO06 / VE-UXO04-05SB06-TDBD				1	
Decision Unit 6 - Northwest UXO 4 Lagoon - Laguna Gatos					
Sediment & Surface Water Samples					
VE-UXO04-06SDSW01 / VE-UXO04-06SD01-MMYY VE-UXO04-06SDSW01 / VE-UXO04-06SD01P-MMYY VE-UXO04-06SDSW01 / VE-UXO04-06SW01-MMYY VE-UXO04-06SDSW01 / VE-UXO04-06SW01P-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL SD: EXPLO, METAL, GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 2 (FD) SW: 2 (FD)	See Worksheet #21
VE-UXO04-06SDSW02 / VE-UXO04-06SD02-MMYY VE-UXO04-06SDSW02 / VE-UXO04-06SD02-MMYY-MS VE-UXO04-06SDSW02 / VE-UXO04-06SD02-MMYY-SD VE-UXO04-06SDSW02 / VE-UXO04-06SW02-MMYY				SD: 3 (MS/MSD) SW: 1	
VE-UXO04-06SDSW03 / VE-UXO04-06SD03-MMYY VE-UXO04-06SDSW03 / VE-UXO04-06SW03-MMYY				SD: 1 SW: 1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Decision Unit 7 - Southwest UXO 4 Lagoons - Laguna Icacos					
Sediment & Surface Water Samples					
VE-UXO04-07SDSW01 / VE-UXO04-07SD01-MMYY VE-UXO04-07SDSW01 / VE-UXO04-07SD01P-MMYY VE-UXO04-07SDSW01 / VE-UXO04-07SW01-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL, FMETAL SD: EXPLO, METAL, GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 2 (FD) SW: 1	See Worksheet #21
VE-UXO04-07SDSW02 / VE-UXO04-07SD02-MMYY VE-UXO04-07SDSW02 / VE-UXO04-07SW02-MMYY				SD: 1 SW: 1	
VE-UXO04-07SDSW03 / VE-UXO04-07SD03-MMYY VE-UXO04-07SDSW03 / VE-UXO04-07SW03-MMYY				SD: 1 SW: 1	
Decision Unit 8 - Northwest UXO 4 Lagoon Fringes - Laguna Gatos					
SMI Samples					
VE-UXO04-08DU01 / VE-UXO04-08SMI01-000H	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO04-08DU02 / VE-UXO04-08SMI02-000H				1	
Deep Surface Soil Samples					
VE-UXO04-08SO01 / VE-UXO04-08SS01-0H02 VE-UXO04-08SO01 / VE-UXO04-08SS01-0H02-MS VE-UXO04-08SO01 / VE-UXO04-08SS01-0H02-MSD	SS	2.5 - 24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO04-08SO02 / VE-UXO04-08SS02-0H02				1	
Decision Unit 9 - Southwest UXO 4 Lagoon Fringes - Laguna Icacos					
SMI Samples					
VE-UXO04-09DU01 / VE-UXO04-09SMI01-MMYY VE-UXO04-09DU01 / VE-UXO04-09SMI01T-MMYY VE-UXO04-09DU01 / VE-UXO04-09SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (TOC and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO04-09DU02/ VE-UXO04-09SMI02-MMYY				1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Deep Surface Soil Samples					
VE-UXO04-09SO01 / VE-UXO04-09SS01-0H02 VE-UXO04-09SO01 / VE-UXO04-09SS01P-0H02	SS	2.5 - 24 inches	EXPLO, METAL, WCHEM (TOC and ORP)	2 (FD)	See Worksheet #21
VE-UXO04-09SO02/ VE-UXO04-09SS02-0H02				1	
Decision Unit 10 - Laguna Anones					
Sediment & Surface Water Samples					
VE-UXO04-10SDSW01 / VE-UXO04-10SD01-MMYY VE-UXO04-10SDSW01 / VE-UXO04-10SD01-MMYY-MS VE-UXO04-10SDSW01 / VE-UXO04-10SD01-MMYY-MSD VE-UXO04-10SDSW01 / VE-UXO04-10SW01-MMYY VE-UXO04-10SDSW01 / VE-UXO04-10SW01-MMYY-MS VE-UXO04-10SDSW01 / VE-UXO04-10SW01-MMYY-MSD	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL (including U), FMETAL (including U), RAD, FRAD SD: EXPLO, METAL (including U), GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 3 (MS/MSD) SW: 3 (MS/MSD)	See Worksheet #21
VE-UXO04-10SDSW02 / VE-UXO04-10SD02-MMYY VE-UXO04-10SDSW02 / VE-UXO04-10SW02-MMYY	SD/SW			SD: 1 SW: 1	
VE-UXO04-10SDSW03 / VE-UXO04-10SD03-MMYY VE-UXO04-10SDSW03 / VE-UXO04-10SW03-MMYY	SD/SW			SD: 1 SW: 1	
VE-UXO04-10SDSW04 / VE-UXO04-10SD04-MMYY VE-UXO04-10SDSW04 / VE-UXO04-10SD04P-MMYY VE-UXO04-10SDSW04 / VE-UXO04-10SW04-MMYY VE-UXO04-10SDSW04 / VE-UXO04-10SW04P-MMYY	SD/SW			SD: 2 (FD) SW: 2 (FD)	
VE-UXO04-10SDSW05 / VE-UXO04-10SD05-MMYY VE-UXO04-10SDSW05 / VE-UXO04-10SW05-MMYY	SD/SW			SD: 1 SW: 1	
VE-UXO04-10SDSW06 / VE-UXO04-10SD06-MMYY VE-UXO04-10SDSW06 / VE-UXO04-10SW06-MMYY	SD/SW			SD: 1 SW: 1	
VE-UXO04-10SDSW07 / VE-UXO04-10SD07-MMYY	SD			SD: 1	
VE-UXO04-10SDSW08 / VE-UXO04-10SD08-MMYY	SD			SD: 1	
VE-UXO04-10SDSW09 / VE-UXO04-10SD09-MMYY	SD			SD: 1	
VE-UXO04-10SDSW10 / VE-UXO04-10SD10-MMYY	SD			SD: 1	
VE-UXO04-10SDSW11 / VE-UXO04-10SD11-MMYY	SD			SD: 1	
VE-UXO04-10SDSW12 / VE-UXO04-10SD12-MMYY	SD			SD: 1	
VE-UXO04-10SDSW13 / VE-UXO04-10SD13-MMYY	SD			SD: 1	
VE-UXO04-10SDSW14 / VE-UXO04-10SD14-MMYY	SD			SD: 1	
VE-UXO04-10SDSW15 / VE-UXO04-10SD15-MMYY	SD			SD: 1	

SAP Worksheet #18c: UXO 04 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 4					
Decision Unit 11 - Laguna Anones Fringe					
SMI Samples					
VE-UXO04-11DU01 / VE-UXO04-11SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO04-11DU02 / VE-UXO02-11SMI02-MMYY				1	
VE-UXO04-11DU03 / VE-UXO04-11SMI03-MMYY				1	
VE-UXO04-11DU04 / VE-UXO04-11SMI04-MMYY				1	
VE-UXO04-11DU05 / VE-UXO04-11SMI05-MMYY				1	
Deep Surface Soil Samples					
VE-UXO04-11SO01 / VE-UXO04-11SS01-0H02	SS	2.5 - 24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO04-11SO02 / VE-UXO04-11SS02-0H02				1	
VE-UXO04-11SO03 / VE-UXO04-11SS03-0H02				1	
VE-UXO04-11SO04 / VE-UXO04-11SS04-0H02				1	
VE-UXO04-11SO05 / VE-UXO04-11SS05-0H02				1	
Field Identified Craters					
Sediment & Surface Water Samples					
VE-UXO04-11SDSW01 / VE-UXO04-11SD01-MMYY VE-UXO04-11SDSW01 / VE-UXO04-11SW01-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL FMETAL SD: EXPLO, METAL GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 1 SW: 1	See Worksheet #21
VE-UXO04-11SDSW02 / VE-UXO04-11SD02-MMYY VE-UXO04-11SDSW02 / VE-UXO04-11SW02-MMYY	SD/SW			SD: 1 SW: 1	
VE-UXO04-11SDSW03 / VE-UXO04-11SD03-MMYY VE-UXO04-11SDSW03 / VE-UXO04-11SW03-MMYY	SD/SW			SD: 1 SW: 1	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

1. FDs, triplicates, and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18d: UXO 05 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 5 - SIA Restricted Roads					
Decision Unit 1 - UXO 5 SIA Restricted Roads					
SMI Samples					
VE-UXO05-1DU01 / VE-UXO05-1SMI01-MMYY VE-UXO05-1DU01 / VE-UXO05-1SMI01T-MMYY VE-UXO05-1DU01 / VE-UXO05-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO05-1DU02 / VE-UXO05-1SMI02-MMYY VE-UXO05-1DU02 / VE-UXO05-1SMI02-MMYY-MS VE-UXO05-1DU02 / VE-UXO05-1SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO05-1DU03 / VE-UXO05-1SMI03-MMYY				1	
VE-UXO05-1DU04 / VE-UXO05-1SMI04-MMYY				1	
VE-UXO05-1DU05 / VE-UXO05-1SMI05-MMYY				1	
VE-UXO05-1DU06 / VE-UXO05-1SMI06-MMYY				1	
VE-UXO05-1DU07 / VE-UXO05-1SMI07-MMYY				1	
VE-UXO05-1DU08 / VE-UXO05-1SMI08-MMYY				1	

SAP Worksheet #18d: UXO 05 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 5 - SIA Restricted Roads					
Discrete Subsurface Soil Samples					
VE-UXO05-1SO01 / VE-UXO05-1SB01-TDBD VE-UXO05-1SO01 / VE-UXO05-1SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO05-1SO02 / VE-UXO05-1SB02-TDBD VE-UXO05-1SO02 / VE-UXO05-1SB02-TDBD-MS VE-UXO05-1SO02 / VE-UXO05-1SB02-TDBD-SD				3 (MS/MSD)	
VE-UXO05-1SO03 / VE-UXO05-1SB03-TDBD				1	
VE-UXO05-1SO04 / VE-UXO05-1SB04-TDBD				1	
VE-UXO05-1SO05 / VE-UXO05-1SB05-TDBD				1	
VE-UXO05-1SO06 / VE-UXO05-1SB06-TDBD				1	
VE-UXO05-1SO07 / VE-UXO05-1SB07-TDBD				1	
VE-UXO05-1SO08 / VE-UXO05-1SB08-TDBD VE-UXO05-1SO08 / VE-UXO05-1SB08P-TDBD				2 (FD)	
VE-UXO05-1SO09 / VE-UXO05-1SB09-0101				1	
VE-UXO05-1SO10 / VE-UXO05-1SB10-TDBD				1	
VE-UXO05-1SO11 / VE-UXO05-1SB11-TDBD				1	
VE-UXO05-1SO12 / VE-UXO05-1SB12-TDBD				1	
VE-UXO05-1SO13 / VE-UXO05-1SB13-TDBD				1	
VE-UXO05-1SO14 / VE-UXO05-1SB14-TDBD				1	
VE-UXO05-1SO15 / VE-UXO05-1SB15-TDBD				1	
VE-UXO05-1SO16 / VE-UXO05-1SB16-TDBD				1	

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

1. FDs, Triplicates and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18e: UXO 06 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 6 - SIA Public Roads					
Decision Unit 1 - UXO 6 SIA Public Roads					
SMI Samples					
VE-UXO06-1DU01 / VE-UXO06-1SMI01-MMYY VE-UXO06-1DU01 / VE-UXO06-1SMI01T-MMYY VE-UXO06-1DU01 / VE-UXO06-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO06-1DU02 / VE-UXO06-1SMI02-MMYY VE-UXO06-1DU02 / VE-UXO06-1SMI02-MMYY-MS VE-UXO06-1DU02 / VE-UXO06-1SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO06-1DU03 / VE-UXO06-1SMI03-MMYY				1	
VE-UXO06-1DU04 / VE-UXO06-1SMI04-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO06-1SO01 / VE-UXO06-1SB01-TDBD VE-UXO06-1SO01 / VE-UXO06-1SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO06-1SO02 / VE-UXO06-1SB02-TDBD VE-UXO06-1SO02 / VE-UXO06-1SB02-TDBD-MS VE-UXO06-1SO02 / VE-UXO06-1SB02-TDBD-SD				3 (MS/MSD)	
VE-UXO06-1SO03 / VE-UXO06-1SB03-TDBD				1	
VE-UXO06-1SO04 / VE-UXO06-1SB04-TDBD				1	
VE-UXO06-1SO05 / VE-UXO06-1SB05-TDBD				1	
VE-UXO06-1SO06 / VE-UXO06-1SB06-TDBD				1	
VE-UXO06-1SO07 / VE-UXO06-1SB07-TDBD				1	
VE-UXO06-1SO08 / VE-UXO06-1SB08-TDBD				1	

Note:Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

1. FDs, Triplicates and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18f: UXO 07 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 7					
Decision Unit 1 - Diablo Beach					
SMI Samples					
VE-UXO07-1DU01 / VE-UXO07-1SMI01-MMYY VE-UXO07-1DU01 / VE-UXO07-1SMI01T-MMYY VE-UXO07-1DU01 / VE-UXO07-1SMI01TT-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO07-1DU02 / VE-UXO07-1SMI02-MMYY				1	
Deeper Surface Soil Samples					
VE-UXO07-1SO01 / VE-UXO07-1SS01-1H03 VE-UXO07-1SO01 / VE-UXO07-1SS01P-1H03	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO07-1SO02 / VE-UXO07-1SS02-1H03				1	
Decision Unit 1 - Purple Beach					
SMI Samples					
VE-UXO07-1DU03 / VE-UXO07-1SMI03-MMYY VE-UXO07-1DU03 / VE-UXO07-1SMI03-MMYY-MS VE-UXO07-1DU03 / VE-UXO07-1SMI03-MMYY-MSD	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO07-1DU04 / VE-UXO07-1SMI04-MMYY				1	
Deep Surface Soil Samples					
VE-UXO07-1SO03 / VE-UXO07-1SS03-1H03 VE-UXO07-1SO03 / VE-UXO07-1SS03-1H03-MS VE-UXO07-1SO03 / VE-UXO07-1SS03-1H03-SD	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO07-1SO04 / VE-UXO07-1SS04-1H03				1	
Decision Unit 1 - Beach 33					
SMI Samples					
VE-UXO07-1DU05 / VE-UXO07-1SMI05-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Deep Surface Soil Samples					
VE-UXO07-1SO05/VE-UXO07-1SS05-MMYY	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21

[1.] FDs, Triplicates and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18g: UXO 08 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 8					
Decision Unit 1 - Playa Jalova					
SMI Samples					
VE-UXO08-1DU01 / VE-UXO08-1SMI01-MMYY VE-UXO08-1DU01 / VE-UXO08-1SMI01T-MMYY VE-UXO08-1DU01 / VE-UXO08-1SMI01TT-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
Deep Surface Soil Samples					
VE-UXO08-1SO01 / VE-UXO08-1SS01-1H03 VE-UXO08-1SO01 / VE-UXO08-1SS01P-1H03	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
Decision Unit 1 - Playa Jalovita					
SMI Samples					
VE-UXO08-1DU02 / VE-UXO08-1SMI02-MMYY VE-UXO08-1DU02 / VE-UXO08-1SMI02-MMYY-MS VE-UXO08-1DU02 / VE-UXO08-1SMI02-MMYY-SD	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
Deep Surface Soil Samples					
VE-UXO08-1SO02 / VE-UXO08-1SS02-1H03 VE-UXO08-1SO02 / VE-UXO08-1SS02-1H03-MS VE-UXO08-1SO02 / VE-UXO08-1SS02-1H03-SD	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
Decision Unit 1 - Playa Matias/Yellow Beach					
SMI Samples					
VE-UXO08-1DU03 / VE-UXO08-1SMI03-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO08-1DU04 / VE-UXO08-1SMI04-MMYY				1	
Deep Surface Soil Samples					
VE-UXO08-1SO03 / VE-UXO08-1SS03-1H03	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO08-1SO04 / VE-UXO08-1SS04-1H03				1	
Decision Unit 1 - Cayo Conejo					
SMI Samples					
VE-UXO08-1DU05 / VE-UXO08-1SMI05-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Deep Surface Soil Samples					
VE-UXO08-1SO05 / VE-UXO08-1SS05-1H03	SS	18-36 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21

[1.] FDs, Triplicates and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18h: UXO 09 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 9					
Decision Unit 1 - Northeast UXO 9					
SMI Samples					
VE-UXO09-01DU01 / VE-UXO09-01SMI01-MMYY VE-UXO09-01DU01 / VE-UXO09-01SMI01T-MMYY VE-UXO09-01DU01 / VE-UXO09-01SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO09-01DU02 / VE-UXO09-01SMI02-MMYY VE-UXO09-01DU02 / VE-UXO09-01SMI02-MMYY-MS VE-UXO09-01DU02 / VE-UXO09-01SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO09-01DU03 / VE-UXO09-01SMI03-MMYY				1	
VE-UXO09-01DU04 / VE-UXO09-01SMI04-MMYY				1	
VE-UXO09-01DU05 / VE-UXO09-01SMI05-MMYY				1	
VE-UXO09-01DU06 / VE-UXO09-01SMI06-MMYY				1	
VE-UXO09-01DU07 / VE-UXO09-01SMI07-MMYY				1	
VE-UXO09-01DU08 / VE-UXO09-01SMI08-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO09-01SO01 / VE-UXO09-01SB01-TDBD VE-UXO09-01SO01 / VE-UXO09-01SB01P-TDBD	SB	(in accordance with modified Vieques Protocols).	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO09-01SO02 / VE-UXO09-01SB02-TDBD VE-UXO09-01SO02 / VE-UXO09-01SB02-TDBD-MS VE-UXO09-01SO02 / VE-UXO09-01SB02-TDBD-SD				3 (MS/MSD)	
VE-UXO09-01SO03 / VE-UXO09-01SB03-TDBD				1	
VE-UXO09-01SO04 / VE-UXO09-01SB04-TDBD				1	
VE-UXO09-01SO05 / VE-UXO09-01SB05-TDBD				1	
VE-UXO09-01SO06 / VE-UXO09-01SB06-TDBD				1	
VE-UXO09-01SO07 / VE-UXO09-01SB07-TDBD				1	
VE-UXO09-01SO08 / VE-UXO09-01SB08-TDBD				1	
VE-UXO09-01SO09 / VE-UXO09-01SB09-TDBD				1	
VE-UXO09-01SO10 / VE-UXO09-01SB10-TDBD				1	
VE-UXO09-01SO11 / VE-UXO09-01SB11-TDBD				1	
VE-UXO09-01SO12 / VE-UXO09-01SB12-TDBD				1	
VE-UXO09-01SO13 / VE-UXO09-01SB13-TDBD				1	
VE-UXO09-01SO14 / VE-UXO09-01SB14-TDBD				1	
VE-UXO09-01SO15 / VE-UXO09-01SB15-TDBD				1	
VE-UXO09-01SO16 / VE-UXO09-01SB16-TDBD				1	

SAP Worksheet #18h: UXO 09 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 9					
Decision Unit 2 - Northwest UXO 9					
SMI Samples					
VE-UXO09-02DU01 / VE-UXO09-02SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-02DU02 / VE-UXO09-02SMI02-MMYY				1	
VE-UXO09-02DU03 / VE-UXO09-02SMI03-MMYY VE-UXO09-02DU03 / VE-UXO09-02SMI03T-MMYY VE-UXO09-02DU03 / VE-UXO09-02SMI03TT-MMYY				3 (Triplicate)	
VE-UXO09-02DU04 / VE-UXO09-02SMI04-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO09-02SO01 / VE-UXO09-02SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-02SO02 / VE-UXO09-02SB02-TDBD				1	
VE-UXO09-02SO03 / VE-UXO09-02SB03-TDBD VE-UXO09-02SO03 / VE-UXO09-02SB03P-TDBD				2 (FD)	
VE-UXO09-02SO04 / VE-UXO09-02SB04-TDBD				1	
VE-UXO09-02SO05 / VE-UXO09-02SB05-TDBD				1	
VE-UXO09-02SO06 / VE-UXO09-02SB06-TDBD				1	
VE-UXO09-02SO07 / VE-UXO09-02SB07-TDBD				1	
VE-UXO09-02SO08 / VE-UXO09-02SB08-TDBD				1	
Decision Unit 3 - Southeast UXO 9					
SMI Samples					
VE-UXO09-03DU01 / VE-UXO09-03SMI01-MMYY	SMI	0 -2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-03DU02 / VE-UXO09-03SMI02-MMYY				1	
VE-UXO09-03DU03 / VE-UXO09-03SMI03-MMYY				1	

SAP Worksheet #18h: UXO 09 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 9					
Discrete Subsurface Soil Samples					
VE-UXO09-03SO01 / VE-UXO09-03SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-03SO02 / VE-UXO09-03SB02-TDBD				1	
VE-UXO09-03SO03 / VE-UXO09-03SB03-TDBD				1	
VE-UXO09-03SO04 / VE-UXO09-03SB04-TDBD VE-UXO09-03SO04 / VE-UXO09-03SB04P-TDBD				2 (FD)	
VE-UXO09-03SO05 / VE-UXO09-03SB05-TDBD				1	
VE-UXO09-03SO06 / VE-UXO09-03SB06-TDBD				1	
Decision Unit 4 - South UXO 9					
SMI Samples					
VE-UXO09-04DU01 / VE-UXO09-04SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-04DU02 / VE-UXO09-04SMI02-MMYY				1	
VE-UXO09-04DU03 / VE-UXO09-04SMI03-MMYY				1	
VE-UXO09-04DU04 / VE-UXO09-04SMI04-MMYY				1	
VE-UXO09-04DU05 / VE-UXO09-04SMI05-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO09-04SO01 / VE-UXO09-04SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-04SO02 / VE-UXO09-04SB02-TDBD				1	
VE-UXO09-04SO03 / VE-UXO09-04SB03-TDBD				1	
VE-UXO09-04SO04 / VE-UXO09-04SB04-TDBD				1	
VE-UXO09-04SO05 / VE-UXO09-04SB05-TDBD				1	
VE-UXO09-04SO06 / VE-UXO09-04SB06-TDBD				1	
VE-UXO09-04SO07 / VE-UXO09-04SB07-TDBD				1	
VE-UXO09-04SO08 / VE-UXO09-04SB08-TDBD				1	
VE-UXO09-04SO09 / VE-UXO09-04SB09-TDBD				1	
VE-UXO09-04SO10 / VE-UXO09-04SB10-TDBD VE-UXO09-04SO10 / VE-UXO09-04SB10P-TDBD				2 (FD)	

SAP Worksheet #18h: UXO 09 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 9					
Decision Unit 5 - Southwest UXO 9					
SMI Samples					
VE-UXO09-05DU01 / VE-UXO09-05SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Discrete Subsurface Soil Samples					
VE-UXO09-05SO01 / VE-UXO09-05SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-05SO02 / VE-UXO09-05SB02-TDBD				1	
Decision Unit 6 - North UXO 9					
SMI Samples					
VE-UXO09-06DU01 / VE-UXO09-06SMI01-MMYY VE-UXO09-06DU01 / VE-UXO09-06SMI01T-MMYY VE-UXO09-06DU01 / VE-UXO09-06SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO09-06DU02 / VE-UXO09-06SMI02-MMYY VE-UXO09-06DU02 / VE-UXO09-06SMI02-MMYY-MS VE-UXO09-06DU02 / VE-UXO09-06SMI02-MMYY-MSD				3 (MS/MSD)	
Discrete Subsurface Soil Samples					
VE-UXO09-06SO01 / VE-UXO09-06SB01-TDBD VE-UXO09-06SO01 / VE-UXO09-06SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO09-06SO02 / VE-UXO09-06SB02-TDBD VE-UXO09-06SO02 / VE-UXO09-06SB02-TDBD-MS VE-UXO09-06SO02 / VE-UXO09-06SB02-TDBD-MSD				3 (MS/MSD)	
VE-UXO09-06SO03 / VE-UXO09-06SB03-TDBD				1	
VE-UXO09-06SO04 / VE-UXO09-06SB04-TDBD				1	

SAP Worksheet #18h: UXO 09 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 9					
Decision Unit 7 - Northwest UXO 9 Lagoons (Laguna Puerta Diablo)					
Sediment & Surface Water Samples					
VE-UXO09-07SDSW01 / VE-UXO09-07SD01-MMYY VE-UXO09-07SDSW01 / VE-UXO09-07SD01P-MMYY VE-UXO09-07SDSW01 / VE-UXO09-07SW01-MMYY VE-UXO09-07SDSW01 / VE-UXO09-07SW01P-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL, FMETAL SD: EXPLO, METAL, GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 2 (FD) SW: 2 (FD)	See Worksheet #21
VE-UXO09-07SDSW02 / VE-UXO09-07SD02-MMYY VE-UXO09-07SDSW02 / VE-UXO09-07SD02-MMYY-MS VE-UXO09-07SDSW02 / VE-UXO09-07SD02-MMYY-SD VE-UXO09-07SDSW02 / VE-UXO09-07SW02-MMYY VE-UXO09-07SDSW02 / VE-UXO09-07SW02-MMYY-MS VE-UXO09-07SDSW02 / VE-UXO09-07SW02-MMYY-SD				SD: 3 (MS/MSD) SW: 3 (MS/MSD)	
VE-UXO09-07SDSW03 / VE-UXO09-07SD03-MMYY VE-UXO09-07SDSW03 / VE-UXO09-07SW03-MMYY				SD: 1 SW: 1	
VE-UXO09-07SDSW04 / VE-UXO09-07SD04-MMYY VE-UXO09-07SDSW04 / VE-UXO09-07SW04-MMYY				SD: 1 SW: 1	
VE-UXO09-07SDSW05 / VE-UXO09-07SD05-MMYY VE-UXO09-07SDSW05 / VE-UXO09-07SW05-MMYY				SD: 1 SW: 1	
VE-UXO09-07SDSW06 / VE-UXO09-07SD06-MMYY VE-UXO09-07SDSW06 / VE-UXO09-07SW06-MMYY				SD: 1 SW: 1	
Decision Unit 8 - Northwest UXO 9 Lagoon Fringes (Laguna Puerta Diablo)					
SMI Samples					
VE-UXO09-08DU01 / VE-UXO09-08SMI01-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-08DU02 / VE-UXO09-08SMI02-MMYY				1	
VE-UXO09-08DU03 / VE-UXO09-08SMI03-MMYY				1	
VE-UXO09-08DU04 / VE-UXO09-08SMI04-MMYY				1	

SAP Worksheet #18h: UXO 09 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 9					
Deep Surface Soil Samples					
VE-UXO09-08SO01 / VE-UXO09-08SS01-0H02 VE-UXO09-08SO01 / VE-UXO09-08SS01-0H02-MS VE-UXO09-08SO01 / VE-UXO09-08SS01-0H02-MSD	SS	2.5-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO09-08SO02 / VE-UXO09-08SS02-0H02				1	
VE-UXO09-08SO03 / VE-UXO09-08SS03-0H02				1	
VE-UXO09-08SO04 / VE-UXO09-08SS04-0H02				1	
Decision Unit 9 - Laguna Matias					
Sediment & Surface Water Samples					
VE-UXO09-09SDSW01 / VE-UXO09-09SD01-MMYY VE-UXO09-09SDSW01 / VE-UXO09-09SW01-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL, FMETAL SD: EXPLO, METAL, GRAINSIZE, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-09SDSW02 / VE-UXO09-09SD02-MMYY VE-UXO09-09SDSW02 / VE-UXO09-09SW02-MMYY				1	
VE-UXO09-09SDSW03 / VE-UXO09-09SD03-MMYY VE-UXO09-09SDSW03 / VE-UXO09-09SW03-MMYY				1	
Decision Unit 10 - Laguna Matias Fringe					
SMI Samples					
VE-UXO09-10DU01 / VE-UXO09-10SMI01-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Deep Surface Soil Samples					
VE-UXO09-10SO01 / VE-UXO09-10SS01-0H02	SS	2.5-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Decision Unit 11 - Southwest UXO 9 Lagoons (Lagoon 11)					
Sediment & Surface Water Samples					
VE-UXO09-11SDSW01 / VE-UXO09-11SD01-MMYY VE-UXO09-11SDSW01 / VE-UXO09-11SW01-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL, FMETAL SD: EXPLO, METAL, GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 1 SW: 1	See Worksheet #21
VE-UXO09-11SDSW02 / VE-UXO09-11SD02-MMYY VE-UXO09-11SDSW02 / VE-UXO09-11SW02-MMYY				SD: 1 SW: 1	
VE-UXO09-11SDSW03 / VE-UXO09-11SD03-MMYY VE-UXO09-11SDSW03 / VE-UXO09-11SW03-MMYY				SD: 1 SW: 1	

SAP Worksheet #18h: UXO 09 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 9					
Decision Unit 12 - Southwest UXO 9 Lagoon Fringes (Lagoon 11)					
SMI Samples					
VE-UXO09-12DU01 / VE-UXO09-12SMI01-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-12DU02 / VE-UXO09-12SMI02-MMYY				1	
Deep Surface Soil Samples					
VE-UXO09-12SO01 / VE-UXO09-12SS01-0H02	SS	2.5-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO09-12SO02 / VE-UXO09-12SS02-0H02 VE-UXO09-12SO02 / VE-UXO09-12SS02P-0H02				2 (FD)	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

[1.] FDs, Triplicates and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18i: UXO 10 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 10					
Decision Unit 1 - Southwest UXO 10					
SMI Samples					
VE-UXO10-1DU01 / VE-UXO10-1SMI01-MMYY VE-UXO10-1DU01 / VE-UXO10-1SMI01T-MMYY VE-UXO10-1DU01 / VE-UXO10-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicates)	See Worksheet #21
VE-UXO10-1DU02 / VE-UXO10-1SMI02-MMYY VE-UXO10-1DU02 / VE-UXO10-1SMI02-MMYY-MS VE-UXO10-1DU02 / VE-UXO10-1SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO10-1DU03 / VE-UXO10-1SMI03-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO10-1SO01 / VE-UXO10-1SB01-TDBD VE-UXO10-1SO01 / VE-UXO10-1SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO10-1SO02 / VE-UXO10-1SB02-TDBD VE-UXO10-1SO02 / VE-UXO10-1SB02-TDBD-MS VE-UXO10-1SO02 / VE-UXO10-1SB02-TDBD-MSD				3 (MS/MSD)	
VE-UXO10-1SO03 / VE-UXO10-1SB03-TDBD				1	
VE-UXO10-1SO04 / VE-UXO10-1SB04-TDBD				1	
VE-UXO10-1SO05 / VE-UXO10-1SB05-TDBD				1	
VE-UXO10-1SO06 / VE-UXO10-1SB06-TDBD				1	
Decicion Unit 2 - Northeast UXO 10					
SMI Samples					
VE-UXO10-2DU01 / VE-UXO10-2SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO10-2DU02 / VE-UXO10-2SMI02-MMYY				1	
VE-UXO10-2DU03 / VE-UXO10-2SMI03-MMYY				1	

SAP Worksheet #18i: UXO 10 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 10					
Discrete Subsurface Soil Samples					
VE-UXO10-2SO01 / VE-UXO10-2SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO10-2SO02 / VE-UXO10-2SB02-TDBD				1	
VE-UXO10-2SO03 / VE-UXO10-2SB03-TDBD				1	
VE-UXO10-2SO04 / VE-UXO10-2SB04-TDBD				1	
VE-UXO10-2SO05 / VE-UXO10-2SB05-TDBD				1	
VE-UXO10-2SO06 / VE-UXO10-2SB06-TDBD				1	
Decision Unit 3 - Southeast UXO 10					
SMI Samples					
VE-UXO10-3DU01 / VE-UXO10-3SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO10-3DU02 / VE-UXO10-3SMI02-MMYY				1	
VE-UXO10-3DU03 / VE-UXO10-3SMI03-MMYY				1	
VE-UXO10-3DU04 / VE-UXO10-3SMI04-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO10-3SO01 / VE-UXO10-3SB01-TDBD VE-UXO10-3SO01 / VE-UXO10-3SB01-TDBD-MS VE-UXO10-3SO01 / VE-UXO10-3SB01-TDBD-MSD	SB	(in accordance with modified Vieques protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO10-3SO02 / VE-UXO10-3SB02-TDBD				1	
VE-UXO10-3SO03 / VE-UXO10-3SB03-TDBD				1	
VE-UXO10-3SO04 / VE-UXO10-3SB04-TDBD				1	
VE-UXO10-3SO05 / VE-UXO10-3SB05-TDBD				1	
VE-UXO10-3SO06 / VE-UXO10-3SB06-TDBD				1	
VE-UXO10-3SO07 / VE-UXO10-3SB07-TDBD				1	
VE-UXO10-3SO08 / VE-UXO10-3SB08-TDBD				1	

SAP Worksheet #18i: UXO 10 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 10					
Decision Unit 4 - Central UXO 10					
SMI Samples					
VE-UXO10-4DU01 / VE-UXO10-4SMI01-MMYY	SMI	0 -2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO10-4DU02 / VE-UXO10-4SMI02-MMYY VE-UXO10-4DU02 / VE-UXO10-4SMI02T-MMYY VE-UXO10-4DU02 / VE-UXO10-4SMI02TT-MMYY				3 (Triplicates)	
VE-UXO10-4DU03 / VE-UXO10-4SMI03-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO10-4SO01 / VE-UXO10-4SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO10-4SO02 / VE-UXO10-4SB02-TDBD VE-UXO10-4SO02 / VE-UXO10-4SB02P-TDBD				2 (FD)	
VE-UXO10-4SO03 / VE-UXO10-4SB03-TDBD				1	
VE-UXO10-4SO04 / VE-UXO10-4SB04-TDBD				1	
VE-UXO10-4SO05 / VE-UXO10-4SB05-TDBD				1	
VE-UXO10-4SO06 / VE-UXO10-4SB06-TDBD				1	
Decision Unit 5 - North UXO 10					
SMI Samples					
VE-UXO10-5DU01 / VE-UXO10-5SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO10-5DU02 / VE-UXO10-5SMI02-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO10-5SO01 / VE-UXO10-5SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO10-5SO02 / VE-UXO10-5SB02-TDBD				1	
VE-UXO10-5SO03 / VE-UXO10-5SB03-TDBD				1	
VE-UXO10-5SO04 / VE-UXO10-5SB04-TDBD VE-UXO10-5SO04 / VE-UXO10-5SB04P-TDBD				2 (FD)	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

[1.] FDs, triplicates, and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18j: UXO 11 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 11 - EMA Restricted Roads					
Decision Unit 1 - UXO 11 EMA Restricted Roads					
SMI Samples					
VE-UXO11-1DU01 / VE-UXO11-1SMI01-MMYY VE-UXO11-1DU01 / VE-UXO11-1SMI01T-MMYY VE-UXO11-1DU01 / VE-UXO11-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO11-1DU02 / VE-UXO11-1SMI02-MMYY VE-UXO11-1DU02 / VE-UXO11-1SMI02-MMYY-MS VE-UXO11-1DU02 / VE-UXO11-1SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO11-1DU03 / VE-UXO11-1SMI03-MMYY				1	
VE-UXO11-1DU04 / VE-UXO11-1SMI04-MMYY				1	
VE-UXO11-1DU05 / VE-UXO11-1SMI05-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO11-1SO01 / VE-UXO11-1SB01-TDBD VE-UXO11-1SO01 / VE-UXO11-1SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO11-1SO02 / VE-UXO11-1SB02-TDBD VE-UXO11-1SO02 / VE-UXO11-1SB02-TDBD-MS VE-UXO11-1SO02 / VE-UXO11-1SB02-TDBD-MSD				3 (MS/MSD)	
VE-UXO11-1SO03 / VE-UXO11-1SB03-TDBD				1	
VE-UXO11-1SO04 / VE-UXO11-1SB04-TDBD				1	
VE-UXO11-1SO05 / VE-UXO11-1SB05-TDBD				1	
VE-UXO11-1SO06 / VE-UXO11-1SB06-TDBD				1	
VE-UXO11-1SO07 / VE-UXO11-1SB07-TDBD				1	
VE-UXO11-1SO08 / VE-UXO11-1SB08-TDBD				1	
VE-UXO11-1SO09 / VE-UXO11-1SB09-TDBD				1	
VE-UXO11-1SO10 / VE-UXO11-1SB10-TDBD				1	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

[1.] FDs, triplicates, and MS/MSDs do not require WCHEM analysis.

SAP Worksheet #18k: UXO 12 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 12					
Decision Unit 1 - Northeast UXO 12					
SMI Samples					
VE-UXO12-1DU01 / VE-UXO12-1SMI01-MMYY VE-UXO12-1DU01 / VE-UXO12-1SMI01T-MMYY VE-UXO12-1DU01 / VE-UXO12-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO12-1DU02 / VE-UXO12-1SMI02-MMYY VE-UXO12-1DU02 / VE-UXO12-1SMI02-MMYY-MS VE-UXO12-1DU02 / VE-UXO12-1SMI02-MMYY-SD				3 (MS/MSD)	
VE-UXO12-1DU03 / VE-UXO12-1SMI03-MMYY				1	
VE-UXO12-1DU04 / VE-UXO12-1SMI04-MMYY				1	
VE-UXO12-1DU05 / VE-UXO12-1SMI05-MMYY				1	
VE-UXO12-1DU06 / VE-UXO12-1SMI06-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO12-1SO01 / VE-UXO12-1SB01-TDBD VE-UXO12-1SO01 / VE-UXO12-1SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO12-1SO02 / VE-UXO12-1SB02-TDBD VE-UXO12-1SO02 / VE-UXO12-1SB02-TDBD-MS VE-UXO12-1SO02 / VE-UXO12-1SB02-TDBD-MSD				3 (MS/MSD)	
VE-UXO12-1SO03 / VE-UXO12-1SB03-TDBD				1	
VE-UXO12-1SO04 / VE-UXO12-1SB04-TDBD				1	
VE-UXO12-1SO05 / VE-UXO12-1SB05-TDBD				1	
VE-UXO12-1SO06 / VE-UXO12-1SB06-TDBD				1	
VE-UXO12-1SO07 / VE-UXO12-1SB07-TDBD				1	
VE-UXO12-1SO08 / VE-UXO12-1SB08-TDBD				1	
VE-UXO12-1SO09 / VE-UXO12-1SB09-TDBD				1	
VE-UXO12-1SO10 / VE-UXO12-1SB10-TDBD				1	
VE-UXO12-1SO11 / VE-UXO12-1SB11-TDBD				1	
VE-UXO12-1SO12 / VE-UXO12-1SB12-TDBD				1	

SAP Worksheet #18k: UXO 12 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 12					
Decision Unit 2 - Southwest UXO 12					
SMI Samples					
VE-UXO12-2DU01 / VE-UXO12-2SMI01-MMYY	SMI	0 -2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO12-2DU02 / VE-UXO12-2SMI02-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO12-2SO01 / VE-UXO12-2SB01-TDBD VE-UXO12-2SO01 / VE-UXO12-2SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO12-2SO02 / VE-UXO12-2SB02-TDBD VE-UXO12-2SO02 / VE-UXO12-2SB02-TDBD-MS VE-UXO12-2SO02 / VE-UXO12-2SB02-TDBD-MSD				3 (MS/MSD)	
VE-UXO12-2SO03 / VE-UXO12-2SB03-TDBD				1	
VE-UXO12-2SO04 / VE-UXO12-2SB04-TDBD				1	
Decision Unit 3 - South-Central UXO 12					
SMI Samples					
VE-UXO12-3DU01 / VE-UXO12-3SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO12-3DU02 / VE-UXO12-3SMI02-MMYY				1	
VE-UXO12-3DU03 / VE-UXO12-3SMI03-MMYY				1	
VE-UXO12-3DU04 / VE-UXO12-3SMI04-MMYY VE-UXO12-3DU04 / VE-UXO12-3SMI04T-MMYY VE-UXO12-3DU04 / VE-UXO12-3SMI04TT-MMYY				3 (Triplicate)	
VE-UXO12-3DU05 / VE-UXO12-3SMI05-MMYY				1	

SAP Worksheet #18k: UXO 12 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 12					
Discrete Subsurface Soil Samples					
VE-UXO12-3SO01 / VE-UXO12-3SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO12-3SO02 / VE-UXO12-3SB02-TDBD				1	
VE-UXO12-3SO03 / VE-UXO12-3SB03-TDBD				1	
VE-UXO12-3SO04 / VE-UXO12-3SB04-TDBD VE-UXO12-3SO04 / VE-UXO12-3SB04P-TDBD				2 (FD)	
VE-UXO12-3SO05 / VE-UXO12-3SB05-TDBD				1	
VE-UXO12-3SO06 / VE-UXO12-3SB06-TDBD				1	
VE-UXO12-3SO07 / VE-UXO12-3SB07-TDBD				1	
VE-UXO12-3SO08 / VE-UXO12-3SB08-TDBD				1	
VE-UXO12-3SO09 / VE-UXO12-3SB09-TDBD				1	
VE-UXO12-3SO10 / VE-UXO12-3SB10-TDBD				1	
Decision Unit 4 - North UXO 12					
SMI Samples					
VE-UXO12-4DU01 / VE-UXO12-4SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Discrete Subsurface Soil Samples					
VE-UXO12-4SO01 / VE-UXO12-4SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO12-4SO02 / VE-UXO12-4SB02-TDBD				1	
Decision Unit 5 - South UXO 12					
SMI Samples					
VE-UXO12-5DU01 / VE-UXO12-5SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO12-5DU02 / VE-UXO12-5SMI02-MMYY				1	

SAP Worksheet #18k: UXO 12 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 12					
Discrete Subsurface Soil Samples					
VE-UXO12-5SO01 / VE-UXO12-5SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO12-5SO02 / VE-UXO12-5SB02-TDBD				1	
VE-UXO12-5SO03 / VE-UXO12-5SB03-TDBD				1	
VE-UXO12-5SO04 / VE-UXO12-5SB04-TDBD				1	
Decision Unit 6- Southeast UXO 12					
SMI Samples					
VE-UXO12-6DU01 / VE-UXO12-6SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO12-6DU02 / VE-UXO12-6SMI02-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO12-6SO01 / VE-UXO12-6SB01-TDBD VE-UXO12-6SO01 / VE-UXO12-6SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO12-6SO02 / VE-UXO12-6SB02-TDBD				1	
VE-UXO12-6SO03 / VE-UXO12-6SB03-TDBD				1	
VE-UXO12-6SO04 / VE-UXO12-6SB04-TDBD				1	
Decision Unit 7- North-Central UXO 12					
SMI Samples					
VE-UXO12-7DU01 / VE-UXO12-7SMI01-MMYY VE-UXO12-7DU01 / VE-UXO12-7SMI01-MMYY-MS VE-UXO12-7DU01 / VE-UXO12-7SMI01-MMYY-MSD	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
Discrete Subsurface Soil Samples					
VE-UXO12-7SO01 / VE-UXO12-7SB01-TDBD VE-UXO12-7SO01 / VE-UXO12-7SB01-TDBD-MS VE-UXO12-7SO01 / VE-UXO12-7SB01-TDBD-MSD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO12-7SO02 / VE-UXO12-7SB02-TDBD				1	

SAP Worksheet #18k: UXO 12 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 12					
Decision Unit 8 - Laguna Monte Largo					
Sediment & Surface Water Samples					
VE-UXO12-8SDW01 / VE-UXO12-8SD01-MMYY VE-UXO12-8SDW01 / VE-UXO12-8SD01P-MMYY VE-UXO12-8SDW01 / VE-UXO12-8SW01-MMYY VE-UXO12-8SDW01 / VE-UXO12-8SW01P-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: METAL, FMETAL, EXPLO SD: METAL, EXPLO, GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 2 (FD) SW: 2 (FD)	See Worksheet #21
VE-UXO12-8SDW02 / VE-UXO12-8SD02-MMYY VE-UXO12-8SDW02 / VE-UXO12-8SD02-MMYY-MS VE-UXO12-8SDW02 / VE-UXO12-8SD02-MMYY-SD VE-UXO12-8SDW02 / VE-UXO12-8SW02-MMYY VE-UXO12-8SDW02 / VE-UXO12-8SW02-MMYY-MS VE-UXO12-8SDW02 / VE-UXO12-8SW02-MMYY-SD				SD: 3 (MS/MSD) SW: 3 (MS/MSD)	
VE-UXO12-8SDW03 / VE-UXO12-8SD03-MMYY VE-UXO12-8SDW03 / VE-UXO12-8SW03-MMYY				1	
Decision Unit 9 - Laguna Monte Largo Fringe					
SMI Samples					
VE-UXO12-9DU01 / VE-UXO12-9SMI01-MMYY VE-UXO12-9DU01 / VE-UXO12-9SMI01T-MMYY VE-UXO12-9DU01 / VE-UXO12-9SMI01TT-MMYY	SMI	0 -2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	Worksheet #21
VE-UXO12-9DU02 / VE-UXO12-9SMI02-MMYY				1	
VE-UXO12-9DU03 / VE-UXO12-9SMI03-MMYY				1	
VE-UXO12-9DU04 / VE-UXO12-9SMI04-MMYY				1	
Deep Surface Soil Samples					
VE-UXO12-9SO01 / VE-UXO12-9SS01-0H02 VE-UXO12-9SO01 / VE-UXO12-9SS01P-0H02	SS	2.5-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	Worksheet #21
VE-UXO12-9SO02 / VE-UXO12-9SS02-0H02 VE-UXO12-9SO02 / VE-UXO12-9SS02-0H02-MS VE-UXO12-9SO02 / VE-UXO12-9SS02-0H02-MSD				3 (MS/MSD)	
VE-UXO12-9SO03 / VE-UXO12-9SS03-0H02				1	
VE-UXO12-9SO04 / VE-UXO12-9SS04-0H02				1	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

[1.] FDs, MS/MSDs, and triplicates do not require analysis for WCHEM.

SAP Worksheet #18I: UXO 13 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 13					
Decision Unit 1 - Northeast UXO 13					
SMI Samples					
VE-UXO13-1DU01 / VE-UXO13-1SMI01-MMYY VE-UXO13-1DU01 / VE-UXO13-1SMI01T-MMYY VE-UXO13-1DU01 / VE-UXO13-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO13-1DU02 / VE-UXO13-1SMI02-MMYY				1	
VE-UXO13-1DU03 / VE-UXO13-1SMI03-MMYY				1	
VE-UXO13-1DU04 / VE-UXO13-1SMI04-MMYY				1	
VE-UXO13-1DU05 / VE-UXO13-1SMI05-MMYY				1	
VE-UXO13-1DU06 / VE-UXO13-1SMI06-MMYY VE-UXO13-1DU06 / VE-UXO13-1SMI06-MMYY-MS VE-UXO13-1DU06 / VE-UXO13-1SMI06-MMYY-MSD			EXPLO, METAL, SVOC (PAHs), WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	
VE-UXO13-1DU07 / VE-UXO13-1SMI07-MMYY			EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	
VE-UXO13-1DU08 / VE-UXO13-1SMI08-MMYY				1	
VE-UXO13-1DU09 / VE-UXO13-1SMI09-MMYY				1	
VE-UXO13-1DU10 / VE-UXO13-1SMI10-MMYY VE-UXO13-1DU10 / VE-UXO13-1SMI10T-MMYY VE-UXO13-1DU10 / VE-UXO13-1SMI10TT-MMYY			EXPLO, METAL, SVOC (PAHs), WCHEM (pH, TOC, and ORP)	3 (Triplicate)	
VE-UXO13-1DU11 / VE-UXO13-1SMI11-MMYY			EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	
VE-UXO13-1DU12 / VE-UXO13-1SMI12-MMYY				1	

SAP Worksheet #18I: UXO 13 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 13					
Discrete Subsurface Soil Samples					
VE-UXO13-1SO01 / VE-UXO13-1SB01-TDBD VE-UXO13-1SO01 / VE-UXO13-1SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO13-1SO02 / VE-UXO13-1SB02-TDBD VE-UXO13-1SO02 / VE-UXO13-1SB02-TDBD-MS VE-UXO13-1SO02 / VE-UXO13-1SB02-TDBD-MSD				3 (MS/MSD)	
VE-UXO13-1SO03 / VE-UXO13-1SB03-TDBD				1	
VE-UXO13-1SO04 / VE-UXO13-1SB04-TDBD				1	
VE-UXO13-1SO05 / VE-UXO13-1SB05-TDBD				1	
VE-UXO13-1SO06 / VE-UXO13-1SB06-TDBD				1	
VE-UXO13-1SO07 / VE-UXO13-1SB07-TDBD				1	
VE-UXO13-1SO08 / VE-UXO13-1SB08-TDBD				1	
VE-UXO13-1SO09 / VE-UXO13-1SB09-TDBD				1	
VE-UXO13-1SO10 / VE-UXO13-1SB10-TDBD VE-UXO13-1SO10 / VE-UXO13-1SB10P-TDBD				2 (FD)	
VE-UXO13-1SO11 / VE-UXO13-1SB11-TDBD				1	
VE-UXO13-1SO12 / VE-UXO13-1SB12-TDBD			EXPLO, METAL, SVOC (PAHs), WCHEM (pH, TOC, and ORP)	1	
VE-UXO13-1SO13 / VE-UXO13-1SB13-TDBD				1	
VE-UXO13-1SO14 / VE-UXO13-1SB14-TDBD			EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	
VE-UXO13-1SO15 / VE-UXO13-1SB15-TDBD				1	
VE-UXO13-1SO16 / VE-UXO13-1SB16-TDBD				1	
VE-UXO13-1SO17 / VE-UXO13-1SB17-TDBD				1	
VE-UXO13-1SO18 / VE-UXO13-1SB18-TDBD				1	
VE-UXO13-1SO19 / VE-UXO13-1SB19-TDBD				1	
VE-UXO13-1SO20 / VE-UXO13-1SB20-TDBD			EXPLO, METAL, SVOC (PAHs), WCHEM (pH, TOC, and ORP)	1	
VE-UXO13-1SO21 / VE-UXO13-1SB21-TDBD				1	
VE-UXO13-1SO22 / VE-UXO13-1SB22-TDBD			EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	
VE-UXO13-1SO23 / VE-UXO13-1SB23-TDBD				1	
VE-UXO13-1SO24 / VE-UXO13-1SB24-TDBD VE-UXO13-1SO24 / VE-UXO13-1SB24-TDBD-MS VE-UXO13-1SO24 / VE-UXO13-1SB24-TDBD-MSD				3 (MS/MSD)	

SAP Worksheet #18I: UXO 13 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 13					
Decision Unit 2 - Central UXO 13					
SMI Samples					
VE-UXO13-2DU01 / VE-UXO13-2SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO13-2DU02 / VE-UXO13-2SMI02-MMYY				1	
VE-UXO13-2DU03 / VE-UXO13-2SMI03-MMYY				1	
VE-UXO13-2DU04 / VE-UXO13-2SMI04-MMYY				1	
VE-UXO13-2DU05 / VE-UXO13-2SMI05-MMYY				1	
VE-UXO13-2DU06 / VE-UXO13-2SMI06-MMYY				1	
VE-UXO13-2DU07 / VE-UXO13-2SMI07-MMYY				1	
VE-UXO13-2DU08 / VE-UXO13-2SMI08-MMYY VE-UXO13-2DU08 / VE-UXO13-2SMI08T-MMYY VE-UXO13-2DU08 / VE-UXO13-2SMI08TT-MMYY				3 (Triplicate)	
VE-UXO13-2DU09 / VE-UXO13-2SMI09-MMYY				1	
VE-UXO13-2DU10 / VE-UXO13-2SMI10-MMYY				1	
VE-UXO13-2DU11 / VE-UXO13-2SMI11-MMYY VE-UXO13-2DU11 / VE-UXO13-2SMI11-MMYY-MS VE-UXO13-2DU11 / VE-UXO13-2SMI11-MMYY-SD				3 (MS/MSD)	

SAP Worksheet #18I: UXO 13 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 13					
Discrete Subsurface Soil Samples					
VE-UXO13-2SO01 / VE-UXO13-2SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO13-2SO02 / VE-UXO13-2SB02-TDBD				1	
VE-UXO13-2SO03 / VE-UXO13-2SB03-TDBD				1	
VE-UXO13-2SO04 / VE-UXO13-2SB04-TDBD				1	
VE-UXO13-2SO05 / VE-UXO13-2SB05-TDBD				1	
VE-UXO13-2SO06 / VE-UXO13-2SB06-TDBD				1	
VE-UXO13-2SO07 / VE-UXO13-2SB07-TDBD				1	
VE-UXO13-2SO08 / VE-UXO13-2SB08-TDBD VE-UXO13-2SO08 / VE-UXO13-2SB08P-TDBD				2 (FD)	
VE-UXO13-2SO09 / VE-UXO13-2SB09-TDBD				1	
VE-UXO13-2SO10 / VE-UXO13-2SB10-TDBD				1	
VE-UXO13-2SO11 / VE-UXO13-2SB11-TDBD VE-UXO13-2SO11 / VE-UXO13-2SB11-TDBD-MS VE-UXO13-2SO11 / VE-UXO13-2SB11-TDBD-MSD				3 (MS/MSD)	
VE-UXO13-2SO12 / VE-UXO13-2SB12-TDBD				1	
VE-UXO13-2SO13 / VE-UXO13-2SB13-TDBD				1	
VE-UXO13-2SO14 / VE-UXO13-2SB14-TDBD				1	
VE-UXO13-2SO15 / VE-UXO13-2SB15-TDBD				1	
VE-UXO13-2SO16 / VE-UXO13-2SB16-TDBD				1	
VE-UXO13-2SO17 / VE-UXO13-2SB17-TDBD				1	
VE-UXO13-2SO18 / VE-UXO13-2SB18-TDBD VE-UXO13-2SO18 / VE-UXO13-2SB18P-TDBD				2 (FD)	
VE-UXO13-2SO19 / VE-UXO13-2SB19-TDBD				1	
VE-UXO13-2SO20 / VE-UXO13-2SB20-TDBD				1	
VE-UXO13-2SO21 / VE-UXO13-2SB21-TDBD				1	
VE-UXO13-2SO22 / VE-UXO13-2SB22-TDBD				1	

SAP Worksheet #18I: UXO 13 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 13					
Decision Unit 3 - East Northeast UXO13					
SMI Samples					
VE-UXO13-3DU01 / VE-UXO13-3SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO13-3DU02 / VE-UXO13-3SMI02-MMYY				1	
Discrete Subsurface Soil Samples					
VE-UXO13-3SO01 / VE-UXO13-3SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO13-3SO02 / VE-UXO13-3SB02-TDBD				1	
VE-UXO13-3SO03 / VE-UXO13-3SB03-TDBD				1	
VE-UXO13-3SO04 / VE-UXO13-3SB04-TDBD				1	
Decision Unit 4 - Parcel C UXO 13					
Discrete Surface Soil & Subsurface Soil Samples					
VE-UXO13-4SO01 / VE-UXO13-4SS01-0001 VE-UXO13-4SO01 / VE-UXO13-4SB01-TDBD	SS SB	0 - 12 inches TBD	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	SS: 1 SB: 1	See Worksheet #21
VE-UXO13-4SO02 / VE-UXO13-4SS02-0001 VE-UXO13-4SO02 / VE-UXO13-4SB02-TDBD	SS SB	0 - 12 inches TBD		SS: 1 SB: 1	
VE-UXO13-4SO03 / VE-UXO13-4SS03-0001 VE-UXO13-4SO03 / VE-UXO13-4SB03-TDBD	SS SB	0 - 12 inches TBD		SS: 1 SB: 1	
VE-UXO13-4SO04 / VE-UXO13-4SS04-0001 VE-UXO13-4SO04 / VE-UXO13-4SB04-TDBD	SS SB	0 - 12 inches TBD		SS: 1 SB: 1	
VE-UXO13-4SO05 / VE-UXO13-4SS05-0001 VE-UXO13-4SO05 / VE-UXO13-4SS05P-0001 VE-UXO13-4SO05 / VE-UXO13-4SB05-TDBD VE-UXO13-4SO05 / VE-UXO13-4SB05P-TDBD	SS SB	0 - 12 inches TBD		SS: 2 (FD) SB: 2 (FD)	
VE-UXO13-4SO06 / VE-UXO13-4SS06-0001 VE-UXO13-4SO06 / VE-UXO13-4SB06-TDBD	SS SB	0 - 12 inches TBD		SS: 1 SB: 1	
VE-UXO13-4SO07 / VE-UXO13-4SS07-0001 VE-UXO13-4SO07 / VE-UXO13-4SB07-TDBD	SS SB	0 - 12 inches TBD		SS: 1 SB: 1	
VE-UXO13-4SO08 / VE-UXO13-4SS08-0001 VE-UXO13-4SO08 / VE-UXO13-4SS08-0001-MS VE-UXO13-4SO08 / VE-UXO13-4SS08-0001-MSD VE-UXO13-4SO08 / VE-UXO13-4SB08-TDBD VE-UXO13-4SO08 / VE-UXO13-4SB08-TDBD-MS VE-UXO13-4SO08 / VE-UXO13-4SB08-TDBD-MSD	SS SB	0 - 12 inches TBD		SS: 3 (MS/MSD) SB: 3 (MS/MSD)	

SAP Worksheet #18I: UXO 13 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 13					
Decision Unit 5 - South					
SMI Samples					
VE-UXO13-5DU01 / VE-UXO13-5SMI01-MMYY VE-UXO13-5DU01 / VE-UXO13-5SMI01T-MMYY VE-UXO13-5DU01 / VE-UXO13-5SMI01TT-MMYY	SMI	0 -2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
Discrete Subsurface Soil Samples					
VE-UXO13-5SO01 / VE-UXO13-5SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO13-5SO02 / VE-UXO13-5SB02-TDBD VE-UXO13-5SO02 / VE-UXO13-5SB02P-TDBD				2 (FD)	
Decision Unit 6 - Laguna Algodones					
Sediment & Surface Water Samples					
VE-UXO13-6SDSW01 / VE-UXO13-6SD01-MMYY VE-UXO13-6SDSW01 / VE-UXO13-6SD01P-MMYY VE-UXO13-6SDSW01 / VE-UXO13-6SW01-MMYY VE-UXO13-6SDSW01 / VE-UXO13-6SW01P-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: EXPLO, METAL, FMETAL SD: EXPLO, METAL,GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 2 (FD) SW: 2 (FD)	See Worksheet #21
VE-UXO13-6SDSW02 / VE-UXO13-6SD02-MMYY VE-UXO13-6SDSW02 / VE-UXO13-6SD02-MMYY-MS VE-UXO13-6SDSW02 / VE-UXO13-6SD02-MMYY-SD VE-UXO13-6SDSW02 / VE-UXO13-6SW02-MMYY VE-UXO13-6SDSW02 / VE-UXO13-6SW02-MMYY-MS VE-UXO13-6SDSW02 / VE-UXO13-6SW02-MMYY-SD				SD: 3 (MS/MSD) SW: 3 (MS/MSD)	
VE-UXO13-6SDSW03 / VE-UXO13-6SD03-MMYY VE-UXO13-6SDSW03 / VE-UXO13-6SW03-MMYY				SD: 1 SW: 1	
VE-UXO13-6SDSW04 / VE-UXO13-6SD04-MMYY VE-UXO13-6SDSW04 / VE-UXO13-6SW04-MMYY				SD: 1 SW: 1	
VE-UXO13-6SDSW05 / VE-UXO13-6SD05-MMYY VE-UXO13-6SDSW05 / VE-UXO13-6SW05-MMYY				SD: 1 SW: 1	
VE-UXO13-6SDSW06 / VE-UXO13-6SD06-MMYY VE-UXO13-6SDSW06 / VE-UXO13-6SW06-MMYY				SD: 1 SW: 1	

SAP Worksheet #18I: UXO 13 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 13					
Decision Unit 7 - Laguna Algodones Fringe					
SMI Samples					
VE-UXO13-7DU01 / VE-UXO13-7SMI01-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO13-7DU02 / VE-UXO13-7SMI02-MMYY				1	
VE-UXO13-7DU03 / VE-UXO13-7SMI03-MMYY				1	
Deep Surface Soil Samples					
VE-UXO13-7SO01 / VE-UXO13-7SS01-0002	SS	2.5-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO13-7SO02 / VE-UXO13-7SS02-0002 VE-UXO13-7SO02 / VE-UXO13-7SS02P-0002				2 (FD)	
VE-UXO13-7SO03 / VE-UXO13-7SS03-0002				1	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

[1.] FDs, triplicates, and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18m: UXO 14 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 14					
Decision Unit 1 - East UXO 14					
SMI Samples					
VE-UXO14-01DU01 / VE-UXO14-01SMI01-MMYY VE-UXO14-01DU01 / VE-UXO14-01SMI01T-MMYY VE-UXO14-01DU01 / VE-UXO14-01SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
Discrete Subsurface Soil Samples					
VE-UXO14-01SO01 / VE-UXO14-01SB01-TDBD VE-UXO14-01SO01 / VE-UXO14-01SB01P-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO14-01SO02 / VE-UXO14-01SB02-TDBD				1	
Decision Unit 2 - East Central UXO 14					
SMI Samples					
VE-UXO14-02DU01 / VE-UXO14-02SMI01-MMYY VE-UXO14-02DU01 / VE-UXO14-02SMI01-MMYY-MS VE-UXO14-02DU01 / VE-UXO14-02SMI01-MMYY-SD	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
Discrete Subsurface Soil Samples					
VE-UXO14-02SO01 / VE-UXO14-02SB01-TDBD VE-UXO14-02SO01 / VE-UXO14-02SB01-TDBD-MS VE-UXO14-02SO01 / VE-UXO14-02SB01-TDBD-MSD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO14-02SO02 / VE-UXO14-02SB02-TDBD				1	
Decision Unit 3 - West Central UXO 14					
SMI Samples					
VE-UXO14-03DU01 / VE-UXO14-03SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO14-03DU02 / VE-UXO14-03SMI02-MMYY				1	

SAP Worksheet #18m: UXO 14 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 14					
Discrete Subsurface Soil Samples					
VE-UXO14-03SO01 / VE-UXO14-03SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO14-03SO02 / VE-UXO14-03SB02-TDBD				1	
VE-UXO14-03SO03 / VE-UXO14-03SB03-TDBD				1	
VE-UXO14-03SO04 / VE-UXO14-03SB04-TDBD				1	
Decision Unit 4 - West UXO 14					
SMI Samples					
VE-UXO14-04DU01 / VE-UXO14-04SMI01-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
Discrete Subsurface Soil Samples					
VE-UXO14-04SO01 / VE-UXO14-04SB01-TDBD	SB	(in accordance with modified Vieques Protocols)	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO14-04SO02 / VE-UXO14-04SB02-TDBD				1	
Decision Unit 5 - West UXO 14 Lagoons					
Sediment & Surface Water Samples					
VE-UXO14-05SDSW01 / VE-UXO14-05SD01-MMYY VE-UXO14-05SDSW01 / VE-UXO14-05SD01P-MMYY VE-UXO14-05SDSW01 / VE-UXO14-05SW01-MMYY VE-UXO14-05SDSW01 / VE-UXO14-05SW01P-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: METAL, FMETAL, EXPLO SD: METAL, EXPLO, GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 2 (FD) SW: 2 (FD)	See Worksheet #21
VE-UXO14-05SDSW02 / VE-UXO14-05SD02-MMYY VE-UXO14-05SDSW02 / VE-UXO14-05SD02-MMYY-MS VE-UXO14-05SDSW02 / VE-UXO14-05SD02-MMYY-SD VE-UXO14-05SDSW02 / VE-UXO14-05SW02-MMYY VE-UXO14-05SDSW02 / VE-UXO14-05SW02-MMYY-MS VE-UXO14-05SDSW02 / VE-UXO14-05SW02-MMYY-SD				SD: 3 (MS/MSD) SW: 3 (MS/MSD)	
VE-UXO14-05SDSW03 / VE-UXO14-05SD03-MMYY VE-UXO14-05SDSW03 / VE-UXO14-05SW03-MMYY				SD: 1 SW: 1	

SAP Worksheet #18m: UXO 14 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 14					
Decision Unit 6 - West UXO 14 Lagoon Fringes					
SMI Samples					
VE-UXO14-06DU01 / VE-UXO14-06SMI01-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO14-06DU02 / VE-UXO14-06SMI02-MMYY				1	
VE-UXO14-06DU03 / VE-UXO14-06SMI03-MMYY				1	
VE-UXO14-06DU04 / VE-UXO14-06SMI04-MMYY				1	
Deep Surface Soil Samples					
VE-UXO14-06SO01 / VE-UXO14-06SS01-0H02 VE-UXO14-06SO01 / VE-UXO14-06SS01P-0H02	SS	2.5-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO14-06SO02 / VE-UXO14-06SS02-0H02				1	
VE-UXO14-06SO03 / VE-UXO14-06SS03-0H02				1	
VE-UXO14-06SO04 / VE-UXO14-06SS04-0H02				1	
Decision Unit 7 - East Central UXO 14 Lagoons					
Sediment & Surface Water Samples					
VE-UXO14-07SDSW01 / VE-UXO14-07SD01-MMYY VE-UXO14-07SDSW01 / VE-UXO14-07SW01-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: METAL, FMETAL, EXPLO SD: METAL, EXPLO, GRAINSIZE, WCHEM (pH, TOC, and ORP)	SD: 1 SW: 1	See Worksheet #21
VE-UXO14-07SDSW02 / VE-UXO14-07SD02-MMYY VE-UXO14-07SDSW02 / VE-UXO14-07SW02-MMYY				SD: 1 SW: 1	
VE-UXO14-07SDSW03 / VE-UXO14-07SD03-MMYY VE-UXO14-07SDSW03 / VE-UXO14-07SW03-MMYY				SD: 1 SW: 1	
VE-UXO14-07SDSW04 / VE-UXO14-07SD04-MMYY VE-UXO14-07SDSW04 / VE-UXO14-07SW04-MMYY				SD: 1 SW: 1	
VE-UXO14-07SDSW05 / VE-UXO14-07SD05-MMYY VE-UXO14-07SDSW05 / VE-UXO14-07SW05-MMYY				SD: 1 SW: 1	

SAP Worksheet #18m: UXO 14 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 14					
Decision Unit 8 - East Central UXO 14 Lagoon Fringes					
SMI Samples					
VE-UXO14-08DU01 / VE-UXO14-08SMI01-MMYY VE-UXO14-08DU01 / VE-UXO14-08SMI01T-MMYY VE-UXO14-08DU01 / VE-UXO14-08SMI01TT-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO14-08DU02 / VE-UXO14-08SMI02-MMYY				1	
Deep Surface Soil Samples					
VE-UXO14-08SO01 / VE-UXO14-08SS01-0H02 VE-UXO14-08SO01 / VE-UXO14-08SS01-0H02-MS VE-UXO14-08SO01 / VE-UXO14-08SS01-0H02-MSD	SS	2.5-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (MS/MSD)	See Worksheet #21
VE-UXO14-08SO02 / VE-UXO14-08SS02-0H02				1	
Decision Unit 9 - East UXO 14 Lagoons					
Sediment & Surface Water Samples					
VE-UXO14-09SDSW01 / VE-UXO14-09SD01-MMYY VE-UXO14-09SDSW01 / VE-UXO14-09SW01-MMYY	SD/SW	SW: Mid-Depth SD: 0 - 6 inches	SW: METAL, FMETAL, EXPLO SD: METAL, EXPLO, GRAINSIZE, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO14-09SDSW02 / VE-UXO14-09SD02-MMYY VE-UXO14-09SDSW02 / VE-UXO14-09SW02-MMYY				1	
VE-UXO14-09SDSW03 / VE-UXO14-09SD03-MMYY VE-UXO14-09SDSW03 / VE-UXO14-09SW03-MMYY				1	
VE-UXO14-09SDSW04 / VE-UXO14-09SD04-MMYY VE-UXO14-09SDSW04 / VE-UXO14-09SD04P-MMYY VE-UXO14-09SDSW04 / VE-UXO14-09SW04-MMYY VE-UXO14-09SDSW04 / VE-UXO14-09SW04P-MMYY				SD: 2 (FD) SW: 2 (FD)	
VE-UXO14-09SDSW05 / VE-UXO14-09SD05-MMYY VE-UXO14-09SDSW05 / VE-UXO14-09SW05-MMYY				1	
VE-UXO14-09SDSW06 / VE-UXO14-09SD06-MMYY VE-UXO14-09SDSW06 / VE-UXO14-09SW06-MMYY				1	

SAP Worksheet #18m: UXO 14 Location-Specific Sampling Methods/SOP Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 14					
Decision Unit 10 - East UXO 14 Lagoon Fringes (Lagoons 12 and 13)					
SMI Samples					
VE-UXO14-10DU01 / VE-UXO14-10SMI01-MMYY	SMI	0-2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO14-10DU02 / VE-UXO14-10SMI02-MMYY				1	
Deep Surface Soil Samples					
VE-UXO14-10SO01 / VE-UXO14-10SB01-0002	SB	2-24 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	1	See Worksheet #21
VE-UXO14-10SO02 / VE-UXO14-10SB02-0002				1	

Notes: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

[1.] FDs, triplicates, and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18n: UXO 17 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 17					
Decision Unit 1 - UXO 17					
Discrete Surface Soil Samples					
VE-UXO17-1SO01 / VE-UXO17-1SS01-0001 VE-UXO17-1SO01 / VE-UXO17-1SS01P-0001	SS	0 - 12 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO17-1SO02 / VE-UXO17-1SS02-0001 VE-UXO17-1SO02 / VE-UXO17-1SS02-0001-MS VE-UXO17-1SO02 / VE-UXO17-1SS02-0001-MSD				3 (MS/MSD)	
VE-UXO17-1SO03 / VE-UXO17-1SS03-0001				1	

[1.] FDs, triplicates, and MS/MSDs do not require analysis for WCHEM.

SAP Worksheet #18o: UXO 18 Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sampling Location / ID Number	Matrix	Depth	Analytical Group[1]	Number of Samples	Sampling SOP Reference
UXO 18					
Decision Unit 1 - Cayo de la Chiva					
SMI Samples					
VE-UXO18-1DU01 / VE-UXO18-1SMI01-MMYY VE-UXO18-1DU01 / VE-UXO18-1SMI01T-MMYY VE-UXO18-1DU01 / VE-UXO18-1SMI01TT-MMYY	SMI	0 - 2.5 inches	EXPLO, METAL, WCHEM (pH, TOC, and ORP)	3 (Triplicate)	See Worksheet #21
VE-UXO18-1DU02 / VE-UXO18-1SMI02-MMYY VE-UXO18-1DU02 / VE-UXO18-1SMI02-MMYY-MS VE-UXO18-1DU02 / VE-UXO18-1SMI02-MMYY-SD				3 (MS/MSD)	
Discrete Surface Soil Samples					
VE-UXO18-1SO01 / VE-UXO18-1SS01-0001 VE-UXO18-1SO01 / VE-UXO18-1SS01P-0001	SS	0 - 12 inches	SVOC (Hexachloroethane-only), EXPLO, METAL, WCHEM (pH, TOC, and ORP)	2 (FD)	See Worksheet #21
VE-UXO18-1SO02 / VE-UXO18-1SS02-0001 VE-UXO18-1SO02 / VE-UXO18-1SS02-0001-MS VE-UXO18-1SO02 / VE-UXO18-1SS02-0001-MSD				3 (MS/MSD)	
VE-UXO18-1SO03 / VE-UXO18-1SS03-0001				1	

[1.] FDs, MS/MSDs, and triplicates do not require analysis for WCHEM.

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SAP Worksheet #19 — Field Sampling Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference	Containers2	Sample Volume1	Preservation Requirements	Maximum Holding Time
GW	METAL	LAB-12, LAB-13, LAB-14	One of 250mL HDPE	50mL	HNO_3 to pH < 2; ≤ 6°C but not frozen	6 months
		LAB-15	One of 125mL HDPE	95mL	≤ 6°C but not frozen	24 hours
	FMETAL	LAB-12, LAB-13, LAB-14	One of 250mL HDPE	50mL	HNO_3 to pH < 2; ≤ 6°C but not frozen	6 months
		LAB-15	One of 125mL HDPE	95mL	≤ 6°C but not frozen	24 hours
	EXPLO	LAB-08, LAB-09	Two of 1L AWM	1000mL	≤ 6°C but not frozen	7 days / 40 days
		LAB-10	One of 125mL HDPE	10mL	Field-filter with 0.2um PTFE membrane filter; ≤6°C but not frozen; headspace in jar; protect from light	28 days
	RAD	LAB-24, LAB-25, LAB-26	TBD (HDPE)	TBD	HNO_3 to pH < 2; ≤ 6°C but not frozen	TBD
	FRAD	LAB-24, LAB-25, LAB-26	TBD (HDPE)	TBD	HNO_3 to pH < 2; ≤ 6°C but not frozen	TBD
SB	EXPLO	LAB-07, LAB-09	One of 8oz CWM	10g	≤ 6°C but not frozen	14 days / 40 days
		LAB-10	One of 4oz CWM	10g	≤ 6°C but not frozen	28 days
	METAL	LAB-11, LAB-13, LAB-14	One of 8oz CWM	2g	≤ 6°C but not frozen	6 months
		LAB-15		2.5g	≤ 6°C but not frozen	30 days / 7 hours
	SVOC	LAB-16, LAB-18	One of 8oz CWM	30g	≤ 6°C but not frozen	14 days / 40 days
		LAB-16, LAB-19		30g	≤ 6°C but not frozen	14 days / 40 days
	WCHEM (pH and TOC)	LAB-20, LAB-21	One of 4oz CWM	20g for pH; 100g for TOC	≤ 6°C but not frozen	ASAP (pH); 14 days (TOC)
	RAD	LAB-23, LAB-25, LAB-26	TBD (glass)	TBD	≤ 6°C but not frozen	TBD

SAP Worksheet #19 — Field Sampling Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference	Containers[2]	Sample Volume[1]	Preservation Requirements	Maximum Holding Time
SS	EXPLO	LAB-07, LAB-09	One of 8oz CWM	10g	≤ 6°C but not frozen	14 days / 40 days
		LAB-10	One of 4oz CWM	10g	≤ 6°C but not frozen	28 days
	METAL	LAB-11, LAB-13, LAB-14	One of 8oz CWM	2g	≤ 6°C but not frozen	6 months
		LAB-15		2.5g	≤ 6°C but not frozen	30 days / 7 days
	SVOC	LAB-16, LAB-18	One of 8oz CWM	30g	≤ 6°C but not frozen	14 days / 40 days
		LAB-16, LAB-19		30g	≤ 6°C but not frozen	14 days / 40 days
	RAD	LAB-23, LAB-25, LAB-26	TBD (glass)	TBD	≤ 6°C but not frozen	TBD
	WCHEM (pH and TOC)	LAB-20, LAB-21	One of 4oz CWM	20g for pH; 100g for TOC	≤ 6°C but not frozen	ASAP (pH); 14 days (TOC)
SD	EXPLO	LAB-07, LAB-09	One of 8oz CWM	10g	≤ 6°C but not frozen	14 days / 40 days
		LAB-10	One of 4oz CWM	10g	≤ 6°C but not frozen	28 days
	METAL	LAB-11, LAB-13, LAB-14	One of 8oz CWM	2g	≤ 6°C but not frozen	6 months
		LAB-15		2.5g	≤ 6°C but not frozen	30 days / 7 days
	GRAINSIZE	LAB-22	One of 8oz CWM	500g	N/A	N/A
	WCHEM (pH and TOC)	LAB-20, LAB-21	One of 4oz CWM	20g for pH; 100g for TOC	≤ 6°C but not frozen	ASAP (pH); 14 days (TOC)
	RAD	LAB-23, LAB-25, LAB-26	TBD (glass)	TBD	≤ 6°C but not frozen	TBD
SMI	EXPLO	LAB-07, LAB-09	Two of 16oz CWM	10g	≤ 6°C but not frozen	14 days / 40 days
		LAB-10		10g		28 days
	METAL	LAB-11, LAB-13, LAB-14		10g		6 months
		LAB-15		10g		30 days / 7 days
	SVOC	LAB-16, LAB-18		30g		14 days / 40 days
		LAB-16, LAB-19		30g		14 days / 40 days
	WCHEM (pH and TOC)	LAB-20, LAB-21		20g for pH; 100g for TOC		ASAP (pH); 14 days (TOC)

SAP Worksheet #19 — Field Sampling Requirements Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference	Containers[2]	Sample Volume[1]	Preservation Requirements	Maximum Holding Time
SW	METAL	LAB-12, LAB-13, LAB-14	One of 250mL HDPE	50mL	HNO_3 to pH < 2; ≤ 6°C but not frozen	6 months
		LAB-15	One of 125mL HDPE	95mL	≤ 6°C but not frozen	24 hours
	FMETAL	LAB-12, LAB-13, LAB-14	One of 250mL HDPE	50mL	HNO_3 to pH < 2; ≤ 6°C but not frozen	6 months
		LAB-15	One of 125mL HDPE	95mL	≤ 6°C but not frozen	24 hours
	EXPLO	LAB-08, LAB-09	Two of 1L AWM	1000mL	≤ 6°C but not frozen	7 days / 40 days
		LAB-10	One of 125mL HDPE	10mL	Field-filter with 0.2um PTFE membrane filter; ≤6°C but not frozen; headspace in jar; protect from light	28 days
	RAD	LAB-24, LAB-25, LAB-26	TBD (HDPE)	TBD	HNO_3 to pH < 2; ≤ 6°C but not frozen	TBD
	FRAD	LAB-24, LAB-25, LAB-26	TBD (HDPE)	TBD	HNO_3 to pH < 2; ≤ 6°C but not frozen	TBD

Notes:

1. Fill to capacity. These are typical minimums required for preparation or analysis.
2. Bottleware may vary. These are typical requirements.

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SAP Worksheet #20 — Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
Regional Groundwater Sampling										
GW	METAL	23		3	2		14			44
	FMETAL	23		3	2		14			44
	EXPLO	23		3	2		14			44
	METAL (add U to above)	1		1			1			3
	FMETAL (add U to above)	1		1			1			3
	RAD	1		1			1			3
	FRAD	1		1			1			3
SB	METAL	23		3	2		2			32
	EXPLO	23		3	2		2			32
	METAL (add U to above)	1		1			1			3
	FMETAL (add U to above)	1		1			1			3
	RAD	1		1			1			3
	WCHEM (pH and TOC)	23								23
UXO-2 Decision Unit 1 - Playa Salinas del Sur (2 SMI, 2 SS samples) UXO-2 Decision Unit 1 - Turtle Beach (3 SMI, 3 SS samples) UXO-2 Decision Unit 1 - Icacos/Playa Yallis (2 SMI, 2 SS samples) UXO-2 Decision Unit 1 - Playa Salinas del Norte/Fossil Beach (1 SMI, 1 SS samples)										
SMI	EXPLO	8	1		1		2			14
	METAL	8	1		1		2			14
	WCHEM (pH and TOC)	8								8
SS	EXPLO	8		1	1		1			12
	METAL	8		1	1		1			12
	WCHEM (pH and TOC)	8								8

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-3 Decision Unit 1 - UXO 3 LIA Roads										
SMI	EXPLO	8	1		1		2			14
	METAL	8	1		1		2			14
	WCHEM (pH and TOC)	8								8
SB	EXPLO	16		2	1		1			21
	METAL	16		2	1		1			21
	WCHEM (pH and TOC)	16								16
UXO-4 Decision Unit 1 - Central UXO 4 (16 SMI, 39 SB samples) UXO-4 Decision Unit 2 - North UXO 4 (8 SMI, 16 SB samples) UXO-4 Decision Unit 3 - Northwest UXO 4 (5 SMI, 10 SB samples) UXO-4 Decision Unit 4 - Southwest UXO 4 (5 SMI, 10 SB samples) UXO-4 Decision Unit 5 - East UXO 4 (3 SMI, 6 SB samples) UXO-4 Decision Unit 8 - Northwest UXO 4 Lagoon Fringes - Laguna Gatos (2 SMI, 2 SS sample) UXO-4 Decision Unit 9 - Southwest UXO 4 Lagoon Fringes - Laguna Icacos (2 SMI, 2 SS sample) UXO-4 Decision Unit 11 - Laguna Anones Fringe (5 SMI, 5 SS samples)										
SMI	EXPLO	46	5		3		23			85
	SVOC	1								
	METAL	46	5		3		23			85
	WCHEM (pH and TOC)	46								46
SB	EXPLO	81		9	5		4			104
	METAL	81		9	5		4			104
	WCHEM (pH and TOC)	81								81
SS	EXPLO	9		9	5		1			29
	METAL	9		9	5		1			29
	WCHEM (pH and TOC)	9								9

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-4 Decision Unit 6 - Northwest UXO 4 Lagoon - Laguna Gatos (3 SW, 3 SD samples) UXO-4 Decision Unit 7 - Southwest UXO 4 Lagoons - Laguna Icacos (3 SW, 3 SD samples) UXO-4 Decision Unit 10 - Laguna Anones (6 SW, 15 SD samples) Field Identified Craters (3 SW, 3 SD samples)										
SW	EXPLO	15		2	1		1			20
	METAL	15		2	1		1			20
	FMETAL	15		2	1		1			20
SD	EXPLO	24		3	2		2			33
	METAL	24		3	2		2			33
	GRAINSIZE	24								24
	WCHEM (pH and TOC)	24								24
UXO-4 Depleted Uranium Area										
SS	METAL (U only)	12		2	1		1			17
	RAD	12		2	1		1			17
SB	METAL (U only)	12		2	1		1			17
	RAD	12		2	1		1			17
UXO-5 Decision Unit 1 - UXO 5 SIA Restricted Roads										
SMI	EXPLO	8	1		1		4			16
	METAL	8	1		1		4			16
	WCHEM (pH and TOC)	8								8
SB	EXPLO	16		2	1		1			21
	METAL	16		2	1		1			21
	WCHEM (pH and TOC)	16								16

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-6 Decision Unit 1 - UXO 6 SIA Public Roads										
SMI	EXPLO	4	1		1		2			10
	METAL	4	1		1		2			10
	WCHEM (pH and TOC)	4								4
SB	EXPLO	8		1	1		1			12
	METAL	8		1	1		1			12
	WCHEM (pH and TOC)	8								8
UXO-7 Decision Unit 1 - Diable Beach UXO-7 Decision Unit 1 - Purple Beach UXO-7 Decision Unit 1 - Beach 33										
SMI	EXPLO	5	1		1		2			11
	METAL	5	1		1		2			11
	WCHEM (pH and TOC)	5								5
SS	EXPLO	4		1	1		1			8
	METAL	4		1	1		1			8
	WCHEM (pH and TOC)	4								4
UXO-8 Decision Unit 1 - Playa Jalova (1 SMI, 1 SS samples) UXO-8 Decision Unit 1 - Playa Jalovita (1 SMI, 1 SS samples) UXO-8 Decision Unit 1 - Playa Matias/Yellow Beach (2 SMI, 2 SS samples) UXO-8 Decision Unit 1 - Cayo Conejo (1 SMI sample)										
SMI	EXPLO	5	1		1		2			11
	METAL	5	1		1		2			11
	WCHEM (pH and TOC)	5								5
SS	EXPLO	4		1	1		1			8
	METAL	4		1	1		1			8
	WCHEM (pH and TOC)	4								4

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-9 Decision Unit 1 - Northeast UXO 9 (8 SMI, 16 SB samples) UXO-9 Decision Unit 2 - Northwest UXO 9 (4 SMI,8 SB samples) UXO-9 Decision Unit 3 - Southeast UXO 9 (3 SMI, 6 SB samples) UXO-9 Decision Unit 4 - South UXO 9 (5 SMI, 10 SB samples) UXO-9 Decision Unit 5 - Southwest UXO 9 (1 SMI, 2 SB sample) UXO-9 Decision Unit 6 - North UXO 9 (2 SMI, 4 SB samples) UXO-9 Decision Unit 8 - Northwest UXO 9 Lagoon Fringes (Laguna Puerta Diablo) (4 SMI, 4 SS samples) UXO-9 Decision Unit 10 - Laguna Matias Fringe (1 SMI, 1 SS sample) UXO-9 Decision Unit 12 - Southwest UXO 9 Lagoon Fringes (Lagoon 11) (2 SMI, 2 SS sample)										
SMI	EXPLO	30	3		2		15			55
	METAL	30	3		2		15			55
	WCHEM (pH and TOC)	30								30
SB	EXPLO	46		5	3		2			59
	METAL	46		5	3		2			59
	WCHEM (pH and TOC)	46								46
SS	EXPLO	7		1	1		1			11
	METAL	7		1	1		1			11
	WCHEM (pH and TOC)	7								7
UXO-9 Decision Unit 7 - Northwest UXO 9 Lagoons (Laguna Puerta Diablo) (3 SW, 3 SD samples) UXO-9 Decision Unit 9 - Laguna Matias (3 SW, 3 SD samples) UXO-9 Decision Unit 11 - Southwest UXO 9 Lagoons (Lagoon 11) (3 SW, 3SD samples)										
SW	EXPLO	9		1	1		1			13
	METAL	9		1	1		1			13
	FMETAL	9		1	1		1			13
SD	EXPLO	9		1	1		1			13
	METAL	9		1	1		1			13
	GRAINSIZE	9								9
	WCHEM (pH and TOC)	9								9

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-10 Decision Unit 1 - Southwest UXO 10 (3 SMI, 6 SB) UXO-10 Decision Unit 2 - Northeast UXO 10 (3 SMI, 6 SB) UXO-10 Decision Unit 3 - Southeast UXO 10 (4 SMI, 8 SB) UXO-10 Decision Unit 4 - Central UXO 10 (3 SMI, 6 SB) UXO-10 Decision Unit 5 - North UXO 10 (2 SMI, 4 SB)										
SMI	EXPLO	15	2		1		7			28
	METAL	15	2		1		7			28
	WCHEM (pH and TOC)	15								15
SB	EXPLO	30		3	2		2			39
	METAL	30		3	2		2			39
	WCHEM (pH and TOC)	30								30
UXO-11 Decision Unit 1 - UXO 11 EMA Restricted Roads										
SMI	EXPLO	5	1		1		2			11
	METAL	5	1		1		2			11
	WCHEM (pH and TOC)	5								5
SB	EXPLO	10		1	1		1			14
	METAL	10		1	1		1			14
	WCHEM (pH and TOC)	10								10
UXO-12 Decision Unit 1 - Northeast UXO 12 (6 SMI, 12 SB samples) UXO-12 Decision Unit 2 - Southwest UXO 12 (2 SMI, 4 SB sample) UXO-12 Decision Unit 3 - South-Central UXO 12 (5 SMI, 10 SB samples) UXO-12 Decision Unit 4 - North UXO 12 (1 SMI, 2 SB sample) UXO-12 Decision Unit 5 - South UXO 12 (2 SMI, 4 SB samples) UXO-12 Decision Unit 6- Southeast UXO 12 (2 SMI, 4 SB samples) UXO-12 Decision Unit 7- North-Central UXO 12 (1 SMI, 2 SB sample) UXO-12 Decision Unit 9 - Laguna Monte Largo Fringe (4 SMI, 4 SS sample)										

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
SMI	EXPLO	23	3		2		11			44
	METAL	23	3		2		11			44
	WCHEM (pH and TOC)	23								23
SB	EXPLO	38		4	3		2			50
	METAL	38		4	3		2			50
	WCHEM (pH and TOC)	38								38
SS	EXPLO	4		1	1		1			8
	METAL	4		1	1		1			8
	WCHEM (pH and TOC)	4								4
UXO-12 Decision Unit 8 - Laguna Monte Largo (3 SW, 3 SD samples)										
SW	EXPLO	3		1	1		1			7
	METAL	3		1	1		1			7
	FMETAL	3		1	1		1			7
SD	EXPLO	3		1	1		1			7
	METAL	3		1	1		1			7
	GRAINSIZE	3								3
	WCHEM (pH and TOC)	3								3

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-13 Decision Unit 1 - Northeast UXO 13 (12 SMI, 24 SB samples) UXO-13 Decision Unit 2 - Central UXO 13 (11 SMI, 22 SB samples) UXO-13 Decision Unit 3 - East Northeast UXO13 (2 SMI, 4 SB sample) UXO-13 Decision Unit 4 - Parcel C UXO 13 (8 SS, 8 SB samples) UXO-13 Decision Unit 5 - South UXO 13 (1 SMI, 2 SB sample) UXO-13 Decision Unit 7 - Laguna Algodones Fringe (3 SMI, 3 SS samples)										
SMI	EXPLO	29	3		2		14			53
	METAL	29	3		2		14			53
	SVOC (PAHs only)	2	1		1					6
	WCHEM (pH and TOC)	29								29
SB	EXPLO	60		6	4		3			77
	METAL	60		6	4		3			77
	WCHEM (pH and TOC)	60								60
SS	EXPLO	11		2	1		1			16
	METAL	11		2	1		1			16
	WCHEM (pH and TOC)	11								11
UXO-13 Decision Unit 6 - Laguna Algodones (6 SW, 6 SD samples)										
SW	EXPLO	6		1	1		1			10
	METAL	6		1	1		1			10
	FMETAL	6		1	1		1			10
SD	EXPLO	6		1	1		1			10
	METAL	6		1	1		1			10
	GRAINSIZE	6								6
	WCHEM (pH and TOC)	6								6

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-14 Decision Unit 1 - East UXO 14 (1 SMI, 2 SB sample) UXO-14 Decision Unit 2 - East Central UXO 14 (1 SMI, 2 SB sample) UXO-14 Decision Unit 3 - West Central UXO 14 (2 SMI, 4 SB samples) UXO-14 Decision Unit 4 - West UXO 14 (1 SMI, 2 SB samples) UXO-14 Decision Unit 6 - West UXO 14 Lagoon Fringes (Laguna Yanuel) (4 SMI, 4 SS sample) UXO-14 Decision Unit 8 - East Central UXO 14 Lagoon Fringes (Lagoon 15) (2 SMI, 2 SS sample) UXO-14 Decision Unit 10 - East UXO 14 Lagoon Fringes (Lagoons 12 and 13) (2 SMI, 2 SS samples)										
SMI	EXPLO	13	2		1		6			25
	METAL	13	2		1		6			25
	WCHEM (pH and TOC)	13								13
SB	EXPLO	10		1	1		1			14
	METAL	10		1	1		1			14
	WCHEM (pH and TOC)	10								10
SS	EXPLO	8		1	1		1			12
	METAL	8		1	1		1			12
	WCHEM (pH and TOC)	8								8
UXO-14 Decision Unit 5 - West UXO 14 Lagoons (Laguna Yanuel) (3 SW, 3 SD samples) UXO-14 Decision Unit 7 - East Central UXO 14 Lagoons (Lagoons 14 and 15) (5 SW, 5 SD samples) UXO-14 Decision Unit 9 - East UXO 14 Lagoons (Lagoons 12 and 13) (6 SW, 6 SD samples)										
SW	EXPLO	14		2	1		1			19
	METAL	14		2	1		1			19
	FMETAL	14		2	1		1			19
SD	EXPLO	14		2	1		1			19
	METAL	14		2	1		1			19
	GRAINSIZE	14								14
	WCHEM (pH and TOC)	14								14

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group[2]	No. of Sampling Locations	No. of Field Triplicates	No. of Field Duplicates	No. of MS/MSD Pairs	No. of Field Blanks	No. of Equipment Blanks[1]	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
UXO-17 Decision Unit 1 - PAOC EE										
SS	EXPLO	3		1	1		1			7
	METAL	3		1	1		1			7
	WCHEM (pH and TOC)	3								3
UXO-18 Decision Unit 1 - Cayo de la Chiva										
SMI	EXPLO	2	1		1		1			7
	METAL	2	1		1		1			7
	WCHEM (pH and TOC)	2								2
SS	EXPLO	3		1	1		1			7
	SVOC (Hexachloroethane-only)	3		1	1		1			7
	METAL	3		1	1		1			7
	WCHEM (pH and TOC)	3								3

Notes:

1. The number of equipment blanks is based on a fundamental assumptions. For groundwater, it is assumed that two samples can be collected per day using a submersible pump. For multi-incremental samples, it was assumed that four samples can be collected per day. For surface and subsurface soil samples, it was assumed that 20 samples can be collected per day. For surface water samples, it was assumed that 20 samples can be collected per day. For sediment samples, it was assumed that 20 samples can be collected per day.
2. Analytical protocol for uranium and radiological analysis will be covered in a UFP-SAP addendum.

SAP Worksheet #21 — Project Sampling SOP References Table

Reference numbers refer to the SOP number in the Master Protocols.

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOPs A-2a	Soil Sampling	CH2M HILL	Stainless steel hand auger, stainless steel spoons, or split spoons	N	
SOPs A-2b	Thin-Walled Tube Sampling of Soils for Geotechnical Purposes	American Society for Testing and Materials (ASTM) International	Shelby tubes	N	
SOPs A-2c	Description and Identification of Soils	ASTM	SOP	N	
SOPs A-7	Systematic Random Incremental Sampling	CH2M HILL	Clean hardened plastic or metal scoops, spoons, or coring tools (such as MIST sampling tool)	N	
SOPs B-1	Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling	CH2M HILL	Polyethylene sheeting, photoionization detector (PID), groundwater sampling pump, water level indicator, tubing, and multi-parameter monitoring instrument	N	
SOPs C-1	Calibration and Measurement with Field Instruments	CH2M HILL	Multi-parameter monitoring instrument	N	
SOPs C-4	Operation of Ludlum Model 19 Micro R Meter, Gamma Radiation Detector	CH2M HILL	Ludlum Model 19 Micro R Meter	N	
SOPs D-1	Monitoring Well Installation	CH2M HILL	Well completion diagrams and boring logs	N	
SOPs D-2	Monitoring Well Development	CH2M HILL	Surge block plus PVC pipe, well-development pump, tubing, multi-parameter monitoring instrument, water level indicator, and containers for purge water	N	
SOPs E-1	Decontamination of Personnel and Equipment	CH2M HILL	Decon equipment	N	
SOPs G-1	Surface Water Sampling	CH2M HILL	Kemmerer or pump	N	
SOPs G-2	Sediment Sampling	CH2M HILL	Grab sampler	N	
SOPs H-1	Preparing Field Log Books	CH2M HILL	Log book	N	
SOPs H-2	Water-Level Measurements	CH2M HILL	Water level indicator		
SOPs H-4	Chain-of-Custody	CH2M HILL	SOP, tape, custody seals, electronic chain of custody forms	N	
SOPs H-5	Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods	CH2M HILL	SOP	N	
SOPs H-6	Equipment Blank Preparation	CH2M HILL	Sample containers	N	
	Introducing the MIST, Multi-incremental sampling tool	Centauri Labs	MIST sampling tool	N	
	Modified Soil Sample Depth Selection Protocol	CH2M HILL	SOP	N	

SAP Worksheet #21 — Project Sampling SOP References Table (continued)

Reference numbers refer to the SOP number in the Master Protocols.

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOPs MR-1	Vegetation Removal	CH2M HILL	Handheld vegetation cutting tools, back hoe (optional); hand-held magnetometer	N	
SOPs MR-2	Surface Munitions and Explosives of Concern Removal	CH2M HILL	Hand-held magnetometer, data collection device, hand tools (shovel, pick ax, breaker bar, etc)	N	
SOPs MR-3	Vieques Electronic Data Entry SOP	CH2M HILL	Trimble GeoXT with stylus, or equivalent GPS device	N	
SOPs MR-4	Digital Geophysical Mapping	CH2M HILL	Geonics EM61-MK2 time domain electromagnetic metal detectors with real-time kinematic (RTK) global positioning systems (GPS), or equivalent	N	
SOPs MR-5	Geophysical Survey Verification	CH2M HILL	Geonics EM61-MK2 time domain electromagnetic metal detectors with real-time kinematic (RTK) global positioning systems (GPS), or equivalent; QC seeds	N	
SOPs MR-6	Subsurface Anomaly Removal	CH2M HILL	Geonics EM61-MK2 time domain electromagnetic metal detectors with real-time kinematic (RTK) global positioning systems (GPS), or equivalent; hand-held magnetometer; data collection device; hand tools (shovel, pick ax, breaker bar, etc); backhoe (optional)	N	
SOPs MR-7	MPPEH/MD Collection and Inspection	CH2M HILL	Heavy equipment for picking up and transporting recovered materials; Hammermill, or equivalent, for demilitarization of item; thermal treatment furnace	N	
SOPs MR-8	Explosives Management	CH2M HILL	Demolition materials;; Vehicle for transportation of explosives; explosives storage magazines; fire extinguishers	N	
SOPs MR-9	Geographic Information System Procedures	CH2M HILL	SOP	N	
SOPs MR-10	Subsurface Anomaly Inspection	CH2M HILL	EM61-MK2, or equivalent; RTK-GPS; Magnetometer; Data collection device; Hand tools – shovel, pick ax, breaker bar, etc.; Back hoe (optional)	N	

Note: The SOPs related to the munitions response activities provided in this SAP present the minimum standards through which MR work will be completed at the former VNTR. MEC removal contractors will develop specific SOPs for conducting their respective scope that meet, or exceed, the standards presented in the SOPs provided in this SAP.

SAP Worksheet #22 — Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Resp. Person	SOP Reference
YSI pH probe	Calibrate probe using YSI Auto-Calibration Standard Solution			Daily, before use	Std X-0.2<Reading<Std X+0.2	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
YSI Specific conductance Probe	Calibrate probe using YSI Calibration Standard Solution			Daily, before use	±3%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
Hach Turbidity Meter	Calibrate probe using Hach-Calibration Standard			Daily, before use	0.1 to 10 Nephelmetric Turbidity Unit (NTU) standard - ±10%; 11 to 40 NTU standard - ±8%; 41 to 100 NTU standard - ±6.5%; >100 NTU standard - ±5%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
YSI Dissolved oxygen and Temperature Probes	Calibrate probe using YSI-Calibration Standard Solution		During calibration of other probes, check these readings against the day's atmospheric pressure and ambient temperature Check sensor for bubbles and membrane for wrinkles or tear	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	±0.3 milligrams per liter (mg/L) DO of what the tabulated DO is for the measured temperature	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly. Follow manufacturer's instructions to remove bubble or replace torn membrane	FTL	SOP C-1
YSI multi-meter	Calibrate probe using multiple Calibration Standard Solutions	Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check.	Visual Inspection	Daily before use, at the end of the day (if practicable), and when unstable readings occur.	Stable readings after 3 minutes pH reads 4.0 +/- 3% conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
ORP	Calibrate using ORP standard solution	Check batteries and have a replacement set on hand	Visual inspection	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	±10 mV of the theoretical redox standard value at that temperature	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly	FTL	SOP C-1
Hand-held magnetometer	Verify functionality using known locations of ferrous items	Check batteries and have a replacement set on hand	During functionality test verify audible response to ferrous item	Daily, before use, and as deemed necessary throughout use	Audible response to ferrous item	Replace batteries and attempt functionality test again. Do not use individual instrument an audible response is not heard during functional test.	MR Team Leader	SOP MR-2
Geonics EM61-MK2 time domain electromagnetic metal detectors with RTK GPS	Verify user does not impact data collection ability/results, positional accuracy of data, and unit is properly connected	Check operators for metallic items on clothing or in pockets that may impact data collection results Check batteries and cable connections, have additional batteries/cables available (if feasible)	Visual inspection of unit "Personnel test" to determine if items on or within clothing have an impact on the data collection Run equipment over known locations of items to verify readings and positional data are consistent and accurate "Cable shake" of cables to determine if connections are loose or vibrations will introduce spikes in the data	Daily, before use, and as deemed necessary throughout use	"Personnel test" and "cable shake" do not introduce spikes in the data, as determined by observation of the real-time data collection displays Equipment displays consistent mV readings for known items, as determined by observation of the real-time data collection displays Positional location of known items is accurate, as verified through analysis of data collected and real-time observation of GPS coordinates	Remove metallic items from clothing and pockets Tighten loose connections Replace cables with loose or failing connectors Check GPS unit settings if positional data is not correct Do not use instruments if consistent/accurate readings are not displayed.	FTL	SOPs MR-4 and MR-5
Ludlum Model 19 Micro R Meter, Gamma Radiation Detector	The meter will be calibrated and operated in accordance with the manufacturer's calibration and operation procedures in the manual, Section 2, operational check.	Refer to SOP C-4 for recommended maintenance and calibration checks and follow them to the extent practical. Note deviations in logbook. Clean all instruments when done with a damp paper towel.	Check batteries. Have spare unit readily available.	Daily, before use	Refer to SOP C-4 for acceptance criteria listed in Documentation of Field Calibration Check Section.	Clean instrument with a damp paper towel.	FTL	SOP C-4

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SAP Worksheet #23 — Analytical SOP References Table

(UFP-QAPP Manual Section 3.2.1)

Lab SOP Number	Title, Revision Date, and/or Number[1]	Date Last Revisited if not Revised[2]	Definitive or Screening Data[3]	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM	Modified for Project Work? (Y/N)[4]
LAB-01	Sample Receiving		N/A	N/A	N/A	TBD	TBD	TBD
LAB-02	Sample Management and Chain of Custody		N/A	N/A	N/A	TBD	TBD	TBD
LAB-03	Laboratory Waste Disposal		N/A	N/A	N/A	TBD	TBD	TBD
LAB-04	8330B-Prep (grinding and milling) suitable for EXPLO analysis		N/A	SMI / EXPLO	N/A (Grinder)	TBD	TBD	TBD
LAB-05	8330B-Prep (grinding and milling) suitable for SVOC analysis		N/A	SMI / SVOC	N/A (Grinder)	TBD	TBD	TBD
LAB-06	8330B-Prep (grinding and milling) suitable for METAL analysis		N/A	SMI / METAL	N/A (Mortar and Pestle)	TBD	TBD	TBD
LAB-07	Extraction of solid samples prior to 8330B analysis		N/A	SD, SMI, SS, SB / EXPLO	N/A	TBD	TBD	TBD
LAB-08	Extraction of aqueous samples prior to 8330B analysis		N/A	GW, SW / EXPLO	N/A	TBD	TBD	TBD
LAB-09	8330B (Explosives) analysis		Definitive	SD, SMI, SB, GW, SS, SW / EXPLO	HPLC	TBD	TBD	TBD
LAB-10	6850 (Perchlorate) analysis		Definitive	SD, SMI, SB, SS, GW, SW / EXPLO	LC/MS/MS	TBD	TBD	TBD
LAB-11	Digestion of solid samples prior to 6010/6020 analysis		N/A	SD, SMI, SS, SB / METAL	N/A	TBD	TBD	TBD
LAB-12	Digestion of aqueous samples prior to 6010/6020 analysis		N/A	GW, SW / METAL, FMETAL	N/A	TBD	TBD	TBD
LAB-13	6010 (Metals) analysis		Definitive	SD, SMI, SB, SS, GW, SW / METAL, FMETAL	ICP-AES	TBD	TBD	TBD
LAB-14	6020 (Metals) analysis		Definitive	SD, SMI, SB, SS, GW, SW / METAL, FMETAL	ICP-MS	TBD	TBD	TBD
LAB-15	7196 (Hexavalent chromium) analysis		Definitive	SD, SMI, SB, SS, GW, SW / METAL, FMETAL	Colorimeter	TBD	TBD	TBD
LAB-16	Extraction of solid samples prior to 8270 analysis		N/A	SD, SMI, SS, SB / SVOC	N/A	TBD	TBD	TBD
LAB-17	Extraction of aqueous samples prior to 8270 analysis		N/A	GW, SW / SVOC	N/A	TBD	TBD	TBD
LAB-18	8270 (Semivolatiles) analysis		Definitive	SD, SMI, SB, SS, GW, SW / SVOC	GC-MS	TBD	TBD	TBD
LAB-19	8270_SIM (Semivolatiles via SIM) analysis		Definitive	SD, SMI, SB, SS, GW, SW / SVOC	GC-MS	TBD	TBD	TBD
LAB-20	9045 (pH) analysis		Screening	SD, SMI, SB / WCHEM	pH Probe	TBD	TBD	TBD
LAB-21	Lloyd Kahn (Total Organic Carbon (TOC)) analysis		Screening	SD, SMI, SB / WCHEM	TOC Analyzer	TBD	TBD	TBD
LAB-22	D422 (Grain size) analysis		Screening	SD / GRAINSIZE	Sieves	TBD	TBD	TBD
LAB-23	Preparation of solid samples prior to radiological analysis		N/A	SD, SMI, SS, SB / RAD	N/A	TBD	TBD	TBD
LAB-24	Preparation of aqueous samples prior to radiological analysis		N/A	GW, SW / RAD, FRAD	N/A	TBD	TBD	TBD
LAB-25	Isotopic uranium analysis		Definitive	SD, SMI, SS, SB, GW, SW / RAD, FRAD	N/A (column separation)	TBD	TBD	TBD
LAB-26	Alpha spectroscopy		Definitive	SD, SMI, SS, SB, GW, SW / RAD, FRAD	Alpha Spectrometer	TBD	TBD	TBD

Notes:

1. These are examples of SOPs which may be gathered (kept on file). Often, laboratories combine SOPs (i.e. extraction method and analysis method together). Upon laboratory selection, SOPs are gathered and a laboratory-specific Worksheet #23 is prepared.
2. If an SOP was not revised in the past year (as of the date of preparation of this worksheet) then it must have been revisited within the past year or must be in the process of revision/revisitation. This revision/revisitation requirement applies only to preparation and analysis SOPs.
3. Prior to analysis, the selected laboratory must have DoD-ELAP accreditation for all analytes to be returned via analysis methods generating definitive data. For screening data, DoD-ELAP accreditation is preferred but not required.
4. If the laboratory intends to deviate from their SOP for this project, the modification (designated by "Y") must be specified. If the laboratory intends to utilize a non-standard method option (i.e. such as 25mL purge for VOCs), the option (designated by "N") must be described.

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SAP Worksheet #24 — Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
HPLC (for EXPLO)[1]	Initial calibration (ICAL)	Minimum of 5 calibration standards with the lowest standard concentration at or below the Reporting Limit (RL). Once calibration curve or line is generated, the lowest calibration standard must be re-analyzed.	The apparent signal-to-noise ratio at the RL must be at least 5:1. If linear regression is used, r ≥ 0.995. If using Internal Standardization, Relative Standard Deviation (RSD) ≤ 15%.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate. No samples can be run without a valid ICAL.	Analyst	LAB-09
	Second source calibration verification (ICV)	Immediately following ICAL.	All analyte(s) and surrogates within ±20% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until calibration has been verified.		
	Continuing calibration verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All target analytes and surrogates within ±20% of the expected value from the ICAL.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		
LC/MS/MS[1]	Initial calibration (ICAL)	Minimum of 5 calibration standards to establish linearity at method set-up and after major maintenance.	r ≥ 0.995 or RSD ≤ 20%. The concentration corresponding to the absolute value of the calibration curve's Y-intercept must be ≤ LOD.	Correct problem then repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until ICAL has passed. Calibration is linear and shall not be forced through the origin.	Analyst	LAB-10
	Initial calibration verification (ICV)	Once after each ICAL, analysis of a second source standard at the midpoint of the calibration.	Within ±15% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until calibration has been verified.		
	Continuing calibration verification (CCV)	Analysis of mid-level standard after every 10 field samples. All samples must be bracketed by the analysis of a standard demonstrating that the system was capable of accurately detecting and quantifying perchlorate.	Within ±15% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		
	Tuning	Prior to ICAL and after any mass calibration or maintenance is performed.	Tuning standards must contain the analytes of interest and meet acceptance criteria outlined in LAB-10.	Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone. Flagging criteria are not appropriate. Problem must be corrected. Sample analysis shall not proceed without acceptable tuning.		
	Mass calibration	Instrument must have a valid mass calibration prior to any sample analysis. The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses show large deviations from known masses, major instrument maintenance is performed, or the instrument is moved).	Mass calibration range must bracket the ion masses of interest without greatly exceeding the range. The most-recent mass calibration must be used for an analytical run and the same mass calibration must be used for all data files in an analytical run. Mass calibration must be verified by acquiring a full scan continuum mass spectrum of a perchlorate stock standard. Perchlorate ions should be within ±0.3 m/z of masses 99, 101, and 107 or of their respective daughter ion masses (83, 85, and 89) depending on which ions are quantitated.	If the mass calibration fails, recalibrate. If it still fails, consult manufacturer instructions on corrective maintenance. Flagging criteria are not appropriate. Problem must be corrected. No samples may be analyzed under a failing mass calibration.		
	Interference threshold study	At initial setup and when major changes occur in the method's operating procedures (e.g., addition of cleanup procedures, column changes, mobile phase changes).	Measure the threshold of common suppressors (chloride, sulfate, carbonate, bicarbonate) that can be present in the system without affecting the quantitation of perchlorate. The threshold is the concentration of the common suppressors where perchlorate recovery falls outside an 85-115% window.	N/A. Flagging criteria are not appropriate.		

SAP Worksheet #24 — Analytical Instrument Calibration Table (continued)

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
ICP-AES[1]	Initial Calibration (ICAL) for all analytes (minimum one high standard and a calibration blank)	Daily ICAL prior to sample analysis	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until ICAL has passed.	Analyst	LAB-13
	Second Source Calibration Verification	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes within ±10% of true value.	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until calibration has been verified.		
	Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All analytes within ±10% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		
	Low-level calibration check standard	Daily, after one-point ICAL.	Within ±20% of true value.	Correct problem, then reanalyze. Flagging criteria are not appropriate. No samples may be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the RL.		
	Linear dynamic range or high-level check standard	Every 6 months.	Within ±10% of true value.	N/A		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed. Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.		
ICP-MS[1]	Tuning	Prior to ICAL	Mass calibration ≤ 0.1 amu from the true value; Resolution ≤ 0.9 amu full width at 10% peak height; For stability, RSD ≤ 5% for at least four replicate analyses.	Retune instrument then reanalyze tuning solutions. Flagging criteria are not appropriate. No analysis shall be performed without a valid MS tune.	Analyst	LAB-14
	Initial Calibration (ICAL) for all analytes (minimum one high standard and a calibration blank)	Daily ICAL prior to sample analysis	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until ICAL has passed.		
	Second Source Calibration Verification	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes within ±10% of true value.	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until calibration has been verified.		
	Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All analytes within ±10% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		
	Low-level calibration check standard	Daily, after one-point ICAL.	Within ±20% of true value.	Correct problem, then reanalyze. Flagging criteria are not appropriate. No samples may be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the RL.		
	Linear dynamic range or high-level check standard	Every 6 months.	Within ±10% of true value.	N/A		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed. Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.		

SAP Worksheet #24 — Analytical Instrument Calibration Table (continued)

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
Colorimeter[1]	Reference blank (reagent water)	Before beginning standards or sample analysis.	N/A	Used for blank subtraction of standards, field, and QC samples. For turbid field samples, a turbidity blank must be used instead of the reference blank (using a sample aliquot prepared in accordance with SW-846 7196A Section 7.1 .	Analyst	LAB-15
	Initial calibration (ICAL) (minimum three standards and a calibration blank)	Daily ICAL prior to sample analysis	r ≥ 0.995	Correct problem and repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until ICAL has passed.		
	Second source calibration verification (ICV) (also known as independently-prepared check standard)	Before beginning a sample run.	Value of second source within ±10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat calibration. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until calibration has been verified.		
	Continuing calibration verification (CCV)	After every 15 field samples and at the end of the analysis sequence.	Value of CCV within ±10% of true value.	Correct problem then repeat CCV and reanalyze all samples since last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Problem must be corrected. No samples may be run until calibration has been verified. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		
GC-MS (for SVOC)[1]	Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to SW-846 8270D for specific ion criteria.	Retune instrument and verify. Rerun affected samples. Flagging criteria are not appropriate. Problem must be corrected. No samples may be accepted without a valid tune.	Analyst	LAB-18, LAB-19
	Minimum five-point ICAL for all analytes	ICAL prior to sample analysis.	1. Average response factor (RF) for SPCCs:SVOCs ≥ 0.050.2. RSD for RFs for CCCs: SVOCs ≤ 30% and one option below: Option 1: RSD for each analyte ≤ 15%; Option 2: Linear least-squares regression r ≥ 0.995; Option 3: Non-linear regression - coefficient of determination (COD) r^2 ≥ 0.99 (six points shall be used for second order, seven points shall be used for third order).	Correct problem then repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until ICAL has passed. Calibration may not be forced through the origin.		
	Second source calibration verification (ICV)	Once after each ICAL.	All project analytes within ±20% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until calibration has been verified.		
	Retention time window position establishment for each analyte and surrogate	Once per ICAL	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	N/A		
	Evaluation of relative retention times (RRT)	With each sample.	RRT of each target analyte within ±0.06 RRT units.	Correct problem, then rerun ICAL. Flagging criteria are not appropriate. Refer to DoD QSM v. 4.1 Table F-4 for more information.		
	Continuing calibration verification (CCV)	Daily before sample analysis and every 12 hours of analysis time.	1. Average response factor (RF) for SPCCs: SVOCs ≥ 0.050. 2. %Difference/Drift for all target compounds and surrogates: SVOCs ≤ 20%D (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV. Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		

SAP Worksheet #24 — Analytical Instrument Calibration Table (continued)

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
pH Probe[2]	Two-point ICAL using pH buffers.	Daily	±0.05 pH units for each buffer.	If calibration is not achieved, then check pH meter, buffer solutions, and pH probe. Replace if necessary. Repeat calibration.	Analyst	LAB-20
	Continuing calibration verification (CCV) using a mid-range pH buffer.					
TOC Analyzer[2]	Four-point ICAL. Three standards and a blank.	Initially and as needed.	r ≥ 0.995 for each regression line.	Repeat until acceptable. Perform instrument maintenance if needed.	Analyst	LAB-21
	Initial Calibration Verification (ICV)	After each ICAL and daily prior to sample analysis.	90-110%R	Reanalyze ICV. If still unacceptable, repeat ICAL.		
	Initial Calibration Blank (ICB)	After each ICV, prior to sample analysis.	< RL	Remake and reanalyze ICB once. If still unacceptable, investigate and correct problem or B-qualify results less than 20X the related blank detect.		
	Continuing calibration verification (CCV)	Daily, prior to sample analysis, after every 10 analyses, and at the end of a run.	90-110%R	Remake and reanalyze CCV. If still unacceptable, investigate and correct problem. Reanalyze all samples after last acceptable CCV.		
	Continuing calibration blank (CCB)	After each CCV.	< RL or < 1/20 the lowest sample result	Remake and reanalyze CCB once. If still unacceptable, investigate and correct problem. Then, reanalyze all samples after the last acceptable CCB or B-qualify results less than 20X the related blank detect.		
Alpha Spectrometer[3]	Initial calibration (ICAL)	Initially and as needed.	TBD	Refer to laboratory SOP.	Analyst	LAB-26
	Monthly checks	If and as-required by laboratory SOP.	TBD	Refer to laboratory SOP.		
	Weekly checks	If and as-required by laboratory SOP.	TBD	Refer to laboratory SOP.		
	Continuing calibration verification (CCV)	Daily or as required by laboratory SOP.	TBD	Refer to laboratory SOP.		
	Background check	As-required by laboratory SOP.	TBD	Refer to laboratory SOP.		

Notes:

1. DoD QSM v. 4.1 is the basis for specifications on this table for definitive analyses.
2. Specifications may vary slightly for screening analyses.
3. Most specifications for alpha spectrometer are to be determined.

SAP Worksheet #25 — Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.3)

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Grinder	Refer to referenced analytical laboratory SOPs. Maintenance, testing, and inspection records are kept on file at the laboratory where analysis is performed.						Analyst	LAB-04, LAB-05
Mortar and Pestle								LAB-06
HPLC (for EXPLO)								LAB-09
LC/MS/MS								LAB-10
ICP-AES								LAB-13
ICP-MS								LAB-14
Colorimeter								LAB-15
GC-MS (for SVOC)								LAB-18, LAB-19
pH Probe								LAB-20
TOC Analyzer								LAB-21
Sieves								LAB-22
Alpha Spectrometer								LAB-26

Notes:

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SAP Worksheet #26 — Sample Handling System

(UFP-QAPP Manual Appendix A)

Sample Collection, Packaging, And Shipment	
Sample Collection (Personnel/Organization):	Field Team Leader (TBD)/CH2M HILL
Sample Packaging (Personnel/Organization):	Sample Processor or Field Team Member (TBD)/CH2M HILL
Coordination of Shipment (Personnel/Organization):	Sample Processor or Field Team Member (TBD)/CH2M HILL
Type of Shipment/Carrier:	Overnight/FedEx
Sample Receipt And Analysis	
Sample Receipt (Personnel/Organization):	Sample Receipt Personnel/Analytical Laboratory (TBD).
Sample Custody and Storage (Personnel/Organization):	Sample Receipt Personnel/Analytical Laboratory (TBD).
Sample Preparation (Personnel/Organization):	Extractions Personnel/Analytical Laboratory (TBD). Digestions Personnel/Analytical Laboratory (TBD)
Sample Determinative Analysis (Personnel/Organization):	Analyst/Analytical Laboratory (TBD)
Sample Archiving	
Field Sample Storage (No. of days from sample collection):	90 Days
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	Extracts may be disposed of 90 days after extraction. Digestates may be disposed of 90 days after digestion.
Biological Sample Storage (No. of days from sample collection):	N/A
Sample Disposal	
Personnel/Organization:	Environmental Health and Safety Officer/Analytical Laboratory (TBD)
Number of Days from Analysis:	Samples may be disposed of 90 days after report mail date.

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SAP Worksheet #27 — Sample Custody Requirements

(UFP-QAPP Manual Section 3.3.3)

Sample Labeling

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservative, and sampler's initials. Labels will be taped to the jar to ensure that they do not separate. Note that tape may not be necessary if it adds to the weight of pre-tared vials. Note that tape may not be necessary if it interferes with the robotics of an autosampler. In the event that tape is not necessary, waterproof labels and ink will be used.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory)

Samples will be collected by field team members under the supervision of the field team leader. As samples are collected, they will be placed into containers and labeled, as outlined above. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples below 4 degrees Celsius (°C) until they are received by the laboratory. The chain of custody (COC) will also be placed into the cooler. Coolers will be shipped to the laboratory via FedEx, with the airbill number indicated on the COC (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal)

Please refer to LAB-01 for details on sample receipt. Please refer to LAB-02 for details on sample management and chain of custody. Please refer to LAB-03 for details on laboratory waste disposal.

Sample Identification Procedures

Upon opening the cooler, the receiving clerk signs the COC and then takes the temperature using the temperature blank (if absent, then a sample container or infrared thermometer is used). The sample containers in the cooler are unpacked and checked against the client's COC and any discrepancies or breakage is noted on the COC. Next, if any water samples require preservative, the clerk will check the pH values to see if they are in the acceptable pH range. The clerk will deliver the COC (and any other paperwork; e.g. temperature or pH QA notice) to the project manager for Laboratory Information Management Systems (LIMS) entry and client contact (if needed).

The field logbook will identify the sample ID with the location, depth, date/time collected, and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain of custody. The laboratory will send sample log-in forms to the project data manager to check sample IDs and parameters are correct.

Chain-of-Custody Procedures

Chains of custody will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID, date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain of custody will also have the sampler's name and signature. The chain of custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the LIMS database for each sample.

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SAP Worksheet #28-1 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SS, SB, SD, SMI
Analytical Group: EXPLO
Analytical Method / SOP Reference: LAB-04, LAB-05, LAB-06, LAB-07, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate (for SB and SD only)	One per 10 normal field samples per matrix	% Relative Percent Difference (RPD) < 30%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Assess field homogenization procedures. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 30%
Field Triplicate (for SMI only)	One per 10 normal field samples per matrix at a site	%RSD < 30% (advisory only)	None.	N/A	Precision	%RSD < 30% (advisory only)
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Matrix Spike/Matrix Spike Duplicate	One per 20 normal field samples per matrix	See below.				
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
Multi Incremental Sample Preparation (for SMI samples) via LAB-04 (for EXPLO), LAB-05 (for METAL), and LAB-06 (for SVOC)						
Soil drying procedure	Each sample and batch Laboratory Control Sample (LCS)	Laboratory must have a procedure to determine when the sample is dry to constant weight. Record date, time, and ambient temperature on a daily basis while drying samples.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	Laboratory must have a procedure to determine when the sample is dry to constant weight. Record date, time, and ambient temperature on a daily basis while drying samples.
Soil sieving procedure	Each sample and batch LCS	Weigh entire sample. Sieve entire sample with a 10 mesh sieve. Breakup pieces of soil (especially clay) with gloved hands. Do not intentionally include vegetation in the portion of the sample that passes through the sieve unless this is a project specific requirement. Collect and weigh any portion unable to pass through the sieve.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	Weigh entire sample. Sieve entire sample with a 10 mesh sieve. Breakup pieces of soil (especially clay) with gloved hands. Do not intentionally include vegetation in the portion of the sample that passes through the sieve unless this is a project specific requirement. Collect and weigh any portion unable to pass through the sieve.
Soil subsampling process	Each sample and batch LCS	Prior to grinding for explosives (8330B and 6850), an aliquot is removed for hand-grinding of metals (6010/6020, 7196), for hand-grinding of semivolatiles (8270, 8270_SIM) if not done simultaneously with explosives, and for pH and TOC without grinding.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	Prior to grinding for explosives (8330B and 6850), an aliquot is removed for grinding of metals (6010/6020, 7196), for grinding of semivolatiles (8270, 8270_SIM) if not done simultaneously with explosives, and for pH and TOC without grinding.
Sol grinding procedure	Initial demonstration	The laboratory must initially demonstrate that the grinding procedure is capable of reducing the particle size to < 75 um by passing representative portions of ground sample through a 200 mesh sieve. Note that there may be three grinding procedures: one appropriate for EXPLO, one appropriate for METAL, and one appropriate for SVOC (if not identical to that for EXPLO).	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	The laboratory must initially demonstrate that the grinding procedure is capable of reducing the particle size to < 75 um by passing representative portions of ground sample through a 200 mesh sieve. Note that there may be three grinding procedures: one appropriate for EXPLO, one appropriate for METAL, and one appropriate for SVOC (if not identical to that for EXPLO).

SAP Worksheet #28-1 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix:	SS, SB, SD, SMI
Analytical Group:	EXPLO
Analytical Method / SOP Reference:	LAB-04, LAB-05, LAB-06, LAB-07, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Soil grinding blank	Between each sample	A grinding blank using clean solid matrix (such as Ottawa sand) must be prepared (e.g., ground and subsampled) and analyzed in the same manner as a field sample. Grinding blanks can be analyzed individually or composited. No target analytes detected greater than 1/2 RL.	All blank results must be reported and the affected samples must be flagged accordingly if blank criteria is not met. If the composite grinding blank exceeds the acceptance criteria, apply B-flag to all samples associated with the grinding composite. If any individual grinding blank is found to exceed the acceptance criteria, apply B-flag to the sample following that blank.	Analyst	Contamination, Representativeness	A grinding blank using clean solid matrix (such as Ottawa sand) must be prepared (e.g., ground and subsampled) and analyzed in the same manner as a field sample. Grinding blanks can be analyzed individually or composited. No target analytes detected greater than 1/2 RL.
Soil subsampling process	Each sample and batch LCS	Entire ground sample is mixed, spread out on a large flat surface (e.g., baking tray), and 30 or more randomly located increments are removed from the entire depth to sum a subsample.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	Entire ground sample is mixed, spread out on a large flat surface (e.g., baking tray), and 30 or more randomly located increments are removed from the entire depth to sum a subsample.
Ground LCS (or certified reference material)	One per preparatory batch	A solid reference material containing all reported analytes must be prepared (e.g., ground and subsampled) and analyzed in exactly the same manner as a field sample. Accuracy limits are specified in Worksheet #15. However, if a certified reference material is used, then manufacturer's limits shall apply.	Reevaluate grinding procedure for future samples. At this point, the affected samples have already been ground. Qualify as per Worksheet #36.	Analyst, Data Validator	Accuracy, Representativeness	A solid reference material containing all reported analytes must be prepared (e.g., ground and subsampled) and analyzed in exactly the same manner as a field sample. Accuracy limits are specified in Worksheet #15. However, if a certified reference material is used, then manufacturer's limits shall apply.
Laboratory triplicate	At the subsampling step, one sample per batch. Cannot be performed on any type of blank sample	Three subsamples are taken from a sample expected to contain the highest levels of explosives within the Quantitation Range of the method. The RSD for results above the RL must not exceed 20%.	Corrective action must be taken if this criterion is not met (e.g., the grinding process should be investigated to ensure that the samples are being reduced to a sufficiently small particle size). Apply J-flag if corrective action does not solve problem and no sample available.	Analyst	Precision, Representativeness	Three subsamples are taken from a sample expected to contain the highest levels of explosives within the Quantitation Range of the method. The RSD for results above the RL must not exceed 20%.
8330B-List Explosives via SW-846 8330B (LAB-09)						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
LCS containing all analytes to be reported	One per preparatory batch	LCS may be solid or aqueous (does not assess grinding procedures). Accuracy limits specified in Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	LCS may be solid or aqueous (does not assess grinding procedures). Accuracy limits specified in Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS. For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.	Analyst	Accuracy	Same as for LCS. For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken.

SAP Worksheet #28-1 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SS, SB, SD, SMI
Analytical Group: EXPLO
Analytical Method / SOP Reference: LAB-04, LAB-05, LAB-06, LAB-07, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS and RPD ≤ 20%.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. The data shall be evaluated to determine the source of difference.	Analyst	Accuracy / Precision	Same as for LCS and RPD ≤ 20%.
Confirmation Analysis	When target analytes are detected on the primary column using the UV Detector (HPLC) at concentrations exceeding the Limit of Detection (LOD).	Calibration and QC criteria are the same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40%.	Report from both columns. If there is a > 40% RPD between the two column results, data must be J-flagged accordingly. Confirmation analysis is not needed if LC/MS or LC/MS/MS was used for the primary analysis. The secondary column must be capable of resolving (separating) all of the analytes of interest and must have a different retention time order relative to the primary column. Any HPLC column used for confirmation analysis must be able to resolve and quantify all project analytes. Detection by HPLC UV, LC/MS or LC/MS/MS. Calibration and calibration verification acceptance criteria are the same as for the primary analysis.	Analyst	Precision	Calibration and QC criteria are the same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40%.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A
Perchlorate via SW-846 6850 (LAB-10)						
Limit of Detection Verification (LODV) (per batch)	Prior to sample analysis and at the end of the analysis sequence. It can be analyzed after every 10 samples in order to reduce the reanalysis rate.	Within ±30% of true value.	Correct problem and rerun LODV and all samples analyzed since last successful LODV. If a sample with perchlorate concentration at or between the LOD and RL is bracketed by a failing LODV, it must be reanalyzed. A sample with concentration above the RL can be reported. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable LODV. Problem must be corrected. Results may not be reported without a valid LODV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Within ±30% of true value.
Isotope Ratio 35Cl/37Cl	Every sample, batch QC sample, and standard.	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference, etc.). Apply J-flag if acceptance criteria are not met. Decision to report data failing ratio check should be thoroughly documented in case narrative.	Analyst	Accuracy	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.
Internal Standard (IS)	Addition of 18O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank.	Measured 18O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0 ±2% (0.98 – 1.02).	Rerun the sample at increasing dilutions until the ±50% acceptance criteria are met. If criteria cannot be met with dilution, then interference are suspected and the sample must be reprepped using additional pretreatment steps. Apply Q-flag and discuss in the case narrative. If peak is not within retention time window, presence is not confirmed. Use for quantitation and to ensure identification. Failing internal standard should be thoroughly documented in the case narrative.	Analyst	Accuracy	Measured 18O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0 ±2% (0.98 – 1.02).

SAP Worksheet #28-1 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix:	SS, SB, SD, SMI
Analytical Group:	EXPLO
Analytical Method / SOP Reference:	LAB-04, LAB-05, LAB-06, LAB-07, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Interference Check Solution (ICS)	One ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.	Within ±30% of true value.	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed. Flagging criteria are not appropriate. Analysis of a standard containing perchlorate at the RL and interfering anions at the concentration determined by the interference threshold study. Monitor recovery of perchlorate and retention time. No samples may be reported that are associated with a failing ICS.	Analyst	Accuracy	Within ±30% of true value.
Laboratory Reagent Blank	Prior to calibration, after samples with overrange concentration of perchlorate, and at the end of the analytical sequence.	No perchlorate detected > 1/2 RL.	Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated batch. Problem must be corrected. Results may not be reported without a valid reagent blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No perchlorate detected > 1/2 RL.
Method Blank	One per preparatory batch.	No perchlorate detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed. Method blank must undergo the same preparation and pretreatment steps as the samples in the batch.	Analyst	Contamination	No perchlorate detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
Laboratory Control Sample (LCS)	One per preparatory batch. LCS must be spiked at the RL.	Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed. LCS must undergo the same preparation and pretreatment steps as the samples in the batch.	Analyst	Accuracy	Refer to Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix. The MS must be spiked at the RL.	Same as for LCS.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. For matrix evaluation only. If MS results are outside the limits, the data must be evaluated to determine the source of the difference and to determine if there is a matrix effect or analytical error. MS must undergo the same preparation and pretreatment steps as the samples in the batch.	Analyst	Accuracy	Same as for LCS.

SAP Worksheet #28-1 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SS, SB, SD, SMI
Analytical Group: EXPLO
Analytical Method / SOP Reference: LAB-04, LAB-05, LAB-06, LAB-07, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix. The MSD must be spiked at the RL.	Same as for LCS and RPD ≤ 15%.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. The data shall be evaluated to determine the source of difference.	Analyst	Accuracy, Precision	Same as for LCS and RPD ≤ 15%.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

Notes:
DoD QSM v. 4.1 is the basis for specifications on this table.

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SAP Worksheet #28-2 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SS, SB, SD, SMI
Analytical Group: METAL
Analytical Method / SOP Reference: LAB-11, LAB-13, LAB-14, LAB-15 / TBD, SW-846 6010, 6020, 7196

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate (for SB and SD only)	One per 10 normal field samples per matrix	%RPD < 30%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Assess field homogenization procedures. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 30%
Field Triplicate (for SMI only)	One per 10 normal field samples per matrix	%RSD < 30% (advisory only)	None.	N/A	Precision	%RSD < 30% (advisory only)
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Matrix Spike/Matrix Spike Duplicate	One per 20 normal field samples per matrix	See below.				
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
Multi Incremental Sample Preparation (for SMI samples) - Refer to Worksheet #28-1						
Metals via SW-846 6010 (LAB-13)						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
Interference Check Solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples. If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	Analyst	Accuracy	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.
Laboratory Control Sample (LCS)	One per preparatory batch.	Refer to Worksheet #15.	Correct problem then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Refer to Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests (dilution test and post-digestion spike addition) are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as for LCS

SAP Worksheet #28-2 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SS, SB, SD, SMI
Analytical Group: METAL
Analytical Method / SOP Reference: LAB-11, LAB-13, LAB-14, LAB-15 / TBD, SW-846 6010, 6020, 7196

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS and 20% RPD.	Same as MS.	Analyst	Accuracy, Precision	Same as for LCS and 20% RPD.
Dilution Test	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement.	Perform post-digestion spike addition. Flagging criteria are not appropriate. Only applicable for samples within concentration > 50X LOQ.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement.
Post digestion spike addition	When dilution test fails or analyte concentration for all samples < 50X LOD.	Recovery within 75-125%.	Run all associated samples in the preparatory batch by method of standard additions (MSA) or see flagging criteria. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. Spike addition should produce a concentration of 10-100X LOQ.	Analyst	Accuracy	Recovery within 75-125%.
Method of standard additions (MSA)	When matrix interference is confirmed.	N/A	Document use of MSA in the case narrative.	Analyst	Accuracy	N/A
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A
Metals via SW-846 6020 (LAB-14)						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).
Interference Check Solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples. If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	Analyst	Accuracy	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.
Laboratory Control Sample (LCS)	One per preparatory batch.	Refer to Worksheet #15.	Correct problem then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Refer to Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests (dilution test and post-digestion spike addition) are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as for LCS
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS and 20% RPD.	Same as MS.	Analyst	Accuracy, Precision	Same as for LCS and 20% RPD.
Dilution Test	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement.	Perform post-digestion spike addition. Flagging criteria are not appropriate. Only applicable for samples within concentration > 50X LOQ.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement.

SAP Worksheet #28-2 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SS, SB, SD, SMI
Analytical Group: METAL
Analytical Method / SOP Reference: LAB-11, LAB-13, LAB-14, LAB-15 / TBD, SW-846 6010, 6020, 7196

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Post digestion spike addition	When dilution test fails or analyte concentration for all samples < 50X LOD.	Recovery within 75-125%.	Run all associated samples in the preparatory batch by MSA or see flagging criteria. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. Spike addition should produce a concentration of 10-100X LOQ.	Analyst	Accuracy	Recovery within 75-125%.
Method of standard additions (MSA)	When matrix interference is confirmed.	N/A	Document use of MSA in the case narrative.	Analyst	Accuracy	N/A
Internal Standards (IS)	Every sample.	IS intensity within 30-120% of intensity of the IS in the ICAL.	Reanalyze sample at 5-fold dilution with addition of appropriate amounts if internal standards. Flagging criteria are not appropriate.	Analyst	Accuracy	IS intensity within 30-120% of intensity of the IS in the ICAL.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A
Hexavalent Chromium via SW-846 7196 (LAB-15)						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 the RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results See Box D-1 of DoD QSM v 4.1 .	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analytes(s) in all samples in the associated preparatory batch.	Analyst	Contamination	No analytes detected > 1/2 the RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results See Box D-1 of DoD QSM v 4.1 .
Laboratory Control Sample (LCS)	One per preparatory batch.	Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Analyst	Accuracy	Refer to Worksheet #15.
Sample matrix verification (also known as matrix spike (MS))	One for every sample matrix analyzed.	Same as LCS.	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use method of standard additions. Flagging criteria are not appropriate. Verification check ensures lack of reducing condition or interference from matrix. Additional corrective actions are identified in Method 7196A (Sections 7.4 and 7.5).	Analyst	Accuracy	Same as LCS.
Matrix Spike Duplicate (MSD) or Laboratory Replicate (LR)	Solid Matrix: One per preparatory batch per matrix.	Same as LCS and ≤30% RPD.	Same as MS. Examine project-specific DQOs. Contact the client as to additional measures to be taken. Flagging criteria are not appropriate.	Analyst	Accuracy, Precision	Same as LCS and ≤30% RPD.
Post-digestion matrix spike	One per preparatory batch.	85-115% recovery.	Correct problem and rehomogenize, redigest, and reanalyze samples. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst	Accuracy	85-115% recovery.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

Notes:
DoD QSM v. 4.1 is the basis for specifications on this table.

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SAP Worksheet #28-3 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SB, SMI
Analytical Group: SVOC
Analytical Method / SOP Reference: LAB-16, LAB-18, LAB-19 / TBD, SW-846 8270, 8270_SIM

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate (for SB and SD only)	One per 10 normal field samples per matrix	%RPD < 30%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 30%
Field Triplicate (for SMI only)	One per 10 normal field samples per matrix	%RSD < 30% (advisory only)	None.	N/A	Precision	%RSD < 30% (advisory only)
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Matrix Spike/Matrix Spike Duplicate	One per 20 normal field samples per matrix	See below.				
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
Multi Incremental Sample Preparation (for SMI samples) - Refer to Worksheet #28-1						
SVOCs via SW-846 8270 and 8270_SIM (LAB-18, LAB-19)						
Breakdown Check	At the beginning of each 12-hour period, prior to analysis of samples	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses and should not exceed a tailing factor of 2.	Correct problem then repeat breakdown check. Flagging criteria are not appropriate. No samples shall be run until degradation ≤ 20%.	Analyst	Accuracy	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses and should not exceed a tailing factor of 2.
Internal Standards Verification	Every field sample, standard, and QC sample.	Retention time ±30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory. If corrective action fails in field samples, apply Q-flag to analytes associated with the non-compliant IS. Flagging criteria are not appropriate for failed standards. Sample results are not acceptable without a valid IS verification.	Analyst	Accuracy	Retention time ±30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard.
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).
Laboratory Control Sample (LCS) containing all analytes to be reported, including surrogates	One per preparatory batch.	Refer to Worksheet #15.	Correct problem then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Refer to Worksheet #15.

SAP Worksheet #28-3 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SB, SD, SMI
Analytical Group: SVOC
Analytical Method / SOP Reference: LAB-16, LAB-18, LAB-19 / TBD, SW-846 8270, 8270_SIM

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as for LCS
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS.	Same as MS.	Analyst	Accuracy / Precision	Same as for LCS.
Surrogate Spike	All field and QC samples	2-Fluorobiphenyl: 45-105% Terphenyl-d14: 30-125% 2,4,6-Tribromophenol: 35-125% 2-Fluorophenol: 35-105% Phenol-d5/d6: 40-100% Nitrobenzene-d5: 35-100%	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatoraphic interference with surrogate is present, reanalysis may not be necessary. Apply Q-flag to all associated analytes if acceptance criteria are not met.	Analyst	Accuracy	2-Fluorobiphenyl: 45-105% Terphenyl-d14: 30-125% 2,4,6-Tribromophenol: 35-125% 2-Fluorophenol: 35-105% Phenol-d5/d6: 40-100% Nitrobenzene-d5: 35-100%
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

Notes:
DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-4 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SB, SMI, SS, SD
Analytical Group: WCHEM (pH and TOC)
Analytical Method / SOP Reference: LAB-06, LAB-20, LAB-21 / SW-846 9045, Lloyd Kahn

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
Multi Incremental Sample Preparation (for SMI samples) - Refer to Worksheet #28-1						
pH via SW-846 9045 (LAB-20)						
Laboratory Control Sample (LCS)	One per 20 samples of solid matrix	90-110%R	Correct problem, recalibrate.	Analyst	Accuracy	90-110%R
Laboratory Replicate (LR)	One laboratory replicate per 10 field samples.	≤ 20% RPD	Investigate problem and reanalyze parent sample and laboratory replicate. If RPD is still unacceptable, report and narrate.	Analyst	Precision	≤ 20% RPD
Total Organic Carbon (TOC) via Lloyd Kahn (LAB-21)						
Method Blank	Analyzed with each batch of samples	No detections > 1/2 RL	Reanalyze all associated samples with detects greater than the (method detection limit (MDL) and < 20X the blank detection. If reanalysis cannot be performed, B-qualify associated results and explain in the case narrative.	Analyst	Contamination	No detections > 1/2 RL
Laboratory Control Sample (LCS)	Analyzed with each batch of samples	80-120% Recovery	Reprep and reanalyze LCS once. If still unacceptable, investigate and correct problem. Reanalyze all samples associated with the failed LCS. If reanalysis is not possible, Q-qualify associated results and explain in the case narrative.	Analyst	Accuracy	80-120% Recovery
Laboratory Quadruplicate	One per 20 samples of solid matrix	≤ 30% RSD	Y-qualify associated results and explain in the case narrative.	Analyst	Precision	≤ 30% RSD
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

Notes:

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SAP Worksheet #28-5 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix:	SD
Analytical Group:	GRAINSIZE
Analytical Method / SOP Reference:	LAB-22 / ASTM D422

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
QA/QC Samples are not required for GRAINSIZE analysis.						

Notes:

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SAP Worksheet #28-6 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: EXPLO
Analytical Method / SOP Reference: LAB-08, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate	One per 10 normal field samples per matrix	%RPD < 20%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 20%
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Matrix Spike/Matrix Spike Duplicate	One per 20 normal field samples per matrix	See below.				
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
8330B-List Explosives via SW-846 8330B (LAB-09)						
Aqueous sample preparation	Each sample	Solid phase extraction (SPE) using resin-based solid phase disks or cartridges is required. The salting-out procedure is not permitted.	N/A. Flagging criteria are not appropriate.	Analyst	Representativeness	Solid phase extraction (SPE) using resin-based solid phase disks or cartridges is required. The salting-out procedure is not permitted.
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
LCS containing all analytes to be reported	One per preparatory batch	Accuracy limits specified in Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Accuracy limits specified in Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS. For matrix evaluation only.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.	Analyst	Accuracy	Same as for LCS. For matrix evaluation only.

SAP Worksheet #28-6 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: EXPLO
Analytical Method / SOP Reference: LAB-08, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS and RPD ≤ 20%.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. The data shall be evaluated to determine the source of difference.	Analyst	Accuracy / Precision	Same as for LCS and RPD ≤ 20%.
Confirmation Analysis	When target analytes are detected on the primary column using the UV Detector (HPLC) at concentrations exceeding the Limit of Detection (LOD).	Calibration and QC criteria are the same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40%.	Report from both columns. If there is a > 40% RPD between the two column results, data must be J-flagged accordingly. Confirmation analysis is not needed if LC/MS or LC/MS/MS was used for the primary analysis. The secondary column must be capable of resolving (separating) all of the analytes of interest and must have a different retention time order relative to the primary column. Any HPLC column used for confirmation analysis must be able to resolve and quantify all project analytes. Detection by HPLC UV, LC/MS or LC/MS/MS. Calibration and calibration verification acceptance criteria are the same as for the primary analysis.	Analyst	Precision	Calibration and QC criteria are the same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40%.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A
Perchlorate via SW-846 6850 (LAB-10)						
Limit of Detection Verification (LODV) (per batch)	Prior to sample analysis and at the end of the analysis sequence. It can be analyzed after every 10 samples in order to reduce the reanalysis rate.	Within ±30% of true value.	Correct problem and rerun LODV and all samples analyzed since last successful LODV. If a sample with perchlorate concentration at or between the LOD and RL is bracketed by a failing LODV, it must be reanalyzed. A sample with concentration above the RL can be reported. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable LODV. Problem must be corrected. Results may not be reported without a valid LODV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Within ±30% of true value.
Isotope Ratio 35Cl/37Cl	Every sample, batch QC sample, and standard.	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference, etc.). Apply J-flag if acceptance criteria are not met. Decision to report data failing ratio check should be thoroughly documented in case narrative.	Analyst	Accuracy	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.
Internal Standard (IS)	Addition of 18O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank.	Measured 18O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0 ±2% (0.98 – 1.02).	Rerun the sample at increasing dilutions until the ±50% acceptance criteria are met. If criteria cannot be met with dilution, then interference are suspected and the sample must be reprepped using additional pretreatment steps. Apply Q-flag and discuss in the case narrative. If peak is not within retention time window, presence is not confirmed. Use for quantitation and to ensure identification. Failing internal standard should be thoroughly documented in the case narrative.	Analyst	Accuracy	Measured 18O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0 ±2% (0.98 – 1.02).
Interference Check Sample (ICS)	One ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.	Within ±30% of true value.	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed. Flagging criteria are not appropriate. Analysis of a standard containing perchlorate at the RL and interfering anions at the concentration determined by the interference threshold study. Monitor recovery of perchlorate and retention time. No samples may be reported that are associated with a failing ICS.	Analyst	Accuracy	Within ±30% of true value.

SAP Worksheet #28-6 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: EXPLO
Analytical Method / SOP Reference: LAB-08, LAB-09, LAB-10 / TBD, SW-846 8330B, 6850

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Laboratory Reagent Blank	Prior to calibration, after samples with overrange concentration of perchlorate, and at the end of the analytical sequence.	No perchlorate detected > 1/2 RL.	Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated batch. Problem must be corrected. Results may not be reported without a valid reagent blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No perchlorate detected > 1/2 RL.
Method Blank	One per preparatory batch.	No perchlorate detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed. Method blank must undergo the same preparation and pretreatment steps as the samples in the batch.	Analyst	Contamination	No perchlorate detected > 1/2 RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
Laboratory Control Sample (LCS)	One per preparatory batch. LCS must be spiked at the RL.	Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed. LCS must undergo the same preparation and pretreatment steps as the samples in the batch.	Analyst	Accuracy	Refer to Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix. The MS must be spiked at the RL.	Same as for LCS.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. For matrix evaluation only. If MS results are outside the limits, the data must be evaluated to determine the source of the difference and to determine if there is a matrix effect or analytical error. MS must undergo the same preparation and pretreatment steps as the samples in the batch.	Analyst	Accuracy	Same as for LCS.
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix. The MSD must be spiked at the RL.	Same as for LCS and RPD ≤ 15%.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. The data shall be evaluated to determine the source of difference.	Analyst	Accuracy, Precision	Same as for LCS and RPD ≤ 15%.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

Notes:
DoD QSM v. 4.1 is the basis for specifications on this table.

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SAP Worksheet #28-7 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: METAL, FMETAL
Analytical Method / SOP Reference: LAB-12, LAB-13, LAB-14, LAB-15 / TBD, SW-846 6010, 6020, 7196

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate	One per 10 normal field samples per matrix	%RPD < 20%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 20%
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Matrix Spike/Matrix Spike Duplicate	One per 20 normal field samples per matrix	See below.				
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
Metals and Filtered Metals via SW-846 6010 (LAB-13)						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
Interference Check Solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples. If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	Analyst	Accuracy	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.
Laboratory Control Sample (LCS)	One per preparatory batch.	Refer to Worksheet #15.	Correct problem then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Refer to Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests (dilution test and post-digestion spike addition) are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as for LCS
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS and 20% RPD.	Same as MS.	Analyst	Accuracy, Precision	Same as for LCS and 20% RPD.
Dilution Test	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement.	Perform post-digestion spike addition. Flagging criteria are not appropriate. Only applicable for samples within concentration > 50X LOQ.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement.

SAP Worksheet #28-7 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: METAL, FMETAL
Analytical Method / SOP Reference: LAB-12, LAB-13, LAB-14, LAB-15 / TBD, SW-846 6010, 6020, 7196

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Post digestion spike addition	When dilution test fails or analyte concentration for all samples < 50X LOD.	Recovery within 75-125%.	Run all associated samples in the preparatory batch by MSA or see flagging criteria. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. Spike addition should produce a concentration of 10-100X LOQ.	Analyst	Accuracy	Recovery within 75-125%.
Method of standard additions (MSA)	When matrix interference is confirmed.	N/A	Document use of MSA in the case narrative.	Analyst	Accuracy	N/A
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A
Metals and Filtered Metals via SW-846 6020 (LAB-14)						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).
Interference Check Solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples. If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	Analyst	Accuracy	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.
Laboratory Control Sample (LCS)	One per preparatory batch.	Refer to Worksheet #15.	Correct problem then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Refer to Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests (dilution test and post-digestion spike addition) are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as for LCS
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS and 20% RPD.	Same as MS.	Analyst	Accuracy, Precision	Same as for LCS and 20% RPD.
Dilution Test	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement.	Perform post-digestion spike addition. Flagging criteria are not appropriate. Only applicable for samples within concentration > 50X LOQ.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement.
Post digestion spike addition	When dilution test fails or analyte concentration for all samples < 50X LOD.	Recovery within 75-125%.	Run all associated samples in the preparatory batch by MSA or see flagging criteria. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. Spike addition should produce a concentration of 10-100X LOQ.	Analyst	Accuracy	Recovery within 75-125%.
Method of standard additions (MSA)	When matrix interference is confirmed.	N/A	Document use of MSA in the case narrative.	Analyst	Accuracy	N/A

SAP Worksheet #28-7 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: METAL, FMETAL
Analytical Method / SOP Reference: LAB-12, LAB-13, LAB-14, LAB-15 / TBD, SW-846 6010, 6020, 7196

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Internal Standards (IS)	Every sample.	IS intensity within 30-120% of intensity of the IS in the ICAL.	Reanalyze sample at 5-fold dilution with addition of appropriate amounts if internal standards. Flagging criteria are not appropriate.	Analyst	Accuracy	IS intensity within 30-120% of intensity of the IS in the ICAL.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A
Hexavalent Chromium and Filtered Hexavalent Chromium via SW-846 7196 (LAB-15)						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 the RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results See Box D-1 of DoD QSM v 4.1 .	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analytes(s) in all samples in the associated preparatory batch.	Analyst	Contamination	No analytes detected > 1/2 the RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results See Box D-1 of DoD QSM v 4.1 .
Laboratory Control Sample (LCS)	One per preparatory batch.	Refer to Worksheet #15.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Analyst	Accuracy	Refer to Worksheet #15.
Sample matrix verification (also known as matrix spike (MS))	One for every sample matrix analyzed.	Same as LCS.	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use method of standard additions. Flagging criteria are not appropriate. Verification check ensures lack of reducing condition or interference from matrix. Additional corrective actions are identified in Method 7196A (Sections 7.4 and 7.5).	Analyst	Accuracy	Same as LCS.
Matrix Spike Duplicate (MSD) or Laboratory Replicate (LR)	Aqueous Matrix: One per every 10 project samples per matrix.	Same as LCS and ≤30% RPD.	Same as MS. Examine project-specific DQOs. Contact the client as to additional measures to be taken. Flagging criteria are not appropriate.	Analyst	Accuracy, Precision	Same as LCS and ≤30% RPD.
Post-digestion matrix spike	One per preparatory batch.	85-115% recovery.	Correct problem and rehomogenize, redigest, and reanalyze samples. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst	Accuracy	85-115% recovery.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

Notes:
DoD QSM v. 4.1 is the basis for specifications on this table.

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SAP Worksheet #28-8 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: SVOC
Analytical Method / SOP Reference: LAB-17, LAB-18, LAB-19 / TBD, SW-846 8270, 8270_SIM

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate	One per 10 normal field samples per matrix	%RPD < 20%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 20%
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Matrix Spike/Matrix Spike Duplicate	One per 20 normal field samples per matrix	See below.				
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
SVOCs via SW-846 8270 and 8270_SIM (LAB-18, LAB-19)						
Breakdown Check	At the beginning of each 12-hour period, prior to analysis of samples	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses and should not exceed a tailing factor of 2.	Correct problem then repeat breakdown check. Flagging criteria are not appropriate. No samples shall be run until degradation ≤ 20%.	Analyst	Accuracy	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses and should not exceed a tailing factor of 2.
Internal Standards Verification	Every field sample, standard, and QC sample.	Retention time ±30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory. If corrective action fails in field samples, apply Q-flag to analytes associated with the non-compliant IS. Flagging criteria are not appropriate for failed standards. Sample results are not acceptable without a valid IS verification.	Analyst	Accuracy	Retention time ±30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard.
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v. 4.1).
Laboratory Control Sample (LCS) containing all analytes to be reported, including surrogates	One per preparatory batch.	Refer to Worksheet #15.	Correct problem then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	Refer to Worksheet #15.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as for LCS

SAP Worksheet #28-8 — Laboratory QC Samples Table (continued)

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: SVOC
Analytical Method / SOP Reference: LAB-17, LAB-18, LAB-19 / TBD, SW-846 8270, 8270_SIM

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS.	Same as MS.	Analyst	Accuracy / Precision	Same as for LCS.
Surrogate Spike	All field and QC samples	2-Fluorobiphenyl: 50-110% Terphenyl-d14: 50-135% 2,4,6-Tribromophenol: 40-125% 2-Fluorophenol: 20-110% Nitrobenzene-d5: 40-110%	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatoraphic interference with surrogate is present, reanalysis may not be necessary. Apply Q-flag to all associated analytes if acceptance criteria are not met.	Analyst	Accuracy	2-Fluorobiphenyl: 50-110% Terphenyl-d14: 50-135% 2,4,6-Tribromophenol: 40-125% 2-Fluorophenol: 20-110% Nitrobenzene-d5: 40-110%
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

Notes:
DoD QSM v. 4.1 is the basis for specifications on this table.

SAP Worksheet #28-9 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SB, SD
Analytical Group: RAD
Analytical Method / SOP Reference: LAB-23, LAB-25, LAB-26 / Laboratory SOP

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate	One per 10 normal field samples per matrix	%RPD < 30%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 30%
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
RAD via Laboratory SOP						
Method Blank	One per preparatory batch.	All targets less than the reporting limit.	Refer to laboratory SOP.	Analyst	Contamination	All targets less than the reporting limit.
Laboratory Control Sample (LCS)	One per preparatory batch.	75-125% Recovery (nominal limits)	Refer to laboratory SOP.	Analyst	Accuracy	75-125% Recovery (nominal limits)
Laboratory Replicate	One per preparatory batch.	< 20% RPD when sample result is sufficiently-high.	Refer to laboratory SOP.	Analyst	Precision	< 20% RPD when sample result is sufficiently-high.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

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SAP Worksheet #28-10 — Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix: SW, GW
Analytical Group: RAD, FRAD
Analytical Method / SOP Reference: LAB-24, LAB-25, LAB-26 / Laboratory SOP

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Field QA/QC Samples						
Field Duplicate	One per 10 normal field samples per matrix	%RPD < 20%	Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Precision	%RPD < 20%
Equipment Blank	One per day per equipment type (when decontaminated). One per event per equipment type (when disposable).	Same as method blank (see below)	Assess decontamination procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PM/FTL, Data Validator	Contamination	Same as method blank (see below)
Temperature Blank	One per cooler	≤ 6°C but not frozen	Notify project chemist. Assess sample packaging and shipment procedures. Consider recollection if the exceedance may cause data rejection. Qualify as per Worksheet #36.	Laboratory PM, PC, PM/FTL, Data Validator	Representativeness	≤ 6°C but not frozen
RAD via Laboratory SOP						
Method Blank	One per preparatory batch.	All targets less than the reporting limit.	Refer to laboratory SOP.	Analyst	Contamination	All targets less than the reporting limit.
Laboratory Control Sample (LCS)	One per preparatory batch.	75-125% Recovery (nominal limits)	Refer to laboratory SOP.	Analyst	Accuracy	75-125% Recovery (nominal limits)
Laboratory Replicate	One per preparatory batch.	< 20% RPD when sample result is sufficiently-high.	Refer to laboratory SOP.	Analyst	Precision	< 20% RPD when sample result is sufficiently-high.
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Results less than the DL are reported as nondetects at the LOD.	N/A	Analyst	Accuracy	N/A

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SAP Worksheet #29 — Project Documents and Records Table

Document	Where Maintained
Field Notebooks	Electronic portable document format (.pdf) copies in the project file. Hardcopy (bound notebook) in the project file. Archived at project closeout*.
Chain-of-Custody Records	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
Air Bills	Hardcopy in the project file. Archived at project closeout.
Telephone Logs	Hardcopy in the project file. Archived at project closeout.
Corrective Action Forms	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
Water quality field parameters collected during groundwater and surface water sampling	Recorded in Field Notebook. Stored in VDMS.
Various field measurements	Recorded in Field Notebook.
All field equipment calibration information	Recorded in Field Notebook.
Pertinent telephone conversations	Recorded in Field Notebook.
Field equipment maintenance records	Inspected by Field Team Leader. Not maintained.
Sample Receipt, Custody, and Tracking Records	Electronic .pdf copies in the project file. Hardcopy in the full data package.
Equipment Calibration Logs	Hardcopy in the full data package[1]. Archived at project closeout.
Sample Prep Logs	Hardcopy in the full data package[1]. Archived at project closeout.
Run Logs	Hardcopy in the full data package[1]. Archived at project closeout.
Reported Field Sample Results	Electronic .pdf copies in the project file. Hardcopy in the full data package[1]. Archived at project closeout.
Reported Results for Standards, QC Checks, and QC Samples	Hardcopy in the full data package[1]. Archived at project closeout.
Instrument Printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples	Hardcopy in the full data package[1]. Archived at project closeout.
Sample Disposal Records	Maintained by the laboratory.
Extraction/Clean-up Records	Hardcopy in the full data package[1].
Raw Data	Hardcopy in the full data package[1]. Archived at project closeout.
Field Sampling Audit Checklists	Hardcopy in the project file. Archived at project closeout.
Fixed Laboratory Audit Checklists	If completed, hardcopy in the project file. Archived at project closeout.
Data Validation Reports	Electronic .pdf copies in the project file. Hardcopy stored with the data package. Archived at project closeout.
Instrument QC Inspections	Recorded in Field Notebook. Archived at project closeout.
DGM data	Electronic .pdf copies in the project file. Hardcopy stored in on-site data files. Archived at project closeout.
Explosives Inventory Records	Electronic .pdf copies in the project file. Hardcopy stored in on-site data files. Archived at project closeout.
MDAS Certification	Electronic .pdf copies in the project file. Hardcopy stored in on-site data files. Archived at project closeout.
MDAS Shipping container COCs	Electronic .pdf copies in the project file. Hardcopy stored in on-site data files. Archived at project closeout.
Remedial Investigation Report	Electronic .pdf copies in the project file. Hardcopy (bound notebook) in the project file and administrative record. Archived at project closeout.

SAP Worksheet #29 — Project Documents and Records Table (continued)

* Data archiving will be done in accordance with Navy requirements. CH2M HILL will provide the Navy (currently Bonnie Capito) all data and reports for archiving. After completion of the project, project documents required to be maintained will be stored at the Federal Records Center (FRC) in Suitland, MD:

  Washington National Records Center
  4205 Suitland Road
  Suitland, Maryland 20746-8001

[1] The format of the full hardcopy data package is described in Laboratory SOP. CH2M HILL requires a "Level 4" package

SAP Worksheet #30 — Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations / ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory / Organization	Backup Laboratory / Organization
GW	METAL	23	LAB-12, LAB-13, LAB-14, LAB-15	28 Calendar-day TAT	TBD	TBD
	FMETAL	23				
	EXPLO	23	LAB-08, LAB-09, LAB-10			
	METAL (add U to above)	1	LAB-12, LAB-13, LAB-14, LAB-15			
	FMETAL (add U to above)	1				
	RAD	1	LAB-24, LAB-25, LAB-26			
	FRAD	1	LAB-24, LAB-25, LAB-26			
SB	EXPLO	181	LAB-07, LAB-09, LAB-10			
	METAL	181	LAB-11, LAB-13, LAB-14, LAB-15			
	METAL (add U to above)	1				
	SVOC	11	LAB-16, LAB-18, LAB-19			
	WCHEM (pH and TOC)	181	LAB-20, LAB-21			
	RAD	12	LAB-23, LAB-25, LAB-26			
SS	EXPLO	14	LAB-07, LAB-09, LAB-10			
	METAL	14	LAB-11, LAB-13, LAB-14, LAB-15			
	SVOC	8	LAB-16, LAB-18, LAB-19			
	METAL (add U to above)	12	LAB-11, LAB-13, LAB-14, LAB-15			
	WCHEM (pH and TOC)	6	LAB-20, LAB-21			
SD	EXPLO	53	LAB-07, LAB-09, LAB-10			
	METAL	53	LAB-11, LAB-13, LAB-14, LAB-15			
	GRAINSIZE	53	LAB-22			
	WCHEM (pH and TOC)	53	LAB-20, LAB-21			
	METAL (add U to above)	14	LAB-11, LAB-13, LAB-14, LAB-15			
	RAD	14	LAB-23, LAB-25, LAB-26			
SMI	EXPLO	177	LAB-04, LAB-07, LAB-09, LAB-10			
	METAL	177	LAB-06, LAB-11, LAB-13, LAB-14, LAB-15			
	SVOC	2	LAB-05, LAB-16, LAB-18, LAB-19			
	WCHEM (pH and TOC)	177	LAB-06, LAB-20, LAB-21			
SW	METAL	45	LAB-12, LAB-13, LAB-14, LAB-15			
	FMETAL	45				
	EXPLO	45	LAB-08, LAB-09, LAB-10			
	METAL (add U to above)	12	LAB-12, LAB-13, LAB-14, LAB-15			
	FMETAL (add U to above)	12				
	RAD	6	TBD			
	FRAD	6	TBD			

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SAP Worksheet #31 — Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Field Performance Audit	Once a sampling event if deemed necessary. Field performance audits are handled on a program level.	Internal	CH2M HILL	Lisa Carter/CH2M HILL (Program Field Auditor)	John Swenfurth, Project Manager/CH2M HILL	John Swenfurth, Project Manager/CH2M HILL	Brett Doerr/CH2M HILL (Activity Quality Manager)
Offsite Laboratory Technical Systems Audit (via DoD ELAP)[1]	As needed (DoD ELAP accreditation must be renewed before it expires.)	External	A2LA, ACLASS, L-A-B, or PJLA	DoD ELAP Auditor (TBD)	Analytical Laboratory PM (TBD)	Analytical Laboratory PM (TBD)	Anita Dodson/CH2M HILL (Program Chemist)
Performance and Safety Audit	Once a year	External	NOSSA	Doug Murray/NOSSA	Navy, MR contractor, and or Title II contractor	Respective project manager for the Navy, MR contractor, and or Title II contractor	Respective project manager for the Navy, MR contractor, and or Title II contractor
Surface MEC Removal	Every grid surface cleared of MEC. The percentage of the grid that will be QA'd will be contingent upon the verification level and requirements specified in MIL-STD-1916 or the relavent work plan.	External	Navy or Title II contractor	Navy QA officer or Title II QA Lead	MR contractor performing removal action	MR contractor UXOQCS	MR contractor UXOQCS, MR contractor project manager, Title II QA Lead
Subsurface MEC Removal	Every grid surface cleared of MEC. The percentage of the grid that will be QA'd will be contingent upon the verification level and requirements specified in MIL-STD-1916 or the relavent work plan.	External	Navy or Title II contractor	Navy QA officer or Title II QA Lead	MR contractor performing removal action	MR contractor UXOQCS	MR contractor UXOQCS, MR contractor project manager, Title II QA Lead

Notes:

1. DoD ELAP accreditation is required for all definitive (refer to Worksheet #23) analyses. The laboratory must be accredited for each analyte (refer to Worksheet #15) for each matrix (i.e. solid and/or liquid). Accreditation must be current before samples are collected.

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SAP Worksheet #32 — Assessment Findings and Corrective Action Responses Table

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Field Performance Audit	Checklist and Written Audit Report	John Swenfurth, Project Manager/CH2M HILL	Within one week of audit	Memorandum	Field Team Leader/CH2M HILL (TBD) Brett Doerr/CH2M HILL (Activity Quality Manager)	Within one week of receipt of CA form
Offsite Laboratory Technical Systems Audit (via DoD ELAP)	Written audit report	Analytical Laboratory PM (TBD)	Within two months of audit	Memorandum	DoD ELAP Auditor (TBD)	Within two months of receipt of initial notification
Performance and Safety Audit	Written audit report	Navy, MR contractor, and or Title II contractor	As soon as practicable	Memorandum	Doug Murray/NOSSA	Within 30 days of audit report receipt
Surface MEC Removal	Corrective Action Request	MR contractor project manager	As soon as practicable	Corrective Action Plan	Navy, MR contractor UXOQCS, and or Title II contractor	As soon as practicable
Subsurface MEC Removal	Corrective Action Request	MR contractor project manager	As soon as practicable	Corrective Action Plan	Navy, MR contractor UXOQCS, and or Title II contractor	As soon as practicable

Notes:

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SAP Worksheet #33 — QA Management Reports Table

Type of Report	Frequency (Daily, Weekly, Monthly, Quarterly, Annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliations)
Field Audit Report	One during sampling activities	Submitted with report in which data are analyzed and presented	Project Manager: John Swenfurth/CH2M HILL	Regional Health, Safety, Environment, and Quality Manager: Mark Orman/CH2M HILL Included in project files.
Data Validation Reports	Once, after analysis by laboratory, for all laboratory analytical data except WCHEM and MICRO analyses.	Submitted by the data validator within 14 calendar-days of notification to begin)	Project Manager: John Swenfurth/CH2M HILL	Project Chemist: Michael Zamboni/CH2M HILL Project EIS: Hillary Ott/CH2M HILL Project Manager: John Swenfurth/CH2M HILL
Data Usability Assessments (Data Quality Evaluation)	Once, as an appendix to the report in which data are analyzed and presented.	Along with the project report.	Project Chemist: Michael Zamboni/CH2M HILL	Vieques RPM: Daniel Rodriquez/USEPA and Vieques RPM Wilmarie Rivera/PREQB
Corrective Action Request	As appropriate	Submitted with project status report and or after action report	Title II contractor	Navy, MR contractor UXOQCS, and or Title II contractor
Corrective Action Plan	As appropriate	Submitted with project status report and or after action report	MR contractor project manager	Navy, MR contractor UXOQCS, and or Title II contractor

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SAP Worksheet #34, 35, and 36 — Data Verification and Validation (Steps I and IIa/IIb) Process Table

(UFP-QAPP Manual Section 5.2.1) (UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

Data Review Input	Description	Responsible for Verification	Step I / IIa / IIb[1]	Internal / External
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	Field Team Leader/CH2M HILL (TBD)	Step I	Internal
Chains of Custody and Shipping Forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	Field Team Leader/CH2M HILL (TBD) Hillary Ott/CH2M HILL (Project Data Manager)	Step I	Internal / External
Sample Condition Upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the project data manager in the form of laboratory logins.	Hillary Ott/CH2M HILL (Project Data Manager)	Step I	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the project chemist. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	Michael Zamboni/CH2M HILL (Project Chemist)	Step I	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check).	Hillary Ott/CH2M HILL (Project Data Manager)	Step I	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against data validation reports and marked-up Form 1s (100% check of all changes made during data validation).	Michael Zamboni/CH2M HILL (Project Chemist)	Step I	External
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and applicable to the data packages.	Third-Party Data Validator (TBD)	Step I	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Analytical Laboratory QAO (TBD)	Step I	Internal
Laboratory Data	The data will be verified for completeness by a PDM.	Hillary Ott/CH2M HILL (Project Data Manager)	Step I	External
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.	John Swenfurth/CH2M HILL (Project Manager) Michael Zamboni/CH2M HILL (Project Chemist)	Step I	Internal
Corrective Action Reports	CA reports will be reviewed by the project chemist or PM and placed into the project file for archival at project closeout.	John Swenfurth/CH2M HILL (Project Manager) Michael Zamboni/CH2M HILL (Project Chemist)	Step I	External
Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	Michael Zamboni/CH2M HILL (Project Chemist)	Step IIa	External
Target Compounds List Target Analyte List	Ensure the laboratory reported all analytes from each analysis group as per Worksheet 15.	Michael Zamboni/CH2M HILL (Project Chemist)	Step IIa	External
Reporting Limits	Ensure the laboratory met the project-designated quantitation limits as per Worksheet 15. If quantitation limits were not met, the reason will be determined and documented.	Michael Zamboni/CH2M HILL (Project Chemist)	Step IIb	External
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Third-Party Data Validator (TBD)	Step IIa	External
Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process.	Third-Party Data Validator (TBD)	Step IIa / IIb	External
Raw Data	10 percent review of raw data to confirm laboratory calculations.	Third-Party Data Validator (TBD)	Step IIa	External
Onsite Screening	All non-analytical field data will be reviewed against QAPP requirements for completeness and accuracy based on the field calibration records.	Field Team Leader/CH2M HILL (TBD)	Step IIb	Internal
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	Third-Party Data Validator (TBD)	Step IIa	External
Documentation of Field QC Sample Results	Establish that all required QAPP QC samples were run and met limits.	Michael Zamboni/CH2M HILL (Project Chemist) Third-Party Data Validator (TBD)	Step IIb	External
Third-Party Data Validation (METAL, FMETAL)2	Analytical methods and laboratory SOPs, as presented in this UFPSAP, will be used to evaluate compliance against QA/QC criteria. QA/QC criteria for field QC samples are presented in Worksheet 28, QA/QC criteria for calibrations are presented in Worksheet 24, and QA/QC criteria for laboratory QC samples are presented in Worksheet 28. Reference limits, laboratory-specific limits, and accuracy/precision limits are presented in Worksheet 15. Data may be qualified if QA/QC exceedances have occurred. Data qualifiers will be those presented in "Evaluation of Metals Data for the Contract Laboratory Program (CLP)" (SOP HW-02; Rev. 13; February, 2009). Note that, because there are no EPA Region II SOPs for data validation of 6010/6020 and 7196 data, the data validator may prepare in-house worksheets similar to those familiar to Region II. Guidance and qualifiers from "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review" (OSWER 9240.1-51; EPA 540-R-10-011; January, 2010) may also be applicable.	Third-Party Data Validator (TBD)	Step IIa and IIb	External

SAP Worksheet #34, 35, and 36 — Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

(UFP-QAPP Manual Section 5.2.1) (UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

Data Review Input	Description	Responsible for Verification	Step I / IIa / IIb1	Internal / External
Third-Party Data Validation (EXPLO)2	For SW-846 8330B: "Nitroaromatics and Nitroamines by HPLC" (SOP HW-16 Rev. 2; August, 2009). Note that this validation SOP is specific to 8330A; therefore A/P limits from this UFP-SAP will take precedence over validation SOP limits.For SW-846 6850: Analytical methods and laboratory SOPs, as presented in this UFPSAP, will be used to evaluate compliance against QA/QC criteria. QA/QC criteria for field QC samples are presented in Worksheet 28, QA/QC criteria for calibrations are presented in Worksheet 24, and QA/QC criteria for laboratory QC samples are presented in Worksheet 28. Reference limits, laboratory-specific limits, and accuracy/precision limits are presented in Worksheet 15. Data may be qualified if QA/QC exceedances have occurred. Data qualifiers will be those presented in "Evaluation of Metals Data for the CLP Program" (SOP HW-02; Rev. 13; February, 2009). Note that, because there are no EPA Region II SOPs for data validation of 6850 data, the data validator may prepare in-house worksheets similar to those familiar to Region II. Guidance and qualifiers from "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review" (OSWER 9240.1-51; EPA 540-R-10-011; January, 2010) may also be applicable.	Third-Party Data Validator (TBD)	Step IIa and IIb	External
Third-Party Data Validation (SVOC)[2]	"Validating Semivolatile Organic Compounds by SW-846 Method 8270" (SOP HW-22; Rev. 4; August, 2009)	Third-Party Data Validator (TBD)	Step IIa and IIb	External
Data Validation (WCHEM and GRAINSIZE)	Third-party analytical data validation is not required for screening data. However, they are still subject to the verification and validation procedures described above.	Michael Zamboni/CH2M HILL (Project Chemist)	Step I, IIa, and IIb	External
MR Field Data	Data entries will be reviewed on a daily basis by the MR contractor's data management personnel. The data will be reviewed to ensure completeness, consistency, and accuracy. Any discrepancies or incorrect data will be resolved during the review. Data subject to this QC review includes, but is not limited to, items found, grid status, and team operations. The Title 2 data management personnel will review data only after it has been QC'd by the MR contractor collecting the data. The data will be reviewed to ensure completeness, consistency, and accuracy. Data subject to this QA review includes, but is not limited to, items found, grid status, and team operations. Any discrepancies will be identified and reported to the MR contractor for clarification and or correction.	MR Contractor Data Manager Title 2 Data Manager	IIa	Internal
Surface MEC Removal	The MR contractor's UXOQCS is responsible for onsite monitoring of the practices and operations taking place and verifying continued compliance with the specifications and requirements of the contract, task order, and approved project plans and procedures. The UXOQCS is also responsible for verifying that a daily Health and Safety Inspection is performed and documented as prescribed in the project SSHP. Discrepancies between site practices and approved plans/ procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the UXOQCS or a designee prior to granting approval to continue work. Follow-up inspection results are to be documented in the QC logbook and summarized in the Weekly QC Report. QC testing will be performed to ensure that MEC removal is being performed according to the project Definable Quality Objective and prior to submitting to the Navy Technical Representative and Title II Services Contractor for QA testing. The UXOQCS will inspect each grid to determine whether or not the grid has been cleared IAW performance requirements presented in the QC Section of the Removal Action Contractor's Work Plan. The UXOQCS will re-sweep this portion of the grid using the same geophysical instrument. The results of the QC inspections, both passing and failing, will be recorded in the QC log. For any grid that fails a QC inspection, the grid will be completely reworked and re-QC'd before submitting the grid for QA inspection. Once the grid has passed the QC process, an independent third-party UXO Quality Assurance (QA) officer will perform a detector-aided visual inspection of the ground surface ensure all MEC has been removed; the percentage of the grid to be checked will correspond to the MILSTD 1916 verification level for the contractor.	MR Contractor UXOQCS Title 2 Contractor QA Lead		
DGM Equipment Performance	Evaluate DGM equipment functionality, signal strength, and sensor performance against known response curves of industry standard objects to verify DGM systems prior to and during site surveys. The details of this equipment testing are provided in the Geophysical System Verification SOP and DGM SOP.	Project Geophysicist		Internal
Subsurface Anomaly Removal	Once the UXO Team has completed a specified number of anomalies to create a quality control lot, the MR contractor UXOQCS will check the anomaly locations with an EM61-MK2 to ensure that the source of the anomalies have been removed; the number of anomalies to be checked will correspond to the MILSTD 1916 verification level for the contractor. The UXOQCS will have undertaken training on operation of an EM61-MK2 and pass a test as described in the standard operating procedure (SOP) for EM61-MK2 Skills Determination Prior to Use. The maximum amplitude anomaly response will be recorded over the investigation location, and if the total is below the action threshold, the source of the anomaly will be considered removed. If the result is greater than the action threshold, then the QC lot will fail QC and all anomaly locations will be re-acquired and investigated to locate the remainder of the source. Once the QC lot has passed the QC process, a third-party UXO Quality Assurance (QA) officer will check the anomaly locations within the QC lot with an EM61-MK2 to ensure that the source of the anomalies have been removed; the number of anomalies to be checked will correspond to the MILSTD 1916 verification level for the contractor. The UXO QA Officer will have undertaken training on operation of an EM61-MK2 and pass a test as described in the standard operating procedure (SOP) for EM61-MK2 Skills Determination Prior to Use. The maximum amplitude anomaly response will be recorded over the investigation location, and if the total is below the action threshold, the source of the anomaly will be considered removed and the lot will pass QA. If the result is greater than the action threshold, then the QC lot will fail QA and the excavation and QC process will start over.	MR Contractor UXOQCS Title 2 Contractor QA Lead		Internal
Receiving, tracking, and storage of explosives purchased and used during the munitions response activities	If/when explosives are stored onsite, each Magazine Data Card will be audited at least weekly by project QC and QA staff. The senior authorized individual(s) will ensure that the contents of each magazine are inventoried on a weekly basis and that the quantities of explosives on hand match the quantities listed in the Magazine Data Cards. During this inventory, the numbers of each item stored in the magazine will be determined by sight inspection and count. Sealed containers will be left unopened and counted as full.	MR Contractor UXOQCS Title 2 Contractor QA Lead		Internal

Notes:

1. IIa = compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
   IIb = comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]
2. Level IV third-party data validation will be performed on 100% of definitive analyses. Of the 100% validated, 10% of results will be recalculated from the raw data in order to verify calculations.

SAP Worksheet #37 — Usability Assessment

Data usability evaluation comprises critical assessment of the data with respect to the project objective. Given that the primary objective of the field activities is to evaluate the nature and extent of contamination, the comprehensive dataset will be reviewed to determine if it is adequate for making the project-specific determinations.

Some specific examples of data availability and usability protocol are:

- The third-party data validator is the only party that may apply qualifiers to the data. Minor QC exceedances will result in “estimated” data, represented by J, NJ, and UJ qualifiers. Major QC exceedances will result in “rejected” data, represented by R-qualifiers. The effect on availability and usability of rejected results will be evaluated.
- The use of “estimated” data will be discussed in the report. “Estimated” data are generally considered usable for all purposes.
- While all non-rejected data are available for use to the project team, non-detect (and attributable to blank contamination) results may not be useful if the quantitation limit (QL) is greater than the associated project action limit. In these cases, the project team will determine whether or not the laboratory would likely have detected the contaminant if present at or above the Project Action Limit (PAL) (i.e., evaluation of the PAL versus the MDL).
- Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check). The check will verify results and qualifiers. This process is intended to identify discrepancies between the hardcopy and electronic data. If any discrepancies are identified during the ten percent verification, the laboratory will be contacted, the discrepancies will be communicated, and the laboratory will resolve the discrepancies.
- If significant deviation is evident between parent samples and their field or laboratory duplicate, the cause will be investigated. The possibility of a switched sample will be examined. Field duplicates are expected to exhibit greater deviation than laboratory duplicates. Field duplicate and laboratory duplicate reproducibility is outlined in Worksheets 28.
- The greater of results between field duplicates (discreet sampling) or field triplicates (for multi-incremental sampling) are used for each constituent when making comparisons to screening levels.
- Significant biases may be evident based on LCS, MS/MSD, and spiked surrogate exceedances. The third-party data validator will consider QC exceedances and biases when applying qualifiers to data. The project team will consider the direction of bias when determining the usability of qualified data compared to PALs. Low biases are expected to occur more frequently than high biases. In the case of rejected non-detect data, low biases represent the inability of the laboratory to detect contaminants that may or may not be present at the site. The project team will act conservatively and understand that it is not known whether or not these compounds are present below, at, or above the PAL. High biases indicate that a result may be lower than it is reported. When high-biased data are greater than a PAL, the project team will examine the proximity of the result to the PAL to determine whether additional data are needed or if the result should simply be considered a PAL exceedance.
- After completion of the data validation, the distribution of applied data validation qualifiers will be examined to determine if there are patterns that negatively affect the usability of data. This information will be compiled into a DQE, which will be presented as an appendix to the project report.

SAP Worksheet #37 — Usability Assessment (continued)

- Data usability is not decided upon by any one individual or entity. The project team, as a whole, will decide upon the usability of the data.
- Deviations from the SAP sampling and analytical protocols will be reviewed to ascertain whether or not they are significant enough to negatively affect the usability of data.

Notes:

1. Completeness is defined as the percentage of measurements that are judged to be available compared to the total number of measurements made. The objective of the overall completeness goal for this project is set at 95% available data. This goal is inclusive of both field and laboratory analytical data.
2. Discussions of precision, accuracy, representativeness, completeness, and comparability will be included in the data quality review to describe the impact of data quality on project data quality objectives and data usability.

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Tables

Table 1
Category Descriptions
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Category		Description/Explanation
UXO		• Column 1 describes which UXO site the particular area is located in.
Decision Units		• Column 2 describes the decision units within each UXO site. • Decision units divide are based on hydrologic drainage areas. • The decision units are named based on their location within the UXO site.
Site Screening Areas (i.e., PI/SWMUs, etc.)		• Column 3 indicates whether any decision units have previously identified site screening areas, such as a PI, PAOC, AOC, or SWMU that need to be considered for sampling purposes.
Range/Target Areas/Gun Positions		• Column 4 indicates whether any military training features such as ranges, target areas, or gun positions are present within the decision unit. • An 'X' located in the column, represents that a previously used military feature was identified within the given decision unit area. • This data was determined based on the information provided during the ERA/SI.
Former Activity Features		• Column 5 identifies how many former activity features are present in each decision unit. • The former activity features potentially located within each decision unit are as follows: ranges, naval gunfire support target areas, targets, gun positions, consolidation points, controlled detonation locations, EADAs, LIDAR indicated areas, bulls-eyes, open burn areas, open detonation areas, and sub-munitions areas. • The number located in each column quantitatively identifies how many of each type of feature is located within that decision unit. • This data was determined based on the information provided during the ERA/SI.
Munitions Type		• Munitions type features are discussed in column 6. • Each column represents one of the 7 categories of munitions type as follows: flares-pyrotechnics, bombs, grenades, projectiles/mortars, rockets/guided missiles, sub-munitions, or MEC components. • An 'X' located in one of the columns, represents that a particular munitions type was identified within the given decision unit area. • In order to conserve space the types of munitions items were abbreviated in the excel file as follows: Flares-Pyrotechnics = FP Bombs = B Grenades = G Projectiles/Mortars = P/M Rockets/Guided Missiles = R/G Sub-munitions = S MEC component = MC
Munitions Item Scoring		• Column 7 quantitatively evaluates the number of munitions items identified per 30 ft x 30 ft grid within each decision unit. • In order to evaluate the density of munitions items in each decision area, values were assigned to quantitatively rank each area in comparison to one another. • The combined scores for both the quantity and frequency of munitions items equals the total munitions score, which provides a comparison for approximately how many munitions items were identified and how often they were identified.
	Quantity	• Ranks the quantity of munitions items identified per grid area. • The value given is based on the maximum number of munitions items identified within an individual grid, in each decision unit. • The values assigned to each decision unit were determined based on the following, where the left side represents the maximum number of munitions items identified within a single grid, and the left side is the score assigned to that range: 0 munitions items → Score = 0 1 to 5 munitions items → Score = 1 6 to 100 munitions items → Score = 2 101 to 500 munitions items → Score = 3 501 to 1000 munitions items → Score = 4 1001 to 5000 munitions items → Score = 5 5000+ munitions items → Score = 6

Table 1
Category Descriptions
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Category		Description/Explanation
	Frequency	• The Frequency column quantitatively evaluates each decision unit based on the frequency or reoccurrence that munitions items were identified in grids within each decision area. • The frequency is defined as how often munitions items were identified in a decision unit, based on how many grids within the decision unit had values greater than or equal to 1. • The frequency was determined based on the total percentage of grids that had munitions items identified, over the total number of grids within the decision unit. • The values assigned to each decision unit were determined based on the following, where the left side represents frequency that munitions items were identified in a decision unit, and the left side is the score assigned to that range: 0 to 20% → Score = 1 20 to 40% → Score = 2 40 to 60% → Score = 3 60 to 80% → Score = 4 80 to 100% → Score = 5 • For example: if there were 20 grids within one decision unit, and 5 of the grids had munitions items identified within them, than 5 out of 20 grids or 25% of the grids had MEC items identified. This correlates to a frequency of approximately 25%, and a score of 2.
	Total Munitions Score	• The total munitions score is the quantitative value given to each decision unit, combining the scores for both the quantity and frequency. • The decision units that had both a large quantity of munitions items identified as well as a high frequency had the highest score, while decision units that had a small quantity of MEC items identified and a low frequency had the lowest score.
MEC Investigation Status		• The status of munitions clearance activities is provided in Column 8. The sample units and locations at locations where munitions clearance activities are ongoing will be re-evaluated prior to field mobilization.
Biological Assessment (Inland Terrestrial Sites Only)		• Biological features are discussed in column 9 on Table 1 and evaluates the decision units based on the type of habitat. • Each column represents one of the 9 categories of ecosystems found in East Vieques as follows: evergreen scrub, forest, forest scrub, grass, mangrove, mixed woodlands, sparse thorn scrub, thick thorn scrub, lagoon. • An 'X' located in one of the columns represents that a particular ecosystem was identified within the given decision unit. • This data was determined based on the information provided during the Biological Assessment of East Vieques. • In order to conserve space the ecosystem types were abbreviated in the excel file as follows: Evergreen Scrub = ES Forests = F Forest Scrub = FS Grass = G Mangroves = M Mixed Woodlands = MW Sparse Thorn Scrub = STS Thick Thorn Scrub = TTS Lagoon = L
Receptor Exposure Summary		• Column 10 (Table 1) and Column 9 (Table 2) evaluates the decision unit based on the potential for human exposure and ecological sensitivity. • In order to evaluate the potential receptor exposures for human health and ecological scenarios, values were assigned to quantitatively rank each area in comparison to one another. • The combined scores for both human health and ecological sensitivity provide a scale to evaluate the potential receptor exposure.
	Human Health	• Assigns a value for each decision unit, based on the potential for humans to be exposed to site conditions. • The potential receptor exposures for human health are based on the three categories of future land use as follows: unrestricted use, public or recreational area, or wildlife refuge or restricted area. • Areas planned for unrestricted land use have the highest human health exposure factor and were assigned a value of 3; areas planned to be open to the public as recreational with restrictions were given a score of 2; areas that are restricted to USFWS and had the lowest human health factor and were given a score of 1 because they have the minimum potential for exposure to humans.
	Ecological	• Assigns a value for each decision unit, based on the ecological sensitivity of the area. • Along the beaches, areas that were listed as major turtle nesting areas or have endangered species habitat had the highest value and the highest corresponding concern for potential exposure to a species of noted importance and therefore received a score of 3, versus areas identified as minor turtle nesting areas (score of 2), or very limited/potential turtle nesting areas (score of 1).
		• In the interior, areas that have endangered species habitat had the highest value and the highest corresponding concern for potential exposure to a species of noted importance and therefore received a score of 3. Lagoons and lagoon fringes were identified as potential sensitive habitats due to aquatic organisms and land crab areas and received a score of 2. Upland terrestrial habitats without a noted presence of endangered species received a score of 1.
	Total Receptor Score	• Represents the total combined scores from both a human health and ecological perspective. • The total Receptor Score is a value given to each decision unit based on the potential receptor exposure. • The decision units with the highest value in this category have the highest potential for receptor exposure; where as the areas with the lowest score have the lowest potential for receptor exposure.
Sample Unit Approach and Rationale		• Column 11 (Table 1) and Column 10 (Table 2) describes the reasoning behind determining whether an area will be sampled based on the decision units characteristics evaluated throughout the spreadsheet.

Table 1a
UXO 4
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5																										6							7			8	9										10			11	
UXO	Decision Units	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)																										Munitions Type (x=occurs within decision unit)							Munitions Item Scoring			MEC Investigation Status	Biological Assessment (x=occurs within decision unit)										Receptor Exposure Summary			Decision Unit Approach	
				Range	Naval Gunfire Support Target Area	Target	Gun Position	Consolida-tion points	Controlled Detonation Location	EADA	LIDAR	Bulls-eye	Open Burn	Open Detona-tion	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)	ES	F	FS	G	M	MW	STS	TTS	L	Human Health	Ecological	Total Receptor Score	Recommended Samples	Rationale
UXO 4	Decision Unit 1 - Central UXO 4	Y	Y	0	2	9	0	multiple	multiple	1	1	0	1	1	0	x	x	x	x	x	x	x	6	5	11	Yes							x	x		1	1	2	SMI - 16 Discrete soil - 39	Decision Unit contains both SSAs identified for further investigation and former activity features. Additionally, decision unit contains most diverse former activity features, which are not identified in other UXO 4 decision units. Sampling units biased toward diversity and quantity of MEC and munitions scrap, target areas, craters, the OB/OD, and drainage. Two sampling units are located over the former OB and OD areas, which were formerly designated as SWMU 3.
UXO 4	Decision Unit 2 - North UXO 4	Y	Y	0	1	2	0	multiple	multiple	1	2	0	0	0	1	x	x		x	x	x	x	6	5	11	Yes			x				x			1	1	2	SMI - 8 Discrete soil - 16	High munitions score and multiple former activity features. Sampling units biased toward diversity and quantity of MEC and munitions scrap, target areas, craters, and drainage.
UXO 4	Decision Unit 3 -Northwest UXO 4	Y	Y	0	1	3	0	multiple	multiple	1	0	1	0	0	0	x	x	x	x	x	x	x	6	5	11	Yes			x	x			x	x		1	1	2	SMI - 5 Discrete soil -10	High munitions score and former activity features. Sampling units (0 to 2.5 inches) biased toward diversity and quantity of MEC and munitions scrap, craters, target areas, and drainage.
UXO 4	Decision Unit 4-Southwest UXO 4	Y	Y	0	1	3	0	multiple	multiple	1	0	1	0	0	0	x	x	x	x	x	x	x	5	5	10	Yes			x	x			x	x		1	1	2	SMI - 5 Discrete soil - 10	High munitions score and former activity features. Sampling units (0 to 2.5 inches) biased toward diversity and quantity of MEC and munitions scrap, craters, target areas, and drainage.
UXO 4	Decsion Unit 5 - East UXO 4	Y	Y	0	0	2	0	multiple	multiple	1	2	0	0	0	1	x	x	x	x	x	x	x	6	5	11	Yes	x						x	x		1	1	2	SMI - 3 Discrete soil - 6	Comparable to the Northern Decision Unit, which has similar former activity features and munitions score. Samples will focus more on former target areas.
UXO 4	Decision Units 6 and 7 Western UXO 4 Lagoons	Y		0	0	0	0	0	0	0	0	0	0	0	0	x	x		x	x			5	5	10	Yes									x	1	2	3	Discrete SW/SD - 6	Each lagoon will be sampled based on high munitions score proximity to targets. Each lagoon will have three discrete SW and SD samples.The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 4	Decision Units 8 and 9 - Western UXO 4 Lagoon Fringes	Y	Y	0	0	1	0	0	0	0	0	0	0	0	0	x	x		x	x			5	5	10	Yes							x			1	2	3	SMI - 4 Disrete soil - 4	Due to each lagoon being ~2 acres in size, two SMI sample unit and two deep surface soil sample for each lagoon fringe is proposed.The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. Discrete samples will be biased toward areas where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.
UXO 4	Decision Unit 10 - Laguna Anones	Y	Y	0	1	0	0	0	0	0	0	0	0	0	0	x	x	x	x	x	x	x	5	4	9	Yes									x	1	2	3	Discrete SD - 15 SW - 6	Contains the largest sample density of UXO 4 lagoons. Lagoon closest to the majority of targets and includes a target area. Surface water and sediment samples will be co-located at 15 stations.The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 4	Decision Unit 11 - Laguna Anones Fringe	Y	Y	0	1	0	0	0	0	0	0	0	0	0	0	x	x	x	x	x	x	x	5	4	9	Yes							x			1	2	3	SMI- 5 Discrete Soil - 5	Five sampling units proposed due to the size of the lagoon and adjacent MR features. Lagoon closest to the majority of targets and includes a target area.The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. Discrete samples will be biased toward areas where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.

Table 1b
UXO 9 and UXO 9/UXO 12
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5												6							7			8	9									10			11	
UXO	Decision Units	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)												MEC Type (x=occurs within decision unit)							MEC Item Scoring			MEC Investigation Status	Biological Assessment (x=occurs within decision unit)									Receptor Exposure Summary			Decision Unit Approach	
				Range	Naval Gunfire Support Target Area	Target	Gun Position	Consolida-tion points	Controlled Detonation Location	EADA	LIDAR	Bulls-eye	Open Burn	Open Detona-tion	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)	ES	F	FS	G	M	MW	STS	TTS	L	Human Health	Ecological	Total Receptor Score	Recommended Samples	Rationale
UXO 9	Decision Unit 1 - Northeast UXO 9	Y	Y	0	0	0	1	1	11	3	0	0	0	0	0	x	x	x	x	x		x	5	4	9	No			x	x	x			x		1	1	2	SMI -8 Discrete soil - 16	High munitions score and former activity features. sampling units (0 to 2.5 inches) biased toward diversity and quantity of MEC and munitions scrap, drainage and transport pathways (such as ephemeral streams), PI-1, and PI-22. Two sampling units will also characterize potential contamination transport along two ephemeral streams originating from UXO 10.
UXO 9	Decision Unit 2 - Northwest UXO 9	Y	Y	0	0	0	0	1	10	2	0	1	0	0	0	x	x		x	x		x	4	4	8	No			x	x	x			x		1	1	2	SMI - 4 Discrete soil - 8	Sampling units biased toward diversity and quantity of MEC and munitions scrap, the former bulls-eye target, and drainage.
UXO 9	Decision Unit 3 - Southeast UXO 9	N	Y	0	0	0	3	3	5	3	0	0	0	0	0	x	x	x	x	x	x	x	3	2	5	No	x		x	x				x		1	1	2	SMI - 3 Discrete soil - 6	Sampling units biased toward diversity and quantity of MEC and munitions scrap, a gun position, and transport pathways (ephemeral stream).
UXO 9	Decision Unit 4 - South UXO 9	N	N	0	0	0	0	0	2	2	0	0	0	0	0	x	x	x	x	x		x	3	2	5	No			x		x			x		1	1	2	SMI - 5 Discrete soil - 10	Proposed sampling is focused on drainage features, munitions items within decision unit. One sampling unit covers the extent of PI-17. One sampling unit will also characterize potential contamination along the confluence of two ephemeral streams originating from UXO 10.
UXO 9	Decision Unit 5 - Southwest UXO 9	N	N	0	0	0	0	0	1	1	0	0	0	0	0				x	x			2	1	3	No	x		x		x			x		1	1	2	SMI -1 Discrete soil - 2	MEC clearance activities are not complete in this area.
UXO 9	Decision Unit 6 - North UXO 9	N	N	0	0	0	0	0	1	2	0	0	0	0	0	x	x		x	x		x	4	2	6	No			x					x		1	1	2	SMI -2 Discrete soil - 4	Decision unit is smaller in size. Minimal transects conducted north of road due to sensitive vegetation. Comparable to other decision unit with similar munitions score, type, and no former activity features. Samples focused on quantity and diversity of munitions.
UXO9/UXO12	Decision Unit 7 - Northwest UXO 9 Lagoons (Laguna Puerta Diablo)	N	N	0	0	0	0	0	0	2	0	0	0	0	0		x		x				2	2	4	No									x	1	2	3	Discrete SD/SW - 6	3 discrete samples proposed at Laguna Puerto Diablo North and South (total of 6 samples) due to the presence of ephemeral streams from UXO 10 draining to these lagoons.The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO9/UXO12	Decision Unit 8 - Northwest UXO 9 Lagoon Fringes (Laguna Puerto Diablo)	N	N	0	0	0	0	0	0	1	0	0	0	0	0		x		x				2	2	4	No					x					1	2	3	SMI - 4 Discrete Soil - 4	~4 acre sized lagoon. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.
UXO 9	Decision Unit 9 - Laguna Matias	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	No									x	1	2	3	Discrete SD/SW - 3	MEC characterization surrounding this lagoon has not been completed. 3 SW/SD samples are proposed in the lagoon.The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 9	Decision Unit 10 - Laguna Matias Fringe	N	N	0	0	0	0	0	0	1	0	0	0	0	0								0	0	0	No					x			x		1	2	3	SMI - 1 Discrete Soil - 1	~1 acre sized lagoon. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.
UXO 9	Decision Unit 11 - Southwest UXO 9 Lagoons (Lagoon 11)	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	No									x	1	2	3	Discrete SD/SW - 3	MEC characterization surrounding this lagoon has not been completed. 3 SW/SD samples are proposed in 1 of the three lagoons (lagoon 11) which drains an upgradient SSA site.The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 9	Decision Unit 12-Southwest UXO 9 Lagoon Fringes (Lagoon 11)	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	No			x		x			x		1	2	3	SMI - 2 Discrete Soil - 2	~2 acre sized lagoon. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.

Table 1c
UXO 10
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5												6							7			8	9										10			11	
UXO	Decision Units	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)												Munitions Type (x=occurs within decision unit)							Munitions Item Scoring			MEC Investigation Status	Biological Assessment (x=occurs within decision unit)										Receptor Exposure Summary			Decision Unit Approach	
				Range	Naval Gunfire Support Target Area	Target	Gun Position	Consolida-tion points	Controlled Detonation Location	EADA	LIDAR	Bulls-eye	Open Burn	Open Detona-tion	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)	ES	F	FS	G	M	MW	STS	TTS	L	Human Health	Ecological	Total Receptor Score	Recommended Samples	Rationale
UXO 10	Decision Unit 1 - Southwest UXO 10	Y	N	0	0	0	0	0	2	1	0	0	0	0	0	x	x		x	x		x	4	3	7	No										1	1	2	SMI- 3 Discrete soil - 6	Samples focused at SSA site, toward quantity and diversity of munitions, and drainage pathways.
UXO 10	Decision Unit 2 - Northeast UXO 10	N	N	0	0	0	0	0	15	1	0	0	0	0	0	x	x		x	x		x	4	3	7	No										1	1	2	SMI - 3 Discrete soil - 6	Sample units will focus within quantity and diversity of munitions, the drainage area/depositional areas within the ephemeral stream.
UXO 10	Decision Unit 3 - Southeast UXO 10	N	N	0	0	0	0	0	10	1	0	0	0	0	0	x	x		x	x		x	5	3	8	No										1	1	2	SMI - 4 Discrete soil - 8	Sample units will focus within quantity and diversity of munitions, the drainage area/depositional areas within the ephemeral stream.
UXO 10	Decision Unit 4 - Central UXO 10	Y	N	0	0	0	0	0	5	2	0	0	0	0	0	x	x		x	x		x	4	3	7	No										1	1	2	SMI - 3 Discrete soil - 6	Samples will focus on existing transect and clearance information, drainage areas, and quantity and diversity of munitions.
UXO 10	Decision Unit 5 - North UXO 10	N	N	0	0	0	0	0	0	2	0	0	0	0	0	x			x	x		x	3	1	4	No										1	1	2	SMI - 2 Discrete soil - 4	Limited transects conducted in this decision unit. Samples will focus on existing information within the two drainage areas where transects were conducted.

Table 1d
UXO 12
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5												6								7			8	9									10			11	
UXO	Decision Units	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)												Munitions Type (x=occurs within decision unit)								Munitions Item Scoring			MEC Investigation Status	Biological Assessment (x=occurs within decision unit)									Receptor Exposure Summary			Decision Unit Approach	
				Range	Naval Gunfire Support Target Area	Target	Gun Position	Consolida-tion points	Controlled Detonation Location	EADA	LIDAR	Bulls-eye	Open Burn	Open Detona-tion	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)	ES	F	FS	G	M	MW	STS	TTS	L	Human Health	Ecological	Total Receptor Score	Recommended Samples	Rationale
UXO 12	Decision Unit 1 - Northeast UXO 12	Y	Y	0	0	0	3	0	0	2	0	0	0	0	0	x	x	x	x	x		x	4	2	6	Yes		x	x	x				x		1	1	2	SMI - 6 Discrete soil - 12	Decision unit contains limited munitions information; sample units will focus on MR features, AOC/SSA Sites, areas where MEC information is available, and drainage areas.
UXO 12	Decision Unit 2 - Southwest UXO 12	Y	N	0	0	0	0	0	0	2	0	0	0	0	0	x		x	x				1	1	2	No		x		x				x		1	1	2	SMI - 2 Discrete soil - 4	Sampling units will focus on SSA Sites.
UXO 12	Decision Unit 3 - South-Central UXO 12	Y	Y	0	0	0	12	0	0	1	0	0	0	0	0	x			x				2	1	3	Yes			x					x		1	1	2	SMI - 5 Discrete soil - 10	There are a number of gun positions and two SSA sites in this Decision Unit. Sampling units will be focused in the vicinity of SSA sites, gun positions, and drainage areas.
UXO 12	Decision Unit 4 - North UXO 12	Y	Y	0	0	0	9	0	0	3	0	0	0	0	0	x		x	x			x	3	1	4	Yes		x	x	x	x			x		1	1	2	SMI - 1 Discrete soil - 2	Sample units will focus on SSA Site and Burn Area.
UXO 12	Decision Unit 5 -South UXO 12	N	Y	0	0	0	3	0	0	0	0	0	0	0	0		x		x	x		x	2	1	3	Yes			x	x				x		1	1	2	SMI - 2 Discrete soil - 4	Sample units will focus on gun positions and drainage areas conveying surface runoff.
UXO 12	Decision Unit 6 - Southeast UXO 12	N	Y	0	0	0	4	0	6	4	0	0	0	0	0	x	x	x	x	x		x	3	2	5	No				x				x		1	1	2	SMI - 2 Discrete soil - 4	Sample units will focus on limited clearance areas, gun positions and drainage areas conveying surface runoff.
UXO 12	Decision Unit 7 - North-Central UXO 12	Y	Y	0	0	0	9	0	0	3	0	0	0	0	0	x		x	x			x	3	1	4	Yes		x	x	x	x			x		1	1	2	SMI - 1 Discrete soil - 2	Sampling unit biased toward gun position and transport pathways (ephemeral streams). A sampling unit is not proposed at PI-12, since this site is only a former water production well and private residence. In addition, only one sampling unit is proposed due to the lack of munitions identified within this decision unit.
UXO 12	Decision Unit 8 - Laguna Monte Largo	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	Yes									x	1	2	3	SMI - 3 Discrete SD/SW	Major drainage feature in UXO 12. Three SW/SD samples proposed in large lagoon. The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 12	Decision unit 9 - Laguna Monte Largo Fringe	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	Yes					x			x		1	2	3	SMI -4 Discrete Soil - 4	~4 acre sized lagoon. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.

Table 1e
UXO 13
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5												6								7			8	9									10			11	
UXO	Decision Units	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)												Munitions Type (x=occurs within decision unit)								Munitions Item Scoring			MEC Investigation Status	Biological Assessment (x=occurs within decision unit)									Receptor Exposure Summary			Decision Unit Approach	
				Range	Naval Gunfire Support Target Area	Target	Gun Position	Consolida-tion points	Controlled Detonation Location	EADA	LIDAR	Bulls-eye	Open Burn	Open Detona-tion	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)	ES	F	FS	G	M	MW	STS	TTS	L	Human Health	Ecological	Total Receptor Score	Recommended Samples	Rationale
UXO 13	Decision Unit 1 - Northeast UXO 13	Y	Y	5	0	0	2	0	0	1	0	0	0	0	0	x		x	x	x		x		2	1	3	No		x		x				x		1	1	2	SMI - 12 Discrete soil - 24	MEC clearance activities have not been conducted in this decision unit. Sample Units will focus on SSA Sites, range targets and firing points, gun positions, and drainage areas. Information from future MEC clearance activities should be considered to determine if existing sampling units should be modified or if additional sampling units are warranted.
UXO 13	Decision Unit 2 - Central UXO 13	Y	Y	4	0	0	2	0	0	3	0	0	0	0	0			x	x	x				1	1	2	No		x		x				x		1	1	2	SMI - 11 Discrete soil - 22	MEC clearance activities have not been conducted in this decision unit. Sample Units will focus on SSA Sites, range targets and firing points, gun positions, and drainage areas. Information from future MEC clearance activities should be considered to determine if existing sampling units should be modified or if additional sampling units are warranted.
UXO 13	Decision Unit 3 - East Northeast UXO13	N	Y	1	0	0	1	0	0	2	0	0	0	0	0	x			x	x		x		2	1	3	No					x			x		1	1	2	SMI - 2 Discrete soil - 4	MEC clearance activities have not been conducted in this decision unit. Sample units will be focused in the drainage area and the range.Information from future MEC clearance activities should be considered to determine if existing sampling units should be modified or if additional sampling units are warranted.
UXO 13	Decision Unit 4 -Parcel C UXO 13	N	N	0	0	0	0	0	0	2	0	0	0	0	0									0	0	0	No								x		3	1	4	To Be Determined	Only unrestricted scenario on East Vieques. MEC investigation will comprise of transects with minimal vegetation clearance. If MEC items are identified, environmental sampling will be conducted. Sample units will be established in the vicinity of the MEC items. discrete subsurface soil samples will be collected if sample unit results indicate surface soil contamination is present. No environmental sampling is proposed if MEC is not encountered during clearance activities.
UXO 13	Decision Unit 5 - South UXO 13	N	Y	1	0	0	1	0	0	1	0	0	0	0	0									1	1	2	No								x		1	1	2	SMI - 1 Discrete soil - 2	MEC Clearance activities have not been conducted in this decision unit. Sample Units will focus on range and gun positions. Information from future MEC clearance activities should be considered to determine if existing sampling units should be modified or if additional sampling units are warranted.
UXO 13	Decision Unit 6 - Laguna Algodones	N	N	0	0	0	0	0	0	1	0	0	0	0	0									0	0	0	Yes									x	1	2	3	Discrete SW/SD - 6	Three discrete samples within each lagoon are proposed because it is a drainage area for gun positions within UXO 12.
UXO 13	Decision Unit 7 - Laguna Algodones Fringe	N	N	0	0	0	0	0	0	1	0	0	0	0	0									0	0	0	Yes					x			x		1	2	3	SMI - 3 Disrete soil - 3	~3 acre sized lagoon. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.

Table 1f
UXO 14
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5												6								7			8	9									10			11	
UXO	Decision Units	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)												Munitions Type (x=occurs within decision unit)								Munitions Item Scoring			MEC Investigation Status	Biological Assessment (x=occurs within decision unit)									Receptor Exposure Summary			Decision Unit Approach	
				Range	Naval Gunfire Support Target Area	Target	Gun Position	Consolida-tion points	Controlled Detonation Location	EADA	LIDAR	Bulls-eye	Open Burn	Open Detona-tion	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)	ES	F	FS	G	M	MW	STS	TTS	L	Human Health	Ecological	Total Receptor Score	Recommended Samples	Rationale
UXO 14	Decision Unit 1 - East UXO 14	N	Y	0	0	0	1	0	0	0	0	0	0	0	0	x			x	x			1	1	2	Yes					x			x		2	1	3	SMI - 1 Discrete soil - 2	Sample units will be focused on former gun position.
UXO 14	Decision Unit 2 -East Central UXO 14	N	N	0	0	0	0	0	0	1	0	0	0	0	0	x		x	x				1	1	2	Yes				x	x			x		2	1	3	SMI - 1 Discrete soil - 2	One sample unit is proposed in a drainage area of the Decision Unit.
UXO 14	Decision Unit 3 - West Central UXO 14	N	Y	0	0	0	1	0	0	0	0	0	0	0	0				x				1	1	2	Yes		x			x			x		2	1	3	SMI - 2 Discrete soil - 4	No SSA sites within Decision Unit. Sample units will focus on drainage features and gun position within the Decision Unit.
UXO 14	Decision Unit 4 - West UXO 14	N	N	0	0	0	0	0	0	1	0	0	0	0	0								1	0	1	Yes	x				x			x		2	1	3	SMI - 1 Discrete soil - 2	No former activity features or SSA sites within Decision Unit. One sample unit is proposed focusing on drainage features within the Decision Unit.
UXO 14	Decision Unit 5 - West UXO 14 Lagoons (Laguna Yanuel)	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	Yes									x	1	2	3	Discrete SW/SD - 3	Three samples proposed within lagoon Yaneul. Area is a drainage area from upgradient UXO 12 gun positions as well as UXO 14. The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 14	Decision Unit 6 - West UXO 14 Lagoon Fringes (Laguna Yanuel)	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	Yes					x					1	2	3	SMI - 4 Discrete Soil - 4	~4 acre sized lagoon. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.
UXO 14	Decision Unit 7 - East Central UXO 14 Lagoons (Lagoons 14 and 15)	N	N					0	0	0													0	0	0	Yes									x	1	2	3	Discrete SW/SD - 5	Three samples proposed within lagoon 15 and two samples proposed within lagoon 14. The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 14	Decision Unit 8 - East Central UXO 14 Lagoon Fringes (Lagoons 14 and 15)	N	N					0	0	0													0	0	0	Yes					x					1	2	3	SMI - 2 Discrete Soil - 2	Each lagoon is ~1 acre in size. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. The discrete sample will be biased toward an area where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.
UXO 14	Decision Unit 9 - East UXO 14 Lagoons (Lagoons 12 and 13)	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	Yes									x	1	2	3	Discrete SD/SW - 6	Three samples proposed within the lagoon 13. Area is a drainage area from upgradient UXO 12 and 14 east gun positions.The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination. See WS# 17 for further detail.
UXO 14	Decision Unit 10 - East UXO 14 Lagoon Fringes	N	N	0	0	0	0	0	0	0	0	0	0	0	0								0	0	0	Yes					x			x		1	2	3	SMI - 2 Disrete soil - 2	One sample unit proposed around the lagoon 12 and 13 fringes as these areas are a drainage area from upgradient gun positions.The lagoon fringe boundary begins at the high water mark of the lagoon to 30 ft inland. Discrete samples will be biased toward areas where higher frequencies of MEC and munitions scrap were found and removed (primarily) and land crab burrow density is highest.

Table 1g
UXO 18
Inland Terrestrial UXO Sites Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5												6							7			8	9									10			11	
UXO	Decision Units	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)												Munitions Type (x=occurs within decision unit)							Munitions Item Scoring			MEC Investigation Status	Biological Assessment (x=occurs within decision unit)									Receptor Exposure Summary			Decision Unit Approach	
				Range	Naval Gunfire Support Target Area	Target	Gun Position	Consolida-tion points	Controlled Detonation Location	EADA	LIDAR	Bulls-eye	Open Burn	Open Detona-tion	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)	ES	F	FS	G	M	MW	STS	TTS	L	Human Health	Ecological	Total Receptor Score	Recommended Samples	Rationale
UXO 18	Decision Unit 1 - Chayo la Chiva	N	N	0	0	0	0	0	0	0	0	0	0	0	0	x				x			1	1	2	No									3	1	4	SMI - 2 Discrete soil - 3	Based on munitions findings, two sample units are proposed to differentiate between the smoke pots and other MEC items.

Table 2a
UXO 2
East Vieques Beaches Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5									6							7			8			9				10	
UXO	Beach	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)									Munitions Type (x=occurs within beach)							Munitions Items Scoring			MEC Investigation Status	Is the Potential for Sampling Considered Based on Site Releases? (Yes/No)	Rationale	Receptor Exposure Scoring			Is the Potential for Sampling Considered Based on Receptor Exposure? (Yes/No)	Rationale	Is Sampling Proposed (Yes/No) If Yes, recommend samples	Rationale
				Range	Naval Gunfire Support Target Area	Target	Gun Position	LIDAR	Bulls-eye	Open Burn	Open Detonation	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)			Human Health	Ecological	Total Receptor Score				
UXO 2	2 - Unnamed	N	N										X	X	X	X				5	4	9	No	No	Munitions score lower than other beaches	1	3	4	Yes	Highest total receptor score	No	Receptor score addressed at other beaches
UXO 2	3 - Playa Salinas Del Sur	N	Y			1							X	X	X	X			X	5	4	9	No	Yes	Target Area within beach area	1	3	4	Yes	Highest total receptor score	Yes SMI - 2 Discrete Soil - 2	Both potential site releases and receptor are most conservative. See additional explanation on WS#17 for sampling approach and rationale.
UXO 2	4 – Playa Carucho/Turtle Beach	N	Y		1								X	X	X	X	X	X	X	6	4	10	No	Yes	Target Area within beach area; highest munitions score and most diversity of munitions	1	3	4	Yes	Highest total receptor score	Yes SMI - 3 Discrete Soil - 3	Both potential site releases and receptor are most conservative. See additional explanation on WS#17 for sampling approach and rationale.
UXO 2	5 – Icacos/Playa Yallis	N	N										X	X	X	X	X		X	5	4	9	No	No	Munitions score lower than other beaches	1	2	3	Yes	Lower ecological receptor score attributing to lower overall receptor score. However, historical trespassing has been observed at this beach.	Yes SMI - 2 Discrete Soil - 2	Although MEC score and receptor exposure are less than other potential sampling units, sampling is recommended based on historical accounts of trespassing activity. See additional explanation on WS#17 for sampling approach and rationale.
UXO 2	6 – Playa Salinas del Norte/Fossil Beach	N	N										X	X	X	X	X	X	X	6	4	10	No	Yes	Highest munitions score and most diversity of Types of MEC items	1	2	3	No	Lower ecological receptor score attributing to lower overall receptor score.	Yes SMI - 1 Discrete Soil - 1	Potential site releases and receptor addressed with other beaches. See additional explanation on WS#17 for sampling approach and rationale.
UXO 2	7 – Unnamed	N	N										X	X		X				2	3	5	No	No	Munitions score lower than other beaches	1	2	3	No	Lower ecological receptor score attributing to lower overall receptor score.	No	Potential site releases and receptor addressed with other beaches
UXO 2	8 – Unnamed	N	N										X	X		X		X	X	2	3	5	No	No	Munitions score lower than other beaches	1	2	3	No	Lower ecological receptor score attributing to lower overall receptor score.	No	Potential site releases and receptor addressed with other beaches
UXO 2	9 - Unnamed	N	N													X	X			3	4	7	No	No	Munitions score lower than other beaches	1	2	3	No	Lower ecological receptor score attributing to lower overall receptor score.	No	Potential site releases and receptor addressed with other beaches
UXO 2	10 - Unnamed	N	N										X	X		X	X		X	2	3	5	No	No	Munitions score lower than other beaches	1	3	4	Yes	Highest total receptor score	No	Receptor score addressed at other beaches
UXO 2	11 – Unnamed	N	N										X	X		X	X	X	X	5	4	9	No	No	Munitions score lower than other beaches	1	3	4	Yes	Highest total receptor score	No	Receptor score addressed at other beaches
UXO 2	12 – Unnamed	N	N										X	X		X		X	X	3	4	7	No	No	Munitions score lower than other beaches	1	3	4	Yes	Highest total receptor score	No	Receptor score addressed at other beaches
UXO 2	13 – Playa Barco	N	N													X		X		3	1	4	No	No	Munitions score lower than other beaches	1	3	4	Yes	Highest total receptor score	No	Receptor score addressed at other beaches
UXO 2	14 – Playa Brava	N	N										X	X		X	X	X	X	4	2	6	No	No	Munitions score lower than other beaches	1	3	4	Yes	Highest total receptor score	No	Receptor score addressed at other beaches
UXO 2	34 – Unnamed	N	N											X		X	X			6	2	8	No	No	Highest munitions score; but diversity of munitions addressed in other beaches	1	2	3	No	Lower ecological receptor score attributing to lower overall receptor score.	No	Potential site releases and receptor addressed with other beaches
UXO 2	35 - Unnamed	N	N													X				2	2	4	No	No	Munitions score lower than other beaches	1	1	2	No	Lower ecological receptor score attributing to lower overall receptor score.	No	Potential site releases and receptor addressed with other beaches

Table 2b
UXO 7
East Vieques Beaches Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5									6							7			8	Is the Potential for Sampling Considered Based on Site Releases? (Yes/No)	Rationale	9			Is the Potential for Sampling Considered Based on Receptor Exposure? (Yes/No)	Rationale	Is Sampling Proposed (Yes/No) If Yes, recommend samples	10
UXO	Beach	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)									Munitions Type (x=occurs within beach)							Munitions Items Scoring			MEC Investigation Status			Receptor Exposure Scoring						Rationale
				Range	Naval Gunfire Support Target Area	Target	Gun Position	LIDAR	Bulls-eye	Open Burn	Open Detonation	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)			Human Health	Ecological	Total Receptor Score				
UXO 7	33 - Unnamed	N	N										X	X		X			X	2	1	3	Yes	No	Munitions score lower than other beaches	2	2	4	Yes	High human health	Yes SMI - 1 Discrete Soil - 1	Beach is selected based on high receptor score and intended future use. See additional explanation on WS#17 for sampling approach and rationale.
UXO 7	Isla Yallis	N	N											X						1	1	2	No	No	Munitions score lower than other beaches	1	1	2	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	27 - Unnamed	N	N													X	X		X	2	2	4	Yes	No	Munitions score lower than other beaches; subsurface DGM anomalies have been investigated and has less than or equivalent to the number of munitions identified than other beaches	1	2	3	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	21 - Unnamed	N	N																	0	n/a		No	No	Beach Clearance not complete; if MEC clearance indicates high munitions score, proposal not to sample will be revisited.	1	1	2	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	22 - Puerto Diablo	N	N											X		X			X	2	3	5	Yes	Yes	Munitions score lower than other beaches; but munitions type not addressed	2	3	5	Yes	High human health and ecological sensitivitiy	Yes SMI - 2 Discrete Soil - 2	Munitions type and high receptor score. See additional explanation on WS#17 for sampling approach and rationale.
UXO 7	32 - Unnamed	N	N													X				0	0	0	Yes	No	Munitions score lower than other beaches	1	1	2	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	31- Unnamed	N	N																	0	0	0	No	No	Munitions score lower than other beaches	1	1	2	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	23 - Puerto Negro	N	N																	0	0	0	Yes	No	Munitions score lower than other beaches	2	2	4	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	30 - Punta Brigadere	N	Y	1																0	0	0	Yes	No	Clearance has not been conducted at this Site. If munitions type or munitions score are different than other ranges at UXO 8 then this will be considered.	1	2	3	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	24 - Playa Compania/Purple Beach	Y	Y	1													X			3	1	4	Yes	Yes	PAOC Site and range features with high munitions score within the UXO site.	2	3	5	Yes	High human health and ecological sensitivitiy	Yes SMI - 2 Discrete Soil - 2	PAOC, major turtle nesting area, recreational; high MEC quantities. See additional explanation on WS#17 for sampling approach and rationale.
UXO 7	25 - Unnamed	Y	Y	1																0	0	0	No	No	Munitions score lower than other beaches; PAOC also on Purple Beach	1	1	2	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	29 - Unnamed	N	Y	1											X					1	1	2	No	No	Low munitions and no site release areas	1	1	2	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	28 - Unnamed	N	N																	0	0	0	No	No	Low munitions and no site release areas	1	1	2	No	Lower receptor score	No	No for both potential site releases and receptor
UXO 7	26 - Unnamed	N	N																	0	0	0	No	No	Low munitions and no site release areas	1	2	3	No	Lower receptor score	No	No for both potential site releases and receptor

Table 2c
UXO 8
East Vieques Beaches Evaluation and Rationale for Sampling Approach
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

1	2	3	4	5									6							7			8			9				10	
UXO	Beach	Site Screening Areas (i.e., PI/SWMUs, etc.) (Y=Yes, N=No)	Range/ Target Areas/ Gun Positions (Y=Yes, N=No)	Former Activity Features (quantity)									Munitions Type (x=occurs within beach)							Munitions Items Scoring			MEC Investigation Status	Is the Potential for Sampling Considered Based on Site Releases? (Yes/No)	Rationale	Receptor Exposure Scoring			Is the Potential for Sampling Considered Based on Receptor Exposure? (Yes/No)	Rationale	Is Sampling Proposed (Yes/No) If Yes, recommend samples	Rationale
				Range	Naval Gunfire Support Target Area	Target	Gun Position	LIDAR	Bulls-eye	Open Burn	Open Detonation	Sub-munitions Area	FP	B	G	P/M	R/G	S	MC	Quantity	Frequency	Total Munitions Score	Complete (Yes/No)			Human Health	Ecological	Total Receptor Score				
UXO 8	36 - Unnamed	N	N													X				2	1	3	No	No	Although higher quantity; munitions type is addressed with other sample units.	1	1	2	No	lower receptor score	No	No for both potential site releases and receptor
UXO 8	1 - Playa Matias/Yellow Beach	N	N										X			X	X		X	1	1	2	Yes	No	Lower munitions quantity, highest diversity of munitions	2	3	5	Yes	Highest receptor score for both human health and ecological sensitivity.	Yes SMI - 2 Discrete Soil - 2	Highest receptor score. See additional explanation on WS#17 for sampling approach and rationale.
UXO 8	17 - Playa Jalova	N	N													X	X		X	2	2	4	Yes	Yes	Higher munitions quantity and diversity of munitions	1	3	4	No	Lower receptor score	Yes SMI - 1 Discrete Soil - 1	Based on site releases. See additional explanation on WS#17 for sampling approach and rationale.
UXO 8	18 - Playa Jalovita	N	N										X							2	2	4	Yes	Yes	Diversity of munitions not addressed with other potential sampling units.	1	3	4	No	Lower receptor score	Yes SMI - 1 Discrete Soil - 1	Based on potential site releases. See additional explanation on WS#17 for sampling approach and rationale.
UXO 8	19 - Playa Yoye	N	N													X			X	1	1	2	Yes	No	Lower munitions quantity although clearance activities may not be complete; prior to investigation of beaches a re-evaluation of munitions quantities may be necessary to incorporate into the decision analysis.	1	2	3	No	Lower receptor score	No	No based on potential site releases and receptor evaluation.
UXO 8	20 - Playa Fanduca	N	N										X							1	1	2	Yes	No	Lower munitions quantity although clearance activities may not be complete; prior to investigation of beaches a re-evaluation of munitions quantities may be necessary to incorporate into the decision analysis.	1	2	3	No	Lower receptor score	No	No based on potential site releases and receptor evaluation
UXO 8	38 - Unnamed	N	N																	0	0	0	No	No	Lower munitions quantity although clearance activities may not be complete; prior to investigation of beaches a re-evaluation of munitions quantities may be necessary to incorporate into the decision analysis.	1	1	2	No	Lower receptor score	No	No based on potential site releases and receptor evaluation
UXO 8	39 - Punta Carenera	N	N																	0	0	0	No	No	Lower munitions quantity although clearance activities may not be complete; prior to investigation of beaches a re-evaluation of munitions quantities may be necessary to incorporate into the decision analysis.	1	1	2	No	Lower receptor score	No	No based on potential site releases and receptor evaluation
UXO 8	Cayo Conejo	N	N											X		X			X	1	1	2	No	No	Low munitions quantity	1	3	4	Yes	Ecological receptor score	Yes SMI - 1	Habitat for the endangered brown pelican. See additional explanation on WS#17 for sampling approach and rationale.

Table 3
Monitoring Well Nomenclature and Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Database ID	Well ID	Decision Unit	Rationale
VE-EAST-MW01	MW-01	North UXO 4	Former mock target area (railroad tunnel), high density of munitions, potential depleted uranium area, northern portion of LIA
VE-EAST-MW02	MW-02	Central UXO 4	Vicinity of OB and OD areas, high density of munitions, central portion of LIA
VE-EAST-MW03	MW-03	Central UXO 4	Former targets (air strip), numerous craters, high density of munitions, central portion of LIA
VE-EAST-MW04	MW-04	Central UXO 4	Former targets (air strip), high density of munitions, central portion of LIA
VE-EAST-MW05	MW-05	East UXO 4	Former targets, numerous craters, high density of munitions, southern portion of LIA
VE-EAST-MW06	MW-06	East UXO 4	Potential migration pathway in south-eastern portion of LIA adjacent to the ECA
VE-EAST-MW07	MW-07	UXO 3 (LIA Roads)/Northwest UXO 4	Bulls Eye Target #1, CPC, high density of munitions, northwestern portion of LIA
VE-EAST-MW08	MW-08	Southwest UXO 4	Former target (strafing target), southwestern portion of LIA
VE-EAST-MW09	MW-09	UXO 5 (SIA Restricted Roads)/Northeast UXO 9	Located downgradient of former targets within SIA, adjacent to ephemeral streams to assess potential migration, northern portion of SIA
VE-EAST-MW10	MW-10	Northeast UXO 9	Located downgradient of former targets within SIA to assess potential migration, northeastern portion of SIA
VE-EAST-MW11	MW-11	UXO 5 (SIA Restricted Roads)/Southeast UXO 9	Located downgradient of former targets within SIA to assess potential migration, southeastern portion of SIA
VE-EAST-MW12	MW-12	UXO 5 (SIA Restricted Roads)/Northwest UXO 9	High density of munitionswithin SIA, located adjacent to Bulls Eye Target #2, northwestern portion of SIA
VE-EAST-MW13	MW-13	UXO 6 (EMA/SIA Public Roads)/South UXO 9	Located downgradient of former targets within SIA adjacent to ephemeral streams to assess potential migration, southern portion of SIA
VE-EAST-MW14	MW-14	South UXO 9	Located downgradient of former targets within SIA adjacent to ephemeral streams to assess potential migration, southeastern portion of SIA
VE-EAST-MW15	MW-15	UXO 11 (EMA Public Roads)/North UXO 12	Vicinity of a gun position, assess potential migration within EMA, northern portion of EMA
VE-EAST-MW16	MW-16	UXO 11 (EMA Public Roads)/North UXO 12	Vicinity of a gun position, assess potential migration within EMA, northern portion of EMA
VE-EAST-MW17	MW-17	UXO 11 (EMA Public Roads)/Northeast UXO 12	East-Central portion of EMA to assess potential migration
VE-EAST-MW18	MW-18	UXO 6 (EMA/SIA Public Roads)/Southeast UXO 12	Located downgradient of gun positions within southeastern portion of EMA to assess potential migration
VE-EAST-MW19	MW-19	UXO 6 (EMA/SIA Public Roads)/West Central UXO 12	Located downgradient of gun positions within southern portion of EMA to assess potential migration
VE-EAST-MW20	MW-20	UXO 6 (EMA/SIA Public Roads)/South Central UXO 12	Southwestern portion of EMA to assess potential migration
VE-EAST-MW21	MW-21	Northeast UXO 13	Located within range, northern portion of EMA
VE-EAST-MW22	MW-22	Central UXO 13	Assess potential migration within northern portion of EMA
VE-EAST-MW23	MW-23	UXO 11 (EMA Public Roads)/North Central UXO 13	Located within range, western portion of EMA to assess potential migration

Table 4
UXO 2 - Munitions Items Removed within Sampling Unit and Sampling Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1, LIA Beaches UXO 2														
VE-UXO2-1DU01	Playa Salinas Del Sur 1	0	0	0	0	1	0	0	3,568	X		X		High site release and receptor scores (Table 2a); where strafing target overlaps beach, high density of munitions, other LIA targets in vicinity
VE-UXO2-1DU02	Playa Salinas Del Sur 2	21	0	2	1	33	0	0	5,248	X		X		High site release and receptor scores (Table 2a); located adjacent to air-to-ground target and other LIA targets, highest density of munitions on beach
VE-UXO2-1DU03	Playa Carucho/Turtle Beach 1	9	0	21	0	64	0	7	6,042			X		High site release and receptor scores (Table 2a); located within Naval Gunfire Support Target Area and adjacent to air-to-ground target, other LIA targets in vicinity, highest density of munitions on beach
VE-UXO2-1DU04	Playa Carucho/Turtle Beach 2	7	1	0	0	5	0	0	1,047			X		High site release and receptor scores (Table 2a); located within Naval Gunfire Support Target Area and Target T3, other LIA targets in vicinity, high density of munitions on beach, drainage area from Laguna Anones
VE-UXO2-1DU05	Playa Carucho/Turtle Beach 3	0	0	0	0	1	0	0	130			X		High site release and receptor scores (Table 2a); high density of munitions on beach, located between Target T5 and Target T6
VE-UXO2-1DU06	Icacos/Playa Yallis 1	6	0	0	0	3	0	0	2,300					Trespassing activities (Table 2a); high density of munitions on beach, vicinity of strafing, bulls-eye, and LIA targets
VE-UXO2-1DU07	Icacos/Playa Yallis 2	9	0	0	0	0	0	0	2,799					Trespassing activities (Table 2a); high density of munitions on beach, adjacent to strafing, bulls-eye target, and other LIA targets
VE-UXO2-1DU08	Playa Salinas Norte/Fossil 1	7	1	0	0	0	0	0	40					High site release score (Table 2a); high density of munitions on beach, adjacent to LIA targets

Table 5
UXO 3 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - LIA Roads UXO 3														
VE-UXO3-1DU01	LIA Roads 1	308	0	1	1	23	0	0	4,396			X	X	High density of munitions, where strafing target overlaps road, LIA targets in vicinity, low-lying area along the road
VE-UXO3-1DU02	LIA Roads 2	85	0	3	0	17	0	11	17,115				X	High density of munitions, LIA targets in vicinity, low-lying area along the road
VE-UXO3-1DU03	LIA Roads 3	38	4	4	5	33	5	5	28,123		X		X	High density and diversity of munitions, LIA targets in vicinity, low-lying area along the road
VE-UXO3-1DU04	LIA Roads 4	84	2	0	3	105	2	5	30,305		X	X	X	High density and diversity of munitions, adjacent to OD and air-to-ground target, LIA targets in vicinity, low-lying area along the road
VE-UXO3-1DU05	LIA Roads 5	375	0	0	5	371	3	22	45,959		X		X	High density of munitions, adjacent to multiple target features, low-lying area along the road
VE-UXO3-1DU06	LIA Roads 6	12	0	10	0	4,991	1	0	2,500			X	X	High density of munitions, adjacent to strafing target, low-lying area along the road
VE-UXO3-1DU07	LIA Roads 7	41	2	32	23	169	0	3	10,861		X	X	X	High density of munitions, located at target T5, other LIA targets in vicinity, low-lying area along the road
VE-UXO3-1DU08	LIA Roads 8	3	0	0	1	46	5	3	190	X	X	X	X	High density of munitions, located at target area, other LIA target in vicinity, low-lying area along the road

Table 6
UXO 4 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1, Central UXO 4														
VE-UXO4-1DU01	Central 1	25	0	14	0	30	1	0	7,179			X	X	High density of munitions, potential depositional area for surrounding drainage, LIA targets in vicinity
VE-UXO4-1DU02	Central 2	21	0	0	0	29	0	2	12,768		X	X		OD (SWMU 3), high density of munitions, adjacent to air-to-ground target, LIA targets in vicinity
VE-UXO4-1DU03	Central 3	17	0	0	1	5	0	0	30,903					Target area (mock air strip), high density of munitions, LIA targets in vicinity
VE-UXO4-1DU04	Central 4	32	0	2	0	20	0	18	16,782			X		Target area (mock air strip), high density of munitions, adjacent to mock air strip target, LIA targets in vicinity
VE-UXO4-1DU05	Central 5	74	0	0	0	65	0	0	7,315			X		Target area (mock ammo dump), high density of munitions, LIA targets in vicinity
VE-UXO4-1DU06	Central 6	32	0	6	1	34	1	0	0			X	X	Target T2, potential depositional area for surrounding drainage
VE-UXO4-1DU07	Central 7	13	3	7	4	30	2	0	6,259		X	X	X	OB (SWMU 3), adjacent to air-to-ground target, high density of munitions, potential depositional area for surrounding drainage
VE-UXO4-1DU08	Central 8	50	1	0	1	22	3	0	22,026			X		Target area (mock airstrip), high density of munitions, LIA targets in vicinity
VE-UXO4-1DU09	Central 9	38	1	0	1	49	1	1	21,580			X		Target area (mock airstrip), high density of munitions, LIA targets in vicinity
VE-UXO4-1DU10	Central 10	16	0	22	0	16	6	0	14,218				X	High density of munitions, potential depositional area for surrounding drainage
VE-UXO4-1DU11	Central 11	247	2	10	1	150	1	11	5,261			X	X	Target area (mock airstrip), high density of munitions scrap, potential depositional area for surrounding drainage
VE-UXO4-1DU12	Central 12	142	0	21	1	225	2	8	35,502			X		Target area (mock airstrip), high density of munitions, adjacent to air-to-ground target, LIA targets in vicinity
VE-UXO4-1DU13	Central 13	41	0	0	0	10	0	0	50			X		Target area (mock fuel farm), adjacent to air-to-ground target, LIA targets in vicinity
VE-UXO4-1DU14	Central 14	10	0	1	0	7	0	0	6,609			X		Target T3, adjacent to air-to-ground target, adjacent to Naval Gunfire Support Target Area, LIA targets in vicinity
VE-UXO4-1DU15	Central 15	24	0	5	2	89	0	0	37,378					High density of munitions, LIA targets in vicinity
VE-UXO4-1DU16	Central 16	21	2	0	1	16	1	0	95					Air-to-ground target, LIA targets in vicinity
VE-UXO4-1SB33	-	-	-	-	-	-	-	-	-	-	-	X	-	OD area
VE-UXO4-1SB34	-	-	-	-	-	-	-	-	-	-	-	X	-	OD area
VE-UXO4-1SB35	-	-	-	-	-	-	-	-	-	-	-	X	-	OD area
VE-UXO4-1SB36	-	-	-	-	-	-	-	-	-	-	-	X	-	OD area
VE-UXO4-1SB37	-	-	-	-	-	-	-	-	-	-	-	X	-	OD area
VE-UXO4-1SB38	-	-	-	-	-	-	-	-	-	-	-	X	-	OB area
Decision Unit 2, North UXO 4														
VE-UXO4-2DU01	North 1	25	0	0	1	10	2	0	42,900				X	High density of munitions, potential depositional area for surrounding drainage, LIA targets in vicinity
VE-UXO4-2DU02	North 2	29	0	0	3	34	1	4	27,060					High density of munitions scrap, LIA targets in vicinity
VE-UXO4-2DU03	North 3	32	1	0	14	0	1	85	16,700					High density of munitions, LIA targets in vicinity
VE-UXO4-2DU04	North 4	80	0	0	2	75	3	182	21,696			X		Target area (mock convoy), high density of munitions scrap, adjacent to air-to-ground target, LIA targets in vicinity

Table 6
UXO 4 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
VE-UXO4-2DU05	North 5	14	1	0	0	14	2	1	17,025				X	High density of munitions, potential depositional area for surrounding drainage, LIA targets in vicinity
VE-UXO4-2DU06	North 6	44	0	0	4	15	0	4	29,550					High density ofmunitions, LIA targets in vicinity
VE-UXO4-2DU07	North 7	67	0	0	0	192	0	1	2,945		X	X		Target area (mock railroad tunnel), high density of munitions, LIA targets in vicinity
VE-UXO4-2DU08	North 8	68	0	0	2	118	0	10	44,844			X		High density of munitions, LIDAR identified targets, LIA targets in vicinity
Decision Unit 3, Northwest UXO 4														
VE-UXO4-3DU01	Northwest 1	252	0	0	0	22	0	0	0			X	X	Target area (strafing target) and bulls-eye target, CPC, high density of bombs, potential depositional area for surrounding drainage
VE-UXO4-3DU02	Northwest 2	30	0	0	0	4	1	16	13,800	X			X	High density of munitions, potential depositional area for surrounding drainage, LIA targets in vicinity
VE-UXO4-3DU03	Northwest 3	102	0	8	0	18	0	0	3,945			X		Target area (SAM west), high density of munitions
VE-UXO4-3DU04	Northwest 4	63	0	36	0	86	1	0	10,528			X		Target area (SAM west), high density of munitions
VE-UXO4-3DU05	Northwest 5	30	0	133	0	56	1	0	1,700			X		Historical Naval Gunfire Target and high density of munitions
Decision Unit 4, Southwest UXO 4														
VE-UXO4-4DU01	Southwest 1	30	0	14	0	2,301	2	0	4,716			X	X	Target area (strafing target) in vicinity, high density of munitions (projectiles), potential depositional area for surrounding drainage, LIA targets in vicinity
VE-UXO4-4DU02	Southwest 2	0	1	0	0	11	0	0	2,130			X	X	Target area (strafing target), potential depositional area for surrounding drainage, LIA targets in vicinity
VE-UXO4-4DU03	Southwest 3	17	3	0	1	15	0	0	16,544		X		X	High density of munitions, potential depositional area for surrounding drainage, LIA targets in vicinity
VE-UXO4-4DU04	Southwest 4	29	0	7	1	245	0	0	12,030				X	Historical Naval Gunfire Target, high density of munitions, potential depositional area for surrounding drainage
VE-UXO4-4DU05	Southwest 5	45	0	50	0	64	0	0	6,358			X		Target T1, high density of munitions, LIA targets in vicinity
Decision Unit 5 - East UXO 4														
VE-UXO4-5DU01	East 1	5	1	0	5	9	0	6	750		X			Air-to-ground target, LIA targets in vicinity
VE-UXO4-5DU02	East 2	22	1	9	2	142	4	1	34,396		X			High density of munitions, LIA targets in vicinity
VE-UXO4-5DU03	East 3	4	0	0	0	7	0	0	778		X	X		Target T6, high density of munitions, LIA targets in vicinity
Decision Unit 6 - Northwest UXO 4 Lagoons (Laguna Gato) - quantity of items are for entire lagoon														
VE-UXO4-6SDW01	Laguna Gato	46	16	0	9	95	6	0	44,535		X		X	The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination
VE-UXO4-6SDW02														
VE-UXO4-6SDW03														

Table 6
UXO 4 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 7 - Southwest UXO 4 Lagoons (Laguna Icacos) - quantity of items are for entire lagoon														
VE-UXO4-7SDW01	Laguna Icacos	11	0	0	0	1052	3	0	36,624		X		X	The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination
VE-UXO4-7SDW02														
VE-UXO4-7SDW03														
Decision Unit 8 - Northwest UXO 4 Lagoon Fringes (Laguna Gatos)														
VE-UXO4-8DU01	Laguna Gato Fringe 1	150	3	110	10	151	7	1	45,315				X	One acre sampling unit within ~2 acre lagoon fringe
VE-UXO4-8DU02	Laguna Gato Fringe 2	13	0	14	0	11	2	0	152				X	One acre sampling unit within ~2 acre lagoon fringe
Decision Unit 9 - Southwest UXO 4 Lagoon Fringe (Laguna Icacos)														
VE-UXO4-9DU01	Laguna Icacos Fringe 1	77	8	1	2	668	2	0	9,086				X	One acre sampling unit within ~2 acre lagoon fringe
VE-UXO4-9DU02	Laguna Icacos Fringe 2	4	2	0	0	6	0	0	21					One acre sampling unit within ~2 acre lagoon fringe
Decision Unit 10 - Laguna Anones - quantity of items are for entire lagoon														
VE-UXO4-10SDSW01	Laguna Anones	85	8	25	0	528	13	48	80,714				X	The number of sediment and surface water samples per lagoon was selected based on the size of the lagoon and proximity to areas with the highest potential for contamination
VE-UXO4-10SDSW02														
VE-UXO4-10SDSW03														
VE-UXO4-10SDSW04														
VE-UXO4-10SDSW05														
VE-UXO4-10SDSW06														
VE-UXO4-10SDSW07														
VE-UXO4-10SDSW08														
VE-UXO4-10SDSW09														
VE-UXO4-10SDSW10														
VE-UXO4-10SDSW11														
VE-UXO4-10SDSW12														
VE-UXO4-10SDSW13														
VE-UXO4-10SDSW14														
VE-UXO4-10SDSW15														
Decision Unit 11 - Laguna Anones Fringe														
VE-UXO4-11DU01	Laguna Anones 1	43	24	27	18	124	3	4	11,609				X	Five samples due to larger size of lagoon, depositional environment and adjacent to the area with the highest potential for contamination within the former VNTR
VE-UXO4-11DU02	Laguna Anones 2	42	1	2	5	89	3	0	16,153					
VE-UXO4-11DU03	Laguna Anones 3	105	3	1	1	57	0	0	38,753					
VE-UXO4-11DU04	Laguna Anones 4	110	2	2	4	116	3	15	11,012					
VE-UXO4-11DU05	Laguna Anones 5	145	0	13	6	205	2	18	16,397					
Field Identified Craters														
VE-UXO4-12SDSW01	Crater 1													One sediment (0 to 6 inches) and one surface water sample (mid-depth) will be collected from three field identified craters, which act as potential habitat for waterfowl and shorebirds.
VE-UXO4-12SDSW02	Crater 2													
VE-UXO4-12SDSW03	Crater 3													

(x=occurs within decision unit)

Table 7
UXO 5 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - UXO 5 SIA Restricted Roads														
VE-UXO5-1DU01	UXO 5 Roads 1	0	0	0	0	1	0	0	78	X			X	Higher density of subsurface munitions, low-lying area along the road
VE-UXO5-1DU02	UXO 5 Roads 2	3	0	0	0	1	0	0	52	X			X	Higher density of subsurface munitions, low-lying area along the road
VE-UXO5-1DU03	UXO 5 Roads 3	0	0	0	2	6	1	0	495	X			X	Downgradient of gun positions, low-lying area along the road
VE-UXO5-1DU04	UXO 5 Roads 4	0	0	0	0	5	0	0	127	X			X	Higher density of subsurface munitions, low-lying area along the road
VE-UXO5-1DU05	UXO 5 Roads 5	0	2	0	3	43	1	0	302	X			X	Higher density of munitions in surface and subsurface, low-lying area along the road
VE-UXO5-1DU06	UXO 5 Roads 6	407	0	0	2	4	2	0	84	X		X	X	High density of MEC, in the vicinity of Bulls eye Target #2, low-lying area along the road
VE-UXO5-1DU07	UXO 5 Roads 7	0	0	0	0	0	0	0	0	X		X	X	Area proposed as a scenic overlook and historical site for public use
VE-UXO5-1DU08	UXO 5 Roads 8	1	0	0	2	1	0	1	58					Downgradient of former gun position

Table 8
UXO 6 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - UXO 6 SIA Public Roads														
VE-UXO6-1DU01	UXO 6 Roads 1	0	0	0	0	3	1	0	100	X			X	Area with higher density of MEC and munitions scrap within surface and subsurface
VE-UXO6-1DU02	UXO 6 Roads 2	0	0	0	0	1	0	0	104	X			X	Area with higher density of MEC and munitions scrap within surface and subsurface
VE-UXO6-1DU03	UXO 6 Roads 3	1	0	0	0	0	0	0	24					Area is intended to have recreational use, munitions debris identified
VE-UXO6-1DU04	UXO 6 Roads 4	0	0	0	1	1	0	0	15					Area is intended to have recreational use, munitions debris identified

Table 9
UXO 7 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
UXO 7														
Decision Unit 1 - UXO 7 EMA/SIA North Beaches														
VE-UXO7-1DU01	22 -Diablo 1	48	0	0	0	0	0	0	40	X			X	High site release and receptor scores (Table 2b); Bulls-eye target #2 in vicinity, high density of MEC, downgradient of ephemeral stream
VE-UXO7-1DU02	22 -Diablo 2	0	0	0	0	1	0	0	9	X			X	High site release and receptor scores (Table 2b); downgradient of two ephemeral streams, higher density of subsurface munitions, Bulls-eye target #2 in vicinity
VE-UXO7-1DU03	24 - Playa Compania/Purple Beach 1	0	0	0	0	0	0	0	57	X	X	X		High site release and receptor scores (Table 2b); PAOC Site and occurs within range boundary
VE-UXO7-1DU04	24 - Playa Compania/Purple Beach 2	0	0	0	0	0	0	0	5	X			X	High site release and receptor scores (Table 2b); high diversity of subsurface munitions; ephemeral stream
VE-UXO7-1DU05	Beach 33	0	0	0	0	0	0	0	795	X				High receptor scores (Table 2b); much higher number of munitions debris relative to number of MEC

Table 10
UXO 8 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
UXO 8														
Decision Unit 1 - UXO 8 SIA South Beaches														
VE-UXO8-1DU01	17 - Playa Jalova	0	0	0	1	2	0	0	34	X			X	High site release score (Table 2c); higher density of subsurface munitions, ephemeral stream
VE-UXO8-1DU02	18 - Playa Jalovita	0	0	0	0	0	0	0	45	X			X	High site release score (Table 2c); located at both higher density of surface and subsurface munitions
VE-UXO8-1DU03	1 - Playa Matias/Yellow Beach	0	0	0	1	0	0	0	4	X			X	High receptor score (Table 2c); high density of subsurface munitions, ephemeral stream
VE-UXO8-1DU04	1 - Playa Matias/Yellow Beach	0	0	0	0	0	0	0	0	X			X	High receptor score (Table 2c); high density of subsurface munitions
VE-UXO8-1DU05	Cayo Conejo	3	0	0	0	1	0	0	1					Habitat for the endangered brown pelican

Table 11

UXO 9 - Munitions Items Removed within Sampling Unit and Sample Rationale

Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites

Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1, Northeast UXO 9														
VE-UXO9-1DU01	Northeast 1	0	0	0	0	4	0	0	26				X	Ephemeral stream that drains from UXO 10, density of munitions
VE-UXO9-1DU02	Northeast 2	0	1	0	0	1	0	0	44				X	Ephemeral stream that drains from UXO 10, density of munitions
VE-UXO9-1DU03	Northeast 3	1	0	0	0	1	0	0	10	X	X			PI-22 (former target area) and density of munitions
VE-UXO9-1DU04	Northeast 4	11	1	0	0	2	0	0	1,910	X			X	High density of munitions, ephemeral stream
VE-UXO9-1DU05	Northeast 5	0	0	1	0	3	1	0	84					Density and diversity of munitions
VE-UXO9-1DU06	Northeast 6	106	1	0	0	1	0	0	2,531	X		X		High density of munitions, located adjacent to Bulls Eye Target #1 and P-1 (aircraft strafing target)
VE-UXO9-1DU07	Northeast 7	0	0	0	2	2	2	0	485					High density of munitions
VE-UXO9-1DU08	Northeast 8	57	0	0	0	9	0	0	15		X	X		PI-1 (aircraft strafing target), high density of munitions, located adjacent to Bulls Eye Target #1
Decision Unit 2, Northwest UXO 9														
VE-UXO9-2DU01	Northwest 1	0	0	0	5	6	3	0	1,100					High density of munitions
VE-UXO9-2DU02	Northwest 2	681	0	0	4	8	2	0	522					High density of munitions, in the vicinity of Bulls Eye Target #2
VE-UXO9-2DU03	Northwest 3	962	0	0	1	8	0	0	1,160			X		High density of munitions, located adjacent to Bulls Eye Target #2
VE-UXO9-2DU04	Northwest 4	1206	0	0	0	0	4	0	416					High density of munitions, in the vicinity of Bulls Eye Target #2
Decision Unit 3, Southeast UXO 9														
VE-UXO9-3DU01	Southeast 1	0	0	0	0	0	0	0	17			X	X	Located at gun position, within ephemeral stream, downslope of UXO 10
VE-UXO9-3DU02	Southeast 2	1	0	0	1	4	0	1	23					Diversity of munitions, downslope of UXO 10
VE-UXO9-3DU03	Southeast 3	1	2	0	1	8	0	0	71				X	Density and diversity of munitions
Decision Unit 4, South UXO 9														
VE-UXO9-4DU01	South 1	1	0	4	0	4	0	0	330					High density of munitions, downslope of UXO 10
VE-UXO9-4DU02	South 2	0	0	0	0	5	0	0	22				X	Located within ephemeral stream that drains from UXO 10, munitions identified
VE-UXO9-4DU03	South 3	0	1	0	0	1	0	0	19				X	Located within two ephemeral streams that drains from UXO 10, munitions identified
VE-UXO9-4DU04	South 4	0	0	0	1	0	0	0	0		X			PI-17 (former target and possibly used for landing exercises and as a munitions storage area)
VE-UXO9-4DU05	South 5	0	0	0	0	0	0	0	3				X	Located within ephemeral stream, munitions identified
Decision Unit 5, Southwest UXO 9														
VE-UXO9-5DU01	Southwest 1	0	0	0	0	1	1	0	60					Density of munitions
Decision Unit 6, North UXO 9														
VE-UXO9-6DU01	North 1	0	1	0	8	11	0	0	2,333					High density of munitions
VE-UXO9-6DU02	North 2	0	0	0	2	22	0	0	1,150					High density of munitions
Decision Unit 7 - Northwest UXO 9 Lagoons (Laguna Puerto Diablo) - quantity of items are for entire lagoon														
VE-UXO9-7SDSW01	Laguna Puerto Diablo 1	16	0	0	0	1	0	0	0				X	Sediment and surface water samples were located for broad spatial distribution, while ensuring areas with the highest frequencies of munitions identified were included.
VE-UXO9-7SDSW02														
VE-UXO9-7SDSW03														
VE-UXO9-7SDSW04														
VE-UXO9-7SDSW05														
VE-UXO9-7SDSW06														
Decision Unit 8 - Northwest UXO 9 Lagoon Fringe (Laguna Puerto Diablo)														
VE-UXO9-8DU01	Luguna Puerto Diablo 1	11	0	0	50	1	0	0	46				X	One acre sampling unit within ~4 acre lagoon fringe (includes both lagoons)
VE-UXO9-8DU02	Luguna Puerto Diablo 2	8	0	0	0	0	1	0	0				X	One acre sampling unit within ~4 acre lagoon fringe (includes both lagoons)
VE-UXO9-8DU03	Luguna Puerto Diablo 3	1	0	0	0	0	0	0	1				X	One acre sampling unit within ~4 acre lagoon fringe (includes both lagoons)
VE-UXO9-8DU04	Luguna Puerto Diablo 4	1	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe (includes both lagoons)

Table 11

UXO 9 - Munitions Items Removed within Sampling Unit and Sample Rationale

Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites

Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 9 - Laguna Matias														
VE-UXO9-9SDSW01	Laguna Matias	0	0	0	0	0	0	0	0					One sample across the entire lagoon fringe due to smaller size
VE-UXO9-9SDSW02													X	
VE-UXO9-9SDSW03														
Decision Unit 10 - Laguna Matias Fringe														
VE-UXO9-10DU01	Laguna Matias Fringe	0	0	0	0	2	0	0	0				X	One acre sampling unit within ~1 acre lagoon fringe
Decision Unit 11 - Southwest UXO 9 Lagoons (Lagoon 11)														
VE-UXO9-11SDSW01	Lagoon 11	0	0	0	0	0	0	0	0				X	Sediment and surface water samples were located for broad spatial distribution, while ensuring areas with the highest frequencies of munitions identified were included.
VE-UXO9-11SDSW02														
VE-UXO9-11SDSW03														
Decision Unit 12 - Southwest UXO 9 Lagoon Fringes (Lagoon 11)														
VE-UXO9-12DU01	Lagoon 11 Fringe 1	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~2 acre lagoon fringe
VE-UXO9-12DU02	Lagoon 11 Fringe 2	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~2 acre lagoon fringe

Table 12
UXO 10 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - Southwest UXO 10														
VE-UXO10-1DU01	Southwest 1	2	4	0	0	11	2	0	0		X		X	PAOC Y (identified as a large metal object), ephemeral stream, and diversity of munitions
VE-UXO10-1DU02	Southwest 2	0	2	0	8	23	1	0	56					Diversity and high density of munitions
VE-UXO10-1DU03	Southwest 3	0	0	0	0	0	0	0	0				X	Located within ephemeral stream, characterizes what is potentially leaving the site
Decicion Unit 2 - Northeast UXO 10														
VE-UXO10-2DU01	Northeast 1	0	0	0	0	2	0	0	225				X	Located within ephemeral stream, characterizes what is potentially leaving the site, density of munitions
VE-UXO10-2DU02	Northeast 2	0	0	0	0	5	0	0	372				X	Located within two ephemeral streams, density of munitions
VE-UXO10-2DU03	Northeast 3	0	0	0	0	5	1	0	2,195					High density of munitions
Decision Unit 3 - Southeast UXO 10														
VE-UXO10-3DU01	Southeast 1	0	0	0	0	2	0	0	945				X	High density of munitions, located within ephemeral stream
VE-UXO10-3DU02	Southeast 2	0	0	0	1	9	0	0	575				X	High density of munitions, located within ephemeral stream
VE-UXO10-3DU03	Southeast 3	0	1	0	0	1	0	0	546				X	High density of munitions, located within ephemeral stream
VE-UXO10-3DU04	Southeast 4	0	4	0	3	6	0	0	2,068					High density of munitions, diversity of munitions
Decision Unit 4 - Central UXO 10														
VE-UXO10-4DU01	Central 1	2	0	0	0	6	3	0	448				X	High density and diversity of munitions, located within ephemeral stream
VE-UXO10-4DU02	Central 2	0	2	0	0	5	1	0	1,739					High density and diversity of munitions
VE-UXO10-4DU03	Central 3	0	0	0	0	0	0	0	0				X	Located within confluence of two ephemeral streams, characterizes what is potentially leaving the site
Decision Unit 5 - North UXO 10														
VE-UXO10-5DU01	North 1	0	0	0	0	0	0	0	0				X	Located within ephemeral stream
VE-UXO10-5DU02	North 2	0	0	0	0	0	0	0	0				X	Located within ephemeral stream

Table 13
UXO 11 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1, UXO 11 - EMA Restricted Roads														
VE-UXO11-1DU01	UXO 11 Roads 1	10	0	0	500	7	0	0	100			X	X	Highest density of munitions, located adjacent to Bulls-Eye Target #2, low-lying area along the road
VE-UXO11-1DU02	UXO 11 Roads 2	0	0	0	0	0	0	0	354	X			X	Density of munitions debris, low-lying area along the road
VE-UXO11-1DU03	UXO 11 Roads 3	74	0	0	0	0	0	0	115	X	X	X	X	PAOC Z (former target), high density of munitions, in vicinity of Bulls Eye Target #2
VE-UXO11-1DU04	UXO 11 Roads 4	0	0	0	0	0	1	0	105			X		Located in Range 11, density of muntions, adjacent to ephemeral stream

Table 14
UXO 12 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - Northeast UXO 12														
VE-UXO12-1DU01	Northeast 1	21	0	0	0	515	1	0	350				X	High density of munitions, located within ephemeral stream leaving the site
VE-UXO12-1DU02	Northeast 2	0	0	0	0	0	0	0	0			X	X	Gun position and located in ephemeral stream
VE-UXO12-1DU03	Northeast 3	1	4	0	0	4	1	0	0		X			PI-16 (potential disposal area for munitions)
VE-UXO12-1DU04	Northeast 4	1	0	0	0	3	1	0	0		X			PI-15 (possible former range)
VE-UXO12-1DU05	Northeast 5	6	2	0	0	1	0	0	527					High density and diversity of munitions
VE-UXO12-1DU06	Northeast 6	27	2	0	1	4	0	0	200			X	X	Higher density and diversity of munitions, adjacent to Bulls Eye Target #2, located within ephemeral stream
Decision Unit 2 - Southwest UXO 12														
VE-UXO12-2DU01	Southwest 1	0	0	0	0	0	0	0	0		X			PI-18 (potential small arms range)
VE-UXO12-2DU02	Southwest 2	0	1	0	0	1	0	0	0		X			PI-19 (possible gun position)
Decision Unit 3 - South-Central UXO 12														
VE-UXO12-3DU01	South-Central 1	0	0	0	0	0	0	0	0			X	X	Multiple gun positions, ephemeral streams from the gun positions
VE-UXO12-3DU02	South-Central 2	0	0	0	0	0	0	0	0			X	X	Gun positions, ephemeral streams from the gun positions
VE-UXO12-3DU03	South-Central 3	0	0	0	0	0	0	0	0		X			PI-3 (former small arms range)
VE-UXO12-3DU04	South-Central 4	0	0	0	0	0	0	0	0		X			PI-2 (former small arms range
VE-UXO12-3DU05	South-Central 5	0	0	0	0	0	0	0	0				X	Ephemeral stream from the gun position
Decision Unit 4 - North UXO 12														
VE-UXO12-4DU01	North 1	0	4	0	0	1	0	0	301			X	X	Gun position, density of munitions, located in ephemeral stream
Decision Unit 5 - South UXO 12														
VE-UXO12-5DU01	South 1	0	0	0	0	0	0	0	0			X	X	Gun position and ephemeral stream
VE-UXO12-5DU02	South 2	0	0	0	0	0	0	0	0			X	X	Gun position and ephemeral streams
Decision Unit 6- Southeast UXO 12														
VE-UXO12-6DU01	Southeast 1	0	0	0	11	1	0	0	250			X	X	Range 11 (former artillery range), density of munitions, and located at ephemeral stream
VE-UXO12-6DU02	Southeast 2	0	0	0	0	0	0	0	0			X	X	Gun position and located in ephemeral stream
Decision Unit 7- North-Central UXO 12														
VE-UXO12-7DU01	North-Central 1	0	0	0	0	0	0	0	0			X	X	Located in gun position and ephemeral stream that leaves the site
Decision Unit 8 - Laguna Monte Largo - quantity of items are for entire lagoon														
VE-UXO12-8SDSW01	Laguna Monte Largo	0	0	0	0	0	0	0	0				X	Sediment and surface water samples were located for broad spatial distribution; MEC investigations have historically been conducted in some areas of Laguna Monte Largo and no munitions were identified.
VE-UXO12-8SDSW02														
VE-UXO12-8SDSW03														
Decision Unit 9 - Laguna Monte Largo Fringe														
VE-UOX12-9DU01	Laguna Monte Largo Fringe 1	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe
VE-UOX12-9DU02	Laguna Monte Largo Fringe 2	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe
VE-UOX12-9DU03	Laguna Monte Largo Fringe 3	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe
VE-UOX12-9DU04	Laguna Monte Largo Fringe 4	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe

Table 15
UXO 13 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - Northeast UXO 13														
VE-UXO13-1DU01	Northeast 1	0	2	0	0	0	0	0	0			X		Gun position
VE-UXO13-1DU02	Northeast 2	0	0	0	0	0	0	0	0			X	X	Located within ephemeral stream downgradient from Range 4A
VE-UXO13-1DU03	Northeast 3	0	1	0	0	0	0	0	0			X		Former target area within Range 4
VE-UXO13-1DU04	Northeast 4	0	0	0	0	0	0	0	0			X		Former target area within Range 4
VE-UXO13-1DU05	Northeast 5	0	0	0	0	0	0	0	0			X		Former target area within Range 4B
VE-UXO13-1DU06	Northeast 6	0	0	0	0	0	0	0	0			X		Former target area within Range 4A
VE-UXO13-1DU07	Northeast 7	0	0	0	0	0	0	0	0			X		Former target area within Range 4
VE-UXO13-1DU08	Northeast 8	0	0	0	0	0	0	0	0			X		Former firing point within Range 4B
VE-UXO13-1DU09	Northeast 9	0	0	0	0	0	0	0	0			X		Former target area within Range 3
VE-UXO13-1DU10	Northeast 10	0	0	0	0	1	0	0	0			X		Former target area within Range 4A
VE-UXO13-1DU11	Northeast 11	0	1	0	0	0	0	0	0			X		Former firing point within Range 7
VE-UXO13-1DU12	Northeast 12	0	0	0	0	0	0	0	0			X		Former target area within Range 9
Decision Unit 2 - Central UXO 13														
VE-UXO13-2DU01	Central 1	0	0	0	0	0	0	0	0			X	X	Range 7 and confluence of two ephemeral streams
VE-UXO13-2DU02	Central 2	0	0	0	0	0	0	0	0			X	X	Gun positions and transport pathway (ephemeral stream)
VE-UXO13-2DU03	Central 3	0	0	0	0	0	0	0	0			X		Former target area within Range 2
VE-UXO13-2DU04	Central 4	0	0	0	0	1	0	0	0			X	X	Former target area within Range 7 and transport pathway (ephemeral stream)
VE-UXO13-2DU05	Central 5	0	1	0	0	0	0	0	15			X		Former target area within Range 7
VE-UXO13-2DU06	Central 6	0	0	0	0	0	0	0	0			X		Former target area within Range 1
VE-UXO13-2DU07	Central 7	0	3	1	0	3	0	0	0			X		Former target area within Range 2
VE-UXO13-2DU08	Central 8	0	0	0	0	0	0	0	0			X		Former target area within Range 5
VE-UXO13-2DU09	Central 9	0	0	0	0	0	0	0	0			X		Firing point within Range 1
VE-UXO13-2DU10	Central 10	0	0	0	0	0	0	0	0			X		Firing point within Range 2
VE-UXO13-2DU11	Central 11	0	0	0	0	0	0	0	0			X		Firing point within Range 5
Decision Unit 3 - East Northeast UXO13														
VE-UXO13-3DU01	East Northeast 1	0	0	0	1	0	1	0	0					Low quantity of MEC and munitions scrap
VE-UXO13-3DU02	East Northeast 2	0	0	0	0	0	0	0	0				X	Transport pathways (ephemeral stream)
Decision Unit 5 - South UXO 13														
VE-UXO13-5DU01	South 1	0	1	0	0	0	0	0	0			X		Gun position and within Range 8
Decision Unit 6 - Laguna Algodones - quantity of items are from entire lagoon														
VE-UXO13-6SDSW01	Laguna Algodones	0	0	0	a	0	0	0	0				X	Sediment and surface water samples were located for broad spatial distribution
VE-UXO13-6SDSW02														
VE-UXO13-6SDSW03														
VE-UXO13-6SDSW04														
VE-UXO13-6SDSW05														
VE-UXO13-6SDSW06														
Decision Unit 7 - Laguna Algodones Fringe														
VE-UXO13-7DU01	Laguna Algodones Fringe 1	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~3 acre lagoon fringe (includes both lagoons)
VE-UXO13-7DU02	Laguna Algodones Fringe 2	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~3 acre lagoon fringe (includes both lagoons)
VE-UXO13-7DU03	Laguna Algodones Fringe 3	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~3 acre lagoon fringe (includes both lagoons)

Table 16
UXO 14 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - East UXO 14														
VE-UXO14-1DU01	East 1	0	0	0	0	0	0	0	0			X		Gun position and within Range 10
Decision Unit 2 - East Central UXO 14														
VE-UXO14-2DU01	East Central 1	0	1	0	0	0	0	0	0				X	Transport pathways (ephemeral stream)
Decision Unit 3 - West Central UXO 14														
VE-UXO14-3DU01	West Central 1	0	0	0	0	0	0	0	0				X	Confluence of two ephemeral streams, potential transport pathway
VE-UXO14-3DU02	West Central 2	0	0	0	0	0	0	0	0			X		Gun position
Decision Unit 4 - West UXO 14														
VE-UXO14-4DU01	West 1	0	0	0	0	0	0	0	0				X	Confluence of two ephemeral streams, potential transport pathway
Decision Unit 5 - West UXO 14 Lagoons (Laguna Yanuel)														
VE-UXO14-5SDSW01	Laguna Yanuel	0	0	0	0	0	0	0	0				X	Sediment and surface water samples were located for broad spatial distribution
VE-UXO14-5SDSW02														
VE-UXO14-5SDSW03														
Decision Unit 6 - West UXO 14 Lagoon Fringes (Laguna Yanuel)														
VE-UXO14-6DU01	Laguna Yanuel Fringe 1	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe
VE-UXO14-6DU02	Laguna Yanuel Fringe 2	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe
VE-UXO14-6DU03	Laguna Yanuel Fringe 3	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe; subsurface soil sample at where ephemeral stream enters lagoon
VE-UXO14-6DU04	Laguna Yanuel Fringe 4	0	0	0	0	0	0	0	0				X	One acre sampling unit within ~4 acre lagoon fringe; subsurface soil sample at where ephemeral stream enters lagoon
Decision Unit 7 - East Central UXO 14 Lagoons (Lagoons 14 and 15)														
VE-UXO14-7SDSW01	Lagoon 15	0	0	0	0	0	0	0	0				X	Sediment and surface water samples were located for broad spatial distribution
VE-UXO14-7SDSW02														
VE-UXO14-7SDSW03														
VE-UXO14-7SDSW04	Lagoon 14	0	0	0	0	0	0	0	0				X	Sediment and surface water sample located at where ephemeral stream enters lagoon and spatial distribution
VE-UXO14-7SDSW05		0	0	0	0	0	0	0	0					

Table 16
UXO 14 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale (in order of importance)
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 8 - East Central UXO 14 Lagoon Fringes (Lagoon 15)														
VE-UXO14-8DU01	Lagoon 15	0	0	0	0	0	0	0	0				X	One sample across the entire lagoon fringe due to smaller size
VE-UXO14-8DU01	Lagoon 14	0	0	0	0	0	0	0	0				X	One sample across the entire lagoon fringe due to smaller size
Decision Unit 9 - East UXO 14 Lagoons (Lagoons 12 and 13)														
VE-UXO14-9SDSW01	Lagoons 12 and 13	0	0	0	0	0	0	0	0				X	Sediment and surface water samples were located for broad spatial distribution
VE-UXO14-9SDSW02														
VE-UXO14-9SDSW03														
VE-UXO14-9SDSW04														
VE-UXO14-9SDSW05														
VE-UXO14-9SDSW06														
Decision Unit 10 - East UXO 14 Lagoon Fringes (Lagoons 12 and 13)														
VE-UXO14-10DU01	Lagoon 12	0	0	0	0	0	0	0	0				X	One sample across the entire lagoon fringe at both lagoons due to smaller size
VE-UXO14-10DU02	Lagoon 13	0	0	0	0	0	0	0	0				X	One sample across the entire lagoon fringe at both lagoons due to smaller size; subsurface soil sample at where ephemeral stream enters lagoon

Table 17

UXO 17 - Munitions Items Removed within Sampling Unit and Sample Rationale

Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites

Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								DGM Data Available	Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap					
Decision Unit 1 - UXO 17														
VE-UXO17-1SO01	PAOC EE 1	0	0	0	0	1	0	0	0	X				Potential site release
VE-UXO17-1SO02	PAOC EE 2	0	0	0	0	0	0	0	0	X				Potential site release
VE-UXO17-1SO03	PAOC EE 3	0	0	0	0	0	0	0	0	X				Potential site release

Table 18
UXO 18 - Munitions Items Removed within Sampling Unit and Sample Rationale
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Sample ID	Sampling Unit	Quantity of MEC/MD Removed from Surface								Site Screening Areas (i.e., PI/SWMUs, etc.)	Former Activity Feature (i.e. ranges, gun positions, target areas)	Preferential Transport Pathway	Sample Rationale
		Bombs	Flares/ Pyrotechnics	Grenades	MEC Components	Projectiles /Mortars	Rockets/ Guided Missiles	Submunitions	Scrap				
Decision Unit 1 - Cayo de la Chiva													
VE-UXO18-1DU01	Cayo de la Chiva 1	0	0	0	0	1	0	0	0				Area where MEC were identified
VE-UXO18-1DU02	Cayo de la Chiva 2	0	2	0	0	0	0	0	0				Area where smoke pots were identified
VE-UXO18-1SO03	Cayo de la Chiva 3	0	0	0	0	0	0	0	0				Potential Site Release

Table 19
MEC/MD Items Encountered at Each UXO Site and Their Constituents
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Item Classification	UXO 2	UXO 3	UXO 4	UXO 5	UXO 6	UXO 7	UXO 8	UXO 9	UXO 10	UXO 11	UXO 12	UXO 13	UXO 14	UXO 15	UXO 17	UXO 18	Possible Munitions Constituents			
																	Primary Metal	Secondary Metal	Possible Additional Metal Constituents	Likely Explosive Filler
Bombs																				
AN-M30 (100lb)			X					X									Steel			Composition B or Tritonal
AN-M64 (500lb)			X	X				X									Steel			TNT or Composition B
AN-M65 (1000lb)			X														Steel			TNT or Composition B
BDU-33	X							X	X								Cast iron	Steel		Depends on signal
BDU-45	X	X	X					X									Steel	Aluminum		Concrete
BDU-48			X														Steel			Depends on signal
BDU-50		X	X								X						Steel			Concrete
M117 (750lb)			X														Steel			Tritonal, H6, or minol
MB2 (Old-style)			X														Unable to find information on this item			
MK-106 (5lb)/BDU-48 (10lb)	X	X	X					X	X	X	X						Steel, maybe tin			Depends on signal
MK-23 (Old-style)	X	X	X														Cast iron			
MK-76/BDU 33 (25lb)	X	X	X	X	X	X	X	X	X	X	X						Cast iron	Steel		
MK-77 (Firebomb)		X		X				X	X								Aluminum			Napalm
MK-78 (Firebomb)							X	X	X								Sheet steel			Napalm
MK-81 (250lb)	X		X					X	X								Steel	Aluminum		Composition H6 or Tritonal
MK-82 (500lb)	X	X	X	X	X	X		X	X		X						Steel	Aluminum		Composition H6 or Tritonal
MK-82 (500lb) and BDU-45	X	X	X														Steel	Aluminum		Concrete
MK-83 (1000lb)	X	X	X	X				X									Steel	Aluminum		Composition H6 or Tritonal
MK-84 (2000lb)	X	X	X					X									Steel	Aluminum		Composition H6 or Tritonal
Flares/Pyrotechnics																				
MK-24 Flare (Parachute)	X		X				X	X	X		X	X	X				Aluminum			Illuminating Mixture
MK-25 Flare (Marine Marker)	X		X			X		X									Aluminum			Pyrotechnic Mixture
MK-45 Flare (Aircraft)	X	X	X					X	X		X						Aluminum			Illuminating Mixture
Grenades																				
40mm Projected Grenade	X	X	X	X				X		X	X	X	X				Aluminum	Steel	Gilding metal	Octol or Composition B
Hand Grenade	X							X	X	X	X	X	X	X			Steel (likely)			Composition B (likely)
Projectiles/Mortars																				
105mm Projectile	X	X	X	X		X	X	X	X	X	X	X	X	X			Steel		Gilding metal	TNT or Composition B
106mm Projectile	X		X	X	X	X	X	X	X		X	X	X	X			Steel	Copper	Aluminum	Composition B
107mm Mortar									X								Steel			TNT
155mm Projectile	X	X	X	X		X	X	X	X	X	X		X				Steel		Gilding metal	TNT or Composition B
16" / 50		X	X														Steel		Gilding metal	Explosive D
175mm Projectile			X						X								Steel		Gilding metal	Composition B
20mm Projectile	X	X	X	X	X	X	X	X	X	X	X		X				Steel		Gilding metal	Tetryl
25mm Projectile	X	X	X					X	X		X						Steel		Gilding metal	RDX
27mm Projectile			X														Unable to find information on this item			
3" Projectile				X				X	X								Steel		Gilding metal	Explosive D
3"/50 (MK-27, MK-29, MK-33)	X	X	X	X	X	X	X	X	X		X	X	X				Steel		Gilding metal	Explosive D
30mm Projectile	X	X	X	X		X	X	X					X				Steel		Gilding metal	RDX
37mm Projectile		X	X					X	X		X						Steel		Gilding metal	TNT
4.2" Mortar			X	X		X		X	X		X						Steel			TNT
4.5" / 38(UK)	X	X	X				X	X	X								Steel		Gilding metal	Composition B
40mm Projectile	X	X	X	X		X		X	X		X	X	X		X		Steel		Gilding metal	Octol
5" / 54			X														Steel		Gilding metal	Explosive D or Composition A3
5" Projectile	X	X	X	X	X	X	X	X	X	X	X	X	X				Steel		Gilding metal	Explosive D or Composition A3

X Item identified at the site

Table 19
MEC/MD Items Encountered at Each UXO Site and Their Constituents
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Item Classification	UXO 2	UXO 3	UXO 4	UXO 5	UXO 6	UXO 7	UXO 8	UXO 9	UXO 10	UXO 11	UXO 12	UXO 13	UXO 14	UXO 15	UXO 17	UXO 18	Possible Munitions Constituents			
																	Primary Metal	Secondary Metal	Possible Additional Metal Constituents	Likely Explosive Filler
6" Projectile								X									Steel		Gilding metal	Explosive D
60mm Mortar	X	X	X	X	X	X		X	X	X	X	X					Pearlitic malleable iron	Aluminum		Composition B
75mm Projectile	X	X	X	X	X	X	X	X	X	X	X						Steel		Gilding metal	TNT or Composition B
76mm Projectile			X	X				X	X	X							Steel		Gilding metal	Composition B
8" Projectile	X		X			X		X	X		X						Steel		Gilding metal	TNT or Composition B
81mm Mortar	X	X	X	X	X	X	X	X	X	X	X	X	X				Steel		Aluminum	Composition B
90mm Projectile	X	X	X	X	X	X	X	X	X	X	X						Steel		Gilding metal	Composition B
Rockets/Guided Missiles																				
2.75" Rocket	X	X	X	X	X	X	X	X	X	X	X	X					Steel	Aluminum		Composition B
3.5" Rocket			X		X	X		X	X	X	X	X		X			Steel	Aluminum	Copper	Composition B
5" Rocket	X	X	X	X	X		X	X	X	X	X		X			X	Steel	Aluminum		Explosive D or Composition B
AT4 Rocket (84mm)		X	X														Steel	Aluminum		Octol
BGM-71 (TOW)			X					X									Steel (likely)	Aluminum		Octol
LAW (M72 66mm)					X			X				X					Steel	Aluminum		Octol
M47 Dragon Missile								X									Steel	Aluminum		Octol
Submunitions																				
BL-755 (UK No.1 MK1)		X	X														British submunition; do not have information on this item			
BLU-61			X														Steel			Octol
BLU-63	X	X	X														Steel			Cyclotol
BLU-77	X	X	X														Steel (likely)	Aluminum		Octol
BLU-97	X	X	X														Steel	Aluminum	Zirconium	Cyclotol
M39			X														Steel	Aluminum		Composition A5
MK-118	X	X	X	X													Steel	Aluminum	Copper	Composition B
MK-20 Submunition Dispenser			X														Aluminum	Steel		Submuntions
SUU-30 Submunition Dispenser			X														Steel	Aluminum		Submunitions
SUU-40 Submunition Dispenser								X									Steel	Aluminum		Submunitions
Other																				
Flare									X								Unknown; not enough information available about			Pyrotechnic mixture (likely)
Fuze w/Booster									X								Unknown; not enough information available about			Tetryl (likely)

X Item identified at the site

Figures

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 1 - Regional Location Map.mxd11/6/2012fcain

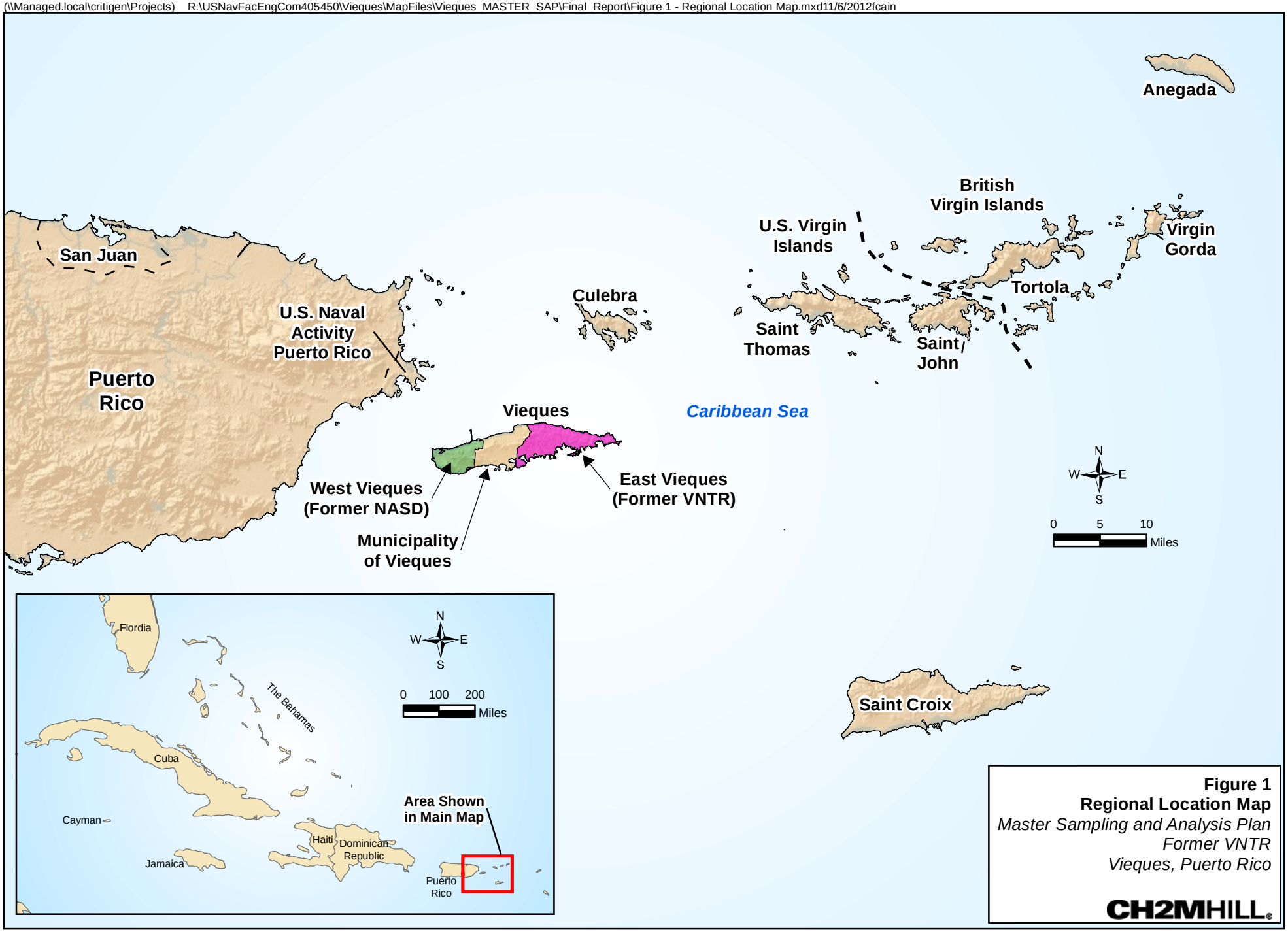

Figure 1
Regional Location Map
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\mnustrictgfs01\ctg$\projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 2 - Former VNTR Site Map.mxd11/12/2012fcain

Former VNTR (East Vieques)

Department of Interior

Isabel Segunda

Legend

- UXO 1 - ECA
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South
- UXO 15 - Puerto Ferro (Expanded Site Inspection)
- UXO 16 - Underwater Areas
- UXO-17 - PAOC EE
- UXO 18 - Cayo de la Chiva

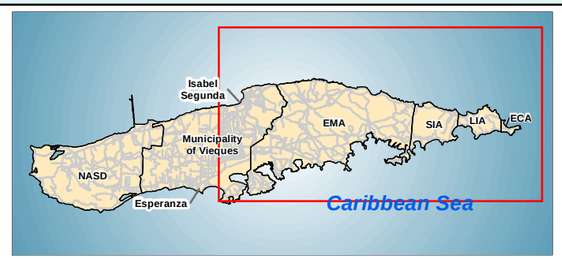

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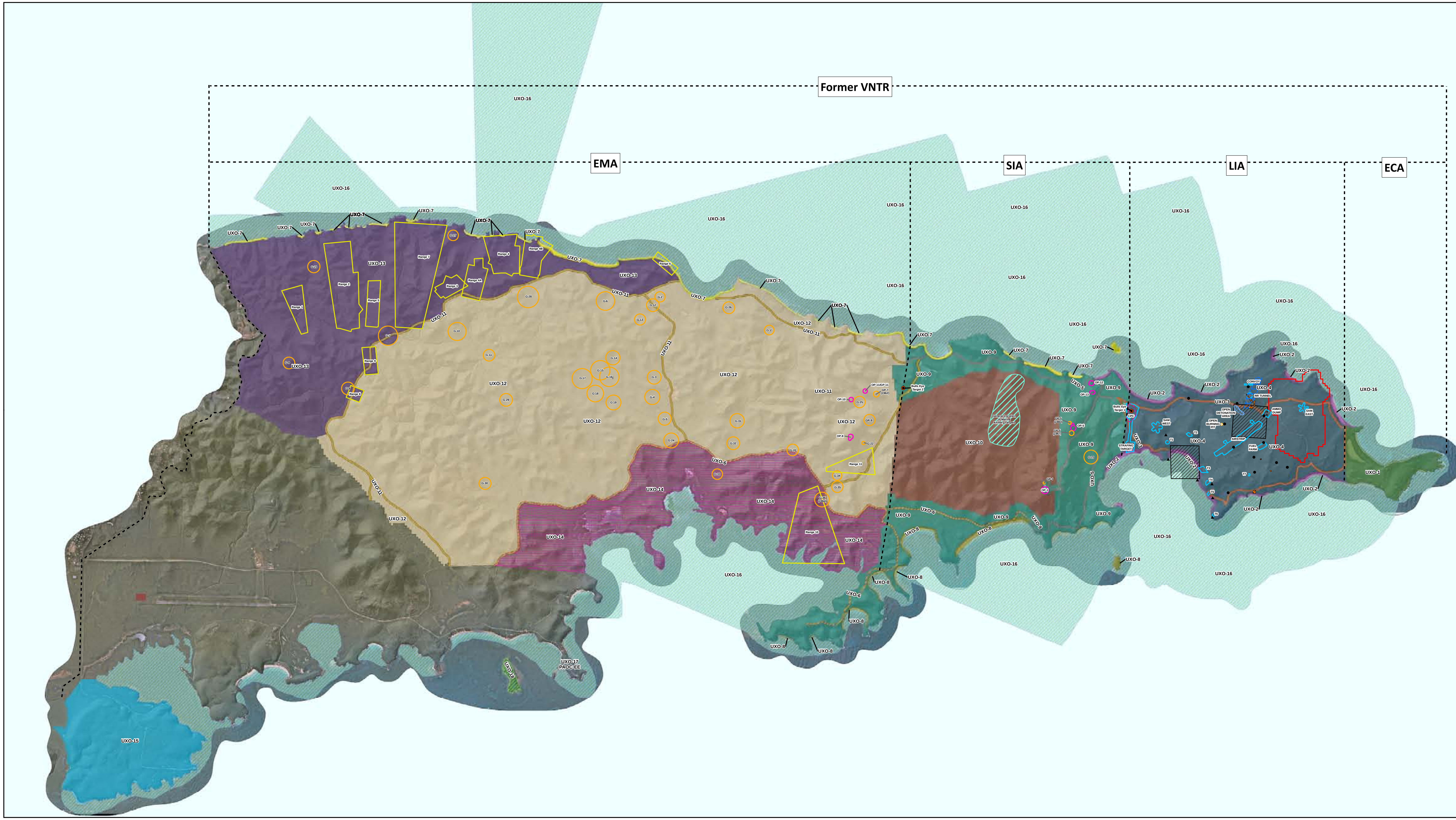
Figure 2
Former VNTR Site Map
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL



Legend

- Historical Air-To-Ground (ATG) Target
- Historical Naval Gunfire Support (NGFS) Target
- Bulls Eye Target
- General Location of Marine Artillery Targets
- Depleted Uranium Area
- LIDAR (Light Detection and Radar) Identified Target Feature
- Central Processing Center
- Gun Positions
- Target Area
- Observation Point
- Range
- Open Burn Pit
- Open Detonation Area
- Naval Gunfire Support (NGFS) Target Area
- Dense Submunitions Area

2005 Aerial Imagery
2005 Hillshade

Munitions Response Sites

- UXO 1 - ECA
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South
- UXO 15 - Puerto Ferro
- UXO 16 -Underwater Areas
- UXO 17 - PAOC-EE
- UXO 18 - Cayo de la Chiva

Sources of Former Military Features:

Ranges, Gun Positions, and Observation Points – Aerial Photographic Analysis by Environmental Research Inc. 2000 and the Environmental Impact Statement prepared by the Naval Facilities Engineering Command 1979.

Target Features – Environmental Impact Statement prepared by the Naval Facilities Engineering Command 1979 and by LiDAR/Orthophotography Survey by SKY Research Inc.

Depleted Uranium Area – Area delineated by CH2MHILL based on locations of DU penetrators found by the Navy and the sample locations of the U.S. Nuclear Regulatory Commission.

Submunitions Area – Area delineated by CH2MHILL based on high density of submunitions found.

Open Burning Pit and Open Detonation Area - Aerial Photographic Analysis by Environmental Research Inc. 2000.

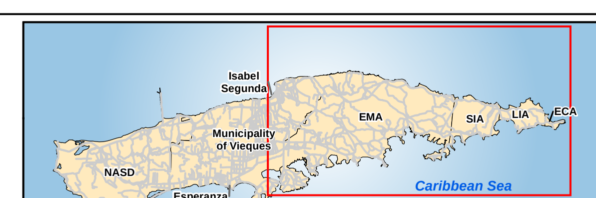


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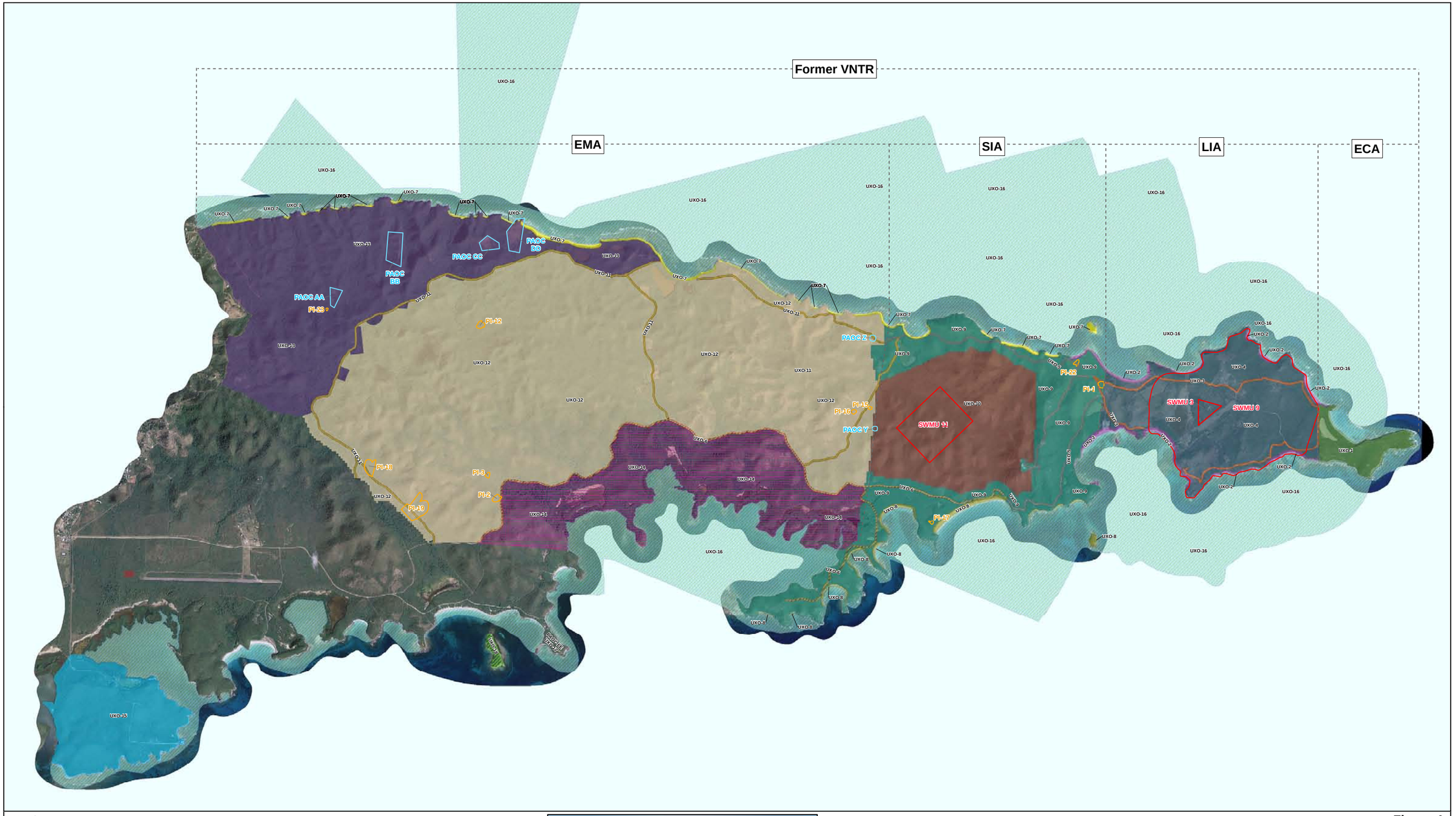
Figure 3
Former Military Operations
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 3 - Vieques_Former_Military_Operations_Map.mxd11/6/2012fcain

ES011413081845TPA Figure 3 - Vieques_Former_Military_Operations_Map.ai



Legend

- Photo Identified Area
- Preliminary Area of Concern
- Solid Waste Management Unit

Munitions Response Sites

- UXO 1 - ECA
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South
- UXO 15 - Puerto Ferro
- UXO 16 -Underwater Areas
- UXO 17 - PAOC-EE/PI-21
- UXO 18 - Cayo de la Chiva

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Figure 4
Site Screening Areas - Munitions Response Sites
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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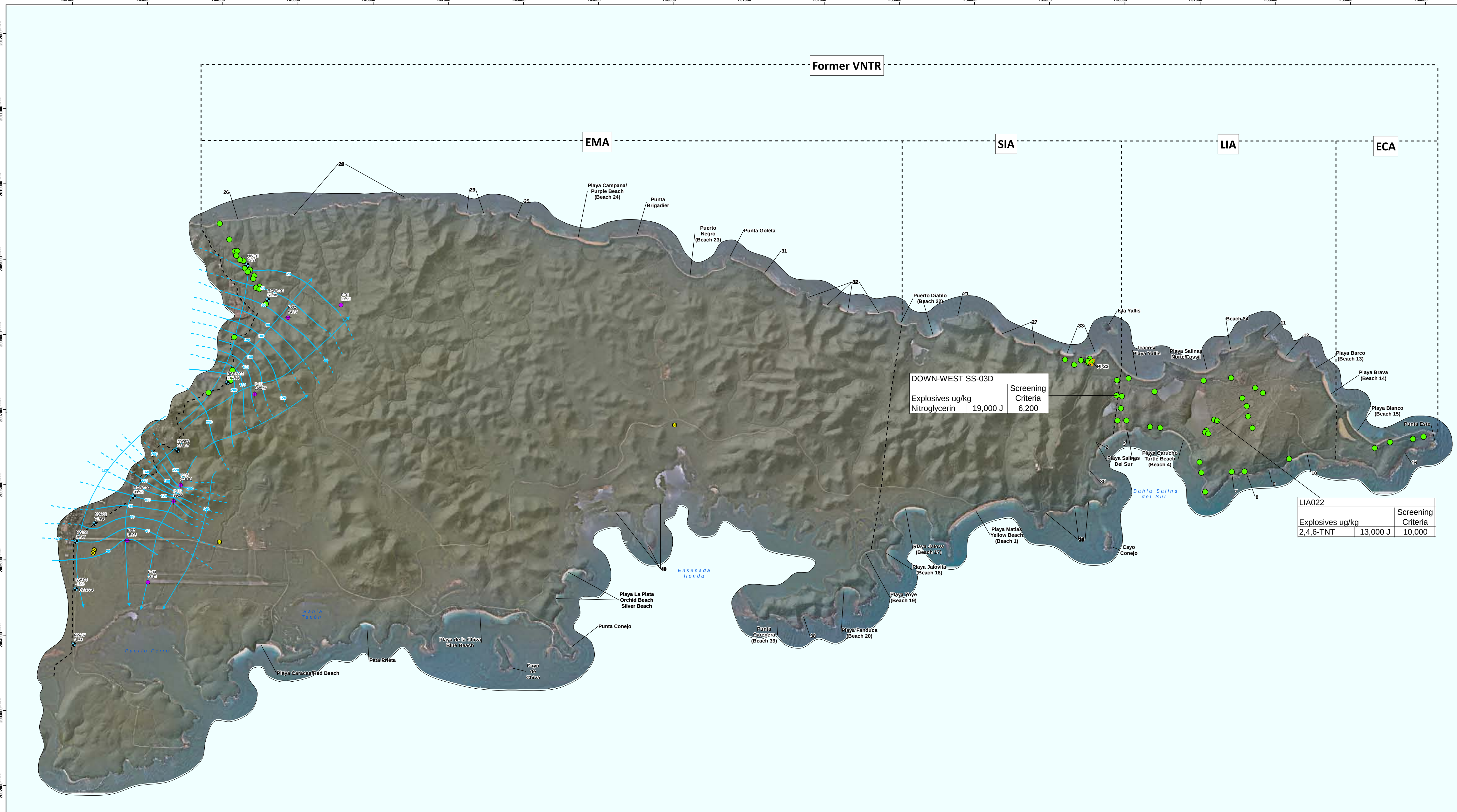
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 4 - Site Screening Areas.mxd11/6/2012fcain
ES011413081845TPA Figure 4 - Site Screening Areas.ai



DOWN-WEST SS-03D		
Explosives ug/kg		Screening Criteria
Nitroglycerin	19,000 J	6,200

LIA022		
Explosives ug/kg		Screening Criteria
2,4,6-TNT	13,000 J	10,000

- Peizometer with posted Groundwater Elevation (MSL)(Baker, 1999) Note P-03 could not be relocated and is believed to be destroyed.
- Monitoring Well with posted Groundwater Elevation (MSL) (Baker, 1999) Note RCRA-04, NW-04, and RCRA-02 could not be relocated and are believed to be destroyed.
- Previous Surface Soil Sample
- Water Supply Well Abandoned or Not Found
- Inferred Groundwater Elevation Contour (Baker, 1999)
- Interpreted Groundwater Elevation Contour (Baker, 1999)
- Interpreted Groundwater Flow Direction (Baker, 1999)
- Photo Identified Site

2005 Aerial Imagery
2005 Hillshade

Note:
(MSL) - Mean Sea Level

The screening criteria are the most conservative screening levels identified in WS 15.

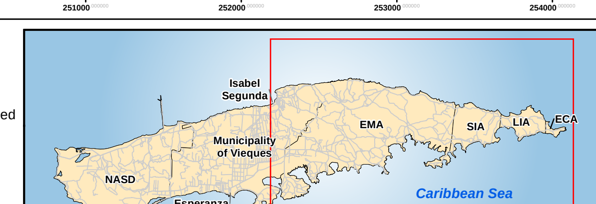


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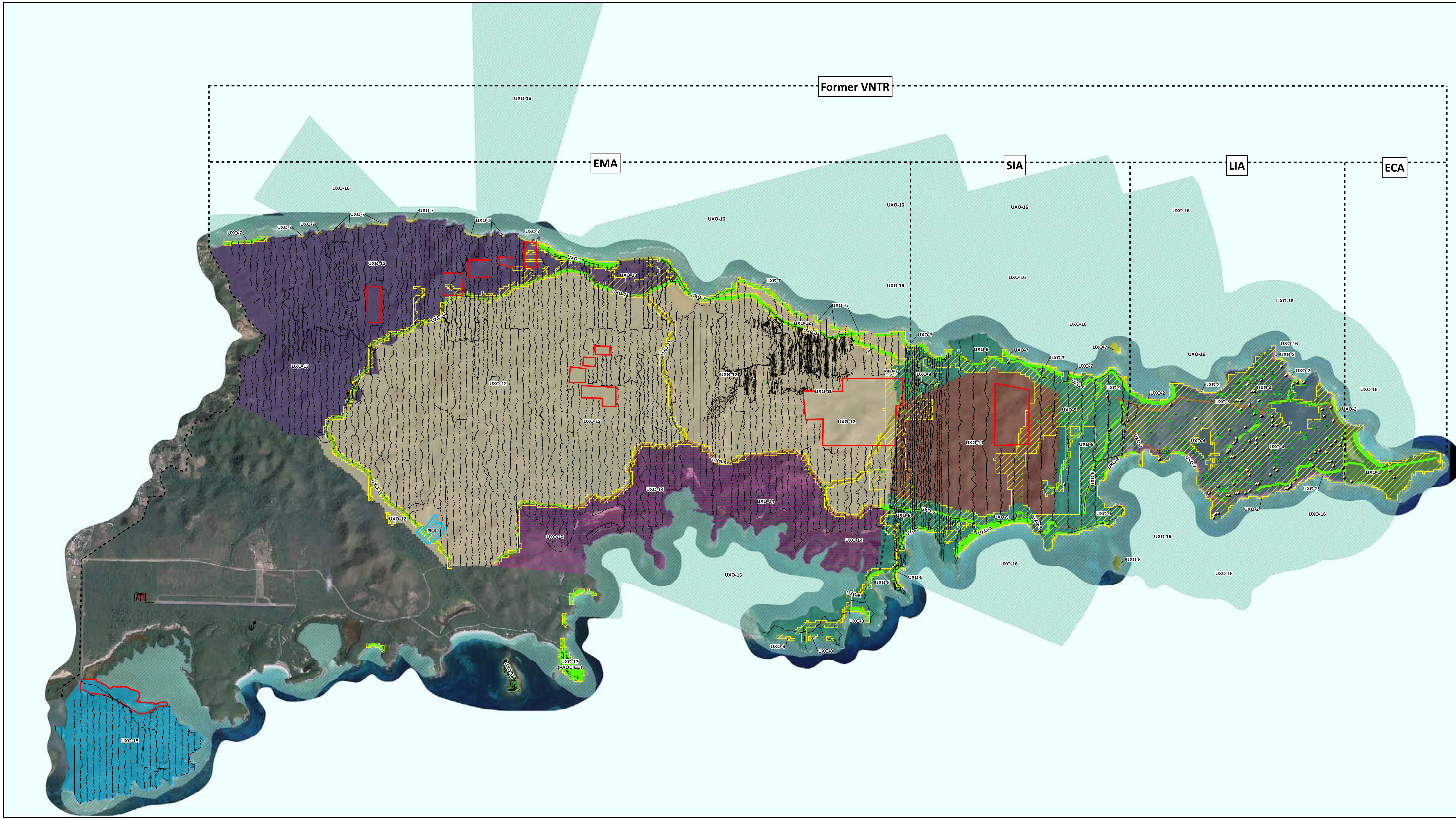
Figure 5
Previous Environmental Investigation Information
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

ES011413081845TPA Figure 5 - Previous Environmental Investigation Information.ai



Legend

- MEC Investigation Transects
- Phase 1 MEC Investigation Area (Refer to Appendix A)
- Site screening area (PI 19)
- Consolidation Point
- Detonation Area
- DGM Coverage
- TCRA and NTCRA Activities

Munitions Response Sites

- UXO 1 - ECA
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South
- UXO 15 - Puerto Ferro
- UXO 16 -Underwater Areas
- UXO 17 - PAOC-EE
- UXO 18 - Cayo de la Chiva

2007 Aerial Imagery

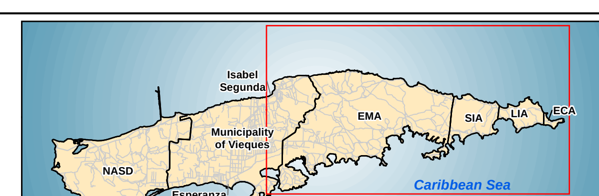


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Figure 6
MEC Investigation Transects, Controlled Detonation Areas, and Digital Geophysical Mapping Coverage
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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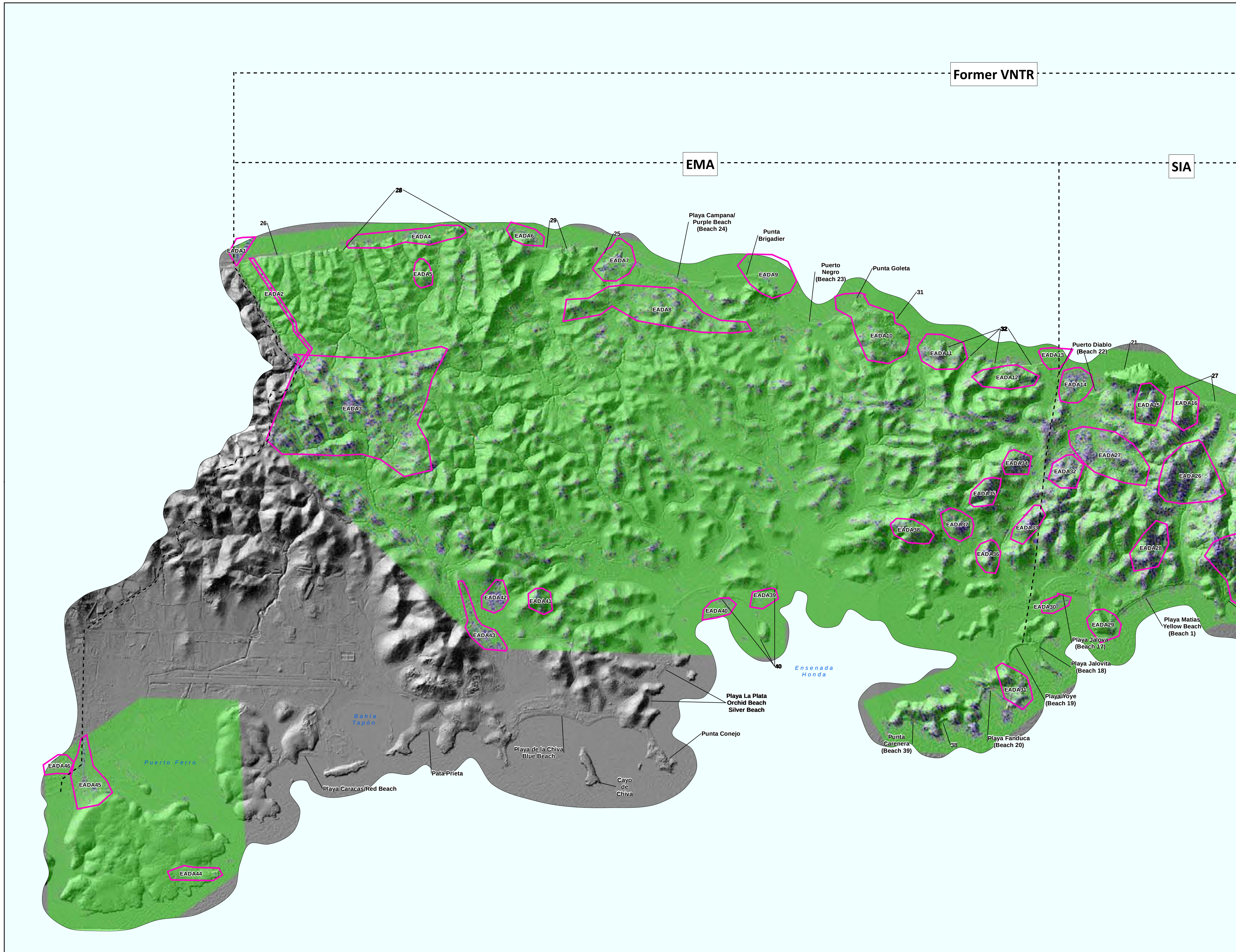
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 6 - MEC_Investigation_Transects_and_DGM_Coverage.mxd11/12/2012fcain

ES011413081845TPA Figure 6 - MEC_Investigation_Transects_and_DGM_Coverage.ai



Elevated Anomaly Density Area Description

Name	Description
EADA1	Apparent infrastructure – linear features running offshore
EADA2	Apparent infrastructure
EADA3	High geologic return and high survey alt prevent meaningful conclusions | possibly due to houses
EADA4	Geology associated w shoreline, & numerous LDAs indicate probable ferrous material – particularly in E extent
EADA5	Presence of LDAs and apparent clearing indicate probable presence of ferrous material
EADA6	Presence of LDAs and high target density – possibly related to shoreline geology. DAD indicates moderate % less than 75°
EADA7	Although geologically active, the presence of LDAs, high anomaly density and an apparent clearing indicate the presence of ferrous material. DAD indicates high % less than 75°
EADA8	Well defined concentration of anomalies (possibly associated with shallow sea-floor) LDAs along shoreline are likely ferrous material. DAD indicates high % less than 75°
EADA9	High target density appears to follow road, but this could also be due to geology – there are some LDAs that are not likely to be geology(located in cell G3J8)
EADA10	LDAs and associated high anomaly density area
EADA11	LDAs might be associated with localized geology
EADA12	Many LDAs (possibly associated with geology). DAD indicates high % less than 75°
EADA13	Localized grouping of small anomalies just off shore
EADA14	Many large discrete targets (possibly associated with geology)
EADA15	Many large discrete targets (possibly associated with geology)
EADA16	Many LDAs
EADA17	Many LDAs associated with a clearing
EADA18	Many small anomalies consistent with typical responses from UXO related activity. DAD indicates high % less than 75°
EADA19	Many small anomalies consistent with typical responses from UXO related activity. DAD indicates high % less than 75°
EADA20	Area encompasses most of cleared area on eastern tip of the island – there are many sub-regions of very high anomaly density and very large LDAs
EADA21	Sub region of area 18 – with distinctive very large discrete anomalies
EADA22	LDAs associated with a shoal region. DAD indicates moderate % less than 75°
EADA23	A few very large distinct anomalies (sunken ship??)
EADA24	Large discrete anomalies along shoreline region
EADA25	Many LDAs indicate presence of ferrous material
EADA26	LDAs and medium anomaly density indicate possible ferrous material
EADA27	LDAs and medium anomaly density indicate possible ferrous material
EADA28	LDAs and medium anomaly density indicate possible ferrous material
EADA29	LDAs and numerous small anomalies indicate presence of ferrous material. DAD indicates moderate % less than 75°
EADA30	LDAs indicate presence of ferrous material
EADA31	LDAs indicate presence of ferrous material
EADA32	Presence of LDAs indicate probable ferrous material - apparent density variation resulting is separation of these areas may be a result of topography (32,33,34,37) and/or geology (35,36)
EADA33	Presence of LDAs indicate probable ferrous material - apparent density variation resulting is separation of these areas may be a result of topography (32,33,34,37) and/or geology (35,36)
EADA34	Presence of LDAs indicate probable ferrous material - apparent density variation resulting is separation of these areas may be a result of topography (32,33,34,37) and/or geology (35,36)
EADA35	Presence of LDAs indicate probable ferrous material - apparent density variation resulting is separation of these areas may be a result of topography (32,33,34,37) and/or geology (35,36)
EADA36	Presence of LDAs indicate probable ferrous material - apparent density variation resulting is separation of these areas may be a result of topography (32,33,34,37) and/or geology (35,36)
EADA37	Presence of LDAs indicate probable ferrous material - apparent density variation resulting is separation of these areas may be a result of topography (32,33,34,37) and/or geology (35,36)
EADA38	Presence of LDAs indicate probable ferrous material - apparent density variation resulting is separation of these areas may be a result of topography (32,33,34,37) and/or geology (35,36)
EADA39	Collection of small anomalies – possible ferrous material
EADA40	LDAs and cluster of anomalies indicate ferrous material
EADA41	LDAs and elevated anomaly density possibly associated with topography/geology
EADA42	LDAs indicate ferrous material
EADA43	LDAs indicate ferrous material – possible linear feature extending northward may be a fence line
EADA44	LDAs and smaller anomalies indicate probable ferrous material
EADA45	LDAs indicate ferrous material – possible linear feature extending northward may be a fence line
EADA46	Cluster of small anomalies may be geologic in origin

Legend

Elevated Anomaly Density Area

Total Magnetic Field - Demedian Filtered (nT)

-4.6 -2.3 0.0 1.9 3.8 5.8 7.7 9.6

2005 Aerial Imagery
2005 Hillshade

Notes:
Coordinate System - NAD 1983 UTM Zone 20 (Meters)

Aerial Magnetometer data providedby Sky Research.

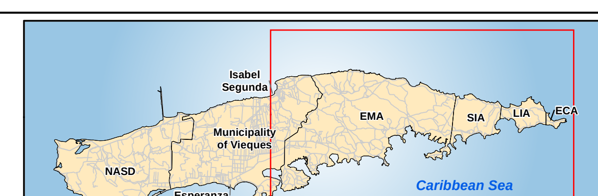


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Figure 7
East Vieques Aerial Magnetometer Survey (AMS)
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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ES011413081845TPA Figure 7 - Aerial magnetometer survey (AMS).ai

Former VNTR

EMA

SIA

LIA

ECA

Playa Campana/
Purple Beach
(Beach 24)

Punta
Brigadier

Puerto
Negro
(Beach 23)

Punta Goleta

Puerto Diablo
(Beach 22)

Isla Yallis

Beach 34

Icacos
Playa Yallis

Playa Salinas
Norte/Fossil

Playa Barco
(Beach 13)

Playa Brava
(Beach 14)

Playa Blanco
(Beach 15)

Punta Este

Playa Carucho
Turtle Beach
(Beach 4)

Playa Salinas
Del Sur

Bahia Salina
del Sur

Playa Matias
Yellow Beach
(Beach 1)

Cayo
Conejo

Playa Jaloza
(Beach 17)

Playa Jalovita
(Beach 18)

Playa Hoye
(Beach 19)

Playa Fanduca
(Beach 20)

Punta
Carenero
(Beach 39)

Ensenada
Honda

Playa La Plata
Orchid Beach
Silver Beach

Punta Conejo

Playa de la Chiva
Blue Beach

Cayo
de
Chiva

Pata Prieta

Playa Caracas/Red Beach

Bahia
Tapon

Puerto Ferro

Legend

- Topographic Contours (10 Meter)
- Ephemeral Stream
- Lagoon
- North/South Drainage Divide
- Crater

2005 Aerial Imagery
2005 Hillshade

Notes:
Drainage Devide Source: Natural Resources Conservation Service.

Topographic Contours derived from United States Geological Survey 30 Meter Digital Elevation Model.

Stormwater Flow and Ephemeral Streams were derived from LiDAR topographic data using ESRI's Spatial Analyst Hydrology Tools.

Coordinate System - NAD 1983 UTM Zone 20 (Meters)

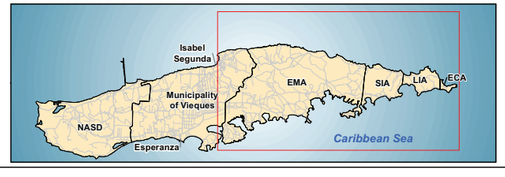

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Figure 8
East Vieques Topographic/Hydrologic Map
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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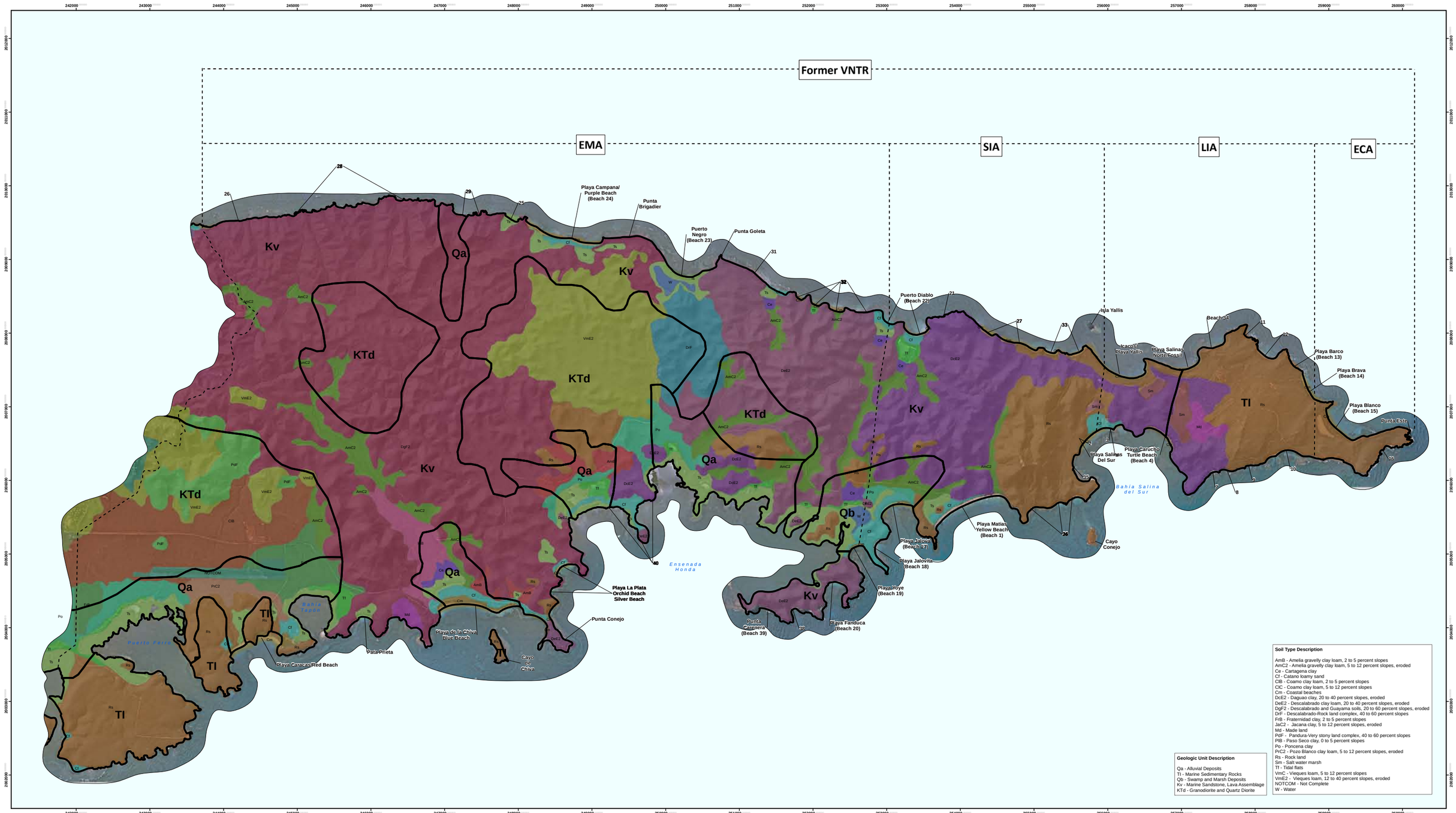
I:\Managed Local\Intrgen\Projects\ - R:\USNavFacEngCom\405430\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 8 - East_Vieques_Topo-Hydro_Map.mxd 11/7/2013 tkain



Legend

Geologic Unit

Soil Type

AmB AmC2 Ce Cf CIB CIC Cm DcE2 DeE2 DgF2 DrF FrB JaC2 Md NOTCOM PdF PlB Po PrC2 Rs Sm Tf Ts VmC VmE2 W

2005 Aerial Imagery
2005 Hillshade

Notes:
Soil Data Source - U.S. Department of Agriculture and Natural Resources Conservation Service

Coordinate System - NAD 1983 UTM Zone 20 (Meters)

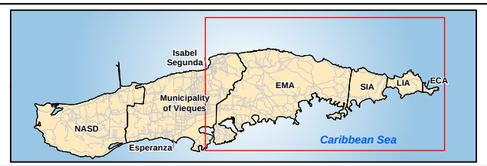


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Figure 9
East Vieques Soil Type and Geologic Unit Map
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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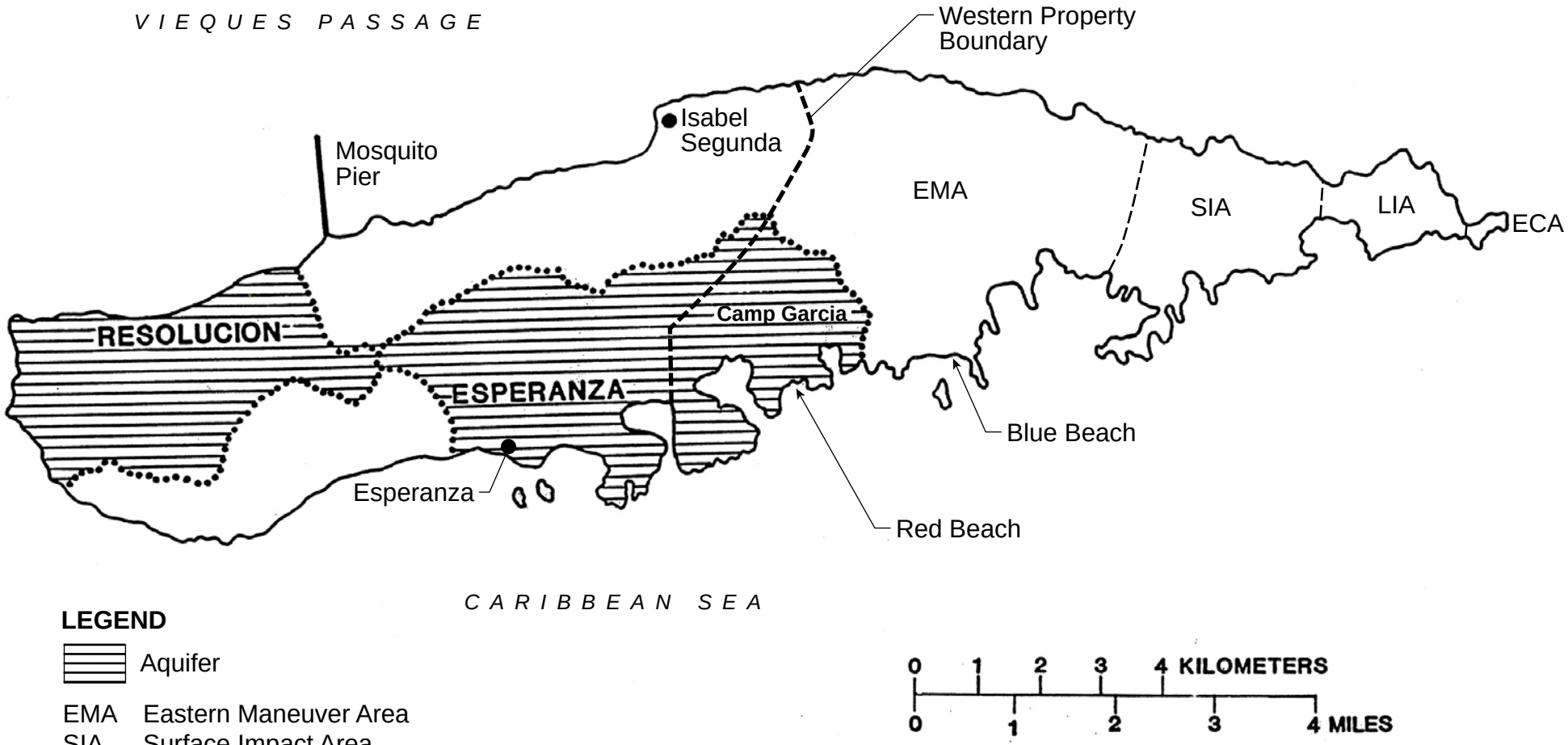
(\Managed.local\colltgen\Projects) R:\s25\out\acEng\Com\405450\Vieques\MapFiles\Vieques_MAST\ER_SAP\Final_Report\Figure 9 - Eastern_Vieques_Soil-Geology_Map.mxd15/5/2012fcain

ES011413081845TPA Figure 9 - Eastern_Vieques_Soil-Geology_Map.ai



(Reference: USGS, 1989)

FIGURE 10
Resolución and Esperanza Aquifers
Former VNTR
Vieques, Puerto Rico

Former VNTR

EMA

SIA

LIA

ECA

Playa Campana/
Purple Beach
(Beach 24)

Punta
Brigadier

Puerto
Negro
(Beach 23)

Punta Goleta

Puerto Diablo
(Beach 22)

Isla Yallis

Icacos/
Playa Yallis

Playa Salinas
Norte/Fossil

Beach 34

Playa Barco
(Beach 13)

Playa Brava
(Beach 14)

Playa Blanco
(Beach 15)

Punta Este

Playa Salinas
Del Sur

Playa Carucho
Turtle Beach
(Beach 4)

Bahia Salina
del Sur

Playa Matias
Yellow Beach
(Beach 1)

Cayo
Conejo

Playa Jelowa
(Beach 17)

Playa Jalovita
(Beach 18)

Playa Yoye
(Beach 19)

Playa Fanduca
(Beach 20)

Punta
Carenero
(Beach 39)

Ensenada
Honda

Playa La Plata
Orchid Beach
Silver Beach

Punta Conejo

Playa de la Chiva
Blue Beach

Cayo
de
Chiva

Pata Prieta

Playa Caracas/Red Beach

Bahia
Tapon

Puerto Ferro

Lo Abra

Laguna La Playa

Laguna Tapon

Laguna Grande

Laguna Chiva

Laguna Fanduca

Laguna Jelowa

Laguna Salinas

Laguna Fosil

Laguna Blanco

Laguna 9

Laguna 11

Laguna 12

Laguna 13

Laguna 14

Laguna 15

Laguna 16

Laguna 17

Laguna 18

Laguna 19

Laguna 20

Laguna 21

Laguna 22

Laguna 23

Laguna 24

Laguna 25

Laguna 26

Laguna 27

Laguna 28

Laguna 29

Laguna 30

Laguna 31

Laguna 32

Laguna 33

Laguna 34

Laguna 35

Laguna 36

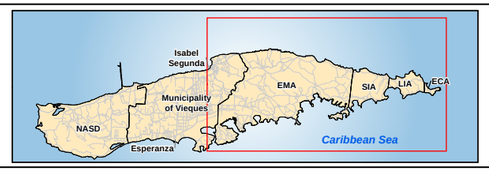
Laguna 38

Laguna 40

Legend

- Evergreen Scrub
- Forest
- Forest Scrub
- Grass
- Mangrove
- Mixed Woodland
- Sparse Thorn Scrub
- Thick Thorn Scrub
- Lagoon

2005 Aerial Imagery



N
W E
S

0 1,500 3,000 4,500 6,000
Feet

Figure 11
East Vieques General Habitat Map
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

Former VNTR

EMA

SIA

LIA

ECA

Playa Campana/ Purple Beach (Beach 24)

Punta Brigadier

Puerto Negro (Beach 23)

Punta Goleta

Puerto Diablo (Beach 22)

Isla Yallis

Playa Salinas Norte Fossil

Beach 34

Playa Barco (Beach 13)

Playa Brava (Beach 14)

Playa Blanco (Beach 15)

Punta Este

Punta Este Conservation Zone

Playa Salinas Del Sur

Playa Carucho Turtle Beach (Beach 4)

Bahia Salina del Sur

Ensenada Honda Conservation Zone

Ensenada Honda

Bahia de la Chiva Conservation Zone

Playa Matias Yellow Beach (Beach 1)

Playa Jalova (Beach 17)

Playa Jalovita (Beach 18)

Playa Roye (Beach 19)

Playa Fanduca (Beach 20)

Punta Carenera (Beach 39)

Cayo Conejo Conservation Zone

Cayo Conejo

Playa La Plata Orchid Beach Silver Beach

Punta Conejo

Playa de la Chiva Blue Beach

Pata Prieta

Playa Caracas/Red Beach

South Coast Bays Conservation Zone

Bahia Tapon

Puerto Fe

Cayo de Chiva

Legend

- Vehicle Public Use Road Open
- Proposed Hiking/Biking Interpretive Trail
- Vehicle Public Use Road Proposed
- Conservation Zone (Vieques INRMP 2003)
- Mangrove Habitat (Red, White, Black, Button)
- Undelineated Critical Habitat

Turtle Beach Setbacks

- Zone 2 - Minor Restrictions
- Zone 3 - Major Restrictions

Refuge Entrance; Beach Use; Bermuda Triangle Interpretive Site; Biking Trail; Fishermen's Launch Facilities; Fishing Access; Hiking Trail; Historic Site; Interpretive Trail; Kayaking; Faro Berdiales Lighthouse; Lookout Area, Binoculars; Observation Tower; Parking Area; Reforestation Area; Rest Area; Scenic View; Seasonal Beach Use; Beach Use; Visitor Contact Center

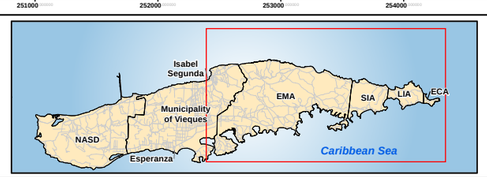
2005 Aerial Imagery
2005 Hillshade

Notes:
Land Use Source: United States Fish & Wildlife Service (USFWS). Draft Comprehensive Conservation Plan/Envrionmental Impact Statement for Vieques National Wildlife Refuge, Vieques, Puerto Rico. October 2006.

Note that the icon placement is not necessarily representative of the actual locations where the proposed recreational uses may occur.

Conservations Zones and Habitat data provided by Geo-marine.

Coordinate System - NAD 1983 UTM Zone 20 (Meters)



N W E S

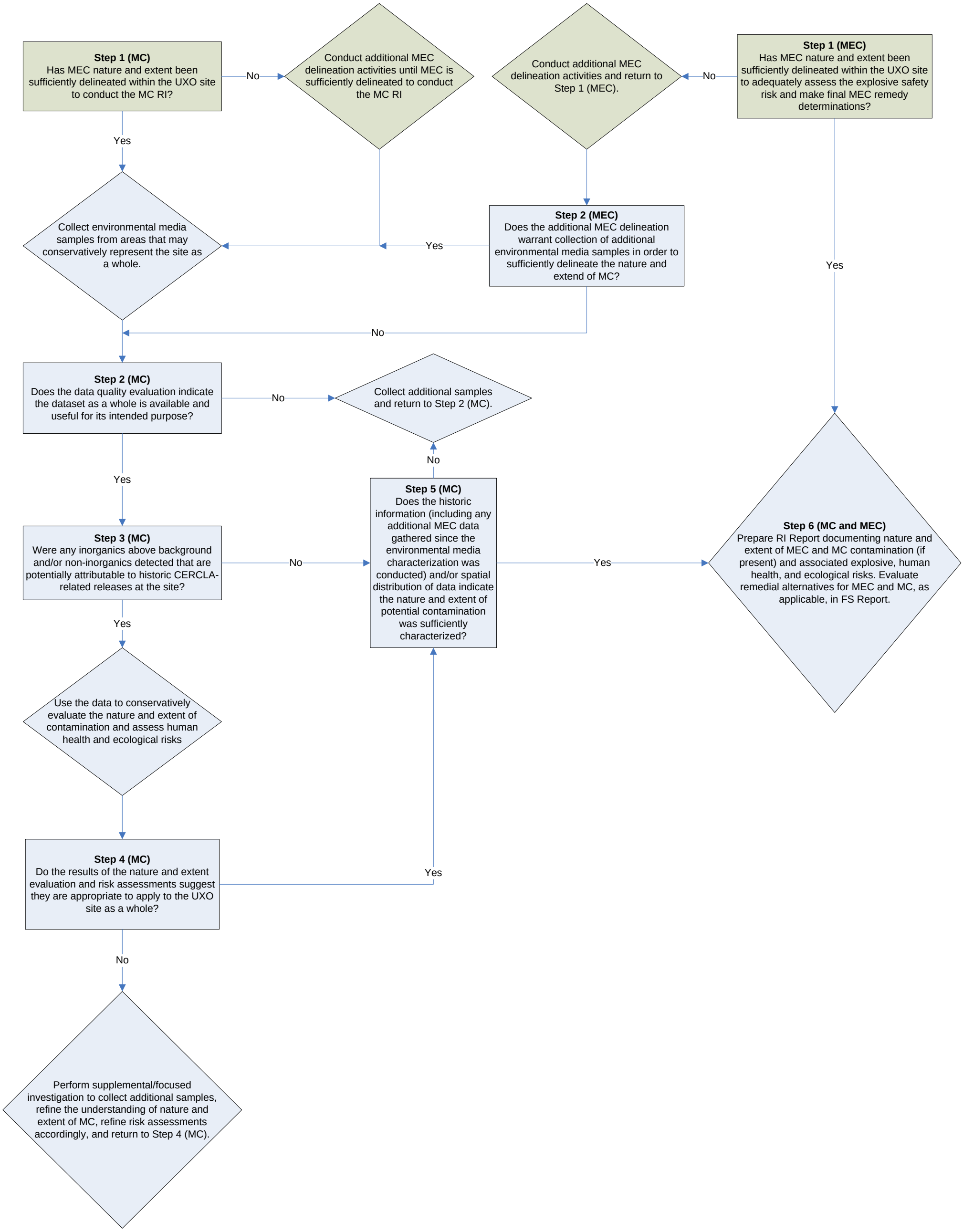
0 1,500 3,000 4,500 6,000 Feet

Figure 12
USFWS Land Use Plan
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\Managed.local\oltgen\Projects) R:\US\Nav\Acad\ngCom40\5450\Vieques\Map\Rest\Vieques_MASTER_SAP\Final_Report\Figure 12 - Land Use Plan.mxd 11/6/2012 9:am

ES011413081845TPA Figure 12 - Land Use Plan.ai



Notes:
The decision makers associated with this decision tree are the Navy, USEPA, PREQB, and USFWS.

FIGURE 13
MEC and MC Remedial Investigation Decision Process
East Vieques Master Sampling Plan
Former Vieques Naval Training Range

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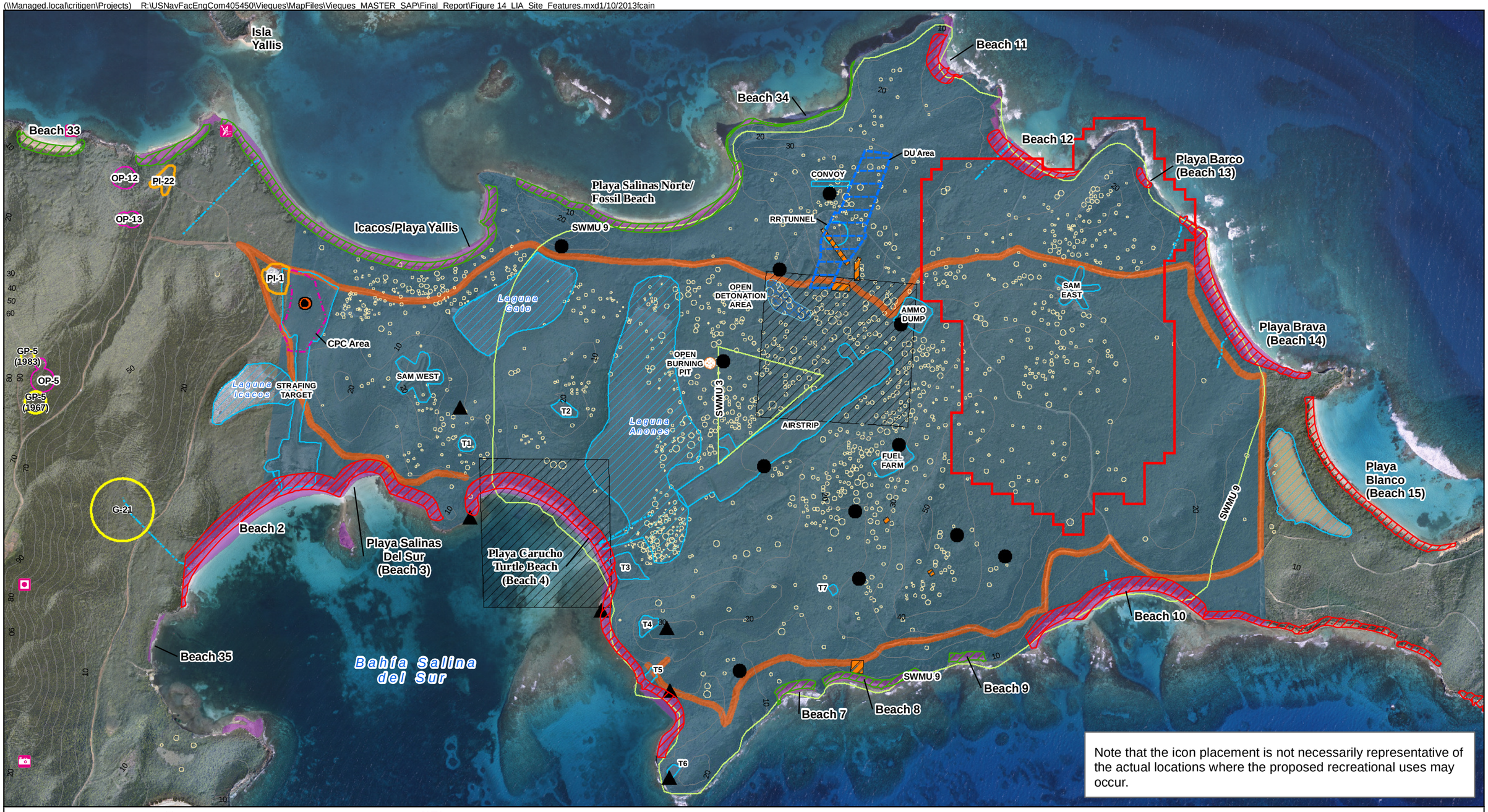

LIA Munitions Response Sites
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior

Turtle Beach Setbacks
- Zone 2 - Minor Restrictions
- Zone 3 - Major Restrictions

- Historical Air-To-Ground (ATG) Target
- Historical Naval Gunfire Support (NGFS) Target
- Bulls Eye Target
- Depleted Uranium Area
- Photo Identified Area
- Solid Waste Management Unit
- LIDAR (Light Detection and Radar) Identified Target Feature
- Central Processing Center
- Gun Positions
- Target Area
- Observation Point
- Open Burn Pit
- Open Detonation Area
- Naval Gunfire Support (NGFS) Target Area
- Dense Submunitions Area
- Lagoon
- Crater
- Ephemeral Stream
- Topographic Contours (10 Meter)
- Beach Use
- Historic Site
- Kayaking
- Scenic View

N W E S

0 450 900 Feet

Figure 14
LIA Site Features
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

Note: Geology for the region is interpreted from USGS rock and soil maps.

Land Crabs Exposure
Exposure to deep surface soil (0-2 feet) in appropriate habitat

Upland Areas
Terrestrial Plants and Soil Invertebrates
Exposure to surface soil across the site

Terrestrial Wildlife
Birds, mammals, and reptiles consuming invertebrates, plants, and/or small mammals

- Fruit Bat
- Velvet Free-Tailed Bat
- Norway Rat
- Indian Mongoose
- Common Ground Dove
- Pearl-Eyed Thrasher
- Cave Swallow
- Red-Tailed Hawk
- Lizards

Prevailing Wind Direction

Wind dispersion is a possible potential contaminant migration pathway

Mammalian Omnivore (Indian Mongoose): Ingestion of terrestrial invertebrates, plants, small mammals, and incidental surface soil in upland areas
* Evaluated as invertivore in SLERA

Avian Insectivore (Cave Swallow): Ingestion of terrestrial and aquatic insects in all terrestrial and aquatic habitats

Aquatic Organisms
Fish and invertebrates exposed to surface water and sediment

- Fishing Bat
- Velvet Free-Tailed Bat
- Cave Swallow
- Green Heron
- Spotted Sandpiper
- White-Cheeked Pintail

Aquatic Wildlife
Birds and mammals consuming fish, invertebrates, or plants

Potential Trespasser (adolescent and adult)
Ingestion/dermal/inhalation exposure to surface soil and ingestion of land crab

Terrestrial Reptile (Crested Anole): ingestion of terrestrial insects in all terrestrial environments

Mammalian Insectivore (Velvet Free-tailed Bat): Ingestion of terrestrial and aquatic insects in all terrestrial and aquatic habitats

Terrestrial Plants and Soil Invertebrates
Exposure to surface soil

Avian Omnivore (Pearly-eyed Thrasher): Ingestion of terrestrial invertebrates, plants, and incidental surface soil in all upland areas
* Evaluated as invertivore in SLERA

Turtle Nesting Area

Precipitation Infiltration

Soil Invertebrates (earthworms, insects): Dermal exposure and ingestion of surface soil in all upland areas

Terrestrial Plants: Direct exposure to surface soil in all upland areas

FWS Workers
Ingestion/dermal/inhalation exposures to surface soil and deep surface soil (where planting and turtle nesting area); exposures to sediment (ingestion/dermal) and surface water (dermal) in the lagoon

Fish (snapper, mullet): Direct exposure to surface water and sediment

Avian Piscivore (Green Heron): Ingestion of aquatic fish and invertebrates

Aquatic Invertebrates (crabs, snails): Direct exposure to surface sediment

Mammalian Omnivore (Norway Rat): Ingestion of terrestrial invertebrates, plants, and incidental surface soil in all upland areas.
* Evaluated as herbivore in SLERA

Avian Carnivore (Red-tailed Hawk): Ingestion of small mammals in all upland areas

Turtle Nesting Beaches
Exposure of buried eggs to deep surface soil (18-24 feet)

Avian Invertivore (Spotted Sandpiper): Ingestion of aquatic invertebrates and incidental sediment

Mammalian Piscivore (Fishing Bat): Ingestion of fish

LEGEND

- UXO 2 Boundary
- UXO 3 Boundary
- UXO 4 Boundary
- Submunitions Area
- Naval Gunfire Support (NGFS) Target Area
- Target Area
- Turtle Nesting Area
- Historic Naval Gunfire Support (NGFS) Target
- Historic Bulls Eye Target
- Historic Targets
- Ocean
- Qb (Quaternary beach sand)
- Tl (Tertiary Limestone and Dolomite)
- Kv (Cretaceous Andesite, Tuff, and Breccia, and Minor Limestone)

FIGURE 15
LIA Conceptual Site Model (UXO's 2, 3, and 4)
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico

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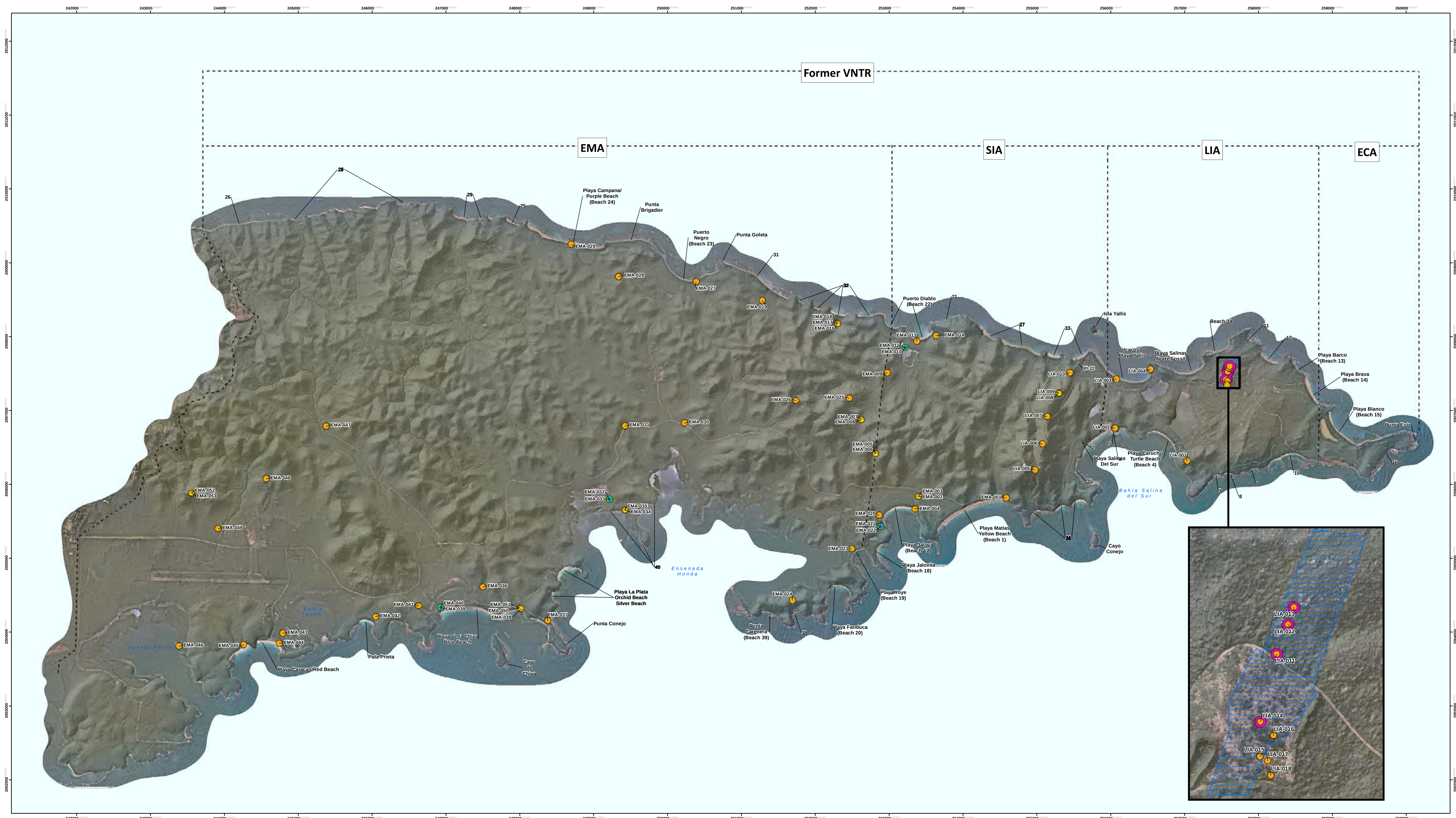


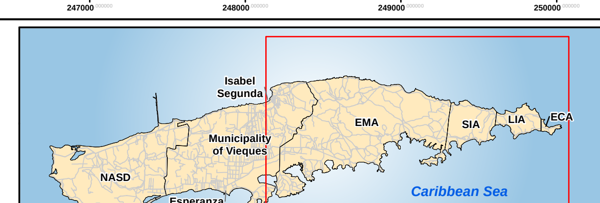
Sample Type

- Sediment
- Vegetation
- Water
- Soil

DU Penetrator Location

Depleted Uranium Area

2005 Aerial Imagery
2005 Hillshade



0 1,500 3,000 4,500 6,000 Feet

Figure 16
Nuclear Regulatory Commission Sample Locations
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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ES011413081845TPA Figure 16 - NRC Investigation Sample Locations.ai

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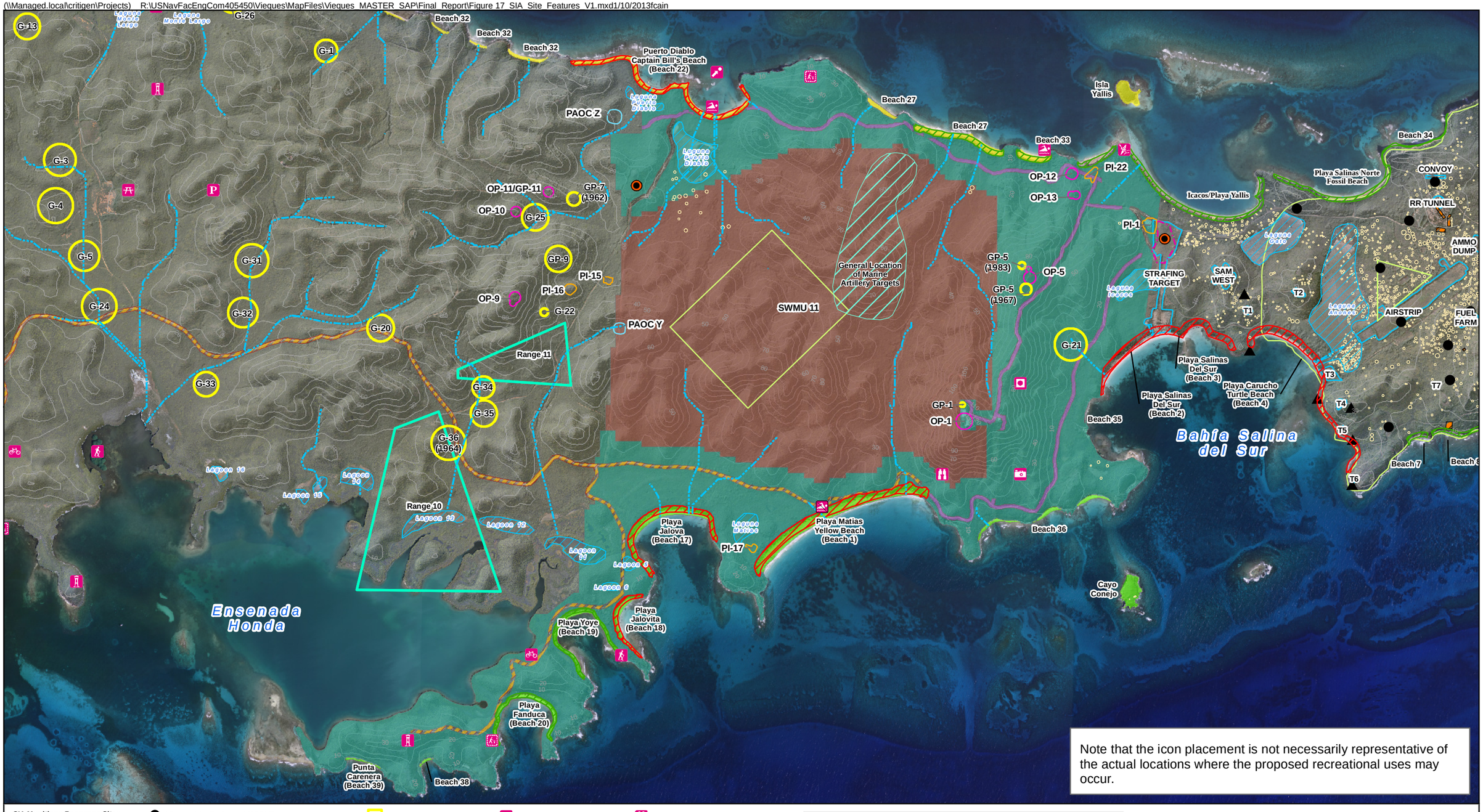

Note that the icon placement is not necessarily representative of the actual locations where the proposed recreational uses may occur.

SIA Munitions Response Sites
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior

Turtle Beach Setbacks
- Zone 2 - Minor Restrictions
- Zone 3 - Major Restrictions

- Historical Air-To-Ground (ATG) Target
- Historical Naval Gunfire Support (NGFS) Target
- Bulls Eye Target
- Photo Identified Area
- Preliminary Area of Concern
- General Location of Marine Artillery Targets
- Solid Waste Management Unit
- LIDAR (Light Detection and Radar) Identified Target Feature
- Central Processing Center
- Gun Positions
- Target Area
- Observation Point
- Range
- Crater
- Lagoon
- Topographic Contours (10 Meter)
- Ephemeral Stream
- Beach Use
- Bermuda Triangle Interpretive Site
- Biking Trail
- Hiking Trail
- Historic Site
- Interpretive Trail
- Kayaking
- Lookout Area, Binoculars
- Observation Tower
- Parking Area
- Rest Area
- Scenic View
- Seasonal Beach Use

N
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S

0 900 1,800
Feet

Figure 17
SIA Site Features
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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Note: Geology for the region is interpreted from USGS rock and soil maps. The geology presented is representational only and is not to be used for geologic studies.

FWS Workers
Ingestion/dermal/inhalation exposures to surface soil and deep surface soil (turtle nesting area); exposures to sediment (ingestion/dermal) and surface water (dermal) in the lagoon; exposure to explosive hazard of MEC

Beach 22
Puerto Diablo Beach
Puerto Diablo Lagoon
Storm Surge
Prevailing Wind Direction
Wind dispersion is a possible potential contaminant migration pathway

Upland Areas
Terrestrial Plants and Soil Invertebrates
Exposure to surface soil across the site
Terrestrial Wildlife
Birds, mammals, and reptiles consuming invertebrates, plants, and/or small mammals
- Fruit Bat
- Velvet Free-Tailed Bat
- Norway Rat
- Indian Mongoose
- Common Ground Dove
- Pearl-Eyed Thrasher
- Cave Swallow
- Red-Tailed Hawk
- Lizards

Avian Insectivore (Cave Swallow): Ingestion of terrestrial and aquatic insects in all terrestrial and aquatic habitats

Avian Piscivore (Green Heron): Ingestion of aquatic fish and invertebrates

Potential Trespasser
Ingestion/dermal/inhalation exposure to soil, sediment, surface water, and ingestion of land crab; exposure to explosive hazard at MEC

Surface Water Infiltration
Bulls Eye
Precipitation infiltration
Historical detonation release
Matias Lagoon
Controlled detonation release; MEC scrap metal, and deterioration release
Particulates from gunfire
Observation Tower
Beach 39 Punta Carenera
Beach 38
Beach 20 Playa Fanduca
Beach 19 Playa Yoye
Beach 17 Playa Jalova
Lagoon 11
Lagoon 5
Lagoon 6
Beach 18 Playa Jalovita
Beach 1 Yellow Beach
Beach 27
Beach 33
GP-5 (1983)
OP-12
OP-13
OP-5
GP-5 (1967)
GP-1
OP-1
Beach 5 Icacos Beach
PL-1
G-21
Icacos Lagoon
Beach 2 Playa Salinas Del Sur
Beach 35
Beach 36
EMA
LIA
UXO-5
UXO-6
UXO-7
UXO-8
UXO-9
UXO-10
Storm Surge
Qb
TKp
TKs

Water Table
Sea Water Intrusion
Surface Water Intrusion

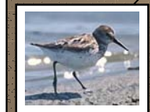
Terrestrial Reptile (Crested Anole): ingestion of terrestrial insects in all terrestrial environments

Public Recreators
Ingestion/dermal/inhalation exposure to soil; exposure to explosive hazard of MEC

Construction Workers
Ingestion/dermal/inhalation exposure to soil; exposure to explosive hazard of MEC

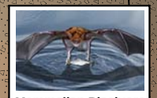
Soil Invertebrates (earthworms, insects): Dermal exposure and ingestion of surface soil in all upland areas

Mammalian Insectivore (Velvet Free-tailed Bat): Ingestion of terrestrial and aquatic insects in all terrestrial and aquatic habitats



Avian Invertivore (Spotted Sandpiper): Ingestion of aquatic invertebrates and incidental sediment

Mammalian Omnivore (Norway Rat): Ingestion of terrestrial invertebrates, plants, and incidental surface soil in all upland areas.
* Evaluated as herbivore in SLERA



Mammalian Piscivore (Fishing Bat): Ingestion of fish

Turtle Nesting Beaches
Exposure of buried eggs to deep surface soil (18-36 inches)

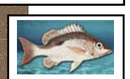
Avian Carnivore (Red-tailed Hawk): Ingestion of small mammals in all upland areas

Avian Omnivore (Pearly-eyed Thrasher): Ingestion of terrestrial invertebrates, plants, and incidental surface soil in all upland areas.
* Evaluated as invertivore in SLERA

Terrestrial Plants: Direct exposure to surface soil in all upland areas

Mammalian Omnivore (Indian Mongoose): Ingestion of terrestrial invertebrates, plants, small mammals, and incidental surface soil in upland areas
* Evaluated as invertivore in SLERA

Aquatic Invertebrates (crabs, snails): Direct exposure to surface sediment



Fish (snapper, mullet): Direct exposure to surface water and sediment

Lagoon Fringe and Ephemeral Stream Areas
Land Crabs
Exposure to deep surface soil (0-2 feet) in appropriate habitat along lagoon perimeter or within portions of ephemeral streams with suitable land crab burrow habitat

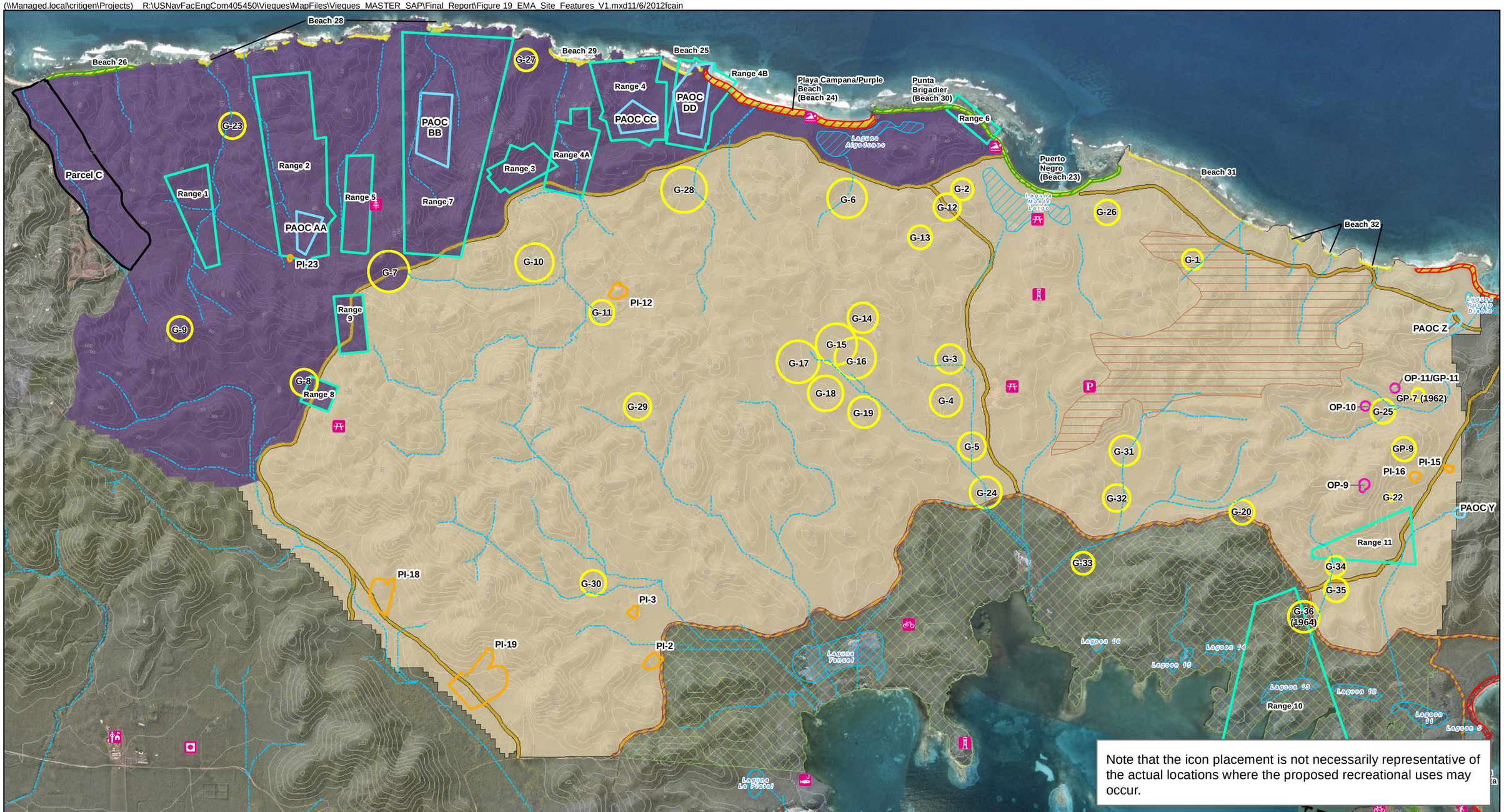
Interior Lagoon Areas
Aquatic Organisms
Fish and invertebrates exposed to surface water or sediment
Aquatic Wildlife
Birds and mammals consuming fish, invertebrates, or plants
- Fishing Bat
- Velvet Free-Tailed Bat
- Cave Swallow
- Green Heron
- Spotted Sandpiper
- White-Cheeked Pintail

LEGEND

- UXO 9 Boundary
- UXO 10 Boundary
- UXO 5 Boundary
- UXO 6 Boundary
- UXO 8 Boundary
- UXO 7 Boundary
- Gun Positions
- Observation Point
- Ocean
- Qb - Quaternary beach sand
- TKp - Intrusive rocks, Quartz Diorite, Diorite, Granodiorite, Apilite and Porphery
- TKs - Tertiary and Cretaceous aged marine Andesitic Volcanics and sediment
- Surface water runoff

FIGURE 18
SIA Conceptual Site Model (UXOs 5,6,7,8,9, and 10)
Conceptual Site Model
Former VNTR
Vieques, Puerto Rico

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 19_EMA_Site_Features_V1.mxd11/6/2012fcain



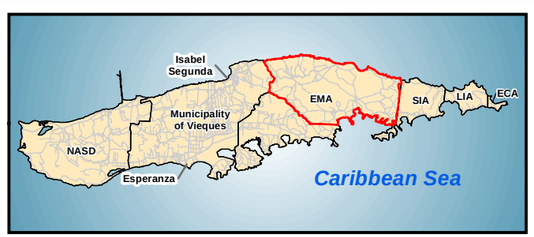
Note that the icon placement is not necessarily representative of the actual locations where the proposed recreational uses may occur.

EMA Munitions Response Sites
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South

Turtle Beach Setbacks
- Zone 2 - Minor Restrictions
- Zone 3 - Major Restrictions

- EMA Fire Area
- Parcel C
- Photo Identified Area
- Preliminary Area of Concern
- Gun Positions
- Observation Point
- Range
- Lagoon
- Ephemeral Stream
- Topographic Contours (10 Meter)

- Beach Use
- Biking Trail
- Fishing Access
- Hiking Trail
- Historic Site
- Interpretive Trail
- Observation Tower
- Parking Area
- Reforestation Area
- Rest Area
- Visitor Contact Center



N W E S

0 1,000 2,000 Feet

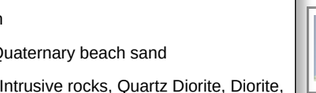
Figure 19
EMA Site Features
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

Note: Geology for the region is interpreted from USGS rock and soil maps. The geology presented is representational only and is not to be used for geologic studies.

LEGEND

- UXO 12 Boundary
- UXO 13 Boundary
- UXO-11 Boundary
- Observation Point
- Range
- Gun Positions
- Ocean
- Qb - Quaternary beach sand
- TKp - Intrusive rocks, Quartz Diorite, Diorite, Granodiorite, Apilite and Porphory
- TKs - Tertiary and Cretaceous aged marine Andesitic Volcanics and sediment
- Surface water runoff



Avian Carnivore (Red-tailed Hawk): Ingestion of small mammals in all upland areas

Terrestrial Plants: Direct exposure to surface soil in all upland areas

Upland Areas

Terrestrial Plants and Soil Invertebrates

Exposure to surface soil across the site

Terrestrial Wildlife

Birds, mammals, and reptiles consuming invertebrates, plants, and/or small mammals

- Fruit Bat
- Velvet Free-Tailed Bat
- Norway Rat
- Indian Mongoose
- Common Ground Dove
- Pearl-Eyed Thrasher
- Cave Swallow
- Red-Tailed Hawk
- Lizards

UXO 13 Ranges for:

- Small Arms
- Grenade
- Flame Throwers
- Rocket Launchers
- Machine Gun

Parcel C - unrestricted use; residential recptors

Soil Invertebrates (earthworms, insects): Dermal exposure and ingestion of surface soil in all upland areas

Mammalian Insectivore (Velvet Free-tailed Bat): Ingestion of terrestrial and aquatic insects in all terrestrial and aquatic habitats

Avian Insectivore (Cave Swallow): Ingestion of terrestrial and aquatic insects in all terrestrial and aquatic habitats

Wind dispersion is a possible potential contaminant migration pathway

Prevailing Wind Direction

Storm Surge

Precipitation Infiltration

MOV

Range 9

Range 5

Range 1

G-11

G-10

G-23

Range 2

Range 3

UXO-13

Range 7

Beach 26

G-28

G-27

Range 4

Beach 28

Range 4B

Beach 29

Beach 25

G-32

G-33

G-24

G-5

G-20

G-19

G-18

G-17

G-15

G-16

G-14

G-2

G-4

G-31

Particulates from gunfire

UXO-12

UXO-11

G-13

G-12

G-6

Lagoon Monte Largo

Lagoon Algodones

G-2

Playa Campana/Purple Beach (Beach 24)

TKs

Water Table

Sea Water Intrusion

G-9

G-25

OP-10

G-7

OP-11/GP-11

G-1

G-26

Puerto Negro (Beach 23)

Range 6

Punta Brigadier (Beach 30)

Storm Surge

Historical detonation release; MEC scrap metal

Terrestrial Reptile (Crested Anole): ingestion of terrestrial insects in all terrestrial environments

Ephemeral Streams

SIA

Beach 31

Beach 32

Beach 22

Puerto Diablo

Captain Bills Beach

Qb

TKp

Mammalian Omnivore (Norway Rat): Ingestion of terrestrial invertebrates, plants, and incidental surface soil in all upland areas.
* Evaluated as herbivore in SLERA

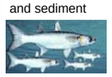
Mammalian Omnivore (Indian Mongoose): Ingestion of terrestrial invertebrates, plants, small mammals, and incidental surface soil in upland areas
* Evaluated as invertivore in SLERA

Avian Omnivore (Pearly-eyed Thrasher): Ingestion of terrestrial invertebrates, plants, and incidental surface soil in all upland areas
* Evaluated as invertivore in SLERA

Avian Invertivore (Spotted Sandpiper): Ingestion of aquatic invertebrates and incidental sediment

Avian Piscivore (Green Heron): Ingestion of aquatic fish and invertebrates

Fish (snapper, mullet): Direct exposure to surface water and sediment



Aquatic Invertebrates (crabs, snails): Direct exposure to surface sediment

Mammalian Piscivore (Fishing Bat): Ingestion of fish

FWS Workers
Ingestion/dermal/inhalation exposure to surface soil and deep surface soil (turtle nesting area and where planting); exposures to sediment (injestion/dermal) and surface water (dermal) in the lagoons; exposure to explosive hazard with MEC

Public Recreators
Ingestion/dermal/inhalation exposure to soil; exposure to explosive hazard with MEC

Lagoon Fringe and Ephemeral Stream Areas
Land Crabs
Exposure to deep surface soil (0-2 feet) in appropriate habitat along lagoon perimeter or within portions of ephemeral streams with suitable land crab burrow habitat

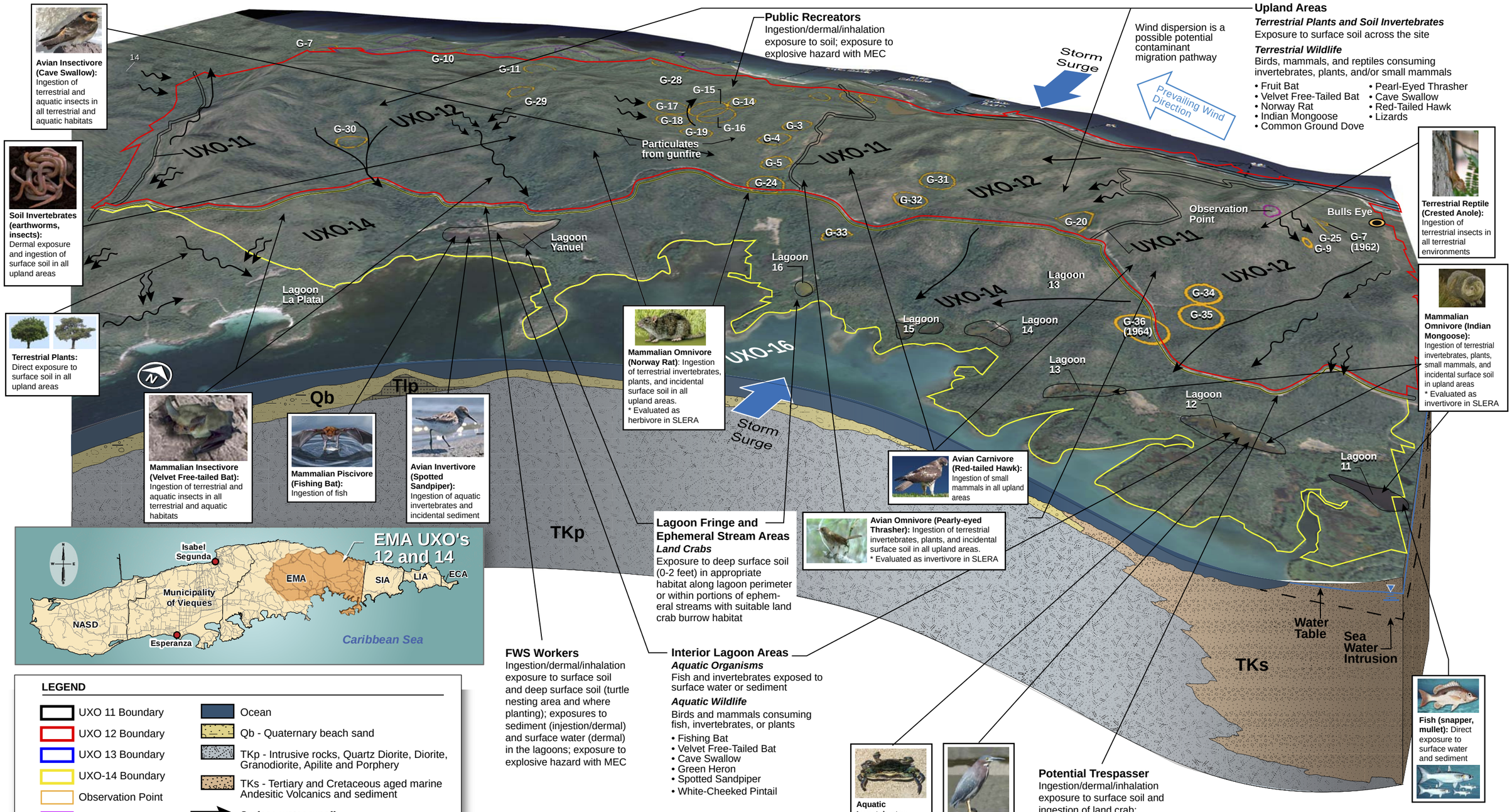
Potential Trespasser
Ingestion/dermal/inhalation exposure to surface soil and ingestion of land crab; exposure to explosive hazard with MEC

Construction Workers
Ingestion/dermal/inhalation exposure to soil; exposure to explosive hazard with MEC

Interior Lagoon Areas
Aquatic Organisms
Fish and invertebrates exposed to surface water or sediment
Aquatic Wildlife
Birds and mammals consuming fish, invertebrates, or plants
- Fishing Bat
- Velvet Free-Tailed Bat
- Cave Swallow
- Green Heron
- Spotted Sandpiper
- White-Cheeked Pintail

Turtle Nesting Beaches
Exposure of buried eggs to deep surface soil (18-36 inches)

FIGURE 20
EMA Conceptual Site Model (UXO's 11, 12 and 13)
Conceptual Site Model
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico



Note: Geology for the region is interpreted from USGS rock and soil maps. The geology presented is representational only and is not to be used for geologic studies.

FIGURE 21
EMA Conceptual Site Model (UXO's 11, 12, and 14)
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico

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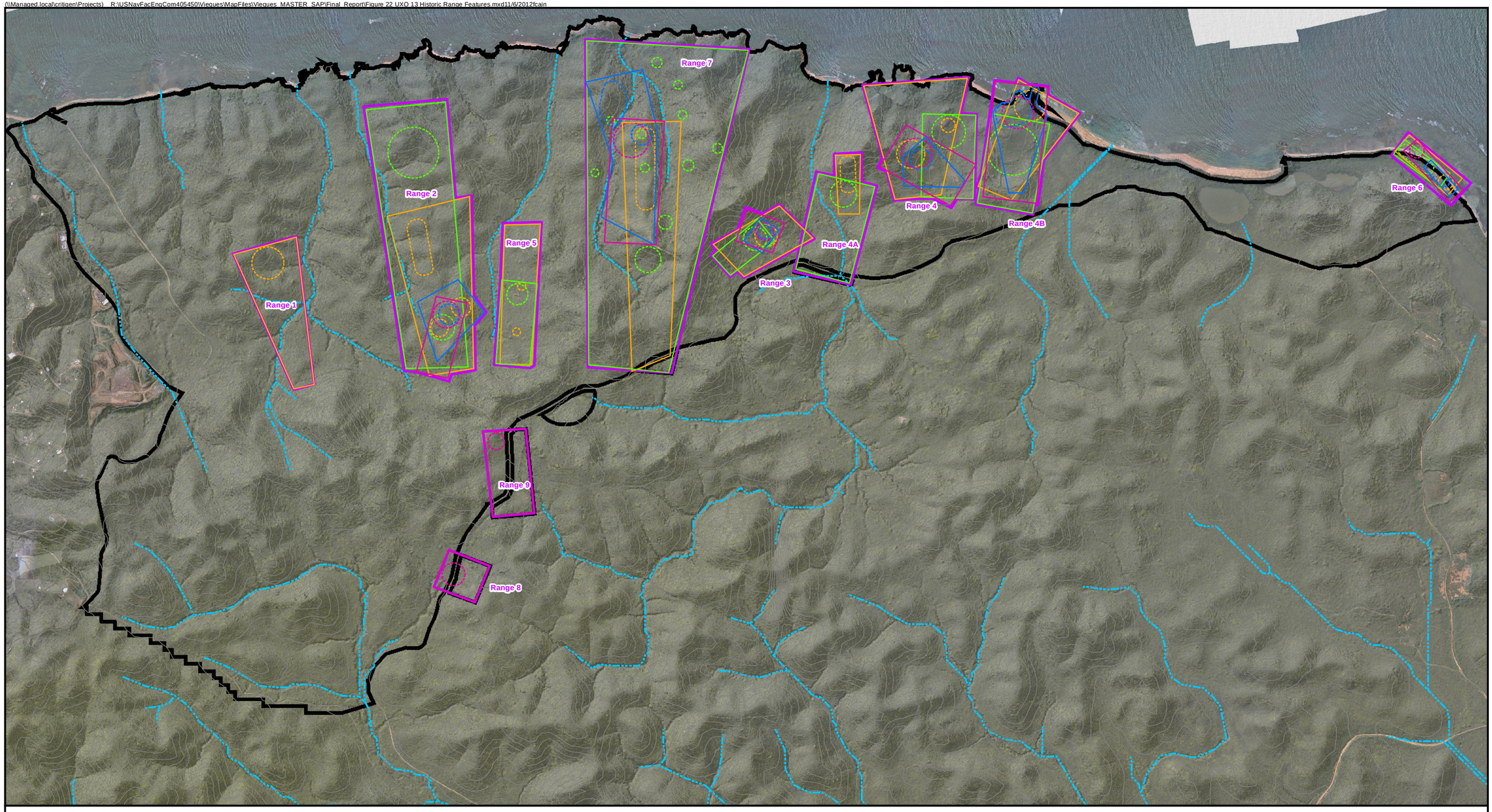
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 22 UXO 13 Historic Range Features.mxd11/6/2012fcain

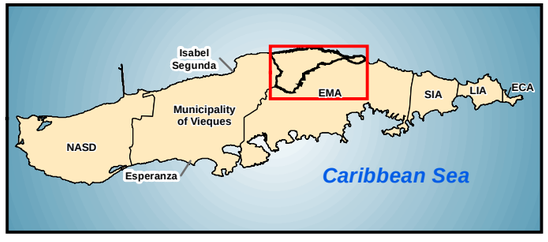


Historic Range Areas
- 1962
- 1967
- 1983
- 1994

Historic Impact Area
- 1962
- 1967
- 1983
- 1994

- Topographic Contours (10 Meter)
- Stream
- Range
- UXO 13

2005 Aerial Imagery
2005 Hillshade



N
W E
S

0 650 1,300
Feet

Figure 22
UXO 13 Historic Range Features
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 23 UXO 17 Site Features.mxd11/6/2012fcain

PAOC EE

PAOC EE TOWER

40mm Projectile

Propellant

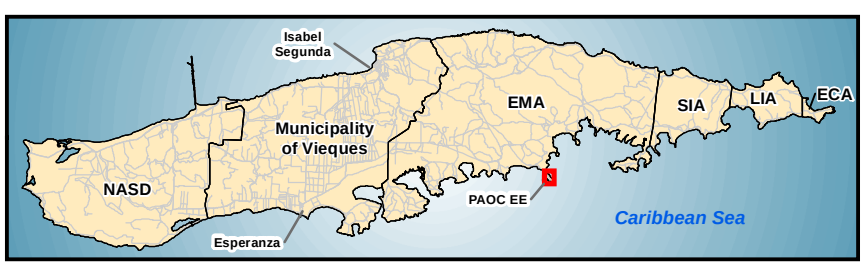
Small Arms Ammunition

Tower

Topographic Contour (5 foot interval)

Approximate Extent of Matting

PAOC EE



N
W E
S

0 50 100
Feet

2007 Aerial Imagery

Figure 23
UXO 17 Site Features
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 24 – UXO 18 Cayo Chiva Site Features.mxd11/6/2012fcain

Rockets / Guided Missiles (5 inch HE Rockets)

Non-Munitions Findings

Access Restriction Sign

UXO 18 Boundary

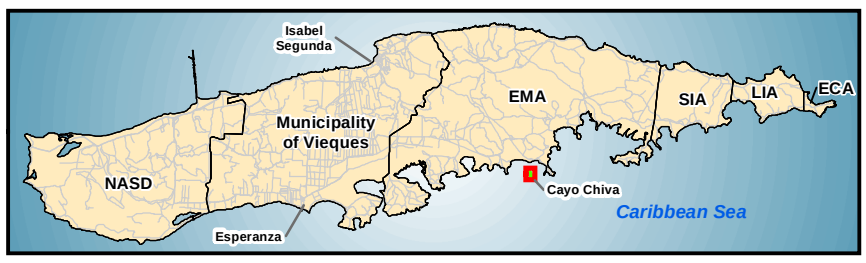

Figure 24
UXO 18 Cayo Chiva Site Features
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N W E S

0 50 100 Feet

2005 Aerial Imagery

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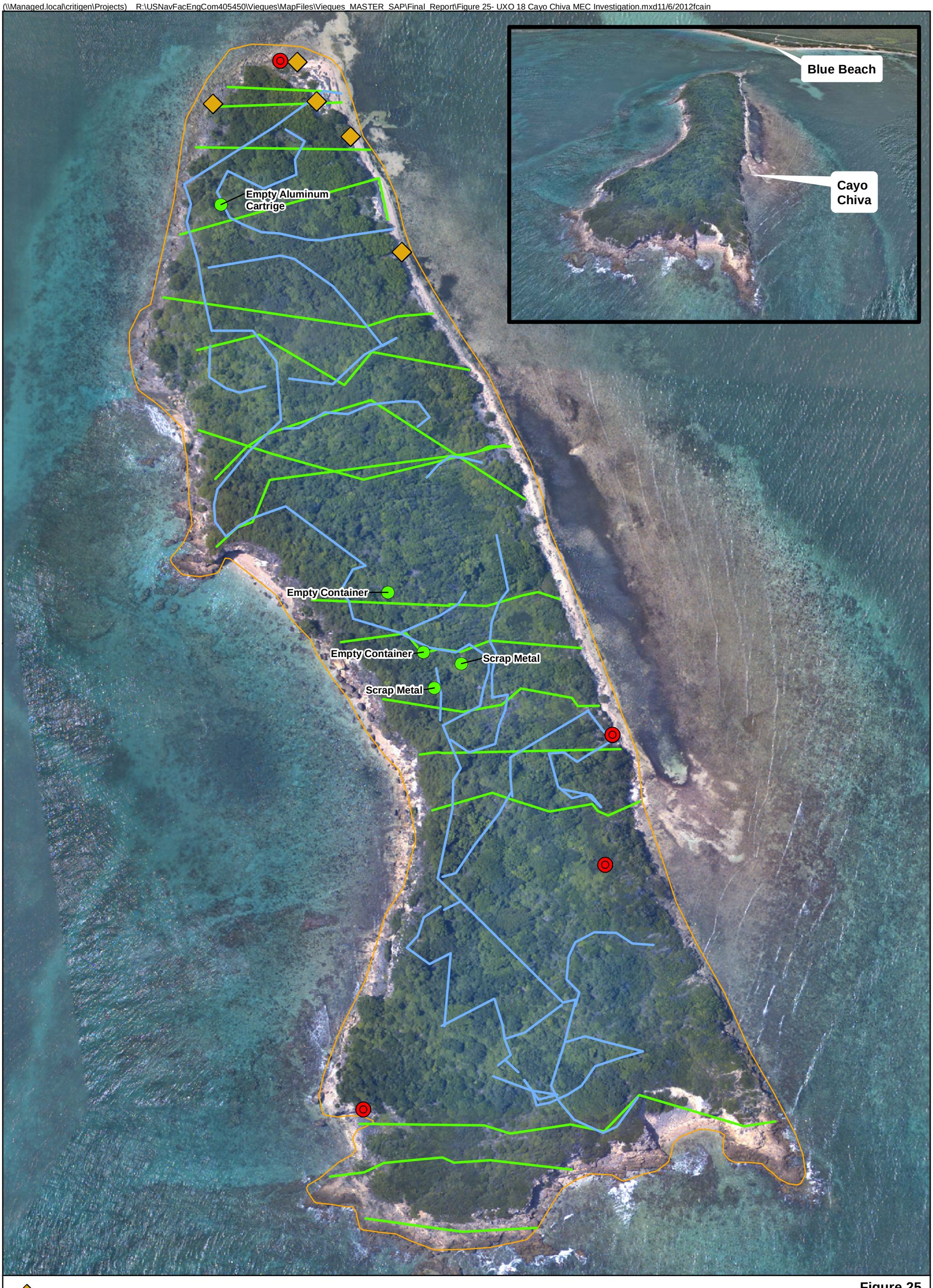
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 25- UXO 18 Cayo Chiva MEC Investigation.mxd11/6/2012fcain



Access Restriction Sign

Non-Munitions Findings

Rockets / Guided Missiles (5 inch HE Rockets)

Biological Assessment Transects

Site Inspection Transects

UXO 18 Boundary

2005 Aerial Imagery

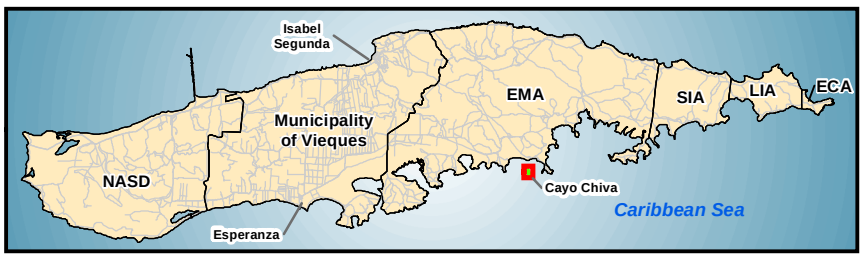
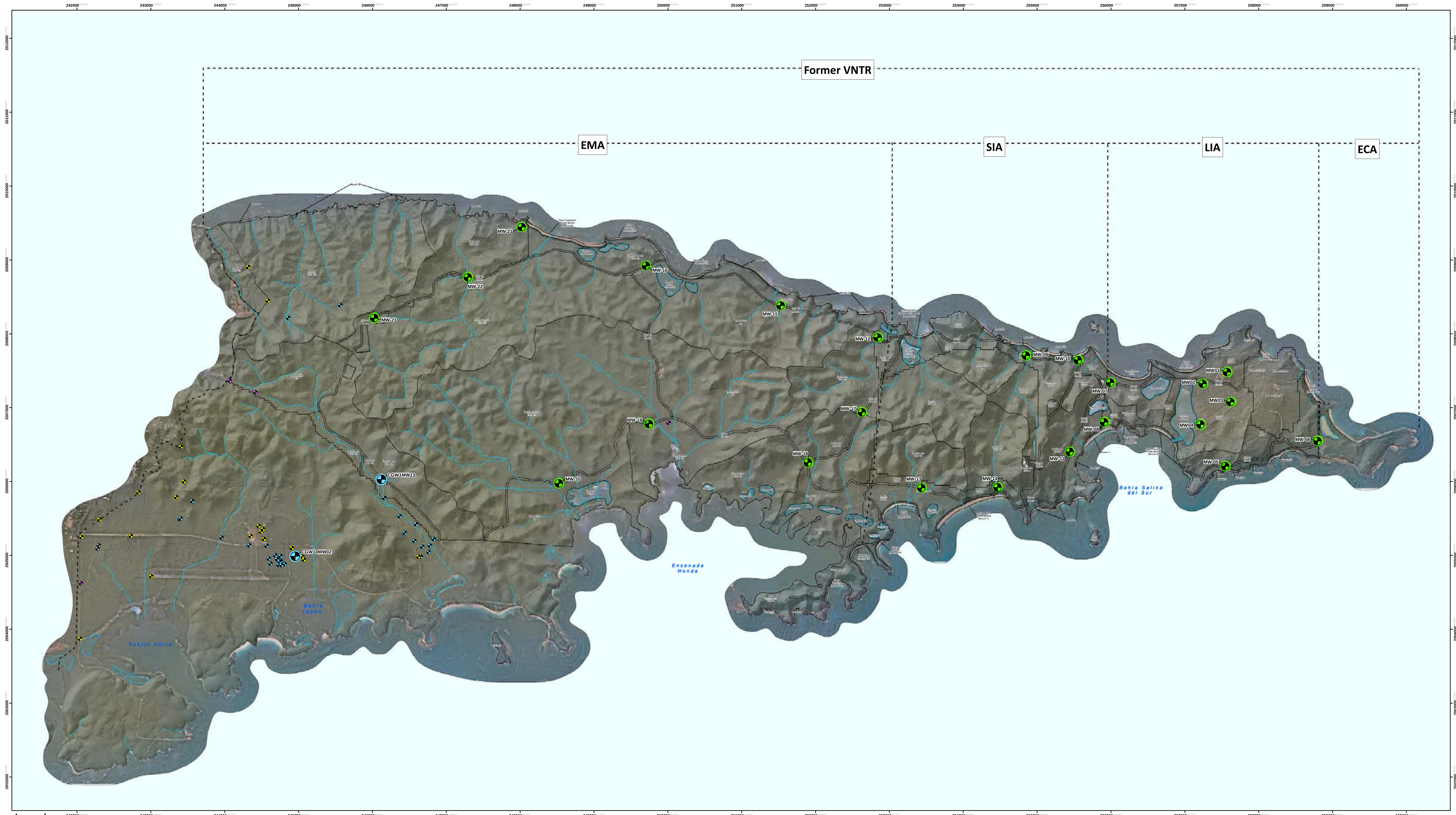


Figure 25
UXO 18 Cayo Chiva MEC Investigation
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 50 100
Feet

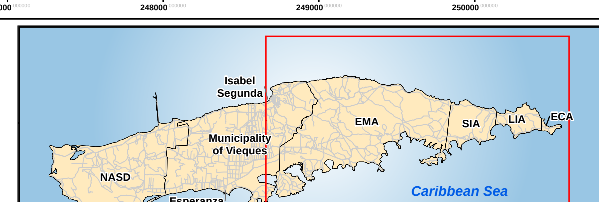
CH2MHILL



Legend

- Well Not Found
- Proposed Monitoring Well
- Existing Monitoring Well
- Abandoned Monitoring Well
- Abandoned Water Supply Well
- Well Not Found
- Ephemeral Stream
- Lagoon
- Decision Units

2005 Aerial Imagery
2005 Hillshade



N W E S

0 1,500 3,000 4,500 6,000 Feet

Figure 26
Location of Proposed Regional Monitoring Wells
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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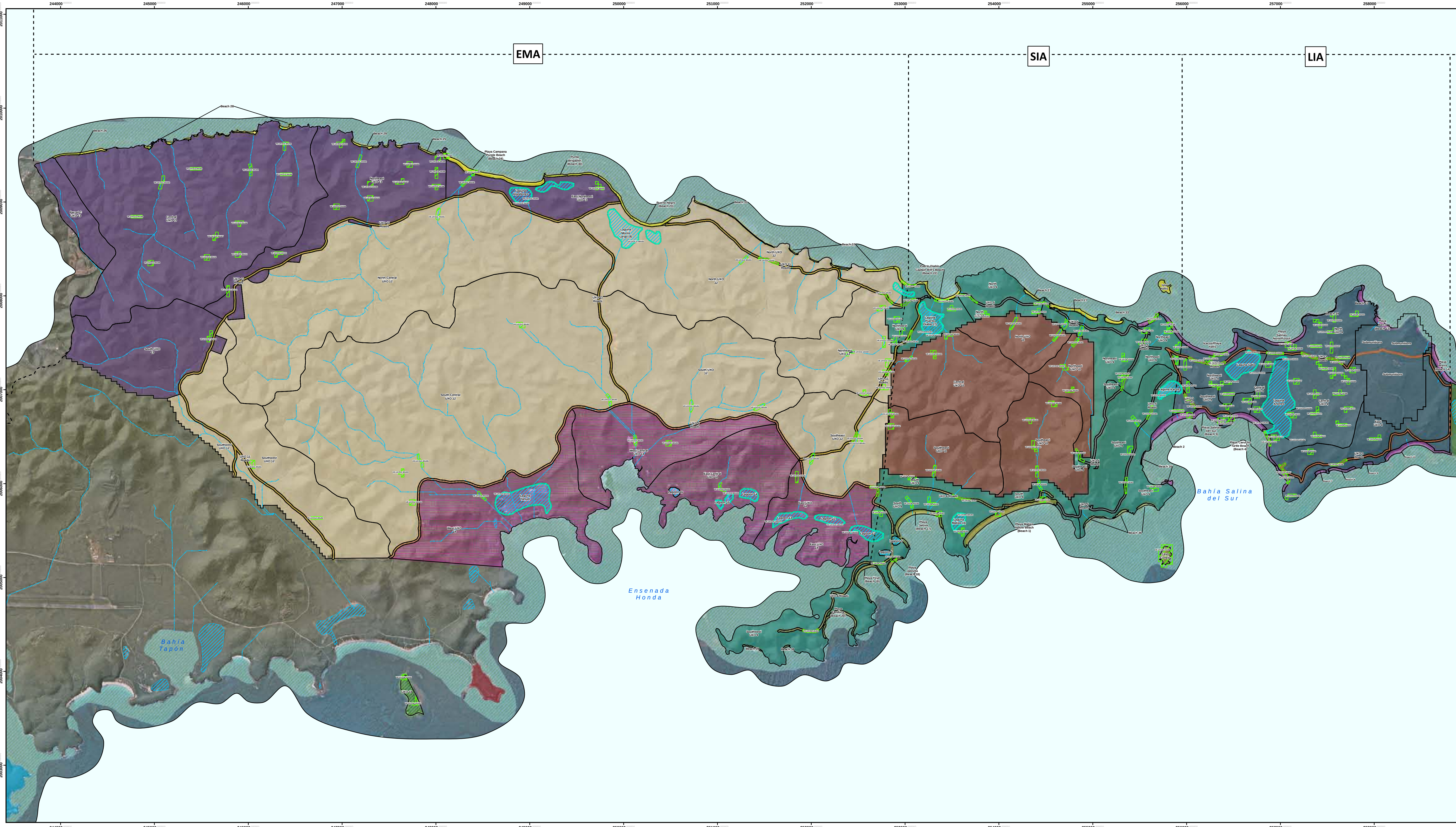
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 26 - Location of Proposed Regional Monitoring Wells.mxd1/18/2013fcain
ES011413081845TPA Figure 26 - Location of Proposed Regional Monitoring Wells.ai



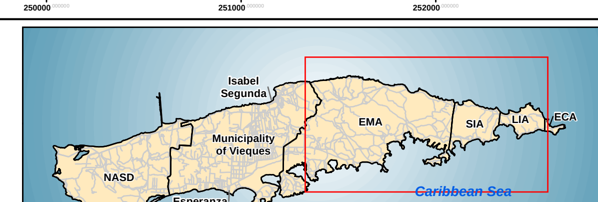
Legend

- Sampling Unit
- Sample Unit (Lagoon Fringe)
- Decision Units
- Ephemeral Stream
- Lagoon

Munitions Response Sites

- UXO 1 - ECA
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South
- UXO 15 - Puerto Ferro
- UXO 16 -Underwater Areas
- UXO-17 - PAOC EE
- UXO 18 - Cayo de la Chiva

2005 Aerial Imagery
2005 Hillshade



N
W E
S

0 1,400 2,800 4,200 5,600 Feet

Figure 27
Location of Decision Units and Sampling Units
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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ES011413081845TPA Figure 27 - Location of Decision Units and Sampling Units.ai

EMA

SIA

LIA

UXO-16

UXO-13

UXO-12

UXO-14

UXO-11

UXO-7

UXO-9

UXO-10

UXO-8

UXO-6

UXO-5

UXO-4

UXO-2

UXO-17 PAOC EE

UXO-18

Munitions Response Sites

- UXO 1 - ECA
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South
- UXO 15 - Puerto Ferro
- UXO 16 -Underwater Areas
- UXO 17 - PAOC-EE
- UXO 18 - Cayo de la Chiva

Subsurface Anomalies/Finds by Grids

- 0 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

Orange outline indicates where total subsurface findings are used for color coding

Subsurface MEC Characterization Location
Historical Air-To-Ground (ATG) Target
Historical Naval Gunfire Support (NGFS) Target
Bulls Eye Target
General Location of Marine Artillery Targets
Depleted Uranium Area
LIDAR Identified Target Feature
Central Processing Center
Gun Positions
Target Area
Observation Point

Range
Open Burn Pit
Open Detonation Area
Naval Gunfire Support (NGFS) Target Area
Dense Submunitions Area
Photo Identified Area
Preliminary Area of Concern
Solid Waste Management Unit

N W E S

0 1,200 2,400 3,600 4,800 Feet

Figure 28
Subsurface MEC Characterization Locations
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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I:\Managed Local\Vieques\Projects\ R:\USNavFacEngCom\ROI\ROI\ViequesMapFiles\Vieques_MASTER_SAP\Final_Report\Figure 28 - Subsurface MEC Characterization Locations.mxd11/6/2012\Cam

ES011413081845TPA Figure 28 - Subsurface MEC Characterization Locations.ai

Isla Yallis
Beach 33
Beach 34
Beach 11
Beach 12
Playa Barco (Beach 13)
Playa Brava (Beach 14)
Playa Blanco (Beach 15)
Playa Salinas del Norte/Fossil Beach
Playa Icacos
Playa Salinas Del Sur (Beach 3)
Playa Carucho Turtle Beach (Beach 4)
Beach 2
Beach 35
Beach 10
Beach 9
Beach 8
Beach 7
VE-UXO2-1SB06
VE-UXO2-1DU06
VE-UXO2-1DU07
VE-UXO2-1SB07
VE-UXO2-1SB08
VE-UXO2-1DU08
VE-UXO2-1SB01
VE-UXO2-1DU01
VE-UXO2-1DU02
VE-UXO2-1DU03
VE-UXO2-1SB02
VE-UXO2-1SB03
VE-UXO2-1SB04
VE-UXO2-1DU04
VE-UXO2-1SB05
VE-UXO2-1DU05
OP-12
OP-13
OP-5
GP-5 (1983)
GP-5 (1967)
G-21
PI-1
PI-2
T1
T2
T4
T5
T6
T7
CONVOY
RR TUNNEL
OPEN DETONATION AREA
AMMO DUMP
SAM EAST
SAM WEST
STRAFING TARGET
OPEN BURNING PIT
SWMU 3
SWMU 9
AIRSTRIP
FUEL FARM
Laguna Cato
Laguna Icacos
Laguna Anones
10
20
30
40
50
60
70
80
90
100

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

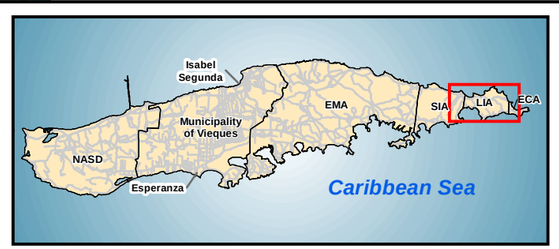
- Deep Surface Soil Sample
- Sample Unit
- Beach Selected for Sampling
- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Submunitions

- Topographic Contours (10 Meter)
- Stream
- Crater
- Historical Air-To-Ground (ATG) Target
- Historical Naval Gunfire Support (NGFS) Target
- Bulls Eye Target
- LIDAR (Light Detection and Radar) Identified Target Feature
- Depleted Uranium Area
- Central Processing Center
- Gun Positions
- 2005 Aerial Imagery
- 2005 Hillshade

- Target Area
- Observation Point
- Open Burn Pit
- Open Detonation Area
- Naval Gunfire Support (NGFS) Target Area
- Dense Submunitions Area
- Photo Identified Area
- Preliminary Area of Concern
- Solid Waste Management Unit
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

Surface Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918



N
W E
S

0 500 1,000
Feet

Figure 29
UXO 2 LIA Beach Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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CONVOY
RR TUNNEL
VE-UXO3-1DU01
VE-UXO3-1DU02
VE-UXO3-1DU03
VE-UXO3-1DU04
VE-UXO3-1DU05
VE-UXO3-1DU06
VE-UXO3-1DU07
VE-UXO3-1DU08
PI-1
STRAFING TARGET
OPEN DETONATION AREA
AMMO DUMP
SAM EAST
SAM WEST
OPEN BURNING PIT
SWMU 3
SWMU 9
AIRSTRIP
FUEL FARM
T1
T2
T3
T4
T5
T6
T7
Laguna Gato
Laguna Anones
Laguna Icacos

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sampling Unit
- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Submunitions
- Decision Unit

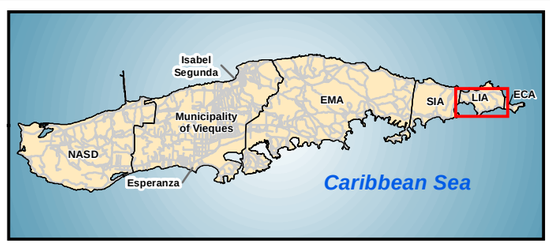
- Topographic Contours (10 Meter)
- Stream
- Crater
- Historical Air-To-Ground (ATG) Target
- Historical Naval Gunfire Support (NGFS) Target
- Bulls Eye Target
- LIDAR (Light Detection and Radar) Identified Target Feature
- Depleted Uranium Area
- Central Processing Center

- Target Area
- Open Burn Pit
- Open Detonation Area
- Naval Gunfire Support (NGFS) Target Area
- Photo Identified Area
- Preliminary Area of Concern
- Solid Waste Management Unit
- Grid (30 Meter)
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918



N
W E
S
0 250 500
Feet

Figure 30
UXO 3 LIA Road Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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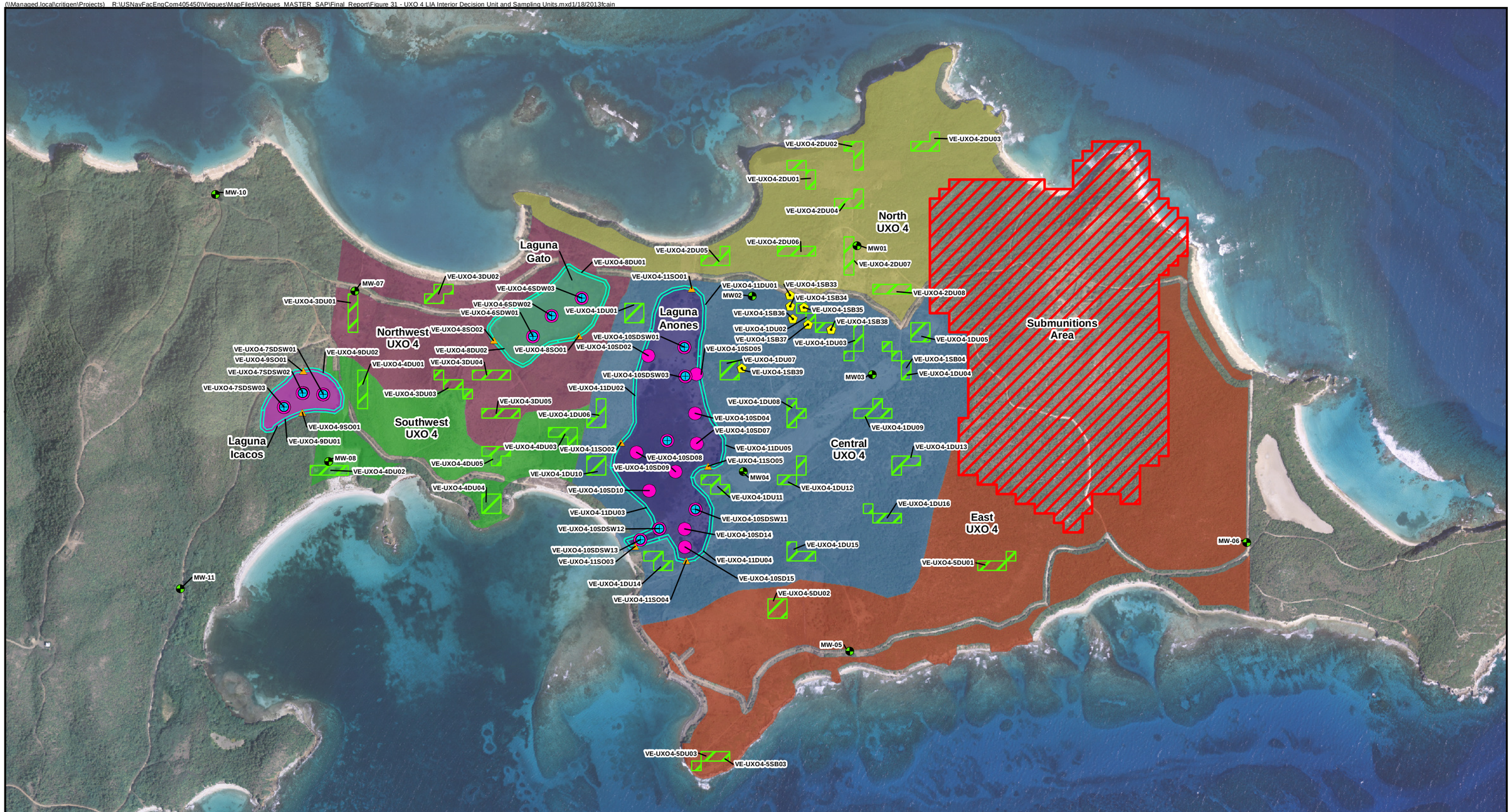


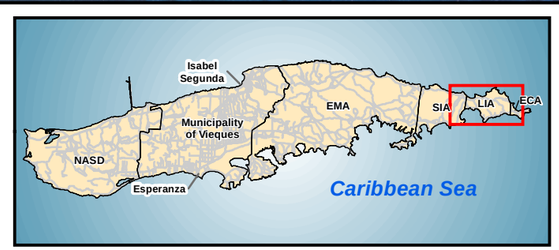
- Deep Surface Soil Sample
- Subsurface Soil Sample
- Proposed Monitoring Well
- Proposed Surface Water Samples
- Proposed Sediment Samples
- Sample Unit (Lagoon Fringe)
- Sample Unit (Interior)

Decision Unit

- Central UXO 4
- North UXO 4
- Northwest UXO 4
- Southwest UXO 4
- East UXO 4
- Laguna Anones
- Laguna Gato
- Laguna Icacos

- Submunitions Area

2007 Aerial Imagery



N
W E
S

0 500 1,000
Feet

Figure 31
UXO 4 LIA Interior Decision Unit and Sampling Units
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico

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VE-UXO4-1SB33
VE-UXO4-1SB34
VE-UXO4-1SB35
VE-UXO4-1SB36
VE-UXO4-1SB37
VE-UXO4-1SB38
VE-UXO4-1SB39
VE-UXO4-1DU01
VE-UXO4-1DU02
VE-UXO4-1DU03
VE-UXO4-1DU04
VE-UXO4-1DU05
VE-UXO4-1DU06
VE-UXO4-1DU07
VE-UXO4-1DU08
VE-UXO4-1DU09
VE-UXO4-1DU10
VE-UXO4-1DU11
VE-UXO4-1DU12
VE-UXO4-1DU13
VE-UXO4-1DU14
VE-UXO4-1DU15
VE-UXO4-1DU16
Laguna Gato
Laguna Anones
SAM EAST
SAM WEST
AMMO DUMP
AIRSTRIP
SWMU 3
SWMU 9
T1
T2
T3
T4
T7

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Subsurface Soil Sample
- Sample Unit
- Decision Unit
- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Submunitions

- Topographic Contours (10 Meter)
- Stream
- Crater
- Historical Air-To-Ground (ATG) Target
- Historical Naval Gunfire Support (NGFS) Target
- LIDAR (Light Detection and Radar) Identified Target Feature

2005 Aerial Imagery
2005 Hillshade

- Target Area
- Open Burn Pit
- Open Detonation Area
- Naval Gunfire Support (NGFS) Target Area
- Dense Submunitions Area
- Soild Waste Management Unit
- Grid (30 Meter)
- Lagoon

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

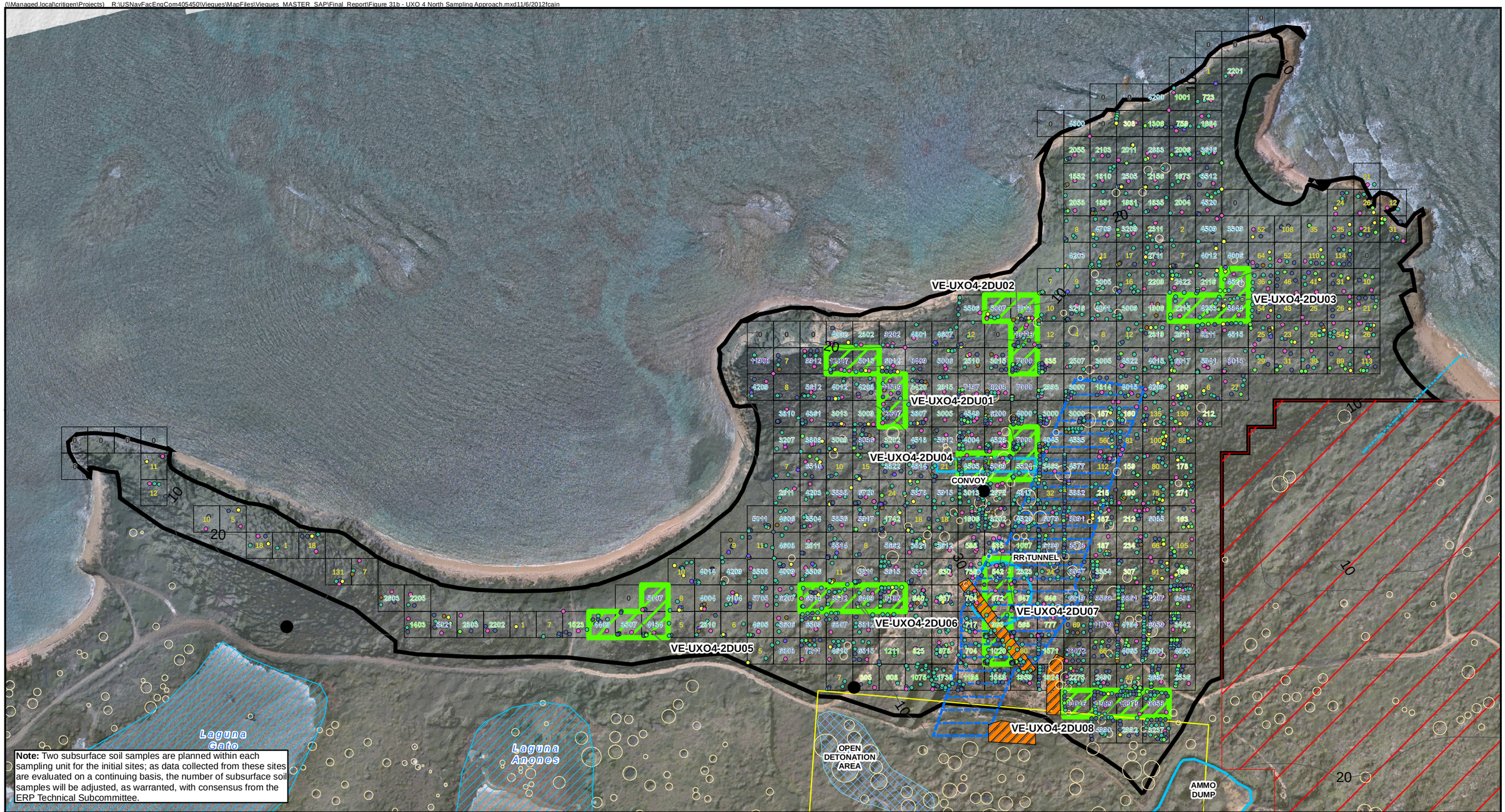
Figure 31a
Central UXO 4 Sampling Approach
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico

N W E S

0 250 500 Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 31b - UXO 4 North Sampling Approach.mxd11/6/2012fcain



Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Submunitions

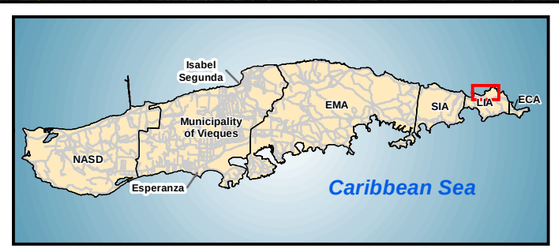
Topographic Contours (10 Meter)
Stream
Crater
LIDAR (Light Detection and Radar) Identified Target Feature
Depleted Uranium Area

Target Area
Open Burn Pit
Open Detonation Area
Naval Gunfire Support (NGFS) Target Area
Dense Submunitions Area
Grid (30 Meter)
Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



N
W E
S

0 250 500
Feet

Figure 31b
UXO 4 North Sampling Approach
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 31c - UXO 4 Northwest Sampling Approach.mxd11/6/2012fcain

VE-UXO4-3DU01
VE-UXO4-3DU02
VE-UXO4-3DU03
VE-UXO4-3DU04
VE-UXO4-3DU05
STRAFING TARGET
SAM WEST
PI-1
T1
T2
SWMU 9
Laguna Gato
Laguna Icacos
Laguna Anones

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

Sample Unit
Decision Unit

Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Submunitions

Topographic Contours (10 Meter)
Stream
Crater
Historical Air-To-Ground (ATG) Target
Bulls Eye Target
Historical Naval Gunfire Support (NGFS) Target
Target Area
Naval Gunfire Support (NGFS) Target Area

Photo Identified Area
Solid Waste Management Unit
Lagoon
Central Processing Center

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

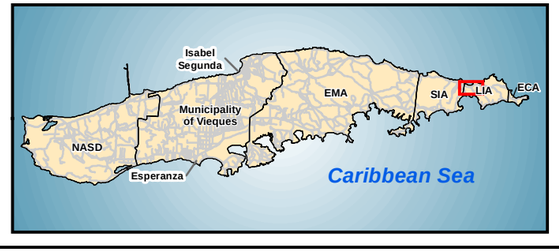

Figure 31c
UXO 4 Northwest Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 150 300
Feet

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 31d - UXO 4 Southwest Sampling Approach.mxd11/6/2012fcain

Laguna Icacos

Laguna Gato

Laguna Anones

VE-UXO4-4DU01

VE-UXO4-4DU02

VE-UXO4-4DU03

VE-UXO4-4DU04

VE-UXO4-4DU05

SAM WEST

STRAFING TARGET

SWMU 9

T1

T2

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

Sample Unit
Decision Unit

Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Submunitions

Topographic Contours (10 Meter)
Lagoon

2005 Aerial Imagery
2005 Hillshade

Crater
Stream
Historical Naval Gunfire Support (NGFS) Target
Central Processing Center
Gun Positions
Target Area
Naval Gunfire Support (NGFS) Target Area
Photo Identified Area
Solid Waste Management Unit
Grid (30 Meter)

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

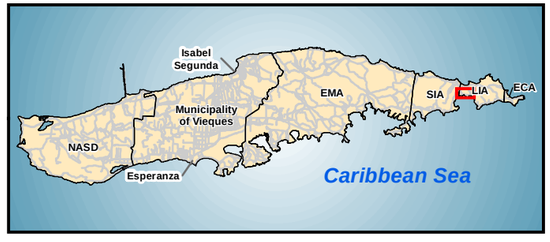

Figure 31d
UXO 4 Southwest Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 125 250
Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 31e - UXO 4 East Sampling Approach.mxd11/6/2012fcain

RR TUNNEL
OPEN DETONATION AREA
AMMO DUMP
SAM EAST
SAM WEST
OPEN BURNING PIT
SWMU 3
AIRSTRIP
FUEL FARM
SWMU 9
Laguna Cato
Laguna Anones
T1
T2
T3
T4
T5
T6
T7
VE-UXO4-5DU01
VE-UXO4-5DU02
VE-UXO4-5DU03

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Submunitions

- Topographic Contours (10 Meter)
- Stream
- Crater
- Historical Air-To-Ground (ATG) Target
- Historical Naval Gunfire Support (NGFS) Target
- LIDAR (Light Detection and Radar) Identified Target Feature

- Target Area
- Open Burn Pit
- Open Detonation Area
- Naval Gunfire Support (NGFS) Target Area
- Dense Submunitions Area
- Soil Waste Management Unit
- Grid (30 Meter)
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

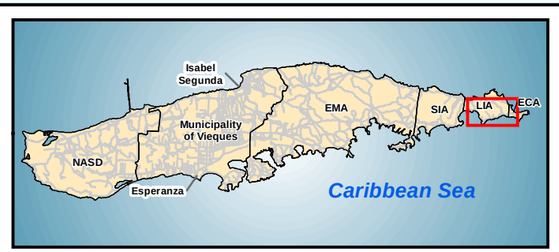

Figure 31e
UXO 4 East Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N W E S

0 500 1,000 Feet

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 31f - UXO 4 Laguna Anones Sampling Approach.mxd1/18/2013fcain

VE-UXO4-11SO01
VE-UXO4-11DU01
VE-UXO4-10SDSW01
VE-UXO4-10SD11
VE-UXO4-10SD13
VE-UXO4-10SDSW03
VE-UXO4-11DU05
VE-UXO4-11DU02
VE-UXO4-10SD12
VE-UXO4-11SO02
VE-UXO4-10SDSW06
VE-UXO4-10SD07
VE-UXO4-10SD08
VE-UXO4-10SD09
VE-UXO4-11SO05
VE-UXO4-10SD10
VE-UXO4-11DU03
VE-UXO4-10SDSW02
VE-UXO4-11DU04
VE-UXO4-10SDSW04
VE-UXO4-10SDSW05
VE-UXO4-10SD14
VE-UXO4-10SD15
VE-UXO4-11SO03
VE-UXO4-11SO04

OPEN DETONATION AREA
AMMO DUMP
OPEN BURNING PIT
AIRSTRIP
FUEL FARM
SAM WEST
SWMU 9
SWMU 3
T1
T2
T3

Proposed Surface Water Samples
Proposed Sediment Samples
Deep Surface Soil Sample
Lagoon Fringe
Lagoon

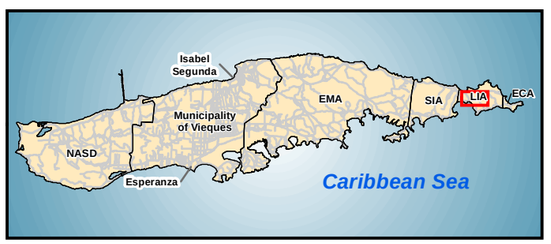
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Submunitions

Topographic Contours (10 Meter)
Crater
Historical Air-To-Ground (ATG) Target
Historical Naval Gunfire Support (NGFS) Target
Depleted Uranium Area
Target Area
LIDAR (Light Detection and Radar) Identified Target Feature
Open Burn Pit
Open Detonation Area
Naval Gunfire Support (NGFS) Target Area
Dense Submunitions Area
Yellow Shading Indicates No MEC Investigation

Soil Waste Management Unit
Grid (30 Meter)

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



2007 Aerial Imagery

Figure 31f
UXO 4 Laguna Anones Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 250 500
Feet

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 31g - UXO 4 Laguna Gato Sampling Approach.mxd1/18/2013fcain

VE-UXO4-8DU01
VE-UXO4-6SDSW03
VE-UXO4-6SDSW02
VE-UXO4-6SDSW01
VE-UXO4-8SO01
VE-UXO4-8SO02
VE-UXO4-8DU02
SWMU 9
SAM WEST
10
20

Proposed Surface Water Samples
Proposed Sediment Samples
Deep Surface Soil Sample
Lagoon
Lagoon Fringe

Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

Topographic Contours (10 Meter)
Crater
Target Area
Solid Waste Management Unit
Grid (30 Meter)

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

2007 Aerial Imagery

Figure 31g
UXO 4 Laguna Gato Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 75 150
Feet

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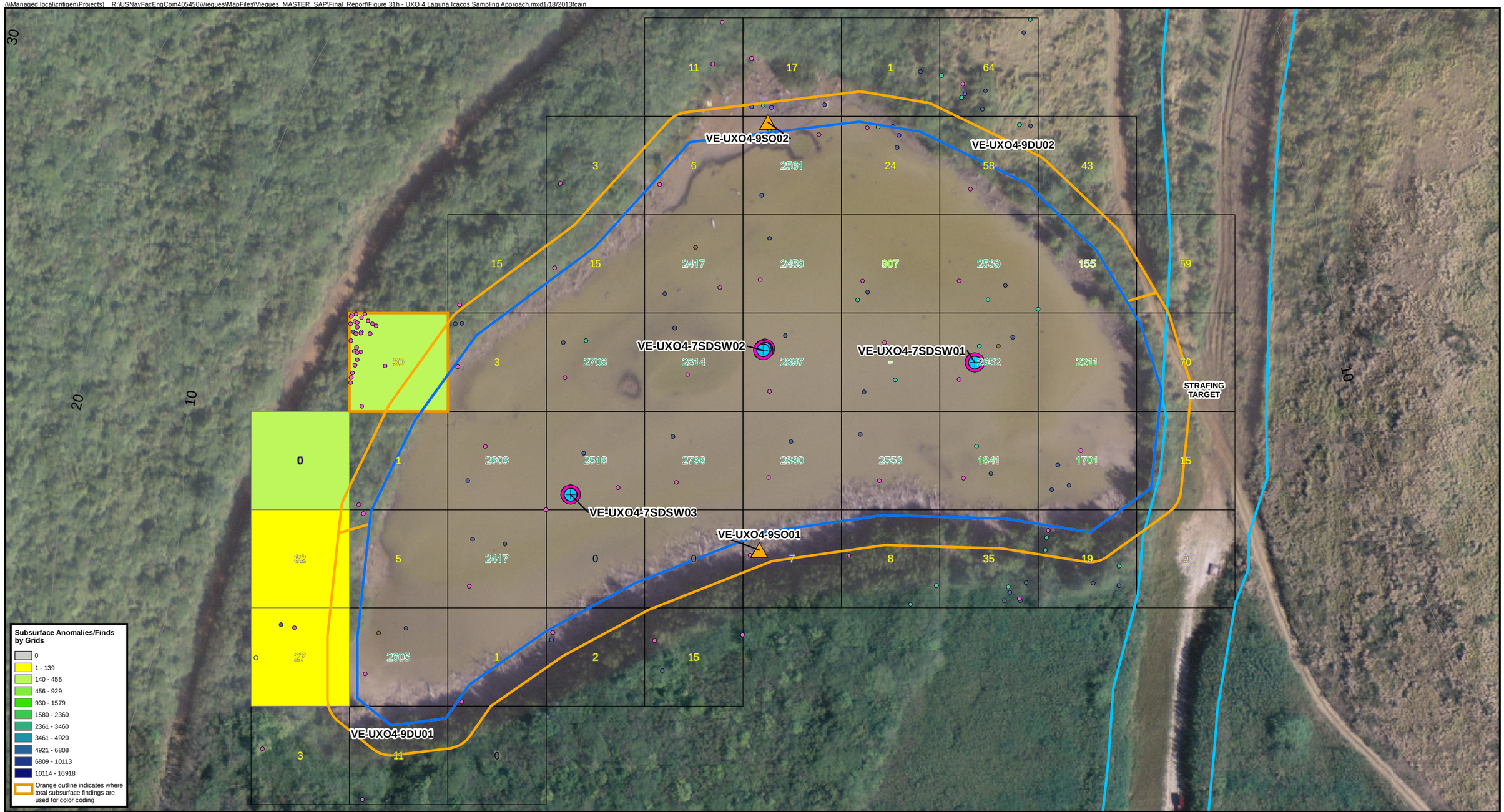
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 31h - UXO 4 Laguna Icacos Sampling Approach.mxd1/18/2013fcain



Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

- Deep Surface Soil Sample
- Proposed Surface Water Samples
- Proposed Sediment Samples
- Lagoon
- Lagoon Fringe

- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Submunitions

- Topographic Contours (10 Meter)
- Target Area
- Grid (30 Meter)

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

2007 Aerial Imagery

Figure 31h
UXO 4 Laguna Icacos Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N W E S

0 50 100 Feet

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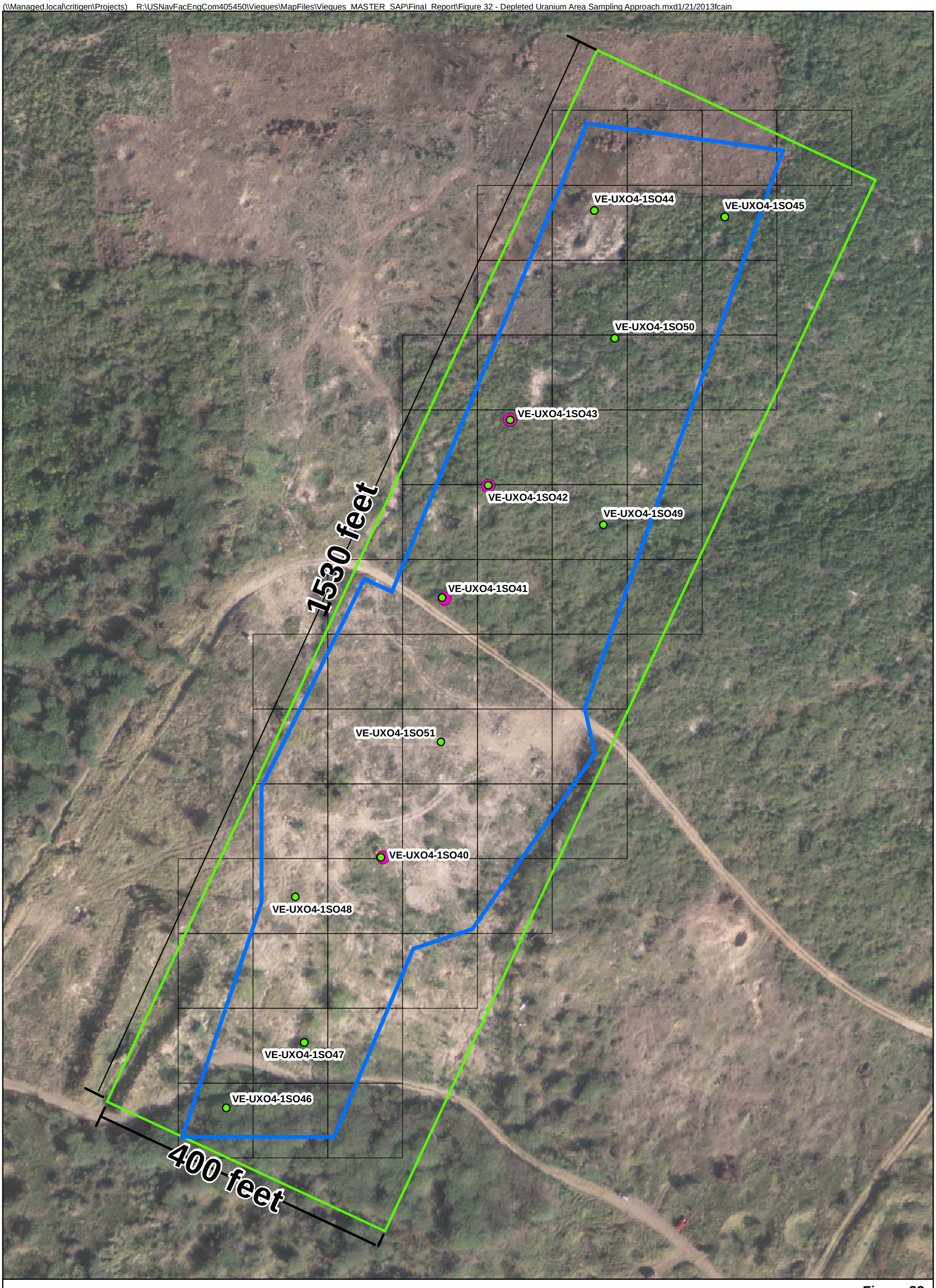
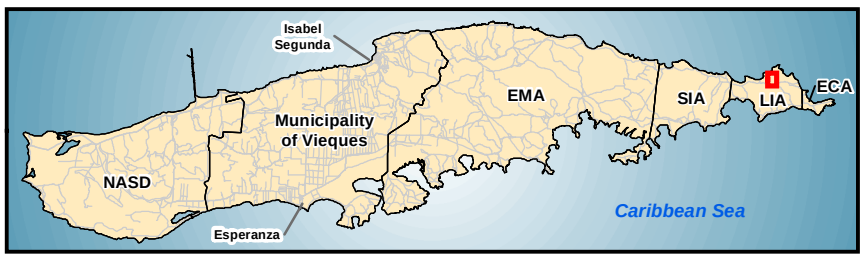
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 32 - Depleted Uranium Area Sampling Approach.mxd1/21/2013fcain



Surface and Subsurface Soil Sample
DU Penetrator Location
Depleted Uranium Area
Rectangular Extent
Grid (30 Meter)



2007 Aerial Imagery

Figure 32
Depleted Uranium Area Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 50 100
Feet

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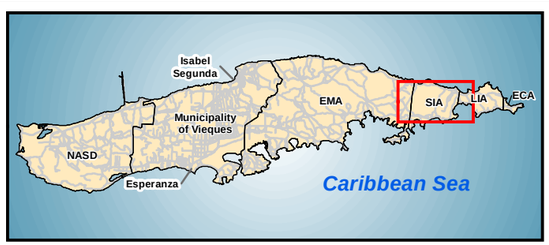
Road Sample Units
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Submunitions
Transect -3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
2005 Aerial Imagery
2005 Hillshade

Crater
Historical Air-To-Ground (ATG) Target
Historical Naval Gunfire Support (NGFS) Target
Bulls Eye Target
Central Processing Center
Gun Positions

Target Area
Observation Point
Range
Naval Gunfire Support (NGFS) Target Area
Photo Identified Area
Preliminary Area of Concern
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



N
W E
S
0 500 1,000
Feet

Figure 33
UXO 5 Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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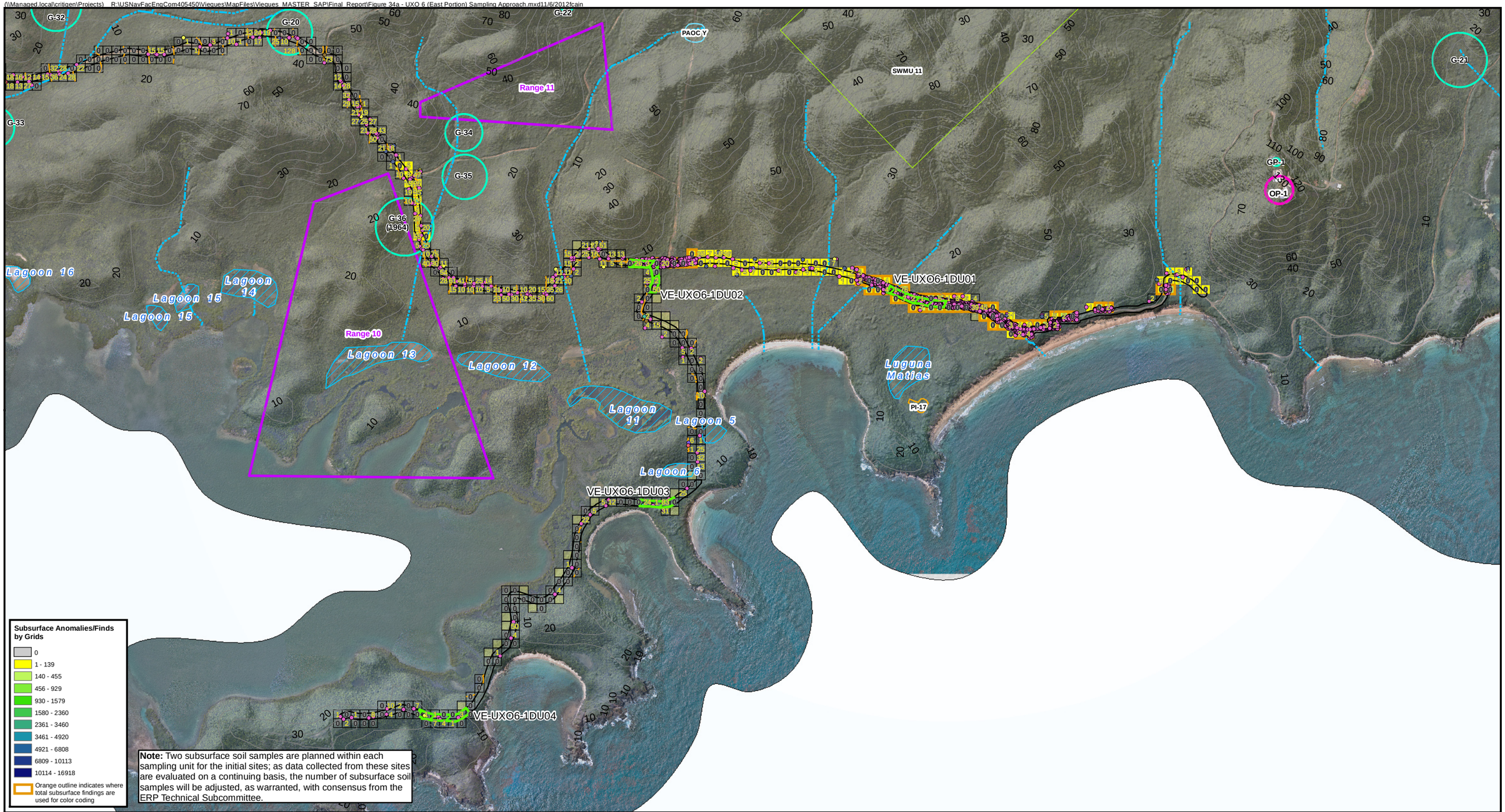
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 34a - UXO 6 (East Portion) Sampling Approach.mxd11/6/2012fcain



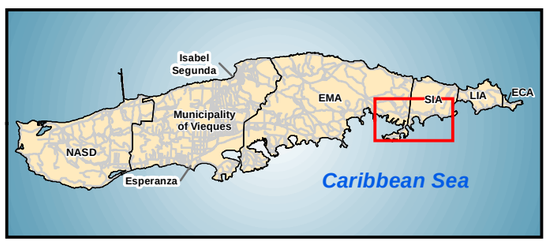
Sampling Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Transect -3 Foot Width was Investigated

Topographic Contours (10 Meter)
Stream
Gun Positions
Target Area
Observation Point
Range
Photo Identified Area
Preliminary Area of Concern
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



N
W E
S

0 500 1,000
Feet

Figure 34a
UXO 6 (East Portion) Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 34b - UXO 6 (West Portion) Sampling Approach.mxd11/6/2012fcain

G-5
G-31
G-24
G-32
G-33
G-30
PI-3
PI-2
PI-19 possible gun position
Laguna Yanuel
Laguna La Plata
Lagoon 16
Lagoon 14
Lagoon 15
Lagoon 15

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Decision Unit
- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Transect -3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Gun Positions
- Photo Identified Area
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

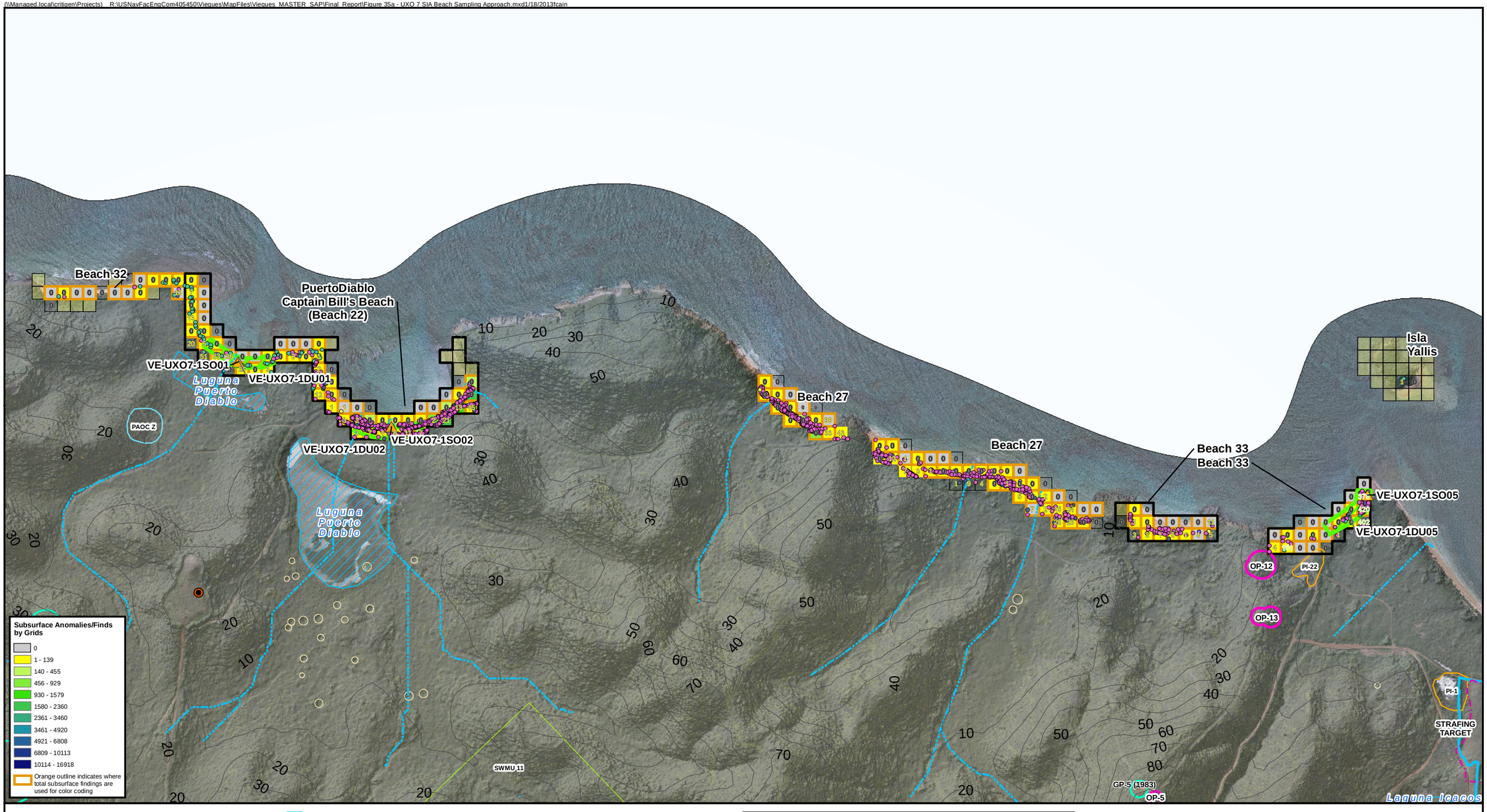
Figure 34b
UXO 6 (West Portion) Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N W E S

0 500 1,000
Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 35a - UXO 7 SIA Beach Sampling Approach.mxd1/18/2013fcain



Deep Surface Soil Sample
Sample Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Beach Selected for Sampling
2005 Aerial Imagery
2005 Hillshade

Topographic Contours (10 Meter)
Stream
Crater
Bulls Eye Target
Central Processing Center
Gun Positions

Target Area
Observation Point
Photo Identified Area
Preliminary Area of Concern
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

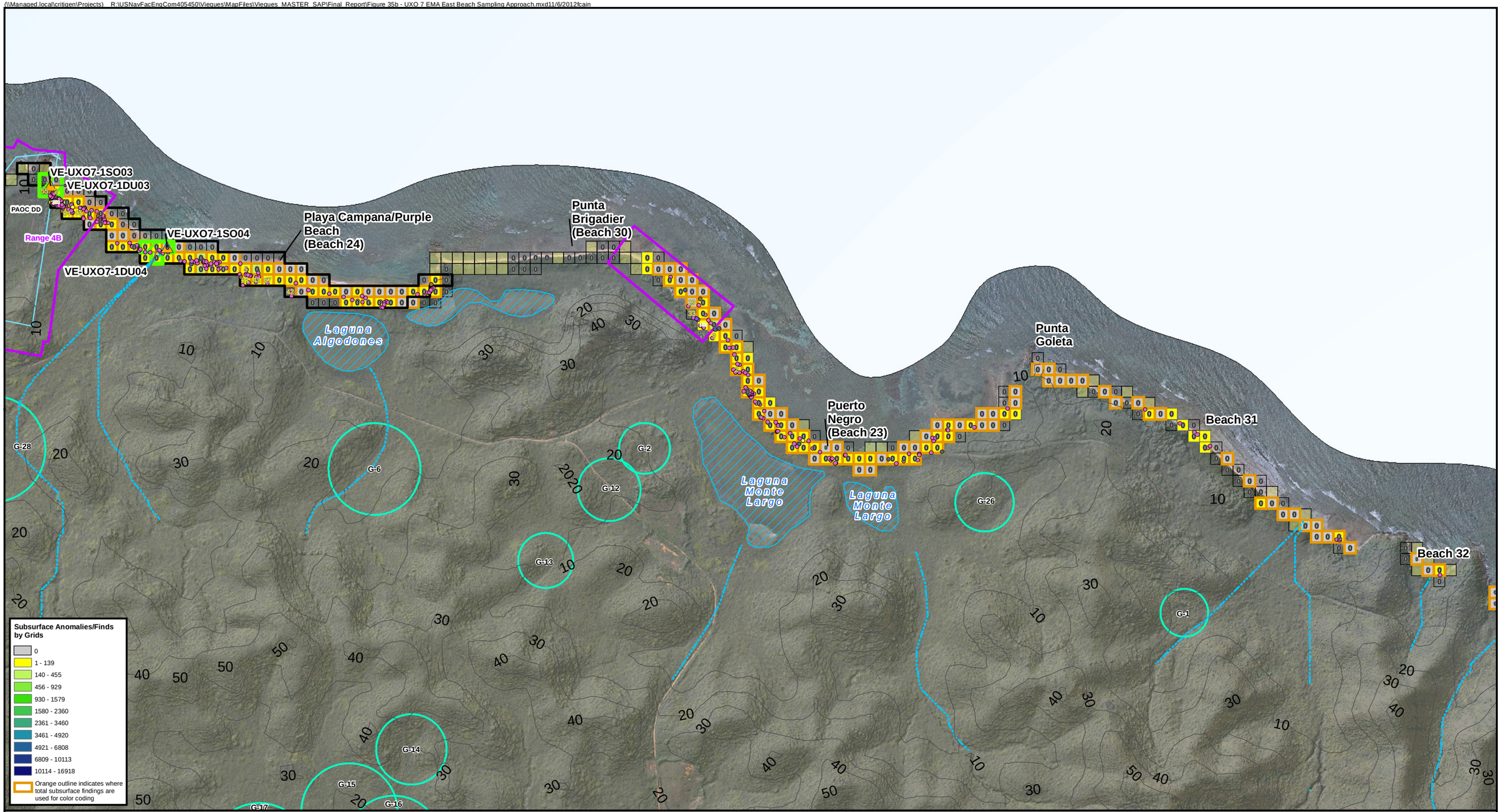
Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

Figure 35a
UXO 7 SIA Beach Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S
0 350 700
Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 35b - UXO 7 EMA East Beach Sampling Approach.mxd11/6/2012fcain



Deep Surface Soil Sample
Sample Unit
Beach Selected for Sampling
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

Topographic Contours (10 Meter)
Stream
Gun Positions
Range
Photo Identified Area
Preliminary Area of Concern
Solidl Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

2005 Aerial Imagery
2005 Hillshade

Surface Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

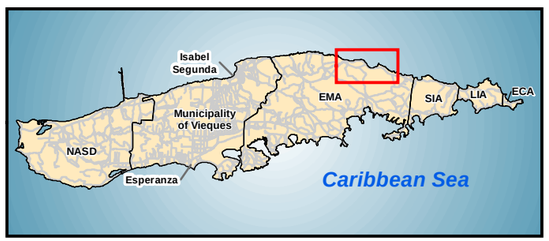
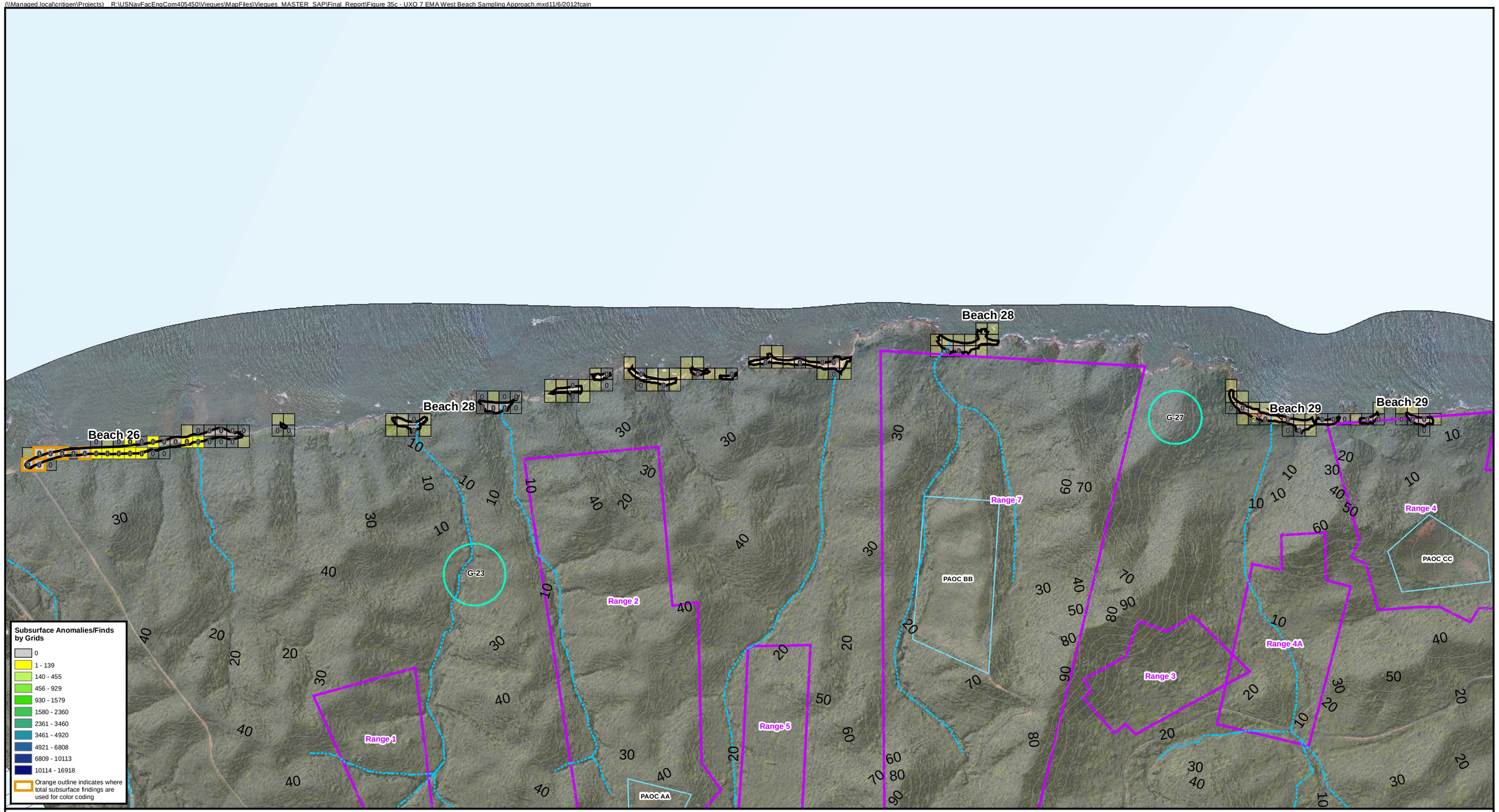


Figure 35b
UXO 7 EMA East Beach Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 400 800
Feet

CH2MHILL



- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Beach Selected for Sampling

- Topographic Contours (10 Meter)
- Stream
- Gun Positions
- Range
- Preliminary Area of Concern
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

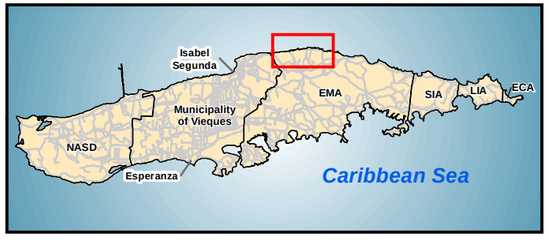


Figure 35c
UXO 7 EMA West Beach Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 400 800
Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 36 - UXO 8 SIA South Beaches Sampling Approac.mxd1/18/2013fcain

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

G-35
G-36 (1964)
SWMU 11
GP-1
OP-1
Lagoon 13
Lagoon 12
Lagoon 11
Lagoon 5
Lagoon 6
Luguna Matias
PI-17
VE-UXO8-1SO01
VE-UXO8-1DU01
VE-UXO8-1SO02
VE-UXO8-1DU02
VE-UXO8-1SO03
VE-UXO8-1DU03
VE-UXO8-1SO04
VE-UXO8-1DU04
VE-UXO8-1SO05
VE-UXO8-1DU05
Playa Jalova (Beach 17)
Playa Jalovita (Beach 18)
Playa Yoye (Beach 19)
Playa Fanduca (Beach 20)
Beach 38
Punta Carenera (Beach 39)
Playa Matias/Yellow Beach (Beach 1)
Beach 36
Beach 36
Beach 36
Cayo Conejo
Brown Pelican Habitat

Deep Surface Soil Sample
Brown Pelican Habitat
Sample Unit
Beach Selected for Sampling
Bombs
Flares-Pyrotechnics
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
2005 Aerial Imagery
2005 Hillshade

Topographic Contours (10 Meter)
Stream
Crater
Gun Positions
Observation Point
Photo Identified Area
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

Surface Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

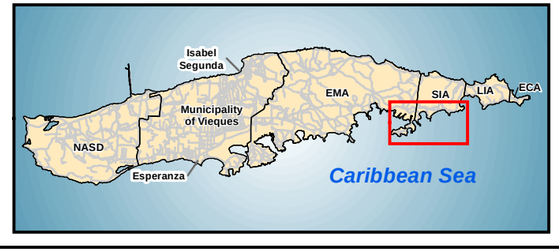


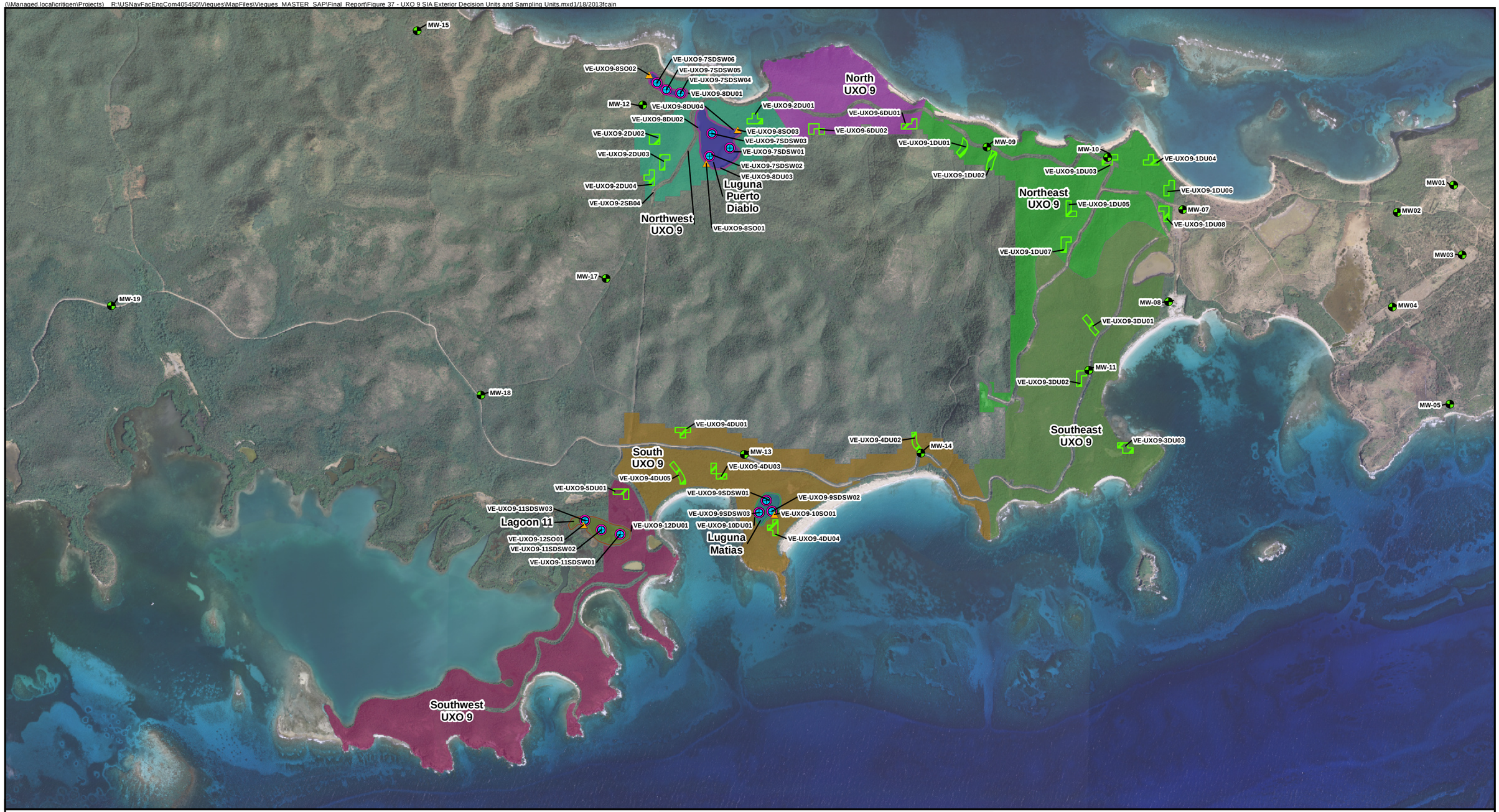
Figure 36
UXO 8 SIA South Beaches Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N W E S

0 500 1,000 Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 37 - UXO 9 SIA Exterior Decision Units and Sampling Units.mxd1/18/2013fcain



- Proposed Surface Water Samples
- Proposed Sediment Samples
- Proposed Monitoring Well
- Deep Surface Soil Sample
- Sample Unit (Interior)

Decision Unit

- North UXO 9
- Northeast UXO 9
- Northwest UXO 9
- South UXO 9
- Southeast UXO 9
- Southwest UXO 9
- Northwest UXO 9 Lagoons (Laguna Puerto Diablo)
- Luguna Matias
- Southwest UXO 9 Lagoons (Lagoon 11)
- Northwest UXO 9 Lagoon Fringe (Laguna Puerto Diablo)
- Laguna Matias Fringe
- Southwest UXO 9 Lagoon Fringes (Lagoon 11)

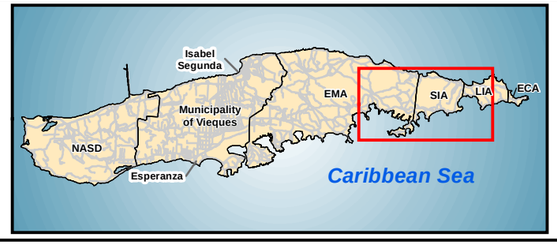


Figure 37
UXO 9 SIA Exterior Decision Units and Sampling Units
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 900 1,800
Feet

2007 Aerial Imagery

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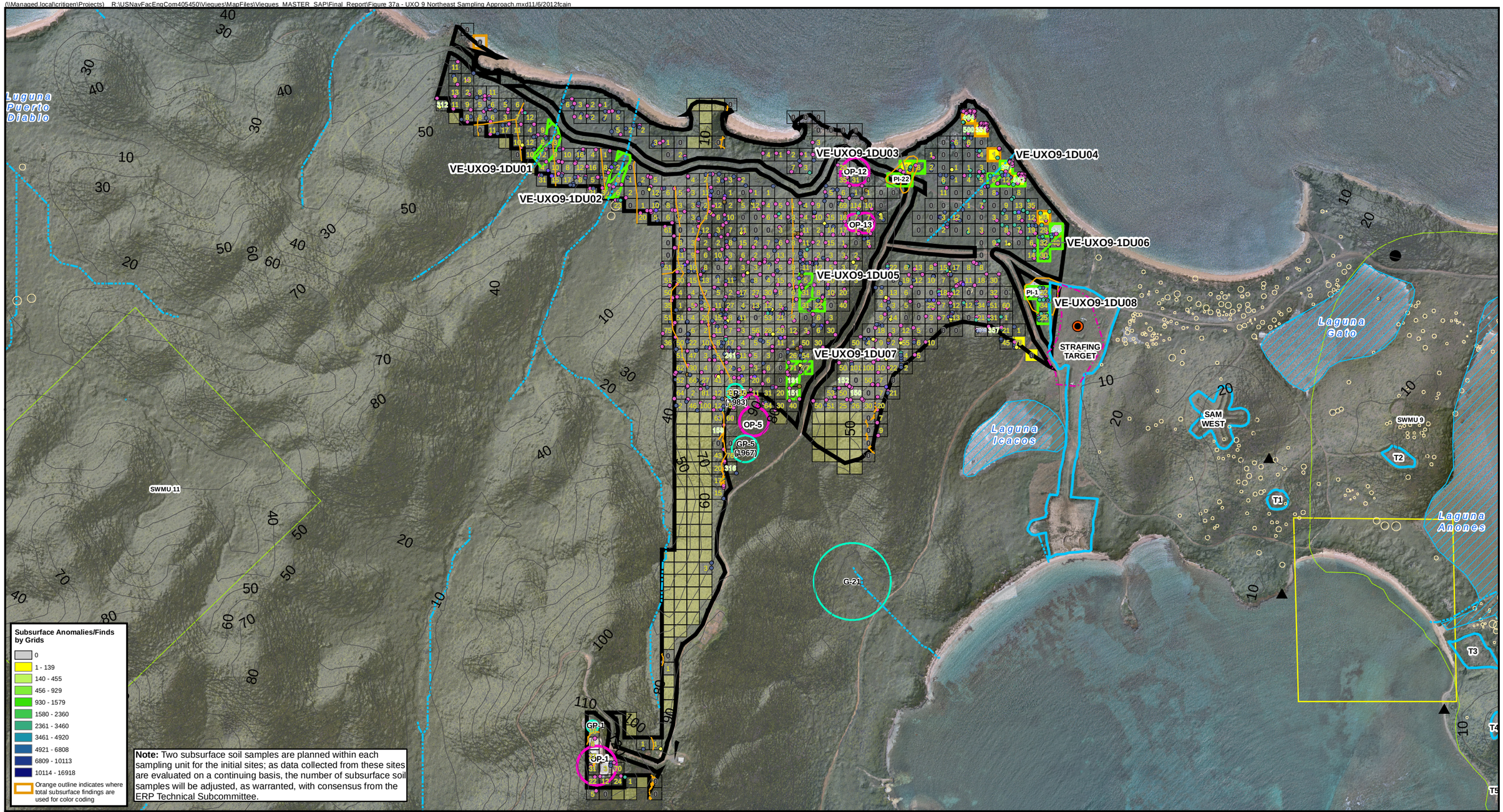
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 37a - UXO 9 Northeast Sampling Approach.mxd11/6/2012fcain



Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

Transect -3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Crater
Historical Air-To-Ground (ATG) Target
Historical Naval Gunfire Support (NGFS) Target
Bulls Eye Target
Central Processing Center
Gun Positions
2005 Aerial Imagery
2005 Hillshade

Observation Point
Target Area
Naval Gunfire Support (NGFS) Target Area
Photo Identified Area
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

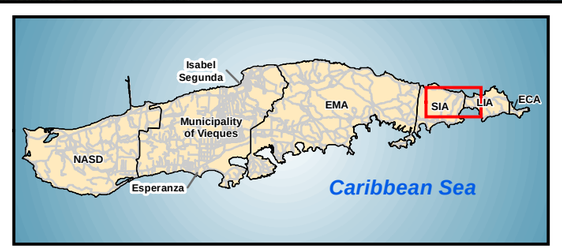
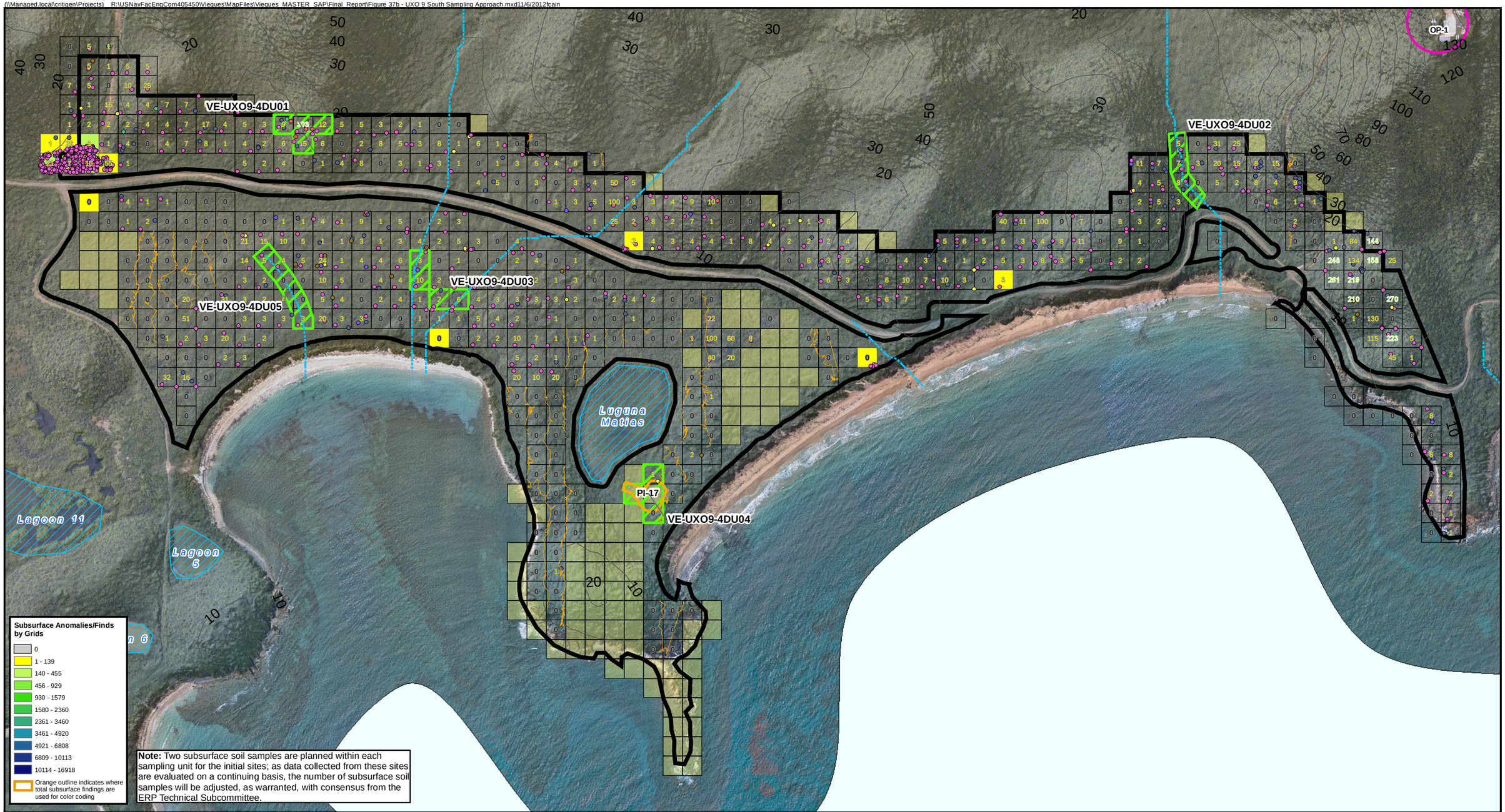


Figure 37a
UXO 9 Northeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 500 1,000
Feet

CH2MHILL



Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

Transect -3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Observation Point
Photo Identified Area
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

N
W E
S

0 250 500
Feet

Figure 37b
UXO 9 South Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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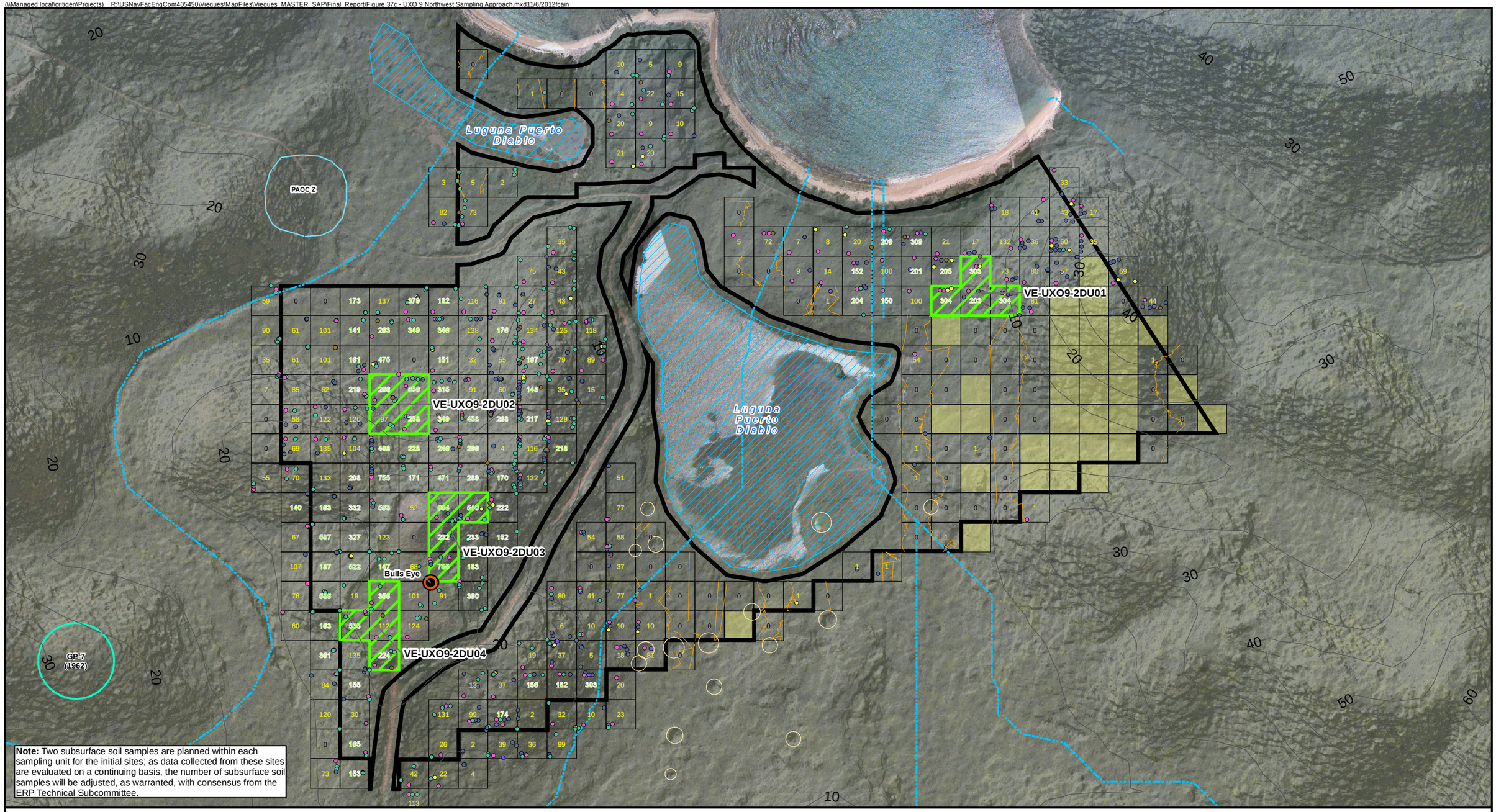
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 37c - UXO 9 Northwest Sampling Approach.mxd11/6/2012fcain



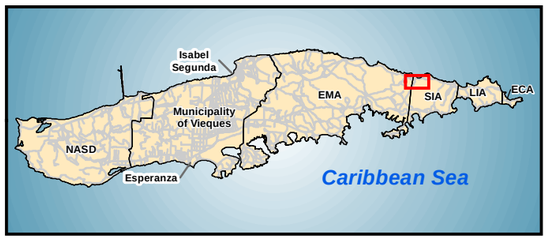
Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Lagoon

Transect -3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Crater
Bulls Eye Target
Gun Positions
Preliminary Area of Concern
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139	
140 - 455	
456 - 929	
930 - 1579	
1580 - 2360	
2361 - 3463	
3464 - 4920	
4921 - 6808	
6809 - 10113	
10114 - 16918	

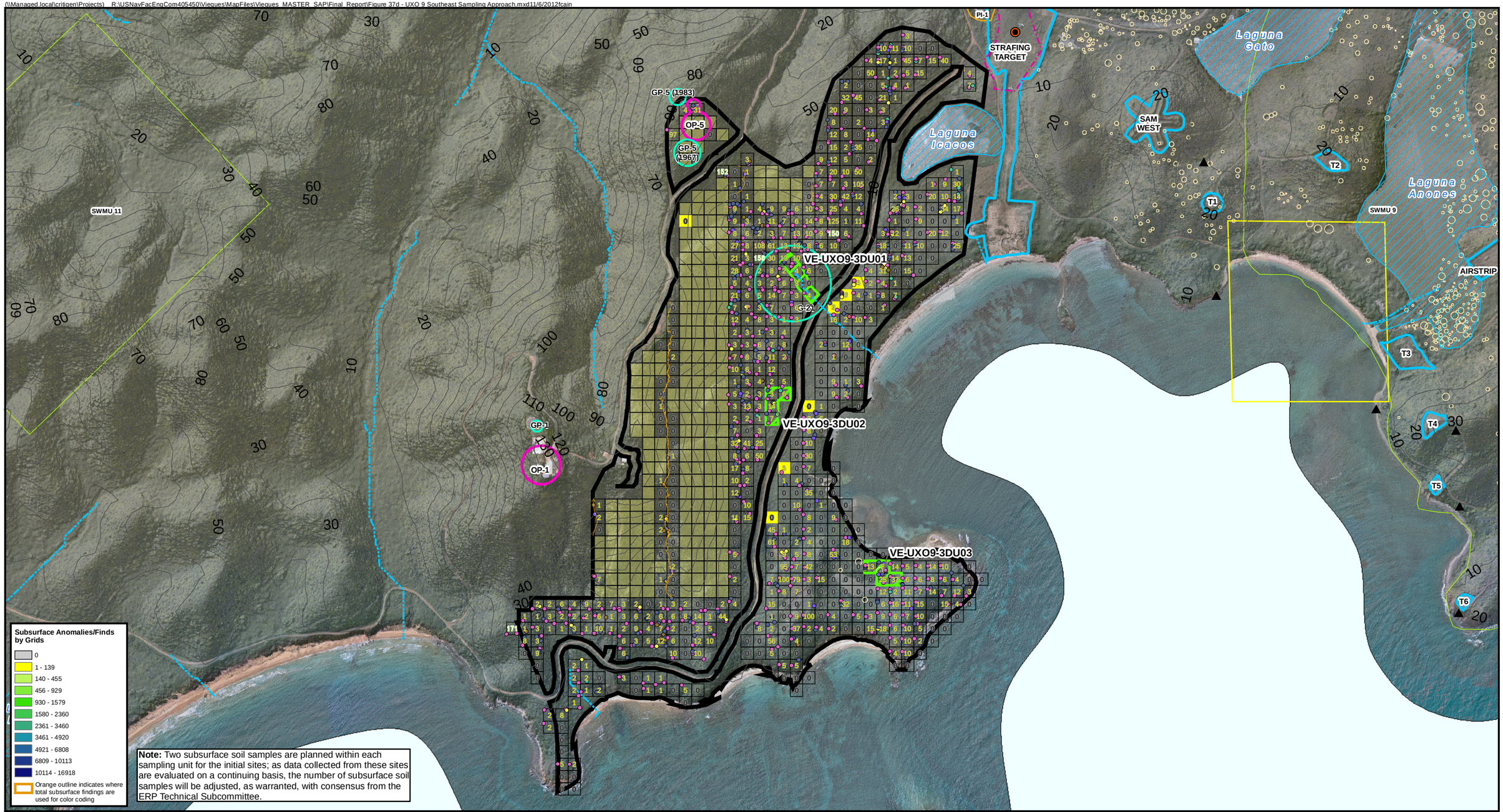


N
W E
S

0 150 300
Feet

Figure 37c
UXO 9 Northwest Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL



Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Submunitions

Transect - 3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Crater
Historical Naval Gunfire Support (NGFS) Target
Bulls Eye Target
Central Processing Center
Gun Positions

Target Area
Observation Point
Naval Gunfire Support (NGFS) Target Area
Photo Identified Area
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

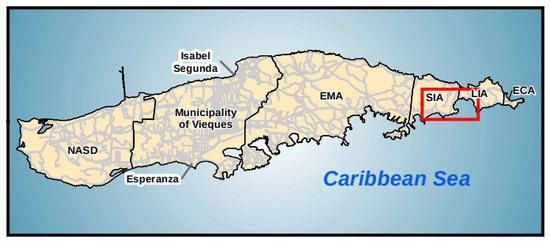


Figure 37d
UXO 9 Southeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N W E S

0 500 1,000 Feet

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Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

VE-UXO9-6DU01

VE-UXO9-6DU02

- Sample Unit
- Decision Unit
- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)

- Transect - 3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Interpretive Trail

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

N
W E
S

0 250 500
Feet

Figure 37e
UXO 9 North Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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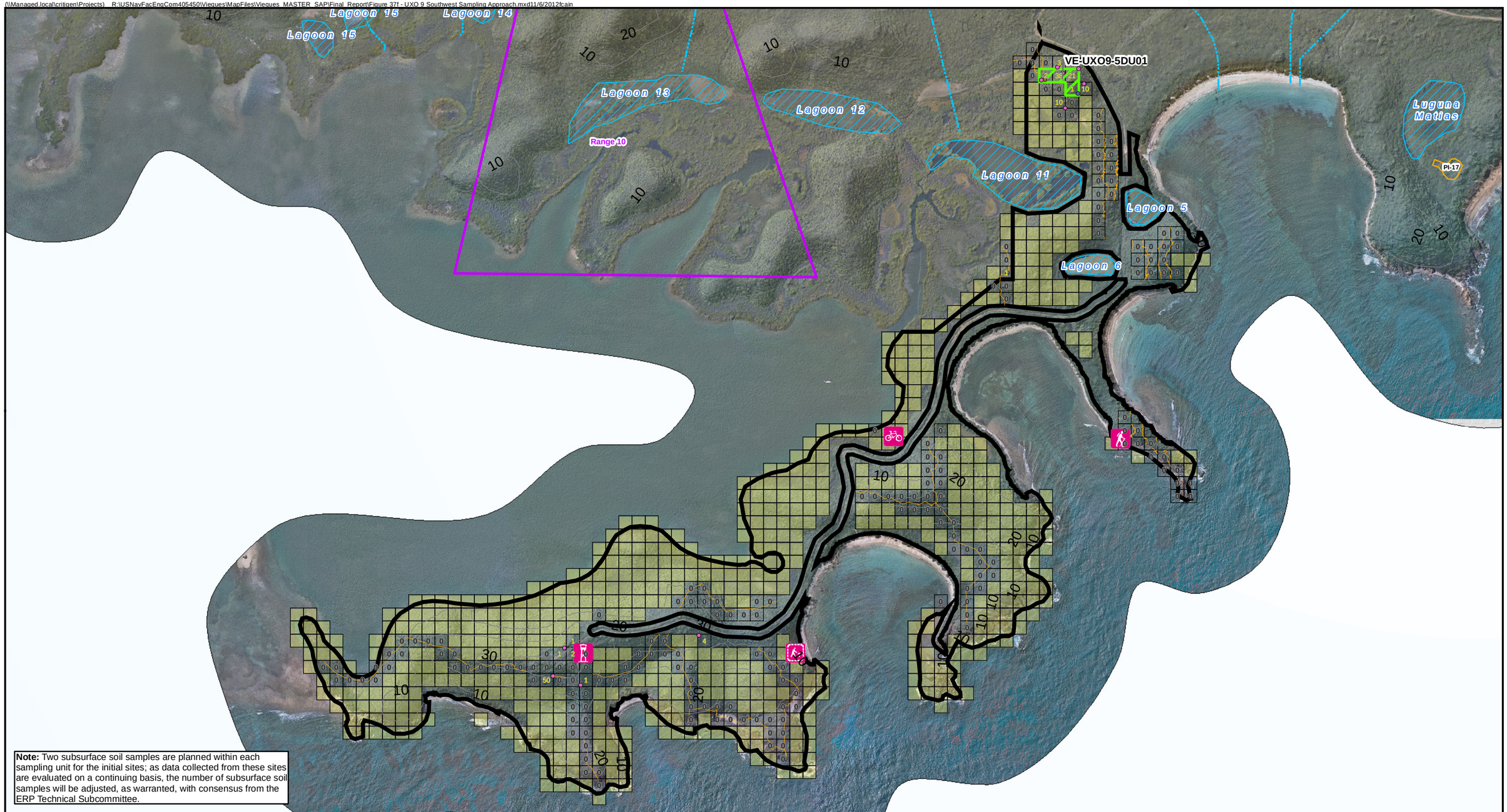
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 37f - UXO 9 Southwest Sampling Approach.mxd 11/6/2012 fcain



Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Transect - 3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Lagoon

2005 Aerial Imagery
2005 Hillshade

- Range
- Photo Identified Area
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Biking Trail
- Hiking Trail
- Interpretive Trail
- Observation Tower

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139	
140 - 455	
456 - 929	
930 - 1579	
1580 - 2360	
2361 - 3463	
3464 - 4920	
4921 - 6808	
6809 - 10113	
10114 - 16918	

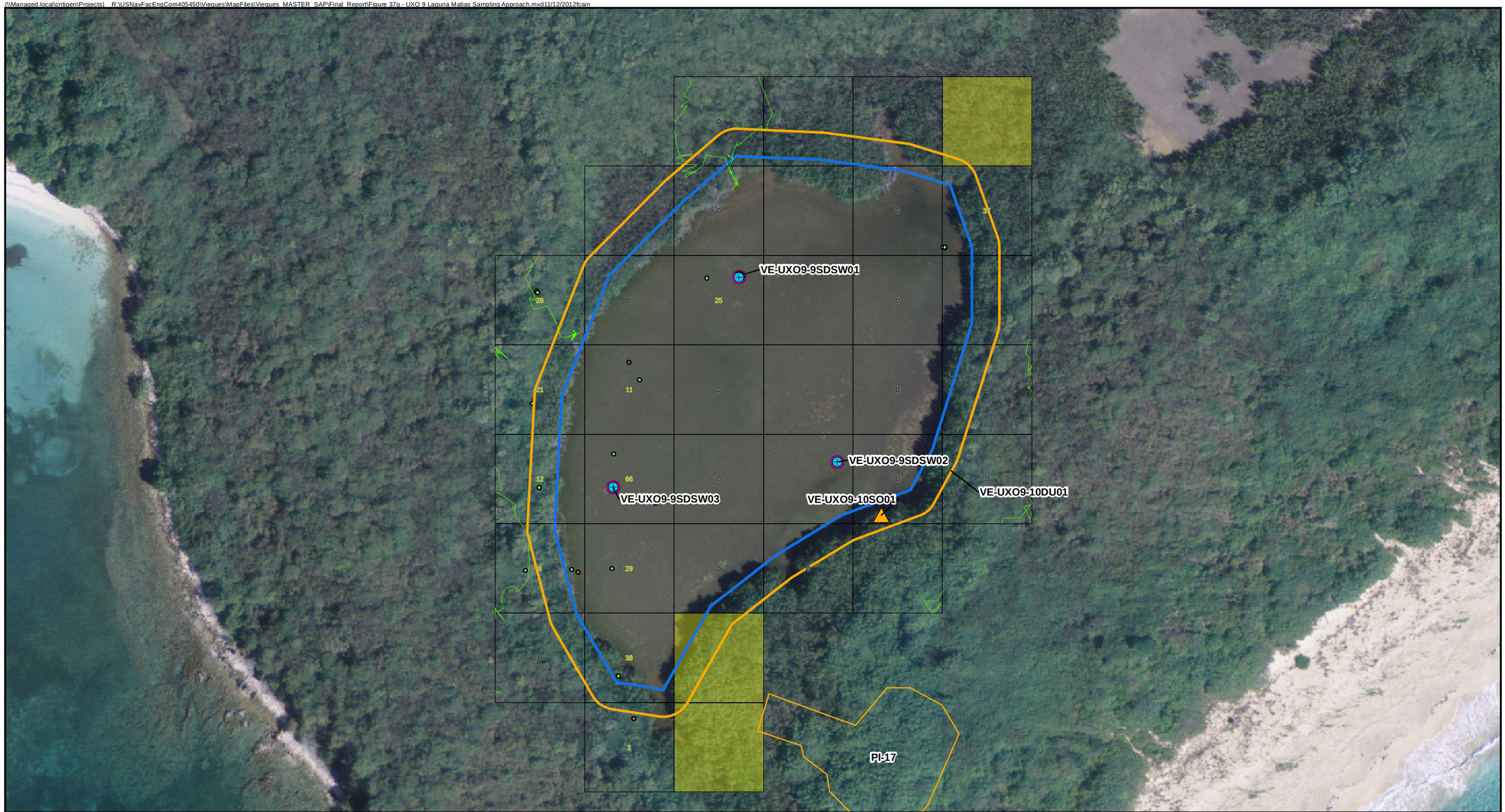
N
W E
S

0 500 1,000
Feet

Figure 37f
UXO 9 Southwest Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 37g - UXO 9 Laguna Matias Sampling Approach.mxd11/12/2012fcain



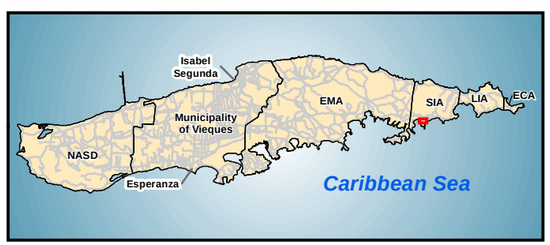
Deep Surface Soil Sample
Proposed Surface Water Samples
Proposed Sediment Samples
Transect - 3 Foot Width was Investigated
Lagoon
Lagoon Fringe
Photo Identified Area
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

2007 Aerial Imagery

Bombs
Projectiles / Mortars
Rockets / Guided Missiles
Scrap

Denisity of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



N
W E
S

0 75 150
Feet

Figure 37g
UXO 9 Laguna Matias Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 37h - UXO 9 Laguna Puerto Diablo Sampling Approach.mxd1/18/2013fcain

VE-UXO9-8DU01
VE-UXO9-8SO01
VE-UXO9-7SDSW06
VE-UXO9-7SDSW05
VE-UXO9-7SDSW04
PAOC Z
VE-UXO9-8SO02
VE-UXO9-8DU02
VE-UXO9-8SO04
VE-UXO9-7SDSW03
VE-UXO9-8DU04
VE-UXO9-7SDSW01
VE-UXO9-7SDSW02
VE-UXO9-8SO03
VE-UXO9-8DU03
Bulls Eye

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

- Proposed Surface Water Samples
- Proposed Sediment Samples
- Deep Surface Soil Sample
- Lagoon
- Lagoon Fringe
- Yellow Shading Indicates No MEC Investigation

- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Bulls Eye Target

- Crater
- Preliminary Area of Concern
- Grid (30 Meter)
- Transect - 3 Foot Width was Investigated
- Topographic Contours (10 Meter)

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

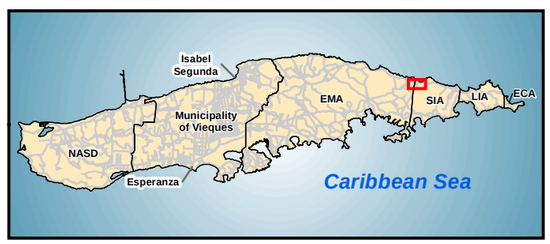


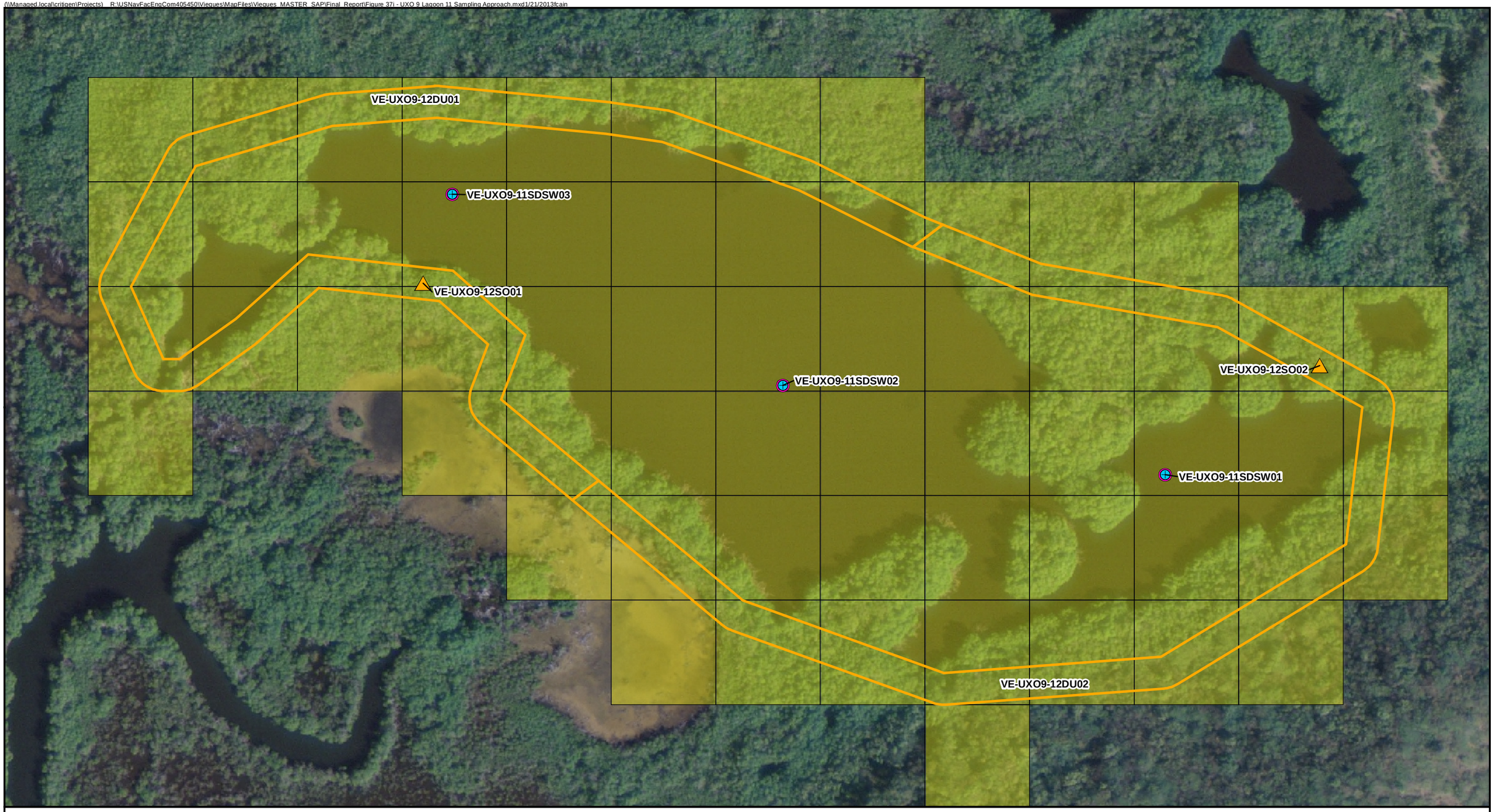
Figure 37h
UXO 9 Laguna Puerto Diablo Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 125 250
Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 37i - UXO 9 Lagoon 11 Sampling Approach.mxd 1/21/2013fcain

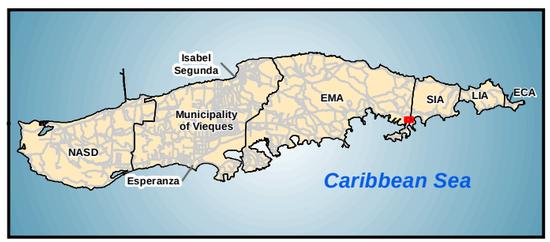


Proposed Surface Water Samples
Proposed Sediment Samples
Deep Surface Soil Sample
Lagoon Fringe
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Submunitions

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



2007 Aerial Imagery

N
W E
S

0 45 90
Feet

Figure 37i
UXO 9 Lagoon 11 Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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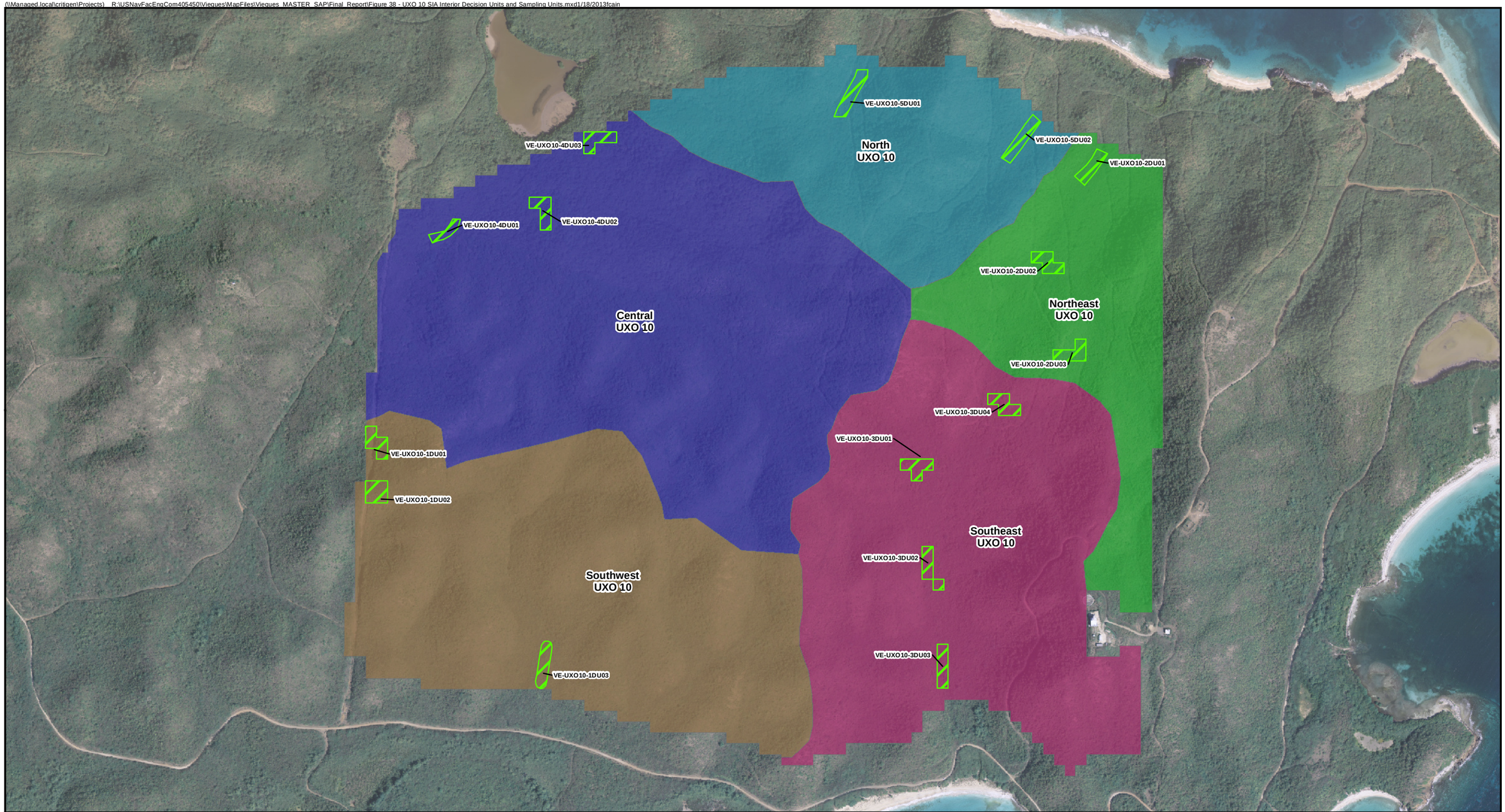
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 38 - UXO 10 SIA Interior Decision Units and Sampling Units.mxd1/18/2013fcain

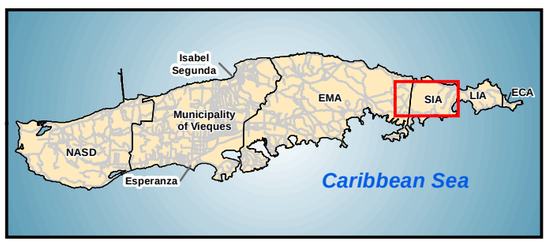


Sample Unit

Decision Unit

- Central UXO 10
- North UXO 10
- Northeast UXO 10
- Southeast UXO 10
- Southwest UXO 10

2007 Aerial Imagery



N
W E
S

0 425 850

Feet

Figure 38
UXO 10 SIA Interior Decision Units and Sampling Units
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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VE-UXO10-1DU01

VE-UXO10-1DU02

VE-UXO10-1DU03

PAOC Y

Range 11

SWMU 11

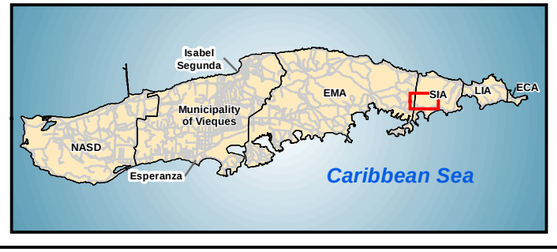
Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Transect - 3 Foot Width was Investigated
- Decision Unit
- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Sample Unit
- Topographic Contours (10 Meter)
- Stream
- Range
- Preliminary Area of Concern
- Solid Waste Management Unit
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

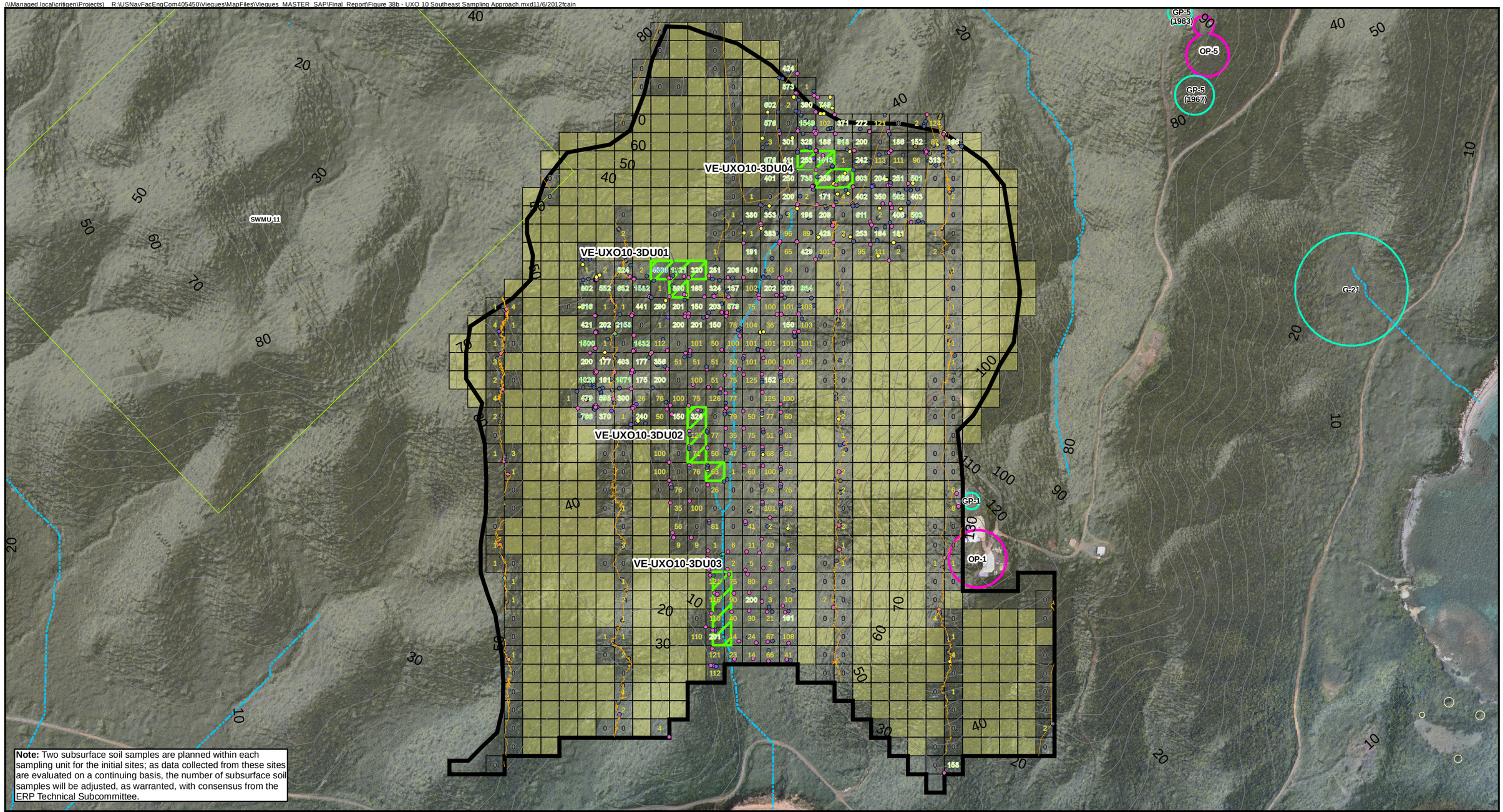


N
W E
S

0 200 400
Feet

Figure 38a
UXO 10 Southwest Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL



Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

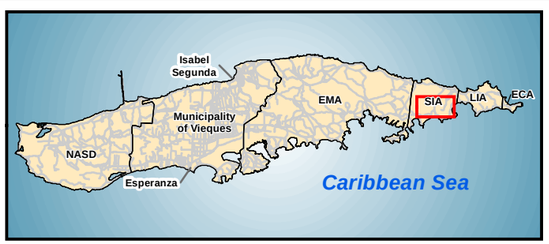
- Sample Unit
- Decision Unit
- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)

- Transect - 3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Crater
- Gun Positions
- Target Area
- Observation Point
- Solid Waste Management Unit
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

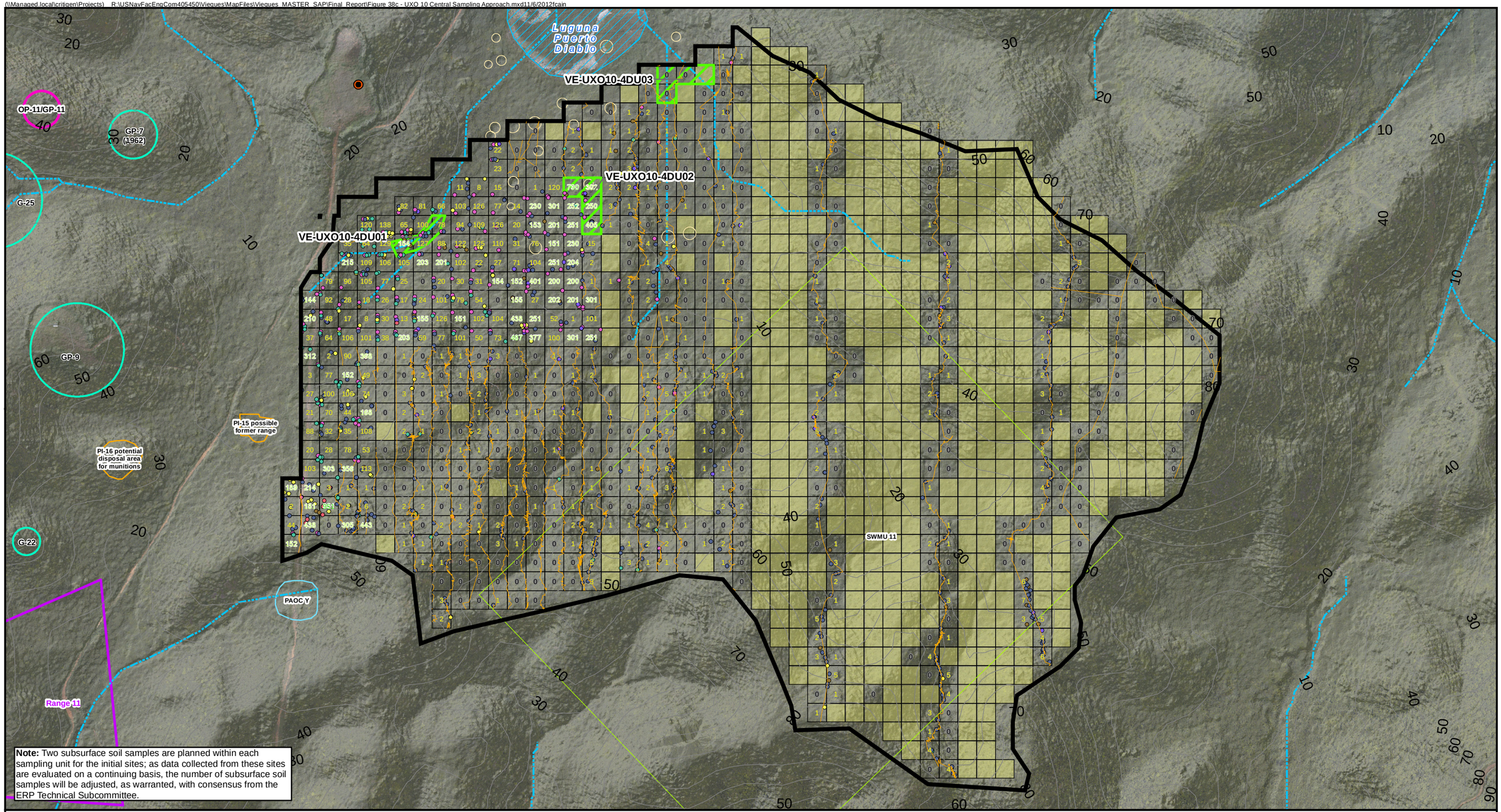


N W E S

0 250 500 Feet

Figure 38b
UXO 10 Southeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL



Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

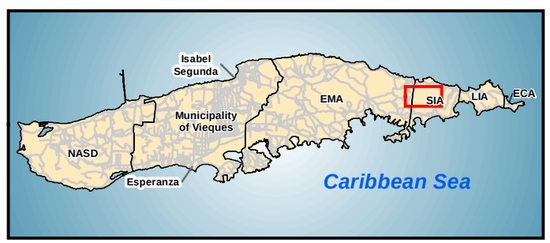
Transect - 3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Crater
Bulls Eye Target
Gun Positions
Observation Point
Range

Photo Identified Area
Preliminary Area of Concern
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



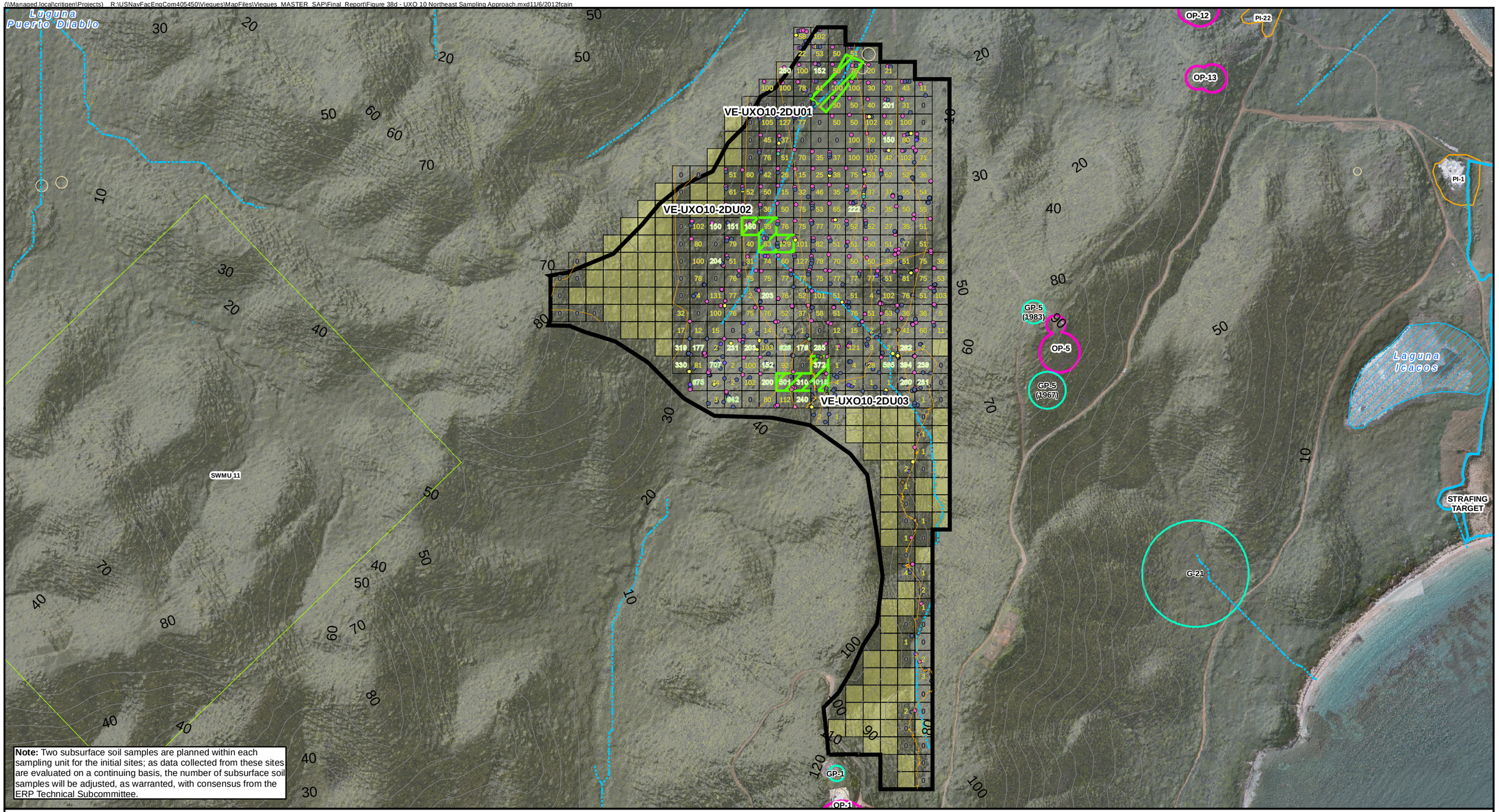
N
W E
S

0 250 500
Feet

Figure 38c
UXO 10 Central Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 38d - UXO 10 Northeast Sampling Approach.mxd 11/6/2012 fcain



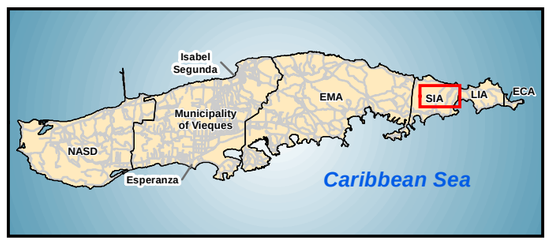
Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Transect - 3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Crater
- Gun Positions
- Target Area
- Observation Point
- Photo Identified Area
- Solid Waste Management Unit
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918



N W E S

0 500 1,000 Feet

Figure 38d
UXO 10 Northeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 38e - UXO 10 North Sampling Approach.mxd11/6/2012fcain

VE-UXO10-5DU01

VE-UXO10-5DU02

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

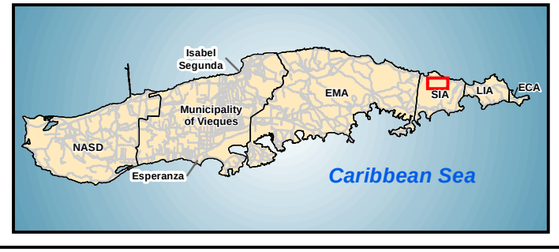
- Sample Unit
- Decision Unit
- Transect - 3 Foot Width was Investigated
- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)

- Topographic Contours (10 Meter)
- Stream
- Solid Waste Management Unit
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



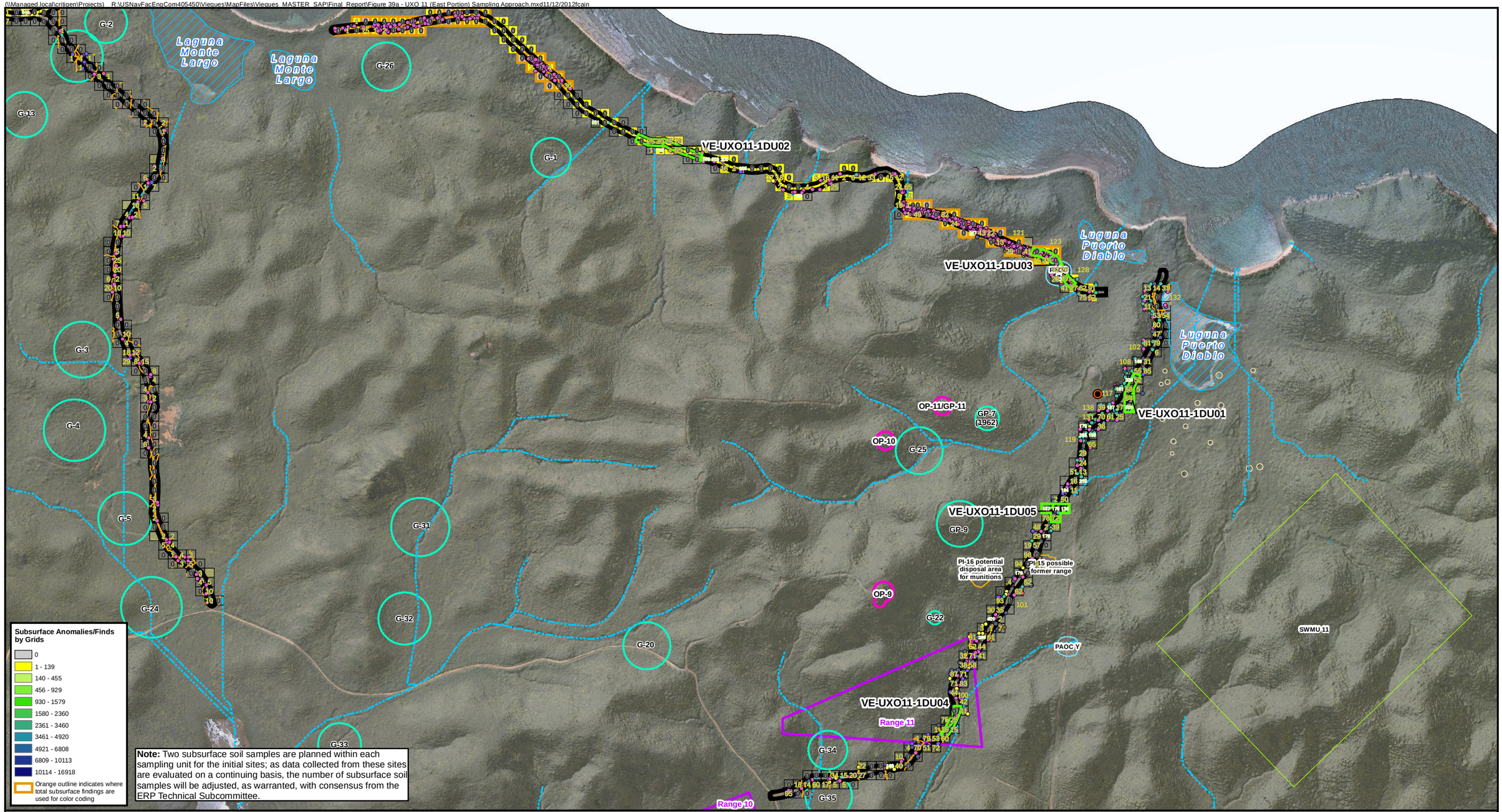
N
W E
S

0 150 300
Feet

Figure 38e
UXO 10 North Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 39a - UXO 11 (East Portion) Sampling Approach.mxd11/12/2012fcain



Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

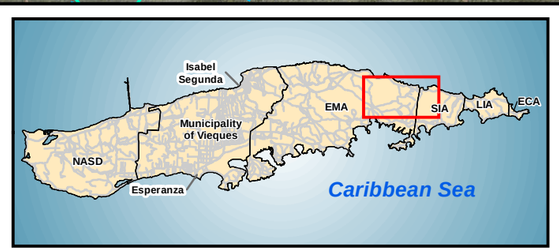
Transect -3 Foot Width was Investigated
Stream
Crater
Bulls Eye Target
Gun Positions
Observation Point
Range
Photo Identified Area
Preliminary Area of Concern
Solidl Waste Management Unit

Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



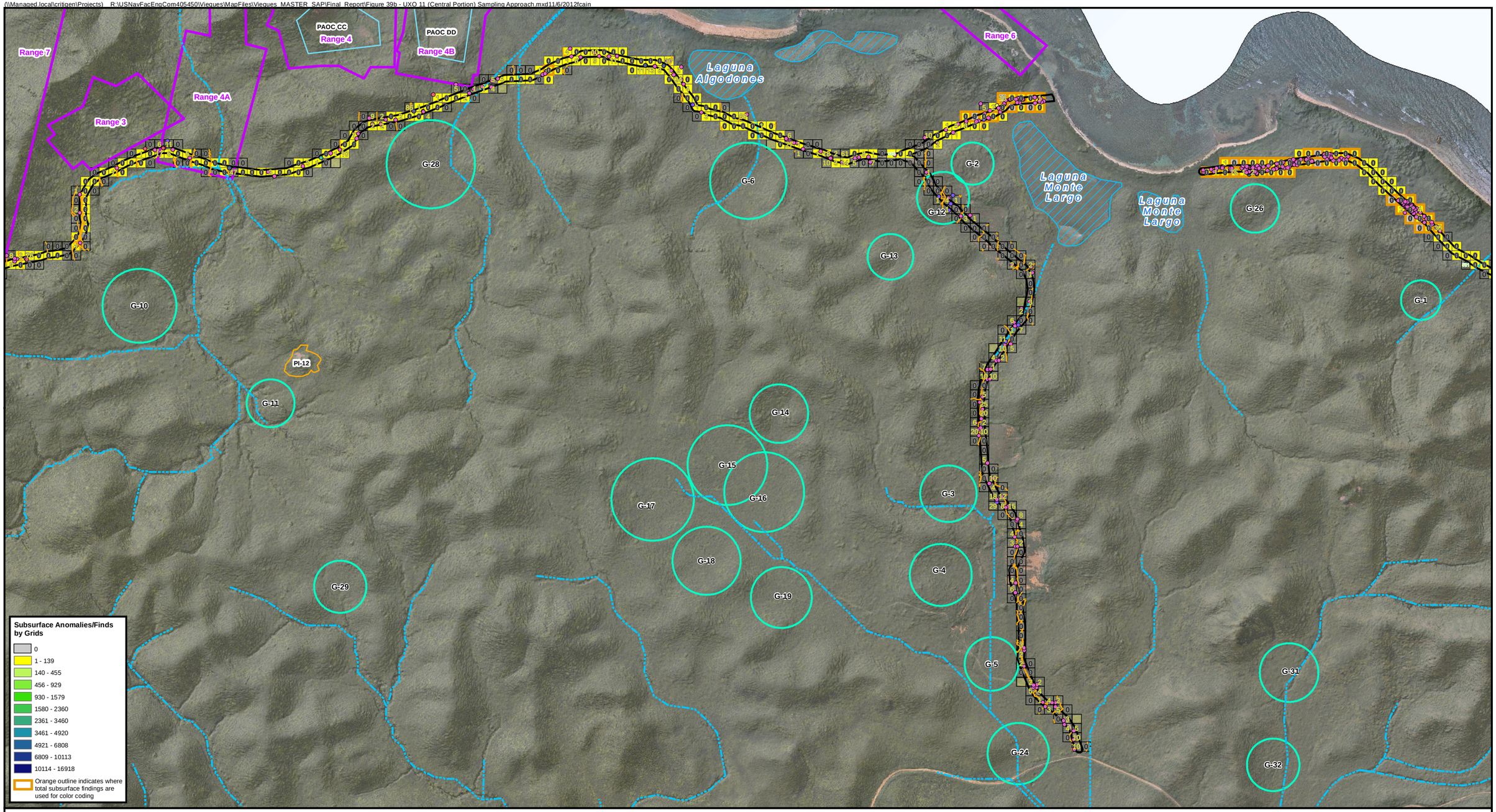
N
W E
S

0 500 1,000
Feet

Figure 39a
UXO 11 (East Portion) Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 39b - UXO 11 (Central Portion) Sampling Approach.mxd 11/6/2012 fcain



Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Transect -3 Foot Width was Investigated
Stream

2005 Aerial Imagery
2005 Hillshade

Gun Positions
Range
Photo Identified Area
Preliminary Area of Concern
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

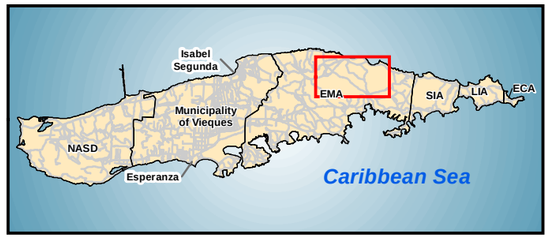


Figure 39b
UXO 11 (Central Portion) Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 500 1,000
Feet

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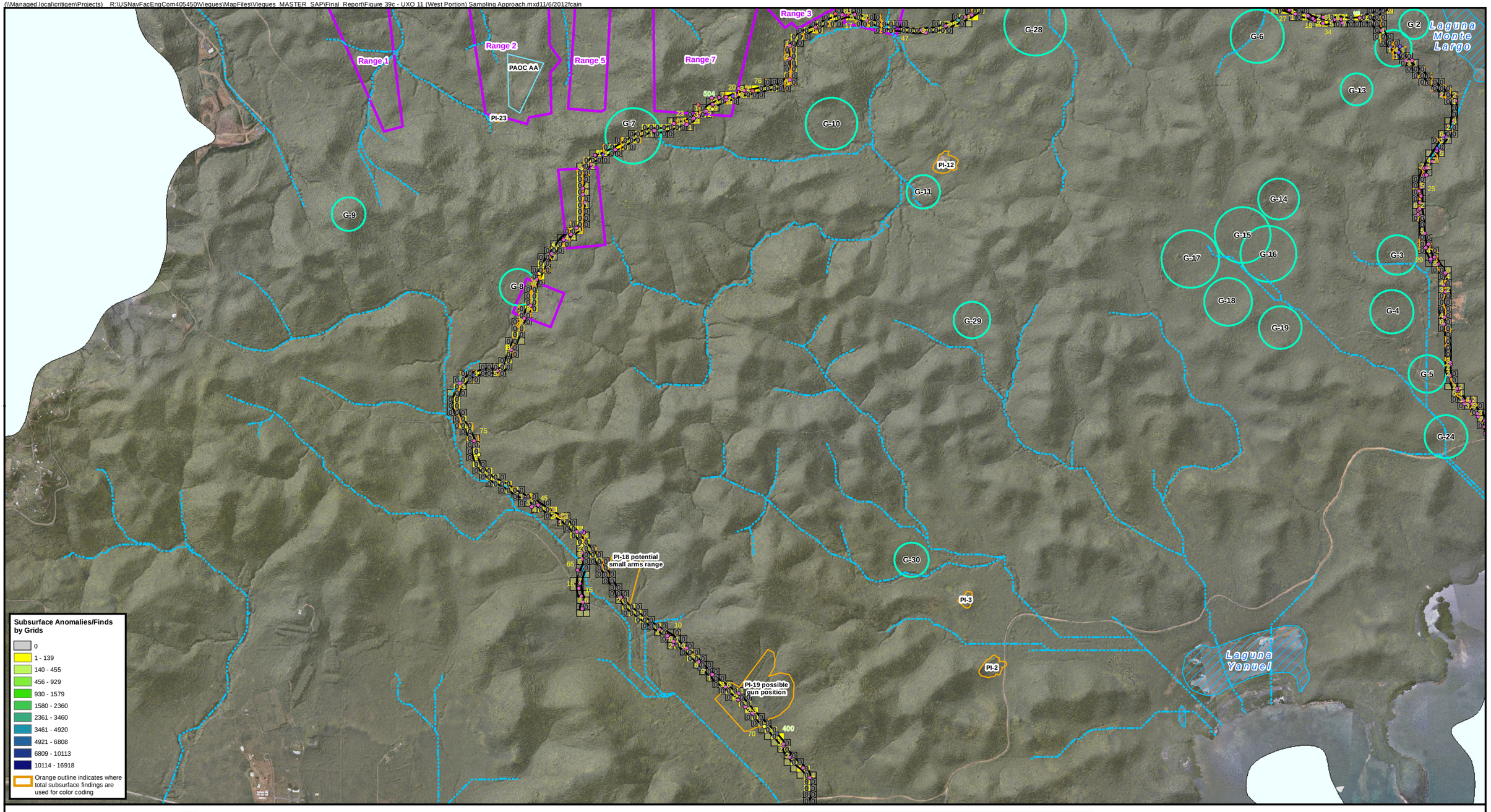

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

- Bombs
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Transect -3 Foot Width was Investigated
- Stream

- Decision Unit
- Gun Positions
- Range
- Photo Identified Area
- Preliminary Area of Concern
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

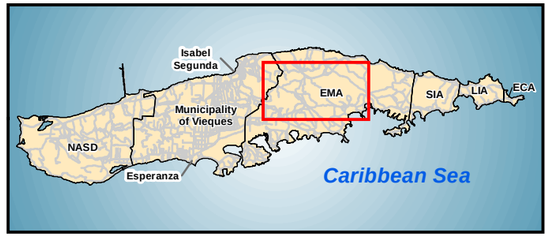

Figure 39c
UXO 11 (West Portion) Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 700 1,400
Feet

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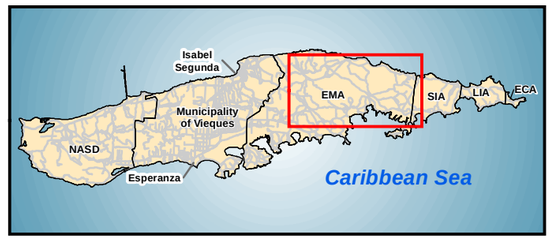
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 40 - UXO 12 EMA Interior Decision Unit and Sampling Units.mxd1/18/2013fcain

MW-21
VE-UXO12-7DU01
MW-22
MW-23
North-Central UXO 12
VE-UXO12-3DU01
South-Central UXO 12
VE-UXO12-2DU01
Southwest UXO 12
VE-UXO12-2DU02
VE-UXO12-3DU05
VE-UXO12-3DU03
MW-20
VE-UXO12-3DU04
VE-UXO12-3DU02
MW-19
VE-UXO12-9SO02
VE-UOX12-9DU02
VE-UOX12-9DU03
MW-16
Laguna Monte Largo
VE-UXO12-8SDSW03
VE-UOX12-9SO03
VE-UXO12-8SDSW02
VE-UOX12-9SO04
VE-UXO12-8SDSW01
VE-UOX12-9DU04
VE-UOX12-9SO01
VE-UOX12-9DU01
VE-UXO12-4DU01
MW-15
North UXO 12
MW-12
VE-UXO12-1DU01
Northeast UXO 12
VE-UXO12-1DU06
VE-UXO12-1DU02
VE-UXO12-1DU05
South UXO 12
VE-UXO12-1DU04
VE-UXO12-1DU03
MW-17
VE-UXO12-5DU02
VE-UXO12-5DU01
VE-UXO12-6DU01
Southeast UXO 12
MW-18
VE-UXO12-6DU02

Deep Surface Soil Sample
Proposed Surface Water Samples
Proposed Sediment Samples
Proposed Monitoring Well
Sample Unit (Lagoon Fringe)
Sample Unit (Interior)

Decision Unit
- North UXO 12
- North-Central UXO 12
- Northeast UXO 12
- South UXO 12
- South-Central UXO 12
- Southeast UXO 12
- Southwest UXO 12
- Laguna Monte Largo

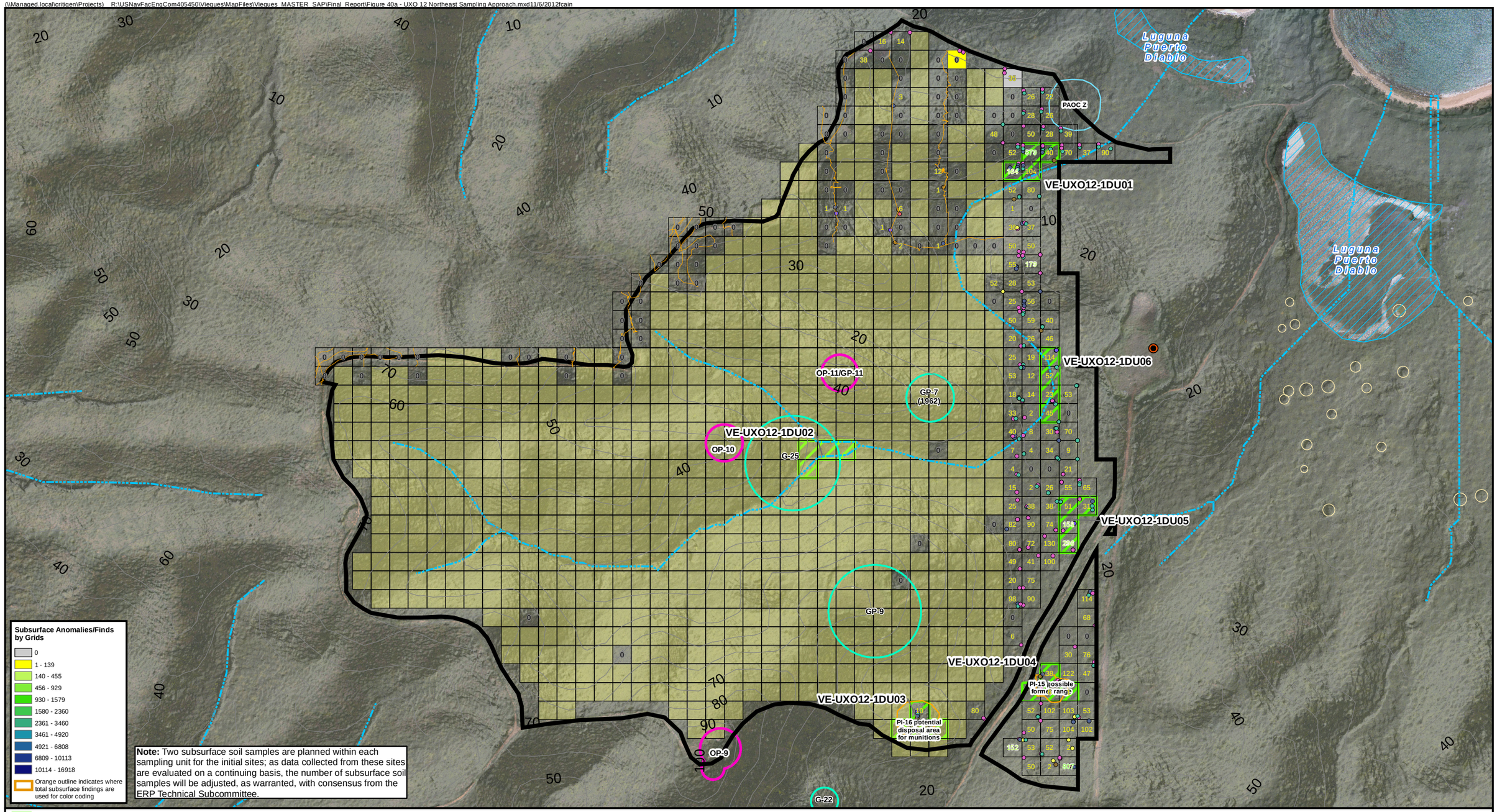


N
W E
S
0 900 1,800
Feet

2007 Aerial Imagery

Figure 40
UXO 12 EMA Interior Decision Unit and Sampling Units
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL



Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

2005 Aerial Imagery
2005 Hillshade

Transect - 3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Crater
Bulls Eye Target
Gun Positions
Observation Point
Photo Identified Area
Preliminary Area of Concern
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

Lagoon

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

Figure 40a
UXO 12 Northeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 250 500
Feet

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Range 2
Range 9
Range 8
G-7
G-10
G-11
PI-12
G-8
G-9
G-14
G-15
G-16
G-17
G-18
G-13
G-3
G-4
G-5
G-31
G-32
G-33
G-24
VE-UXO12-3DU01
VE-UXO12-3DU02
VE-UXO12-3DU05
VE-UXO12-3DU03
VE-UXO12-3DU04
PI-3 (fromer small arms range)
PI-2 (fromer small arms range)
PI-18
PI-19
G-6
Laguna Yanuel
Lagoon 16
Lagoon 15

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

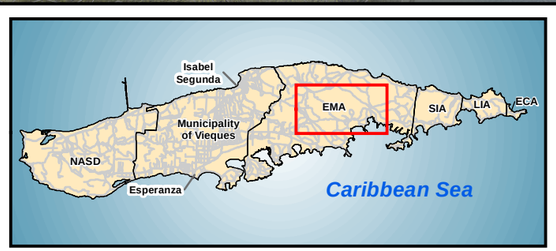
- Sample Unit
- Transect - 3 Foot Width was Investigated
- Decision Unit
- Flares-Pyrotechnics
- Projectiles / Mortars
- Scrap (Munitions Debris)
- Topographic Contours (10 Meter)
- Stream

- Gun Positions
- Range
- Photo Identified Area
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



N
W E
S

0 600 1,200
Feet

Figure 40b
UXO 12 South Central Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

G-3
G-4
G-5
G-24
G-31
G-32
G-20
VE-UXO12-5DU01
VE-UXO12-5DU02
OP-10
OP-9
Range 11

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

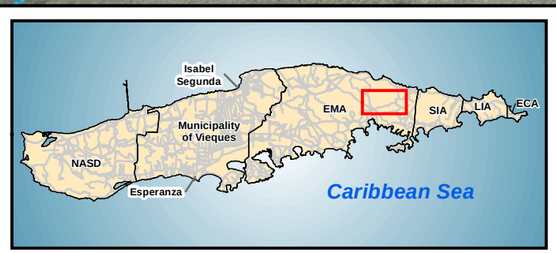
- Transect - 3 Foot Width was Investigated
- Decision Unit
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Sample Unit
- Topographic Contours (10 Meter)
- Stream

2005 Aerial Imagery
2005 Hillshade

- Gun Positions
- Observation Point
- Range
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918



N
W E
S

0 500 1,000
Feet

Figure 40c
UXO 12 South Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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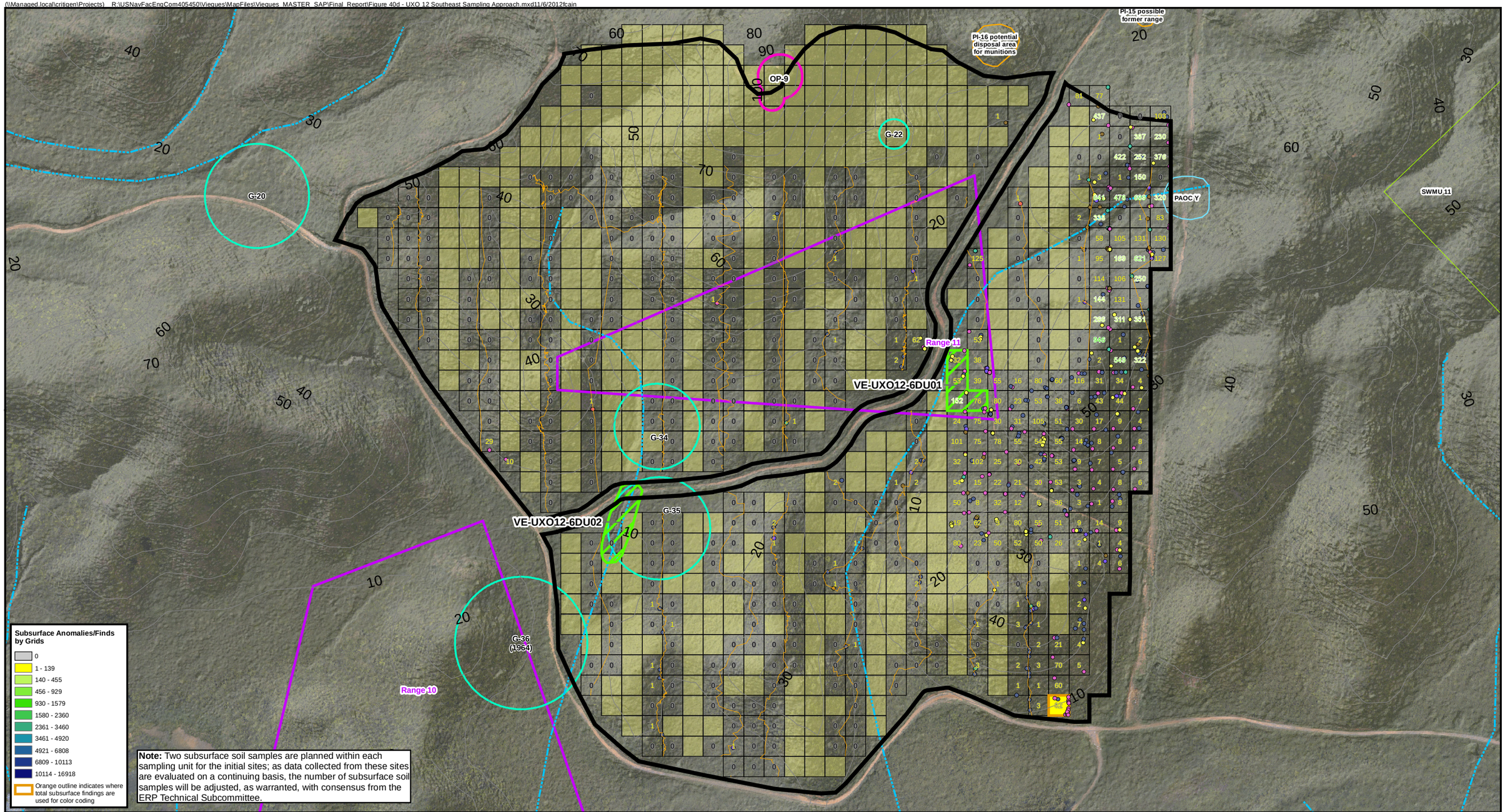
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 40d - UXO 12 Southeast Sampling Approach.mxd11/6/2012fcain



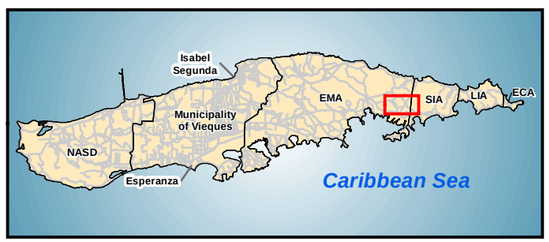
Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

Transect - 3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Gun Positions
Observation Point
Range
Photo Identified Area
Preliminary Area of Concern
Solid Waste Management Unit
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



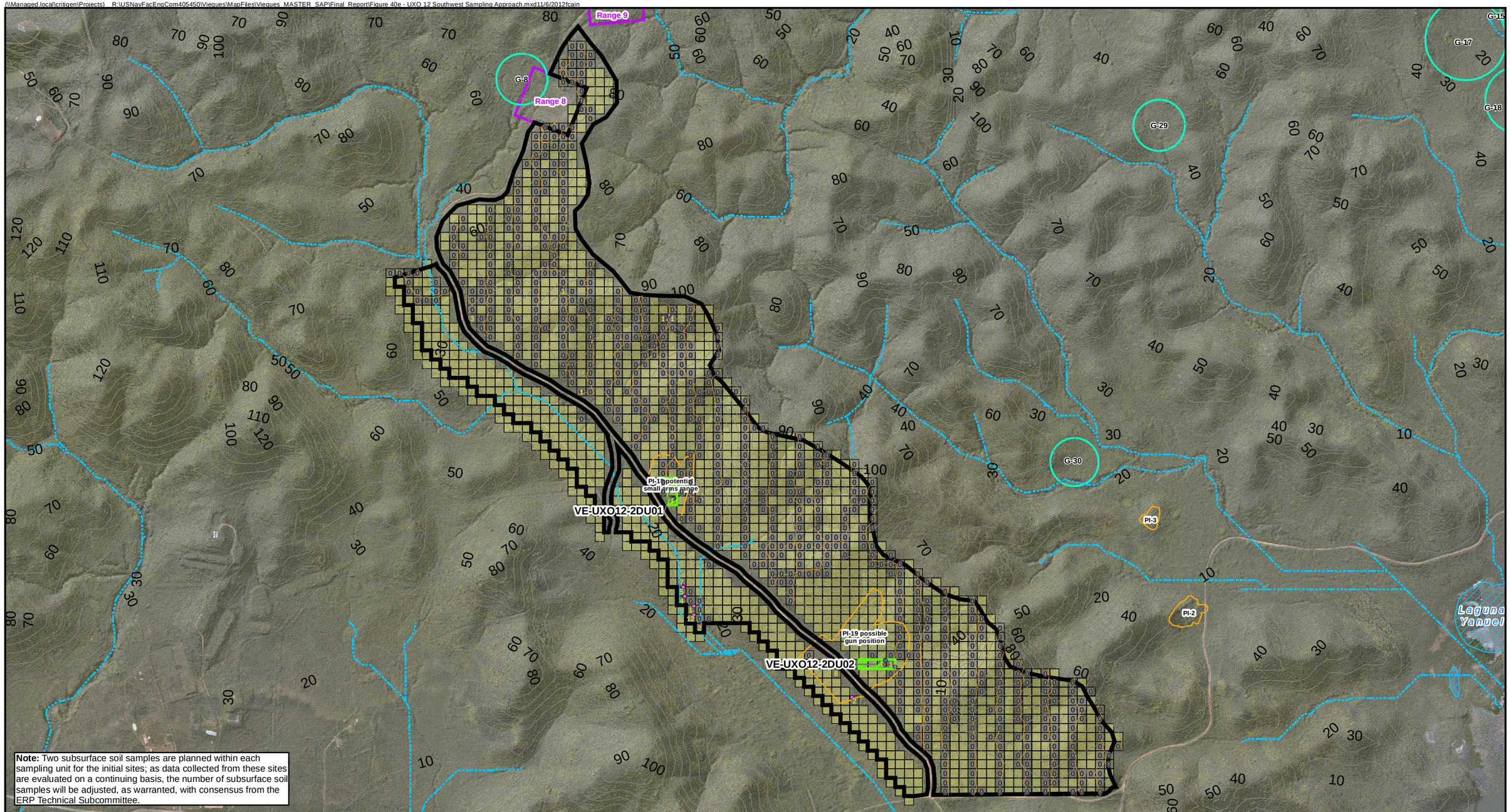
N
W E
S

0 250 500
Feet

Figure 40d
UXO 12 Southeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 40e - UXO 12 Southwest Sampling Approach.mxd11/6/2012fcain



Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Flares-Pyrotechnics
- Grenades
- Projectiles / Mortars
- Scrap (Munitions Debris)
- Transect - 3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream

- Gun Positions
- Range
- Photo Identified Area
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139	
140 - 455	
456 - 929	
930 - 1579	
1580 - 2360	
2361 - 3463	
3464 - 4920	
4921 - 6808	
6809 - 10113	
10114 - 16918	

N
W E
S

0 500 1,000
Feet

Figure 40e
UXO 12 Southwest Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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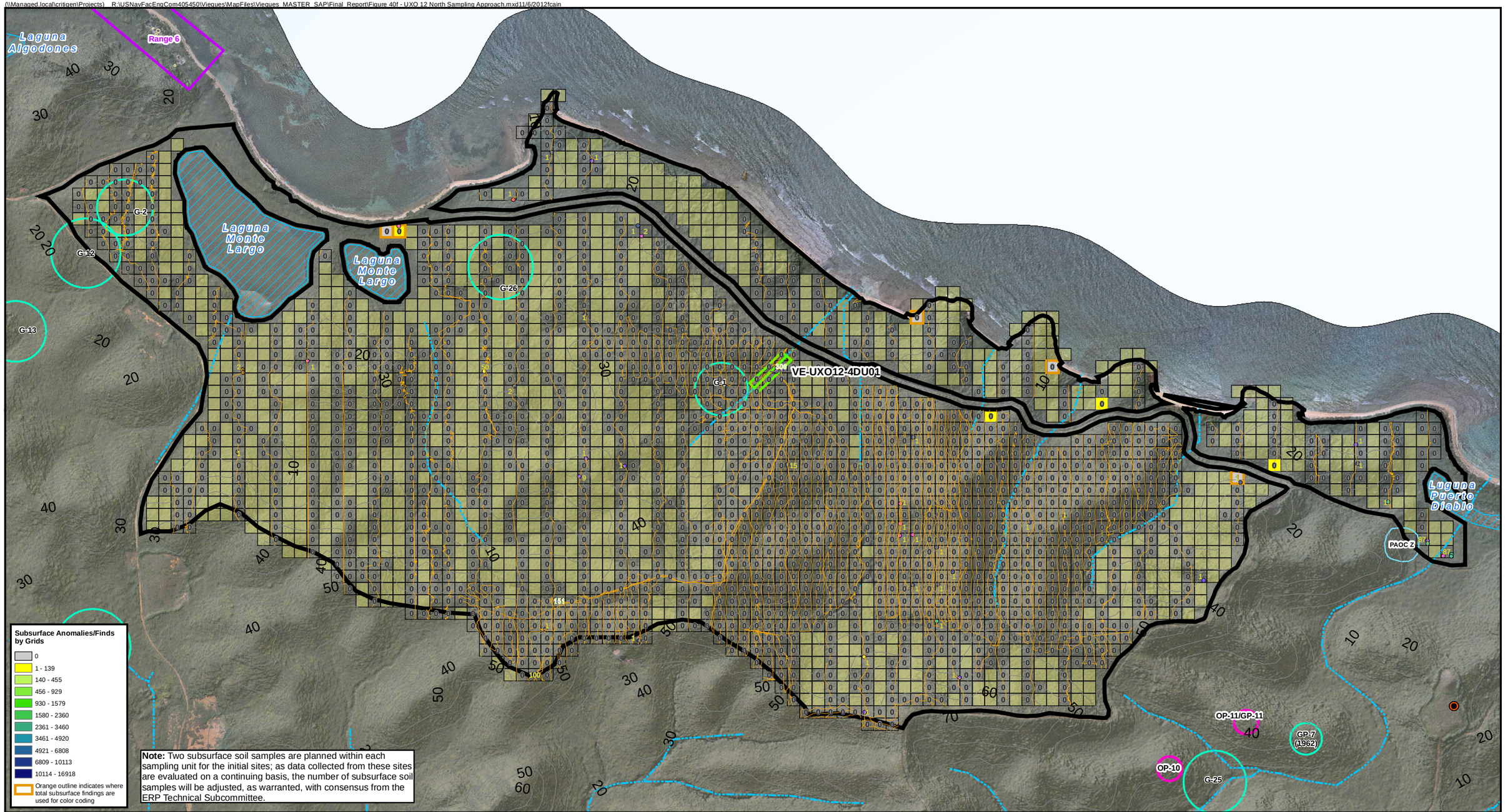
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 40f - UXO 12 North Sampling Approach.mxd 11/6/2012 fcain



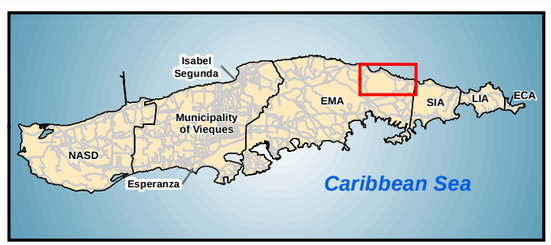
Sample Unit
Decision Unit
Bombs
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Lagoon

Transect - 3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Crater
Bulls Eye Target
Gun Positions
Observation Point
Range
Preliminary Area of Concern
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



N
W E
S

0 500 1,000
Feet

Figure 40f
UXO 12 North Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

Subsurface Anomalies/Finds by Grids

- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

VE-UXO12-7DU01

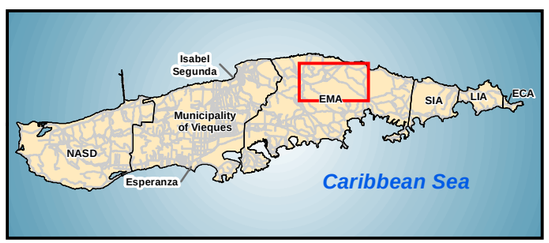
PAOC AA
PAOC CC
PAOC DD
Range 3
Range 4
Range 4A
Range 4B
Range 6
Range 7
Range 8
Range 9
Laguna Algodones
Laguna Monte Largo
G-2
G-3
G-4
G-5
G-6
G-7
G-8
G-10
G-11
G-12
G-13
G-14
G-15
G-16
G-17
G-18
G-19
G-24
G-28
G-29
PI-12

- Sample Unit
- Transect - 3 Foot Width was Investigated
- Decision Unit
- Flares-Pyrotechnics
- Grenades
- MEC Component
- Projectiles / Mortars
- Topographic Contours (10 Meter)
- Stream
- Crater
- Gun Positions
- Range
- Photo Identified Area
- Preliminary Area of Concern
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918



N W E S

0 500 1,000 Feet

Figure 40g
UXO 12 North Central Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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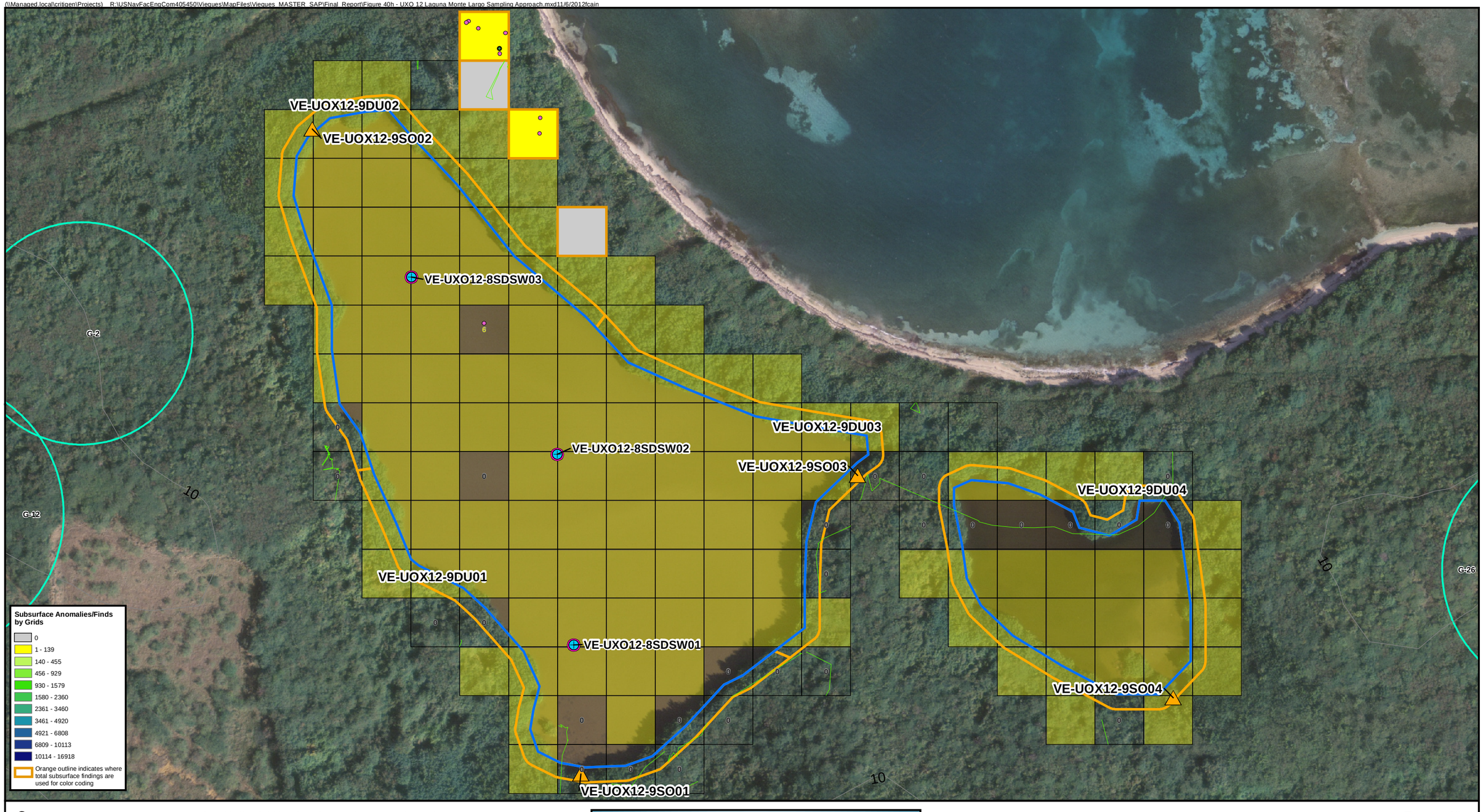
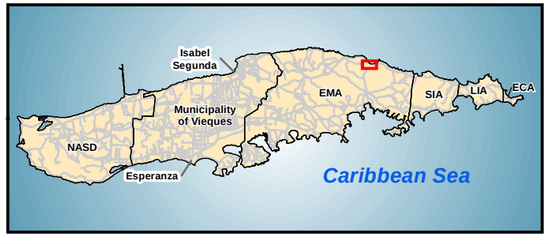
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 40h - UXO 12 Laguna Monte Largo Sampling Approach.mxd11/6/2012fcain



Proposed Surface Water Samples
Proposed Sediment Samples
Deep Surface Soil Sample
Lagoon
Lagoon Fringe
Transect - 3 Foot Width was Investigated
Topographic Contours (10 Meter)
Gun Positions
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
2007 Aerial Imagery

Scrap (Munitions Debris)
Projectiles / Mortars

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



N
W E
S

0 100 200
Feet

Figure 40h
UXO 12 Laguna Monte Largo Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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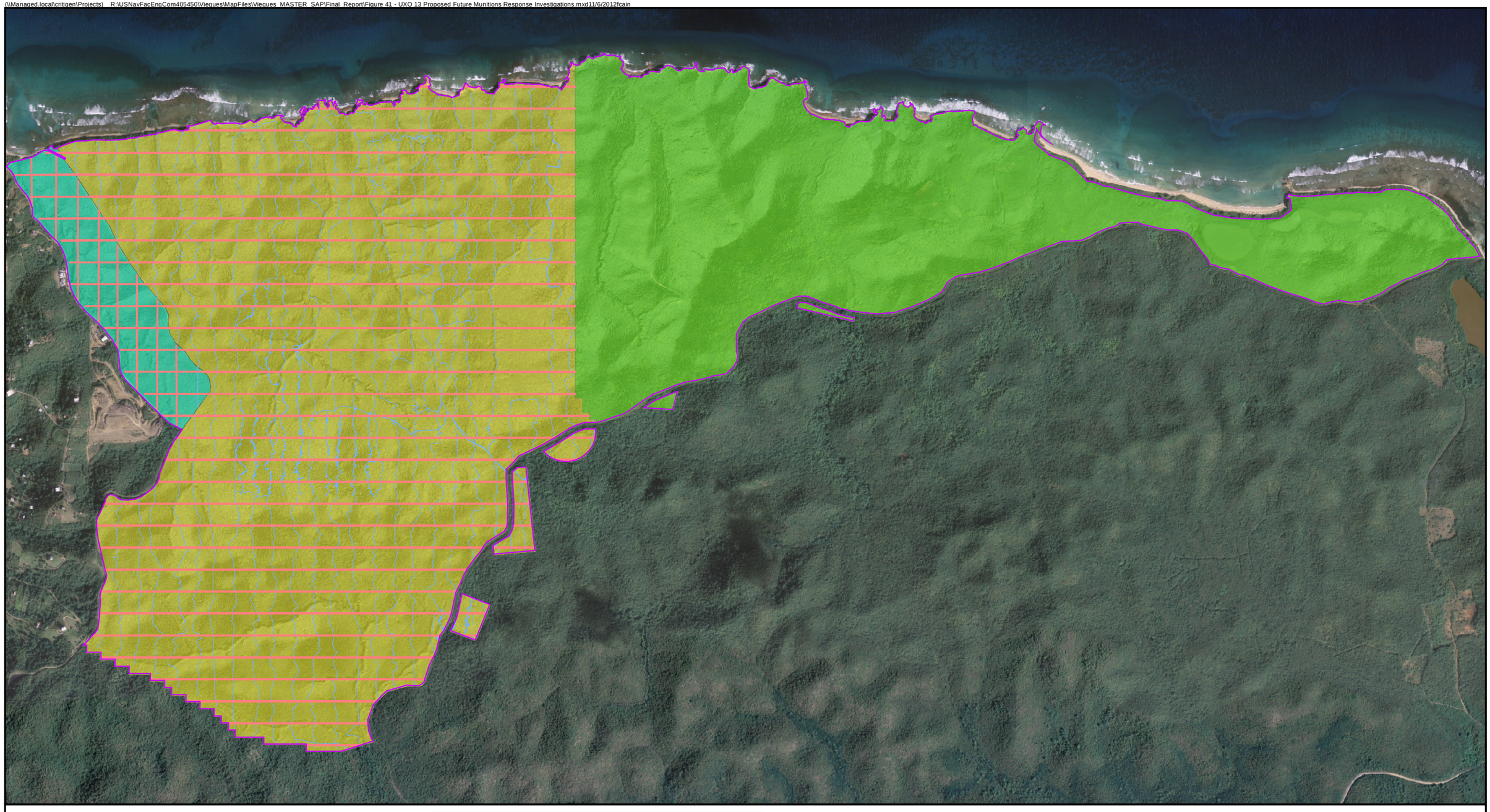
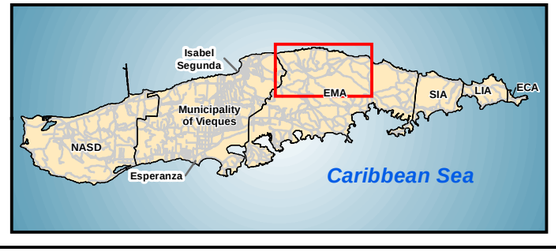
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 41 - UXO 13 Proposed Future Munitions Response Investigations.mxd11/6/2012fcain



Transect Walked During Site Insecption
Proposed Transects
Area Proposed for Transect Investigation
Area proposed for NTCRA
Parcel C - Proposed Transect Investiation Using VSP
UXO 13 Boundary

2007 Aerial Imagery



N
W E
S

0 700 1,400
Feet

Figure 41
Proposed Future Munitions Response Investigations, UXO 13
Master Sampling Analysis Plan
Former VNTR
Vieques, Puerto Rico

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(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 42 - UXO 13 EMA West Decision Units and Sampling Units.mxd1/18/2013fcain

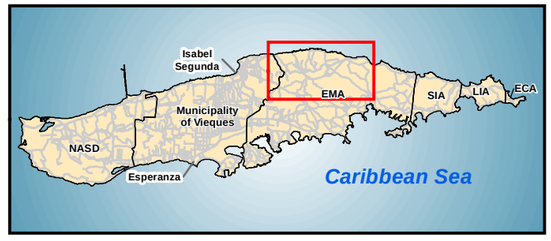
VE-UXO13-2DU01
VE-UXO13-1DU01
VE-UXO13-1DU04
MW-21
VE-UXO13-4SO01
VE-UXO13-2DU03
VE-UXO13-2DU04
VE-UXO13-1DU02
VE-UXO13-1DU03
VE-UXO13-2DU05
VE-UXO13-1DU05
VE-UXO13-3DU02
VE-UXO13-7SO01
VE-UXO13-6SDSW03
VE-UXO13-4SO02
VE-UXO13-1DU07
VE-UXO13-7DU01
VE-UXO13-6SDSW02
VE-UXO13-7DU03
VE-UXO13-2DU02
VE-UXO13-1DU06
VE-UXO13-6SDSW04
VE-UXO13-6SDSW01
VE-UXO13-3DU01
VE-UXO13-4SO03
VE-UXO13-1DU10
VE-UXO13-1DU08
VE-UXO13-7SO03
VE-UXO13-6SDSW06
Parcel C
UXO 13
Northeast
UXO 13
Laguna
Algodones
East
Northeast
UXO 13
VE-UXO13-4SO05
VE-UXO13-1DU09
VE-UXO13-7SO02
VE-UXO13-4SO04
VE-UXO13-2DU06
Central
UXO 13
VE-UXO13-7DU02
MW-16
VE-UXO13-6SDSW05
VE-UXO13-2DU08
MW-22
VE-UXO13-4SO06
VE-UXO13-2DU07
VE-UXO13-4SO07
VE-UXO13-2DU10
VE-UXO13-2DU11
VE-UXO13-1DU11
VE-UXO13-4SO08
VE-UXO13-2DU09
MW-23
VE-UXO13-1DU12
VE-UXO13-5DU01
South
UXO 13
MW-19

- Surface and Subsurface Soil Sample
- Deep Surface Soil Sample
- Proposed Surface Water Samples
- Proposed Sediment Samples
- Proposed Monitoring Well
- Sample Unit (Interior)

Decision Unit

- Central UXO 13
- East Northeast UXO 13
- Laguna Algodones
- Northeast UXO 13
- Parcel C UXO 13
- South UXO 13
- Laguna Algodones Fringe

2007 Aerial Imagery



N
W E
S

0 700 1,400
Feet

Figure 42
UXO 13 EMA West Decision Units and Sampling Units
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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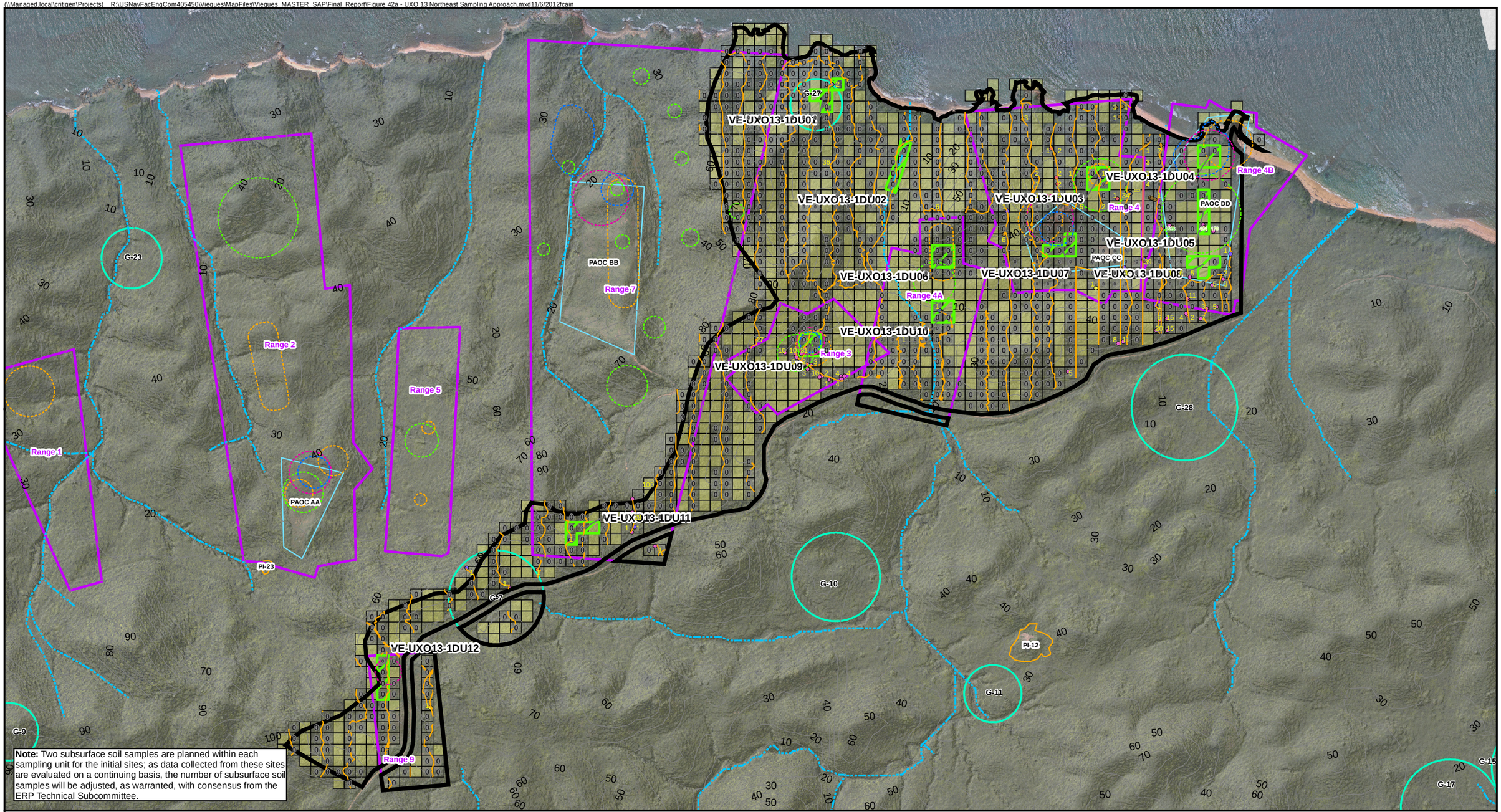


Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

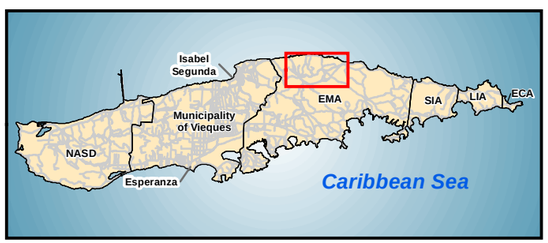
Sample Unit
Decision Unit
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)

Transect -3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Gun Positions
Range
Photo Identified Area
Preliminary Area of Concern
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

Range Impact Areas
1962
1967
1983
1994

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

2005 Aerial Imagery
2005 Hillshade



N
W E
S

0 500 1,000
Feet

Figure 42a
UXO 13 Northeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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VE-UXO13-2DU01
VE-UXO13-2DU02
VE-UXO13-2DU03
VE-UXO13-2DU04
VE-UXO13-2DU05
VE-UXO13-2DU06
VE-UXO13-2DU07
VE-UXO13-2DU08
VE-UXO13-2DU09
VE-UXO13-2DU10
VE-UXO13-2DU11
Range 1
Range 2
Range 3
Range 4
Range 4A
Range 5
Range 7
Range 8
Range 9
G-23
G-27
G-10
G-7
G-9
G-8
G-11
PI-12
PI-29
PAOC AA
PAOC BB
PAOC CC

Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

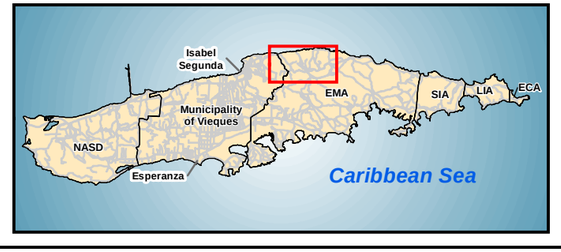
- Sample Unit
- Decision Unit
- Flares-Pyrotechnics
- Grenades
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)

- Transect -3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Gun Positions
- Range
- Photo Identified Area
- Preliminary Area of Concern
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

2005 Aerial Imagery
2005 Hillshade

Range Impact Areas
- 1962
- 1967
- 1983
- 1994

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918



N W E S

0 500 1,000 Feet

Figure 42b
UXO 13 Central Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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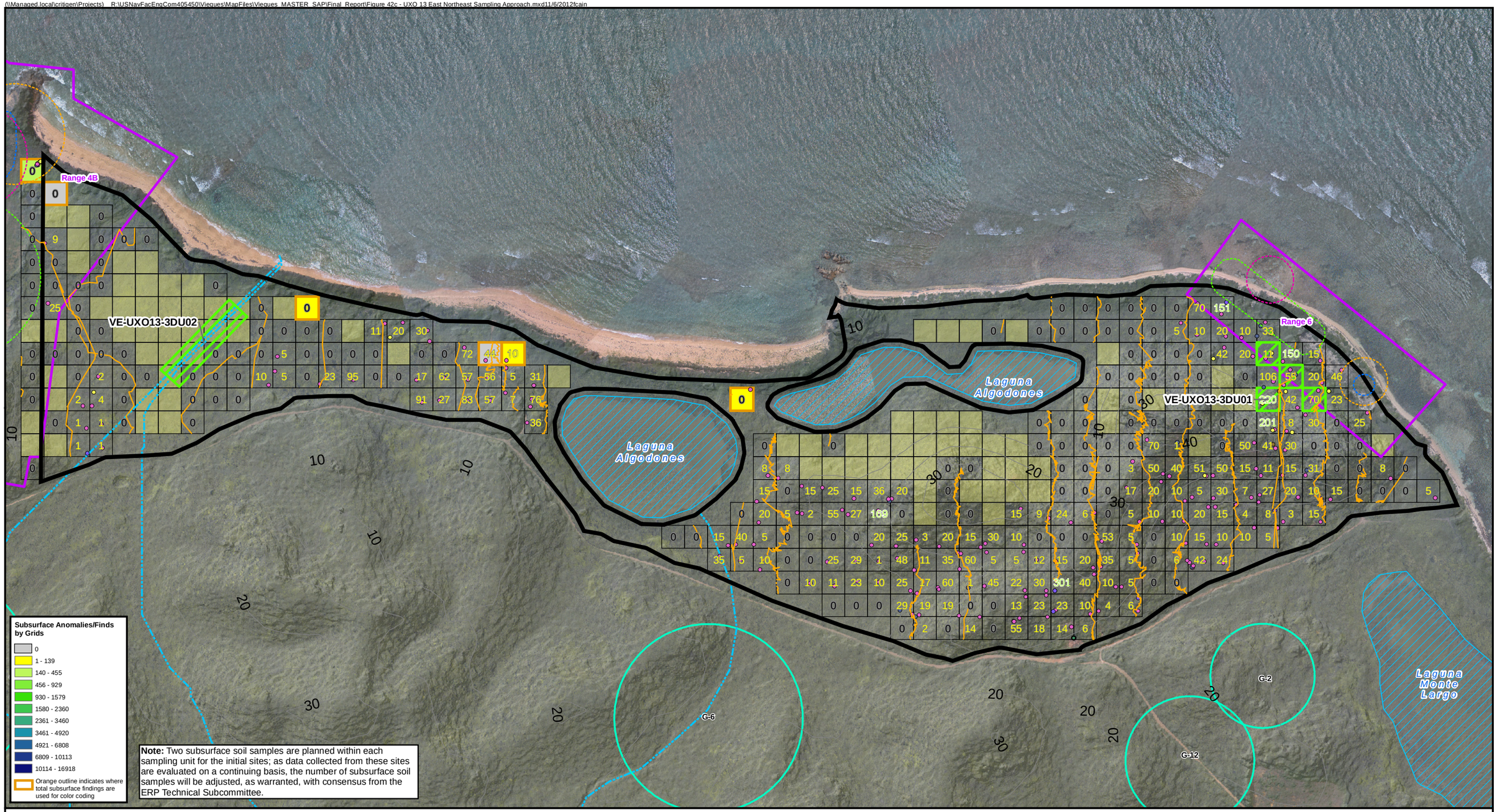


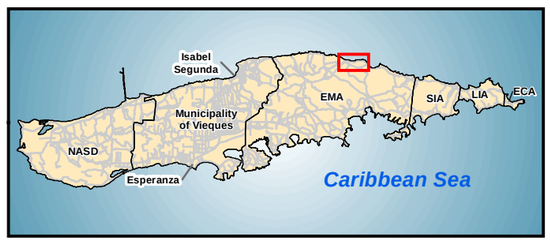
Sample Unit
Decision Unit
Flares-Pyrotechnics
Grenades
MEC Component
Projectiles / Mortars
Rockets / Guided Missiles
Scrap (Munitions Debris)
Transect -3 Foot Width was Investigated

Topographic Contours (10 Meter)
Stream
Gun Positions
Range
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation
Lagoon

Range Impact Areas
1962
1967
1983
1994

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

2005 Aerial Imagery
2005 Hillshade



N
W E
S
0 200 400
Feet

Figure 42c
UXO 13 East Northeast Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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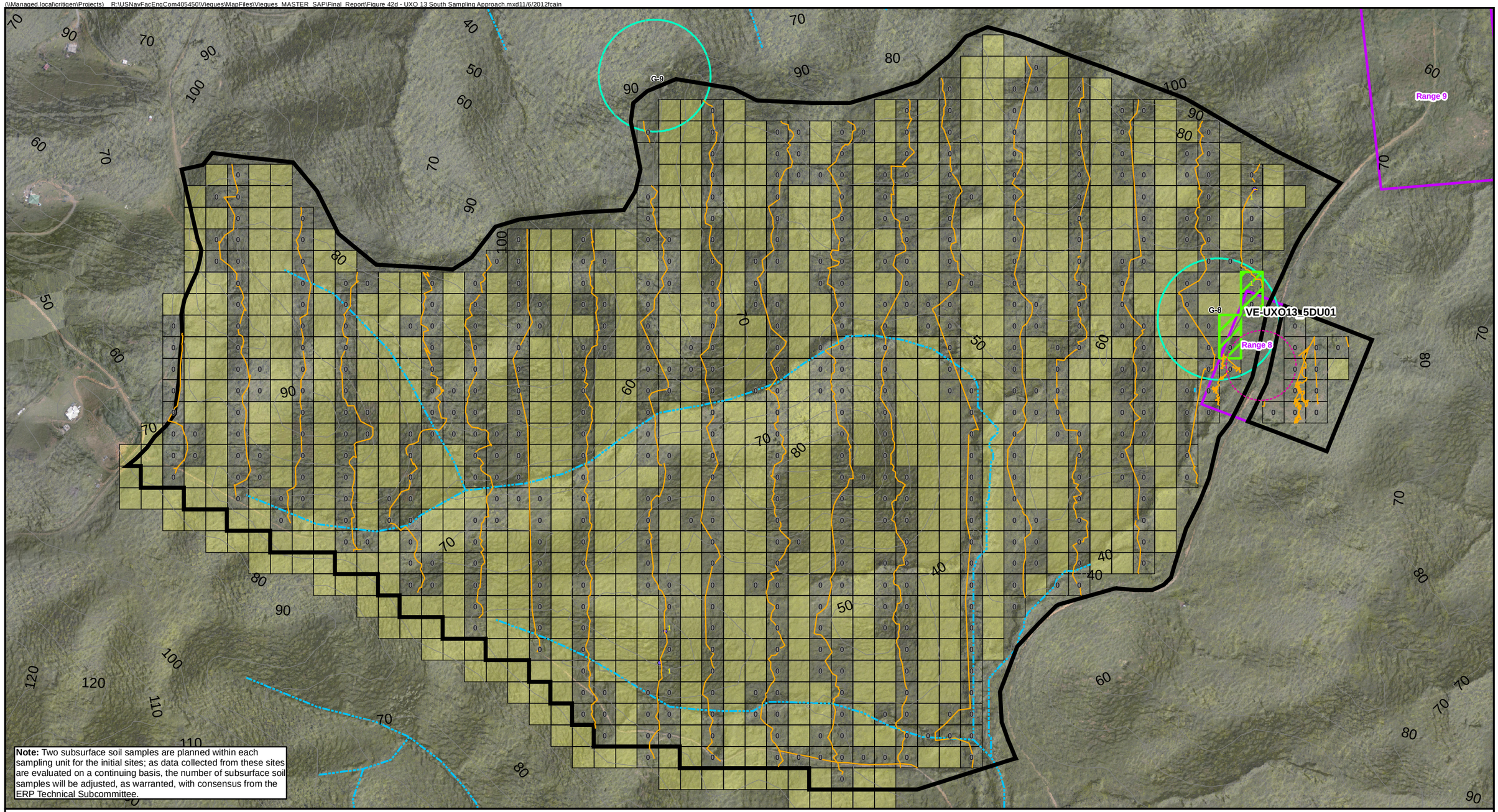
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 42d - UXO 13 South Sampling Approach.mxd11/6/2012fcain



Sample Unit
Decision Unit
Flares-Pyrotechnics
Transect -3 Foot Width was Investigated
Topographic Contours (10 Meter)
Stream
Gun Positions

Range
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

Range Impact Areas
1994

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

N
W E
S

0 250 500
Feet

Figure 42d
UXO 13 South Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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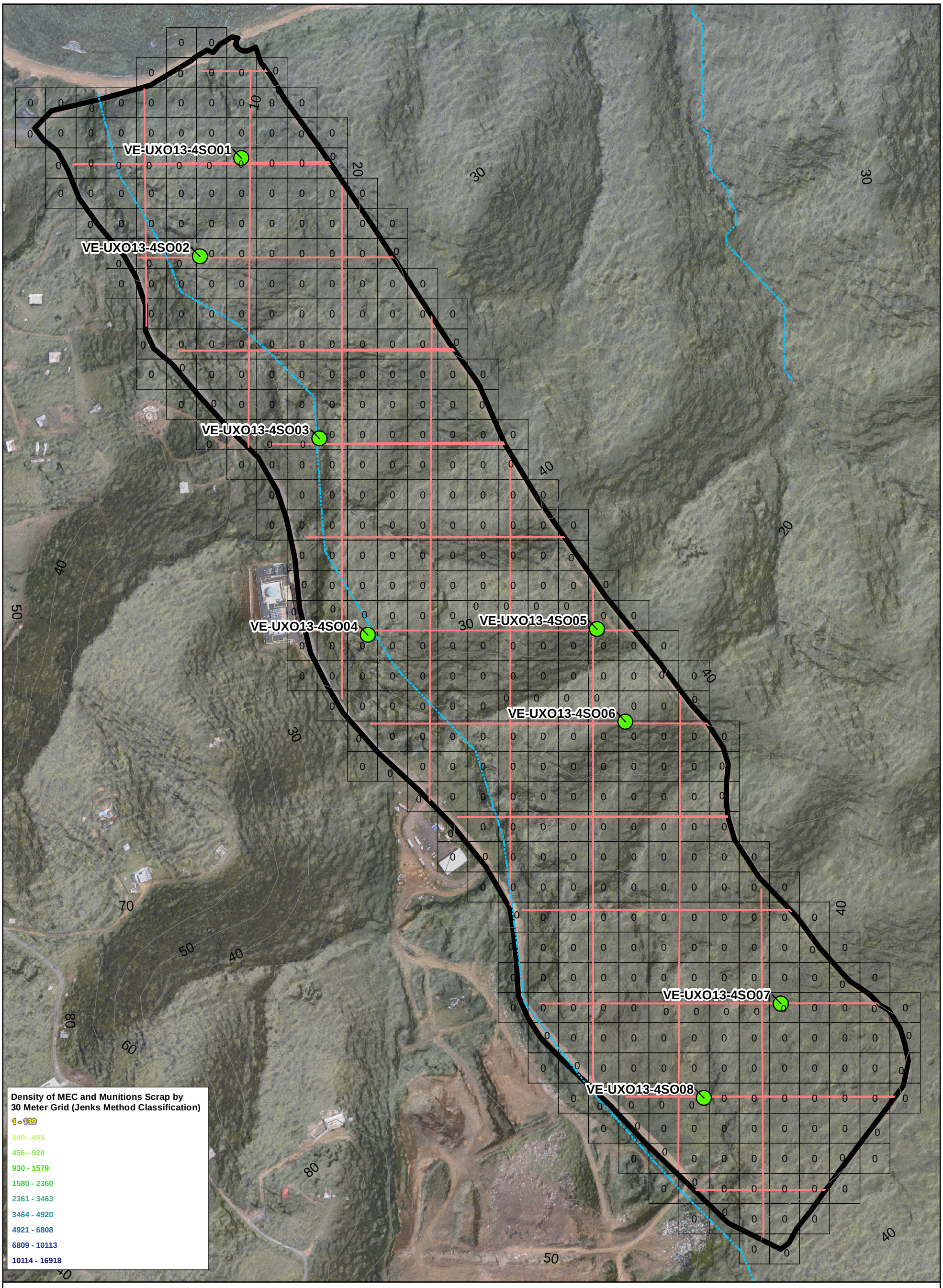
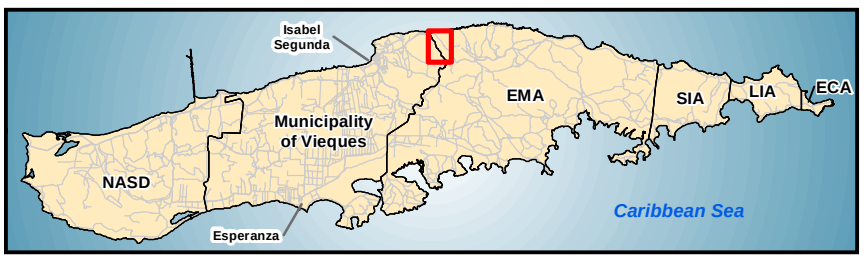
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 42e - UXO 13 Parcel C Sampling Approach.mxd11/6/2012fcain



Surface and Subsurface Soil Sample
Topographic Contours (10 Meter)
Stream
Proposed Transects
Grid (30 Meter)
Decision Unit - Parcel C (No MEC Investigation)



2005 Aerial Imagery

Figure 42e
UXO 13 Parcel C Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 150 300
Feet

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VE-UXO13-7SO01
VE-UXO13-6SDSW02
VE-UXO13-6SDSW01
VE-UXO13-7SO03
VE-UXO13-7DU01
VE-UXO13-7DU02
VE-UXO13-6SDSW03
VE-UXO13-7DU03
VE-UXO13-6SDSW04
VE-UXO13-6SDSW06
VE-UXO13-7SO02
VE-UXO13-6SDSW05

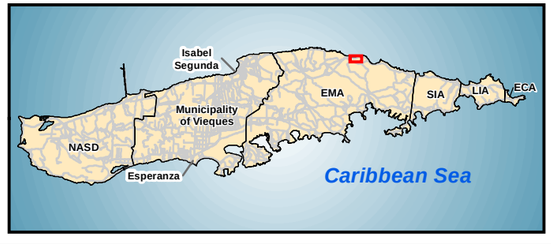
Subsurface Anomalies/Finds by Grids
- 0
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3460
- 3461 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918
- Orange outline indicates where total subsurface findings are used for color coding

- Proposed Surface Water Samples
- Proposed Sediment Samples
- Deep Surface Soil Sample
- Lagoon
- Lagoon Fringe
- Scrap (Munitions Debris)
- Transect -3 Foot Width was Investigated
- Topographic Contours (10 Meter)

2007 Aerial Imagery

- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)
- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918



N W E S

0 75 150

Feet

Figure 42f
UXO 13 Laguna Algodones Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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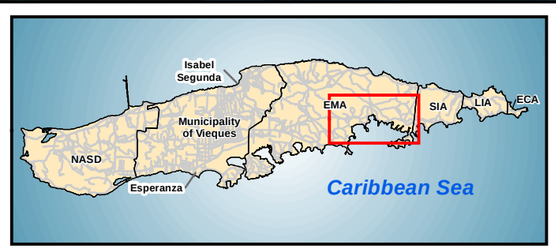
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 43 - UXO 14 EMA South Decision Units and Sampling Units.mxd1/18/2013fcain

Deep Surface Soil Sample
Proposed Surface Water Samples
Proposed Sediment Samples
Proposed Monitoring Well
Sample Unit (Interior)
Sample Unit (Lagoon Fringe)

Decision Unit

- East Central UXO 14
- East UXO 14
- Lagoon 11
- Lagoon 12
- Lagoon 13
- Lagoon 14
- Lagoon 15
- Lagoon 16
- Laguna Yanuel
- West UXO 14
- West-Central UXO 14

2007 Aerial Imagery



N
W E
S

0 600 1,200
Feet

Figure 43
UXO 14 EMA South Decision Units and Sampling Units
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 43a - UXO 14 West Central Sampling Approach.mxd 11/6/2012 fcain

G-24
G-32
G-20
G-33
VE-UXO14-3DU01
VE-UXO14-3DU02
Lagoon 16
Lagoon 15
Lagoon 15
Lagoon 14
Range 10

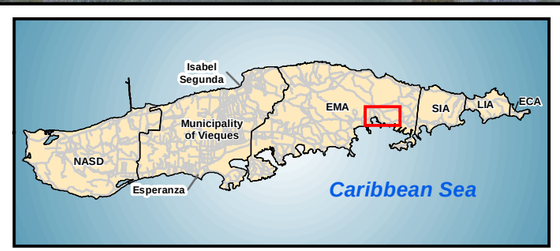
Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Projectiles / Mortars
- Scrap (Munitions Debris)
- Transect -3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Gun Positions
- Range
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918



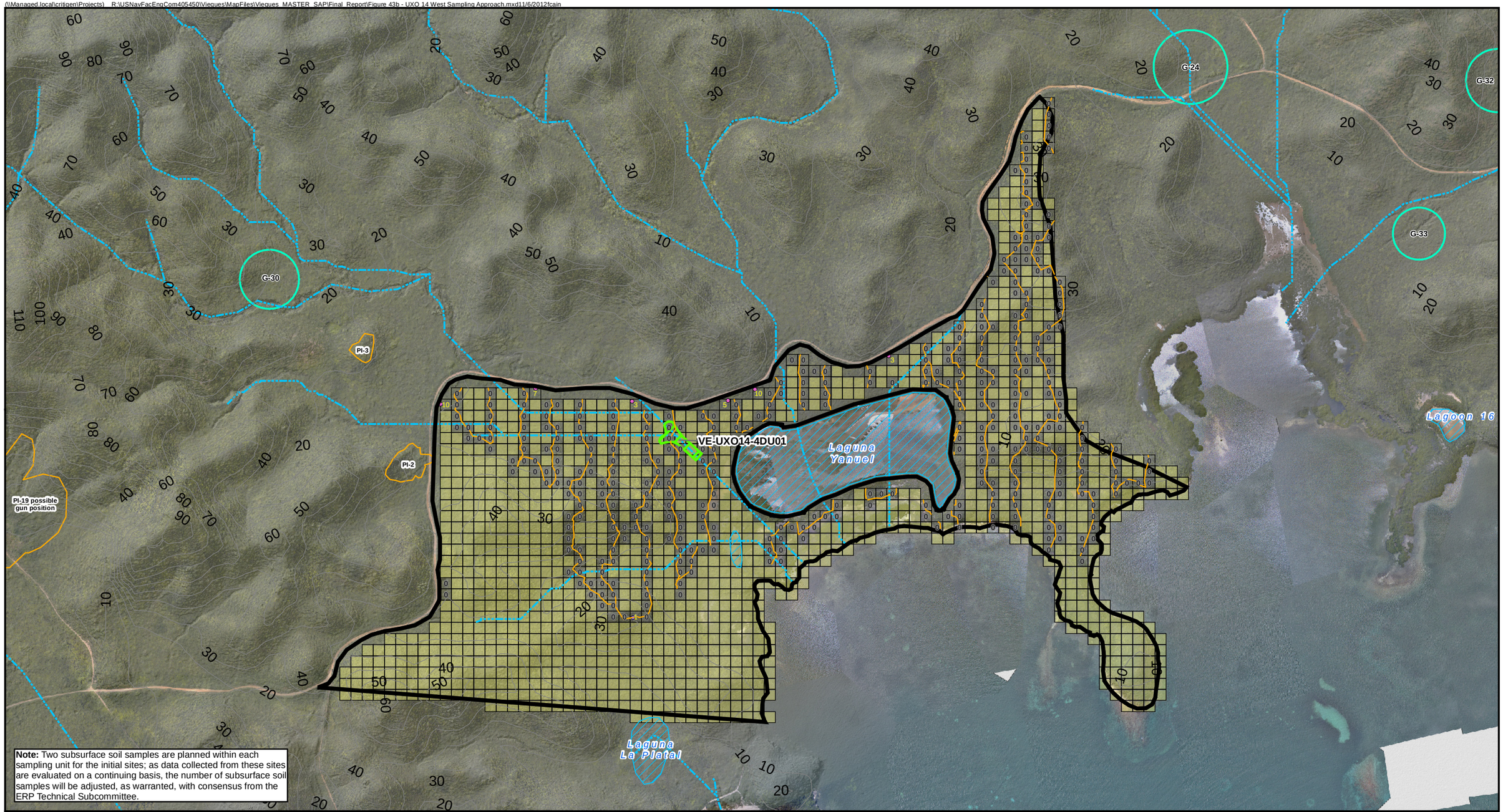
N
W E
S

0 250 500
Feet

Figure 43a
UXO 14 West Central Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 43b - UXO 14 West Sampling Approach.mxd 11/6/2012 fcain



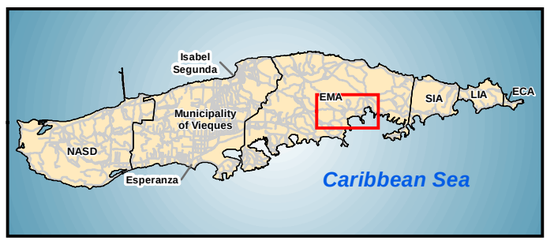
Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Flares-Pyrotechnics
- Scrap (Munitions Debris)
- Transect -3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Gun Positions
- Photo Identified Area
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

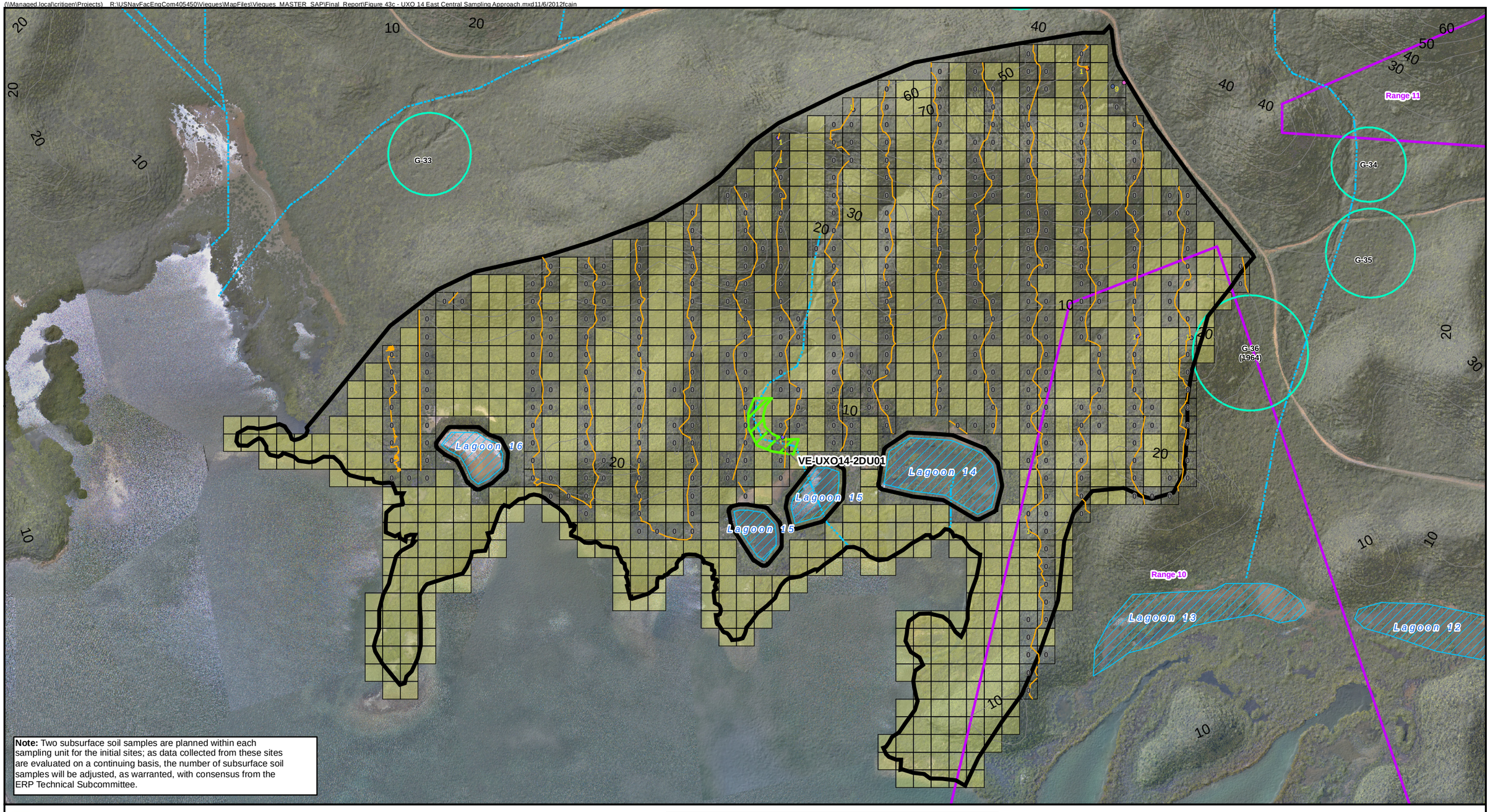


N W E S

0 500 1,000 Feet

Figure 43b
UXO 14 West Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL



Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Flares-Pyrotechnics
- Grenades
- Projectiles / Mortars
- Scrap (Munitions Debris)
- Transect -3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Gun Positions
- Range
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

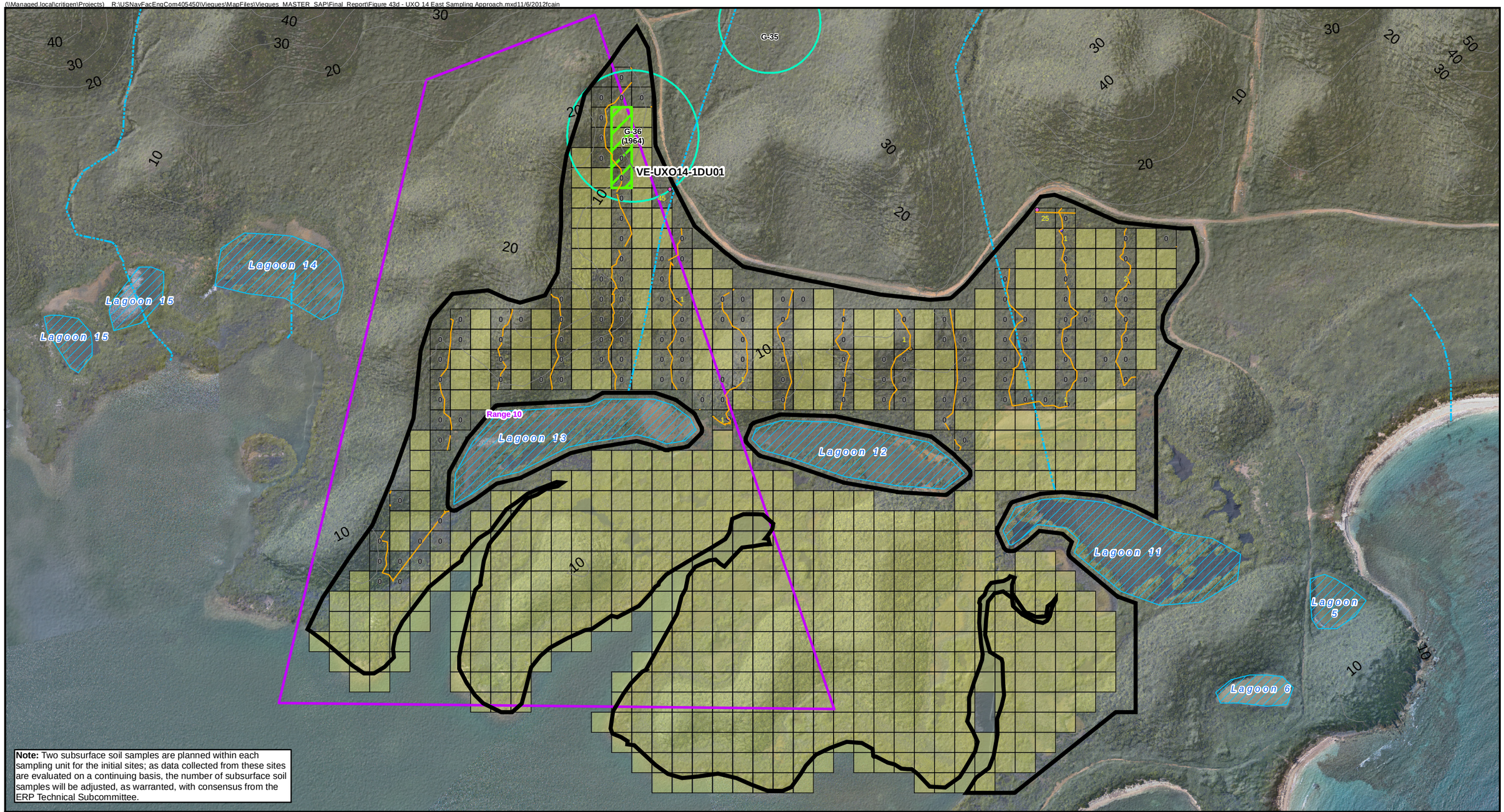
1 - 139	
140 - 455	
456 - 929	
930 - 1579	
1580 - 2360	
2361 - 3463	
3464 - 4920	
4921 - 6808	
6809 - 10113	
10114 - 16918	

N
W E
S

0 250 500
Feet

Figure 43c
UXO 14 East Central Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL



Note: Two subsurface soil samples are planned within each sampling unit for the initial sites; as data collected from these sites are evaluated on a continuing basis, the number of subsurface soil samples will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee.

- Sample Unit
- Decision Unit
- Flares-Pyrotechnics
- Projectiles / Mortars
- Rockets / Guided Missiles
- Scrap (Munitions Debris)
- Transect -3 Foot Width was Investigated
- Topographic Contours (10 Meter)
- Stream
- Gun Positions
- Range
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation
- Lagoon

2005 Aerial Imagery
2005 Hillshade

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

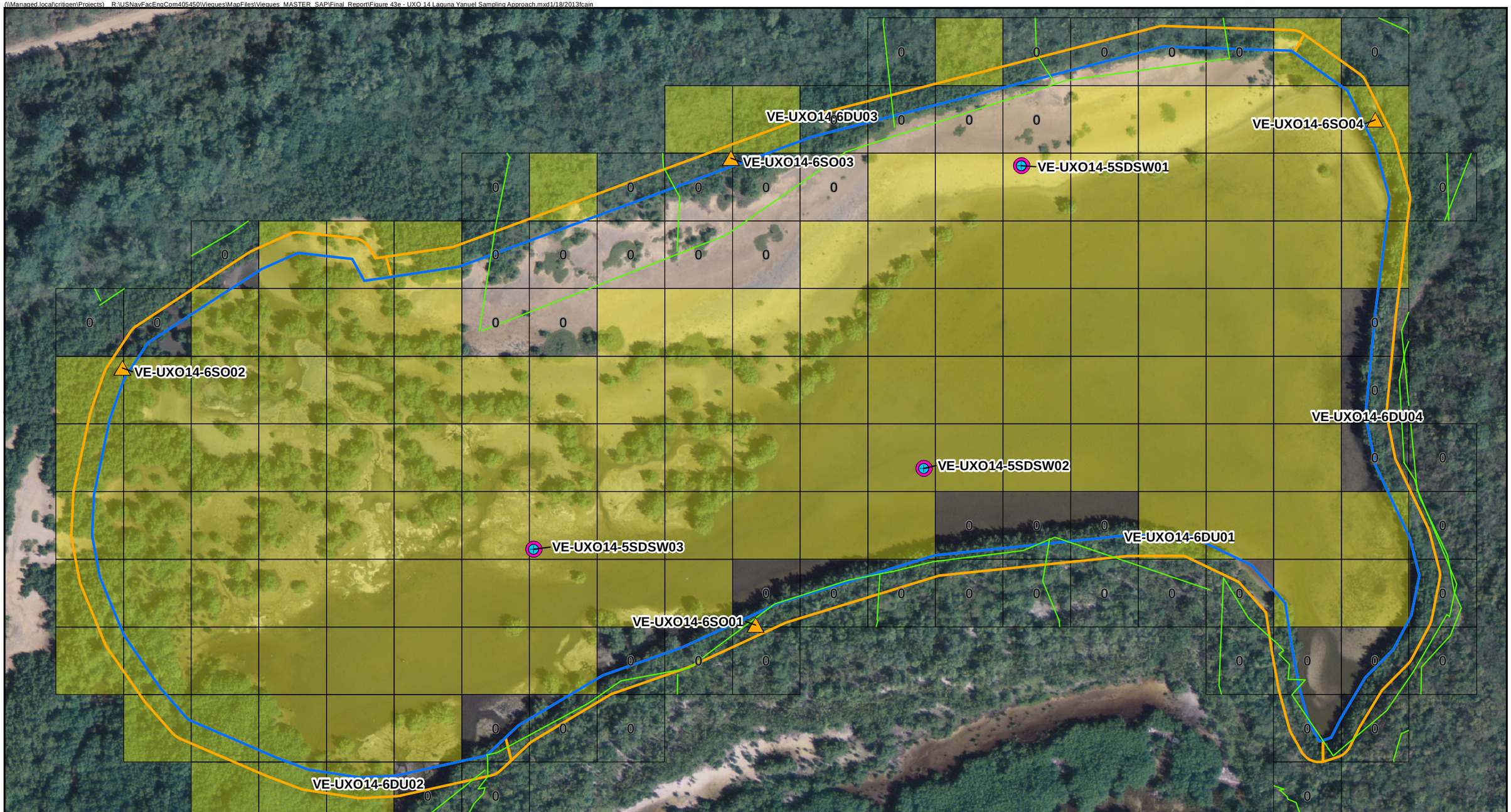
N W E S

0 250 500 Feet

Figure 43d
UXO 14 East Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 43e - UXO 14 Laguna Yanuel Sampling Approach.mxd 1/18/2013 fcain

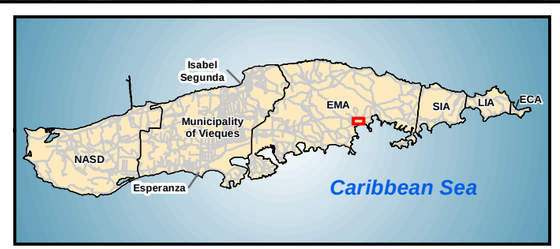


- Proposed Surface Water Samples
- Proposed Sediment Samples
- Deep Surface Soil Sample
- Transect -3 Foot Width was Investigated
- Lagoon
- Lagoon Fringe
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

2007 Aerial Imagery

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139	
140 - 455	
456 - 929	
930 - 1579	
1580 - 2360	
2361 - 3463	
3464 - 4920	
4921 - 6808	
6809 - 10113	
10114 - 16918	



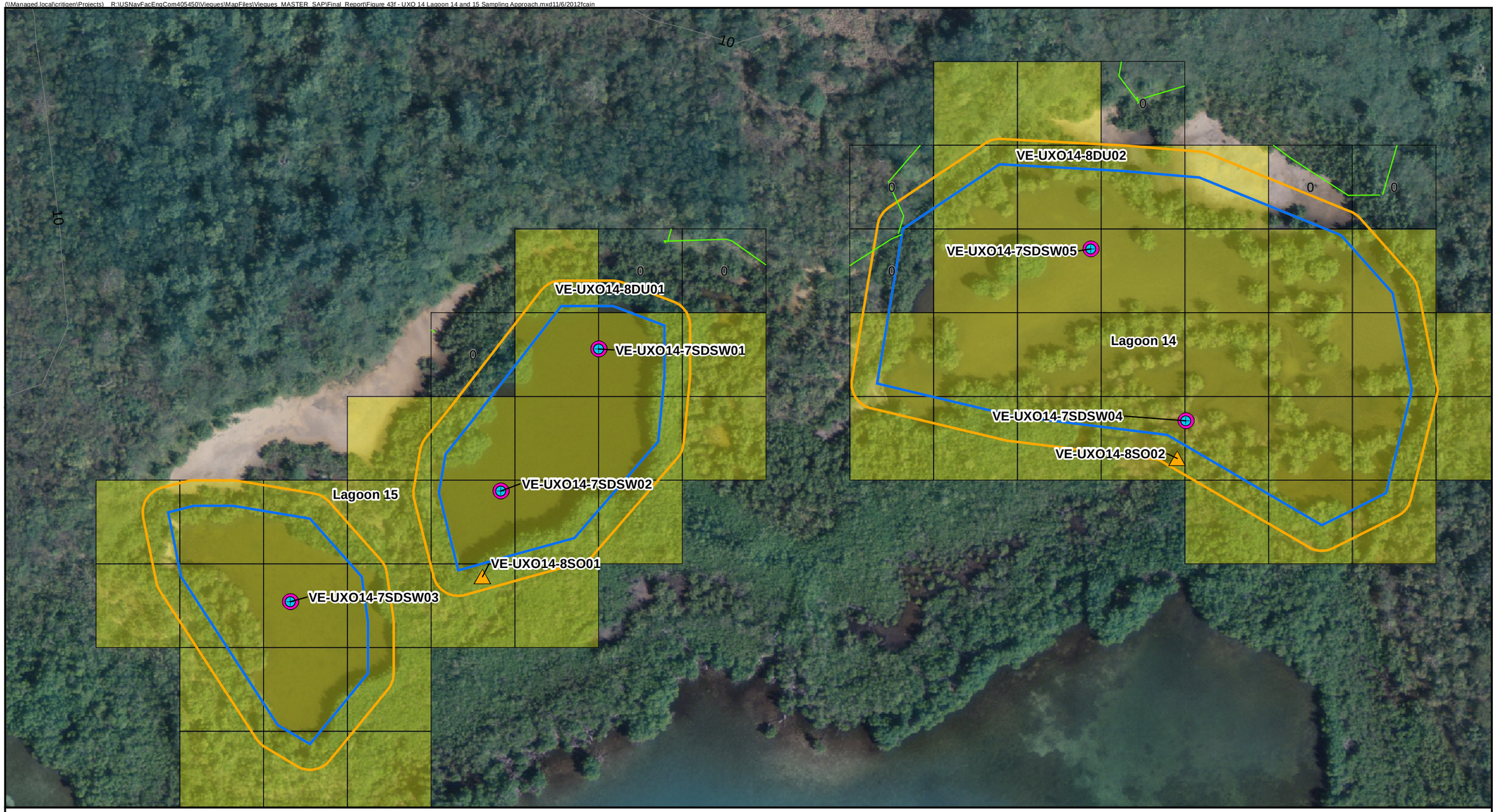
N W E S

0 75 150 Feet

Figure 43e
UXO 14 Laguna Yanuel Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 43f - UXO 14 Lagoon 14 and 15 Sampling Approach.mxd 11/6/2012 fcain



Proposed Surface Water Samples
Proposed Sediment Samples
Deep Surface Soil Sample
Transect -3 Foot Width was Investigated
Lagoon
Lagoon Fringe
Topographic Contours (10 Meter)
Grid (30 Meter)
Yellow Shading Indicates No MEC Investigation

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

2007 Aerial Imagery

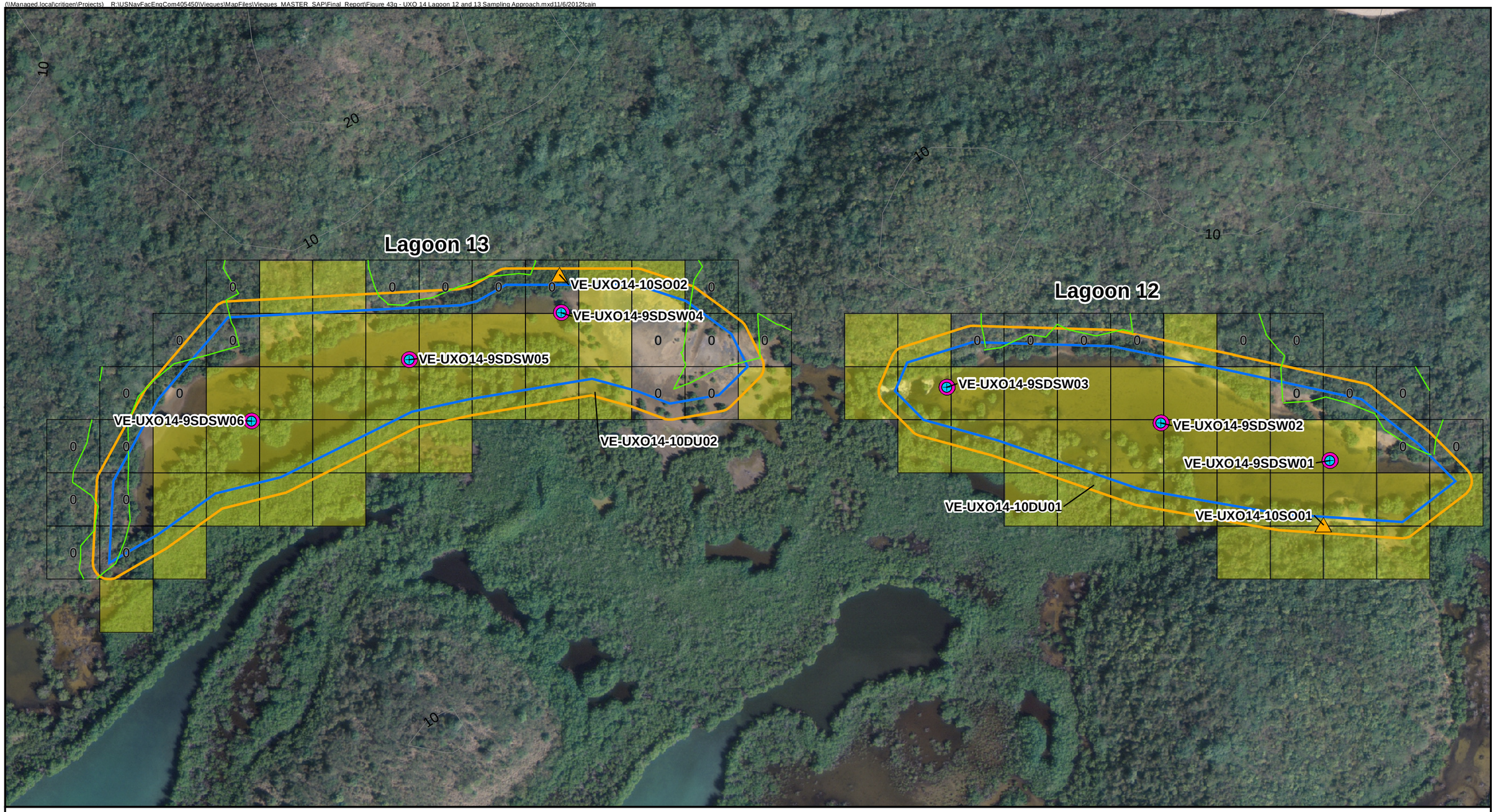
Figure 43f
UXO 14 Lagoon 14 and 15 Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 50 100
Feet

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 43g - UXO 14 Lagoon 12 and 13 Sampling Approach.mxd 11/6/2012 fcain



- Proposed Surface Water Samples
- Proposed Sediment Samples
- Deep Surface Soil Sample
- Transect -3 Foot Width was Investigated
- Lagoon
- Lagoon Fringe
- Topographic Contours (10 Meter)
- Grid (30 Meter)
- Yellow Shading Indicates No MEC Investigation

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

2007 Aerial Imagery

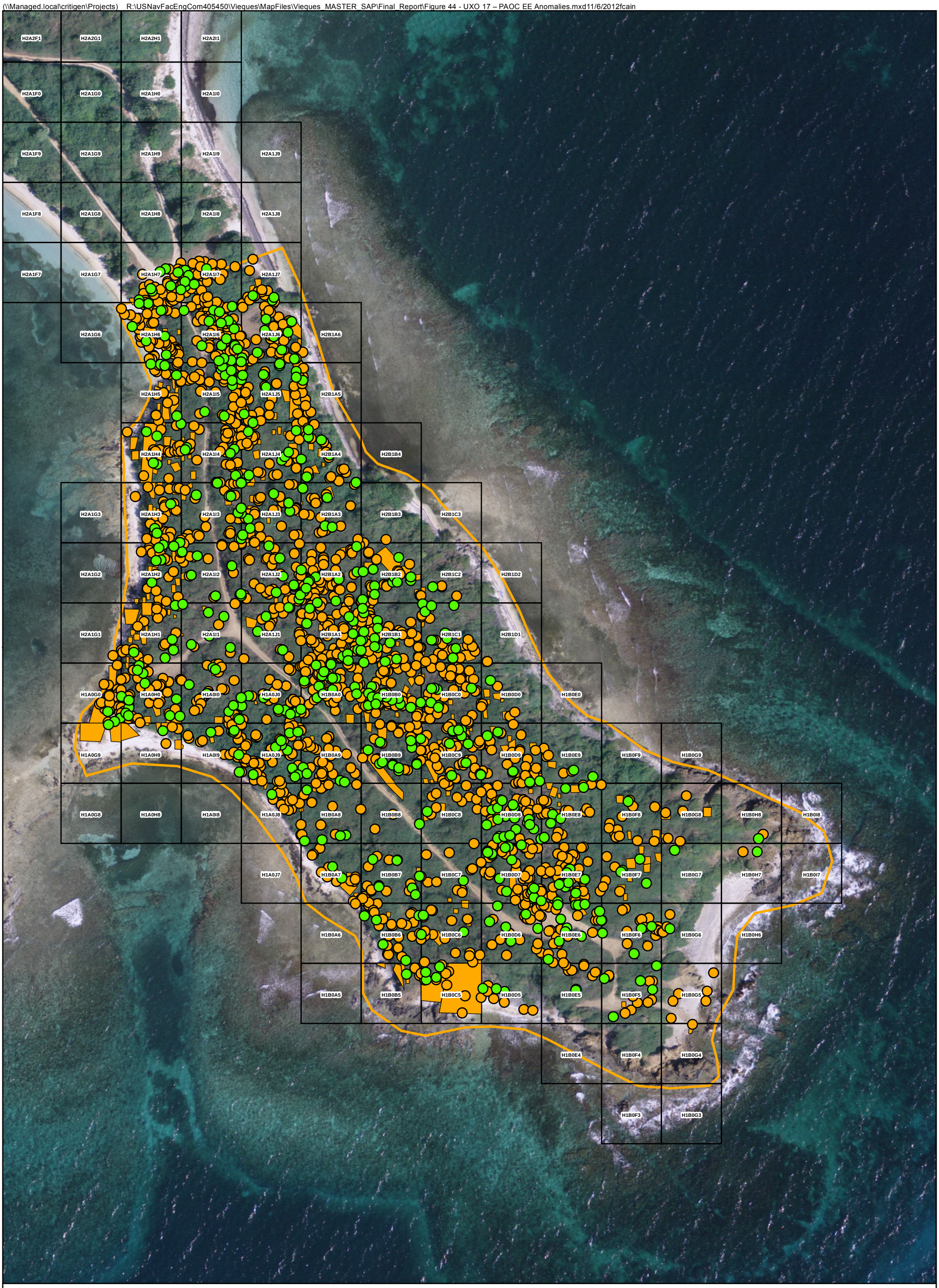
Figure 43g
UXO 14 Lagoon 12 and 13 Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

N
W E
S

0 87.5 175
Feet

CH2MHILL

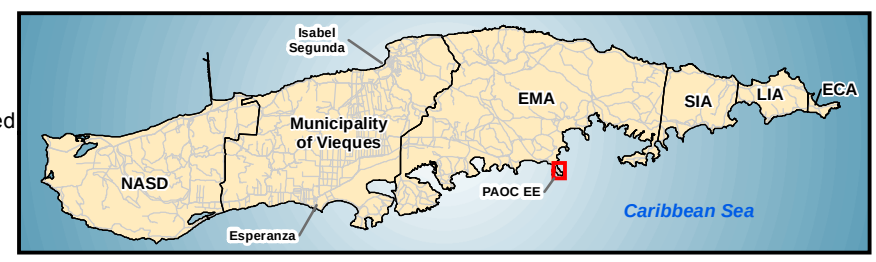
(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 44 - UXO 17 – PAOC EE Anomalies.mxd11/6/2012fcain



Legend

- Anomaly – Excavated
- Anomaly – Not Excavated
- Anomaly Polygon – Not Excavated
- 30 Meter Grid
- PAOC EE

2007 Aerial Imagery



N
W E
S

0 75 150
Feet

Figure 44
PAOC EE Anomalies
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 45 - UXO 17 PAOC EE Sampling Approach.mxd11/6/2012fcain

VE-UXO17-1SO01

VE-UXO17-1SO02

VE-UXO17-1SO03

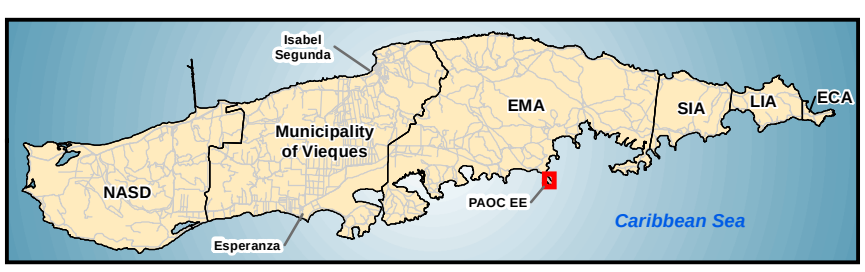
Digital Geophysical Anomalies by Grid

- 1 - 10
- 11 - 24
- 25 - 42
- 43 - 62
- 63 - 83
- 84 - 106
- 107 - 134
- 135 - 169
- 170 - 218
- 219 - 309

Density of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

- 1 - 139
- 140 - 455
- 456 - 929
- 930 - 1579
- 1580 - 2360
- 2361 - 3463
- 3464 - 4920
- 4921 - 6808
- 6809 - 10113
- 10114 - 16918

- 40mm Projectile
- Propellant
- Small Arms Ammunition
- Surface Soil Sample
- Topographic Contour (5 foot interval)
- Grid (30 Meter)
- Decision Unit



N W E S

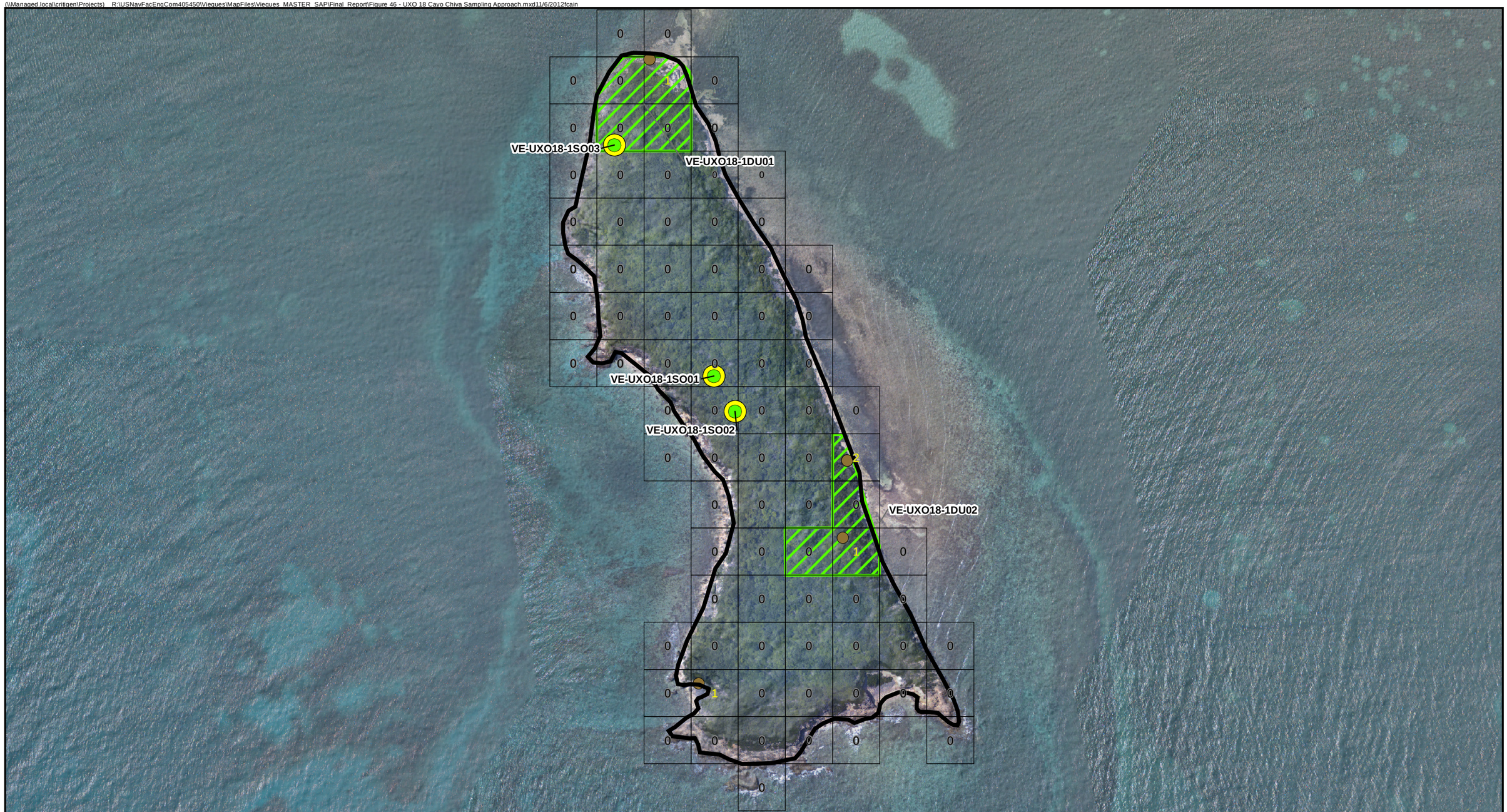
0 50 100 Feet

2005 Aerial Imagery

Figure 45
UXO 17 PAOC EE Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

(\\Managed.local\critigen\Projects) R:\USNavFacEngCom405450\Vieques\MapFiles\Vieques_MASTER_SAP\Final_Report\Figure 46 - UXO 18 Cayo Chiva Sampling Approach.mxd11/6/2012fcain



Surface Soil Sample
Smoke Canister Location
Decision Unit
Rockets / Guided Missiles
Grid (30 Meter)
Sample Unit

2005 Aerial Imagery
2005 Hillshade

Denisity of MEC and Munitions Scrap by 30 Meter Grid (Jenks Method Classification)

1 - 139
140 - 455
456 - 929
930 - 1579
1580 - 2360
2361 - 3463
3464 - 4920
4921 - 6808
6809 - 10113
10114 - 16918

N
W E
S

0 100 200
Feet

Figure 46
UXO 18 Cayo Chiva Sampling Approach
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

Attachment A
Preliminary Range Assessment and Phase I Site Inspection Findings

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Preliminary Range Assessment
Level 1 Site Reconnaissance Form

Site ID: **Range 3** Site use: ***40 mm Rifle Grenade Range***

Date: ***November 6th and 11th, 2001*** Reconnaissance Team: ***F. Ferreira, G. Webb, G. Del Rio***

Site Description: ***Large open area with significant rise in relief northward towards firing berm which surround site on all four sides.***

Access Road: ***Graded native soil*** Condition: ***Good, 2 wheel drive sufficient***

Distance from Main Road: ***Approximately 0.17 miles to Ranges 3 and 4***

Site Elevation: ***70' above msl @ range control tower***

Elevation of Secondary Access Road: ***Approximately 75' above msl***

Size of Area of Concern: ***Approximately 10-12 acres***

Structures: ***Concrete range control tower, 3 wooden barricades, 7 telephone pole stumps.***

Topography: ***Site is at southern flank of 250' hill, elevation rises from 70' @ control tower to 120' above msl at northern berm.***

Vegetation Type: ***Grass and thorny brush***

Percent of Vegetation Coverage: ***75-80% grass and thorny brush***

Soil Type: ***Clayey sand with weathered rock***

Soil Stains: ***None noted***

Environmental and/or Safety Concerns: ***None noted***

Survey/Investigation Methods: ***Initial perimeter walk with UXO avoidance support to map boundaries of site, followed by a ground truthing effort that covered approximately 15% of the site using the aid of a Schonstedt metal detector to evaluate subsurface anomaly density.***

Percentage of Site Investigated: ***15%***

Scrap Metal (Surface): ***None noted***

Ordnance Fragment/OE Scrap (Surface): ***Small arms ammunition, 40 mm projectiles***

Impact Craters: ***None noted*** OB/OD: ***None noted***

Type of Ordnance: ***40 mm***

Ordnance Density: ***Low***

Anomaly Density: ***Low based on 10-15% Schonstedt survey***

Explosive Safety Risk: ***Moderate, risk assessment code of 3 with recommendation for further action***

Notes: ***Digital photos collected***

Preliminary Range Assessment
Level 1 Site Reconnaissance Form

Site ID: ***Range 4*** Site use: ***Anti-armor/Anti-personnel Live Fire Rocket Range***

Date: ***November 6th and 13th, 2002*** Reconnaissance Team: ***F. Ferreira, G. Webb, G. Del Rio***

Site Description: ***Large open area characterized by significant drop in elevation northward from range control tower. Center of open area is the lowest lying area of site. Eight foot berm surrounds site on three sides.***

Access Road: ***Graded native soil with significant weathered rock in road***

Condition: ***Fair, 2 wheel drive OK, some wash out ruts in road***

Distance from Main Road: ***0.17 miles from North Coast Road***

Site Elevation: ***79 ft above msl at observation tower, 15ft at bottom, 50 ft at northern berm***

Elevation of Secondary Access Road: ***75 ft above MSL***

Size of Area of Concern: ***Approximately 12-13 acres***

Structures: ***Concrete range control tower, large aircraft parts used for targets, 75 mm artillery guns used for targets***

Topography: ***Gently sloping hills leading down to ocean, approx. 20° slope northward from tower towards ocean.***

Vegetation Type: ***Grass and thorny brush*** Percent of Vegetation Coverage: ***75-80% grass and thorny brush***

Soil Type: ***Clayey sand with small rock outcrops (<5%)***

Soil Stains: ***None noted***

Environmental and/or Safety Concerns: ***None noted***

Survey/Investigation Methods: ***Initial perimeter walk with UXO avoidance support to map boundaries of site, followed by a ground truthing effort that covered approximately 15% of the site using the aid of a Schonstedt metal detector to evaluate subsurface anomaly density.***

Percentage of Site Investigated: ***15%***

Scrap Metal (Surface): ***Moderate (around targets)***

Ordnance Fragment/OE Scrap (Surface): ***Moderate to high (ORS)***

Impact Craters: ***2 ponds at low point of site*** OB/OD: ***None noted***

Type of Ordnance: ***Rocket motor parts, semi-armor piercing (SAP) rounds***

Ordnance Density: **Moderate in northern end (target area) of site**

Anomaly Density: ***Moderate to high in northern half, low on southern end based on 10-15% Schonstedt survey***

Explosive Safety Risk: ***Moderate, risk assessment code of 3 with recommendation for further action***

Notes: ***Digital photos collected***

Preliminary Range Assessment
Level 1 Site Reconnaissance Form

Site ID: ***Range 5*** Site use: ***Grenade Range***

Date: ***November 6th and 11th, 2002*** Reconnaissance Team: ***F. Ferreira, G. Webb, G. Del Rio***

Site Description: ***Small open area bermed on all four sides. East–West orientation used as a hand throwing grenade range based on size of site and concrete grenade throwing bunkers observed during perimeter walk.***

Access Road: ***Graded native soil*** Condition: ***Fair, 2 wheel drive sufficient***

Distance from Main Road: ***1.26 Miles to G-8, 600 ft from North Coast Road***

Site Elevation: ***95 ft to 118 ft above msl in low lying area*** Elevation of Access Road: **85' above msl**

Size of Area of Concern: ***Approximately 1.5 Acres***

Structures: ***4 bay grenade throwing bunker (concrete)***

Topography: ***On the southern flank of an approximate 250 foot high hill. Site relief drops approx. 50' west to east, towards grenade throwing area.***

Vegetation Type: ***Grass and thorny brush*** Percent of Vegetation Coverage: ***95% grass***

Soil Type: ***Clayey sand with weathered rock***

Soil Stains: ***None noted***

Environmental and/or Safety Concerns: ***None noted***

Survey/Investigation Methods: ***Initial perimeter walk with UXO avoidance support to map boundaries of site, followed by a ground truthing effort that covered approximately 25% of the site using the aid of a Schonstedt metal detector to evaluate subsurface anomaly density.***

Percentage of Site Investigated: ***25%***

Scrap Metal (Surface): ***None noted***

Ordnance Fragment/OE Scrap (Surface): ***Grenade spoons***

Impact Craters: ***None noted*** OB/OD: ***None noted***

Type of Ordnance: ***None noted***

Ordnance Density: ***None noted***

Anomaly Density: ***Low based on 25% Schonstedt survey***

Explosive Safety Risk: ***Moderate, risk assessment code of 3 with recommendation for further action***

Notes:

- ***Some scarring where grenade impacts possibly occurred***
- ***Digital photos collected***

Summary of MEC Identified During the Preliminary Range Assessment (PRA) and the Phase I Site Inspection

The initial site inspections of suspected munitions sites at the former VNTR were completed during the Preliminary Range Assessment (CH2MHILL, 2003) and the Phase I Site Inspection (CH2MHILL, 2007). The data from these inspections were supplemented with data collected along transects during the Phase II SI (CH2M HILL, 2006 and 2008), which is summarized in Final Expanded Range Assessment/Site Inspection Report, Former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico (CH2M HILL, 2010).

Figure A-1 shows eight areas (identified as Areas A through H) that were inspected during the PRA and Phase I SI. The results of the Phase I SI visual inspections of these areas are summarized below. In addition, the data sheets from the inspection of the selected ranges at Areas A, B, and D during the PRA are provided at the end of this Appendix.

- **AREA A –** This area corresponds to the area formerly designated as EMA MRS 5. The results of the inspection of the site from Section 3.3.4 of the Phase I SI Report are provided below:
  - *EMA MRS 5 (Range 5, small arms/impact area/target area) shown in [**Figure A-2**] was historically described as a small arms range. An area of 1.5 acres of the anticipated target area was inspected using a transect approach at the site. Evidence of small arms use in the area was found (e.g., small arms shell casings and ammunition boxes). No target areas could be defined based on the areas investigated. Two grenade safety levers were found. The area around the location of the safety levers was inspected by walking radially in all directions to a distance of approximately 65 ft, but found no other munitions items. No subsurface anomalies were detected during the investigation.*

- **AREA B -** This area corresponds to the area formerly designated as EMA MRS 1. The results of the inspection of the site from Section 3.3.4 of the Phase I SI Report are provided below:
  - *The layout of EMA MRS 1 (Range 3, hand grenade range) has a concrete bunker on an upland berm which overlooks a bowl-shaped landscape feature. Hand grenades were thrown from the bunker area to the bowl-shaped landscape feature. The bowl-shaped feature was the primary target area at the range. Approximately 1 acre was investigated at MRS 1, shown in [Figure A-2]. Numerous hand grenade safety levers, pins, and frag were found across the area which interfered with the collection of subsurface anomaly data. Magnetometer responses were considered relatively low for all subsurface anomalies detected and the anomalies were distributed across the target area. Aside from a number of hand grenade safety levers, pins, and frag, a single Mk26 grenade was found, which required demolition. The item was relocated to MRS 2 (Range 4, 40mm projected grenade range) for demolition.*

- **AREA C-** This area corresponds to the area formerly designated as EMA MRS 3. The results of the inspection of the site from Section 3.3.4 of the Phase I SI Report are provided below:
  - *EMA MRS 3 (Range 4A, rocket range) was investigated using a transect approach initially to locate the target area ([Figure A-2]). Approximately 1 acre of transects were inspected however, a defined target area could not be determined. No target vehicles, landscape features, or munitions related items were found. Additionally, no subsurface anomalies were observed on these transects.*

- **AREA D -** This area corresponds to the area formerly designated as EMA MRS 2. The results of the inspection of the site from Section 3.3.4 of the Phase I SI Report are provided below:
  - *Range 4 in EMA MRS 2 was historically used as a 40mm projected grenade range and the layout of the range consists of an observation tower situated on a small hill. Downrange from the observation tower the elevation drops slightly and then increases up a substantial hill. The target area for this range was on the slope of the down range hill. Approximately 3.5 acres of the target area were inspected at EMA MRS 2 ([Figure A-2]). Magnetometer responses were considered relatively low for all subsurface anomalies detected and the anomalies were distributed across the target area. The surface at EMA MRS 2 was relatively clear of metallic debris including frag. One MEC item was located at the site, a 40mm HE grenade projectile. The 40mm HE grenade projectile was found directly downrange on the steep hillside*

where vegetation becomes denser. The 40mm HE grenade projectile was not expended and was detonated in-place.

- **AREA E-** This area corresponds to the area formerly designated as EMA MRS 4. The results of the inspection of the site from Section 3.3.4 of the Phase I SI Report are provided below:
  - *EMA MRS 4 (Range 4B, rocket range) has an observation tower located up range with a number of target vehicles positioned downrange ([Figure A-2]). Approximately 3.75 acres of the target area were investigated at the range, which runs to a significant rocky cliff that drops to the ocean at the north. The targets located on the range (nine total) included; three howitzers, two armored vehicles, two large truck frames, a boiler tank, and a tank turret. All of the targets were examined as thoroughly as possible without disassembly and no MEC items were found. A substantial amount of frag and metallic debris was present at the site, which generated interference for the magnetomer. However, the subsurface anomalies detected in areas where there was little or no surface debris, produced relatively low responses on the handheld magnetometers. Surface munitions items identified at MRS 4 included: one expended shoulder-launched multipurpose assault weapon (SMAW) rocket motor, four 3.5 inch expended rocket warheads, 83 expended 3.5 inch rocket motors, and one 3.5 inch rocket warhead, not expended. The 3.5 inch rocket warhead that was not expended was relocated to Range 4 and was destroyed using open detonation.*

- **AREA F -** This area corresponds to the area formerly designated as EMA MRSs 7 through 11. The results of the inspection of the site from Section 3.3.4 of the Phase I SI Report are provided below:
  - *A total of five acres were investigated for all the PI gun positions [Photo-Identified Gun Positions G-14, G-15,G-17,G-18,G-19 shown on Figure A-3] using transects. Both mechanical and hand vegetation clearance was conducted to access the area. No UXO was found. One piece of scrap suspected to be from a signal, illumination, round was discovered along with multiple pieces of communications wire. The findings from this ERA/Phase I SI at these gun positions is consistent with the findings at G-1, G-2, G-3, G-4, G-5, G-7, G-8, GP-1, GP-5, GP_9, and OP-5, which were investigated during the PRA.*

- **AREA G -** This area corresponds to the area formerly designated as EMA MRS 6. The results of the inspection of the site from Section 3.3.4 of the Phase I SI Report are provided below:
  - *EMA MRS 6 was investigated using a transect approach where 5 acres were investigated. The transects were cut by hand where necessary. A number of expended munitions items were located on the surface at EMA MRS 6. The expended items located are listed below in [Table A-1] and locations are shown in [Figure A-4]. The items were found across the site with no discernable pattern. Because this MRS borders the MRA-SIA, a moderate number of expended items were located, and a moderate number of subsurface anomalies were found this area may be, as suspected, a "shortfall" area and may be impacted slightly from "off-target" bombing. No subsurface anomalies were detected during the investigation.*

TABLE A-1
EMA MRS 6 Munitions Related Items (MD) Located
Former VNTR, Vieques, Puerto Rico

Item	Number of Surface Items Located
BDU-33	2
100 lb Practice Bomb	1
Mk 25 Flare	5
Signal, illumination, ground	2
155mm Illumination Projectile	1
81mm Illumination Projectile	3
106mm Cartridge Case	4
2.75 inch Rocket Pod	1
3.5 inch Rocket Motor	2

Note: All items located were expended.

- **AREA H -** This area corresponds to the area formerly designated as SIA MRS 1. The results of the inspection of the site from Section 3.3.3 of the Phase I SI Report are provided below:
  - *SIA MRS 1 - The terrain at MRS 1 is very rugged and consisted of thick vegetation with steep inclines and ridges. MEC densities were relatively high at approximately 12 items per acre (actual). The predominant items found at the site were projectiles and mortars. [Table A-2] lists the quantities of munitions found at the MRS. Specifically, a large quantity of 81mm mortars, 105mm projectiles, 155mm projectiles, and 4.2 inch illumination projectiles were located. Projectiles and mortars were found across the investigation area, but were slightly more dense at the western most transects. Bombs were located predominately at the eastern most transects with a few located in the western portion of the investigation area. A total of 30 subsurface anomalies were detected, at a relatively low density, slightly greater than 1 anomaly per acre. [Figure A-5] shows the surface MEC located and [Figure A-6] the subsurface anomalies detected. The target area was not fully defined. The target area(s) in the SIA appear to be multiple and widespread. The number of munitions found is consistent with the historical uses of the SIA and the overall history of the range.*

TABLE A-2
MRA-SIA MRS 1 Surface MEC Located
Former VNTR, Vieques, Puerto Rico

Category	Number of Surface Items Located
Projectiles/Mortars	60
Flares	4

Note: Items categorized as munitions debris are not included in this table.

References

CH2M HILL. 2003. *Final Draft Preliminary Range Assessment Report, Vieques Naval Training Range, Vieques Island Puerto Rico.* April.

CH2M HILL. 2006. *Final Expanded Range Assessment and Phase II Site Inspection Work Plan.* November.

CH2M HILL. 2007. *Revised Draft Expanded Range Assessment and Phase I Site Inspection Report, Former Vieques Naval Training Range, Vieques ,Puerto Rico*. May.

CH2M HILL. 2008. *Final Amendment 1, Expanded Range Assessment and Phase II Site Inspection Work Plan, Former Vieques Naval Training Range, Vieques Puerto Rico.* July.

CH2M HILL. 2010. *Final Expanded Range Assessment/Site Inspection Report, Former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico.* September.

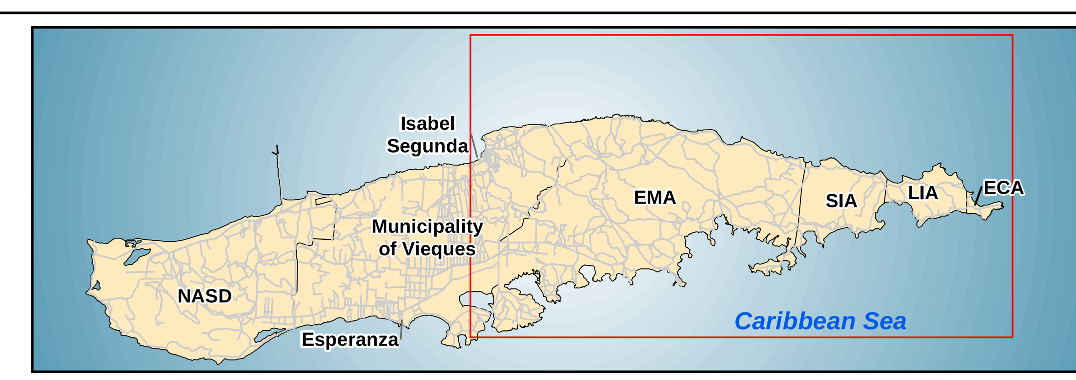
Legend

- Phase 1 Investigation Areas
- MEC Investigation Transects
- Controlled Detonation
- Consolidation Point
- DGM Coverage
- TCRA and NTCRA Activities

Munitions Response Sites

- UXO 1 - ECA
- UXO 2 - LIA Beaches
- UXO 3 - LIA Roads
- UXO 4 - LIA Interior
- UXO 5 - SIA Restricted Roads
- UXO 6 - EMA/SIA Public Roads
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches
- UXO 9 - SIA Exterior
- UXO 10 - SIA Interior
- UXO 11 - EMA Public Roads
- UXO 12 - EMA Interior
- UXO 13 - EMA West
- UXO 14 - EMA South
- UXO 15 - Puerto Ferro
- UXO 16 -Underwater Areas
- UXO 17 - PAOC-EE/PI-21
- UXO 18 - Cayo de la Chiva

2007 Aerial Imagery



0 1,500 3,000 4,500 6,000 Feet

Figure A-1
MEC Investigation Transects and Digital Geophysical Mapping Coverage
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

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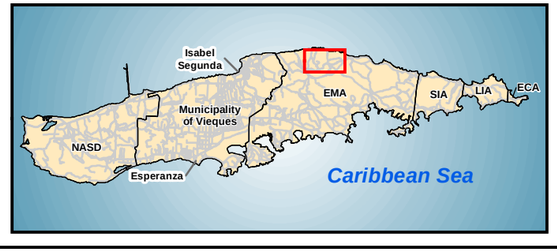
Surface Items: Category
- GRENADES
- PROJECTILES/MORTARS
- ROCKETS/GUIDED MISSILES

Subsurface Items: Response
- 1
- 5
- 10

- Limits of Investigation
- MRS



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W E
S

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Feet

2007 Aerial Imagery

Figure A-2
Phase 1 Investigation Areas A, B, C, D, and E
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

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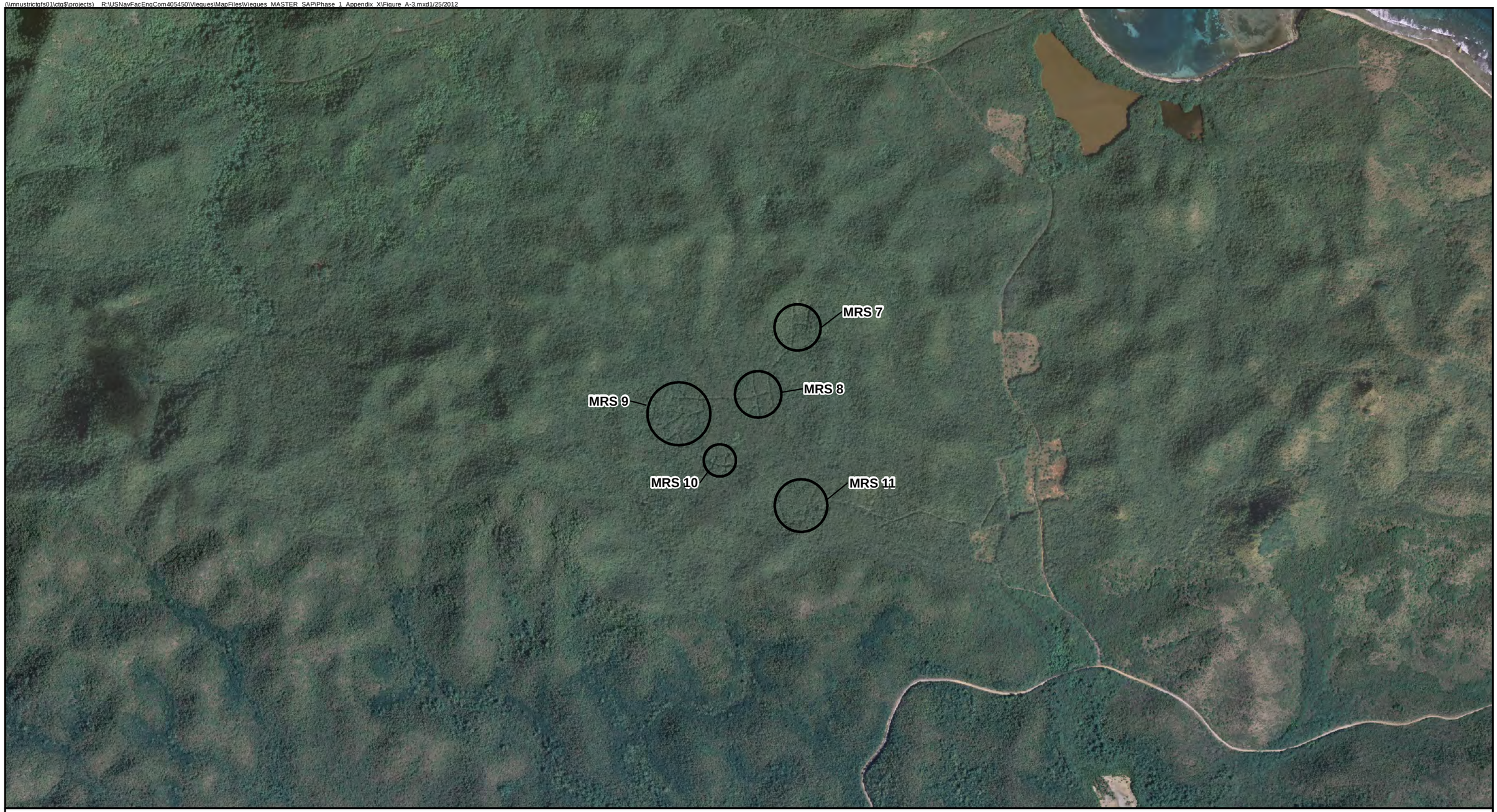
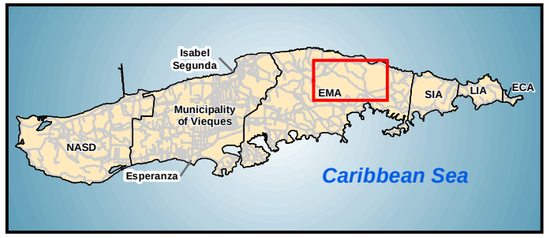


MRS Site Boundary



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Feet

2007 Aerial Imagery

Figure A-3
Phase 1 Investigation Area F
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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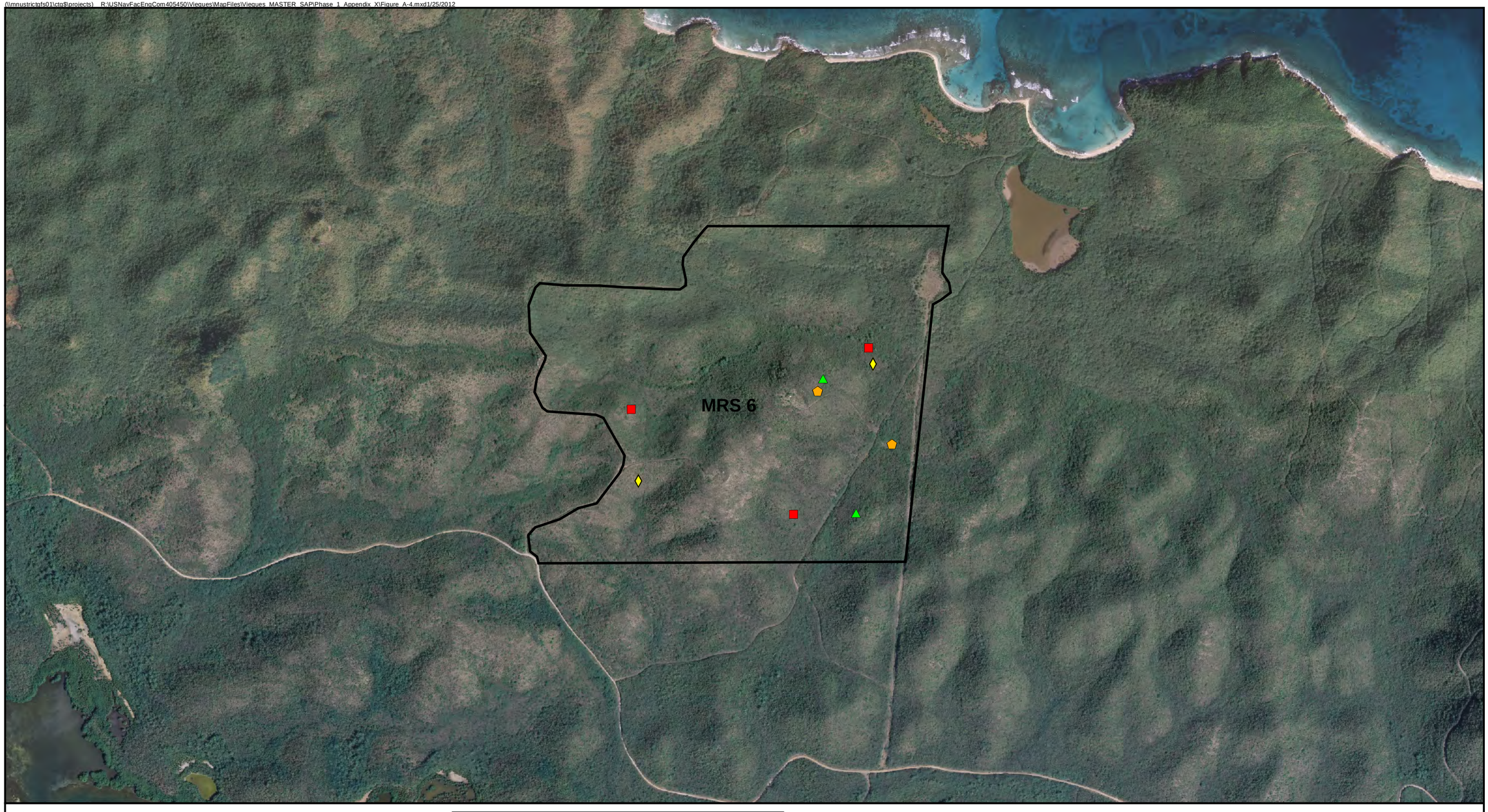
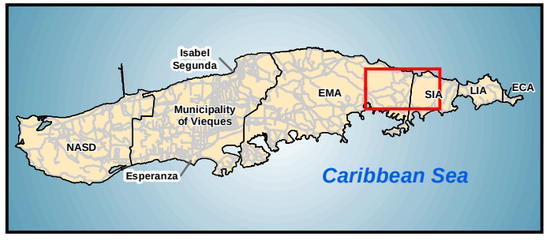


Flares/Pyrotechnics
Bombs
Projectiles/Mortars
Rockets/Guided Missiles
MRS Site Boundary

2007 Aerial Imagery



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Feet

Figure A-4
Phase 1 Investigation Area G
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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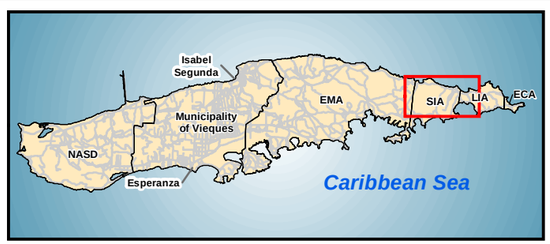
Surface Items: Category

- Flares/Pyrotechnics
- Projectiles
- MRA Boundary

Note: No GPS data available for the following items:
SIA MRS 1: 42 Projectiles/Mortars, 3 Flares/Pyrotechnics



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Feet

2007 Aerial Imagery

Figure A-5
Phase 1 Investigation Area H Surface Items
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

CH2MHILL

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SIA MRS-1

Subsurface Items: Response

- Low
- Medium
- High
- MRA Boundary

2007 Aerial Imagery

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S

0 500 1,000
Feet

Figure A-6
Phase 1 Investigation Area H Subsurface Items
Master Sampling and Analysis Plan
Former VNTR
Vieques, Puerto Rico

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Attachment B
Background Soil Comparison

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Statistical Comparison of Background Incremental and Discrete Soil Samples

PREPARED BY: CH2M HILL

DATE: November 29, 2011

Introduction

Inorganic constituents collected as part of environmental investigations at Vieques are typically screened against the background data set for soil on Eastern Vieques, documented in the report titled East Vieques Background Soil, Inorganics Investigation Report (CH2M HILL, 2007). However, the background data set for soil was collected using discrete sampling techniques. Future environmental investigations proposed in the East Vieques Master SAP include an incremental soil sampling approach and it was unclear if the background study data set could be used for comparison with incremental soil samples.

Ten incremental soil samples were collected as part of the UXO 1 Remedial Investigation (RI) (CH2M HILL, 2012) from the same background study lithologic unit (Tl) and sample locations. This Technical Memorandum presents a statistical comparison of the incremental soil data collected as part of the UXO 1 RI with the discrete surface soil data collected from the background study. The results of this evaluation will be used to determine if background incremental soil data is needed for the upcoming environmental investigations or if the background study soil data is sufficient.

Probability Plots

Overlapping probability plots of the discrete and multi-incremental data offer a visual presentation of the distribution of data for each constituent. Such plots graph actual concentrations against theoretical quantiles if the true distribution of the data were normal. One feature of normal probability plots is that the curve will resemble a straight line if the data can be assumed to be normally distributed. The data often did not appear to be normally distributed via the plots, but this feature is not particularly important for the purposes of this presentation. The ability to visualize the individual concentrations and observe relative differences between reference and site data is not impacted by this lack of straightness.

Overlapping probability plots for each of the background metal constituents are provided in **Figure B-1**. Discrete data are portrayed with blue symbols while multi-incremental data are portrayed with red symbols. Nondetects are represented by unshaded circles (at ½ the detection limit) while detected values are represented by solid circles. Values which were excluded from summary statistics based upon mathematical outlier algorithms are represented by an X.

One would not expect exact overlap due to the differences in sample locations in the two sampling programs, but there is typically considerable similarity in the concentration ranges. While visual review of these plots alone is a valuable exercise, other comparison approaches such as comparing background threshold values (BTVs) and central tendency comparisons between the discrete and incremental populations offer complementary viewpoints. Some of these specific plots are referred to while discussing these additional approaches below.

Comparison of BTVs

For both the discrete and incremental concentrations, BTVs were calculated for comparison to site concentrations from a similar sampling approach. The BTVs were calculated as 95 percent upper confidence limits of the 95th percentile, otherwise known as 95/95 UTLs. In previously reported information for the discrete samples, however, the Tl geologic unit concentrations were sometimes combined with other geologic units (i.e. KTd, Kv,

and Qa) based on similarities in the available concentrations. To avoid presenting a confusing comparison between incremental BTVs from the Tl geologic units and discrete BTVs between potential combined geologic units, new BTVs for the discrete Tl samples alone were calculated (using the same algorithms as used with the incremental concentrations). These BTVs along with other summary statistics (e.g. minimum detect, maximum detect, number of detects, percent detects, etc.) for the discrete Tl concentrations are provided in **Table B-1**. (These discrete Tl statistics are not recommended for use over the previously calculated discrete BTVs, but are only offered to facilitate comparisons with the Tl multi-incremental BTVs). To promote comparisons between this table and the corresponding table of summary statistics for the multi-incremental concentrations, the latter table (previously reported) is provided again in this report as **Table B-2**.

The main comparison between these two tables rests on the calculated BTVs. The BTVs from the discrete and incremental sampling programs are provided in **Table B-3** along with the ratio of the incremental BTVs to the discrete BTVs. Most of these paired BTVs were similar to one another. The greatest differences occurred with cadmium, calcium, and magnesium, all of which had much lower multi-incremental BTVs than discrete BTVs. The difference in overall concentrations for these three can be viewed in the plots in **Figure B-1**. For magnesium, the plot reveals that the original data for the two data sets was similar, but three elevated values for the incremental data set were excluded as mathematical outliers while none of the discrete concentrations were excluded based on established outlier protocol described in the previous background study texts.

Central Tendency Comparions

Central tendency comparisons are two-sample tests to determine whether an overall difference exists between two populations. The Wilcoxon Rank Sum (WRS) test and Gehan test are nonparametric central tendency tests as discussed in EPA and Navy guidance (United States EPA, 2010; United States Department of the Navy, 2002). They can be used to test whether measurements from one population (such as discrete data) tend to be shifted higher or lower than those from another population (such as incremental data) or whether the two cannot be statistically distinguished apart based on available data. As a nonparametric test based on ranks of the data, they are not overly influenced by spurious results in either data set, nor do they require any specific distributional assumption about the data.

Both tests are nonparametric approaches based upon the ranks of the data, however, they handle ties in these ranks differently. For that reason, the Gehan test is recommended when the percent of non-detects is greater. Gehan test conclusions were used when more than 40 percent of the results were nondetect in either the discrete or incremental data.

The results of the central tendency comparisons between the are presented in **Table B-4**. The tests were applied with a significance level of 0.05. If the probability is lower than 0.05, a statistically significant overall shift in site concentrations above background concentrations is concluded to exist based on available data.

The tests were performed on the full data sets as well as data sets after the mathematical outliers were removed (for cadmium, calcium, magnesium, selenium, thallium, and zinc). For cadmium and calcium, the discrete concentrations were shifted significantly higher than the incremental concentrations. For vanadium, the incremental concentrations were shifted significantly higher than the discrete concentrations. For zinc, the incremental concentrations were shifted significantly higher than the discrete concentrations when all results were included, but the test indicated on significant difference when the incremental outlier was removed. For selenium, Gehan's test indicated the incremental concentrations were shifted significantly higher than the discrete concentrations, but the low percentage of detects (50%) an inspection of the selenium plot in **Figure B-1** revealed that the unusual relationship of nondetect proxies (higher than discrete detects and lower than incremental detects) provided a puzzling situation for the test). A visual inspection of the selenium plot suggests little difference between the infrequent detected concentrations.

Conclusions

In summary, three approaches were used to compare the discrete and incremental concentrations to one another. These included the graphical overlapping probability plots, the comparison of BTVs, and the central tendency comparison. The greatest consistent differences occurred with cadmium and calcium, where the discrete concentrations were shifted significantly higher than the incremental concentrations. Less substantial differences occurred with vanadium and zinc where the incremental concentrations were consistently higher than the discrete concentrations, but by a lesser margin. Overall, the incremental background data collected as part of the UXO 1 RI is statistically comparable with the discrete soil data collected from the background study.

References

CH2M HILL, *Draft Remedial Investigation Report, Eastern Conservation Area, UXO 1*, January 2012.

United States Environmental Protection Agency (USEPA), *ProUCL Version 4.1 Technical Guide (Draft),* Office of Research and Development, May, 2010.

United States Navy. Guidance for Environmental Background Analysis, Volume I: Soil, Naval Facilities Engineering Command, Washington, DC, 2002.

Table B-1

Discrete Sample Background Statistics (mg/kg) for TI Geologic Unit

Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites

Vieques, Puerto Rico

Parameter	Number of Detects	Number of Analyses	Percent Detects	Minimum Detected Value	Maximum Detected Value	Minimum DL for Non-detects	Maximum DL for Non-detects	Excluded Outliers	BTV (Calculated 95/95 UTL)	UTL Basis
Aluminum	19	19	100	2340	41500	NA	NA		46400	Normal UTL
Arsenic	19	19	100	1.3	9.6	NA	NA		9.17	Normal UTL
Barium	19	19	100	25.7	114	NA	NA		119	Normal UTL
Beryllium	5	19	26	0.72	0.95	0.54	0.77		0.914	Kaplan Meier UTL
Cadmium	19	19	100	0.85	2.1	NA	NA		2.36	Normal UTL
Calcium	19	19	100	17800	362000	NA	NA		417000	Normal UTL
Chromium	19	19	100	3.4	58.8	NA	NA		70.1	Normal UTL
Cobalt	19	19	100	3.2	7.6	NA	NA		9.16	Normal UTL
Copper	13	13	100	7.4	29	NA	NA		30.6	Normal UTL
Iron	19	19	100	1500	33300	NA	NA		37100	Normal UTL
Lead	19	19	100	1.1	10.6	NA	NA		18.9	Gamma UTL
Magnesium	19	19	100	3210	32300	NA	NA		32300	Nonparametric UTL
Manganese	17	17	100	32.2	972	NA	NA		1150	Normal UTL
Nickel	19	19	100	1.5	17.7	NA	NA		19.3	Normal UTL
Potassium	18	19	95	951	9050	535	535		10800	Normal UTL
Selenium	9	19	47	0.31	1.3	3.7	5		1.53	Kaplan Meier UTL
Silver	1	19	5	0.12	0.12	1.1	1.6		Only a Single Detect	
Thallium	5	17	29	0.046	0.13	0.34	0.49	0.41, 0.5	0.178	Kaplan Meier UTL
Vanadium	19	19	100	4.9	50.3	NA	NA		55.7	Normal UTL
Zinc	19	19	100	4	34.6	NA	NA		37.2	Normal UTL

All concentrations in mg/kg expressed with three significant figures.

NA * = Not applicable; no detections

Table B-2

Multi-Incremental Background Statistics (mg/kg) for TI Geologic Unit

Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites

Vieques, Puerto Rico

Parameter	Number of Detects	Number of Analyses	Percent Detects	Minimum Detected Value	Maximum Detected Value	Minimum DL for Non-detects	Maximum DL for Non-detects	Excluded Outliers	BTV (Calculated 95/95 UTL)	UTL Basis
Aluminum	12	12	100	5110	42900	NA	NA		58200	Normal UTL
Arsenic	12	12	100	0.98	6.1	NA	NA		8.47	Normal UTL
Barium	12	12	100	30.1	97.6	NA	NA		120	Normal UTL
Beryllium	9	12	75	0.15	1.1	0.5	0.5		1.16	Normal UTL MLE
Cadmium	8	10	80	0.18	0.25	0.5	0.5	0.28, 0.3	0.299	Kaplan Meier UTL
Calcium	8	8	100	14400	43200	NA	NA	99600, 102000, 123000, 158000	59500	Normal UTL
Chromium	12	12	100	7.1	59.3	NA	NA		79.4	Normal UTL
Chromium (hexavalent)	1	12	8	0.056	0.056	0.025	0.12		Only a Single Detect	
Cobalt	12	12	100	2	8.4	NA	NA		11.2	Normal UTL
Copper	12	12	100	10.5	21.7	NA	NA		24.6	Normal UTL
Iron	12	12	100	5860	37200	NA	NA		48900	Normal UTL
Lead	11	12	92	1.3	11.9	2.5	2.5		17.2	Normal UTL MLE
Magnesium	9	9	100	4560	6150	NA	NA	8610, 11400, 28200	6540	Normal UTL
Manganese	12	12	100	205	851	NA	NA		1040	Normal UTL
Nickel	12	12	100	3.6	18.2	NA	NA		23	Normal UTL
Potassium	12	12	100	1060	7900	NA	NA		7900	Nonparametric UTL
Selenium	3	9	33	1.1	1.2	2	2	1.5, 2.1, 2.4	1.31	Kaplan Meier UTL
Sodium	12	12	100	163	265	NA	NA		338	Gamma UTL
Thallium	1	12	8	0.26	0.26	0.5	0.5		Only a Single Detect	
Vanadium	12	12	100	15.2	59.4	NA	NA		71.7	Normal UTL
Zinc	11	11	100	13.5	27.5	NA	NA	39.2	34.2	Normal UTL

All concentrations in mg/kg expressed with three significant figures.

NA * = Not applicable; no detections

Table B-3

Comparison of Discrete Sample BTVs to Multi-Incremental BTVs for TI Geologic Unit

Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites

Vieques, Puerto Rico

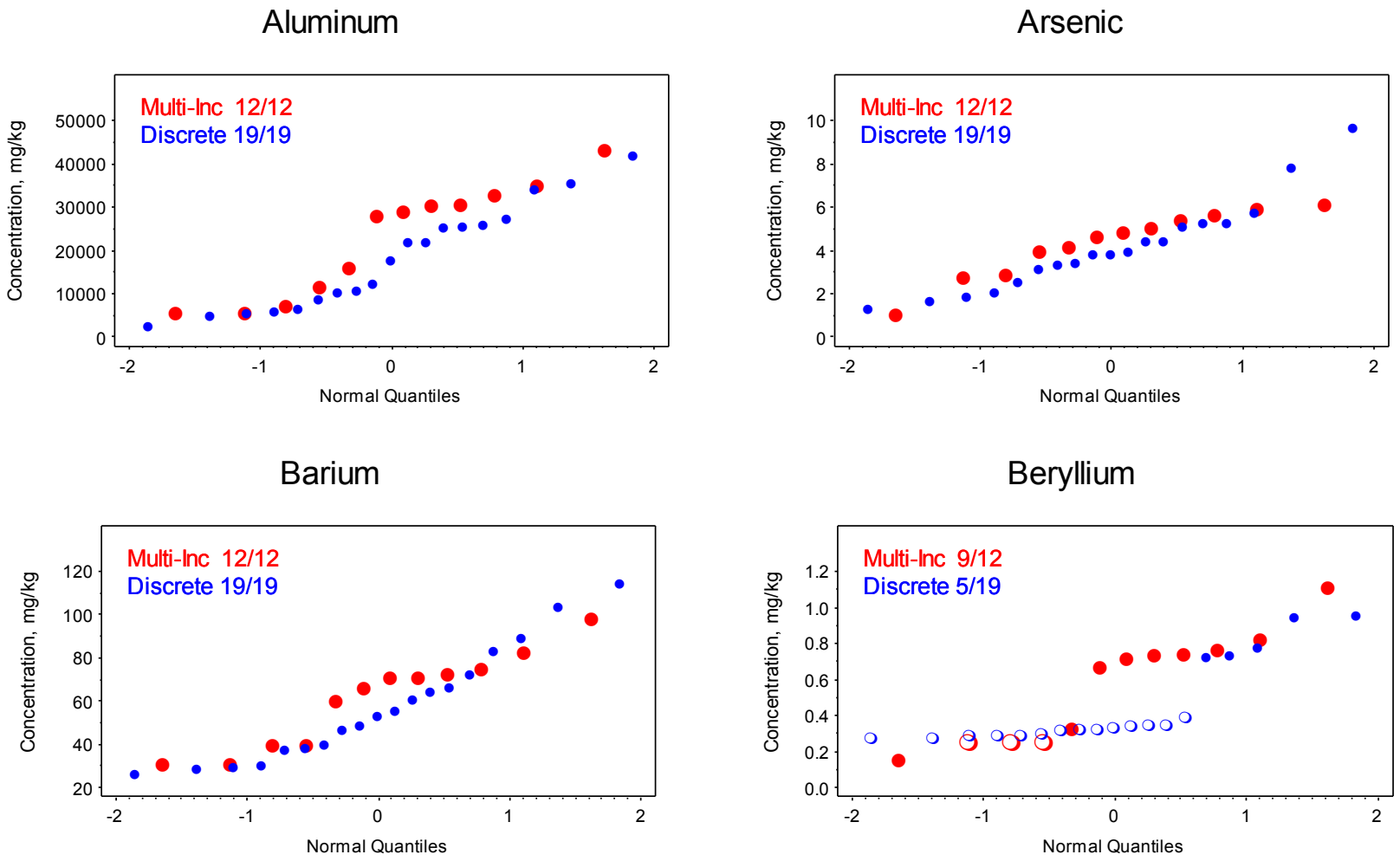
Parameter	Discrete BTV	Multi-Incremental BTV	Ratio of Multi-Incremental Over Discrete BTVs
Aluminum	46400	58200	1.25
Arsenic	9.17	8.47	0.92
Barium	119	120	1.01
Beryllium	0.914	1.16	1.27
Cadmium	2.36	0.299	0.13
Calcium	417000	59500	0.14
Chromium	70.1	79.4	1.13
Cobalt	9.16	11.2	1.22
Copper	30.6	24.6	0.80
Iron	37100	48900	1.32
Lead	18.9	17.2	0.91
Magnesium	32300	6540	0.20
Manganese	1150	1040	0.90
Nickel	19.3	23	1.19
Potassium	10800	7900	0.73
Selenium	1.53	1.31	0.86
Sodium	-	338	-
Thallium	0.178	-	-
Vanadium	55.7	71.7	1.29
Zinc	37.2	34.2	0.92

Table B-4
Central Tendency Comparisons (Discrete to Multi-Incremental)
Wilcoxon Rank Sum (WRS) or Gehan Test
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Constituent	Comparison Test Used	Probability that the Observed Differences Would Occur Purely by Chance	Statistical Decision with 0.05 Signficance Level	Mean of Multi-Incremental Detects	Mean of Discrete Detects	Median of Multi-Incremental Detects	Median of Discrete Detects	Number of Multi-Incremental Detects	Number of Multi-Incremental Samples	Number of Discrete Detects	Number of Discrete Samples	Percent Detects Multi-Incremental	Percent Detects Discrete
Aluminum	WRS	0.265	nsd	22600	17900	28300	17400	12	12	19	19	100	100
Arsenic	WRS	0.372	nsd	4.32	4.1	4.7	3.8	12	12	19	19	100	100
Barium	WRS	0.478	nsd	60.9	56.9	67.8	52.8	12	12	19	19	100	100
Beryllium	Gehan	0.084	nsd	0.666	0.822	0.73	0.77	9	12	5	19	75	26
Cadmium	WRS	0.000	Multi-Incremental < Discrete	0.245	1.4	0.25	1.4	10	12	19	19	83	100
Cadmium *	WRS	0.000	Multi-Incremental < Discrete	0.234	1.4	0.24	1.4	8	10	19	19	80	100
Calcium	WRS	0.005	Multi-Incremental < Discrete	59000	162000	35100	193000	12	12	19	19	100	100
Calcium *	WRS	0.000743963	Multi-Incremental < Discrete	28200	162000	28200	193000	8	8	19	19	100	100
Chromium	WRS	0.556	nsd	32.1	27.3	38.6	25.9	12	12	19	19	100	100
Cobalt	WRS	0.670	nsd	5.13	5.42	6.05	5.2	12	12	19	19	100	100
Copper	WRS	0.446	nsd	15.9	15.1	16.1	15.1	12	12	13	13	100	100
Iron	WRS	0.128	nsd	19500	13800	24500	11400	12	12	19	19	100	100
Lead	WRS	0.157	nsd	7.26	4.81	8.8	5.2	11	12	19	19	92	100
Magnesium	WRS	0.919	nsd	7770	9700	5120	5790	12	12	19	19	100	100
Magnesium *	WRS	0.460588314	nsd	5000	9700	4800	5790	9	9	19	19	100	100
Manganese	WRS	0.364	nsd	516	433	548	327	12	12	17	17	100	100
Nickel	WRS	0.216	nsd	10.1	8.24	11.6	8.8	12	12	19	19	100	100
Potassium	WRS	0.429	nsd	4820	4210	6210	4380	12	12	18	19	100	95
Selenium	Gehan	0.007	Discrete < Multi-Incremental	1.58	0.697	1.35	0.7	6	12	9	19	50	47
Selenium *	Gehan	0.032429927	Discrete < Multi-Incremental	1.17	0.697	1.2	0.7	3	9	9	19	33	47
Thallium	Gehan	0.317	nsd	0.26	0.198	0.26	0.13	1	12	7	19	8	37
Thallium *	Gehan	0.117	nsd	0.26	0.095	0.26	0.1	1	12	5	17	8	29
Vanadium	WRS	0.037	Discrete < Multi-Incremental	34.4	24.8	39.3	27.2	12	12	19	19	100	100
Zinc	WRS	0.030	Discrete < Multi-Incremental	23.9	17.6	23.9	17.4	12	12	19	19	100	100
Zinc *	WRS	0.058	nsd	22.5	17.6	23.6	17.4	11	11	19	19	100	100

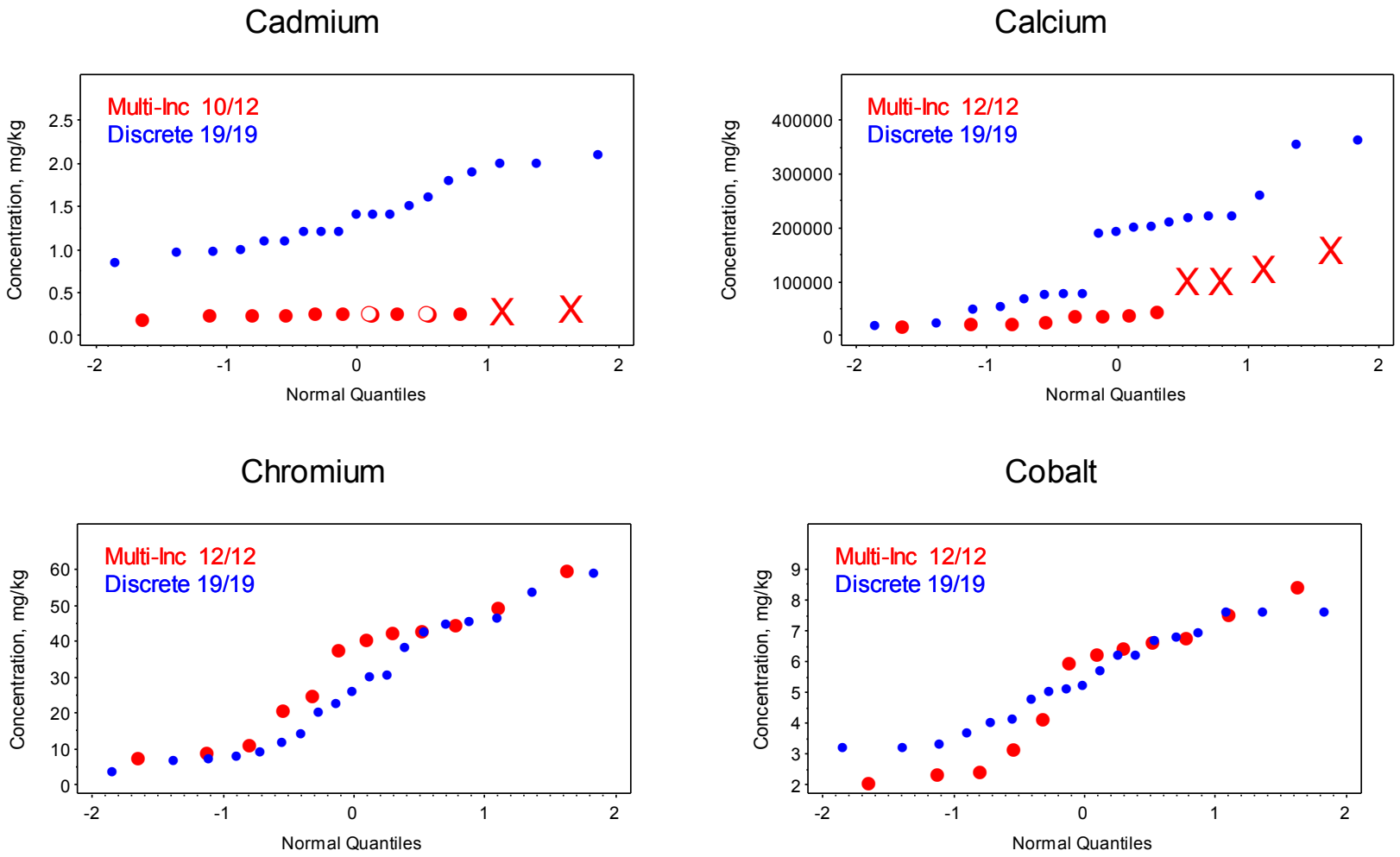
nsd = no significant difference
* Mathematical Outliers Excluded

Figure 1: Probability Plots Comparing Discrete and Multi-Incremental Concentrations from TI Geologic Unit



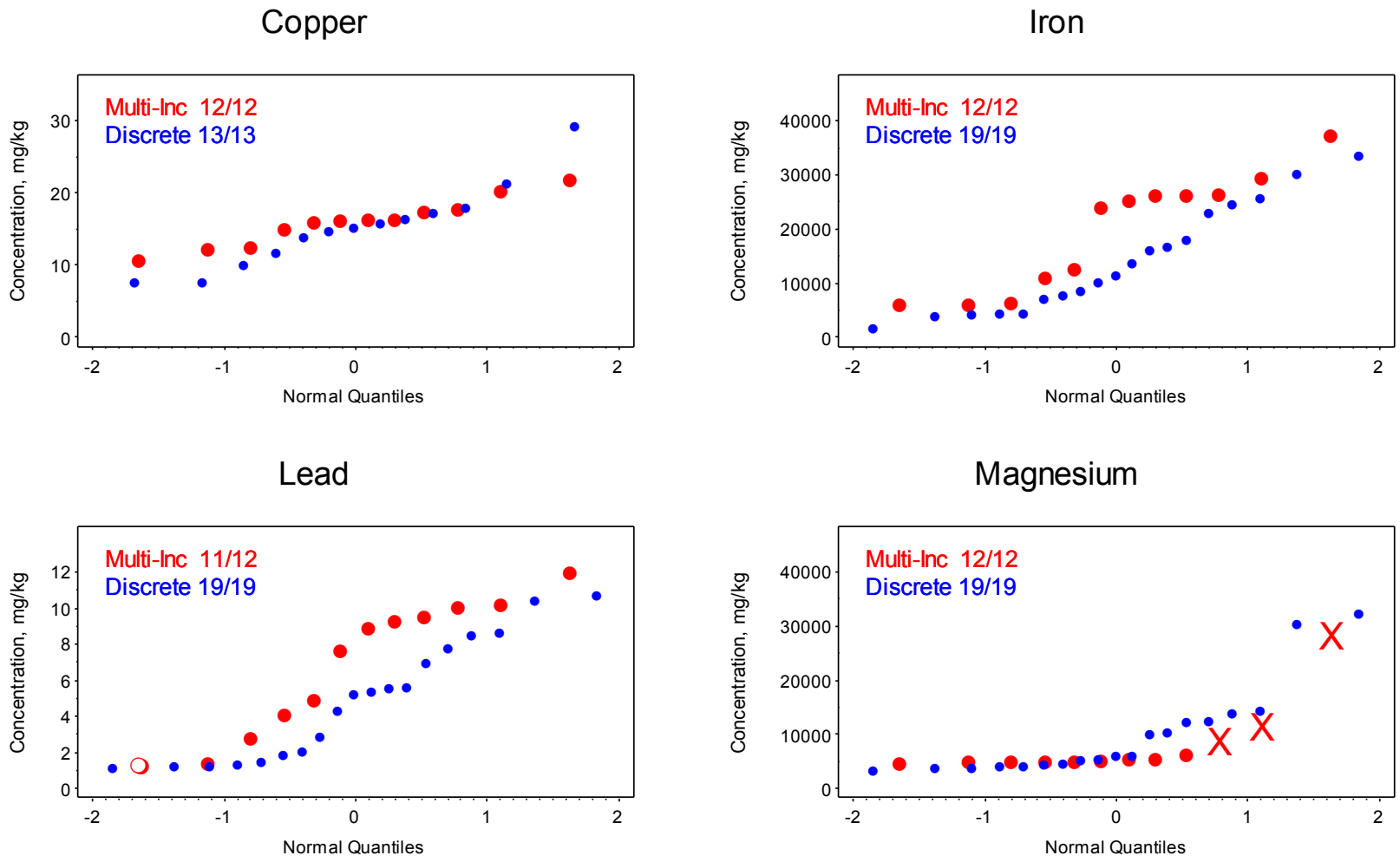
Open Symbol Represents Nondetected Value (1/2 DL); Solid Symbol Represents Detects; X Represents Mathematical Outlier

Figure 1: Probability Plots Comparing Discrete and Multi-Incremental Concentrations from TI Geologic Unit



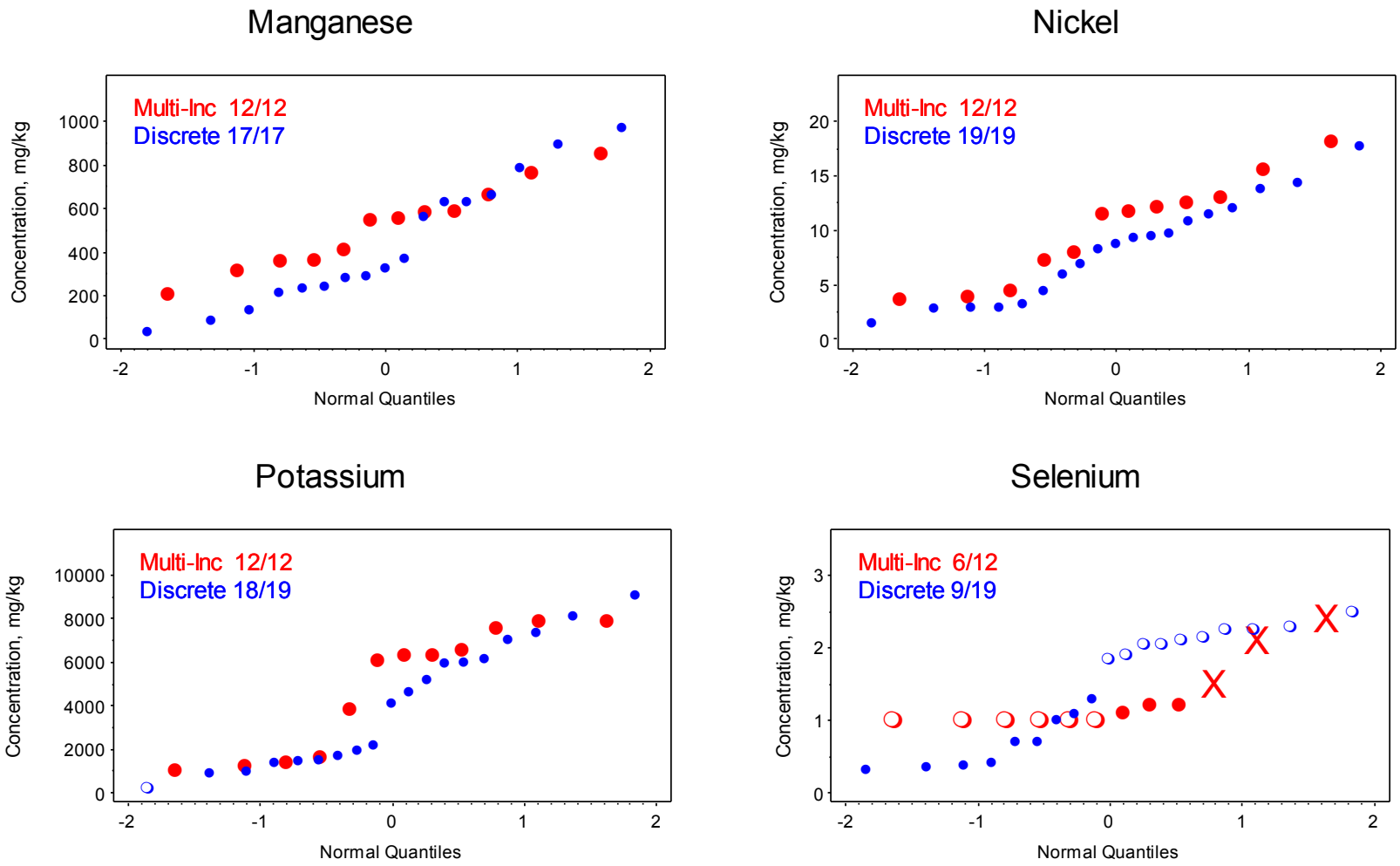
Open Symbol Represents Nondetected Value (1/2 DL); Solid Symbol Represents Detects; X Represents Mathematical Outlier

Figure 1: Probability Plots Comparing Discrete and Multi-Incremental Concentrations from TI Geologic Unit



Open Symbol Represents Nondetected Value (1/2 DL); Solid Symbol Represents Detects; X Represents Mathematical Outlier

Figure 1: Probability Plots Comparing Discrete and Multi-Incremental Concentrations from TI Geologic Unit



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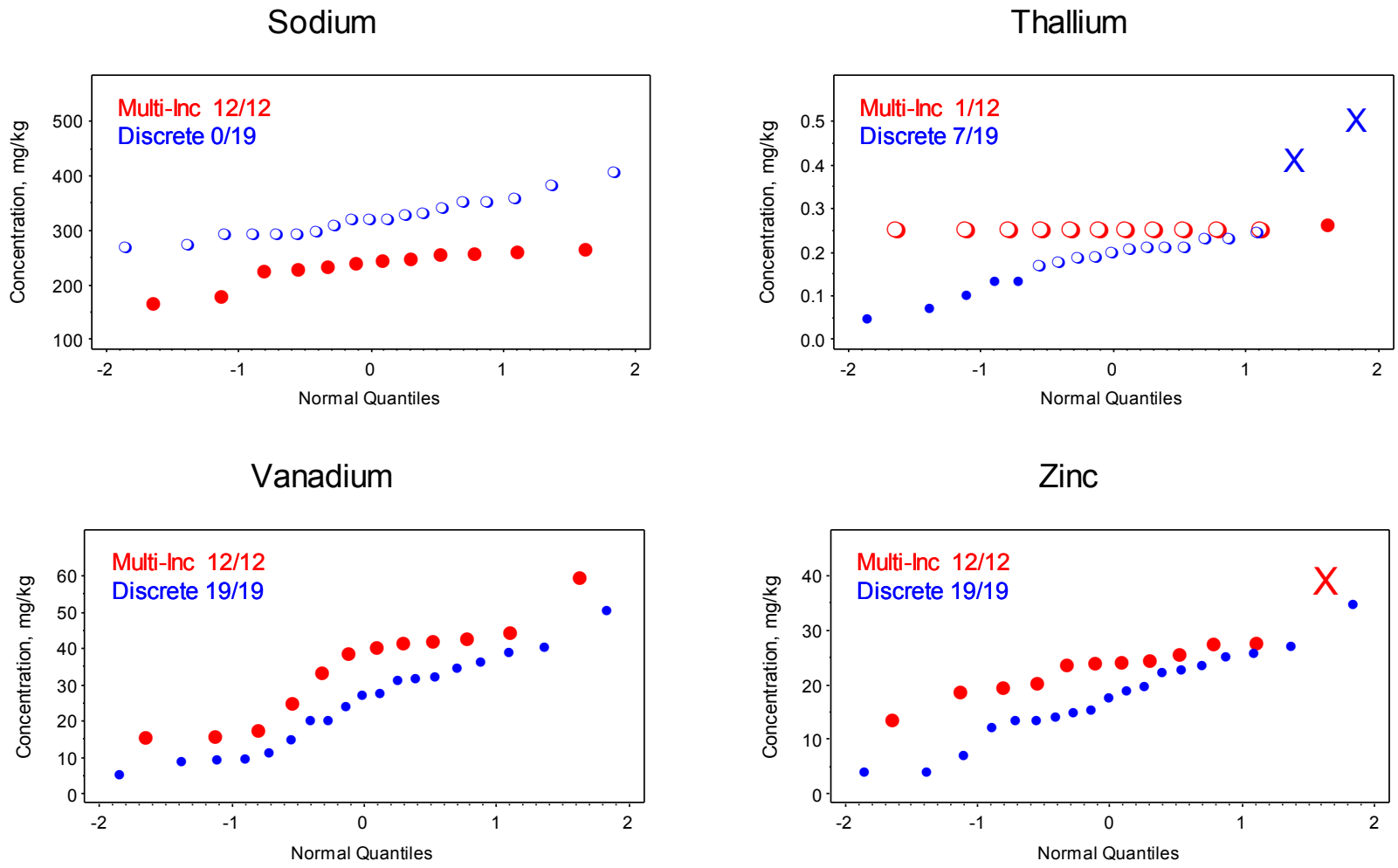

Open Symbol Represents Nondetected Value (1/2 DL); Solid Symbol Represents Detects; X Represents Mathematical Outlier

Attachment C
Radionuclide Screening Levels

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APPENDIX C

Screening Levels for Radionuclides

Screening Levels for Protection of Human Health

Screening levels for protection of human health from radionuclides detected in soil, groundwater, surface water, and sediment are based on radionuclide Preliminary Remediation Goals (PRGs) developed for EPA by the Oak Ridge National Laboratory (ORNL) (http://epa-prgs.ornl.gov/radionuclides/). The PRGs have been developed using exposure factors obtained from EPA's Risk Assessment Guidance for Superfund (RAGS) (EPA, 1991), and EPA's Radionuclide Soil Screening Guidance (EPA, 2000) in addition to other EPA guidance documents. The radionuclide PRGs represent radionuclide concentrations in soil and groundwater corresponding to a 1×10^{-6} excess lifetime cancer risk, calculated for several different exposure scenarios. Further details on the exposure factors and guidance used in developing the radionuclide PRGs are presented in the User's Guide (http://epa-prgs.ornl.gov/radionuclides/prg_guide.html).

Identification of the Exposure Scenario and Complete Exposure Pathways

The receptors used as the basis for assessing cleanup for chemicals in soil are a resident and a commercial/industrial worker. The exposure pathways considered for both the resident and worker exposure scenarios are: incidental soil ingestion, inhalation of suspended dust in air, and external exposure to gamma radiation; external exposure for the resident is estimated assuming a portion of time is spent indoors with the building providing some shielding from gamma radiation. The resident scenario also includes consumption of fruits and vegetables. The resident is assumed to be present at the site 350 days/year for 30 years. The worker is assumed to be present at the site for 250 days/year for 25 years; the worker is assumed to spend this time outdoors, with no reduction of exposure by shielding for purposes of estimating risks from external exposure.

Radionuclide Toxicity Values

The radionuclide PRGs are calculated using cancer slope factors, drawn from the radionuclide Health Effects Assessment Summary Tables (HEAST) (EPA, 2001), and in Federal Guidance Report (FGR) No. 13 (EPA, 1999). Ingestion and inhalation slope factors published in HEAST are age-averaged, lifetime attributable cancer morbidity incidence (nonfatal cancer) risk per unit of radioactivity inhaled or ingested. External exposure slope factors are lifetime attributable radiation cancer incidence for each year of exposure to external radiation from photon-emitting radionuclides distributed uniformly in a defined layer of soil.

With the EPA radionuclide PRGs for an adult worker, the ingestion and inhalation slope factors have been adjusted downward slightly to account only for radiation dose and risks during the duration of exposure as an adult, which accounts for the differences in the values for ingestion and inhalation slope factors found in HEAST (EPA, 2001) and those found in the radionuclide PRG web site for calculating a worker PRG value.

Assessing Risks from Radioactive Decay Products

Uranium occurs in two natural decay series, starting with U-238 and U-235, respectively. In nature, the radionuclides in these decay series are in a state of secular equilibrium, in which the activities of all radionuclides within each decay series are approximately equal. Two conditions are needed for secular equilibrium. First, the parent radionuclide must have a long half-life, much longer than any of the other radionuclides in the decay series. Second, a sufficiently long period of time must have elapsed to allow for ingrowth of the decay products; a period of 10 half-lives of the decay product is considered to be a sufficiently long time to achieve secular equilibrium. The decay chains for U-238 and U-235 are shown in ANL, 2005.

The radiation risk from the decay products in secular equilibrium must be included to properly account for the total risk associated with the parent radionuclides in soil. Calculation of risks accounting for radioactive decay products was conducted using the guidelines provided in EPA's User's Guide (http://epa-prgs.ornl.gov/radionuclides/prg_guide.html). Cancer slope factors for certain radionuclides are designated as "+D" to indicate that these include the contribution to risks from short-lived radioactive daughter products. The

PRG for U-238 is calculated as U-238+D, which includes the cancer risks from the radioactive decay of Th-234, Pa-234m, Pa-234. The PRG for U-235 is calculated as U-235+D including the risks from short-lived daughter products Pa-231 and Ac-227. The cancer slope factor for U-234 does not include any contribution to risk from short-lived daughter products.

Soil Screening Levels for Protection of Groundwater

Soil Screening Levels (SSLs) for the migration to groundwater pathway are used to identify radionuclide concentrations in soil that have the potential to contaminate groundwater above Maximum Contaminant Levels (MCLs). As described in EPA's radionuclide PRG guidance, SSLs are back calculated from acceptable groundwater concentrations. First, the acceptable groundwater concentration is multiplied by a dilution factor of 10 to obtain a target leachate concentration. The target leachate value is then converted to a total soil concentration using a partitioning equation. Default assumptions in the EPA's radionuclide PRG guidance are used in calculating the SSLs. The HHRA uncertainty analysis will discuss and address uncertainties relating to the reporting limits not being low enough to meet the risk-based SSLs for uranium isotopes.

Discussion

As described previously, the PRG for a worker is based on the assumption that the worker is outdoors, with no reduction of exposure by shielding for purposes of estimating risks from external exposure. For development of radionuclide PRGs, the EPA has two sets of assumptions for estimating worker exposure which reflect this scenario:

- Outdoor worker – exposure frequency = 225 days/year; exposure duration = 25 years; gamma shielding factor = 1.0 (represents no shielding from gamma exposure from soil).
- "Composite" worker – exposure frequency = 250 days/year; exposure duration = 25 years; gamma shielding factor = 1.0.

The PRGs shown in Table C-1 reflect the values for the composite worker, as these have slightly more conservative exposure factors (e.g. a higher value for exposure frequency). The differences in the PRGs for the outdoor worker and composite worker scenarios are shown below:

	Outdoor Worker (pCi/g)	Composite Worker (pCi/g)
U-238+D	1.65	1.5
U-235+D	34.3	30.9
U-234	32.3	29.1

Screening Levels for Protection of Ecological Receptors

Two radionuclide effect thresholds, as determined by consensus of international radiation regulatory agencies, form the basis for effect thresholds used to develop screening levels of radionuclides in soil for protection of plants and animals. General guidance from ICRP 60, *Recommendations of the International Commission on Radiological Protection*; IAEA 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards; and Sources and Effects of Ionizing Radiation* (UNSCEAR, 2000) concluded that radiological doses to aquatic animals (including vertebrates and invertebrates) and to terrestrial plants and terrestrial animals (invertebrates and vertebrates) should not exceed 1.0 and 0.1 rad/day, respectively. Provided that radiation exposure does not exceed these biota dose levels, the consensus opinion of the international radiological organizations is that ecological populations will be protected. DOE has adopted these effect thresholds and integrated them into the graded approach (DOE STD 1153 2002).

The DOE graded approach includes a screening method and the following more detailed levels of analysis for demonstrating compliance with applicable dose limits for protection of biota:

- A general screening involves comparing maximum radionuclide concentrations in environmental media (i.e., soil) with a set of BCGs to evaluate compliance with the biota dose limits.

- Site specific screening involves more realistic site representative grouped parameters (e.g., BAFs) in place of conservative default parameters, using mean radionuclide concentrations in place of maximum values, and taking into account time dependence and spatial extent of contamination.
- Site specific analysis employs a kinetic allometric modeling methodology. Multiple parameters that represent contribution to an organism's internal dose can be modified to represent site and organism specific characteristics. These parameters include body mass, consumption rates of food or soil, inhalation rate, lifespan, and biological elimination rates. Development of the organism specific characteristics involve using allometric equations that relate these parameters to body mass.
- Site specific biota dose assessment involves the collection and analysis of biota samples.

The BCGs for plants and animals represent screening levels for radionuclides in soil, sediment and surface water. The BCGs for radionuclides use conservative assumptions for internal and external exposure. While existing effects data support the application of these dose limits to representative individuals within populations of plants and animals, the assumptions and parameters applied in the derivation of the BCGs are based on a maximally exposed individual, representing a conservative approach for screening purposes. The following assumptions are used for estimating doses from external exposure for purposes of developing BCGs:

- The source medium is infinite in extent and contains uniform concentrations of radionuclides (i.e., there are no hot spots).
- The exposed organism is very small; consequently, 100 percent of the radionuclide energies are absorbed.
- Organisms exposed to soil are uniformly surrounded by the source medium.

The following assumptions are used to estimate doses from internal exposure for the purpose of developing BCGs:

- All radionuclide decay energies are retained in tissue (100 percent of energies absorbed).
- Exposure for a given radionuclide includes all decay chain progeny.
- All radionuclides are uniformly distributed such that all target tissues may be affected.

BCGs can be calculated using dose models, equations, and default parameters that are presented in DOE STD 1153 2002.

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Table C-1
Screening Level for Radionuclides for Protection of Human Health and Ecological Receptors
Master Sampling and Analysis Plan - East Vieques Terrestrial UXO Sites
Vieques, Puerto Rico

Radionuclide	Preliminary Remediation Goals (PRGs) for Protection of Human Health						Biota Concentration Guides (BCGs) for protection of Ecological Receptors					
	Residential Scenario - in Soil (pCi/g)	Worker Scenario - in soil (pCi/g)	Ground-water Protection SSL in Soil (pCi/g)	Residential Scenario in Sediment (pCi/g)	Residential Scenario in Ground Water (pCi/L)	Residential Scenario in Surface Water (pCi/L)	BCG in water (pCi/L)	Limiting Organism	BCG in sediment (pCi/g)	Limiting Organism	BCG in Soil (pCi/g)	Limiting Organism
U-238	0.7	1.5	0.12	0.7	0.6	0.6	200	Aquatic Animal	2000	Riparian Animal	2000	Terrestrial Animal
U-235	4	30.9	0.8	4	0.7	0.7	200	Aquatic Animal	4000	Riparian Animal	3000	Terrestrial Animal
U-234	4	29.1	2,240	4	0.7	0.7	200	Aquatic Animal	5000	Riparian Animal	5000	Terrestrial Animal

Notes:

Values for protection of human health are based on EPA's Radionuclide PRGs http://epa-prgs.ornl.gov/radionuclides/

Values for protection of human health are based on a 1 in 1,000,000 target cancer risk level

Values for protection of human health from direct contact with sediment are the same values as for direct contact with soil based on a residential scenario

Values for protection of human health from direct contact with surface water are the same values as for exposure to radionuclides in tap water, based on a residential scenario

Values for protection of ecological receptors are based on DOE's Biota Concentration Guides (BCGs), http://www.hss.doe.gov/nuclearsafety/techstds/docs/standard/1153.htm

Values for protection of ecological receptors are based on a 1 rad/day dose limit for aquatic organisms and a 0.1 rad/day dose limit for terrestrial organisms

Uranium isotopes are not considered to be bioaccumulative; screening levels in abiotic media based on ingestion of fish or shellfish were not calculated.

Groundwater protection Soil Screening Level (SSL) achieves the MCL in groundwater.

Attachment D
Standard Operating Procedures (SOPs)

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STANDARD OPERATING PROCEDURE A-2a

Soil Sampling

I. Purpose and Scope

The purpose of this procedure is to provide standardized procedures for obtaining samples of surface and subsurface soils. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

II. Equipment and Materials

- Personal Protection Equipment
- Stainless-steel hand auger, split spoon, or appropriate hand tool
- Thin-walled sampling tubes (such as a shelby tube)
- Direct-push rig, drilling rig, soil-coring rig, or hand auger equipment
- Stainless-steel pan or bowl
- Stainless-steel spoons or dedicated wooden spoons
- Sample bottles and equipment
- photo-ionization detector (PID) or flame-ionization detector (FID)

III. Procedures and Guidelines

All personnel shall be wearing personal protective equipment (PPE) per health and safety plan (HASP). Decontaminate all equipment per SOP "*Decontamination of Drilling Rigs and Equipment*" and "*Decontamination of Personnel and Equipment.*" Locate and record the sample point in the logbook. If appropriate, record sample location using global positioning system (GPS) or land survey.

A. Surface and Shallow Subsurface Sampling with Hand Auger

Remove soil to a point just above the interval to be sampled. Collect soil at the desired sampling depth. Immediately take soil for volatile organic compound (VOC) analysis directly from the end of the hand auger with an Encore sampler. Place soil for analyses other than VOCs into a stainless-steel bowl, take a PID or FID reading of the soil collected, and log the readings accordingly into the boring (or other) log. Mix the soil in the bowl according to "*Homogenization of Soil and Sediment Samples*" SOP. If this interval is to be collected for analysis, use a stainless-steel spoon or dedicated wooden spoon to transfer the sample from the bowl to the sample container(s). Try not to touch soil to be collected with bare or gloved hands. Soil samples in sample containers should be free of pebbles, roots, and other non-soil debris. Preferably, soil jars should be filled full, but if difficulties are

encountered in getting sample volume, see SAP for minimum sample volume required by lab, or have the Environmental Information Specialist (EIS) call lab for minimum volume lab will need for that/those analyses. For VOC samples in jars, fill completely to avoid headspace. For VOC samples in Encore® samplers see SOP "*Soil Sampling for VOCs using the Encore ® Sampler*". For VOC samples in Terra core® samplers see SOP "*Soil Sampling for VOCs using the Terra core ® Sampler*".

B. Split-Spoon or Direct Push Sampling

Advance a boring to just above the sample depth using a drilling rig, slide hammer, or direct push technology (DPT) rig. Lower the sampler into the hole and advance it to a depth equal to the total length of the desired interval. If using a drilling rig, or slide hammer, advance the split spoon sampler using a weighted or pneumatic hammer. Record the weight, type, blow count (number of blows required to advance 6 inches), and penetrated length into the boring log. Record only the penetrated length if using DPT.

The driller will then open the sampler or extrude the lexan (or similar) sample tube and cut open the tube, leaving the cut piece of tube on the sample to minimize the possibility of soil and vapors to escape. Record the total length of sample retrieved. Using a PID or FID, take readings along several points of the sampler and record them. Also, record any visual observations of suspected contamination. If this interval is to be collected, samples for VOC analysis are to be collected immediately from the core or split spoon at the target location (based on visual observations and PID/FID readings). Samples for analyses other than VOCs should be homogenized according to "*Homogenization of Soil and Sediment Samples*" SOP. Additional sample volume may be obtained by collecting a second sample below the first sample and compositing the sample for non-volatile parameters only (if still within the desired sample depth interval). A co-located hole within approximately 2 feet from the first hole may also be used to collect additional sample volume.

C. Thin-Walled Tube Sampling

Undisturbed samples may be collected for analysis for physical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24 to 36 inches long and 3 to 4 inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax (or comparable) and then sealed with end caps and tape. The sample designation, date and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing.

D. Sampling Descriptions

Following sample retrieval, the soils should be visually described in the boring log using ASTM D 2488, (attached) including approximated depths, PID readings, and any other relevant observations. Use the standard CH2M HILL soil description format found on soil boring log headers:: soil name, USCS group symbol, Munsell number and color, moisture content, relative density or consistency, soil structure, mineralogy (note approximate percentages of sand, silt and clay). Use a measuring tape or folding ruler calibrated in feet

and 10ths for logging soils. Note the depths that drilling penetration is easier/faster. Note at what depth drillers switched from augering to air hammer, as applicable. Make sure to note at what depth soil becomes saturated (and if it appears to return to an unsaturated state, indicating pearched water).

IV. Key Checks and Preventative Maintenance

- Decontamination of all non-disposable equipment between sampling locations.
- PID/FID calibration and checks.

Designation: D 1587 – 08

Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively intact soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston, plug, or rotary-type samplers should comply with Section 6.3 of this practice which describes the thin-walled tubes.

NOTE 1—This practice does not apply to liners used within the samplers.

1.2 This Practice is limited to soils that can be penetrated by the thin-walled tube. This sampling method is not recommended for sampling soils containing gravel or larger size soil particles cemented or very hard soils. Other soil samplers may be used for sampling these soil types. Such samplers include driven split barrel samplers and soil coring devices (D 1586, D 3550, and D 6151). For information on appropriate use of other soil samplers refer to D 6169.

1.3 This practice is often used in conjunction with fluid rotary drilling (D 1452, D 5783) or hollow-stem augers (D 6151). Subsurface geotechnical explorations should be reported in accordance with practice (D 5434). This practice discusses some aspects of sample preservation after the sampling event. For information on preservation and transportation process of soil samples, consult Practice D 4220. This practice does not address environmental sampling; consult D 6169 and D 6232 for information on sampling for environmental investigations.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4.1 The tubing tolerances presented in Table 1 are from sources available in North America. Use of metric equivalent is acceptable as long as thickness and proportions are similar to those required in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 1452 Practice for Soil Investigation and Sampling by Auger Borings

D 1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils

D 3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4220 Practices for Preserving and Transporting Soil Samples

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Oct. 1, 2008. Published October 2008. Originally approved in 1958. Last previous edition approved in 2007 as D 1587 – 00 (2007)$^{\varepsilon 1}$.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

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TABLE 1 Dimensional Tolerances for Thin-Walled Tubes

Size Outside Diameter	Nominal Tube Diameters from Table 2[A] Tolerances					
	2 in.	50.8 mm	3 in.	76.2 mm	5 in.	127 mm
Outside diameter, D_o	+0.007	+0.179	+0.010	+0.254	+0.015	0.381
	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Inside diameter, D_i	+0.000	+0.000	+0.000	+0.000	+0.000	+0.000
	-0.007	-0.179	-0.010	-0.254	-0.015	-0.381
Wall thickness	±0.007	±0.179	±0.010	±0.254	±0.015	±0.381
Ovality	0.015	0.381	0.020	0.508	0.030	0.762
Straightness	0.030/ft	2.50/m	0.030/ft	2.50/m	0.030/ft	2.50/m

[A] Intermediate or larger diameters should be proportional. Specify only two of the first three tolerances; that is, D_o and D_i, or D_o and Wall thickness, or D_i and Wall thickness.

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D 6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities

3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *inside clearance ratio, %, n*—the ratio of the difference in the inside diameter of the tube, D_i, minus the inside diameter of the cutting edge, D_e, to the inside diameter of the tube, D_i expressed as a percentage (see Fig. 1).

3.2.2 *ovality, n*—the cross section of the tube that deviates from a perfect circle.

4. Summary of Practice

4.1 A relatively intact sample is obtained by pressing a thin-walled metal tube into the in-situ soil at the bottom of a boring, removing the soil-filled tube, and applying seals to the soil surfaces to prevent soil movement and moisture gain or loss.

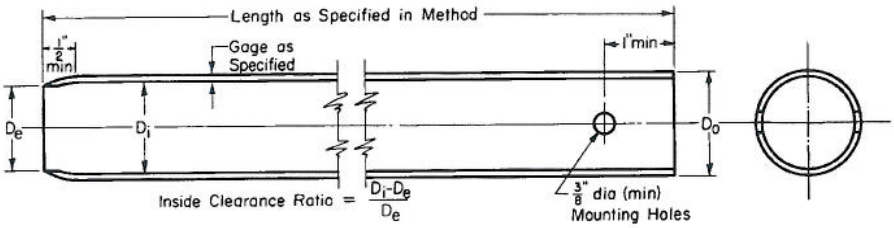
5. Significance and Use

5.1 This practice, or Practice D 3550 with thin wall shoe, is used when it is necessary to obtain a relatively intact specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice. are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Drilling Equipment*—When sampling in a boring, any drilling equipment may be used that provides a reasonably clean hole; that minimizes disturbance of the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside



NOTE 1—Minimum of two mounting holes on opposite sides for D_o smaller than 4 in. (101.6 mm).

NOTE 2—Minimum of four mounting holes equally spaced for D_o 4 in. (101.6 mm) and larger.

NOTE 3—Tube held with hardened screws or other suitable means.

NOTE 4—2-in (50.8 mm) outside-diameter tubes are specified with an 18-gauge wall thickness to comply with area ratio criteria accepted for "intact samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gauge tubes are generally readily available.

Metric Equivalent Conversions

in.	mm
⅜	9.53
½	12.7
1	25.4
2	50.8
3	76.2
4	101.6
5	127

FIG. 1 Thin-Walled Tube for Sampling

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TABLE 2 Suitable Thin-Walled Steel Sample Tubes[A]

Outside diameter (D_o):			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Inside clearance ratio, %	<1	<1	<1

[A] The three diameters recommended in Table 2 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

6.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

6.3 *Thin-Walled Tubes*, should be manufactured to the dimensions as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. (50 to 130 mm) and be made of metal having adequate strength for the type of soil to be sampled. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used but the tube dimensions should be proportional to the tube designs presented here.

6.3.1 *Length of Tubes*—See Table 2 and 7.4.1.

6.3.2 *Tolerances*, shall be within the limits shown in Table 1.

6.3.3 *Inside Clearance Ratio*, should be not greater than 1 % unless specified otherwise for the type of soil to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See 3.2.1 and Fig. 1 for definition of inside clearance ratio.

6.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating, unless the soil is to be extruded less than 3 days. The type of coating to be used may vary depending upon the material to be sampled. Plating of the tubes or alternate base metals may be specified. Galvanized tubes are often used when long term storage is required. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, zinc oxide, and others.

NOTE 3—Most coating materials are not resistant to scratching by soils that contain sands. Consideration should be given for prompt testing of the sample because chemical reactions between the metal and the soil sample con occur with time.

6.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a venting area and suitable check valve with the venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

7. Procedure

7.1 Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the drilling and sampling operation.

7.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted.

NOTE 4—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

7.3 Lower the sampling apparatus so that the sample tube's bottom rests on the bottom of the hole and record depth to the bottom of the sample tube to the nearest 0.1-ft (0.03 m).

7.3.1 Keep the sampling apparatus plumb during lowering, thereby preventing the cutting edge of the tube from scraping the wall of the borehole.

7.4 Advance the sampler without rotation by a continuous relatively rapid downward motion and record length of advancement to the nearest 1 in. (25 mm).

7.4.1 Determine the length of advance by the resistance and condition of the soil formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 in. (76 mm) for sludge and end cuttings.

NOTE 5—The mass of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 2.

7.5 When the soil formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

7.6 Withdraw the sampler from the soil formation as carefully as possible in order to minimize disturbance of the sample. The tube can be slowly rotated to shear the material at the end of the tube, and to relieve water or suction pressures (or both) and improve recovery. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 minutes) may improve sample recovery.

8. Sample Measurement, Sealing and Labeling

8.1 Upon removal of the tube, remove the drill cuttings in the upper end of the tube and measure the length of the soil sample recovered to the nearest 0.25 in. (6 mm) in the tube. Seal the upper end of the tube. Remove at least 1 in. (25 mm)

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of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube.

8.1.1 Tubes sealed over the ends, as opposed to those sealed with expanding packers, should be provided with spacers or appropriate packing materials, or both prior to sealing the tube ends to provide proper confinement. Packing materials must be nonabsorbent and must maintain their properties to provide the same degree of sample support with time.

8.1.2 Depending on the requirements of the investigation, field extrusion and packaging of extruded soil samples can be performed. This allows for physical examination and classification of the sample. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. In some cases, further extrusion may cause sample disturbance reducing suitability for testing of engineering properties. In other cases, if damage is not significant, cores can be extruded and preserved for testing (Practice D 4220). Bent or damaged tubes should be cut off before extruding.

8.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample (see Section 9). Assure that the markings or labels are adequate to survive transportation and storage.

NOTE 6—Top end of the tube should be labeled "top."

9. Field Log

9.1 Record the information that may be required for preparing field logs in general accordance to Guide D 5434. This guide is used for logging explorations by drilling and sampling. Some examples of the information required include;

9.1.1 Name and location of the project,

9.1.2 Boring number,

9.1.3 Log of the soil conditions,

9.1.4 Surface elevation or reference to a datum to the nearest foot (0.5 m) or better,

9.1.5 Location of the boring,

9.1.6 Method of making the borehole,

9.1.7 Name of the drilling foreman and company, and

9.1.8 Name of the drilling inspector(s).

9.1.9 Date and time of boring-start and finish,

9.1.10 Depth to groundwater level: date and time measured,

9.2 Recording the appropriate sampling information is required as follows:

9.2.1 Depth to top of sample to the nearest 0.1 ft. (.03 m) and number of sample,

9.2.2 Description of thin-walled tube sampler: size, type of metal, type of coating,

9.2.3 Method of sampler insertion: push or drive,

9.2.4 Method of drilling, size of hole, casing, and drilling fluid used,

9.2.5 Soil description in accordance with Practice D 2488,

9.2.6 Length of sampler advance (push), and

9.2.7 Recovery: length of sample obtained.

10. Keywords

10.1 geologic investigations; intact; sampling; soil exploration; soil investigations; subsurface investigations

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1587 – 00 (2007)$^{\varepsilon 1}$) that may impact the use of this standard. (Approved October 1, 2008.)

(*1*) Replaced "undisturbed" with "intact" in Sections 1.1, 4.1, 5.1, 10, and Note 4 of Fig. 1.

(*2*) Editorial changes made in Sections 1.4, 7.3, 7.4.1, 7.6, 8.1, and 8.1.2.

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Designation: D 2488 – 00

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Feb. 10, 2000. Published May 2000. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 93ε1.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

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limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula*.

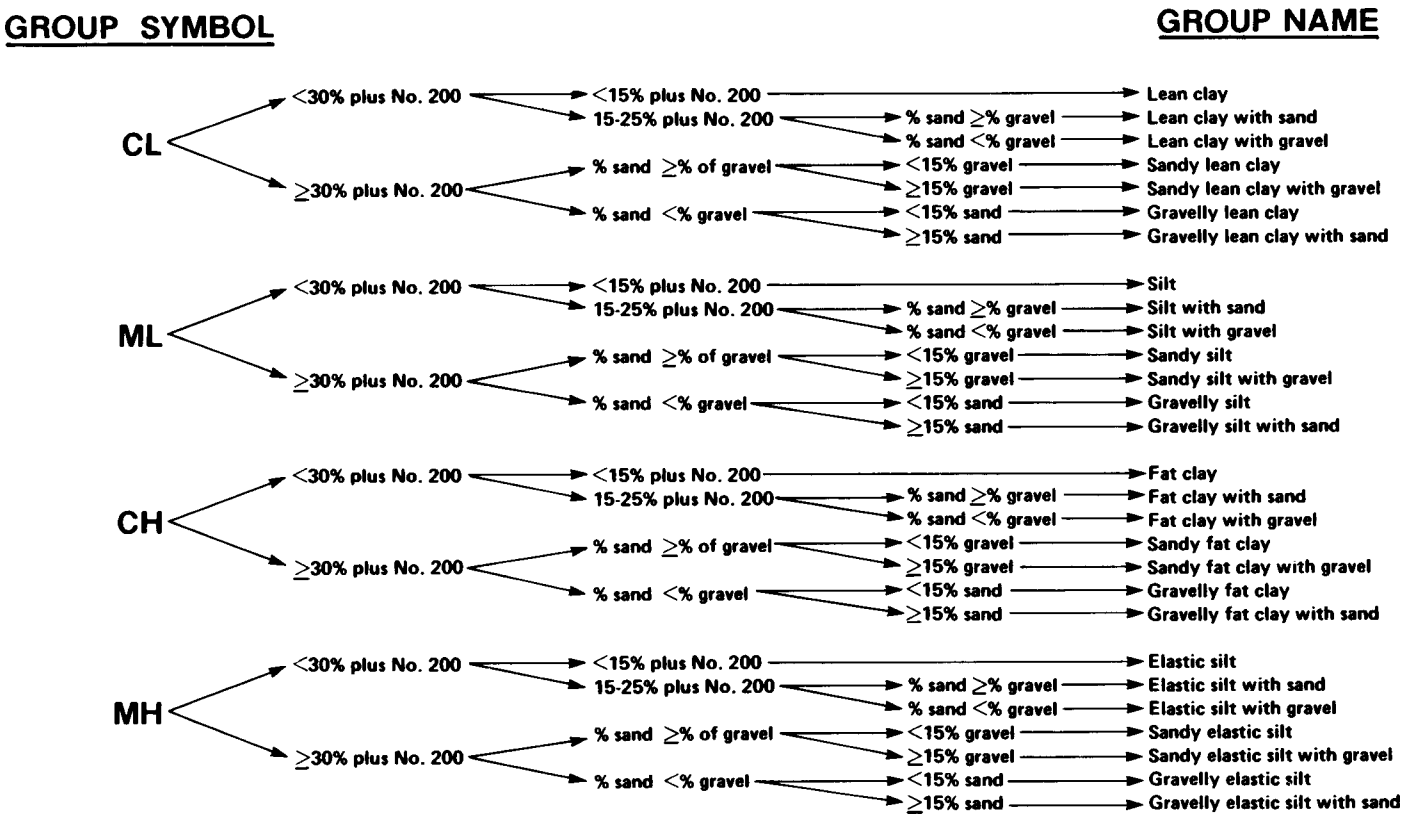
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens*.

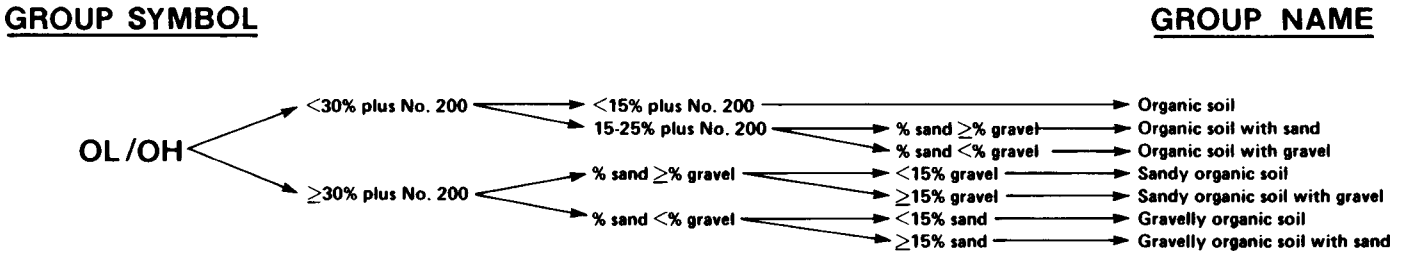
7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

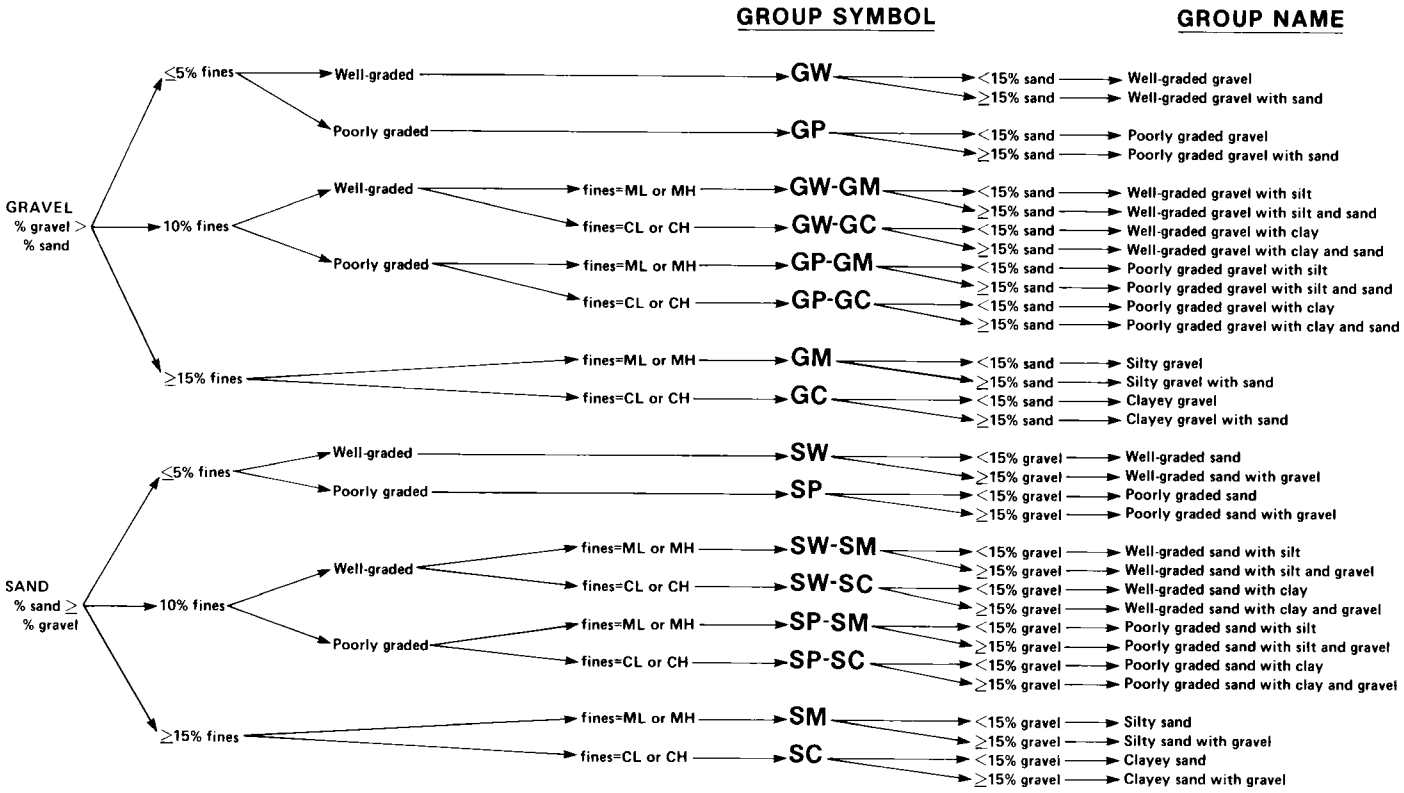
NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

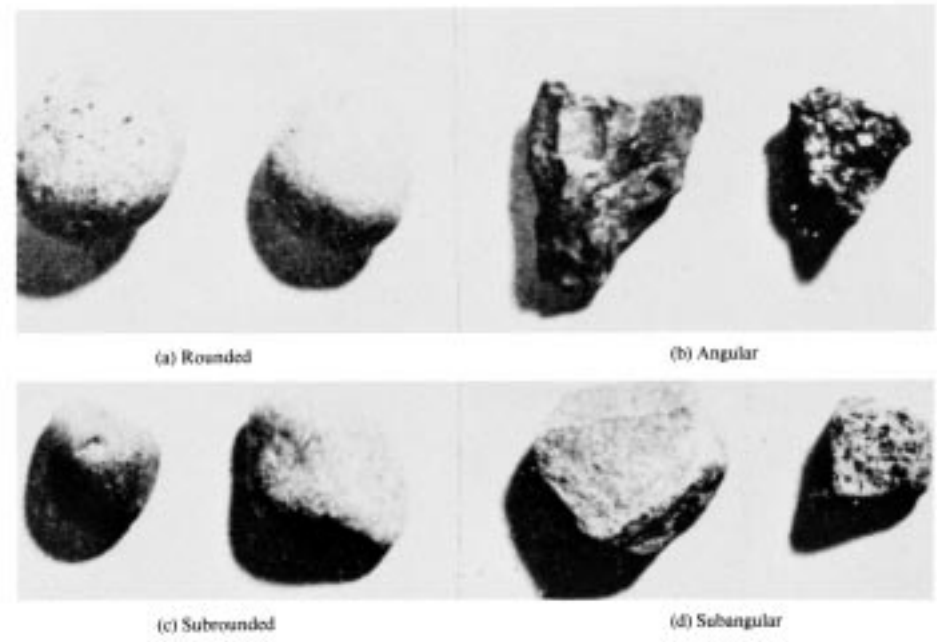


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.	
Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

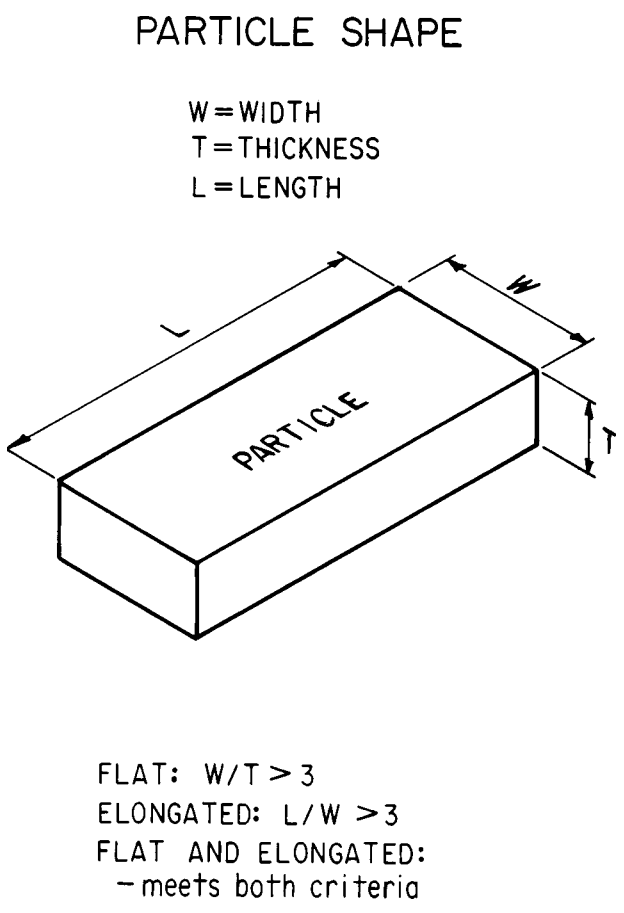


FIG. 4 Criteria for Particle Shape

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Dilatancy

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Toughness

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Dilatancy

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low,

medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

TABLE 8 Criteria for Describing Toughness

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as “Sandy Lean Clay (CL)”; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; “Poorly Graded Sand with Silt (SP-SM)”; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; “Poorly Graded Gravel with Sand (GP).”

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; “Poorly Graded Gravel (GP)”; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard,

angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:

s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (1993$^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

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STANDARD OPERATING PROCEDURE- A-7

Systematic Random Increment Sampling

1.1 Purpose

The Systematic random increment sampling of surface soil samples is performed to minimize any bias of sample representativeness introduced by compositional and distribution heterogeneity of constituents within the sample. This procedure should only be used when sampling surface soils for explosive residuals and metals.

1.2 Scope

Standard techniques for surface soil random incremental sampling for the analysis of explosives residuals, SVOCs, and metals, and required equipment are provided in this SOP.

1.3 Equipment and Materials

Random incremental sampling will be performed with clean hardened plastic or metal scoops, spoons, or coring tools (such as a MIST sampling tool) depending on the cohesiveness of the soil. Sample containers are lab and analyte specific, but generally will consist of two clean 16 ounce wide mouth glass jars for 1 kg samples and two clean 32 ounce wide mouth glass jars for 2 kg samples. Soil will be homogenized in the laboratory rather than the field.

1.4 Procedures and Guidelines

Surface soil composite samples will be collected from Decision or Sampling Units for analysis for explosives residues and/or total metals. Each Decision Unit will be defined based on past range activities and ecological and human health risks associated with that area. Where applicable, larger Decision Units may be sampled multiple times in one acre area Sampling Units. Each Decision/Sampling Unit location sampled and a summary of sampling activities will be recorded in a field book.

Increment composite surface soil samples will be collected within the Decision or Sampling Unit using a systematic sampling pattern with a random starting point. Number of increments should be between 30 and 100 depending on the size of the Decision or Sampling Unit (increments should be discussed with stakeholders prior to sampling) . Samples will be collected by walking from one corner of the grid systematically back and forth across the entire grid area, collecting an increment of soil every so many paces, depending on the grid size and number of increments to be collected. The sample increments will be approximately equal in the amount of soil, which will be collected from depths of approximately 0-2 inches (up to about 2.5-inches) below ground surface. While walking the sampling unit grid, subsamples will be stored in a gallon ziplock or equivalent plastic bag, labeled with the sampling unit number. After the Decision/Sampling Unit has been sampled, the individual increment samples will be transferred to the appropriate laboratory-supplied sample containers. Triplicate (two replicate) samples should be collected from each site on a one per 10 basis. Each replicate sample will be collected using the same method as the original sample. The replicate samples should be started from a different corner of the decision unit to avoid sampling the same location as the original sample.

Samples will be stored on ice in clean plastic bags or clean large mouth glass bottles and submitted for laboratory analysis by one or more of the following analytical methods: EPA SW-846 Method 8330, Method 8330B, Method 6850, and the appropriate project specific analytical methods for metals. Method 8330B uses an air drying and mechanical grinding process. Mechanical grinding will not be conducted for samples submitted for metals analysis. A minimum of 1 kg of soil will be collected per RI sample.

The sampling tools will not need to be cleaned between increments since each individual increment will be apart of the same sample, but tools will be cleaned between each RI sample. The decontamination process follows SOP E1, Decontamination of Personnel and Equipment.

Follow manufacturer's instructions for use of the sampling tool. For pogo-stick type MIS samplers, insert the appropriate core tip, place the tip on the surface to be sampled, and drive the sampler tip into the ground with the pogo-stick foot pedals. If using both foot pedals at the same time, be careful about balance, and if this method cannot be done safely, discontinue use of both foot pedals simultaneously. To extrude the sample, press on the sample extruder, holding the sample tip over the plastic bag in which the sample is to be collected. Decontaminate sampling equipment that has come in contact with the ground before switching to sample a separate sampling unit.

1.5 Attachments

None.

1.6 Key Checks and Items

- Triplicate samples collected from each Decision Unit at 1 per 10 samples.
- Replicate samples should be started from a different corner of the decision unit to avoid sampling the same location as the original sample.
- Sampling method is only applicable to explosives residues and metals.
- Number of increments should be between 30 and 100 depending on the size of the Decision Unit.
- Check that decontamination of equipment is thorough.

STANDARD OPERATING PROCEDURE B-1

Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling

I. Scope & Application

This Low Stress (or Low-Flow) Purging and Sampling Procedure is based on the EPA Region II standard method for collecting low stress (low flow) groundwater samples from monitoring wells. Low stress Purging and Sampling results in collection of groundwater samples from monitoring wells that are representative of groundwater conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater. This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only.

II. Method Summary

The purpose of the low stress purging and sampling procedure is to collect groundwater samples from monitoring wells that are representative of groundwater conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, potentially producing a sample with low turbidity (i.e., low concentration of suspended particles). Second, this procedure minimizes aeration of the groundwater during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of groundwater purged from a well and the costs associated with its proper treatment and disposal.

III. Addressing Potential Problems

Problems that may be encountered using this technique include:

a. difficulty in sampling wells with insufficient yield;

b. failure of one or more key indicator parameters to stabilize;

c. cascading of water and/or formation of air bubbles in the tubing;

d. cross-contamination between wells.

A. Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump's intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided if possible. If the well is pumped dry, just before the pump is stopped, the tubing should be restricted so that the water does not rush back down the tubing and surge the well. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, groundwater samples may be obtained with other techniques, such as bailing.

B. Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameter fails to stabilize after approximately 4 hours, one of three options may be considered:

a. continue purging in an attempt to achieve stabilization, especially if stabilization appears imminent;

b. discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or

c. Stop pumping, secure the well. The next day, purge and collect samples, and document attempts to reach stabilization in the log book.

C. Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8-inch ID) to ensure that the tubing remains filled with groundwater during sampling.

D. Cross-Contamination

To prevent cross-contamination between wells, in-place pumps can be used. As an alternative, the potential for cross-contamination can be reduced by performing decontamination procedures between sampling of each well (see SOP Decontamination of Personnel and Equipment).

IV. Planning Documentation and Equipment

- Well construction data, location map, field data from last sampling event, as warranted.
- Polyethylene (or similar) sheeting.
- Flame Ionization Detector (FID) or Photo Ionization Detector (PID) or similar equipment.

- Adjustable rate, positive displacement groundwater sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may be used for inorganic sample collection.
- Interface probe or equivalent device for determining the presence or absence of NAPL, as needed.
- Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material will be available so that each well has dedicated tubing.
- Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).
- Flow measurement supplies.
- Power source (generator, marine battery, etc.).
- Monitoring instruments for indicator parameters.
- Decontamination supplies (see SOP Decontamination of Personnel and Equipment).
- Sample bottles.
- Sample preservation supplies (if necessary).
- Sample tags or labels, chain of custody.
- Equipment failure is a common occurrence and it is difficult to get equipment to Vieques. Consider keeping two functioning sets of equipment on hand. When all equipment is functioning, two teams may be able to sample two wells simultaneously.

V. Sampling Procedures

A. Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated groundwater and proceed systematically to the well with the most contaminated groundwater.
2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.
3. Remove well cap, measure and record VOCs in the breathing zone above the well with a PID or FID. Do not take the reading directly above or within the well casing as this air tends to be moisture-laden and may interfere with the instrument reading.
4. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), high point or north side of well casing. Note that the reference point should be surveyed for correction of groundwater elevations to the mean geodesic datum (MSL).
5. Measure and record the depth to water in accordance with *SOP H-2. Water-Level Measurements* in all wells to be sampled prior to purging. Care should be taken to

minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well. Decontaminate water level probe between well locations in accordance with SOP Decontamination of Personnel and Equipment.

6. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book.

B. Sampling Procedures

1. A field log book or groundwater sampling form will be kept each time groundwater monitoring activities are conducted in the field. The field log book or groundwater sampling form should document the following:

   - Well identification number and physical condition
   - Well depth (from well completion records; do not measure depth prior to sampling)
   - Static water level depth (to 0.01 ft), date, time, and measurement technique
   - Presence and thickness of immiscible liquid layers and detection method
   - Collection method and quantity of immiscible liquid layers (if removed from the well)
   - Pumping rate, drawdown, indicator parameters values, and clock time, at approximately 3- to 5-minute intervals
   - Well sampling sequence and time of sample collection
   - Sample identification numbers
   - Field observations of sampling event
   - Name of sample collector(s)
   - Weather conditions
   - QA/QC data for field instruments (often in separate calibration log)

2. Assuming no NAPL is present, install pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well generally to a depth of mid-screen or mid-point of water within the screen in the total depth of the well. Record the depth to which the pump is lowered in the well. In order to minimize the disturbance of sediment when lowering the pump, do not strike the bottom of the well with the pump. Where possible, the pump intake should be kept at least 2 feet above the bottom of the well to prevent disturbance and resuspension of any sediment present in the bottom of the well. Measure and record the depth to water after installing the pump. Use the pre-pump installation water level for drawdown calculations.

3. Purge Well: Purging can be done at flow rates of 200 to 500 milliliters per minute (ml/min). However, if possible, purge the well at flow rates between 100 and 250

ml/min because these are the recommended sampling rates and changing the flow rate between purging and sampling should be avoided, if possible. The water level should be monitored approximately every 3 to 5 minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment. Record final volume of groundwater purged.

4. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters approximately every 3 to 5 minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows:

   ±0.1 for pH
   ±3% for specific conductance (conductivity), except in the cases of very low conductivity, as discussed below
   ±10 mv for redox potential, except in the cases of very positive or very negative values, as discussed below.
   ±10% for DO and turbidity, except in the cases of very low DO and turbidity, as discussed below

   Calculate the differences in the three consecutive readings (i.e., last three readings) as follows:

   For pH, subtract the lowest reading from the highest reading.

   For conductivity, subtract the lowest reading from the highest reading and divide the result by lowest reading (multiply by 100 to get the percent difference).

   For redox potential (ORP), subtract the lowest reading from the highest reading.

   For DO, subtract the lowest reading from the highest reading and divide the result by lowest reading (multiply by 100 to get the percent difference).

   At certain levels of conductivity (very low), redox potential (very positive or very negative), DO (very low), and turbidity (very low), it is not practical, nor is it warranted, to use percent differences to assess stability. For example, it may not be feasible to achieve ±3% specific conductance if conductivity is very low (close to zero), even though the values can be considered stable. For example, a difference in specific conductivity measurements of 0.001 mS/cm and 0.002mS/cm is a 100% difference, but these values should be considered to represent acceptable stability. Another example is turbidity. Below about 30NTU, percent differences should no longer be considered indicators of stability. At 30NTU, a 10% difference is only 3NTU; therefore, any three consecutive turbidity readings below 30NTU can be considered stable.

5. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min (if possible) and such that drawdown of the water level within the well does not exceed a drawdown

of 0.3 ft (if possible). If neither of these is possible due to insufficient well yield, follow the procedures in Section III above. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.

If pumping rates less than 100mL/min are needed to maintain less than 0.3' of drawdown, consider how long it will take to fill the required bottleware. If it will take an unreasonable duration of time (i.e., greater than approximately 2 hours) to fill the required bottleware, consider documenting an exception to the 0.3' drawdown goal. Stressing the well by drawing down more than 0.3' is not ideal, but if all parameters (including drawdown) stabilize at a water level lower than 0.3' from static, then this will yield a higher-quality sample than pumping to just above the pump intake, allowing the well to recharge, and then collecting a sample without purging or stabilizing. Where filtered metals samples are to be collected, a disposable in-line filter (0.45 micron filter, QED® FF8100 or equivalent) will be added to the end of the discharge tubing and the sample collected using the pressure provided by the pump or use of a peristaltic pump or similar device.

6. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

7. Close and lock the well.

VI. Field Quality Control Samples

In accordance with the site-specific QAPP, quality control samples may be collected to determine if sample collection and handling procedures have adversely affected the quality of the groundwater samples.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples may be collected during a sampling event:

- Field duplicates
- Trip blanks for VOCs only
- Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, groundwater samples should be collected systematically from wells with the lowest level of contamination through to wells with highest level of contamination, if known.

Sample Groundwater Sampling Sheet

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
362196.FI.ZZ.01	CGW1MW02	SHEET 1 OF 2

GROUNDWATER SAMPLING DATA SHEET

PROJECT : SI/ESI Former VNTR | LOCATION : VE-SWMU-1 | DATE: 5-4-09

Weather: Fair 78°F

Sample Team: Juan Acaron, Matthew Anderson

Total Depth: 36.67 FT.(BTOC) Measured

Depth to Water: (-) 19.98 FT.(BTOC) Measured

Water Column(h): (=) 16.69 FT.

Water Volume in Well: 2.72 GAL (3.141593*h(in)*(wellDIA/2)^2*0.004329)

Pump Depth: 31.5 FT.(BTOC) Measured

Purge Device/Equip: Monsoon Pump

'Measuring Device/Equipment: Heron Dipper T

Date and Time On Well: 5-4-09 1010

Pump Start Date and Time: 5-4-09 1034

Pump Finish Date and Time: 5-4-09 1400

Date and Time Off Well: 5-4-09 1410

Air Monitoring Readings: 0.0 ppm

Total Purge Volume: 2.5 **GAL.**

SAMPLE INFORMATION

Sample ID: VEW01-MW02-0509

Parameters Collected for: VOC, VOC SIM, SVOC, SVOC SIM, Pest., PCB, CN, Total Met, Filt, Met., Explo., Perch.

Sample Date/Time: 5-4-09 1220

Field Dup: YES (NO) ID: ----

Parameters Collected for (FD): ----

FD Sample Date/Time: ----

MS/MSD: YES (NO)

Sample Appearance: Clear

Were samples filtered? (YES) NO

Field Test Kit Details: ----

If YES, Which samples? Filt. Metals

FIELD PARAMETERS

Time	Purged Vol. (gals)	Depth to Water (ft)	Flow Rate (mL/min)	Temp., (°C)	SpCond (uS/cm) w/in 3%	Salinity (ppt)	DO (%)	DO (mg/L) w/in 10%	pH w/in 0.1	ORP (mV) w/in 10mV	Turbidity (NTU) w/in 10%	Color / Odor / Comments
1040	<0.5	20.25	100	26.80	4972	2.66	6.2	0.48	6.79	207.6	114	cloudy
1045	<0.5	20.20	100	27.08	5076	2.72	3.7	0.29	6.76	217.4	110	
1050	<0.5	20.18	100	27.23	5079	2.72	2.9	0.23	6.77	225.9	76.7	
1055	0.5	20.20	100	27.32	5086	2.72	2.4	0.19	6.78	233.5	51.0	
1100	<0.75	20.20	100	27.29	5095	2.73	2.2	0.17	6.78	238.1	38.2	
1105	0.75	20.17	100	27.31	5097	2.73	2.1	0.16	6.78	243.0	23.0	
1110	<1.0	20.18	100	27.31	5100	2.73	2.0	0.16	6.79	246.0	19.3	
1115	<1.0	20.19	100	27.32	5099	2.73	1.9	0.15	6.79	251.0	13.3	
1120	1.0	20.19	100	27.38	5100	2.73	1.8	0.14	6.79	255.8	11.4	
1125	<1.25	20.20	100	27.45	5098	2.73	1.8	0.14	6.80	260.0	8.71	
1130	1.25	20.21	100	27.57	5099	2.73	1.8	0.14	6.80	264.1	7.26	
1135	<1.50	20.16	100	27.65	5097	2.73	1.9	0.15	6.79	266.8	6.17	
1140	1.50	20.15	100	28.10	5103	2.73	1.6	0.13	6.79	271.9	5.32	
1145	<1.75	20.20	100	28.28	5098	2.72	1.6	0.13	6.79	275.4	4.98	
1150	<1.75	20.20	100	28.08	5107	2.73	1.6	0.12	6.79	279.3	4.44	
1155	1.75	20.21	100	27.86	5098	2.73	1.7	0.13	6.79	283.9	3.76	
1200	<2.0	20.21	100	27.94	5093	2.72	1.4	0.11	6.80	287.0	2.85	
1205	2.0	20.20	100	27.89	5101	2.73	1.5	0.11	6.80	289.9	2.95	
1210	<2.25	20.16	100	27.90	5093	2.72	1.5	0.11	6.80	291.9	2.67	
1215	2.25	20.18	100	28.08	5092	2.72	1.5	0.11	6.80	291.9	2.32	clear

Signature: Juan Acaron Date: 5/4/2009

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 2 OF 2
362196.FI.ZZ.01	CGW1MW02	

GROUNDWATER SAMPLING DATA SHEET

PROJECT : SI/ESI Former VNTR LOCATION : VE-SWMU-1 DATE: 5-4-09

SOP(s) used (refer to SOPs in back of this log)? B-1

Were all requirements of the SAP, PIs and above mentioned SOP(s) met? See Below.

Explanation of exceptions to SOP(s) ***including why, under what conditions, who authorized exception, anything considered in the decision*****:**

1.) Unable to have the purge rate set at the minimum purge rate and attain the 0.3 ft. draw down criteria. Purge rate was still within the sample flow rate allowed. The 0.3 ft. drawdown criteria was met.

2.) The turbidity was not within 10%, but was under 5 NTUs. Under 5 NTUs is considered optimal.

3.) Perchlorate is not being filtered in the field per PC. This method will be lab filtered.

PHOTO LOG

Photo Number	Compass Direction	Time	Description

Signature: Juan Acaron Date: 5/4/2009

STANDARD OPERATING PROCEDURE C-1

Calibration and Measurement with Field Instruments

I. Purpose and Scope

The purpose of this document is to provide standardized procedures for using field instruments to collect measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of liquid sample media (groundwater or surface water). The operator's manual should be consulted for detailed calibration and operating procedures for each specific instrument. This guideline will cover field equipment used on a routine basis for field conditions likely encountered on a Vieques site. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs).

II. Equipment and Materials

- Instruments to be calibrated (and spares)
- Manufacturer's calibration manual
- Distilled water in squirt bottle
- Calibration Standard Solution(s) applicable to site conditions and manual

III. Procedures and Guidelines

A. Documentation of Field Calibration and Measurements

Document successful calibration and verification for each instrument in the project logbook. This calibration will be linked with the associated sample measurements.

- Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument used.
- Record manufacturer name, model number and identifying number such as a serial number for each instrument.
- Record the time and date of all initial calibrations and all calibration verifications.
- Record the instrument reading (value in appropriate measurement units) of all calibration verifications.
- Record the name of the analyst(s) performing the calibration or verification.

- Document the specific standards used to calibrate or verify the instrument or field test with the following information:
  - Type of standard or standard name (e.g., pH, buffer, isobutylene) and value of standard, including correct units (e.g., pH = 7.0 SU)
  - Document lot number on calibration gas bottle
- Document whether successful initial calibration occurred or failed.
- Document any corrective actions taken to modify instrument performance and date and time of any corrective actions.
- Note any incidence of discontinuation of use of the instrument due to calibration failure.

B. Instrument Calibration

Prior to each day's use, clean and calibrate the instrument using the procedures described by the manufacturer of the instrument..The following describes typical calibration checks for specific field parameters:

1. pH

   Use at least two standards for initial calibration. One of the standards must be pH 7.0, the other at a value such that it will bracket the anticipated pH of the samples. Always the pH 7 first and rinse the probe between solutions. Follow the manufacturer's calibration instructions specific to your meter.

   Most instruments allow for a two-point calibration and a few models can perform a three-point calibration. Use the appropriate number of standard buffer solutions for calibration. Groundwater is usually between pH 4 and 7 and surface water between pH 7 and 10 (including salt water). Acceptance criteria for initial or continuing calibrations will be Std X – 0.2 < Reading < Std X + 0.2

2. Conductivity

   Check the meter in the field with at least one KCl std with a value close to the conductivity expected in the field. For fresh water groundwater and surface water applications, a standard of 1000 µS (or µmhos) is used while standards of 10,000, 30,000, and 50,000 µS are available for estuarine and marine surface water conditions. Acceptance criterion for this check is that the meter reads in the interval within Std X ± 3% of Std X.

3. Dissolved Oxygen

   Calibrate the meter at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument.

   Allow an appropriate warm up period before initial field calibration. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this

ensures 100% humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate.

Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (See FT 1500-1) what the DO should measure. A stable and accurate temperature is required for a valid calibration. The acceptance criterion for DO calibration verification is +/- 0.3 mg DO/L.

The dissolved oxygen probe requires careful attention to the following items:

- Check sensor for bubbles and membrane for wrinkles or tear (before mobilization)
- Always store probe in saturated atmosphere
- Salinity affects DO readings (make correction, if needed)
- Common interferences: reactive gases, chlorine gas and sulfide will cause bias in results

4. Turbidity

This SOP describes the use of true nephelometric measurement which measures the scattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered light), the higher the turbidity value. The use of in-situ probes with turbidity sensors (infra-red light source) may be used for screening purposes (e.g., groundwater purge stabilization measurements) only. Do not report their results for regulatory purposes.

Perform an initial calibration verification by reading at least one primary standard as a sample. The acceptance criterion for the initial calibration verification depends on the range of turbidity of the standard value:

- Standard Value = 0.1-10 NTU: the response must be within 10% of the standard;
- Standard Value = 11-40 NTU: the response must be within 8% of the standard;
- Standard Value = 41-100 NTU: the response must be within 6.5% of the standard; and
- Standard Value > 100 NTU: the response must be within 5% of the standard.

Take readings with a turbidimeter using the following procedure:

- Gently agitate the sample and wait until air bubbles disappear.
- Double-rinse the sample cell or cuvette with a small amount of the sample. Discard, and pour an aliquot into the sample cell or cuvette.
- Gently dry out its external surface with lint-free paper.
- Insert the cell in the instrument and read the turbidity directly from the meter display.
- Pour out the sample, double-rinse the cuvette with de-ionized water in preparation for the next sample.

5. Oxidation Reduction Potential (ORP)

   Oxidation Reduction Potential (ORP) is a measurement of the potential for a reaction to occur where a positive value indicates that the water is in an oxidized state or oxygen is present and a negative value is indicative of an anaerobic type environment or reducing condition. Equilibrate the standard solution to the temperature of the sample. Calibrate as follows:

   - Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt mode.
   - Let the electrode equilibrate for several minutes and record the reading to the nearest millivolt. The reading must be within ±10 mV from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.
   - Record the mV reading and temperature in the field notebook.
   - Rinse the electrode with distilled water and proceed with the sample measurement.

C. Sample Measurement

Obtain readings and record them in the field notebook or sampling log. Watch for potential fouling of probes, high concentrations of odors, drifting of calibrated zero, or other factors that may skew readings. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units for the measurement
- Initials or name of analyst performing the measurement

IV. Key Checks and Preventive Maintenance

- Refer to operations manuals for recommended maintenance and calibrations and follow them to the extent practical. Note deviations in logbook.
- Clean all instruments when done.

V. Optional but Suggested Practices

- Have a spare unit readily available in case of an equipment malfunction. Check batteries, and have a replacement set on hand.
- Confirm there is sufficient calibration standard on hand. Compressed gas calibration standards cannot be air shipped to Vieques; they must be shipped to mainland Puerto Rico and either brought over by a subcontractor, or an employee must take the ferry to Puerto Rico and courier them back on the ferry. Confirm there is sufficient supply on hand and write "Empty" on empty cylinders, vent the dregs and throw them away immediately (regular landfill disposal of empty cylinders is acceptable). Segregate "in-use" cylinders.
- Check age date on calibration gas cylinders and vent and dispose of out of date cylinders, reconfirming sufficient supplies on hand.

STANDARD OPERATING PROCEDURE C-4

Operation of Ludlum Model 19 Micro R Meter, Gamma Radiation Detector

I. Purpose and Scope

The purpose of this document is to provide standardized procedures for checking calibration and using the Ludlum Model 19 Micro R Meter to detect gamma radiation. The operator's manual should be consulted for detailed calibration check and operating procedures. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs). The Ludlum Model 19 Micro R Meter is used to measure radiation levels in microroentgens per hour. The model 19 can be used to determine area radiation levels ranging from typical background values. Exposure rate indicated by this instrument will overestimate the true level by as much as a factor of 10 at energies below the calibration energy and underestimate the true value by as much as a factor of five at energies above the calibration energy.

II. Equipment and Materials

- Ludlum Model 19 Micro R Meter (and spare)
- Manufacturer's operation manual
- Check source

III. Procedures and Guidelines

A. Documentation of Field Calibration Check

Document calibration certificate and operational checks in the project logbook.

- The Micro R Meter will be calibrated with a cesium 137 check source. The meter will be calibrated and operated in accordance with the manufacturer's calibration and operation procedures in the manual, Section 2, operational check.
- Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument used.
- Record manufacturer name, model number and identifying number such as a serial number for each instrument.
- Record the time and date documented on the certificate of calibration and today's operational checks.
- Turn the range selector switch to the "25" position. Depress the "BAT" pushbutton switch and ensure that the meter needle falls within the "BAT OK" marks. Check for a proper background reading. A typical reading would be 5-15 uR/hr. Document the battery check in the log book, and record the reading.
- Turn the range selector switch to the "5000" position. Expose the instrument to a "check source" and verify that the instrument indicates within 20 percent of the check source reading obtained during the last calibration. Record the current instrument reading (value in uR/hr) of the calibration verification using the check source, and the source's recorded radiation level in uR/hr.
- Switch the AUD ON/OFF switch to the ON position and confirm that the external unimorph speaker produces an audible click for each event detected. The AUD ON/OFF switch will silence the audible clicks if in the OFF position. It is recommended that the AUD ON/OFF switch be kept in the OFF position when not needed in order to preserve battery life.

- Record the name of the analyst(s) performing the operational checks or verifications.
- Note any incidence of discontinuation of use of the instrument due to calibration failure.
- Turn the range selector switch to the “250” position and increase the source activity for a meter reading of 10-100 uR/hr. While observing the meter fluctuations, select the slow response time (“F/S”) positions to observe variations in the display. The slow response position is normally used when the instrument is displaying low numbers which require a more stable meter movement. The fast response position is used at high rate levels.
- Check the meter reset function by depressing RESET and ensuring the meter needle drops to “0”. Document this in the logbook.

B. Sample Measurement

Obtain readings and record them in the field notebook or sampling log. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test
- Location of the measurement, either GPS coordinate, or line/grid/station number.
- Measurement value in uR/hr
- Initials or name of analyst performing the measurement

IV. Key Checks and Preventive Maintenance

- Refer to operation manual for recommended maintenance and calibration checks and follow them to the extent practical. Note deviations in logbook.
- Clean all instruments when done with a damp paper towel.

V. Optional but Suggested Practices

- Have a spare unit readily available in case of an equipment malfunction. Check batteries, and have a replacement set on hand.
- Have map of measuring grid or lines, with either GPS coordinates or distances/bearings from known points.

STANDARD OPERATING PROCEDURE D-1

Monitoring Well Installation

I. Purpose and Scope

This document provides site personnel with a review of the well installation procedures for unconsolidated and bedrock wells. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

II. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Boring logs, well completion diagrams, field logs, field decontamination equipment

III. Procedures

A. Guidelines

- Screen depths will be based on site-specific information and project-specific goals, and discussed in the project-specific SAP. Screen depths will be designed based on the depth of known or anticipated contamination, the type of contamination, etc. In general, 10-foot screens will be placed at the first encountered groundwater (i.e., across the top 10 feet of the water-bearing unit), unless site-specific information or project-specific goals suggest screening a different interval (check project-specific SAP). For wells where floating product is anticipated or detected during drilling, the well screen should be installed across the water table.
- Threaded connections will be water-tight. No glues can be used to make well casing connections.
- Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will generally be 5 to 10 feet in length depending on target saturated interval. The exact slot size and length will be determined by the project objectives and site conditions. Stainless steel may be required under certain contaminant conditions.
- Above ground completion wells will have at least one concrete filled bollard built within the proximity the pad, if not built into the right of way (ROW) of a road.
- A record of the finished well construction will be compiled.

- All soils and liquids generated during well installations will be containerized for proper disposal.

B. Monitoring Well Installation

- Monitoring wells will be installed in at least 6-inch-diameter boreholes and if completed in augers, a minimum of 6-inch ID augers to accommodate well completion materials.
- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer, if the confining layer thickness permits. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).
- Monitoring wells in unconsolidated materials will generally be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC screen with threaded bottom plug and riser.
- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The filter sand pack (typically Morie #2) will extend from approximately 1 to 2 feet below the base to approximately 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack may be placed using a tremie pipe and flowing water.
- Annular well seals will consist of a minimum of 2 feet of pelletized or granular bentonite clay placed above the filter pack. If necessary, the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry introduced with a side-discharging tremie pipe may be used instead of solid bentonite for the bentonite seals in wells greater than 30 feet deep. High-solids slurries will have solids content of at least 20 percent.
- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.
- The annular space above the bentonite seal will be filled to near grade with a cement-bentonite slurry grout mixture.
- The grout mixture will consist of approximately 94 pounds (lbs) of cement (1 bag) per 6 gallons of water and 2 to 3 lbs of powdered bentonite per bag of cement to reduce shrinkage. The grout mixture will be thoroughly mixed before pumping down-hole.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; if not poured into the annular space, the method of grout placement must force grout from the

bottom of the space to be grouted to the near-surface, using a j-fitting or disperser at the base of the tremmie pipe to avoid jetting the grout through the bentonite seal.

- After allowing the grout to settle and set up overnight, additional grout may be added to maintain near-grade, while allowing room to build the protective casing.

C. Surface-Casing Installation

- Surface casings will be constructed of minimum 6-inch ID steel with a minimum wall thickness of 0.20 inches or Schedule 80 PVC. Casing lengths for permanent surface casings will be welded or connected by threaded connections sealed with Teflon tape, while casing lengths for temporary surface casings will be either threaded connections or drilling casing installed as part of the rotary-drilling method. The steel casing and threaded couplings must be free of paint, varnish, or coatings of any kind, both inside and outside. Threaded connections must be free of oils or grease. Welding of the casing is permissible provided that the welds meet the Standards of the American Welding Society.

- Surface casings will be installed approximately 5 feet into a confining layer, if adequate thickness is available.

- Permanent surface casings will be placed in the bottom of the borehole and the surface casing will be pressed into the clay (if present). The surface casing will be grouted in place by installing the grout through a tremie pipe from the bottom of the annulus to the ground surface.

- Alternatively, the surface casing may be installed and grouted in place by a grout displacement method. The bottom of the surface casing is fitted with a tight, drillable plug. The borehole is then filled with the estimated volume of cement-bentonite grout to fill the annular space, and the casing is lowered to the bottom of the borehole (displacement method). If the weight of the casing is not sufficient to displace the grout and allow the casing to sink to the bottom of the borehole, the casing may be filled with potable water.

- Well installation will proceed in the surface casing once the grout has been allowed to set up for approximately 16 to 24 hours. All water in the surface casing will be removed before drilling resumes in order to prevent carrying the water downward into the water-bearing unit below the confining unit. Unless derived from the grout displacement method, all water in the casing will be disposed of according to the Master Waste Management Plan.

- Temporary surface casing installed independently of the drilling process will be placed in the bottom of the borehole and the surface casing will be pressed into the clay (if present). However, it will not be grouted into place.

D. Bedrock Drilling

- If there is the potential for there to be contamination in the unconsolidated water-bearing unit and where there is no confining unit between the unconsolidated water-bearing unit and the bedrock water-bearing unit, the borehole will be advanced several feet into the bedrock in order to install a surface casing. The borehole will be of

sufficient diameter (at least 8 inches ID) so that a minimum 6-inch ID surface casing can be installed into the borehole. Once the borehole is drilled, the surface casing is installed as per the procedure described in the Section C above.

- Air-rotary or air-hammer drilling techniques will be used to install wells into bedrock boreholes. The minimum bedrock borehole diameter for well completion is 6 inches.

E. Well Completion

- For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend approximately 2 feet above ground and approximately 1 foot into the ground but will not penetrate the bentonite seal. The upper edge of the monitoring well casing should stick up very slightly into the opening of the protective casing cap to prevent having to reach down into the protective casing to unscrew the cap. The space between the protective casing and the well should be filled with clean sand to prevent creating insect habitat, to avoid a space that keys can be dropped into, and to allow the protective casing to be reused if the well is abandoned. The concrete pad will be square (up to 36 inches on each side), poured into wooden forms, and sloped away from the protective casing.
- Guard posts may be installed in high-traffic areas for additional protection. If installed immediately adjacent to the well, they may be constructed through the concrete pad. At least one steel guard post will be installed near the protective casing. Guard posts will be concrete-filled, at least 3 inches in diameter, and will extend approximately 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with a primer and epoxy paint to prevent rust.
- For monitoring wells that are flush-mount, the protective cover will contain a Morrison 9-inch or 12-inch 519 manhole cover or similar, a rubber-sealed cover, and a drain. The top of the manhole cover will be positioned approximately 1 inch above grade. A concrete pad, up to 3 feet in diameter, will be installed as a concrete collar surrounding the protective cover, and will slope uniformly downward to the adjacent grade. The protective cover and installation thereof will be of sufficient strength to withstand normal vehicular traffic. Do not install a guard posts in the road right-of-way.
- Concrete pads will be approximately 6 inches below grade, approximately 12 inches thick at the center and taper to approximately 6 inches thick at the edges. Slope the surface of the pad away from the protective casing to prevent water from pooling around the casing.

IV. Attachments

- Monitoring Well construction schematic diagram
- Schematic diagram of double-cased monitoring-well construction

V. Key Check and Items

- Ensure that all downhole equipment is properly decontaminated, as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the wells.
- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.
- As applicable, secure boreholes every night as drilling continues, and lock wells as soon as wells are completed using the standard key-alike locks.
- Confirm drillers have sufficient drums to contain cuttings and water.

Typical well completion diagrams follow

CH2MHILL

PROJECT NUMBER	WELL NUMBER
	SHEET 1 OF 1

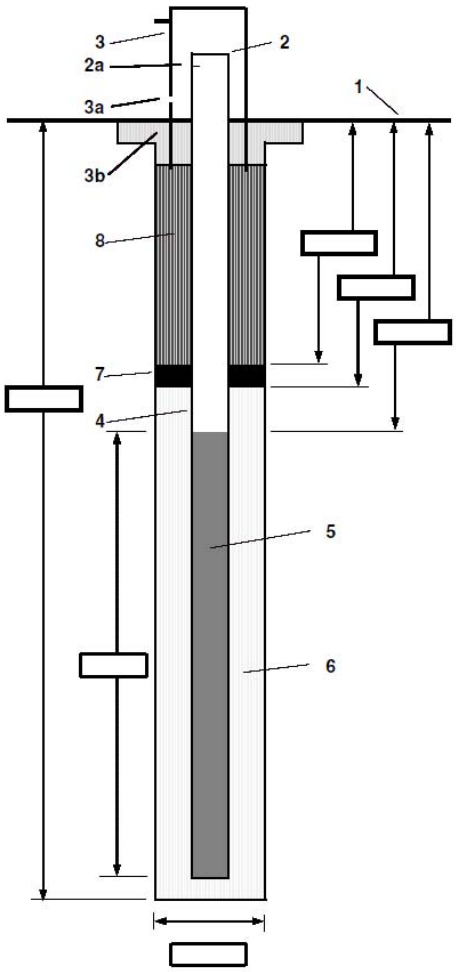
WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____
a) vent hole? _____

3- Wellhead protection cover type _____
a) weep hole? _____
b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Type screen filter _____
a) Quantity used _____

7- Type of seal _____
a) Quantity used _____

8- Grout
a) Grout mix used _____
b) Method of placement _____
c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

CH2MHILL

PROJECT NUMBER	WELL NUMBER SHEET 1 OF 1

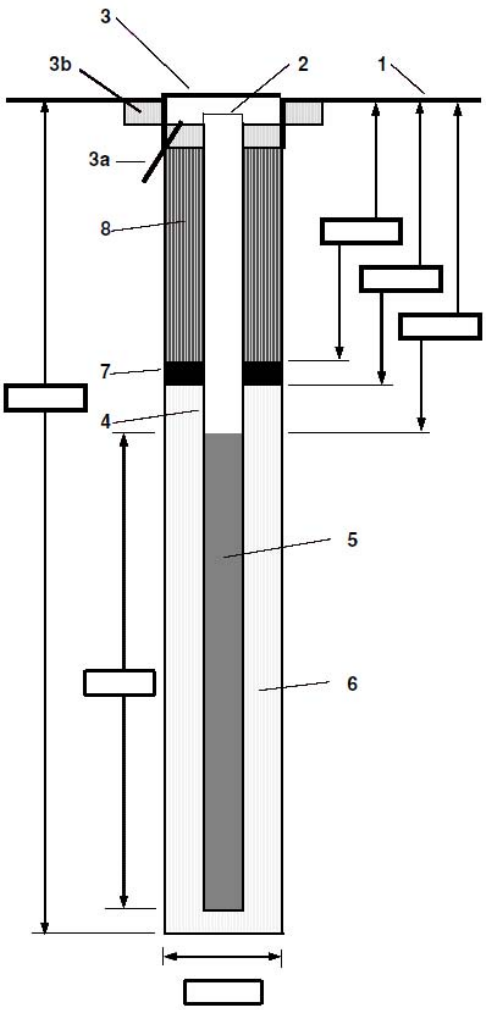
WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____

3- Wellhead protection cover type _____
a) drain tube? _____
b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Type screen filter _____
a) Quantity used _____

7- Type of seal _____
a) Quantity used _____

8- Grout
a) Grout mix used _____
b) Method of placement _____
c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments _____

CH2MHILL

PROJECT NUMBER	WELL NUMBER
	SHEET 1 OF 1

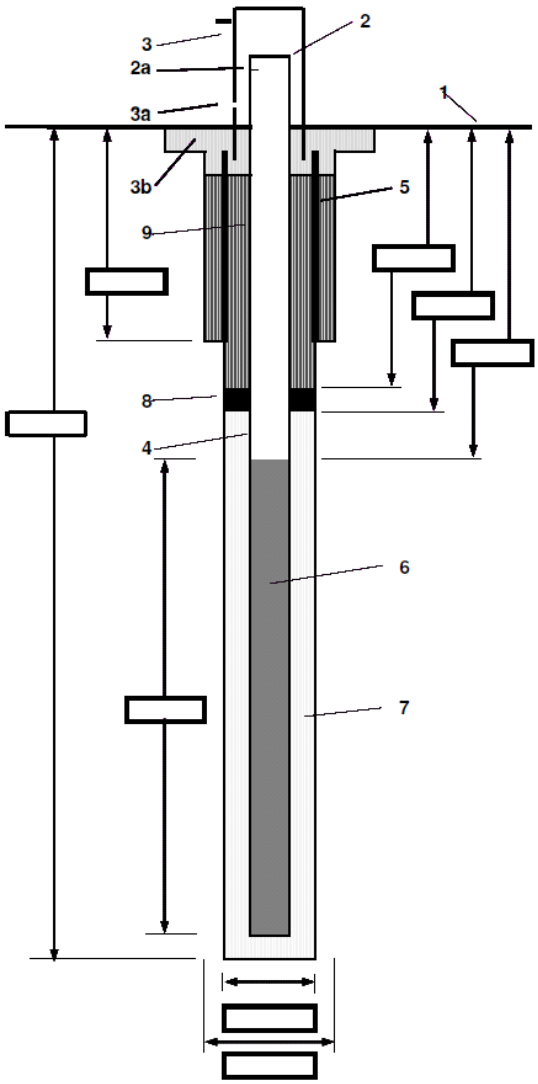
WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well

2- Top of casing elevation
a) vent hole?

3- Wellhead protection cover type
a) weep hole?
b) concrete pad dimensions

4- Dia./type of well casing

5- Dia./type of surface casing

6- Type/slot size of screen

7- Type screen filter
a) Quantity used

8- Type of seal
a) Quantity used

9- Grout
a) Grout mix used
b) Method of placement
c) Vol. of surface casing grout
d) Vol. of well casing grout

Development method

Development time

Estimated purge volume

Comments

STANDARD OPERATING PROCEDURE D-2

Monitoring Well Development

I. Purpose and Scope

This standardized procedure describes the methods used to develop monitoring wells so as to allow for the collection of representative water samples for analysis. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

II. Equipment and Materials

- Surge block and enough pipe to reach the bottom of the well plus 2 feet.
- Well-development pump (GeoSub, whale pump or other disposable non reactive pump) with the appropriate power supply.
- Enough tubing to reach the bottom of the well plus 8 feet.
- Calibrated meters to measure turbidity, pH, temperature, specific conductance, oxygen reduction potential (ORP), and dissolved oxygen of development water.
- Water level indicator.
- Containers (e.g., department of transportation-approved 55-gallon drums, water transportation carboys, or 5-gallon buckets with lids) for water produced from well.

III. Procedures and Guidelines

A. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized.

Lower the surge block to the bottom of the well, threading together each length of pipe as it is lowered. Once the surge block is resting on the bottom, gently surge the block up and down a couple of inches to move the silt/sand into the water column. After several small surges, begin surging the entire screen at least 10 times. Make sure the surge block is not so tight a fit as to damage the screen.

Remove the surge block and lower the pump into the well to the water's surface. Turn the pump on, and continue to lower the pump to just above the bottom of the well. Take care not to allow the pump to contact the well bottom as it may clog the pump with fines. Raise and lower the pump for several minutes to try to remove the bulk of the sand and the silt in

the water column. After several minutes, lower the pump to 6-8" above the bottom of the well and continue to pump.

During pumping, take measurements of depth-to-water, turbidity, pH, temperature, and specific conductance and record in the logbook or well-development log. When taking analytical measurements, avoid moving the hose connecting the pump and the flow through cell. Moving the hose will disturb any sediment that has accumulated along the hose, which may give falsely higher than actual NTU readings, and possibly affecting other parameters.

Continue to develop the well by alternately surging and pumping and monitor the water for pH, turbidity, specific conductance and temperature. When the turbidity (using a target turbidity of less than 5 NTUs) and the other parameters have stabilized for at least three consecutive readings (pH within 0.1 units, temperature within 1°C, specific conductivity within 3%), discontinue development.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Solids and water generated during well development and decontamination fluids will be contained and managed as detailed in the Master Waste Management Plan.

B. Other Development Methods

Backwashing and bailing may be used in specific circumstances as discussed below. Use of backwashing should be limited only to the water removed from the well, and is used to "pinpoint" a small area of the screen that appears especially in need of development (i.e., that produces substantial silt or fine sand even after the rest of the screen appears developed). Backwash by allowing the pumped water in the tubing to backflow down the tubing back into the well.

Bailing shallow (less than approximately 15 feet bgs), slow recharging, or small diameter wells that have a high potentiometric surface may be preferred over pumps. It is suggested that the well is still surged for 10 to 20 minutes prior to bailing it. The bailer itself acts to a limited extent as a surge block; however, because the outside diameter of the bailer is still smaller than the inside diameter of the well, it is much less effective. Allow the bailer to come to rest on the bottom before retrieving it so as to remove the most amount of sediment from the well. Performing short, rapid, upward and downward motions, allowing the bailer to return to the bottom with each stroke may allow the bailer to entrain more bottom sediment.

Complete well development, decontaminate equipment, and manage purged solids/water and decontamination fluids as defined above in Section III.A.

IV. Attachments

Well development log

V. Key Check and Items

- New monitoring wells will be developed after the well has been installed and the grout has cured (at least 24 hours).
- Make sure surge block is not so tight that it damages the screen when surging.
- If information is available, begin developing in the least-contaminated well first.
- If backwashing to develop the well is required, pipes and pumps should not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.

CH2MHILL	PROJECT NUMBER	WELL NUMBER SHEET 1 of
	WELL DEVELOPMENT LOG	

PROJECT : LOCATION : DATES:
DEVELOPMENT CONTRACTOR : CH2M HILL
DEVELOPMENT METHOD AND EQUIPMENT USED :
START WATER LEVELS : START Date/Time: END Date/Time: LOGGER :
MAXIMUM DRAWDOWN DURING PUMPING:
RANGE AND AVERAGE DISCHARGE RATE:
TOTAL QUANTITY OF WATER DISCHARGED (gal):
DISPOSITION OF DISCHARGE WATER:
TOTAL DEPTH OF WELL:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Comments

CH2MHILL

PROJECT NUMBER

WELL NUMBER

SHEET 2 of

WELL DEVELOPMENT LOG

PROJECT : LOCATION : DATES:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (μmhos/cm)	Comments

CH2MHILL	PROJECT NUMBER	WELL NUMBER SHEET 3 of
	WELL DEVELOPMENT LOG	

PROJECT : LOCATION : DATES:

Time	Water Volume Discharged (gal)	Water Level (ft BTOC)	Turbidity (NTU)	Temperature (°C)	pH	Conductivity (µmhos/cm)	Comments

STANDARD OPERATING PROCEDURE E-1

Decontamination of Personnel and Equipment

I. Purpose and Scope

This standard operating procedure (SOP) provides standardized procedures for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments. Any project required deviations from SOPs, will be provided in site specific sampling and analysis plans (SAPs).

II. Equipment and Materials

1. Potable water from a municipal water supplier.
2. ASTM Type II reagent water with analysis certification.
3. Soap solution, such as 2.5% (W/W) Liquinox, or Alconox.
4. 10% solvent such as methanol, isopropyl, hexane or other approved solvent (DO NOT USE ACETONE). Pesticide-grade solvents will only be used if directed by project-specific SAPs.
5. Large plastic pails or tubs, scrub brushes, squirt bottles for soap and solvent solutions, plastic bags and sheets.
6. Department of transportation approved 55-gallon drum for disposal of waste (if required)Personal protective equipment (PPE).

III. Procedures and Guidelines

A. Personnel Decontamination

This is a guide, and may be modified if the contamination is less or more than what is required here.

- Only if there is gross contamination present that cannot be removed using the procedures below should the PPE be disposed of with investigation derived waste (IDW).
- Wash boots in soap solution and rinse with water. If disposable latex booties are worn over boots in the work area, rinse with soap solution, remove, and discard with normal trash.
- Wash outer gloves in soap solution, rinse, remove, and discard with normal trash.
- Remove disposable coveralls (“Tyveks”), wash any obvious dirt or contamination off with soap solution, rinse, and discard with normal trash.

- Remove respirator (if worn).
- Remove inner gloves and discard with normal trash.
- Sanitize respirator if worn in accordance with manufacturer's instructions.
- At the end of the work day, shower entire body, including hair, either at the work site or at home.

B. Sampling Pump Decontamination

- Don disposable gloves.
- Spread plastic on the ground to keep hoses from touching the ground.
- Turn off pump after sampling. Remove pump from well and place pump in decontamination container.
- Pre-rinse the pump in potable water to remove bulk soil or contamination.
- Disassemble pump, as practical, and scrub pump with soap solution. If disassembly of pump not practical, run solution through pump for 1 minute.
- Scrub in tap water, then reassemble and run pump in tap water for one minute.
- Disassemble and spray pump with 70-100% solvent solution. (DO NOT USE ACETONE). If disassembly of pump not practical, run 10 percent solution through pump for 1 minute.
- Allow to air dry.
- Spray with ASTM type II reagent water with analysis certification.
- Reassemble and wrap pump in aluminum foil or clean plastic sheeting and place into decontamination tube.
- Collect all rinsate and dispose of according to the Master Waste Management Plan.
- Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment can be decontaminated (using the above procedure) and disposed of with normal trash or can be disposed of according to the Master Waste Management Plan.

C. Other Sampling Equipment Decontamination

- Don latex-free gloves.
- Pre-rinse and scrub equipment with potable water.
- Wash all equipment surfaces that contacted the potentially contaminated soil/water with soap solution.
- Rinse with potable water.
- Rinse with distilled water and 10% solvent solution.

- Air dry.
- Rinse with ASTM type II reagent water with analysis certification.
- Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling.
- Collect all rinsate and dispose of according to the Master Waste Management Plan.
- Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment can decontaminated (using the above procedure) and disposed of with normal trash or can be disposed of according to the Master Waste Management Plan.

D. Sample Container Exterior Decontamination

- The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection.
- Wipe container with a paper towel dampened with soap solution. Repeat the above steps using potable water.
- Dispose of all used paper towels according to the Master Waste Management Plan.

E. Water Level Meter

Water level meters will be decontaminated before being used in the first well, and after measuring each well as follows:

1. Wipe tape, first with a towel dampened with 10 percent solvent solution, then with a towel dampened with DI water.
2. Spray off probe, first with 10 percent solvent solution, then with ASTM type II reagent water with analysis certification.

IV. Key Checks and Items

- Clean with solutions of soap, solvent, and ASTM type II reagent water with analysis certification.
- Do not use acetone for decontamination.
- Minimize generation of IDW to the maximum extent possible by decontaminating to the extent practical and disposing with normal trash.

STANDARD OPERATING PROCEDURE G-1

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting representative surface water related data, including samples for analytical chemistry, and stream flow measurements.

For typical collection of surface water samples, this SOP describes acceptable equipment selection and construction materials, as well as standard grab, depth-specific, and depth-composited surface water sampling techniques.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the SAP should be consulted for project-specific details. Typical equipment required includes some or all of the following:

Surface Water Analytical Sample Collection

- Dip sampler for direct grabs
- Clean unpreserved containers
- Peristaltic pump and appropriate tubing
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Sample containers
- Polypropylene rope and weight
- Extendable pole
- Meters for specific conductance, temperature, pH, and dissolved oxygen

A. Streamflow Measurement

- Current meter such as the Marsh-McBirney with a steel wading rod and electronic meter to measure the relative velocity of the flow at different locations within the stream channel
- Measuring tape or cable marked in even increments for determining the width of the stream and controlling the location where measurements are taken
- Waders (if necessary)

III. Procedures and Guidelines

Before surface water analytical samples are taken, all sample collection equipment are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment*. For surface water samples collected from tidal water bodies, the tide stage should be considered when selecting sampling time(s).

Methods for surface water sample collection and streamflow are described below.

A. Surface Water Analytical Sample Collection

Manual Sampling

Use manual sampling for collecting grab samples for immediate in-situ field analyses. Measurements of specific conductance, temperature, pH, and dissolved oxygen, are collected after all surface water samples are collected at each station.

1. Surface Grab Samples

Collect surface grab samples within the top 12 inches of the water column unless a specific depth strata has been specified in the Sampling and Analysis Plan (SAP) Avoid skimming the surface of the water during collection unless specifically required by the SAP Very shallow water bodies may require careful techniques of sample collection to avoid disturbing sediments.

Where practical, use the actual sample container (unpreserved) as the collection device (direct grab). Sample containers attached to poles are also considered direct grabs.

2. Direct Grab Technique

- Use an unpreserved sample container to collect the sample.
- Slowly remove the container cap and slowly submerge the container, opening first, into the water.
- Invert the bottle so the opening is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.
- Return the filled container quickly to the surface.
- Pour out a small volume of sample away from and downstream of the sampling location. This procedure allows for addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
- Add preservatives, if required, securely cap container, label and complete field notes.
- If preservatives have been added, invert the container several times to ensure sufficient mixing of sample and preservatives.
- Check preservation of the sample and adjust pH with additional preservative, if necessary.
    - If the sample cannot be collected directly into the sample container to be submitted to the laboratory or if the laboratory provides prepreserved sample containers, use

an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be constructed appropriately including any poles or extension arms used to access the sample location.

- If the intermediate vessel is not a precleaned sample container, decontaminate the vessel following the SOP E1 *Decontamination of Personnel and Equipment.* Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample. Discard rinsate away from or downstream of the sampling location. After adequate rinsing, fill the intermediate vessel with sample water. Minimize agitation of the sample.
- Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
- Add preservatives if required, securely cap container, label and complete field notes. Invert the container several times to ensure sufficient mixing of sample and preservatives.

3. Pumping Technique

Use appropriate pumps, equipment, and tubing (confirming reusable equipment has been appropriately decontaminated) when using a pump to collect surface water samples. Do not collect oil & grease or TRPH with a pump. Follow this procedure:

- Measure the water column to determine the maximum depth and the sampling depth (for surface samples collect at least 12 inches below the surface, where feasible).
- Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do not use a lead or metallic weight if collecting metals samples. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament polypropylene, etc.) so that it is located below the inlet of the tubing.
- Lower tubing to a depth 6-12 inches below water surface, where possible.
- Pump several tubing volumes through the system to flush the tubing prior to collecting the first sample.
- Fill individual sample bottles via the discharge tubing, being careful not to remove the inlet tubing from the water.
- Try to avoid touching the discharge tubing to the sample container.
- Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

4. Depth Grab Samples

Examples of equipment that may be used for depth grab sampling include Kemmerer, Niskin, Van Dorn and similar samplers; pumps with tubing (see above section), and double

check-valve bailers. Before using any reusable equipment, confirm equipment is appropriately decontaminated.

Many of these Kemmerer, Niskin and Van Dorn type samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Stainless steel or Teflon-coated devices are acceptable for all analyte groups.

- Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.
- Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.
- Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.
- At the desired depth, send the messenger weight down to trip the closure mechanism.
- Retrieve the sampler slowly.
- Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.

B Streamflow Measurement

Water discharge can be measured in shallow (less than 4 feet deep) rivers and streams using a hand-held probe that measures instantaneous velocity, and is positioned at multiple depths and distances across that stream cross section.

The current meter is used by suspending the sensing probe in the stream and pointing it in the upstream direction. The assumption is that the stream to be measured is sufficiently shallow to wade in. The sensing probe is attached to a special rod which is graduated in such units as centimeters and which allows the probe to be positioned in the stream at a known depth. The probe measures water velocity by creating a magnetic field and measuring the voltage produced when water flows through the field.

A straight stretch of stream with a fairly constant depth is preferred for conducting streamflow measurements. This will maximize the likelihood that the streamlines are parallel to one another. There should be few if any rocks, holes, or structures in the stream. Preferably the depth of the section to be measured is greater than 0.5 feet and the velocity is greater than 0.5 feet per second.

A tape or marked cable is stretched across the stream channel and anchored securely at each end. The total width of the stream is determined. Flow measurements are taken at known increments (even increments are best because it simplifies the subsequent calculations). There should be 10 to 20 measurements across a large stream, fewer across a small one. The data collected are used to calculate the discharge by the midsection method normally employed by the USGS.

Set the rod firmly on the stream bottom and hold it vertically at the desired distance mark on the tape. Point the probe upstream and stand to the side so that the flow around your legs does not affect the meter.

If the stream is less than 2.5 feet deep, a one point method is used. The probe should be placed at a depth of 0.6 of the total stream depth measured downward from the surface.

If the stream is more than 2.5 feet deep, then the two-point method is used. Measurements are taken at depths of 0.2 and 0.8 of the total stream depth. The measurements at 0.2 and 0.8 are averaged.

The velocity of flow for each set of measurements is determined using tables provided with the current meter used.

IV. Attachments

- Surface water quality sampling field data form.

V. Key Checks and Items

- When using watercraft, take samples near the bow, away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction.
- When wading, collect samples upstream from the body.
- Avoid disturbing sediments in immediate area of sample collection.
- Collect water samples prior to taking sediment samples when obtaining both from the same area (site).
- Collect water samples for chemical analyses prior to taking field measurements.
- Consider the representativeness of selected sampling locations, for example, when attempting to characterize a water body that may be stratified or heterogeneous.
- Unless dictated by the SAP, sampling at or near structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns.
- Collect surface water samples from downstream toward upstream.

Surface Water Quality Sampling Field Data

SITE:

FIELD CREW:

DATE: **CLOUD COVER:**

TIME: **ANTECEDENT RAIN:**

DEPTH OF WATER (FT): **AMBIENT TEMPERATURE:**

FLOW VELOCITY AND DIRECTION:

FIELD MEASUREMENTS

Time	Conductivity (µmhos)	DO (mg/L)	Salinity (ppt)	Temperature (°C)	pH (su)	ORP	Turbidity (NTU)	

SAMPLE PARAMETERS (GRAB OR COMPOSITE) :

OBSERVATIONS

COLOR: CLEAR , AMBER , TAN , BROWN , GREY , MILKY WHITE , OTHER:

ODOR: NONE , LOW , MEDIUM , HIGH , VERY STRONG , H2S , FUEL LIKE , CHEMICAL ?, UNKNOWN

TURBIDITY: NONE , LOW , MEDIUM , HIGH , VERY TURBID. HEAVY SILTS

COMMENTS:

OTHER: PLEASE USE BACK OF SHEET.FOR SKETCHING MAPS , **SEE BACK OF SHT Y / N.**

Q.C. SAMPLE TYPE: DUPLICATE , EQUIPMENT BLANK , OTHER :

SIGNED/SAMPLER: _____

Updated May 2007 PAGE_____OF_____

STANDARD OPERATING PROCEDURE G-2

Sediment Sampling

I. Purpose

These standardized procedures describe the collection and handling of sediment samples during field operations.

II. Scope

Sediments occur in freshwater and marine environments such as streams/rivers, ponds/lakes, canals, ditches, wetlands, lagoons, and estuaries. The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Always collect surface water quality samples prior to collecting sediment samples if sampling locations are located with or near each other.

The sampling team will document the site conditions (e.g., surrounding land use, surface water characteristics, obvious nearby sources of contamination) and sediment characteristics (e.g., color, texture, odor, sediment depth sampled) through a brief description in the logbook, sediment log sheet, and/or representative site photos. It is also important to document that the media being sampled is in fact sediment (and not soil), meaning that overlying water was present at the time of sampling, or that there is obvious evidence of frequent and recent inundation (e.g., sampling exposed sediment at low tide). Any project required deviations from the standard operating procedures (SOPs) will be provided in the site specific sampling and analysis plan (SAP).

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device).
- Rope to lower sediment grab or dredge.
- Measuring tape to measure water depth.
- Sediment log sheets.
- Camera (to document sample characteristics and site conditions).
- Hip waders.
- Materials for classifying soils, particularly the percentage of fines.
- Sample jars, including jars for grain size, total organic carbon, and pH, as appropriate.
- Boat or canoe with U.S. Coast Guard-approved safety equipment.

IV. Procedures and Guidelines

Sediment samples can be collected using one of three different types of equipment: (1) scoops, (2) corers and (3) dredges/grab samplers. Soil sampling equipment is generally not applicable to sediments because of the low cohesion of the medium, but may be used if appropriate. When selecting the appropriate sampling equipment, consider sampling location (edge or middle of lagoon), depth of water and sediment, sediment grain size (fineness), water velocity, and analytes of interest.

Direct collection with the appropriate sample container may be appropriate in very low water or where sediment is exposed. Use dredges for hard or rocky substrates (can also be used for fine sediment). They are heavy enough to use in high velocity streams. Use coring devices in quiescent waters, unless water depth precludes effective sample collection. Always note the depth of sediment actually collected; environmental and mechanical factors may prevent collection to targeted depth (e.g., 0-6 inches).

A. Scoops or Similar Equipment

- Scooping is generally most useful in shallow waters, and where water flow is minimal so as not to disturbed the scooped sample as it is brought up through the water column. Collect samples by facing the direction of minimal flow and approach the location from the downstream direction. Take precautions not to disturb the bottom prior to scooping. Scoop and transfer the sample to the appropriate sample container(s) or to a decontaminated bowl if homogenization is required.

B. Corers

Coring devices can be easily fabricated from many materials. Some corers are simple "push tubes," whereas other more sophisticated models may be finned, gravity driven devices. A core may be useful for preserving the historical layering of sediments.

The corer is an acceptable choice for sampling fine sediments. Corer diameter, grain size, and sample consistency will determine if the sample will remain in the corer upon withdrawal. Sample washout can be a problem, and ways to reduce or prevent it are as follows:

- Fit the leading edge of the corer with a nosepiece or core catcher that physically keeps the sample from slipping back out of the corer. The core catcher material must also be compatible with the analytes of interest.
- A second option is fit the top or back end with a check valve which creates negative pressure as it is being pulled from the substrate, and prevents surface water from washing out the top portion of the sample.
- Rotate the corer, if needed, as it is pushed into the sediment but do not rock the coring device back and forth. Rotation improves penetration and prevents compaction of the sample.
- Upon withdrawal from the water surface, place a cap on the bottom to prevent the sample from sliding out.

- Corers can also be fitted with liners if a complete core is desired.
- As the core is extruded, carefully remove the sample with a decontaminated, non-reactive utensil and transfer into the appropriate sample container(s) or a bowl if homogenization is required or if a specific depth fraction is required to be sampled.

C. Dredges or Grab Samplers

The three main types of devices used in freshwater are the Peterson, Ponar, and Ekman. The Peterson and Ponar dredges are suitable for hard or rocky substrates, deep water bodies, and streams with fast currents. The Peterson and Ponar are virtually the same, except that the Ponar has been adapted with a top screen and side plates to prevent sample loss upon ascent. Use the following method to collect a sediment sample:

- Open the jaws and place the cross bar into the proper notch.
- Lower the dredge to the bottom, making sure it settles flat.
- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.
- Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.
- Carefully open the jaws, remove the sample with a decontaminated, non-reactive utensil and transfer the sample into the appropriate sample container(s) or bowl for homogenization.

The Ekman is designed for sampling soft substrates (e.g., sand, silt, or mud) in areas with little current and is used as follows:

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.
- Lower the dredge to the bottom, making sure it settles flat.
- Holding the line taut, send down the messenger to close the jaws of the dredge.
- Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.
- Carefully open the jaws, remove the sample with a clean, non-reactive utensil and transfer the sample into the appropriate sample container(s) or bowl for homogenization.

D. General Sampling Procedures

1. Field personnel will start downstream and work upstream to prevent disturbance of or influence on unsampled areas. In surface water bodies that are tidally influenced, sampling should be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants; however, sampling at other tide stages may be warranted to provide data representative of other, actual conditions. Sediment sampling activities should not occur immediately after periods of heavy rainfall.

2. As needed, make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Use a GPS to gather station coordinates, if needed. Also characterize depth and width of waterway, rate of flow, type, consistency, and odor of sediment, and point and depth of sample removal (along shore, mid-channel, etc.).

3. Transfer sample into appropriate sample jars with a stainless steel utensil. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. Minimize the amount of overlying water that is collected with the sample matrix. Decant the excess water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since skin or gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.

4. Samples for volatile organics (and, if applicable, acid volatile sulfides/simultaneously extracted metals [AVS/SEM]) should immediately be placed in jars prior to homogenization of sediment. Rocks and other debris should be removed with utensils before placement in jars. If sediment is stiff enough to sample with EnCore® or Terra Core® samplers for VOC analysis, follow the instructions contained in the EnCore® or Terra Core® SOPs, as applicable.

5. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, broken bottles, sharps, snakes, drop-offs, loose silt and muck) which can make wading dangerous.

6. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.

7. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

Sediment Log Form.

VI. Key Checks and Items

- When working in flowing streams, start downstream and work upstream.
- As necessary and practical, log exact locations using permanent features, and gather GPS coordinates.
- Beware of hidden hazards in the water column.
- When sediment sampling at a location for the first time, bring several types of sampling equipment in case one does not work.

CH2MHILL

PROJECT NUMBER	SAMPLE NUMBER
	SHEET 1 OF 1

SEDIMENT LOG

PROJECT : LOCATION : DATE:

WEATHER:

METHOD AND EQUIPMENT USED :

LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SEDIMENT DESCRIPTION COLOR, ODOR, MOISTURE CONTENT PARTICLE SIZE CHARACTERIZATION	COMMENTS UNUSUAL CHARACTERISTICS
0.5						
1.0						
1.5						
2.0						
2.5						

Sampler Signature: _____ Date: _____

G-2_Sediment SAMPLING FORMS2_jrm_jl.xls Updated May 2007

STANDARD OPERATING PROCEDURE H-1

Preparing Field Log Books

I. Purpose and Scope

This SOP will provide standardized procedures and basic requirements for entering field data into log books during field activities. Log books are legal documents. They must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy.

II. Equipment and Materials

- Log book
- Indelible pen

III. Procedures and Guidelines

Properly completed field log books are a requirement of the work performed under the Navy CLEAN contract.

A. Procedures for Completing Field Log Books

1. Field notes are to be kept in bound, hard-covered logbooks, as well as task-specific logs. The pages are to be water-resistant and notes will be taken only with a water-proof, non-erasable permanent ink pen.
2. The inside cover of the log book generally should include:
    - Company name and address.
    - Log-holders name if log book was assigned specifically to that person.
    - Activity or location.
    - Project name.
    - Project manager's (PM's) name.
    - Phone numbers of the company, supervisors, emergency response, etc.
3. Daily entries will be made chronologically. Each page of the log book will have the date of the work and the note takers initials.
4. Information will be recorded directly into the field log during the work activity. Entries into the log should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on memory. Entries must be legible and complete.

5. Every line should be used to prevent later additions of text, or be marked through with a line, initialed and dated. Unused pages will be marked through with a line, the author's initials, date, and the note "Intentionally Left Blank."
6. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the person performing the correction. If possible, all corrections should be made by the individual keeping the log.
7. Only information relevant to the subject project will be added to the log book.
8. The final page of each day's notes will include the note-takers signature and date.
9. Copies of the field notes generally should be sent to the PM or designee in a timely manner (generally by the end of each week of work being performed).

B. Information generally to be Included in Field Logs

1. Use the left side border to record times and the remainder of the page to record information.
2. General project information will be recorded at the beginning of each field project; the project title, project number, staff, scope of the day's work and weather conditions (note changes).
3. Subcontractor Information: Record name of company, names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List start and stop times, and quantities of billable line items accomplished.
4. Technical and Project Information: Describe the details of the work being performed. The project SAP will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the PM prior to beginning the field work.
5. Any conditions that might adversely affect the work or data obtained.
6. Time: Keep a running time log explaining field activities as they occur throughout the day.
7. Tail Gate Safety Talks: Record topics discussed.
8. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE). Also record other required health and safety procedures as specified in the project specific health and safety plan.
9. Instrument Calibration: Record calibration information for each piece of health and safety/field equipment if not recorded elsewhere.
10. Personnel: Record when personnel and visitors enter and leave the site.
11. Communications: Record all communications that impact performance of the project.
12. Deviations from the SAP: Record deviations from the SAP; document the reasons and communications authorizing deviations.

13. Heath and Safety Incidents: Record all health and safety incidents in detail, immediately reporting them to the field team leader (FTL) and PM.
14. Problems and Corrective Actions: Clearly describe problems encountered during the field work and the corrective actions taken.
15. Sampling Information: Specific information that will be relevant to most sampling jobs includes the following:
    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier.
    - Description of the sample location – estimate location in comparison to two fixed points – If location not already identified on a map or figure, draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type.
    - Sample identifier, date and time.
    - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples.
    - Number and type of sample containers collected.
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity).
    - Parameters to be analyzed for, if appropriate.
    - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.
    - If the PM specifies, some of the above can be entered in GBC or spiral bound field sampling books printed specifically for the sampling task instead of in the hard cover log book.

C. Suggested Format for Recording Field Data

1. Use tables to record sampling information and field data from multiple samples. Keep data organized for easier review.
2. Sketch sampling locations, construction sites, and other pertinent information.
3. Sketch well construction diagrams or use well-completion logs.

STANDARD OPERATING PROCEDURE H-2

Water-Level Measurements

I. Purpose and Scope

To provide standardized procedures for the measurements of the depth to groundwater and free product in wells and on staff gages in surface-water bodies. Any project required deviations from standard operating procedures (SOPs) will be provided in the site specific sampling and analysis plans (SAPs).

II. Equipment and Materials

- Electronic water-level meter tape; the tape should have graduations in increments of 0.01-foot or smaller, or
- Interface probe (for second phase liquids) graduated in increments of 0.01-foot or smaller, and/or
- A calibrated staff gage.

III. Procedures and Guidelines

For depth-to-water (DTW) measurements, ensure the electronic water-level meter or interface probe is decontaminated and functioning as per SOP "*Decontamination of personnel and equipment*" and the owner's manual. Lower the probe into the well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Record the DTW from a reference point indicated by notch or sharpie mark on lip on the well riser, or, if no survey point notched or marked, the northern edge of the riser, to the nearest 0.01-foot in the logbook.

If the presence of free product (light or dense non-aqueous phase liquid) is suspected, determine the thickness of the product using the appropriate equipment. The instrument manual will indicate how the depth free-product is to be determined.

The apparent elevation of the water level in the well is determined by measuring both the thickness of the floating free-product and the apparent depth to water floating. Do not use this calculation if free-phase product is located at the bottom of the well. The corrected water-level elevation is calculated by the following equation:

$$WL_c = Wl_a + (\text{Free-product thickness} \times 0.80)$$

Where WL_c = Corrected water-level elevation
Wl_a = Apparent water-level elevation
0.80 = Typical value for the density of petroleum hydrocarbon products.

If free-product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. The tools are constructed by attaching a calibrated staff gage to a wood or metal post, driven into the bottom of the surface-water body. The top of the gage elevation is surveyed to a resolution of 0.01-foot. The elevation of the water is determined by the distance the water level is from the top of the gage. Protection may be needed to reduce fluctuations by wind or current.

IV. Key Checks

- Verify the unit is decontaminated before each use.
- Verify that the battery is charged by pressing the test button on the water-level meter.

STANDARD OPERATING PROCEDURE H-4

Chain-of-Custody

I. Purpose

This SOP provides standardized procedures for completing chain of custody (COC) forms. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs).

II. Scope

This procedure describes the steps necessary for transferring samples through the use of a COC. A COC is required for the tracking and recording of samples collected during program activities. Use of the COC creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over regional- or site-specific requirements.

III. Definitions

Chain-of-Custody Record - A COC is a printed form that accompanies a sample or group of samples as custody is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes the custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and is secured to prevent tampering.

Sample - A sample is physical evidence which is representative of conditions at the point and time that it was collected.

IV. Procedures

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

A. Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which may be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

1. Sample Label

Samples removed and transported from the sample location to a laboratory or other location for analysis will be collected into laboratory provided containers and labeled. Sample labels will include:

- Project - CTO Number.
- Sample Identification - The SAP/SSP I.D. provided for the sample.
- Date - Day, month, and year of sample collection.
- Time - A four-digit number in the 24-hour format at time of collection.
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type of preservation.
- Analysis – Type of analysis to be performed (e.g., VOC).

- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

B. Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under COC procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

1. Field Custody Procedures

- Care must be taken to ensure that the sample information on the label matches the COC exactly.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- Sample labels shall be completed for each sample, using waterproof ink.

2. Transfer of Custody and Shipment

Samples are accompanied by a COC. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the COC. This documents sample custody transfer from the sampler to the analyst in the laboratory. The COC is shipped as described below:

- Place the original (top, signed copy) of the COC in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date two custody seals, 1-inch by 3-inch white paper labels with black lettering and an adhesive backing. The custody seals are part of the COC process and are used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seals across the shipping container opening on diagonally opposite corners, so that one would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

Any corrections are made by drawing a line through, initialing and dating the change, then entering the correct information. Erasures are not permitted.

As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment then signs and dates the COC, completing the sample transfer process. It is then the laboratory's responsibility to maintain custody records throughout sample preparation and analysis.

V. Quality Assurance Records

Once samples have been packaged and shipped, the COC copy and airbill receipt become part of the QA record.

VI. Attachments

Chain of Custody Form.

VII. References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

STANDARD OPERATING PROCEDURE H-5

Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of samples of various media to a laboratory for analysis. This standardized procedure only covers samples of sufficiently low concentration as to not be considered dangerous goods for purposes of shipping.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have sufficiently low concentrations of chemical constituents as to not be considered dangerous goods when being shipped. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped following procedures for dangerous-goods shipping specified by the intended shipper (e.g., Federal Express).

III. Equipment and Materials

- Coolers
- Clear tape
- Duct tape
- "This Side Up" labels
- "Fragile" labels
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

A. Sample Packing

1. Prepare coolers for shipment:
   - Tape drains shut from the inside of the cooler.
   - Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler, if available.
   - Place mailing label with laboratory address on top of coolers.
   - As necessary (helpful for large bottle ware), fill bottom of coolers with about 3 inches of bubble wrap.
2. Arrange decontaminated sample containers in groups by sample number. Consolidate volatile organic compound (VOC) samples into one cooler to minimize the need for trip blanks.
3. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.
4. Seal each set of sample bottles within a separate water proof zipper-type plastic bag and bubble wrap, if available. Make every attempt to ensure the samples are water proof. Double bag Encore VOC samples and soil samples. Sample label should be visible through the bag.
5. Place two large plastic bag liners, one inside the other, openings up. Arrange sample containers in liners so bags do not touch each other. Temp blank should go on the bottom of the cooler, in an area where it can be completely surrounded by ice.
6. If ice is required to preserve the samples, use at least two full bags and place on and around the containers.
7. Fill remaining spaces with bubble wrap or ice as required and add the laboratory provided trip blank.
8. Close the inside liner first by twisting the opening to the bag liner closed, allowing as much air to escape as possible. Zip-tie the bag closed and tie the end into a knot. Do the same to the second liner being sure to remove as much air as possible.
9. Complete and sign COC (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier. Place into a zip-type bag and tape it to the inside of the lid of the cooler.
10. Close lid and latch.
11. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
12. Tape cooler shut on both ends, making several complete revolutions with tape. Do not cover custody seals.

13. Relinquish to Federal Express or to a courier arranged with the laboratory. Scan airbill receipt and COCs to the sample documentation coordinator (or mail if scanner not available) along with the other documentation.

B. Medium- and High-Concentration Samples

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. The sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label.
- Pack sample bottles carefully, with adequate bubble wrap or other packaging and without allowing bottles to touch.
- Be sure there is adequate ice.
- Include COC.
- Affix custody seals.

STANDARD OPERATING PROCEDURE H-6

Equipment Blank Preparation

I. Purpose and Scope

This document provides standardized procedures for collecting equipment blanks used to determine whether decontamination procedures are adequate during sampling. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs). The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

II. Equipment and Materials

- ASTM Type II reagent water with analysis certification (blank water).
- Sample bottles with preservatives according to the SAP.
- Gloves.

III. Procedures and Guidelines

A. Decon all sampling equipment according to "Decontamination of Personnel and Equipment" SOP.

B. For volatile organic compound (VOC) analysis from the surfaces of equipment other than pumps, pour blank water over one piece of equipment and into three 40-ml vials as per VOC water sampling procedure.

C. For non-VOC analyses, one aliquot is to be used for equipment. Pour blank water into the sampling bowl and other equipment so surfaces which previously contacted the sample are now in contact with the blank water. Pour blank fluid from pan into the appropriate sample bottles.

D. For pumps, run an extra gallon of blank water through the pump while collecting the pump outflow into appropriate containers. If a pump with disposable tubing is used, put new tubing onto the pump to collect the equipment blank.

E. Document and ship samples in accordance with the procedures for other samples.

IV. Attachments

None.

V. Key Checks and Items

- Wear gloves.
- Do not use any disposable or non-decontaminated equipment to prepare blank.
- Use ASTM-Type II reagent water with analysis certification.

CENTAURI LABS™

INTRODUCING THE MIST™
MULTI-INCREMENTAL SAMPLING TOOL

Centauri Labs is now offering the patented MIST™ sampling tools, specifically designed for Multi-Incremental Sampling Programs.

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The MIST™ family of tools is currently available in two models:

- The MIST™-01 is our entry level tool and based on the classic CRREL design
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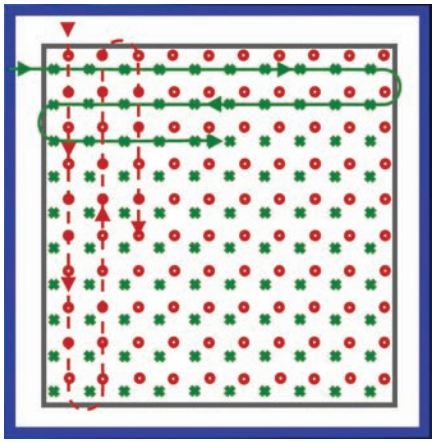
- Improved field sampling efficiency
- Homogenous and statistically valid soil collection from each decision unit

Using Centauri's MIST™ tools results in obtaining sampling accuracy in the field and the analytical accuracy in the laboratory.

MIS IS A TWO-PART PROCESS:



1. Field Sample Collection

- Collect multiple (> 30 to 100) increments of uniform size from the entire area to be represented (i.e. the Decision Unit)
- Composite increments into a single sample (1 to 2 kilogram)

2. Laboratory Processing and Sub-sampling

- Air drying and sieving entire sample
- Particle size reduction (grinding) of entire sample
- Multi-increment sub-sampling (>30 increments) to provide representative ~10 gram aliquot for extraction and analysis

PRODUCT SPECIFICATIONS:

Size –
Length 45 cm, Weight 3 kg

Core Details –
Core #1: 1.0" wide x 4.0" deep = 95 grams
Core #2: 1.0" wide x 2.5" deep = 28 grams
Core #3: 1.5" wide x 2.5" deep = 60 grams
Core #4: 0.5" wide x 2.5" deep = 11 grams

Note: The cores were tested on wet grassy soil. Sample weight may vary.

Pricing –
MIST™-01 with 4 coring tips = $ 1,000
MIST™-02 with 4 coring tips = $ 1,300

Note: Call for rental options.

For more information or to schedule a Multi-Incremental Sampling Seminar please contact Centauri Labs at (301) 694-5310 or info@centaurilabs.com.

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Modified Soil Sample Depth Selection Protocol

This protocol defines the soil sample selection criteria that are used to select soil sampling depths for environmental investigations on Vieques, unless otherwise deemed appropriate and specified in site-specific project plans.

Soil sampling is conducted to provide information for various purposes. In addition to general site characterization use (e.g., nature and extent of contamination), surface soil data are used in human health and ecological risk assessments. Subsurface soil data from samples collected to a depth of 6 feet are used in human health risk assessments. The presence or potential presence of basements often is associated with subsurface soil depths of 10 feet for human health risk assessment. The subsurface soil depth for human health risk assessments conducted for Vieques is limited to 6 feet because there are no basements in Puerto Rico. Soil data are also used to assess the presence of contaminants that may be continuing sources of groundwater contamination.

Surface Soil

In order to provide analytical data from a single depth that can be used for both human health and ecological screening/risk assessments (as well as site characterization), the following are the criteria used to select the surface soil sampling depth at a given site under investigation:

- Surface soil samples will be collected from the top 24 inches of soil when the sample location is near a surface water body and land crabs or burrowing reptiles (e.g., nesting sea turtles) are potential receptors of concern at the sample location.
- Surface soil samples will be collected from the top 12 inches of soil when the sample location is not near a surface water body and land crabs or burrowing reptiles (e.g., nesting sea turtles) are not potential receptors of concern at the sample location.
- Surface soil samples will be collected from the top 6 inches of soil when collected from under debris or contaminated soil that has been removed to determine whether a release to underlying soil has occurred.

Subsurface Soil

The following are the general criteria that are used to select subsurface soil sampling depths at environmental sites. It should be noted that subsurface soil sample selection criteria may be modified on a site-specific basis, based on factors such as the depth to groundwater, depth to bedrock, depth of contaminant source, and extent of contamination.

For the purposes of collecting data for site characterization and human health risk assessment, at each subsurface soil sampling location, continuous split-spoon (or direct-push) samples will be collected from the bottom of the surface soil interval (i.e., 1 foot or 2 feet) to 6 feet (or bedrock or water table if encountered above 6 feet). One subsurface soil sample will be collected for analysis in the 2-ft interval directly beneath a subsurface munitions item (MEC and MD) or highest anomaly reading identified using a geophysical instrument-aided technique, if encountered and **deemed safe to remove**. If subsurface munitions items are not identified, the normal Vieques protocol will be as follows: collected within the 1- or 2-to-6 ft interval (depending on the surface soil depth), based on where visual and/or instrument (e.g., OVA) screening suggests the presence of contamination, to be used for human health risk evaluation (and site characterization). In the absence of potential contamination based on visual and/or instrument screening, the subsurface soil sample will be collected for analysis at the 4-to-6 ft interval (or just above the water table or bedrock, if encountered before this depth).

For the purposes of site characterization (not for risk assessment purposes), continuous soil sampling will continue from 6 feet to bedrock or the water table, whichever is shallower. Additional soil sample(s) will be collected for analysis below the 6-foot depth (i.e., between 6 feet and the water table or bedrock, whichever is shallower) if visual or instrument screening suggests the presence of contamination, to assist in delineating the vertical extent of contamination.

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STANDARD OPERATING PROCEDURE MR-1

Vegetation Removal

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when removing vegetation in support of munitions response (MR) activities.

1.2 Equipment and Materials

- Hand tools – chain saws, trimmers, weed eaters, etc.
- Mechanical cutting equipment, as allowable – mechanized cutting heads, tractors with cutting decks, etc
- Back hoe (optional).

1.3 Procedures and Guidelines

1.3.1 General

- Vegetation removal will be conducted by hand (manual) utilizing hand carried tools (e.g., weed eaters) in areas that have not been surface cleared and completed the quality control/quality assurance (QC/QA) process or are otherwise deemed unsafe for mechanical vegetation cutting. Mechanical cutting of vegetation may occur if the area has completed the QC/QA process and is deemed safe to do so, in accordance with the NOSSA- and DDESB-endorsed Explosive Safety Submission established for the project.
- Unless it is absolutely necessary, cutting trees larger than 3 inches in diameter will be prohibited. Trees will be felled into an area that has already been surface swept for MEC.
- The vegetation will typically be cut to a height of approximately 6 inches above ground surface to eliminate interference with munitions and explosives of concern (MEC) detection or digital geophysical mapping (DGM) survey activities.
- All cut vegetation will be accumulated onsite and left in place.

1.3.2 Vegetation Removal Process

1. Prior to any field activities related to the removal of vegetation, the area(s) to be cleared of vegetation will be identified through the Work Area Determination (WAD) process, or some other equivalent means. The WAD process will consist of reviewing the areas requiring vegetation removal in relation to known areas where sensitive vegetation or habitats exist at the project site as identified through the Biological Assessment. All areas cleared of vegetation will be approved by FWS prior to vegetation removal. Any restrictions on vegetation removal and potential plant species that cannot be cut will be identified prior to approving the area for vegetation removal.
2. Following the WAD approval, UXO Technicians will inspect all areas of the grid ahead of the vegetation removal crews with the aid of handheld magnetometers. The UXO Technicians will mark any MEC or other hazards by encircling the hazard with flagging tape.
3. The vegetation removal will be supervised by UXO Technician III and a UXO Technician II. Laborers will use hand tools that are appropriate for the vegetation being cut, such as chain saws, power string trimmers, and machetes.
4. Trees will be trimmed or removed on a case-by-case basis and only as required to accomplish the project tasks. If removal is required, the tree will be cut using chain saws or other hand held equipment. The tree will be sectioned, if necessary, to remove it from the immediate area, so it does not interfere with MEC detection or survey activities.

1.4 Attachments

- None

STANDARD OPERATING PROCEDURE MR-2

Surface Munitions and Explosives of Concern Removal

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when removing munitions and explosives of concern (MEC) from the ground surface during munitions response (MR) activities.

1.2 Equipment and Materials

- Hand Held Magnetometer
- GPS Data collection device
- Hand tools – shovel, pick ax, breaker bar, etc.

1.3 Procedures and Guidelines

1.3.1 General

- All UXO technicians performing tasks related to surface MEC removal will adhere to the allowable roles and responsibilities established by DDESB TP 18 for their given experience and project role.
- Prior to conducting the removal of MEC from the ground surface vegetation must be cleared, as appropriate, following the procedures in the Vegetation Removal SOP.
- All work will be conducted in accordance with the NOSSA- and DDESB-endorsed Explosive Safety Submission established for the project.
- All personnel accessing the site must be cognizant of and adhere to all relevant exclusion zones established for the work area(s). Depending on the classification of the personnel (essential versus non-essential) and their locations on site, work may need to temporarily cease when authorized personnel enter the work area and are within the EZ.
- A hand held magnetometer assisted visual survey will be performed to locate all surface MEC. All metallic items present at ground surface or partially exposed at the surface will be removed using the following process:
  - UXO technicians will work individual search lanes approximately 3-ft to 5-ft wide and will search each lane using a hand held magnetometer (e.g., Schonstedt Model GA-52Cx), or similar approach to accomplish 100 percent coverage.
  - UXO technicians will start at one end of each lane and move forward toward the opposing base line. During the forward movement the technician will move the magnetometer back and forth from one side of the lane to the other. Both forward movement and the swing of the magnetometer will be performed at a pace, which ensures the entire lane is searched and that the instrument is able to appropriately respond to anomalies.
  - Whenever a metallic surface object is encountered the technician will halt and investigate the anomaly real-time.
  - Throughout this operation the UXO Technician III will closely monitor individual performance to ensure these procedures are being performed with due diligence and attention to detail. If field teams determine

an area is inaccessible or unsafe to work utilizing the work approaches prescribed, they will record the following data, which will be included in the report for that action:

- Reason(s) area was determined inaccessible or unsafe to work (e.g., water, steep slope)
- If area is inaccessible or unsafe to work due to slope, the percent slope
- Record the boundary using global positioning system (GPS) units
- Grid(s) location or MRS location
- Date and time
- Contractor team leader name
- Government representative verification of conditions

- MEC items that are safe to move will be removed by hand. MEC items which are safe to move may be consolidated for disposal/demilitarization within a grid, or several adjacent grids.
- MEC items that are not safe to move will be clearly marked. Additionally, the accessibility, explosive hazard, location, and other factors will be assessed to determine if additional safety measures should be put in place. The item will then be demilitarized during a scheduled demolition event.
- Non-MEC metallic items will be removed from the grid and will be consolidated onsite in a designated and established holding area. These metallic items will be thoroughly screened for MEC. Large items, such as target vehicles, will require additional screening for environmental pollutants (e.g., petroleum products, coolants, batteries). These items may also require onsite disassembly to facilitate removal.

1.1.1 MEC Safety

- In general, a projectile containing a base detonating (BD) fuze is to be considered armed if the projectile has been fired.
- Arming wires and pop-out pins on unarmed fuzes should be secured by taping in place prior to movement.
- Do not rely on the color-coding of MEC for positive identification.
- Avoid the area in front of MEC items until it can be determined the item does not contain a shaped charge. The explosive jet can be fatal at great distances forward of the longitudinal axis of the item. Assume any shaped charge munitions to contain a piezoelectric (PZ) fuze until the fuzing is positively identified. A PZ fuze is extremely sensitive, can function at the slightest physical change, and may remain hazardous for an indefinite period of time.
- Examine all projectile rotating bands for fired/unfired condition. Also examine projectiles for the presence/absence of an unfired tracer.
- Assume practice/training MEC contains a live charge until it can be determined otherwise. Expended pyrotechnic/practice devices may contain red/white phosphorus (WP) residue. Due to incomplete combustion, phosphorus may be present and re-ignite spontaneously if the crust is broken and the contents exposed to air (USACE, 2004). Additionally, red phosphorous is sensitive to shock/friction.
- Do not approach smoking WP MEC. Burning WP may detonate the burster or dispersal explosive charge at any time.

1.3.2 MEC Identification

- The UXO Technician will carefully remove enough soil, without disturbing the MEC, to facilitate positive identification or to obtain its identification features. UXO Technicians will make every effort to identify MEC through visual examination of the item for markings and other identifying features such as shape, size, and external fittings.
- Items will not be moved during the inspection/identification until the fuze condition can be ascertained. If the condition is questionable, consider the fuze to be armed. The fuze is considered the most hazardous

component of a UXO, regardless of type or condition. The Senior UXO Supervisor (SUXOS) will make final determination of identification of the item and the disposition of the item prior to transporting or implementing any disposal operations.

1.3.3 MEC Transportation

- Transportation of MEC may be a consideration if safe to do and there is a compelling reason.
- Recovered military munitions or MEC will not be moved by personnel unless it is safe to do so. Movement of MEC by hand is authorized only after positive identification and a determination by the UXO Technician III and either the SUXOS or UXO Safety Officer (UXOSO) that the MEC is safe to move. A conservative approach to MEC transportation will be taken and only considered when the item is positively identified as safe to move.
- If onsite movement of MEC for disposal or venting is approved, move the MEC in the position found. Movement over short distances for onsite consolidation will be done by hand-carrying the MEC in the position found.
- Movement of greater distances (e.g., to another grid for disposal or venting) may be done in a specially-equipped pickup truck. The truck must have the appropriate placards and a non-sparking bed liner and tie-down points. The MEC will be stabilized with sandbags or placed in a wooden box filled with sand and securely tied down. The driver of the transport vehicle will be followed by another similar vehicle and driver to assist him in loading and unloading the MEC, and in the event of mechanical trouble.

1.3.4 MEC Safe Holding Areas

- Depending on condition and quantity of MEC encountered, MEC will either be left in place pending disposal or transported to onsite consolidation point pending disposal.
- MEC items left in place pending disposal will have geographic coordinates and item information gathered. The specific location of the item will be evaluated to determine any security or access concerns. Finally, the next planned demolition event for the site will be considered to determine if additional measures will be necessary to maintain control/ security of the item. Additionally, activities that may result in increased trespassing or attempts to access the work areas will be evaluated to determine if additional measures should be taken to discourage access, prevent access, or minimize potential encounters with UXO. USFWS, USEPA, and PREQB will be notified if the site personnel are made aware of the possibility of increased trespassing, so they can provide notification to the appropriate enforcement agencies for both waterway access and land access.

1.3.5 Procedures when MEC Cannot be Destroyed Onsite or Cannot be Identified

- MEC items encountered at the ground surface will be destroyed onsite. This will be accomplished through blow-in-place (BIP) or in-grid consolidation shots. Considering the remote location of the work site it is unlikely an MEC item will be encountered which cannot be safely destroyed onsite. However, in the event one or more MEC items are encountered which cannot be destroyed onsite, a suitable treatment site will be located at one of the nearby MRSs. The geographic coordinates for all consolidated shot locations will be recorded.
- Military munitions will not be moved by any project personnel unless safe to do so. Movement of military munitions by hand is authorized only after positive identification and the determination is made by the UXO Technician III and SUXOS that the military munitions are safe to be moved.
- Unidentified military munitions will not be handled or moved for the purpose of identification. All available data will be collected for the unknown MEC item (e.g., dimensions, external features, markings, color-code) and photos will be taken.
- Assistance in identifying unknown UXO and MEC is available from the U.S. Army Corps of Engineers (USACE) Military Munitions Center of Excellence and the Navy's Explosive Ordnance Disposal (EOD) Technology Division. The contact information for the support centers are given below.

USACE Military Munitions Center of Excellence	(256) 895-1200
U.S. Navy EOD Technology Division	(301) 744-4069 or (877) 363-4636

1.3.6 Recovered Chemical Warfare Materiel

- Recovered Chemical Warfare Materiel (RCWM) is not expected to be encountered at the VNTR based on range usage archival searches and previous investigations. If suspected RCWM is encountered the following procedures will be followed:
  - Person discovering suspected RCWM will immediately notify the SUXOS.
  - SUXOS will immediately direct the work team to stop work and evacuate the site in an upwind direction. The initial exclusion zone (EZ) for RCWM is 450 ft upwind per Field Manual (FM)-9-15 (U.S. Army, 1996).
  - SUXOS should note the location of the suspected RCWM to help with its identification and reacquisition.
  - SUXOS will designate a minimum of two UXO-qualified individuals to position themselves upwind as far as possible to prevent unauthorized personnel from accidental exposure.
  - SUXOS will immediately contact the NAVFAC RPM and local Department of Interior (DoI) USFWS representatives to request military assistance.
  - **Note:** Assistance for RCWM will be requested through the U.S. Army's 52nd Ordnance Group at Fort Gillem, GA (404) 469-3333. Should the 52nd Ordnance Group at Fort Gillem be non-responsive, the Chemical Warfare Design Center will be contacted at (296) 895-1180.
  - SUXOS will account for all personnel and notify the Title II Services Contractor PM.
  - SUXOS will ensure the area is secured until relieved by proper authorities. The SUXOS will direct Title II Services Contractor personnel to support response units as appropriate.
  - USEPA Region II, PREQB, and NOSSA will be notified if RCWM is discovered during removal action operations. The contact information for these agencies is given in given below.

USEPA Region II	(787) 741-5201
PREQB	(787) 365-8573
NOSSA	(301) 744-4450

- Before work resumes after RCWM is identified, site plans will be reviewed for adequacy in consideration of this newly discovered hazard.

1.3.7 Demolition Procedures

- Prior to carrying out demolition activities, the U.S. Coast Guard and Federal Aviation administration will be contacted and the appropriate notices made for watercraft and aircraft safety (e.g., notice to mariners, NOTAM). Additionally the following will be notified prior to demolition activities; NAVFAC Atlantic, Title II Services Contractor, USEPA Region II, PREQB, USFWS, and the Municipality of Vieques (MOV).
- During demolition activities, the SUXOS will have overall control of the Site. An EZ will be established around the demolition site according to the Explosive Operations Site Approval and Explosives Safety Submission (ESS). Only the SUXOS, UXO Team, and UXO-qualified safety personnel will be allowed within the EZ once the disposal operations have begun. The UXOSO will ensure safe work practices are observed, and the UXO Technician III will perform the necessary steps to safely dispose of the MEC. The following general procedures will be followed for all disposals by detonation:

- The UXO Team, comprised of the UXO Technician III and a UXO Technician II, will inspect the location, condition, and net explosive weight (NEW) of the MEC selected for disposal.
- The UXO Technician III will ensure that permission to detonate explosives has been obtained from the SUXOS and coordinated with the appropriate outside agencies.
- It is the responsibility of the SUXOS to schedule the detonations and to ensure that all project personnel are accounted for before disposal operations begin.
- The UXO Team will then prepare enough explosive charges to perform the planned detonations. The transportation vehicle will then be loaded with the properly containerized explosives and initiators, and other equipment required.
- Initiators will always be transported in a separate container from the main-charge explosives.
- A minimum separation distance of 25 feet will be observed for initiators and main-charge explosives while at the disposal site.
- If several MEC items are located in close proximity to each other, a mainline/branchline shot may be used to destroy these MEC simultaneously. Ensure the total NEW of the MEC to be destroyed does not increase the EZ minimum separation distance.
- All detonations will be dual-primed. The firing wire and initiators will be tested for continuity and the UXO Technician III will observe the UXO Technician II position the explosive charge against the MEC. The disposal shot may be tamped, however, initiators will never be buried.
- The initiators will then be connected to the firing wire and secured to the end of the detonating cord or placed into the main charge.
- The UXO Technician III will then inspect the disposal shot and return to the safe firing point.
- Prior to initiation, the UXO Technician III will ensure that guards are stationed at the roadblocks, scan the EZ for personnel, sound three distinct blasts on an air or vehicle horn, and then scan the area again and initiate the demolition charge if all is clear.
- In the event of a misfire, a 30-minute wait time for electric misfires or a 60-minute wait time for non-electric misfires will be observed. Then a new dual-primed initiator will be prepared and used to initiate the charges.
- All waterways, roadways, and other access routes will be monitored for non-essential personnel during all phases of demolition operations.

- After successful initiation of the explosive charge, the UXO Team will conduct an inspection of the disposal site and surrounding area to ensure complete destruction of the MEC. After verifying no more detonations will be required, an “all clear” notification will be issued.
- The UXO Team will collect for disposal all large MEC fragments and other debris, and generally clean and restore the area.

1.4 Quality Control

- A general set of Definable Features of Work (DFOW) have been established for surface MEC removal actions. These DFOWs are included as an attachment to this SOP. Additional DFOWs may be established he MR contractor’s site-specific work plan, as appropriate and deemed necessary. Each DFOW will be evaluated using the Three Phases of Control to ensure that the work is planned, executed, and completed appropriately.
- The MR contractor’s UXOQCS is responsible for onsite monitoring of the practices and operations taking place and verifying continued compliance with the specifications and requirements of the contract, task order, and approved project plans and procedures. The UXOQCS is also responsible for verifying that a daily Health and

Safety Inspection is performed and documented as prescribed in the project SSHP. Discrepancies between site practices and approved plans/ procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the UXOQCS or a designee prior to granting approval to continue work. Follow-up inspection results are to be documented in the QC logbook and summarized in the Weekly QC Report.

- Additional audits performed on the same DFOW may be required at the discretion of the Program QC Officer or the UXOQCS. Additional preparatory and initial audits are generally warranted under any of the following conditions: unsatisfactory work, changes in key personnel, resumption of work after a substantial period of inactivity (e.g., 2 weeks or more), or changes to the project scope of work/specifications.
- QC testing will be performed to ensure that MEC removal is being performed according to the project Definable Quality Objective and prior to submitting to the Navy Technical Representative and Title II Services Contractor for QA testing.
- The UXOQCS will inspect each grid to determine whether or not the grid has been cleared IAW performance requirements presented in the QC Section of the Removal Action Contractor's Work Plan. The UXOQCS will re-sweep this portion of the grid using the same geophysical instrument. The results of the QC inspections, both passing and failing, will be recorded in the QC log. For any grid that fails a QC inspection, the grid will be completely reworked and re-QC'd before submitting the grid for QA inspection.
- Once the grid has passed the QC process, an independent third-party UXO Quality Assurance (QA) officer will perform a detector-aided visual inspection of the ground surface ensure all MEC has been removed; the percentage of the grid to be checked will correspond to the MILSTD 1916 verification level for the contractor.

1.5 Attachments

- DFOWs

SURFACE MEC REMOVAL SOP - ATTACHMENT
Definable Features of Work Auditing Procedures

Activity	DFOW with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Planning	GIS Setup (*Pre-Mobilization Activities)*	Verify GIS system has been set up and is ready for site data	PP	Once	GIS system has been set up and is ready for site data	Do not proceed with field activities until criterion is passed
Planning	Document management and control (*Pre-Mobilization Activities*	Verify appropriate measures are in place to manage and control project documents	PP	Once	Appropriate measures are in place to manage and control project documents	Do not proceed with field activities until criterion is passed
Planning	Data Management (*Pre-Mobilization Activities)*	Verify appropriate measures are in place to manage and control project data	PP	Once	Appropriate measures are in place to manage and control project data	Do not proceed with field activities until criterion is passed
Planning	Subcontracting (*Pre-Mobilization Activities)*	Verify Subcontractor qualifications, training, licenses	PP/IP	Once	Subcontractors' qualifications, training, and licenses are up to date and acceptable	Ensure subcontractor provides the qualifications, training, and licenses or change subcontractor
Planning	Technical approach (*Technical Project Planning)*	Verify that technical approach has been agreed on by project team	PP/IP	Once	Technical approach has been agreed on by project team	Do not proceed with field activities until criterion is passed
Planning	Operational approach (*Technical Project Planning)*	Verify that operational approach has been agreed on by project team	PP/IP	Once	Operational approach has been agreed on by project team	Do not proceed with field activities until criterion is passed
Planning	Work Plan preparation and approval (*Technical Project Planning)*	Verify that Work Plan has been prepared and approved	PP/IP	Once	Work Plan has been prepared and approved	Do not proceed with field activities until criterion is passed
Field Operations	Site preparation (including mobilization)	Verify all project plans are approved	PP/IP	Once	All project plans are approved	Do not proceed with field activities until criterion is passed
Field Operations	Site preparation (including mobilization)	Verify local agencies are coordinated	PP/IP	Once	Local agencies are coordinated	Do not proceed with field activities until criterion is passed
Field Operations	Site preparation (including mobilization)	Verify equipment and services are procured	PP/IP	Once	Equipment and services are procured	Proceed only with activities for which equipment has been procured Procure remaining equipment
Field Operations	Site preparation (including mobilization)	Verify communications and other logistical support are coordinated	PP/IP	Once	Communications and other logistical support are coordinated	Do not proceed with field activities until criterion is passed
Field Operations	Site preparation (including mobilization)	Verify Emergency Services are coordinated	PP/IP	Once	Emergency Services are coordinated	Do not proceed with field activities until criterion is passed

SURFACE MEC REMOVAL SOP - ATTACHMENT
Definable Features of Work Auditing Procedures

Activity	DFOW with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Field Operations	Site preparation (including mobilization)	Verify operating schedules are finalized	PP/IP	Once	Operating schedules are finalized	Proceed only with those operations with finalized operating schedules
Field Operations	Site preparation (including mobilization)	Verify explosive storage and MEC debris/scrap storage areas are established	PP/IP	Once	Explosive storage and MEC debris/scrap storage areas are established	Do not proceed with field activities until criterion is passed
Field Operations	Site preparation (including mobilization)	Verify site-specific training is performed and acknowledged	PP/IP	Once	Site-specific training is performed and acknowledged	Do not proceed with field activities until criterion is passed
Field Operations	Site preparation (including mobilization)	Verify project plans are reviewed and acknowledged	PP/IP	Once	Project plans are reviewed and acknowledged	Do not proceed with field activities until criterion is passed
Field Operations	Site survey	Verify Surveyor Qualifications	PP/IP	Once	Surveyor's qualifications are up to date and acceptable	Ensure surveyor provides the qualifications change surveyor
Field Operations	Site survey	Verify Surveyor Licenses	PP/IP	Once	Surveyor's licenses are up to date and acceptable	Ensure surveyor provides the licenses or change surveyor
Field Operations	Site survey	Verify benchmarks for survey are established and documented	PP/IP	Once	Benchmarks for survey are established and documented	Ensure benchmarks for survey are established and documented prior to performing survey
Field Operations	Site survey	Verify site boundaries have been established	PP/IP	Once	Site boundaries have been established	Do not proceed with dependent field activities until criterion is passed
Field Operations	Site survey	Verify proper marker type, material and placement method	PP/IP	Once	Proper marker type, material and placement method were used	Replace markers as necessary to comply with requirement
Field Operations	Site survey	Verify Surveyor notes are legible, accurate and complete	IP	Once	Surveyor notes are legible, accurate and complete	Ensure surveyor replaces deficient notes with legible, accurate and complete notes
Field Operations	Site survey	Verify Stake Alignment and spacing intervals	IP	Once	Stake Alignment and spacing intervals are as specified in Work Plan	Replace stakes not aligned as specified
Field Operations	Vegetation removal	Verify personnel qualifications and training	PP/IP	Once	Personnel qualifications and training are appropriate	Ensure subcontractor provides appropriately trained and qualified personnel or replace subcontractor

SURFACE MEC REMOVAL SOP - ATTACHMENT
Definable Features of Work Auditing Procedures

Activity	DFOW with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Field Operations	Vegetation removal	Verify environmental controls are correct and functional	IP/FP	Once	Environmental controls are correct and functional	Ensure that appropriate environmental controls are in place prior to proceeding with vegetation removal
Field Operations	Vegetation removal	Verify vegetation removal conducted IAW WP Technical Management Plan	FP	Daily	Vegetation removal conducted IAW WP Technical Management Plan	Stop vegetation removal activities until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Field Operations	Surface Clearance	Verify equipment testing	IP/FP	Once/Daily	Equipment passes daily function test in equipment check area	Repair or replace instrument
Field Operations	Surface Clearance	Verify area/boundary	PP/IP	Once	Area/boundary is correct	Stop activities until area/boundary can be verified
Field Operations	Surface Clearance	Verify work methods	IP/FP	Daily	Work methods are being performed IAW the WP and SOPs	Stop activities until WP and SOPs are being followed and any activities not performed within compliance are re-evaluated and re-performed if necessary
Field Operations	Surface Clearance	Verify Team separation distance	IP/FP	Daily	Team separation distance is appropriate for work being performed	Stop activities until appropriate separation distance is being followed
Field Operations	Surface Clearance	Verify clearance conducted IAW WP Technical Management Plan	IP/FP	Daily	Clearance conducted IAW WP Technical Management Plan	Stop activities until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Field Operations	Surface Clearance	Check a portion of each grid/lot to insure Acceptance Criteria are met as defined in the RAC Work Plan.	FP	Each Occurrence	To-be-determined; will be established in site-specific work plan	To-be-determined; will be established in site-specific work plan
Field Operations	Inspection (*MPPEH Management)*	Verify personnel qualifications	IP/FP	Once	Personnel are qualified	Replace unqualified personnel with qualified personnel

SURFACE MEC REMOVAL SOP - ATTACHMENT
Definable Features of Work Auditing Procedures

Activity	DFOW with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Field Operations	Certification (*MPPEH Management)*	Verify Inspection conducted IAW MPPEH Management Plan	IP/FP	Daily/Each Occurrence	Inspection being conducted IAW WP MPPEH Management Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Field Operations	Certification (*MPPEH Management)*	Verify personnel qualifications	IP/FP	Once	Personnel are qualified	Replace unqualified personnel with qualified personnel
Field Operations	Certification (*MPPEH Management)*	Verify Certification is conducted IAW WP MPPEH Management Plan	IP/FP	Daily/Each Occurrence	Certification is conducted IAW WP MPPEH Management SOP	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Field Operations	Disposal (*MPPEH Management)*	Verify Disposal is conducted IAW WP MPPEH Management Plan	IP/FP	Daily/Each Occurrence	Disposal is conducted IAW WP MPPEH Management SOP	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Field Operations	Demilitarization of UXO	Verify personnel qualifications	IP/FP	Once	Personnel are qualified	Replace unqualified personnel with qualified personnel
Field Operations	Demilitarization of UXO	Verify operations conducted IAW contractor SOP	IP/FP	Each Occurrence	Operations conducted IAW Subcontractor SOP	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Field Operations	Demobilization	Verify that all equipment is inspected, packaged, and shipped to appropriate location.	FP	Once	All equipment is inspected, packaged, and shipped to appropriate location.	Ensure equipment is inspected, packaged, and shipped to appropriate location
Field Operations	Demobilization	Verify facilities-support infrastructures are dismantled and shipped to appropriate location.	FP	Once	Facilities-support infrastructures are dismantled and shipped to appropriate location.	Ensure facilities-support infrastructures are dismantled and shipped to appropriate location
Final Project Reports and Close-out	Site Specific Final Report preparation and approval	Verify field site is returned to original condition	FP	Once	Field site is returned to original condition	Ensure field site is returned to original condition
Final Project Reports and Close-out	Site Specific Final Report preparation and approval	Verify tabulation of all MEC, MD, and other material recovered during the removal actions are accurate and complete	IP	Once	Tabulation of all MEC, MD, and other material recovered during the removal actions are accurate and complete	Ensure tabulation of all MEC, MD, and other material recovered during the removal actions are accurate and complete

SURFACE MEC REMOVAL SOP - ATTACHMENT
Definable Features of Work Auditing Procedures

Activity	DFOW with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Final Project Reports and Close-out	Decision Document preparation and approval	Verify reviews performed by project, senior technical and program teams	FP	Once	Reviews performed by project, senior technical and program teams	Ensure reviews performed by project, senior technical and program teams
Final Project Reports and Close-out	MEC Response Completion Acceptance	Verify Final Report, Proposed Plan and Decision Document has been approved	IP	Once	Final Report, Proposed Plan and Decision Document has been approved	Take appropriate actions to ensure document get approved
Final Project Reports and Close-out	Archiving	Verify data back-up systems are in place	IP	Once	Data back-up systems are in place	Ensure data back-up systems are in place
Final Project Reports and Close-out	Project Closeout	Verify purchase orders have been closed out	IP	Once	Purchase orders have been closed out	Ensure purchase orders are closed out
Final Project Reports and Close-out	Project Closeout	Verify invoices completed and approved	IP	Once	Invoices completed and approved	Ensure invoices are completed and approved

STANDARD OPERATING PROCEDURE MR-3

Vieques Electronic Data Entry SOP

1.1 Purpose

This SOP provides general guidelines for entering munitions response (MR)field data into the hand-held electronic data collection devices utilized on Vieques during the munitions response site investigation and remediation activities; the devices are Trimble GeoXTs that are commonly referred to as personal digital assistants (PDAs). This is a general description of the data collection process using the CartoPac Enterprise system and the associated forms developed and loaded to the data collection devices. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

1.2 Equipment and Materials

- Trimble GeoXT/PDA, or equivalent, with the Vieques CartoPac Enterprise project loaded
- Stylus

1.3 Procedures and Guidelines

The procedures for using the PDAs will vary by user/team. The processes for each team are outlined below:

1.3.1 All Teams

- If CartoPac is not already open on the PDA, go to Start – CartoPac Enterprise.
- After CartoPac loads (even if you see the map on the screen) go to File – Open. Under 'Projects,' make sure that your team type is selected. Then tap 'Open.'
- Enter a safety form:
  - Tap on the + button in the bottom toolbar and select 1a – Safety Meeting Form from the dropdown list.
  - Tap on 'Create.' The form will open automatically – you do not need to tap on the screen to select a location.
- Enter the MEC Daily form:
  - Tap on the + button in the bottom toolbar and select 3a – MEC Daily Form from the dropdown list.
  - Tap on 'Create.' The form will open automatically – you do not need to tap on the screen to select a location.

1.3.2 Surface MEC and Vegetation Clearance Teams

- Enter a MEC Operations form for each Grid:
  - Tap on the + button and select 3b – MEC Operations Form.
  - Tap on 'Create.' The form will open automatically.
  - The form uses your current position to load a list of nearby grids. If you receive a message that the form requires your current GPS position, click OK to use your current location on the PDA's map, or tap Cancel and turn on your GPS. The grids available in the dropdown list are within 100 meters of your current position.
  - Select a grid and enter the operation type from the drop down list (such as "Surface MEC Clearance" or "Manual Vegetation Clearance") and enter your start time.

- Tap on the Items Found tab to enter Items:
  - Tap on the 'Add' button.
  - If you have the GPS on, a point will be inserted where you are standing. Otherwise, tap on the screen where you found the item.
  - Enter information about the item. Hit 'OK' in upper right to save item.
  - Continue adding items in this grid by tapping 'Add'
- When finished adding items, enter grid completion info under 'End Info' tab on the MEC Ops form.

Attributes collected for surface items are entered in to the pre-loaded forms as described above. At the end of each day the data will be loaded into the Vieques MR database. The data attributes identified below are recorded through the forms and will appear in the database:

Surface MEC Data Attributes
Unique Identification Number
Item Group
Item Class
Item Category
Type/Filler
Description/Fuzing
Quantity
Depth
Weight
Frag
Demo Required
Team Leader Comment for Item
Location
Date Found
Grid
Action Taken
Item Moved To
X Geographic Coordinate
Y Geographic Coordinate
Team
Item Found During QC/QA?
Demo Complete Date

1.3.3 Subsurface MEC Clearance Teams

- Enter a MEC Operations form for each Grid:
  - Tap on the + button and select 3b – MEC Operations Form
  - Tap on 'Create.' The form will open automatically.
  - The form uses your current position to load a list of nearby grids. If you receive a message that the form requires your current GPS position, click OK to use your current location on the PDA's map, or tap Cancel and turn on your GPS. The grids available in the dropdown list are within 100 meters of your current position.
  - Select a grid, operation type = 'Digital Excavation' and enter your start time.

  - Enter your end time and percent complete of available grid area, then close the form.

- Enter dig results:
  - In the bottom toolbar, tap Mode – Inquire.
  - Tap the third icon from the right in the bottom toolbar. You should see a list of layers pop up. Tap on '3f – MEC Digsheet' to make it the active layer.
  - Zoom to the area where team is digging. Tap on desired anomaly point.
  - Enter item information.

Attributes collected for the subsurface items are entered in to the pre-loaded forms as described above. At the end of each day the data will be loaded into the Vieques MR database. The data attributes identified below are recorded through the forms and will appear in the database:

Subsurface MEC Data Attributes
Unique Identification Number
mV reading from DGM Survey
mV Reading from Anomaly Reaquire
mV Reading After Anomaly Investigation/Recovery
Item Group
Item Class
Item Category
Type/Filler
Description/Fuzing
Quantity
Depth
Weight
Frag
Demo Required
Team Leader Comment for Item
Location
Date Found
Grid
Action Taken
Item Moved To
X Geographic Coordinate
Y Geographic Coordinate
Team
Item Found During QC/QA?
Demo Complete Date

1.3.4 Scrap Processing

- Enter scrap processing data:
  - Tap on the + button and select one of the 5-series forms.
    - 5a – MD/RRD Inspection and Recovery
    - 5b – Steel and Aluminum Recovery
    - 5c – CPC Ops

- 5d – MD Flashing
- 5e – 5X Certification

- If performing other grid operations (such as surface clearance), enter a MEC Operations form for the Grid:
  - Tap on the + button and select 3b – MEC Operations Form
  - Tap on 'Create.' The form will open automatically.
  - The form uses your current position to load a list of nearby grids. If you receive a message that the form requires your current GPS position, click OK to use your current location on the PDA's map, or tap Cancel and turn on your GPS. The grids available in the dropdown list are within 100 meters of your current position.
  - Select a grid, operation type, and enter your start time.
  - Tap on the Items Found tab to enter Items:
    - Tap on the 'Add' button.
    - If you have the GPS on, a point will be inserted where you are standing. Otherwise, tap on the screen where you found the item.
    - Enter information about the item. Hit 'OK' in upper right to save item.
    - Continue adding items in this grid by tapping 'Add'
  - When finished adding items, enter grid completion info under 'End Info' tab on the MEC Ops form.
  - Enter your end time and percent complete of available grid area, then close the form.

1.3.5 Quality Control/Quality Assurance

- Enter a MEC Operations form for the Grid:
  - Tap on the + button and select 3b – MEC Operations Form
  - Tap on 'Create.' The form will open automatically.
  - The form uses your current position to load a list of nearby grids. If you receive a message that the form requires your current GPS position, click OK to use your current location on the PDA's map, or tap Cancel and turn on your GPS. The grids available in the dropdown list are within 100 meters of your current position.
  - Select a grid, operation type = 'QC Surface Clearance' or 'QA Surface Clearance' and enter your start time.
  - Enter your end time and percent complete of available grid area, then close the form.
- Enter a QC/QA Grid Form:
  - Tap on the + button and select 3d – QC/QA Grid Form.
  - Tap on 'Create.' The form will open automatically.
  - Enter QC/QA info and results for the grid, then tap OK to save the form.

1.3.6 To Edit Data That Has Been Entered

- Tap on View – Data Summary.
- Tap on the icon in the top right, and a new window will open.
- Make sure "Layers & Tables" is selected.
- Select the form you want to edit from the drop down list and hit "Select."

- Data you have entered will appear in the list. You can sort the data by tapping on any of the column headings. You can change the columns shown by tapping on the Columns tab.
- Tap once on a line item and then tap “Data” in the bottom right to open the form.
- Make any changes to the data and hit OK in the upper right.

1.4 Quality Control

- Data entries will be reviewed on a daily basis by the MR contractor’s data management personnel. The data will be reviewed to ensure completeness, consistency, and accuracy. Any discrepancies or incorrect data will be resolved during the review. Data subject to this QC review includes, but is not limited to, items found, grid status, and team operations.
- The Title 2 data management personnel will review data only after it has been QC’d by the MR contractor collecting the data. The data will be reviewed to ensure completeness, consistency, and accuracy. Data subject to this QA review includes, but is not limited to, items found, grid status, and team operations. Any discrepancies will be identified and reported to the MR contractor for clarification and or correction.

1.5 Attachments

- None

STANDARD OPERATING PROCEDURE MR-4

Digital Geophysical Mapping

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when conducting digital geophysical mapping (DGM) in support of munitions response (MR) activities. Geophysical instruments will be used during DGM survey operations. DGM operations use instruments that record instrument response digitally, allowing for the subsequent download and interpretation of the data. Geophysical instruments used during operations such as clearance of locations for emplacement of survey stakes will be analog, meaning these instruments will be used to detect metallic items in the subsurface. Generally analog instruments indicate the presence of metallic anomalies through sound or visual display. The analog instruments will be operated by unexploded ordnance (UXO) technicians.

1.2 Equipment and Materials

- Geonics EM61-MK2 time domain electromagnetic (TDEM) metal detectors
- Analog geophysical instruments
- Real-time kinematic (RTK) global positioning systems (GPS)

1.3 Procedures and Guidelines

1.3.1 General

- Because MEC and material potentially presenting an explosive hazard (MPPEH) items may be present in the survey area, DGM survey personnel are prohibited from touching, handling, moving, or investigating any item that resembles MEC or MPPEH. Upon encountering such an item, survey personnel will immediately inform the Senior UXO Supervisor (SUXOS) or a UXO technician. In the event that such an item is discovered, either inside or outside the controlled project boundaries, and no UXO-qualified personnel are present, survey personnel will conspicuously mark and secure a perimeter around the item and immediately contact the SUXOS. DGM survey personnel should not work within 200 feet of any suspected MEC or MPPEH item at the surface.
- DGM survey personnel will not access areas that have not been previously surface cleared by a UXO technician. Personnel will also be required to adhere to their respective corporate Site Safety and Health Plans.
- The Geophysical System Verification (GSV) process will be used to validate DGM instruments prior to use for site surveys. GSV must be conducted prior to the start of and throughout the data collection process. The GSV is a physics-based, presumptively selected technology process used to verify DGM systems. For EM61-MK2 systems, the GSV generates instrument-specific signal strength and sensor performance data that is then compared to known response curves for Industry Standard Objects (ISOs). The GSV includes an initial verification of the DGM system through the use of an Instrument Verification Strip (IVS) and the continuous verification of the system through the use of a blind seeding program. The IVS, ISOs, and blind seeding program are discussed in the GSV SOP.

1.3.2 DGM Personnel Qualifications

- All DGM support personnel on site will have documentation of 40-hour Occupational Safety and Health Administration (OSHA) certification, any necessary re-certification (8-hour refresher), and OSHA-compliant medical monitoring physical exams.
- **Program Geophysicist** - This individual will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have a minimum of five years of experience directly related to the geophysical mapping, detection and discrimination of buried military munitions. This individual has overall responsibility

for design, implementation, and management of all geophysical investigations required for the work effort related to military munitions, but may not necessarily be on site full time. This individual will be the program geophysicist-of-record.

- **Project Geophysicist** - This individual will have a degree in geophysics, geology, geological engineering, or a closely related field. The Project Geophysicist will have training and experience appropriate to any geophysical investigations managed. This individual is responsible for design, implementation and management of geophysical investigations but may not be on site full time.
- **Site Geophysicist** - This individual will have a degree in geophysics, geology, geological engineering, or a closely related field. The Site Geophysicist will have training and experience appropriate to any geophysical investigations being performed and needs to be on site whenever these operations are being performed. The Site Geophysicist will be under the general supervision of the Project Geophysicist and will be the direct supervisor of the field data collection team. When only one or two teams are collecting data, the Site Geophysicist may also be dual-hatted as a Field Geophysicist leading a data collection team.
- **Field Geophysicists** - These individuals will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have training and experience appropriate to any geophysical investigations performed.
- **Geophysical Technicians** -These individuals will have training appropriate to any geophysical investigations performed.

1.3.3 DGM Measurement Quality Objectives

The primary objective of the DGM activities at the site is to identify metallic anomalies that may be MEC or MPPEH. Measurement quality objectives (MQOs) specific to the full coverage EM61-MK2 DGM surveys at the site are summarized in the following subsections.

General Geophysical Systems Functioning

- **DGM Systems Positioning -** The MQO for DGM systems positioning is that the coordinates being obtained from the positioning systems are at a sufficient enough accuracy to allow for appropriate relocation of MEC items for intrusive investigation. The measurement performance criterion for this is that the positional error of the system at known locations will not exceed 10 cm (4 in). This will be evaluated by ensuring that, on a daily basis, the geophysical system being used passes QC Test # 2, Record Sensor Positions, as outlined in the Quality Control section of this SOP.
- **DGM Systems Data Repeatability -** The MQO for DGM systems data repeatability is that the systems respond consistently from the beginning to the end of an operation. The measurement performance criterion for this is that the response to a standardized item will not vary more than ±20% from the NRL published value for that item. This will be evaluated by ensuring that, on a daily basis, the geophysical system being used passes QC Test # 5, Static Background and Static Spike, as outlined as outlined in the Quality Control section of this SOP. Results of QC Test # 6, Repeat Data, will also be qualitatively[1] reviewed for repeatability.

DGM Surveys

- **Downline Data Density -** The MQO for downline (along the survey transect) data density is to have sufficient data collected along each transect to detect MEC items. The measurement performance criterion for this is that at least 98 percent of possible sensor readings are captured along each transect at 0.7 ft (0.213 m) or less. In addition, any transect (or portion thereof) containing a data gap (relative to other collected data points) of 2 feet (0.61 m) or greater does not meet the MQO. This will be evaluated by verifying that all of the DGM data collected and used for anomaly selection meets this standard. The positioning error when various

[1] Comparisons are qualitative as sources of error, including horizontal orientation of the instrument, system bounce, item orientation, and actual item distance from system transmitter and receiver coils, can cause high variability in signal response. Quantitative validation of the system response to an ISO is performed during QC Test #5 (Static Background and Static Spike), described in Section B.21).

elements of the survey (bounce, sway, slopes) are accounted for may compound the error; however, all items will be located within 1m of the anomaly.

- **Survey Coverage (Lane Spacing)** - The MQO for lane spacing is to maintain appropriate lane spacing (0.75 m) to provide 100 percent coverage of accessible portions of the survey area. The measurement performance criterion for this is that the lane spacing varies no more than 1 m. This will be evaluated by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

Positioning Accuracy

- The MQO for horizontal positioning accuracy is that positioning of detected anomalies is accurate enough to allow for effective reacquisition of the anomaly. The measurement performance criterion for this is that a selected anomaly must be within 1m of each blind seed. Any anomaly that is selected outside of 1 m from a point directly above the blind seed will not be considered to be a detection of that item. This will be evaluated by verifying that all blind seeds have an anomaly location selected within this distance or can be otherwise explained.

1.3.4 Geophysical Instrumentation

Analog Geophysical Instruments

The analog geophysical instrument to be used during non-DGM operations where a geophysical instrument is needed to detect metallic items will be a Schonstedt GA-52/Cx magnetometer or a Whites XLT (or equivalent) all metals detector when non-ferrous items are of concern.

DGM Instruments

The EM61-MK2 will be used as the primary survey instrument for this investigation. The EM61-MK2 is a high-resolution time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. In comparison with other metal detectors, especially magnetometers, it is much better suited for work in close proximity to man-made structures and in areas of dense subsurface metallic debris. The Standard EM61-MK2 system consists of two air-cored, 1-meter by 0.5 meter coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the two spatially separated receiver coils measures these eddy currents. The EM61-MK2 offers the ability to measure the eddy currents at three distinct time intervals in the bottom coil or four intervals if no top coil measurements are recorded. Earlier time gates provide enhanced detection of smaller metallic objects. Secondary voltages induced in both coils are measured in millivolts (mV). The arrangement of coils is such that there is a vertical separation of 40 centimeters (cm).

1.3.5 Data Acquisition, Processing and Reporting

Field Data Sheets

Field data sheets will be recorded in the Munitions Response Program Enterprise (MRP Enterprise) system field devices and will include:

- Site ID
- Grid ID (or other identifier of surveyed area)
- Field team leader name
- Field team members' names
- Date of data collection
- Instrument used
- Positioning method used
- Instrument serial numbers (ID link to database record)
- File names in data recorders
- Data collection sampling rate
- Line numbers, survey direction, fiducial locations, start and end points (if applicable)
- Weather conditions

- Grid conditions (if applicable)
- Terrain conditions (if applicable)
- Cultural conditions (if applicable)
- Survey area sketch (if applicable)
- Associated QC data file names
- Field notes (other as applicable)

Data Processing

Instrument-specific software will be used for initial data processing, and the output will be imported into Geosoft Oasis Montaj™ for additional processing, graphical display, anomaly selections and QC. All processing steps will be documented in the MRP Enterprise system by the DGM contractor. The general processing steps that may be performed on the EM61-MK2 data include the following:

- Positional offset correction
- Sensor bias, background leveling and/or standardization adjustment
- Sensor drift removal
- Latency or lag correction
- Geophysical noise identification and removal (spatial, temporal, motional, terrain induced)
- Contour level selection with background shading
- Digital filtering and enhancement (low pass, high pass, band pass, convolution, correlation, non-linear, etc.)

Interpretation/Anomaly Selection

MEC-experienced data processing geophysicists will use the following criteria for selecting and locating EM61-MK2 anomalies:

- A minimum amplitude threshold of 2.5mv in Channel 3 (660 microsecond time gate) (assuming the decay characteristics are appropriate for a metal item) will be used when identifying subsurface anomalies; the actual threshold to be employed during anomaly identification will specified in the site-specific work plans. Site conditions (subsurface anomaly density) may result in using a greater amplitude threshold. Analysis of the DGM data collected at VNTR indicates that increasing the DGM threshold would result in increasing the percentage of metal items removed that are MEC/MPPEH. Based on this information, and impracticability in using a 2.5mv threshold in high density anomaly areas, a higher DGM threshold (up to 8mv) may be used for anomaly selection in areas where a high density of anomalies are present. High anomaly density areas are areas where the DGM signal interference is high such that discrete anomalies cannot be identified. The Project Geophysicist will make the determination of high anomaly areas.
- Lateral extent (plan size) of the area of response
- Three-dimensional shape of the response
- Decay curve characteristics
- Location of the response with respect to the edge of the grid, unsurveyable areas, land features, cultural features, or utilities within or adjacent to the grid
- Potential distortions in the response due to interference from nearby cultural features

Target Files

The target analysis process culminates in the creation of Microsoft Excel target lists in MRP Enterprise format, an example of which is shown as **Figure 1**. The target files are to include:

1. Unique anomaly identification numbers
2. Grid identification
3. Predicted location in Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83) Grid Plane Coordinates in Easting (meters) and Northing (meters), Zone 18N

FIGURE 1
Example MRP Enterprise Target File

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	ID	GRIDCELLID	X1	Y1	X2	Y2	X3	Y3	X4	Y4	TYPE	AMPLITUDE	UNITS	s_ColLineage	s_Generation	s_GUID	s_Lineage
2	1	K2F9J1WB	258959.4	2006299.6	0	0	0	0	0	0	1	3.67	mV				
3	2	K2F9J1WB	258962.4	2006302.2	0	0	0	0	0	0	1	19.42	mV				
4	3	K2F9J1WB	258964.2	2006301.8	0	0	0	0	0	0	1	4.47	mV				

4. Anomaly type identifier
5. Response amplitude
6. Unit of response (mv [millivolt])

Grid Maps

With each target sheet, the DGM contractor will also provide a grid map, which will contain the following:

- Client
- Project
- Contractor
- Map approver
- Date map was created
- Map file name (full path and file extension)
- Scale
- Grid identification
- Grid corner locations
- Contoured data
- Index map
- Anomaly locations with unique identification numbers
- North arrow, legend, title block

Records Management

All files will be made available for quality assurance verification during the project to verify that the field and data processing procedures are properly implemented. All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

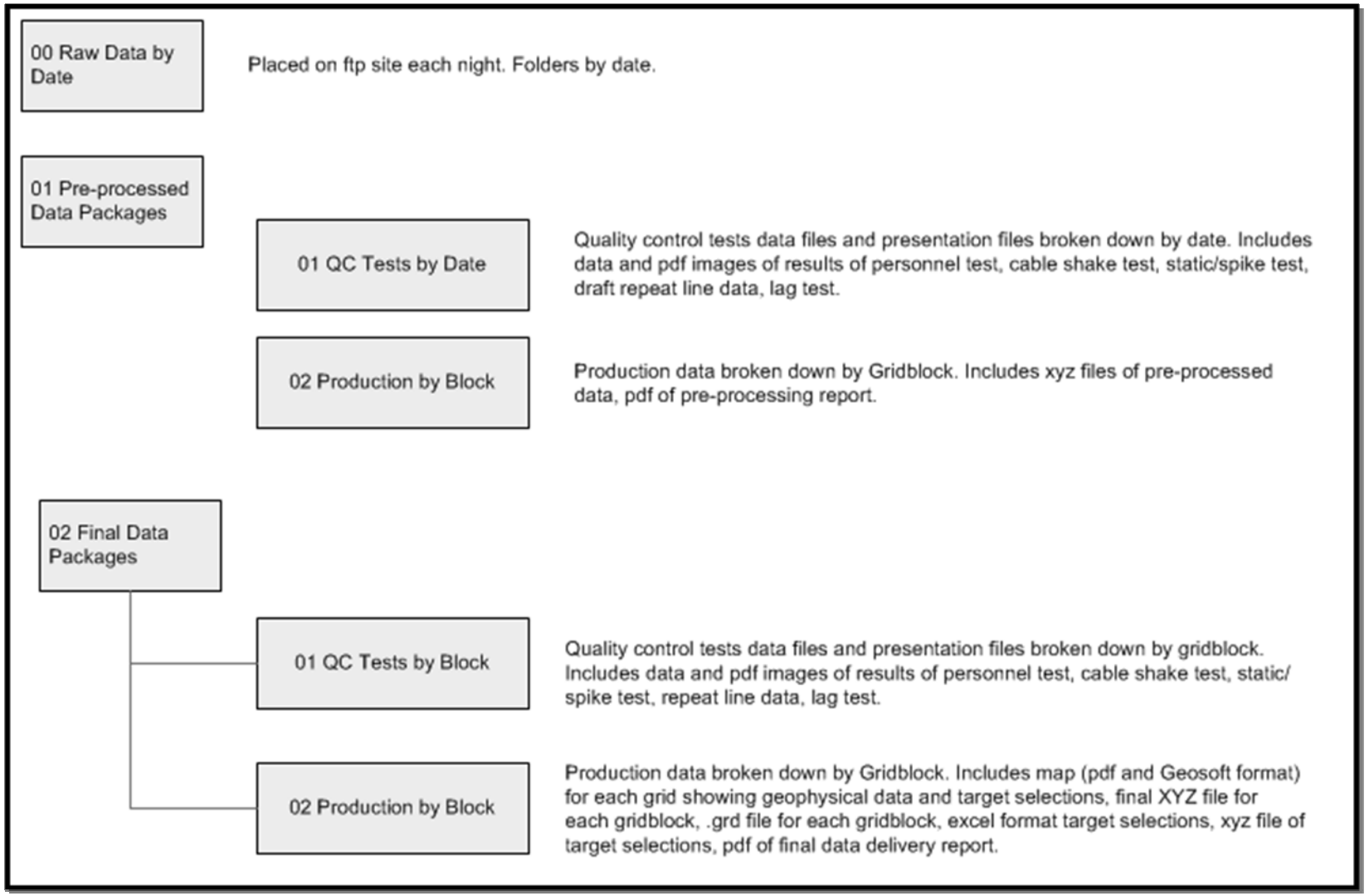
Final Reports, Maps, and Geophysical Mapping Data

All data provided by the DGM contractor will be provided via the Internet using a File Transfer Protocol (FTP) site and on DVD or CD with the final report(s). **Figure 2** shows the folder structure to be used on the FTP site.

The deliverable requirements and required data delivery schedule include the following:

1. On a daily basis the contractor will provide each day's raw data files.
   - Raw data is defined as data directly recorded by the data acquisition system, without any modification (or filtering) that changes the originally recorded values from the geophysical or positional sensors.
   - File Format - Raw data will be provided as American Standard Code for Information Interchange (ASCII) text format so the data files are viewable in text editing software. Proprietary binary format data will be directly converted to text format before delivery.
   - Recommended file extensions are ".txt" and ".xyz"; however, other file extensions are acceptable.
   - Naming Convention - Each delivered raw file will have an informative and unique name. A comprehensive file naming explanation file will be provided on the FTP site.

FIGURE 2
FTP Site Directory Structure



2. No later than 3 work days after collection, the contractor will provide pre-processed data. The following applies to all pre-processed data deliverables.

   - All pre-processed geophysical data, including all QC tests will be delivered in Geosoft Database (GDB) format or xyz format, readable by Geosoft's Oasis Montaj software package.
   - QC test databases and Adobe Acrobat Portable Document Format (PDF) files containing images of QC test results will be provided by date.
   - Pre-processed production data will be provided broken down by gridblock. Gridblocks may contain up to ten contiguous (or otherwise logically connected) grids of data with the southwestern-most grid being the name of the gridblock. (Gridblocks are established in the field during data entry into the MRP Enterprise devices.)
   - An MRP Enterprise Pre-Processed Data Delivery Report will be provided with each gridblock documenting field notes and pre-processing information. Information provided by the MRP Enterprise report is summarized in **Table 1**.
   - Databases will be delivered in GDB or xyz format, and will include the following minimum channel information:
     - Easting (X) and Northing (Y) coordinates in UTM projection (NAD 83), meters
     - Time (with precision to at least 0.1 s)
     - Raw geophysical data channels
     - Pre-Processed geophysical data channels

3. No later than 5 work days after collection, the DGM contractor will provide final (processed) data. The following applies to all final (processed) data deliverables.

   - All processed geophysical data, including all QC tests will be delivered in GDB or xyz format.
   - QC test databases and PDF files containing images of QC test results will be provided by gridblock.
   - Processed production data will be provided broken down by gridblock.
   - An MRP Enterprise Final Data Delivery Report will be provided with each gridblock documenting field notes, pre-processing and processing information. Information provided by the MRP Enterprise report is summarized in **Table 1.**
   - Databases will include the following minimum channel information:
     - Easting (X) and Northing (Y) coordinates in UTM projection (NAD 83), meters
     - Time (with precision to at least 0.1 s)
     - Raw geophysical data channels
     - Pre-Processed geophysical data channels
     - Processed geophysical data channels
   - Deliverable will include:
     - Geosoft ".map" file for each grid included in the gridblock.
     - PDF of Geosoft map for each grid included in the gridblock.
     - Geosoft grid ".grd" file for gridblock showing gridded data from channel used for targeting.
     - Microsoft Excel Target file in MRP Enterprise format for every grid (or text file stating that "there were no selected targets in Block X Grid Y"
     - Geosoft ".xyz" data file and target file
     - Geosoft ".map" mosaic of all processed data to date.
     - PDF mosaic of the Geosoft map of all processed data to date.

TABLE 1
Processing Documentation Requirements

Information Type	Pre-Processed Data Delivery Report	Final Data Delivery Report	Must be in File Headers
Site ID	X	X	X
Geophysical instrument type used	X	X	
Positioning method used	X	X	
Instrument serial numbers (geophysical and positioning)	X	X	
Coordinate system and unit of measure	X	X	
Grid ID (or other identifier of surveyed area)	X	X	X
Date of data collection	X	X	X
Raw data file names associated with delivery	X	X	
Processed data file names associated with delivery	X	X	
Name of Project Geophysicist	X	X	
Name of Site Geophysicist	X	X	
Name of data processor	X	X	
Data processing software used	X	X	
Despiking method and details	X	X	
Sensor drift removal and details	X	X	
Latency/lag correction and details	X	X	
Sensor bias, background leveling and/or standardization adjustment method and details		X	
Diurnal correction (magnetometer data)	X	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details		X	
Other filtering/processing performed and details		X	
Gridding method		X	
Anomaly selection and decision criteria details		X	
Other processing comments		X	
Date data processing is completed	X	X	
Data delivery date	X	X	
Scanned copy of field notes and field mobile data collection device notes (if applicable)	X		

- All filenames must include the gridblock or grid name (as appropriate).

All sensor data will be correlated with navigational data based upon a local “third order” (1:5,000) monument or survey marker.

1.4 Quality Control

A description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized in **Table 2**. The DGM Definable Features of Work (DFOW), the QC audit procedure for each DFOW is summarized in **Table 3**. **Figure 3** shows an overall chart of the QC steps.

1.4.1 DGM Instruments Quality Control

Each of the geophysical systems will be field tested to confirm proper operating conditions. Several basic QC tests will be performed in addition to instrument-specific tests.

1. **Equipment Warm-up**. EM61-MK2 systems will be turned on and warmed up for a minimum of 5 minutes prior to use. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.
2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each work day.
3. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the EM61-MK2 coils for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day.
4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day.

TABLE 2
DGM Instruments Standardization Tests and Acceptance Criteria

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	Between Survey Areas	2% of Total Area Surveyed
1	Equipment Warm-up	Minimum of 5 min	x				
2	Record Sensor Positions	± 4 inch (10 cm) for RTK GPS		X			
3	Personnel Test	Personnel, clothing, etc. should have no effect on instrument response		X			
4	Vibration Test (Cable Shake)	Data profile does not exhibit data spikes		X			
5	Static Background & Static Spike	± 20% of standard item response, after background correction			x	X	
6	Repeat Data	Qualitative repeatability				X	x

TABLE 3
DGM SOP ATTACHMENT
DGM Definable Features of Work Auditing Procedures
Former VNTR, Vieques, Puerto Rico

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Planning						
Geographical Information System (GIS) Setup (Pre-mobilization Activities)	Project GIS Manager	Verify GIS system has been set up and is ready for site data.	PP	O	GIS system has been set up and is ready for site data.	Do not proceed with field activities until criterion is passed.
Document management and control (Pre-mobilization Activities)	Project Manager	Verify appropriate measures are in place to manage and control project documents.	PP	O	Appropriate measures are in place to manage and control project documents.	Do not proceed with field activities until criterion is passed.
Data Management (Pre-mobilization Activities)	Project Manager, Project Geophysicist	Verify appropriate measures are in place to manage and control project data.	PP	O	Appropriate measures are in place to manage and control project data.	Do not proceed with field activities until criterion is passed.
Subcontracting (Pre-mobilization Activities)	Project Manager, Site Manager	Verify subcontractor qualifications, training, and licenses.	PP/IP	O	Subcontractors' qualifications, training, and licenses are up to date and acceptable.	Ensure subcontractor provides the qualifications, training, and licenses or change subcontractor.
Technical and Operational approach (Technical Project Planning)	Project Manager	Verify technical and operational approaches have been agreed on by the project team.	PP/IP	O	Technical and operational approaches have been agreed on by project team and incorporated into the Work Plans.	Do not proceed with field activities until criterion is passed
Geophysical System Verification (GSV) Plan preparation and approval	Project Manager	Verify GSV Plan has been prepared and approved.	PP/IP	O	GSV Plan has been approved	Do not proceed with field activities until criterion is passed.
GSV Execution	Project Manager, Project Geophysicist	Verify data quality objectives (DQOs) established in GSV Plan have been accomplished.	PP/IP	O	DQOs identified in GSV Plan have been achieved	Continue with GSV until DQOs are achieved.
GSV Report	Project Manager, Project Geophysicist	Verify recommendations in GSV Report for Digital Geophysical Mapping (DGM) system and associated DQOs have been approved.	PP/IP	O	Recommendations for DGM equipment and associated DQOs are approved by the Navy	Do not proceed with DGM field activities until recommendations of GSV Report are approved.
Field Operations						
Site preparation (Mobilization)	Project Manager	Verify local agencies are coordinated.	PP/IP	O	Local agencies are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Project Manager	Verify equipment has been inspected and tested.	PP/IP	E	Equipment passes inspection and testing.	Proceed only with activities for which equipment has passed inspection and testing.
Site preparation (Mobilization)	Project Manager	Verify communications and other logistical support are coordinated.	PP/IP	O	Communications and other logistical support are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Project Manager	Verify emergency services have been coordinated.	PP/IP	O	Emergency services are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	MEC QCS, Project Manager	Verify site-specific training is performed and acknowledged.	PP/IP	O	Site-specific training is performed and acknowledged	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	MEC QCS, Project Manager	Hold pre-mobilization meeting and Operations Readiness Review (ORR) with the project team.	PP/IP	O	Project plans are reviewed and acknowledged by team members.	Do not proceed with field activities until criterion is passed.
Site preparation (Site Survey)	Project Manager	Verify surveyor qualifications.	PP/IP	O	Surveyor's qualifications are up to date and acceptable.	Ensure surveyor provides the qualifications prior to starting work or change surveyor.
Site Preparation (Site Survey)	Project Manager	Verify benchmarks for survey have been established and documented.	PP/IP	O	Benchmarks for survey have been established and documented.	Ensure benchmarks for survey are established and documented prior to performing survey.
Site Preparation (Site Survey)	Project Manager	Verify site boundaries and grids have been established.	PP/IP	O	Site boundaries and grids have been established.	Do not proceed with dependent field activities until criterion is passed.
Site Preparation (Vegetation Removal)	Project Manager	Verify personnel qualifications and training.	PP/IP	O	Personnel qualifications and training are appropriate.	Ensure subcontractor provides appropriately trained and qualified personnel or replace with properly trained personnel.
Site Preparation (Vegetation Removal)	Project Manager	Verify environmental controls are correct and functional.	IP/FP	O	Environmental controls are correct and functional.	Ensure that appropriate environmental controls are in place prior to proceeding with vegetation removal.
Site Preparation (Vegetation Removal)	Project Manager, MEC QCS	Verify vegetation removal is conducted IAW the Geophysical Investigation Plan	FP	D	Vegetation removal is conducted IAW the Geophysical Investigation Plan	Stop vegetation removal activities until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
Site Preparation (Surface MEC identification)	MEC QCS	Verify equipment testing is performed per Quality Control Plan	IP/FP	O/D	Equipment passes daily function test in equipment check area.	Repair or replace instrument.
Site Preparation (Surface MEC identification)	MEC QCS	Verify area/boundary.	PP/IP	O	Area/boundary is marked.	Stop activities until area/boundary can be verified.

TABLE 3
DGM SOP ATTACHMENT
DGM Definable Features of Work Auditing Procedures
Former VNTR, Vieques, Puerto Rico

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Site preparation (Surface MEC identification)	MEC QCS, Project Geophysicist	Verify work methods are conducted IAW the Geophysical Investigation Plan and Health and Safety Plan. Survey/Sweeps MEC Surface Sweeps	IP/FP	D	Work methods are being performed IAW the Work Plan and SOPs.	Stop activities until Work Plan and SOPs are being followed and any activities not performed within compliance are re-evaluated and re-performed if necessary.
Site Preparation (Surface MEC identification)	MEC QCS	Verify team separation distance IAW the Geophysical Investigation Plan (Section 6 of Work Plan).	IP/FP	D	Team separation distance is appropriate for work being performed and the site munitions with the greatest fragmentation distance	Stop activities until appropriate separation distance is being followed.
DGM Survey	Project Geophysicist	Verify DGM Survey conducted IAW Geophysical Investigation Plan and DGM SOPs	IP/FP	O/D	DGM Survey conducted IAW Geophysical Investigation Plan and DGM SOPs.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
DGM Survey	Project Geophysicist	Check results of QC tests performed as specified in QCP and DGM SOPs	FP	E	QC tests must pass IAW standards determined during the GPO and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Survey	Project Geophysicist	Confirm that DGM survey DQOs established during GPO are being met.	FP	E	DGM survey DQOs are being met.	If the DQOs are not being met, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Survey	Project Geophysicist	Check results of QC field audits performed by MEC QCS to ensure that no MEC missed from DGM surveys.	FP	E	No MEC or metallic item equal or greater in mass to a 20mm projectile.	If the item was found within the depth criteria established during the GPO, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Data Processing	Project Geophysicist	Verify data checks specified in QCP and SOPs	FP	E	Data checks must pass in accordance with standards determined during the GPO and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Demobilization	Project Manager	Verify facilities-support infrastructures are dismantled and shipped to appropriate location and area is returned to original condition.	FP	O	Facilities-support infrastructures are dismantled and shipped to appropriate location and site is returned to original condition.	Ensure that all support facilities are removed and that the site is returned to original condition
Final Project Reports and Closeout						
Site Specific Final Report preparation and approval	Project Manager, Project Geophysicist	Verify tabulations of all MEC, MD, and other material recovered during the removal actions are accurate and complete.	IP	O	Tabulations of all MEC, MD, and other material recovered during the removal actions are accurate and complete.	Ensure tabulation of all MEC, MD, and other material recovered during the removal actions are accurate and complete
Site Specific Final Report preparation and approval	Project Manager, Project Geophysicist	Verify all dig sheets where geophysical mapping and investigation performed are accurate and complete.	FP	O	All dig sheets where geophysical mapping and investigation performed are accurate and complete.	Ensure all dig sheets where geophysical mapping and investigation performed are accurate and complete
MEC Response Completion Acceptance	Project Manager	Verify Final Report has been approved.	IP	O	Final Report has been approved.	Take appropriate actions to ensure Report gets approved
Archiving	GIS Manager	Verify data back-up systems are in place.	IP	O	Data back-up systems are in place	Ensure data back-up systems are in place
Project Closeout	Project Manager	Verify purchase orders have been closed out.	IP	O	Purchase orders have been closed out	Ensure purchase orders are closed out
Project Closeout	Project Manager	Verify invoices completed and approved.	IP	O	Invoices completed and approved	Ensure invoices are completed and approved

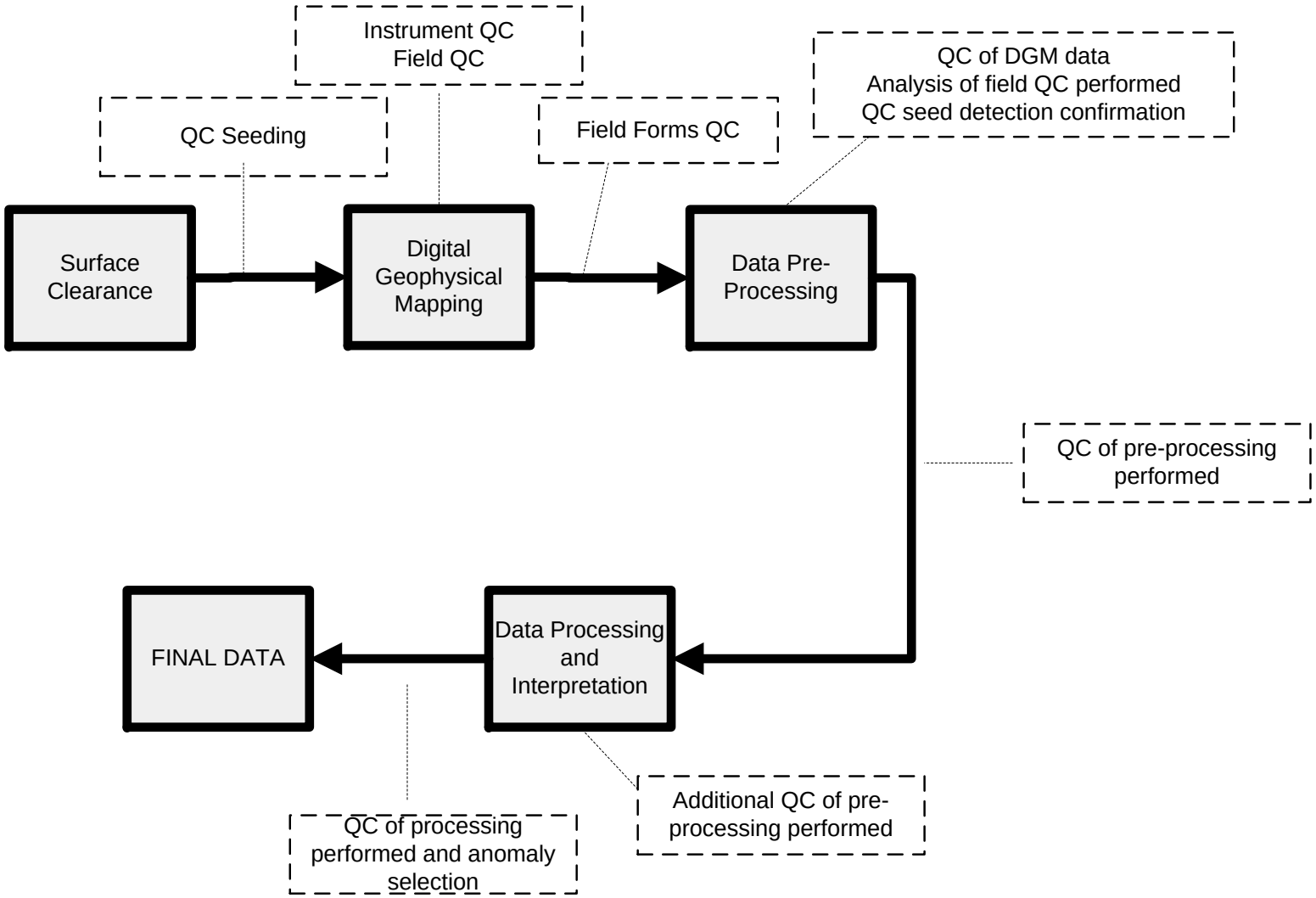
Notes:
IAW = in accordance with

QC Phase
PP = Preparatory Phase
IP = Initial Phase
FP = Follow-up Phase

Frequency
O = Once
D = Daily
W = Weekly
E = Each occurrence

[1] The responsible person (if other than the MEC QCS) is the individual with whom the MEC QCS will coordinate with to ensure compliance with requirements and to verify that any necessary follow-up actions are taken.
[2] Where appropriate, a reference has been included referring the reader to a more detailed description of the procedures being audited.
[3] Documentation to be in accordance with the three-phase control process as outlined in the Quality Control Plan.

FIGURE 3
Overview of DGM Process QC



5. **Static Background and Static Spike.** Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts and collecting data for (minimally) a 1-minute period. During this time, the instrument will be held in a fixed position without a spike (small ISO) and then with a small ISO spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation.
6. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2% of the survey lines will be repeated.

1.4.2 QC Seed Items

At least one QC seed item, a small ISO (discussed in the Geophysical System Verification SOP) will be placed within the survey area to ensure that a minimum of one seed is encountered during each day of data collection.. The seed items will be tagged with a non-biodegradable label identifying the items as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. DGM contractor QC personnel will perform seeding using hand or mechanical tools, depending on soil conditions. The seed locations will be checked using a hand-held analog geophysical instrument to confirm that no existing anomalies are present at the seed location. Once placed, the orientation, inclination, depth to center of mass and locations of all seeded items will be surveyed using an RTK DGPS or conventional survey equipment and the locations provided to the Navy QA Geophysicist. The items will be placed at easily detectable depths (3 to 7 inches below ground surface for the small ISO) in order to have a high enough signal-to-noise ratio to compare to known industry standard target values. Detection of the QC seed items will be monitored and should an item not be detected, a root-cause analysis will be performed and corrective actions determined.

1.4.3 Quality Control of DGM Data and Deliverables

QC of geophysical data and data deliverables will be performed at each step of the processing path. **Figure 4** shows the processing path and the QC steps to be performed. The QC tests, identified in the Quality Control section of this SOP, that are performed on the system on a daily basis that are checked immediately in the field and the day following data collection that indicate whether a system is functioning properly. Data will not move to the next stage until they have passed the QC check.

The following items are among the QC checks performed on the field forms:

- Appropriate fields have been completed
- Field entries are appropriate for work performed
- Data required for geophysical data processors have been entered
- General editorial review (spelling, dates, etc.)

The following items are among the QC checks performed (as applicable to the particular data set) on the “Pre-Processed Data”:

- Data have been translated from local coordinates into the UTM system
- Coordinates are correct (grids fall in correct locations when loaded into GIS)
- Line gaps have been accounted for
- Background geophysical noise is acceptable
- Crosstrack distances between lines are acceptable
- Downline data density is acceptable
- Appropriate file headers have been attached
- Files contain appropriate grids

The following items are among the QC checks performed (as applicable to the particular data set) on the “Processed Data”:

- Latency/Lag correction is appropriate
- Despiking is appropriate

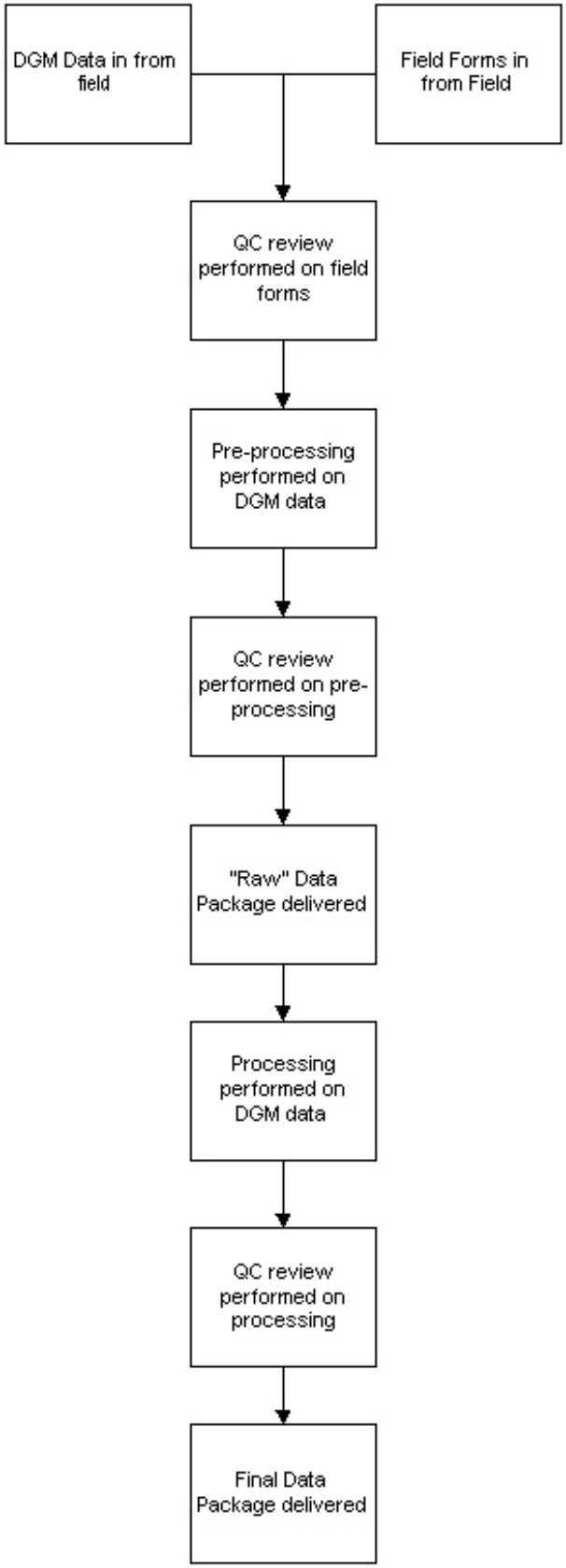
- Leveling is appropriate
- Filtering performed is appropriate
- Line breaking is appropriate
- Anomaly selections are appropriate

1.4.4 Corrective Measures

The following are the basic corrective measures to be followed in association with DGM surveying:

- Replacement of sensors if they fail to meet instrument check requirements.
- Resurvey of grids if seeded items are not identified (do not show in the DGM data). In a situation in which there is a failure to select a seed item from the data but the item is clearly present in the DGM data, a resurvey will not be performed, but instead a re-analysis of the DGM data.

FIGURE 4
QC of DGM Data – Process Flowpath



1.4.5 Analog Geophysical Systems Quality Control

QC of the analog geophysical instruments will be accomplished through daily checks that the instruments are functioning prior to using them for field activities. The IVS or designated analog instrument check areas will be used for assessing instrument functionality for each instrument at the start of each work day. If the instrument is not able to detect the items in the IVS or check areas, it will be taken out of use until it is repaired.

1.5 Attachments

- The definable features of work (DFOWs) for the DGM surveys are included as an attachment to this SOP

Geophysical System Verification

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when conducting Geophysical System Verification (GSV) procedures. The GSV process is a physics-based presumptively-selected technology process in which signal strength and sensor performance are compared to known response curves of industry standard objects (ISOs) to verify digital geophysical mapping (DGM) systems prior to and during site surveys. The GSV process is designed to perform initial verification of the proposed DGM system using an instrument verification strip (IVS) followed by a blind seeding program for continued verification throughout the field operations.

The GSV process will be implemented for the EM61-MK2 survey to be conducted in support of investigations to be conducted at the former Vieques Naval Training Range (VNTR) in Vieques, Puerto Rico.

1.2 Equipment and Materials

- Geonics, Ltd. EM61-MK2 coupled with real-time kinematic GPS (RTK GPS)
- Industry Standard Objects (ISOs)
- Hand tools – shovel, pick ax, breaker bar, etc.

1.3 Procedures and Guidelines

1.3.1 Digital Geophysical Mapping System

DGM will be conducted using the Geonics, Ltd. EM61-MK2. The EM61-MK2 has been presumptively selected based on existing site conditions, site geology and past extensive use at the former VNTR. The EM61-MK2 is a high-resolution time-domain electromagnetic (EM) instrument designed to detect, with high spatial resolution, shallow ferrous and nonferrous metallic objects. The standard EM61-MK2 system consists of two air-cored, 1 meter (m) by 0.5 m (3.3 feet [ft] by 1.2 ft) coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the two spatially separated receiver coils measures these eddy currents. The EM61-MK2 offers the ability to measure the eddy currents at three distinct time intervals in the bottom coil or four intervals if no top coil measurements are recorded. Earlier time gates provide enhanced detection of smaller metallic objects. Secondary voltages induced in both coils are measured in millivolts (mV). The arrangement of coils is such that there is a vertical separation of 40 centimeters (cm) (15.7 inches [in]). To obtain as much information about the decay of the induced EM signal as possible, the top coil will not be used at this site as a data channel, and four bottom coil sensor channels will be recorded.

Positioning of the DGM data will be accomplished using RTK GPS. RTK GPS instruments are ideal for field-mapping applications with adequate satellite visibility conditions as they provide the highest GPS accuracy possible. Typical accuracies of geophysical data positioning after adding errors induced by the movement of the DGM system are in the range of 20–50 centimeters.

1.3.2 Instrument Verification Strip

The initial phase of the GSV process is verification of the selected DGM system using an IVS. Multiple IVS locations may be constructed at VNTR. The constructions details and GSV process described in this document applies to each IVS location.

Location and Length of IVS

IVS locations will be determined during initial site reconnaissance by the DGM field team. The IVS will not be established on beaches or in areas that are prone to flooding, disturbance, or where site access would be cut off by effects of severe weather.

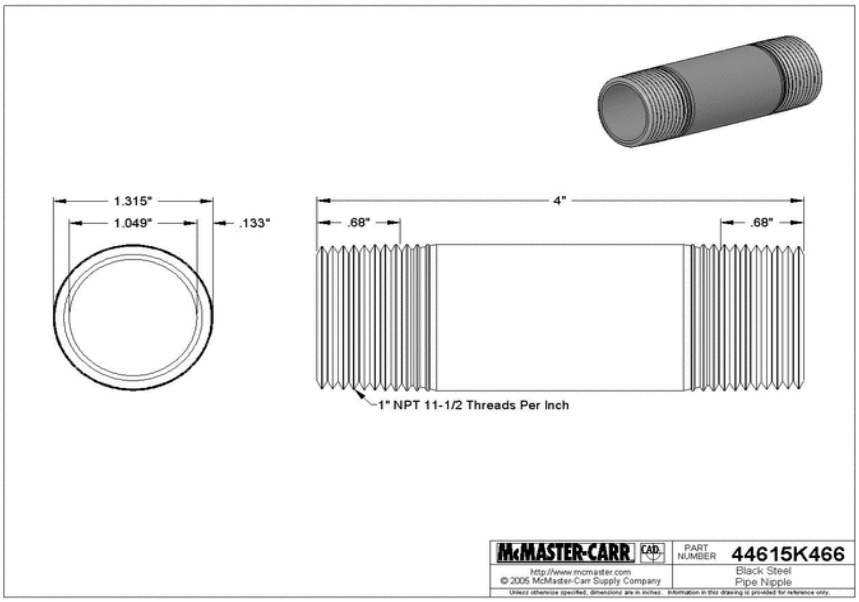
The IVS will be set up as a series of survey lanes, each with a length of approximately 20 m (66 ft). Additional details on the IVS set-up and construction are provided below.

Industry Standard Objects

The ISOs (**Figure 1**) to be used in the IVS are 1-inch by 4-inch (2.54-centimeter [cm] by 10.16 cm) steel pipes (McMaster-Carr part number 44615K466 [http://www.mcmaster.com/]) with the following specifications:

Shape: Straight Nipple, Threaded Both Ends
Schedule: 40
Pipe Size: 1 inch (1.315 inch outer diameter [OD])
Length: 4 inches
Finish: Black Welded Steel.

FIGURE 1
Small ISO

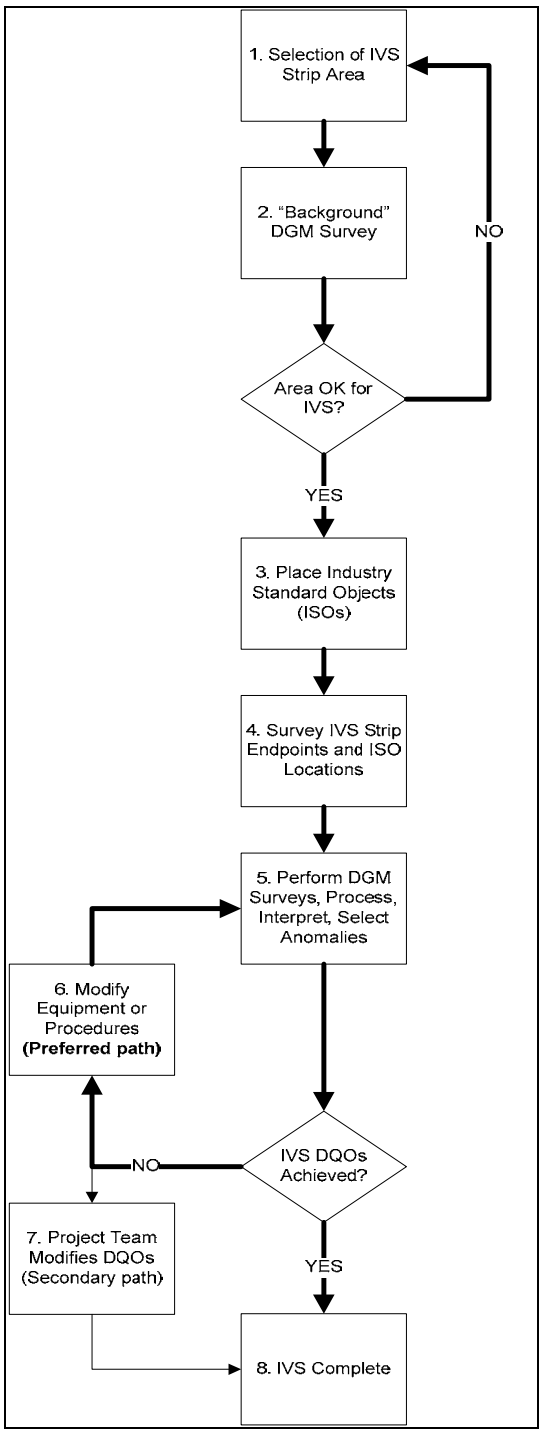


Instrument response curves for this ISO have been developed by the Naval Research Laboratory (NRL) demonstrating their standard response under their most favorable orientation (perpendicular to the EM61-MK2 instrument plane, i.e. buried vertically in the ground surface) and least favorable orientation (parallel to the instrument plane, i.e. buried horizontally and perpendicular to the direction of travel with the EM61-MK2) at a variety of distances from the instrument's bottom transmit/receive coil (NRL, 2009).

IVS Procedures

Figure 2 illustrates the overall IVS process and the procedures to be employed (numbered in accordance with the steps shown on **Figure 2**) during site work.

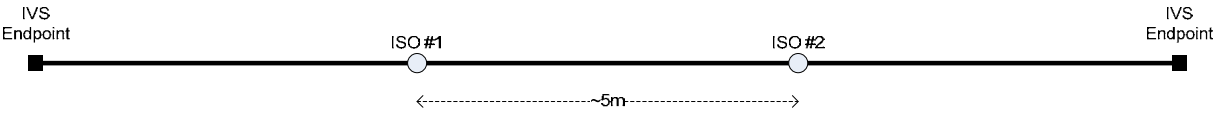
FIGURE 2
IVS Process



1. An IVS area will be selected with preference for the following (although none of the conditions are vital for IVS success):
   - Terrain, geology, and vegetation similar to that of a majority of the DGM survey area.
   - Geophysical noise conditions similar to those expected across the survey area.
   - Large enough site to accommodate all necessary IVS tests and equipment and for adequate spacing (at least 3 m) of the ISO items to avoid ambiguities in data evaluation.
   - Readily accessible to project personnel.
   - Close proximity to the actual survey site (if not within the site).

2. A background DGM survey will be performed with the EM61-MK2 using RTK GPS. This step will help determine the appropriateness of the location (e.g. few existing anomalies), and will verify that ISOs are not seeded near existing anomalies. The data will be processed and provided to the Project/QC Geophysicist for evaluation.
3. Once the IVS area is deemed suitable for use, (i.e. free of significant subsurface anomalies or anomalies that are clearly identified so that they can be avoided during seeding), two small ISOs will be buried vertically at depths below ground surface of approximately 3 and 7 times the small ISO diameter (10 cm and 23 cm, respectively). The ISO will be placed in a plastic sealable bag, identified as inert and labeled with the applicable contract and CTO number and CH2M HILL project manager contact information. These depths are intended to provide adequate signal to noise ratio for detecting the items. The generalized set-up of the seeded IVS transect is presented as **Figure 3.**

FIGURE 3
Generalized IVS Seeded Transect



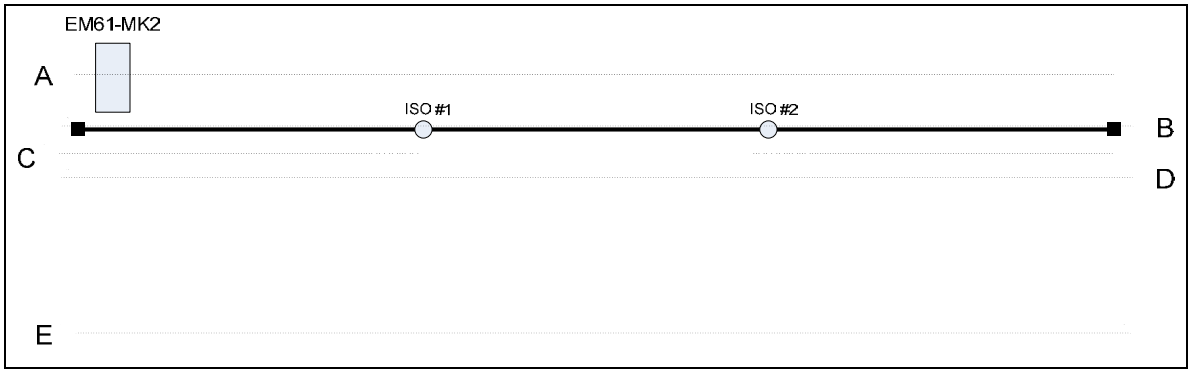
Measurements of the item depths will be to the center of mass of each item. CH2M HILL on-site personnel will bury the ISOs using shovels to dig the holes to the appropriate depths for burial of the seed items in coordination with the Project/QC Geophysicist. UXO personnel will implement MEC avoidance procedures using analog instruments. The background survey data and anomaly avoidance techniques will be reviewed so that transect start and end stakes and the seed items are not placed on top of or near existing anomalies. Personnel will bury the ISOs and record the emplacement depth and orientation.

4. DGM field personnel will record the locations of the IVS transect start and end locations as well as the buried ISOs. The holes will then be filled with soil and a wooden survey stake or other suitable non-metallic marker will be placed at each ISO location. Wooden stakes will also be placed at the start and end location of each transect and ropes will be extended along the ground surface between stakes in order to provide consistent navigation assistance for collecting the initial IVS data and doing daily QC checks. Wooden stakes will not extend more than 1 ft above the ground surface so that the EM61-MK2 can easily pass over top of their locations.
5. A DGM survey using RTK GPS positioning methods will be performed over the IVS area, including transects as described in **Table 1** and shown on **Figure 4**. The IVS will be collected for each mode of operation needed for the investigations (e.g. litter carry, wheel mode, etc.).

TABLE 1
IVS Transect Descriptions and Purpose

Transect	Description	Purpose
A	Offset by 0.75 m	Demonstrate horizontal drop off of item response
B	Directly over center of strip (see **Figure 3**)	Verify response versus established response curves
C	Offset by 0.375 m (half of intended lane separation) from center of strip	Demonstrate horizontal drop off of item response
D	Offset by 0.75 m (on opposite side of strip from Transect A)	Demonstrate horizontal drop off of item response
E	Offset by ~3 m from strip	Measure background noise

FIGURE 4
IVS Layout



The IVS will be established with Transects A and D at a spacing of 0.75 m and Transect C at a spacing of 0.375 m relative to the center strip. Details on the DGM production survey approach are provided in the UFP-QAPP.

The IVS "5-line" survey data will be processed and interpreted by the data processor and provided to the Project/QC Geophysicist within 24 hours of completion of the IVS survey.

- If the initial measurement quality objectives (MQOs) have not been met, the Project/QC Geophysicist will discuss with the Site Geophysicist whether modifications to instrumentation or procedures can be made to the DGM system in order to meet the MQOs.
- If the MQOs cannot be met, the Project/QC Geophysicist will meet with the project team to discuss potential resolutions (e.g. modification of a MQO) prior to completing the IVS and beginning the production survey.
- Once the system has been determined to meet the initial (or modified) MQOs, the IVS survey will be complete.

Blind seeding

As a continuation of the GSV process, small ISOs will be used as blind seeds within DGM survey areas in order to provide on-going validation of the EM61-MK2 system. The Title II contractor will seed items with a vertical orientation and at a depth of six inches below ground surface. Depth will be measured to the center of mass of the item, as illustrated in **Figure 5**.

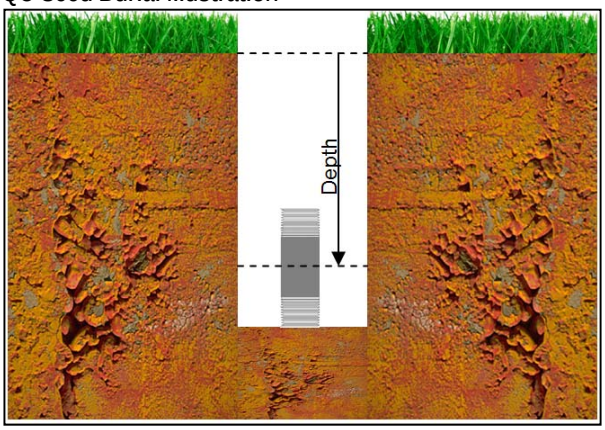
QC seed items will be placed with the intent of the DGM field team encountering at least one seed item per work day. UXO personnel will utilize the handheld geophysical instruments to clear the locations of each proposed seed location in order to avoid placing the seed within 1 m of a subsurface metallic object.

The following also applies to the placement of the seed items:

- UXO personnel will identify locations with no potential competing subsurface anomalies within 1 m of seed location that would adversely impact the ability to successfully detect the seed items with the geophysical instruments.
- Seeds will not be placed within a 1 m (3.3 ft) radius of a surveyor stake, tree, or other physical obstruction.
- Seeds will not be placed within areas that are potentially inaccessible or could be inaccessible at different times of the day (e.g. within a drainage swale or within the high tide surf zone).
- Holes will be dug by UXO personnel or under their direct supervision.
- The seed items will be left exposed after emplacement so that the location can be record using RTK GPS.
- The seed items will be labeled with the CH2M HILL project manager name and contact information, as well as the applicable contract number for the project. They will be marked as inert and placed in a sealed plastic bag or securely wrapped in non-metallic material to prevent groundwater from obscuring the labels.
- Once surveyed, the seeds will be carefully covered with soil so as to not disturb their orientation.
- No physical markers will be left in place to denote the locations of the seed items.

- The surveyed coordinates of the seed items will be provided to the Project/QC Geophysicist.

FIGURE 5
QC Seed Burial Illustration



1.3.3 Personnel and Qualifications

The following individuals will be involved in the IVS, GSV process, and DGM production survey:

- Program Geophysicist
- Project/Quality Control (QC) Geophysicist
- Site Geophysicist
- Field Geophysicist
- Data Processor
- Unexploded Ordnance (UXO) personnel

Personnel involved in performance of the IVS and the production geophysical surveys will meet the following qualifications and have the following responsibilities throughout the duration of the survey:

- The **Program Geophysicist** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have a minimum of five years of experience directly related to the geophysical mapping, detection and discrimination of buried military munitions. This individual has overall responsibility for design, implementation, and management of geophysical investigations required for the work effort related to military munitions, but may not necessarily be on site full time. This individual will be the program geophysicist-of-record.
- **Project/QC Geophysicist** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 5 years of directly related geophysical experience working at MEC and MPPEH sites. This individual will also be capable of overseeing construction of the IVS, geophysical operations and support activities (e.g. land surveying, vegetation clearing), serving as the project team technical lead, performing QC of data as packages are delivered, and coordinating with the CH2M HILL project and activity managers.
- The **Site Geophysicist** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 2 years of directly related geophysical experience working at MEC MPPEH sites. This individual will serve as the primary point of contact in the field, be capable of managing field staff, maintain geophysical equipment, perform in-field data quality checks and make sure that field work and records management is completed in accordance with the project work plans and health and safety plan.
- The **Field Geophysicist** will have a degree in geophysics, geology, geological engineering, or a closely related field and will have had training in the proper and safe operation of geophysical equipment. This individual will have at least 6 months of related geophysical experience working at MEC and MPPEH sites.

- The **Data Processor** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have at least 1 year of experience in processing geophysical data related to MEC and MPPEH projects.
- **UXO Personnel** will be responsible for overall daily site access and safety aspects of the project, compiling subcontractor health and safety documents, conducting daily safety briefings and performing MEC avoidance, as needed, in the field. Information on the specific qualifications for various UXO personnel support roles can be found in the Explosives Safety Submission (ESS).

1.4 Quality Control

1.4.1 General

- Achievement of the GSV MQOs will be verified by the Project/QC Geophysicist. The QC tests will be performed as part of the GSV and IVS procedure for the DGM systems being utilized; instrument-specific QC tests are provided in the DGM SOP.
- During review of the delivered data packages, the Project/QC geophysicist will overlay the locations of the blind seeds to observe whether the munitions detection and positioning MQOs are met. Should an issue be detected (such as a data trend indicating a MQO limit is being approached) or a MQO is not met, a comprehensive root-cause analysis will be performed and a corrective action determined.

1.4.2 Measurement Quality Objectives (MQOs)

The MQOs for the IVS are presented in **Table 2**. The EM61-MK2 will not be used for site surveys until it is able to meet these MQOs or until the project team agrees on modifications to existing MQOs.

TABLE 2
IVS MQOs

Measurement Quality Objective	Measurement Performance Criteria	Test Method During IVS
General System Verification		
DGM System Positioning. Accurate coordinates are obtained from kinematic (i.e. in-motion) DGM positioning systems.	Positional error of ISO seeds will not exceed 25 cm (9.8 inches) relative to surveyed locations.	Results of IVS DGM survey versus IVS seed locations will be evaluated for compliance.
DGM System Munitions Detection. DGM system response is within industry standards for detection.	Response to buried ISO will not vary more than ±20% from known response for specific distance from sensors in static test.	Results of IVS surveys over seed items in strip will be qualitatively reviewed for the person portable system. Results of static tests will be quantitatively reviewed for compliance.
Data Handling		
Data must be delivered in a timely manner and in a useable format.	IVS survey results are delivered within 24 hours of completion of survey. Final processed packages delivered within 3 days.	Evaluate based on actual delivery of data

Additional MQOs for the production survey will be monitored through the blind seeding program and other equipment QC tests (described in the DGM SOP).

1.5 Attachments

- None

STANDARD OPERATING PROCEDURE MR-6

Subsurface Anomaly Removal

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when excavating and removing subsurface anomalies that have been previously identified through digital geophysical mapping (DGM) surveys or through an analog use of a metal detector while performing "mag-and-dig" activities. This SOP is specific for the removal of anomalies and does not apply to investigations to determine the source of anomalies.

1.2 Equipment and Materials

- EM61-MK2
- RTK-GPS
- Magnetometer
- Data collection device
- Hand tools – shovel, pick ax, breaker bar, etc
- Back hoe (optional)

1.3 Procedures and Guidelines

1.3.1 General

- Prior to conducting the excavation and removal of anomalies, the munitions response (MR) contractor(s) will generate a list of anomalies to be investigated that have been identified through DGM. The list of anomalies must include, at a minimum, a unique identification (ID) for the anomalies, the coordinates for the anomalies, and the millivolt (mV) reading for the anomaly as determined by the DGM.
- The mV reading for the anomalies must be equal to or greater than the action threshold set forth for the removal action; 2.5 mV has been established as the minimum threshold for anomaly identification. This threshold value will be determined by the Navy and regulatory agencies and identified in the site-specific work plan for the MR contractor performing the anomaly excavation.
- Anomaly excavation and removal will be conducted to various depths depending on the area of removal and the anticipated land use activities. The removal depth will be determined by the Navy and regulatory agencies and will be specified in the site-specific identified in the site-specific work plan for the MR contractor performing the anomaly excavation.
- Any factors that limit the investigation of an anomaly to the specified will be recorded for the specific locations.
- Due to site conditions that may limit excavation and the limits on clearance depths, all anomalies may not be resolved. Anomalies that are not resolved will be recorded with the site conditions, geographic coordinates, and anomaly ID. This information will be evaluated to assess the need for additional MR action(s) at that location.

All items recovered during the excavation and removal of the anomalies will be handled, as appropriate, according to the item class as described in the MPPEH/MD Collection and Inspection SOP.

1.3.2 Anomaly Excavation and Removal

1. Two UXO Technicians will perform the anomaly reacquisition and marking (as described in the Anomaly Reacquisition SOP).

2. The UXO team, consisting of at least two UXO Technicians (at least one being a UXO Technician II or higher), will excavate anomalies using mechanical and hand digging methods as appropriate. Teams will periodically check the location of the anomaly with a handheld magnetometer to assist in the recovery of the item and to ensure the source of the anomaly has not already been removed from the anomaly location. If mechanical digging methods are use, once excavation is estimated to be within 1 ft of the anomaly all digging will be performed by hand.
3. Unless the source of the anomaly is identified as UXO or is otherwise unsafe to move, personnel will place the recovered source(s) of the anomaly near the investigation location at a distance that the item will not produce a reading from the EM61-MK2 or the hand held magnetometer. If the magnetometer did not indicate that a ferrous anomaly source was present, no intrusive action will take place until after the anomaly location is checked with an EM61-MK2. If no anomaly source is located, the results of the investigation will be recorded in the field data collection device for that target ID.
4. If an intrusive action was taken, the Team Leader and a UXO Technician will enter the result of the intrusive investigation into the field data collection device and then check the investigation location with an EM61-MK2 to ensure that the source of the anomaly has been removed. **The UXO Technician will have undertaken training on operation of an EM61-MK2 and pass a test as described in the standard operating procedure (SOP) for EM61-MK2 Skills Determination Prior to Use.** The maximum amplitude anomaly response will be recorded over the investigation location (up to a 1 meter radius from the identified anomaly location), and if the total is below the action threshold, the source of the anomaly will be considered removed. If the result is greater than the action threshold, then the location will be (re-)excavated to locate the remainder of the source.
5. If an intrusive action was **NOT** taken, the Team Leader and a UXO Technician will check the location with the EM61-MK2 and observe the maximum amplitude anomaly response (of the summed time gates). If the total is below the required action threshold, the anomaly will be considered a false positive. If the result higher than the action threshold, the location will be excavated to locate the source. Step 4 (above) will then be carried out.

1.4 Quality Control

- Inert MEC items (or surrogates if necessary) will be seeded in locations that are otherwise free of anomalies. The QC seeds will be placed at the site commensurate with the production rate of DGM such that one seed is encountered each day of data collection. The MR contractor must acquire, excavate, and recover the QC seeds.
- Once the UXO Team has completed a specified number of anomalies to create a quality control (QC) lot, the UXO Quality Control Specialist (UXOQCS) for the MR contractor will check the anomaly locations with an EM61-MK2 to ensure that the source of the anomalies have been removed; the number of anomalies to be checked will correspond to the MILSTD 1916 verification level for the contractor. **The UXOQCS will have undertaken training on operation of an EM61-MK2 and pass a test as described in the standard operating procedure (SOP) for EM61-MK2 Skills Determination Prior to Use.** The maximum amplitude anomaly response will be recorded over the investigation location, and if the total is below the action threshold, the source of the anomaly will be considered removed. If the result is greater than the action threshold, then the QC lot will fail QC and all anomaly locations will be re-acquired and investigated to locate the remainder of the source.
- Once the QC lot has passed the QC process, a third-party UXO Quality Assurance (QA) officer will check the anomaly locations within the QC lot with an EM61-MK2 to ensure that the source of the anomalies have been removed; the number of anomalies to be checked will correspond to the MILSTD 1916 verification level for the contractor. **The UXO QA Officer will have undertaken training on operation of an EM61-MK2 and pass a test as described in the standard operating procedure (SOP) for EM61-MK2 Skills Determination Prior to Use.** The maximum amplitude anomaly response will be recorded over the investigation location, and if the

total is below the action threshold, the source of the anomaly will be considered removed and the lot will pass QA. If the result is greater than the action threshold, then the QC lot will fail QA and the excavation and QC process will start over.

1.5 Attachments

- None

STANDARD OPERATING PROCEDURE M5-7

MPPEH/MD Collection and Inspection

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when collecting and inspecting material potentially presenting an explosive hazard (MPPEH)/munitions debris (MD) recovered during munitions removal actions. During MEC removal operations, UXO Technicians it is initially assumed that all metallic material identified contains some amount of explosives until further inspection proves differently. Because the material recovered will ultimately be disposed of off-site, it is imperative that procedures be established to provide a system for the recovery, inspection and documentation of all material that will leave the site.

In addition to this SOP, all relevant guidance from the NOSSA- and DDESB-endorsed Explosive Safety Submission for the project and the following publications/guidance must be adhered to during the collection and inspection of items from the site:

DoD 4160.21-M	*Department of Defense Reutilization and Marketing Manual*
DoD 4160.21-M-1	*Department of Defense Demilitarization Manual*
DoD 6055.09-STD	*DOD AMMUNITION AND EXPLOSIVE SAFETY STANDARDS*
TB 700-4	*Department of the Army Technical Bulletin - Decontamination of Facilities and Equipment*
NAVSEA OP 5	*Ammunition and Explosives Safety Ashore*

1.2 Equipment and Materials

- Heavy equipment for picking up and transporting recovered materials
- Hammermill, or equivalent, for demilitarization of items
- Thermal treatment furnace

1.3 Procedures and Guidelines

- Specific procedures regarding the collection, certification as no longer presenting an explosive hazard, processing and the demilitarization of MPPEH will be addressed in contractor site specific work plans, however they must follow the guidance contained in this SOP.
- At the operating site, the UXO Team Leader will designate separate staging areas for recovered material to be placed. These areas should be adjacent to the grid they are working in. At a minimum, an area for explosive free material that does not retain an ordnance appearance such as fragments and another area for items that are free from explosives but still retain an ordnance appearance such as expended ejection projectiles will be established. An area for MEC that is safe to move and will eventually be consolidated for disposal may also be designated at the contractors preference. These items however may be left in the location found prior to consolidation if desired. For the purpose of this work plan these areas are designated as temporary staging areas for MD Scrap , MD Demilitarization and MEC Holding area ,if used.
- Inspection procedures begin at the time the material is discovered by the UXO-qualified Technician. Contractors will develop procedures to ensure that a minimum of two UXO-qualified Technicians inspect all material prior to it being removed from the temporary staging areas. The first inspection will be by the UXO technician discovering the material. The second inspection will be by performed by the UXO Team leader. The UXO Team leader may perform this second inspection at any time prior to the material being moved from the temporary staging areas. Upon completion of operations within a grid, the UXO Team leader for the team that cleared the grid will direct movement of the inspected material from the temporary staging areas to the consolidation point. The material may be moved by the UXO Team that cleared the grid or by a Final

Clearance team at a later date. When Material is placed in the consolidation point the, MD demil will be not be located in the same pile as the MD Scrap.

- Material from the consolidation points will be removed by the scrap management contractor. Out of an abundance of caution, the scrap management contractor's UXO-qualified Technician will perform a third inspection of all material prior to it being transported to the established processing area. If any suspect items are discovered, the removal contractors UXO Quality Control Specialist (UXOQCS) will be notified to rectify the situation. At the processing area, the material recovered from each consolidation point will be weighed separately and that weight will be entered in to the appropriate form on the PDA. The material will then be sorted and staged in the appropriate location within the established processing area. At a minimum, areas within the CPC will be established for Range Related debris (RRD), material requiring further demilitarization, and material requiring thermal treatment. The scrap management contractor may and will likely establish additional staging areas to enhance efficiency.
- Demilitarization Requirements- Many items entering the processing area will still retain the appearance of being an ordnance item, although they have been inspected and are free of explosives. When scrap metal is released to the recycling market it is often stored for a period of time and even sold and resold before being smelted. The mere appearance of an item being a live ordnance item can cause undo alarm and may require the services of military explosive ordnance disposal. Therefore, demilitarization should, to the greatest extent possible, process certified MPPEH until it no longer looks like ordnance (a reasonable person will not mistake it for a hazardous item).
- Certification as material documented as safe (MDAS) - Material that is taken to the processing area will have met the substantive requirements of DoD 6055.9-STD and NAVSEA OP 5 regarding the dual inspection of MPPEH. However, since this material may remain at the processing area for some time, further inspection and documentation is required before any material enters the recycling stream. The scrap management contractor will develop procedures for the treatment, inspection and documentation of MPPEH.
- Munitions Debris - All MD must be inspected following the procedures for range related debris (RRD). A continuous chain of custody will be maintained from the time the material is identified as MD and free of explosives (MDAS) until it is placed in a locked and sealed shipping container. A continuous chain of custody will be maintained for MDAS from the time the material is assessed and documented until it is released from DoD control.
- Range Related Debris - RRD and any other material not subjected to thermal treatment must receive a 100% inspection scrap management contractor's UXOQCS followed by a 100% inspection by the SUXOS-qualified government QA manager or a SUXOS qualified title II QA assessor. The scrap management contractor will provide documents to verify that each lot has received a 100% inspection by these two individuals. Both individuals conducting the inspection must sign these documents.
- No MPPEH, MD and RRD will be offered for commercial recycling until it has been demilitarized in accordance with DoD 4160-21-M-1

1.4 Quality Control

- The scrap management company UXOQCS and the government QA manager or Title II Services QA assessor verify that the material is free of explosive material.
- All RRD and aluminum MD that has undergone 100% inspection by both the scrap management contractor's UXOQCS followed by a 100% inspection by the SUXOS-qualified government QA manager or a SUXOS qualified title II QA assessor must be documented. Prior to any material being shipped off-island for disposal or recycling, these forms must be verified as complete.

1.5 Attachments

- None

STANDARD OPERATING PROCEDURE MR-8

Explosives Management

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when receiving, tracking, and storage explosives purchased and used during the munitions response activities.

1.2 Equipment and Materials

- Demolition materials - high explosive donor charges, jet perforators, detonation cord, electric and/or non-electric blasting caps, NONEL (shock-tube), etc.
- Vehicle for transportation of explosives, with proper placards
- Explosives storage magazines, with proper placards, security, and grounding system
- Fire extinguishers

1.3 Procedures and Guidelines

1.3.1 Licensing

- The project Munitions Removal Contractor should be prepared to acquire commercial explosives from a local vendor who will deliver the materials to the project site. The UXO contractor will maintain a valid ATF User of HE Permit. Explosives vendors cannot supply explosives without the required valid dealer ATF license. A copy of this dealer license will be maintained at the project office, and upon request, will be made available to any local, state, or federal authority.

1.3.2 Initial Receipt

- Explosive shipments will normally originate from the island of Puerto Rico. The mode of delivery to Vieques may vary based upon the DOT Hazard Classification of the explosives being delivered. Binary explosives, NONEL, and certain initiators may be delivered by commercial air carrier to the Vieques Airport. HE main charges, Jet Perforators, detonating cord, and certain initiators may be delivered by special chartered aircraft or delivered to Vieques Island via watercraft.
- Regardless of delivery mode, all incoming shipments will be met by project personnel qualified to transport explosives, such as the SUXOS and/or USOSO for the munitions response contractor, and taken directly to explosive storage magazines near OP1 (buildings 4710A and 4710B) or demolition location.
- Explosives in unsealed boxes containing partial lots will be opened and the contents counted. Any discrepancies between the actual type and quantity of explosives received and the shipping documentation will be noted on the shipping documentation with the signatures of both the delivery driver and the individual authorized to receive the explosives. A legible copy will be filed onsite. The authorized individual receiving the explosives will immediately inform the SUXOS of the discrepancy, who will in turn notify the Title II Services Contractor Munitions Response Manager. Project personnel will take the appropriate action as described below.

Establishment of Explosives Storage Facilities

- Explosives items will be stored in accordance with its Hazard Division (HD) and the storage compatibility group criteria listed in DoD 6055.9-STD and NAVSEA OP 5 Volume 1, as necessary.
- Explosives will be stored only in areas specifically sited in the NOSSA- and DDESB-approved Explosive Safety Submission for the site.

- Permanent explosives storage magazines are available onsite; however, if temporary explosives magazines are required, they will be Type 2 magazines as described in Section 555.208 of ATF P 5400.7, Alcohol, Tobacco, and Firearms Explosives Law and Regulations, will be used. If a portable magazine is used, DDESB site approval will be obtained. The maximum NEW to be stored in each temporary magazine is 50 pounds. This explosives storage area will meet the requirements of:
  - ATF P 5400.7—Alcohol, Tobacco, Firearms, and Explosives Laws and Regulations;
  - DoD 6055.9-STD—DoD Ammunition and Explosives Safety Standards, and
  - NAVSEA OP 5 Volume 1, Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation, and Shipping
- For building 4710B, storage of 2,000 pounds NEW of HD 1.1 explosives, the IBD is 1,250 ft, the PTR distance is 60 percent of the IBD, or 750 ft. For building 4710A, storage of 100 pounds NEW of HD 1.4 explosives the IBD is 75 feet and the PTR distance is 75 feet.
- Explosive storage magazines will be clearly marked with DoD fire symbols and NFPA 704 markers. Signs stating “EXPLOSIVES” and “NO SMOKING” will be posted on the outside of the magazines.
- Buildings 4710A and 4710B have installed lightning protection systems that comply with NAVSEA OP5 Requirements.
- Fire extinguishers of 10 pounds and type BC will be located in the magazine area. Smoking, matches, open flames, spark producing devices, and firearms will not be permitted within 50 feet of the magazines. The area surrounding the magazines will be kept clear of all combustible materials for a distance of at least 50 feet.

Physical Security

- Each explosive storage magazine (buildings 4710A and 4710B) is surrounded by a chain-link security fence with a lockable gate. The magazine doors are fitted with tamper-resistant hardware which has two independent padlock hasps. The gate keys will be issued to the SUXOS and the magazine keys will be issued to the UXOSO. Keys will be secured in the project office or by the contractor storing explosives when not in use.
- If temporary magazines are required, locks will meet the standards for ATF Type 2 magazines, as specified in Section 55.208(a)(4), ATF P 5400.7. Each magazine will have two locks. The SUXOS will hold a key to one of the locks, and the UXOSO will hold the key to the other. Access to the explosives will require both individuals. Keys will be secured in the project office when not in use.
- When explosives are stored in building 4710A and 4710B the magazine will be monitored to ensure the security of the explosives. During working hours site personnel will verify the security of the magazines. During non-work hours the magazines will be monitored one of the means below:
  - Remote viewing cameras will be monitored from Camp Garcia. The person monitoring the camera images will have reliable communications to notify Fish and Wildlife Services and local law enforcement in case of emergency.
  - A guard will check the security of the magazines every 2 hours. The guard will have reliable communications to notify Fish and Wildlife Services and local law enforcement in case of emergency.

Stocking Procedures

- When explosives are stored onsite to meet project requirements, the containers of explosive materials are to be stored so that markings are visible. Stocks of explosive materials are to be stored so that they can easily be counted and checked upon inspection.
- Except for fiberboard and other non-metal packages, containers of explosive materials are not to be unpacked or repacked inside a magazine or within 50 feet of a magazine, and must not be unpacked or repacked close to other explosive materials. Containers of explosive materials must be closed while in storage.

- Tools used for opening and closing containers of explosive materials are to be of non-sparking materials, except that metal box-cutters may be used for opening fiberboard containers. A wood wedge and a fiber, rubber or wooden mallet is to be used for opening and closing wood containers of explosive materials. Metal tools other than non-sparking transfer conveyors are not to be stored in any magazine containing explosives.

1.3.3 Transportation

- Explosives will be delivered to the project site by a licensed and permitted commercial explosives transporter. When explosives are required at the work site, the UXO team will transport the explosives in an appropriately placarded vehicle following the procedures stated in this section.
- Procedures for transporting explosives from the storage facility to the demolition site include the following rules:
  - The driver of any explosive-laden vehicle will ensure that the load is properly braced and that the initiators are carried separately from main charge explosives.
  - The UXO Technician in charge of the explosives movement will ensure the driver and any passengers are not carrying any smoking products or flame producing devices. Smoking is strictly forbidden by all personnel involved in the handling or transportation of explosives.
  - Drivers transporting explosives on roads that are not controlled by the U.S. Government must possess a valid commercial driver's license with a hazardous materials endorsement.
  - The amount of explosives issued and transported will be limited to the amount needed to perform the day's demolition operations and any quantity limitations imposed by transportation regulations.
  - WP munitions will not be transported unless immersed in water, mud, or wet sand.
  - If loose pyrotechnic, tracer, flare, and similar mixtures are transported, they shall be placed in #10 mineral oil or equivalent to minimize fire and explosion hazards.
  - If an unfired rocket motor must be transported, it shall be positioned in such a manner as to offer the maximum protection to personnel in the event of an accident.
  - If base-ejection type projectiles must be transported to a disposal area or collection point, the base will be oriented to the rear of the vehicle and the projectile secured in the event the ejection charge functions in route.
  - If a UXO with exposed hazardous filler (HE, etc.) has to be moved to a disposal area, the item shall be placed in an appropriate container with packing materials to prevent migration of the hazardous filler. Padding should also be added to protect the exposed filler from heat, shock, and friction.
- Vehicles transporting explosives on the Site will comply with the following requirements:
  - Vehicles transporting explosives will be properly placarded.
  - All vehicles transporting explosives will be equipped with reliable communications, a first aid kit, and two 10-pound BC fire extinguishers.
  - Vehicles transporting explosives will be inspected daily when in use and the inspections will be documented in a Motor Vehicle Inspection Form (Form 3-1).
  - The vehicle used to transport the explosives will have a non-sparking bed liner, and all explosive loads will be covered prior to departure.

Inventory Control and Records Management

- If storage of explosives onsite is required, an accurate running inventory of all explosives will be maintained on the Magazine Data Card. One copy of the Magazine Data Card will be kept with the specific lot of explosives, and one copy, which mirrors the original, will be kept in the field office.
- At the time of explosives delivery, and at the time of explosives issue, the SUXOS will ensure all additions and subtractions from the inventory of a magazine are recorded on the Magazine Data Card. If issued explosives are not used, they will be added back in to the inventory and recorded on the Magazine Data Card.
- Explosives will be tracked by lot number on the Magazine Data Card. All explosives inventory records generated will be archived by Title II Services Contractor for a period of at least 5 years in accordance with ATF regulations.
- Written authorization for individuals who can purchase, store, or use explosives must be included in the site specific work plans.
- The SUXOS will be responsible for the proper receipt of explosives from the explosives vendor. Only personnel designated in writing may conduct the receipt and initial inventory of the explosives. Individuals authorized to receive explosives will be at least a UXO Technician III.
- The UXO Technician III or SUXOS, as the end-user of explosives, will certify in writing that the explosives were used for their intended purpose.
- In the event there is a discrepancy following deliveries or onsite storage between the explosives on hand and the explosives inventory recorded on the Magazine Data Card, the SUXOS will be notified. The SUXOS, together with the UXOSO, will review documentation to determine whether the discrepancy is a paperwork error or whether explosives have been lost or stolen. If it is concluded explosives are lost or stolen, the procedures listed below will be followed.

1.3.4 Inventory

- If explosives are stored onsite, each Magazine Data Card will be audited weekly by project staff, such as the Title II Services Contractor PM or UXOSO, on a rotating basis. The SUXOS will ensure that the contents of each magazine are inventoried on a weekly basis and that the quantities of explosives on hand match the quantities listed in the Magazine Data Cards. During this inventory, the numbers of each item stored in the magazine will be determined by inspection and counting. Sealed containers will be left unopened and counted as full. Discrepancies discovered at any time will be handled as described in the following section.

1.3.5 Lost, Stolen, or Unauthorized Use of Explosives

- If explosives are discovered to be lost, stolen, or used without authorization, the incident will be immediately reported to the SUXOS, who in turn will inform the Title II Services Contractor PM. The PM shall immediately notify the NAVFAC RMP.
- The Federal licensee is required by law (27 CFR 55.30) to report the theft or loss of explosives to the ATF within 24 hours. In the event of such an occurrence, the following procedures will be followed:
  - The magazine will be secured, and the area will be sealed until the appropriate authorities complete their investigation.
  - Notify the ATF [(800) 424-9555] and the local law enforcement authorities.
  - The Federal licensee is responsible for completing and forwarding ATF Form 5400.5. This form will be completed by the SUXOS, and a copy will be provided to the RPM.
  - Puerto Rico State Police will be notified [(787)-723-3221] of any lost or stolen explosives.

1.3.6 Return of Unused Explosives

- If explosives are being stored onsite and a situation arises where explosives have been issued to the munitions response contractor staff but not used during the course of the workday, the unused explosives will be returned to the magazine prior to that shift ending. All unused explosives will be returned/taken to the storage magazine and the Magazine Data Cards will be annotated.

1.3.7 Disposal of Explosives

- If explosives were being stored onsite and some quantity remains at the end of the project, the PM for the munitions response contractor will consult with NAVFAC and contracting representative to determine the appropriate disposition. A detailed accounting of remaining explosives and an economic analysis of possible alternatives. Consideration will be given to transfer the remaining explosives to another project via a licensed and permitted commercial explosives carrier. If economically advantageous transfer opportunities cannot be identified, the explosives will be detonated consistent with procedures contained in this work plan.

1.4 Quality Control

- If/when explosives are stored onsite, each Magazine Data Card will be audited at least weekly by project QC and QA staff. The senior authorized individual(s) will ensure that the contents of each magazine are inventoried on a weekly basis and that the quantities of explosives on hand match the quantities listed in the Magazine Data Cards. During this inventory, the numbers of each item stored in the magazine will be determined by sight inspection and count. Sealed containers will be left unopened and counted as full.

1.5 Attachments

- None

Geographic Information System Procedures

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when implementing and using the Geographic Information System (GIS) for the munitions response activities.

1.2 Equipment and Materials

- Ruggedized GPS equipment used for data collection
- Computer, with GIS software
- Centralized munitions response (MR) data management system/database

1.3 Procedures and Guidelines

- A central database was developed to manage, evaluate, and report site information, including MEC encountered and disposed of. All existing data is currently referenced to the 1983 North American Datum 83, UTM coordinate system.
- The Title II Services Contractor will maintain all data collected in a central database file. The database will include functionality to import electronic field data, QC the field data, and print reports for contractor and Navy review. The file will be backed up on a daily basis. Data will be provided to the Navy and removal contractors on a weekly or as-needed basis by exporting the database to Microsoft Excel format.
- A computer system with the central database is available onsite at Camp Garcia for upload of field data, data management, and reporting. The Contractor will provide GIS and database support on an as-needed basis to assist with GIS system functionality and use.
- All field data will be collected using ruggedized handhelds with integrated GPS receivers, and uploaded to the database on a daily basis. The pre-determined nomenclature for MEC Items is loaded into the handhelds to ensure consistency and database integrity. MEC Items found are stored and managed in table separate from other database tables (such as safety meetings, QC/QA operations, Team Leader Dailies, etc). Data will be entered following the Vieques Electronic Data Entry SOP. See the attachment for the data entry options.
- MEC spatial data will be imported into the database as point data identified by a unique northing and easting coordinate pair (a unique point designator will also be assigned) collected by the handheld GPS unit. In the event that multiple MEC items encountered in the field are grouped and classified together, the cluster location will be entered into the database as a single point or polygon.
- MEC item attribute data includes both qualitative and quantitative information such as ordnance type, quantity, and status. In addition, a munitions database can be linked to the MEC item table to provide physical, chemical, and explosive data regarding each MEC or MEC item found in the field. This anomaly validation study will not require the use of various models for evaluation of buried explosives, trajectory, and other assessments related to the unintentional detonation of munitions. If required (as a result of field conditions), this analysis will be scoped in a separate task.
- The workflow for transferring the field data to the database is summarized below:
    1. Field observations are recorded on pre-defined field forms and using handheld Trimble GeoXT GPS units.
    2. Data from the geophysical survey will be processed by the field team leader daily, and the processed files will be submitted to the project data manager for QA and incorporation into the standard data management structure. Each file will be stored in original format and converted to the standard GIS or database format to be included in the system.

3. At the end of the field day, data on field forms and in handheld GPS units are verified for completeness and accuracy (i.e., number of observations made match the number of observations recorded). Copies of the field forms are made and hard copies of the electronic forms are printed for the field office. The data from the handheld units is uploaded to the database on the field computer.
4. The onsite database is sent to the Data Manager and loaded to an FTP site, where it is used as a geodatabase.
5. QC checks of the data are based on a set of reports generated from the database and provided to the PM and field team leader for review.
6. Once daily data is uploaded, the database can be used for data analysis and reporting and map generation.

- The MEC database is also be used to track demolition events, consolidation points, and treatment of MEC Items. If MEC is moved and detonated onsite, this information will also be included in the database system.
- Additional data will be incorporated as necessary into the onsite GIS as layers. These layers consist of pre-existing data, or other non-MEC data collected during the MEC investigation. Sources for such data include existing CAD files, published data, and output from other software applications. Examples of these layers include existing anomaly data, and spatial and attribute data collected and mapped by previous investigators, if available.
- The GIS will not be used to store all raw data generated during the MEC investigations. For example, data points collected by geophysical instruments, gridded data used by modeling programs to generate contour maps, and similar types of backup data will likely be archived as separate tables in the database or as independent databases. An attribute field will be added to the GIS coverage that identifies a file location or similar reference to document these data. The interpreted results of analysis (such as interpreted geophysical results), however, will be included in the GIS.
- All data, text, and digital maps will be available in standard file formats. Text will be delivered in either Microsoft Word or Adobe Acrobat Portable Document Format (PDF), as requested in the specific project task order. The shareware PDF viewer will be provided along with the PDF documents.
- All GIS and associated database and digitized aerial photographs are transportable and can be copied to CD-ROM or DVD for archiving or transfer to other team members.

1.4 Quality Control

- Data entries will be reviewed on a daily basis by the MR contractor's data management personnel. The data will be reviewed to ensure completeness, consistency, and accuracy. Any discrepancies or incorrect data will be resolved during the review. Data subject to this QC review includes, but is not limited to, items found, grid status, and team operations.
- The Title 2 data management personnel will review data only after it has been QC'd by the MR contractor collecting the data. The data will be reviewed to ensure completeness, consistency, and accuracy. Data subject to this QA review includes, but is not limited to, items found, grid status, and team operations. Any discrepancies will be identified and reported to the MR contractor for clarification and or correction.

1.5 Attachments

- Data entry options

STANDARD OPERATING PROCEDURE MR-10

Subsurface Anomaly Inspection

1.1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when inspecting subsurface anomalies that have been previously identified through digital geophysical mapping (DGM) surveys This SOP is specific for the identification of the source of anomalies and does not apply to the excavation and removal of anomalies.

1.2 Equipment and Materials

- EM61-MK2, or equivalent
- RTK-GPS
- Magnetometer
- Data collection device
- Hand tools – shovel, pick ax, breaker bar, etc
- Back hoe (optional)

1.3 Procedures and Guidelines

1.3.1 General

- Prior to conducting the excavation and removal of anomalies, the munitions response (MR) contractor(s) will generate a list of anomalies to be investigated that have been identified through DGM. The list of anomalies must include, at a minimum, a unique identification (ID) for the anomalies, the coordinates for the anomalies, and the millivolt (mV) reading for the anomaly as determined by the DGM.
- The mV reading for the anomalies must be equal to or greater than the action threshold set forth for the anomaly source identification; 2.5 mV has been established as the minimum threshold for anomaly identification. This threshold value will be determined by the Navy and regulatory agencies and identified in the site-specific work plan for the MR contractor performing the anomaly inspection.
- Anomaly inspection will be conducted to various depths depending on the area of removal and the anticipated land use activities. The removal depth will be determined by the Navy and regulatory agencies and will be specified in the site-specific identified in the site-specific work plan for the MR contractor performing the anomaly excavation.
- Any factors that limit the investigation of an anomaly to the specified will be recorded for the specific locations.
- Due to site conditions that may limit excavation and the limits on the inspection depths, all anomalies may not be resolved. Anomalies that are not resolved will be recorded with the site conditions, geographic coordinates, and anomaly ID. This information will be evaluated to assess the need for additional MR action(s) at that location.
- All materials potentially presenting an explosive hazard (MPPEH) identified through the anomaly source inspection will be treated as described in the MPPEH/MD Collection and Inspection SOP.

1.3.2 Anomaly Excavation and Removal

1. Two UXO Technicians will perform the anomaly reacquisition and marking (as described in the Anomaly Reacquisition SOP).

2. The UXO team, consisting of at least two UXO Technicians (at least one being a UXO Technician II or higher), will excavate anomalies using mechanical and hand digging methods as appropriate. Teams will periodically check the location of the anomaly with a handheld magnetometer to assist in the recovery of the item and to ensure the source of the anomaly has not already been removed from the anomaly location. If mechanical digging methods are used, once excavation is estimated to be within 1 ft of the anomaly all digging will be performed by hand.
3. Unless the source of the anomaly is identified as UXO that is unsafe to move, personnel will place the recovered source(s) of the anomaly near the investigation location at a distance that the item will not produce a reading from the EM61-MK2 or the hand held magnetometer. If the magnetometer did not indicate that a ferrous anomaly source was present, no intrusive action will take place until after the anomaly location is checked with an EM61-MK2. If no anomaly source is located, the results of the investigation will be recorded in the field data collection device for that target ID.
4. If an intrusive action was taken, the Team Leader and a UXO Technician will enter the result of the intrusive investigation into the field data collection device and then check the investigation location with an EM61-MK2 to ensure that the source of the anomaly has been identified. **The UXO Technician will have undertaken training on operation of an EM61-MK2 and pass a test as described in the standard operating procedure (SOP) for EM61-MK2 Skills Determination Prior to Use.**
5. Anomaly inspection will continue to the point at which the Team Leader for the UXO team conducting the investigation feels the source of the anomaly has been identified or until the maximum prescribed investigation depth or the water table is encountered. For locations where the maximum investigation depth or water table is reached, the source of the anomaly may be left in place as a result.
6. If an intrusive action was **NOT** taken, the Team Leader and a UXO Technician will check the location with the EM61-MK2 and observe the maximum amplitude anomaly response (of the summed time gates). If the total is below the required action threshold, the anomaly will be considered a false positive. If the result higher than the action threshold, the location will be excavated to identify the source and Step 4 (above) will then be carried out.

1.4 Quality Control

- Inert MEC items (or surrogates if necessary) will be seeded in locations that are otherwise free of anomalies. The QC seeds will be placed at the site commensurate with the production rate of DGM such that one seed is encountered each day of data collection. The MR contractor must acquire, excavate, and recover the QC seeds.

1.5 Attachments

- None

Attachment E
Final Responses to EPA, PREQB, and FWS Comments

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Final Responses to

EPA Comments on the

Draft Master Sampling and Analysis Plan
East Vieques Terrestrial UXO Sites
Former Vieques Naval Training Range

Vieques, Puerto Rico
Dated, April 2012

Presented below are review comments on the *Draft Master Sampling and Analysis Plan, East Vieques Terrestrial UXO Sites, Former Vieques Naval Training Range, Vieques, Puerto Rico*; dated April 2012 (Master SAP).

General Comments

1. Worksheet #11 and Figure 13 identify the six step process that will be used to determine if munitions and explosives of concern (MEC) and munitions constituents (MC) are sufficiently delineated and characterized at each of the sites. However, the Master SAP does not discuss how the determinations will be made for each step. For example, in Step 2 (MEC), it is unclear how it will be determined that the MEC delineation warrants additional environmental media samples, nor is there a pathway to indicate the next step should additional MEC delineation not warrant additional collection of environmental media. As another example, for Step 4 (MC), it is unclear what factors will be used in the assessment of whole-site applicability to determine that results can apply to the entire site. Revise the Master SAP to provide greater detail for the decisions that will be made during the six step process.

   Navy Response:

   How the determinations are made for each step are described in the step-specific discussions on pages 81-84. Like any characterization determinations, "sufficient" is subjective, but will be reviewed and concurred upon by the stakeholder agencies through the Master SAP, Master SAP addenda, and associated reports.

   With respect to the Step 2 (MEC) portion of the comment, for each site, the Master SAP defines the sampling approach based on the stated objective of sampling in areas that can conservatively represent the site as a whole. To that end, the sampling rationale matrices (Tables 1 and 2) were generated. However, it is recognized that if additional MEC delineation activities occur subsequent to issuance of the Master SAP, the new information, when considered in the context of the sampling rationale matrices, may warrant additional samples to ensure the MC characterization objective is met. The Step 2 (MEC) simply provides for this possibility. If the post-SAP MEC delineation data, when plugged into the sampling rationale matrix, result in another area(s) that ranks high enough to warrant sampling, this information will be included in a SAP addendum and the samples (in addition to those already proposed in the Master SAP) collected. If not, no samples other than those already proposed in the Master SAP will be collected.

   Figure 13 has been modified to show a "No" pathway from the Step 2 (MEC) box. In addition, the last sentence of Step 2 (MEC) in WS#11 has been revised as follows: "Since the objective of MC characterization, at least initially, is to collect samples in areas that can conservatively represent the site as a whole, if additional MEC delineation data are gathered that suggest the areas where MC data were (or are planned to be) collected no longer conservatively represent the site as a whole, additional environmental media samples will be collected in accordance with a Master SAP Addendum (provided for review and approval by the regulatory agencies) in order to achieve the MC characterization objective."

With respect to the Step 4 (MC) part of comment, as stated variously within the Master SAP, the sampling approach is designed to sample "worst case" areas as a conservative representation of the site as a whole. Conservative results can be applied to the site as a whole, but it may not be appropriate to do so if it would lead to unintentional or unnecessary remedial action for areas of the site where it is not warranted (see first paragraph under "Step 4 (MC)-Whole Site Applicability Determination" in WS#11. Ultimately, the determination is inherently subjective, but as with the SAP and SAP addenda, the regulatory agencies have the opportunity to review the determinations made and associated rationale that will be provided in the site-specific reports. The PQO statement for Step 4 in WS#11 has been revised as follows: "If the results of the conservative nature and extent of contamination determination and associated risk assessment suggest they are not appropriate to apply to the site as a whole because, for example, they do not reflect actual site conditions, are determined to be too conservative, or may result in unintentional or unnecessary remedial actions at the site, collect additional samples in accordance with a Master SAP Addendum (provided for review and approval by the regulatory agencies) to refine the findings…"

EPA Evaluation of the Response:

The response does not address the comment. The step-specific discussions cited in the response do not provide sufficient information for how decisions will be made. Although the response indicates that the determinations of contamination sufficiency and whole-site applicability are subjective and will be presented for regulatory review and approval, the techniques used for the determinations should be discussed in the Terrestrial SAP. For example, the sampling rationale matrix that determines sampling sufficiency is not discussed in detail. Additionally, the response cites Table 1 and 2 for supporting information, but the tables do not appear to present sufficient detail or discussion to clarify how the determinations will be made for each step. In order to ensure that these determinations are appropriate and consistent for each site, and that the decision process is transparent, the techniques to be used should be clearly discussed. It is especially important for the public involvement at the site that these decision steps are clearly defined. Revise the Terrestrial SAP to provide further information on how the decisions presented in Worksheet 11 and Figure 13 will be made, including but not limited to, how the contamination sufficiency and whole-site applicability will be determined from the data collected. If this information will be presented in the SAP Addenda, revise the Terrestrial SAP to indicate this.

Navy Evaluation Response:

EPA (Michael Sivak) provided the Navy with the appropriate language to include to sufficiently address this comment via email on October 23, 2012.

The following paragraph was revised under Worksheet #11, the subheading Step 2 (MEC) – Determination of Additional MC Data Needs based on Additional MEC Delineation subheading of Worksheet #11: "…suggest the areas where MC data were (or are planned to be) collected no longer conservatively represent the site as a whole, for example, due to information that would suggest other areas potentially represent higher levels of site-related contamination or the potential release from MEC, additional environmental media samples will be collected in accordance with a Master SAP Addendum (provided for review and approval by the regulatory agencies) in order to achieve the MC characterization objective."

The last paragraph was revised under Worksheet #11, subheading Step 4 (MC) – Whole-Site Applicability Determination as follows: "…suggest they are not appropriate to apply to the site as a whole because, for example, they do not reflect actual site conditions, are determined to be too conservative, or may result in unintentional or unnecessary remedial actions at the site, collect additional samples in accordance with a Master SAP Addendum (provided for review and approval by the regulatory agencies) to refine the findings; otherwise, make a final evaluation of the adequacy of the data set (see Step 5) prior to preparation of the RI Report".

2. Worksheet #14 indicates that incremental samples will be collected and sent to the laboratory where the samples will be sieved, homogenized, and a subsample collected for inorganics before grinding. It is unclear how this subsample will be collected or why this will occur before drying and grinding. Further, it is unclear when subsamples for semivolatile organic compounds (SVOCs) and percent moisture analyses will be collected. Considering the particulate nature of the contaminants, it is recommended that the Master SAP be revised to indicate that subsamples for inorganics be collected after drying and grinding to ensure homogeneous subsamples are obtained. If concerned with potentially elevated inorganic results, subsamples before and after grinding may be considered. Revise the Master SAP to address these issues.

Navy Response:

Please refer to Worksheet #28-1 for specific details on the order of events. The general statement is "Prior to grinding for explosives (8330B and 6850), an aliquot is removed for hand grinding of metals (6010/6020, 7196), for hand grinding of semivolatiles (8270, 8270_SIM) if not done simultaneously with explosives, and for pH and TOC without grinding." WS#28-1 was further-clarified (revised) to indicate "hand-grinding" for metals and "hand-grinding" for semivolatiles if not "machine-ground simultaneously" with explosives.

Removal of an aliquot for hand-grinding of metals prior to grinding for explosives is proposed for consistency with the UXO-1 (ECA) RI, where it was approved by the regulatory agencies and worked well. An additional subsample was not collected after machine-grinding at UXO-1. Please note that an aliquot is not removed for percent moisture analysis. Results are reported on an "as-received" basis when the analysis is performed on soil that has been dried to a constant weight prior to analysis. For analyses which are performed on soil which is not dried, the results are reported on a dry-weight basis. The percent moisture is calculated based on the soil mass before and after drying to a constant weight.

EPA Evaluation of the Response:

The response partially addresses the comment. The response indicates that aliquots will be removed from the main sample for grinding for each of the analyses (metals, explosives, and semivolatile organic compounds [SVOCs]) and for general chemistry parameters, but the incremental sampling standard operating procedure (SOP) A-7 (Systematic Random Increment Sampling) indicates that the increments will be collected in a plastic bag and then split in the field into containers for the appropriate analyses. It is unclear which technique will be used, and how it will be ensured that representative subsamples will be collected from the plastic bag in the field or as aliquots collected in the laboratory. Additionally, it is unclear if the entire volume of soil in the sample bottle or aliquot will be dried and ground. Revise the Terrestrial SAP to clarify if incremental samples will be split in the field or at the laboratory through the removal of aliquots for each analysis and if the entire sample/aliquot will be dried and ground or if other measures will be taken to ensure the representativeness of the sample/aliquot.

Navy Evaluation Response:

Worksheet #14 and SOP A-7 are accurate and the methods discussed are similar to the collection methods recently conducted for the UXO 1 (ECA) RI. As subsamples are collected, the soil is placed in a Ziploc bag(s). All of the subsamples collected in the bag(s) that constitute the sampling unit are then placed into the laboratory supplied jars. As stated in the SOP, the soil is then homogenized in the laboratory rather than the field. To remove possible confusion, "as required by the applicable analytical method" has been removed from SOP A-7.

3. It is unclear why the number of subsamples per incremental sample is consistent across the site. Considering the variety of areas covered by the sampling units, it would be expected that the number of subsamples may need to increase, or could be decreased in some instances. Also, the SAP does not discuss why the numbers and locations of discrete samples were considered acceptable for each sampling unit. Further, the SAP does

not provide the rationale for why the location and size of each sampling unit was considered acceptable, or why the analyte list was proposed. Revise the SAP rationale to discuss why the proposed sampling approach was considered acceptable to meet the project goals at each sampling/decision unit.

Navy Response:

The number of subsamples per incremental samples was established by the Environmental Technical Subcommittee based on scoping discussions during the ECA RI SAP. The US Army Corps of Engineers guidance suggests a collection of 30 to 100 increments and that a higher number is selected for highly variable decision units. The Environmental Technical Subcommittee agreed that 100 subsamples are appropriate for each sampling unit due to the likely heterogeneous distribution of MC at the site. However, note that more subsamples may be collected if the soil layer is thin or poor recovery is obtained so that the target 1,000-gram sample mass is achieved (as discussed in WS #14). The fifth sentence of the first paragraph under "Incremental Sample Collection" in WS#14 has been revised to read: "Due to the quantity of soil needed for analysis (approximately 1,000 grams) and sampling device size, each sampling unit will have a target of 100 subsample soil plugs collected in approximately even distribution over the entire sampling area. This approach is consistent with what is recommended in the US Army Corps of Engineer guidance on incremental sampling (USACE, 2009)."

The rationale for the location and size of sampling units and the number and locations of discrete samples is provided in WS#17. As stated in the second paragraph under "Sampling Units" in WS#17, sampling units were generally 1 acre in size to account for receptors with smaller exposure areas (i.e., ecological receptors). This is the same sampling strategy approved by the regulators for the ECA RI.

Note that the locations of the sampling units and analyte rationale are provided throughout each site-specific WS#17 and detailed in Tables 1, 2, and 4 through 18. Sampling units were focused in the areas with the highest potential for contamination.

As discussed in WS#17, discrete deeper surface soil samples are based on receptor exposure scenarios, similarly as the sampling strategy for the ECA RI. Discrete subsurface soil samples are located within sampling units that are focused in areas with the highest potential for contamination and also at monitoring well locations. Discrete sediment samples and co-located surface water samples will be collected in depositional areas of lagoons.

EPA Evaluation of the Response:

As discussed in the response to PREQB comment 6, as agreed during the August 2012 ERP Technical Subcommittee meeting, initially, two subsurface samples will be collected within each sampling unit, where each subsurface sample will be located at areas of anticipated highest subsurface impacts. The data from the subsurface soil samples will be evaluated to determine the need for additional subsurface soil samples or if the subsurface is sufficiently homogeneous as to only require the collection of one subsurface soil sample for adequate characterization.

Navy Evaluation Response:

The appropriate worksheets have been revised to include the collection of two subsurface soil samples within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples within each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. The subsurface soil samples will be focused in areas with the highest potential for a subsurface release using a geophysical instrument-aided technique and deemed safe. Each subsurface soil sample will be collected in accordance with the modified Vieques protocol.

4. The Master SAP indicates that volatile organic compounds (VOCs), specifically hexachloroethane, will be analyzed. However, VOC analyses are not presented in the Master SAP and it appears that hexachloroethane will be analyzed as a semivolatile organic compound (SVOC). Revise the Master SAP to clarify this.

Navy Response:

Hexachloroethane is a specific compound; the terminology "VOCs" and "SVOCs" is simply used to indicate whether the compound is analyzed as a purgeable or an extractable. In this case, hexachloroethane is analyzed as a SVOC so that it is not necessary to add an additional preparation and analysis method for one compound. SVOCs analysis (for more than just hexachloroethane) is needed at some sites and hexachloroethane can reliably be analyzed as a SVOC. As requested, the UFP-SAP was updated, as appropriate, to refer to "SVOCs (hexachloroethane-only)" instead of VOCs.

5. Hexachloroethane from smoke canisters was noted a contaminant in the Master SAP. However, potential breakdown products of hexachloroethane, including smaller chain chloroethanes and chloroethenes, are not proposed for analysis. Revise the Master SAP to clarify why potential breakdown products or hexachloroethane will not be analyzed in areas where smoke canisters were used.

Navy Response:

The following has been added under WS #17o, Sampling Approach, second paragraph, after the third sentence: "Note that most of the hexachloroethane in a smoke canister is used up by the smoke producing reaction and less than 5% may remain after the smoke has formed. Although hexachloroethane may adsorb to soil, volatilization is expected to be the major transport pathway within shallow soil. Note that chemical hydrolysis is not expected and the biotransformation of hexachlorethane in soil has not been well established (ATSDR, 1997 and Howard, 1989). Therefore, analysis of hexachloroethane breakdown products is not warranted."

The following references have been added to the References section:

ATSDR, 1997. Toxicological Profile for Hexachloroethane. September.

Howard, 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume 1. Lewis Publishers. April.

EPA Evaluation of the Response:

The response addresses the comment. However, the Terrestrial SAP should be revised to indicate that if uncombusted smoke canisters are encountered, a SAP addendum will be prepared to include the analysis of volatile organic compounds (i.e., hexachloroethane and its breakdown products). Revise the Terrestrial SAP to include this contingency.

Navy Evaluation Response:

Note that each site-specific Worksheet #17 states that "if information gathered during future munitions-related activities necessitates a modification to the UXO site soil characterization approach contained herein, the modification will be presented in an addendum to this SAP".

6. The Master SAP indicates that subsamples for each incremental sample will be obtained using a systematic random sampling procedure. However, no further information or discussion on this topic is presented. Revise the Master SAP to provide additional discussion on how the locations of the subsamples will be determined, specify the grid sizes, and discuss how grids will be developed and marked in the field.

Navy Response:

Subsamples will be collected in a manner similar to what was conducted for the ECA RI. Note that WS#14 discusses that subsamples will be collected in approximately even distribution over the entire sampling unit area. However, the following sentence has been added after the fourth sentence under "Incremental Sample Collection" in WS#14: "Each 1-acre sampling unit consists of four quarter-acre grids that were

used for munitions characterization. The coordinates of each quadrant are located in the field using a GPS. In general, 25 subsamples will be collected along four transects within the quarter-acre grids."

7. The data management, reduction and reporting discussions in the Master SAP are insufficiently detailed. For example, it is unclear where hardcopy project documents will be stored and where the project database will be maintained (e.g., physical locations). It is also unclear how long project documents and the database will be archived before disposal. For example, Worksheet #11 indicates that the data will be stored and archived in accordance with the Navy CLEAN program/contract, but the Master SAP does not define the storage and archive requirements. Additionally, it is unclear if the qualified data that is uploaded to the database will be verified. Revise the Master SAP to provide greater detail regarding the data management, reduction and reporting tasks as per Section 3.5, Data Management Tasks, of the Uniform Federal Policy Quality Assurance Project Plan Manual, dated March 2005 (UFP QAPP Manual).

Navy Response:

After completion of the project, project documents required to be maintained will be stored at the Federal Records Center (FRC) in Suitland, MD:

Washington National Records Center
4205 Suitland Road
Suitland, Maryland 20746-8001

This statement and the physical address have been added to the bottom of WS#29. The project database (i.e. NIRIS) is maintained by the Navy.

The 10% check described on WS#37 refers to the 10% check between hardcopy and EDD. For clarity, the description has been revised to: "Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check). The check will verify results and qualifiers."

The qualified data uploaded to the database will be verified. As part of the data-loading process, a 100% check is performed on all changes made during data validation (numerical changes, qualifiers added, best-result selection, etc.). A row has been added to WS#34-36 (below 'Electronic Data Deliverables'). The data review input is "Electronic Data Deliverables." The description is: "Electronic Data Deliverables will be compared against data validation reports and marked-up Form 1s (100% check of all changes made during data validation)." The project chemist is responsible for verification. It is Step I. It is external.

EPA Evaluation of the Response:

The response partially addresses the comment. The response does not indicate where all of the project files are maintained during the investigations (e.g., location of the project file) and how long the database and the project documents will be archived at the Federal Records Center before disposal. Revise the Terrestrial SAP to provide this information.

Navy Evaluation Response:

EPA will be provided the required reports in accordance with the SAP; it is anticipated that the Navy will not dispose of project documents.

8. Worksheet #28 indicates that field duplicates and triplicates will be collected at a frequency of one per ten normal field samples per matrix, and one matrix spike/matrix spike duplicate (MD/MSD) sample will be collected per 20 normal field samples per matrix. However, some of the numbers of field quality control (QC) samples identified in Worksheet #20 are not consistent with these frequencies. For example, only two field duplicates are identified for the 23 groundwater samples, but three field duplicates should be identified for a frequency of one per ten samples. Revise Worksheet #20 so that the number of QC samples proposed is consistent with the frequencies identified in Worksheet #28.

Navy Response:

WS#20 has been corrected. The number of groundwater field duplicates has been updated from 2 to 3. The number of MS/MSD pairs has been updated from 1 to 2. The total number of samples has been updated from 40 to 44. Please note that with time, the actual number of samples and associated QA/QC will likely change. However, WS#28 provides the frequencies to which the field team will adhere regardless of the total number of samples actually collected.

EPA Evaluation of the Response:

The response appears to address the comment; however, please note that the example given was one case and other numbers of quality control (QC) samples in Worksheet 20 may need to be updated (e.g., for the subsurface soil samples collected from groundwater monitoring well locations). Ensure the Terrestrial SAP revises all of these cases to be consistent with the frequencies in Worksheet # 28.

Navy Evaluation Response:

Comment noted. The number of QA/QC samples have been revised based on the recent addition of new samples.

9. Worksheet #9-1 – Project Scoping Session Sheet, states "… the investigation approach should start by conducting a munitions constituent release assessment. Additional investigation may be necessary if the release assessment suggests full nature and extent investigation is warranted." It is agreed that the proposed approach in the Sampling and Analysis Plan (SAP) is not a nature and extent investigation in the classic sense, but instead, is simply an investigation designed to determine if releases have occurred and at what magnitude. The Worksheet indicates that further nature and extent investigations may occur, but does not discuss the specific steps that will be utilized to define the nature and extent. For example, Figure 13, MEC and MC Remedial Investigation Decision Process, indicates after Step 4 that Vieques will "collect additional samples, refine the understanding of nature and extent of MC, refine risk assessments accordingly, and return to Step 4 (MC)." It is not clear what is involved in the phrase "collect additional samples, refine the understanding of nature and extent of MC" – namely, how will additional samples be collected (incremental, discrete), where will additional samples be collected (inside the same sampling unit, step-outs from the existing sampling units, or in altogether new sampling units), and how will the extent of contamination be "refined"? This issue was discussed in the May 7, 2012 team meeting and the Navy stated that if contamination was detected at the UXOs, an addendum to the Master SAP would be prepared and additional sampling would be performed. The Navy also stated that additional text would be added to the SAP to clarify this issue. Revise the discussion of the recommended approach to provide clarification on this issue as discussed during the May 7, 2012 team meeting.

Navy Response:

The May 2012 Technical Subcommittee Meeting Minutes have been added as WS#9-6 as it occurred after submittal of the Draft Master SAP. Please also see the response to General Comment #1.

10. The depths at which metal anomalies and munitions-related items were found within each of the parcels (UXO sites) are not indicated. For example, in UXO 2, LIA Beaches, 7,204 subsurface metal anomalies as well as 49,367 munitions-related items were identified and removed. However, it is not clear from what depths all of these items were removed. ``Provide an explanation how the proposed vertical discrete samples are adequate to define the vertical extent of contamination in the sampling units considering the munitions-related items which have been identified and removed from the units.

Navy Response:

The depths of the anomalies or munitions-related items and subsurface soil sample rationale have been added to each site-specific WS#17. Note that, with respect to depth of collection, subsurface soil samples will be collected in accordance with Vieques protocols.

EPA Evaluation of the Response:

As agreed during the August ERP Technical Subcommittee meeting, the subsurface soil sampling protocol will be revised to be consistent with the Master SAP SOP and text will be added to the SOP indicating that subsurface soil samples will coincide with depth and location at which MEC was identified and removed or at depth and location of highest anomaly readings.

Navy Evaluation Response:

Please see the response to General Comment 3.

11. Worksheet #14, Discrete Soil Samples. The depth of subsurface discrete soil samples are proposed at different depths in different UXO sites. For example, subsurface discrete soil samples will be collected from a depth interval of 18-24 inches with the UXO 2 site, and from a depth interval of 12-24 inches within the UXO 4 site. It is unclear if these depth differences are due to the fact that some of the samples may be fringe samples while others are beach samples, or if other factors account for the differences. Provide an explanation as to why different depths were selected for subsurface discrete soil samples at different UXO sites.

Navy Response:

Note that discrete **deeper surface** soil samples (not subsurface soil samples) are proposed at the beaches at UXO 2 (from 18-24 inches) and at the lagoon fringes at UXO 4 (from 2.5-24 inches) to represent the exposure scenario for turtle nesting and land crabs, respectively, as discussed in the Master SAP (e.g., see first sentence under "Discrete Soil Sampling Design and Regional Groundwater Characterization" in WS#17 and see the fifth sentence of the third paragraph under "Sampling Approach" in WS#17a). However, these samples will also be used to assess the vertical extent of contamination.

Discrete subsurface soil samples will be collected in accordance with the Vieques Master Protocols as agreed upon during the May 2012 Environmental Technical Subcommittee meeting. The Master SAP has been updated to reflect this information. Note that this includes subsurface soil samples at each monitoring well location. Since issuance of the Draft Master SAP, six additional subsurface soil samples have also been added within the OD area of UXO 4.

EPA Evaluation of the Response:

The response partially addresses the comment. It is understood that the sampling depths and the potential for data gaps in the characterization of the nature and extent of contamination were discussed at length during the Environmental Restoration Program (ERP)/Munitions Response Program (MRP) Technical Subcommittee Meeting on August 27, 2012. Additionally, the response to GC 11 indicates that the proposed discrete deeper surface soil samples at the UXO 2 beaches will be collected from 18-24 inches. In the RTC for GC 29, the Navy indicates the range will be expanded from 18 – 36 inches. Ensure that the stakeholders' final decision on surface and subsurface soil sample depth intervals is reflected in the updated SAP.

Navy Evaluation Response:

Discrete surface soil samples at the beaches will be collected from 18 to 36 inches.

12. The installation of 23 new monitoring wells is discussed in Worksheet #14, Summary of Project Tasks, as well as in Worksheet 17, Discrete Soil Sampling Design and Regional Groundwater Characterization, page 109. The second paragraph on page 109 states "A total of 23 regional monitoring wells will be installed to determine if a release to groundwater has occurred." However, none of the parcel-specific worksheets within SAP Worksheet #10- Problem Definition, or those within Worksheet #17- Sampling Design and Rationale, describe the monitoring wells that will be located within the decision unit even though groundwater is frequently identified as a potential transport pathway. For the sake of completeness, it is recommended that each UXO parcel be updated to include a discussion of the location and purpose of the monitoring wells that will be installed within each decision unit.

Navy Response:

Please note that groundwater will be evaluated on a regional basis, which is why the wells were not discussed on a site-by-site basis. Please see the second paragraph under "Discrete Soil Sampling Design and Regional Groundwater Characterization" in WS#17 and Table 3 for the rationale for their locations. WS#17 has been revised to indicate the number of monitoring wells planned by site.

13. The terms "MEC (munitions and explosives of concern) avoidance" and "UXO (unexploded ordnance) avoidance have been replaced by the term "anomaly avoidance" in the Department of Defense Ammunition and Explosives Safety Standards (DoDM 6055.09-M). Although NAVSEA OP 5, Volume 1 (Naval Sea Systems Command Ammunition and Explosives Safety Ashore, Volume 1) states in the definition of anomaly avoidance that, "Anomaly avoidance is sometimes referred to as UXO avoidance," the term "anomaly avoidance" is the currently accepted term per the cited DoD standard. Replace all occurrences of the term "UXO avoidance" with "anomaly avoidance."

Navy Response:

Revisions have been made throughout the document in accordance with the comment.

14. The explosives sampling activities noted in the plan do not indicate that samples were analyzed for Explosives D (ammonium picrate). Explosive D was the energetic filler of the Navy projectiles 5-inch and over, as well as the Army/Marine Corps APC (armor piercing-capped) projectiles (sometimes incorrectly referred to as APHE [armor piercing high explosive]) that were in use during a significant portion of the active period of the ranges at Vieques. Although Explosive D is relatively insensitive, its degradation products can be much more sensitive. This can present a safety related issue with projectiles if they have undergone any conditions that allow moisture to react with the filler and other materials (particularly oxidizers or metals) that may be present.

    The list of analytes does not appear to include Explosive D. As there is a potential for Explosive D to be present in target areas suspected to have been subjected to Naval gunfire, particularly if breached projectiles are present, provide the justification for this omission or include Explosive D in the list of analytes as necessary.

Navy Response:

Because the types of armaments containing Explosive D (ammonium picrate) likely were utilized on Vieques, the Navy will consider adding this constituent to the analyte list. However, because there are no widely accepted human health or ecological screening levels for this analyte, there will be no PALs established; the laboratory will report the results at its reporting limit.

15. Some of the figures provided with this plan show a tan rectangle in the legend that is to be used to identify "craters." It appears that tan circles are used instead. As this is somewhat confusing, revise the figures to use a consistent shape to represent craters on the figures.

Navy Response:

The crater symbols in the legends have been revised to circles.

16. The documents found in Appendix D, Standard Operating Procedures, contain no warnings, procedures, or references concerning the fact that the areas where many of the samples are to be taken may be contaminated with surface and/or subsurface MEC, and anomaly avoidance procedures will be required. Although they do generally reference the Health and Safety Plan and advise the samplers to wear all appropriate personal protective equipment, no mention of the MEC potential is made. Correct this omission in an appropriate manner.

Navy Response:

Standard operating procedures (SOPs) are designed to provide a standard procedure for sampling and investigation procedures to avoid lapses in quality. Avoidance and safety measures for MEC and anomaly avoidance are detailed in the Health and Safety Plan (HSP), the Activity Hazard Analysis (AHA), and the site Explosive Safety Submission (ESS).

17. The Master SAP references the Federal Register 23, October 1981, Volume Number 46, No. 205, and NRC guidelines entitled Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproducts, Source, or Special Nuclear Material, which includes an unrestricted use criterion for U-238 of 35 PicoCuries per gram (pCi/g). However, the Master SAP does not state what exposure scenario and dose was used in the NRC regulations to establish the 35 pCi/g limit. Therefore, use of this standard is not justified as it does not demonstrate that it would equate to an industrial worker scenario for which the risk would not exceed the CERCLA risk range of 10E-04 to 10E-06. It should be noted that according to EPA OSWER Directive 9200.4-18, dated August 22, 1997, (EPA guidance on protective cleanup levels for sites with radioactive contamination at CERCLA sites) a dose-based limit of 15 millirems per year (mrem/yr) Effective Dose Equivalent (EDE) should generally be the maximum dose limit for humans, equating to approximately 3x10-4 risk. While the 15 mrem/yr limit slightly exceeds the CERCLA risk range, EPA considers this dose limit generally protective and consistent with regulations and guidance developed by EPA in other radiation control programs. Since the preliminary remedial goals (PRGs) provided in Appendix C are based on radionuclide concentrations in soil and groundwater corresponding to a 10E-06 excess lifetime cancer risk, it may be more appropriate to delete reference to the NRC guidelines. Alternatively, additional justification will need to be provided to include the NRC guidelines as meeting CERCLA cleanup/risk requirements. Revise the SAP to justify all references to radionuclide concentration limits to CERCLA and EPA guidance as the basis for human exposure limits for radiation work at the East Vieques Terrestrial UXO Sites.

Navy Response:

Reference to the NRC regulatory framework has been removed from the SAP. The SAP has been revised to reflect the available concentration limits based on CERCLA guidance, specifically the radionuclide PRGs. As mentioned in Comment 23, the human health-risk based screening levels for radionuclides presented in Table 1 appear appropriate.

18. In accordance with the Nuclear Regulatory Commission (NRC) standard in Title 10, Section 20.1003, of the Code of Federal Regulations (10 CFR 20.1003), the Master SAP should state that all potential exposures/doses should be maintained as low as reasonably achievable (ALARA) during all investigation activities. Revise the Master SAP accordingly.

Navy Response:

Safety requirements are not included in the SAP; they are included in the project-specific HASP. Note that the 2000 NRC Environmental Survey at the site concluded that radiation levels were associated with background, except within the immediate vicinity of each individual penetrator. Munitions avoidance will be practiced for the majority of the investigation activities. If a penetrator is encountered during the depleted uranium survey, the Navy will contact the Radiological Affairs Support Office (RASO) and work will stop until the item is removed by RASO or their designee.

19. Worksheet #17 of the Master SAP states that a gamma walkover survey will be conducted using a sodium iodide detector in the depleted uranium area. However, the SAP lacks sufficient detail about the detection capability of the proposed sodium iodide detector/gamma detection system to determine whether the screening levels provided in the Appendix C Table C-1 can be detected with such a system, or whether an alternate screening level is proposed for the gamma scanning survey. Information that should be provided includes the detector's scanning Minimum Detectable Activity (MDA) in counts per minute (CPM), with information relating the CPM to an activity concentration that demonstrates the detection system is adequate to identifying uranium contamination above background levels. Guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) may be referenced for information about conducting characterization surveys, calculating instrument MDAs/Minimum Detectable Concentrations (MDCs), considering the uncertainty, detector size, scanning speed, geometry factors, and other considerations. Revise the Master SAP to provide specific information about the design and adequacy of the gamma survey in meeting the project objectives for identifying depleted uranium (uranium above background levels) at the East Vieques Terrestrial UXO Sites.

Navy Response:

The sodium iodide detector is not intended to measure values to compare to the screening levels in Appendix C. The instrument will be used to potentially locate individual penetrators not found during the previous NRC study. If a penetrator is found, soil sample locations will be adjusted to that item to provide the most conservative release evaluation at the site. Environmental media samples will only be compared to the Appendix C screening levels. The SOPs related to the operation of the Ludlum Model are provided in Appendix D. The instrument is capable of measuring typical background values (5-15 uR/hr) to 5,000 uR/hr (as stated in WS#14) and is commonly used in radiological investigations. This clarification has been added to WS#17.

EPA Evaluation of the Response:

The response partially addresses the comment. The Terrestrial SAP should state what level of radioactivity/ readings in micro-roentgens from the Ludlum Model 19 Micro R Meter will be used to indicate the potential presence of a penetrator. For example, the Terrestrial SAP may state that a reading on the Micro R Meter that is greater than 2X the average background level of radioactivity will be used to indicate the potential presence of a penetrator. Additionally, since the Manufacturer's Operation Manual does not provide step-by-step instructions for checking the calibration and operating the Micro R Meter, the Terrestrial SAP has not provided sufficient documentation that demonstrates the instrument will be operated properly. The Terrestrial SAP has also not documented what qualifications or training will be required for the operator of the instrument. This information should be provided to ensure the survey meets the project requirements for identification of

penetrators at the site. Additionally, the revised Worksheet 17 has not been provided for review to confirm that the proposed text modifications were incorporated.

Navy Evaluation Response:

The last sentence of the second paragraph under the Depleted Uranium Area subheading of Worksheet #17c has been revised as follows: "If during the radiological survey radiological measurements above background are observed (greater than 2-times the average background), discrete surface and subsurface soil samples will be focused in areas with radiological measurements above background.

As discussed above, the SOPs related to the operation of the instrument are provided in Appendix D and are appropriate for this level of investigation. However, additional instrument procedures have been added to SOP C-4 as follows:

First bullet under Documentation of Field Calibration Check - "The Micro R Meter will be calibrated with a cesium 137 check source. The meter will be calibrated and operated in accordance with the manufacturer's calibration and operation procedures in the manual, Section 2, operational check".

Sixth bullet – "Switch the AUD ON/OFF switch to the ON position and confirm that the external unimorph speaker produces an audible click for each event detected. The AUD ON/OFF switch will silence the audible clicks if in the OFF position. It is recommended that the AUD ON/OFF switch be kept in the OFF position when not needed in order to preserve battery life".

The following has been added as the last sentence under the Radiological Survey subheading of Worksheet #14: "Operators of the meter will be trained in calibration and operation of the meter prior to use".

20. Much of the detailed information pertaining to analytical detection limits and quality control requirements for the analysis of uranium isotopes has not been included in the Master SAP worksheets. This information should be provided to ensure the data meets the data quality objectives for the project, for identifying depleted uranium. Revise the Master SAP to include all analytical quality control information prior to initiating this project.

Navy Response:

Radiological uranium analysis has been described generically in this document because most of the specifications are laboratory-specific. The requested information (chemistry worksheets) will be provided as part of a laboratory-specific addendum corresponding to associated field effort(s). For example, the first Master SAP addendum, corresponding to groundwater and subsurface soil samples at monitoring well locations is in preparation for regulatory review, and it contains laboratory-specific worksheets for analysis of radiological uranium.

21. At each lagoon area, one sampling unit and associated deeper surface soil sample will be collected from the fringe area. Ensure that site figures clearly shows this sampling unit, as currently each sample location is only denoted by an orange triangle which indicates the collection of a deep surface soil sample, not an incremental surface soil sample.

Navy Response:

The figures do include the lagoon fringe sampling units, but have been made clearer to better denote the sampling units.

22. Only one subsurface sample is proposed for collection at many of the lagoon areas to evaluate potential exposure to the land crab. However, it is unclear how it was determined that only one discrete subsurface sample is adequate to characterize the lagoon fringe area. Further, it is recommended that, at a minimum, fringe samples be collected from areas where ephemeral streams enter the lagoon, as there is a potential for surface transport of contaminants from these areas.

Navy Response:

Lagoon fringe sampling units have been revised to be one acre in size where possible (note that some lagoons have fringes less than an acre), which also results in additional discrete deeper surface soil samples to be collected (note, these are not discrete subsurface samples – please see response to General Comment #11). In addition, discrete deeper surface soil samples have been moved to areas where ephemeral streams enter the lagoons, as applicable.

23. Please include the names of all lagoons on the individual UXO figures, along with the ephemeral streams, clearly showing where the streams are entering various water bodies.

Navy Response:

The applicable figures have been revised to more clearly show lagoons and ephemeral streams. However, please note that not all lagoons have names.

24. In the Worksheet 10 series, the Conceptual Site Model, Physical Characteristics and Transport Pathways, should clearly indicate whether there is a groundwater pathway to the lagoons. In UXOs with multiple lagoons, indicate whether groundwater discharges to all lagoons or just one of the lagoons. For example, there are three lagoons at UXO 4, yet the description indicates that "groundwater discharge . . . temporarily discharge to the lagoon." Similarly there are six lagoons at UXO 9, but the statement discussing groundwater discharge only appears to apply to a singular lagoon.

Navy Response:

The descriptions in WS#10c (UXO 4) and WS #10h (UXO 9) have been revised to be plural “Groundwater discharge is to the ocean and believed to temporally discharge to the lagoons since the lagoons are periodically dry.” This statement has also been added to WS#10k (UXO 12), WS#10l (UXO 13), and WS#10m (UXO 14).

25. Soil background data are not available for the beaches, nor are background sediment and surface water data available for the UXO lagoons. It is indicated that representative background data will be collected from appropriate representative locations, however further information regarding this sampling event is not provided. Background samples from the beach area should represent both surface and subsurface soils to appropriately characterize human health and ecological exposure pathways. As per Worksheet #11 (page 83) this information is necessary to determine whether a release has occurred. A SAP for this background sampling event should be provided.

Navy Response:

WS#17 is correct in that background data for the beaches will be compared to the adjacent terrestrial lithologic unit background data, similar to what was done for the ECA RI. However, the sentence has been modified to read “Since background data are not available for the beaches, a multiple lines of evidence approach will be used to evaluate potential inorganic releases at the beaches, such as using the adjacent terrestrial lithologic unit surface and subsurface soil from the background study. If necessary, background

data could be collected from a representative background beach(es), if identified. If a representative background beach(es) is identified, it will be included in an addendum to the Master SAP for regulatory review." In addition, the third sentence of the third paragraph following the bullets under "Objectives and General Characterization Approach" in WS#10 has been revised to: "Since soil background data are not available for the beaches, soil background data will be compared to the adjacent terrestrial lithologic unit background data or to data collected from a representative background beach(es), if identified. If a representative background beach(es) is identified, it will be included in an addendum to the Master SAP for regulatory review." This information has also been added to fourth bullet under "What are the Project Action Limits (PALs)?" in WS#11.

EPA Evaluation of the Response:

The response partially addresses the comment. The original comment states that "Background samples from the beach area should represent both surface and subsurface soils to appropriately characterize human health and ecological pathways". The response to this comment does not clearly state that both surface and subsurface background data will be used for comparison. It is therefore recommended to include surface and subsurface data for comparison to beach data regardless of whether a reference beach is identified or adjacent terrestrial lithologic unit background data are used in the background comparisons.

Navy Evaluation Response:

Both background surface and subsurface soil will be used for comparison to beach data and has been added to the appropriate worksheets.

26. Worksheet #14, Radiological Survey. Background radiation levels will be established on-site from an unaffected area. However, as discussed above, a SAP should be prepared detailing the referenced background radiological survey. The SAP should be submitted to the Agencies for review and approval.

Navy Response:

The background radiological survey only includes measurements from the Ludlum Meter and not the collection of background soil samples. As discussed in WS#17c, the ratios of the uranium isotopes will be used to distinguish between depleted and natural uranium levels. For the purposes of the radiological survey, background will be established away from the potential depleted uranium area. This has been clarified in WS#14.

27. Worksheet #17 - Sampling Design and Rationale. The discussion of incremental sampling indicates that sampling will focus on the top 2 inches of soil (page 108); however the discussion of incremental sampling on Worksheet #14 indicates that samples will be collected from the top 2.5 inches (page 89). Please clarify.

Navy Response:

WS#17 has been revised to "approximately the top 2.5 inches."

28. Worksheet #17 - Sampling Design and Rationale. In the discussion of the Background Dataset (page 109), it is indicated that "soil background data for the beaches will be compared to the adjacent terrestrial lithologic unit for the background study." Please clarify.

Navy Response:

Please see the response to Comment #25.

EPA Evaluation of the Response:

The use of soil background data in the same terrestrial lithologic unit appears to be appropriate, although PREQB has indicated that terrestrial soils are expected to have higher concentrations of metals than beach sands; therefore, concentrations of metals identified in soil samples collected from beaches may be within the range of background for terrestrial soils but may still be considered elevated. This response does not address the concern regarding background sediment and and surface water data for the UXO lagoons. Please address this part of the comment.

Navy Evaluation Response:

Note that the original comment is on clarification of soil background data for the beaches. As discussed in Worksheet #17 under the Background Dataset discussion it is stated that "Surface water and sediment samples will be compared to background data collected from a similar lagoon (if one is identified) or, in the absence of a representative background dataset, a weight-of-evidence evaluation will be used, as was done for the UXO 1 RI.

In the response to PREQB, the appropriate worksheets have been revised to indicate that a multiple lines of evidence approach will be used to evaluate potential inorganic releases at the beaches. One line of evidence would be to compare the beach soil data to the adjacent terrestrial lithologic unit background data. If the multiple lines of evidence approach is unclear, background data would be collected from representative background beach(es), if identified, and would be included in an addendum to the Master SAP for regulatory review.

General Comments - UXO 2 - LIA Beaches, Pages 41-42; 111-112

29. The last paragraph in the section on Land Use in Master SAP Worksheet #10, page 38, suggests that the sea turtle species potentially nesting on the LIA Beaches include green, leatherback, and hawksbill turtles. The Sampling Approach for UXO 2 on page 112 indicates that the discrete deeper (18-24 inches) soil samples are to be collected to represent the depth of turtle egg nests. The mean nest depth of leatherback sea turtles (Dermochelys coriacea) is reported to be 70 -75 cm (27.56-29.53 in) (Billes and Fretey 2001, Conrad et al 2011) with some eggs laid at depths more than 90 cm (Lum 2004, Ernst and Lovich 2009, pg. 161). The section on Physical Characteristics and Transport Pathways, page 42, states that the groundwater is shallow. It may be possible that the water table in the potential nesting area is a limiting factor for sea turtle nest depth (Wood and Bjorndal 2000), but it is unclear if that is true for this location. While the nesting depths can be highly variable and the proposed discrete sampling depth would likely capture the soil present at nesting depths of hawksbill (Eretmochelys imbricata) and green (Chelonia mydas) sea turtles, additional sampling at greater depth should be considered to determine if contaminants are present at typical nesting depths of leatherback sea turtles. As these beaches have been monitored for turtle nesting by FWS Vieques NWR and the Navy, the Navy should verify which turtles are predominantly using these beaches, as well as the depth of turtle nests. An additional discrete sample at 32-36 inches for leatherbacks may be recommended to characterize their exposure.

Navy Response:

Considering the variability of nesting depths that occur amongst the three turtle species (hawksbill, green, and leatherback sea turtles), the depth interval of the discrete deeper surface soil sample will be expanded to range from 18 to 36 inches. The lower end of this depth interval may be adjusted in the field should conditions be found unsuitable for sea turtle nests, such as the presence of groundwater, clay, or bedrock.

In WS#10a, page 42, the third sentence in the last paragraph has been replaced with the following:

"The primary potential ecological receptors are the eggs of hawksbill, green, and leatherback sea turtles exposed to deeper surface soil (18 to 36 inches)."

In WS#17a (UXO 2), Sampling Approach, the third sentence in the third paragraph has been modified to update the discrete deeper surface soil depth to "(18 to 36 inches)."

30. Because of the dynamic nature of sandy beaches and coastal dune habitats, the soil surface is constantly changing due to wave and wind action. As mentioned in the section on Physical Characteristics and Transport Pathways, page 42, this habitat characteristic poses a potential migration pathway. Additionally, the section on Future Land Use and Potential Receptors on page 42 identifies potential terrestrial receptors for surface soils to include terrestrial plants. Provide an explanation as to why sampling at subsurface depths between 2.5 inches and 18 inches were not included considering the dynamic conditions of the coastal zone as well as potential contaminants in the root zone of plants found in the area. Include a description of the plants likely to be found in this area along with their respective root zone.

Navy Response:

The proposed approach of using only surface soil data collected via incremental sampling (0 to 2.5 inches) for evaluating potential risk to terrestrial plants is consistent with the regulatory-approved approach used for UXO 1 (Eastern Conservation Area). For UXO 1, incremental samples were collected from upland, lowland, lagoon fringe, and beach habitats, and were considered sufficiently representative of exposure to terrestrial plants. Uncertainty regarding distribution of potential contaminants within the soil profile in any of these habitats was considered by the stakeholder agencies during the development/approval of the UXO 1 sampling approach; therefore, it is reasonable to continue with the same approach for assessing terrestrial plants in similar habitats (e.g., beaches) at all other UXOs.

The beach sampling unit extends from the waterline to approximately 60 feet inland from the edge of the beach vegetation line. At most beaches, there is a wide zone of open sandy beach devoid of vegetation because of the dynamic marine environmental conditions (e.g., tidal fluctuations, waves, wind, salt spray, shifting sand). Since no plants occur in this zone, collection of a discrete deeper soil sample for assessment of plant root exposure is not warranted. Beach vegetation begins at the upper end of the beach where soil conditions are more stable because of lessened direct impact from the coastal marine environment. The reason for extending the beach unit 60 feet into the dense vegetation is to incorporate the nesting area of the hawksbill sea turtle; the remaining sea turtle species generally prefer the open sand zone. Since soil is relatively stable in this vegetated zone, it remains appropriate to assess potential risk to plants from surface soil (0 to 2.5 inches) collected using just the incremental sampling approach, as is proposed in all other terrestrial habitats within each UXO. An evaluation of beach plants and their individual root zones is therefore not necessary.

General Comments - UXO 4 - LIA Interior, Pages 45-47; 115-117

31. The section on Future Munitions Activities on Page 115 indicates that the surface clearance of the high density submunitions area is awaiting approval, but it does not address the 22 acres of lagoon areas that previously were not cleared as part of the Time Critical Removal Activity (TCRA) due to the presence of standing water. The ephemeral nature of the lagoon areas should allow for clearing of MEC during dry periods. These lagoon areas may represent important pathways for contaminant migration to groundwater and the ocean. During the May 7, 2012 team meeting, the Navy commented that while Laguna Icacos and Laguna Gato periodically dry out, portions of Laguna Anones are perennially submerged. Revise the Master SAP to clarify if the 22 acres of lagoon areas not previously cleared are perennially submerged. If the referenced 22 acres are not perennially submerged, provide the surface clearance plan and anticipated timeframe for clearing these areas.

Navy Response:

The following has been added at the end of the first paragraph: "The TCRA activities are complete for the 9 acres of the steep slope areas since this area is inaccessible and for the 22 acres of Laguna Anones since this area is perennially submerged."

32. Figure 31a, Central UXO 4 Sampling Approach, illustrates the location of the 16 sampling units and 16 discrete subsurface soil samples in the central portion of UXO 4. Several grids within the airstrip region are identified as having a substantially higher number of digital geophysical anomalies; however, no sampling units are proposed in those areas. Additionally, the decision unit outlined in Figure 31a appears to have a high number of craters that were not selected for incremental sampling as part of the field investigation. Provide a detailed narrative description outlining how the different areas throughout the unit were ranked for sampling, and how the data presented in the ranking tables (e.g., Tables 4 and 6) were used in selecting and locating the sampling units.

Navy Response:

Note that the DGM data only provide the number of anomalies detected and not the type of item or the quantity. The sampling units in the airstrip region are positioned in areas with the highest density of munitions observed on the surface. The subsurface density of munitions has frequently been observed to be less than the surface on the Former VNTR. Therefore, it is more conservative to focus sampling units in areas of high density munitions than on high density geophysical anomalies.

Tables 4 through 18 have been updated to provide the rationale in its order of importance for each of the sampling units. Note that the craters were considered a minor line of evidence relative to the other categories.

33. Figure 31d, UXO 4 Southwest Sampling Approach, shows a large density of MEC and/or munitions scrap was identified near Target Area, T1. Provide a discussion why a sampling unit was not selected for the UXO 4 Southwest Sampling Approach near Target Area, T1.

Navy Response:

Note that a number of sampling units are located at numerous targets with high densities of munitions within other decision units of UXO 4. However, one sampling unit has been added at the target referred to in the comment. In addition, since the Northwest UXO 4 decision unit ranks similar to the Southwest UXO 4 decision unit (Table 1a), one sampling unit has also been added there (see revised Figure 31c).

34. An open burning pit is located east of the northern portion of Lagoon Anones. According to the sampling approach and Figure 31f, UXO 4 Laguna Anones Sampling Approach, planned soil sampling locations along the Lagoon Anones Fringe do not include a discrete deeper soil sample on the eastern side of the lagoon. Additionally, the sediment and surface water sampling approach also does not include a location on the eastern side of the lagoon near the open burning pit. Figure 15, LIA Conceptual Site Model, suggests that overland flow generally occurs from the Naval Gunfire Support Target Area towards Lagoon Anones and that the prevailing wind direction is southwest. Because of the location of the open burning pit and the direction of flow for the transport pathways, soil and surface water sampling should be considered along the eastern side of the Lagoon Anones Fringe and within the eastern portion of the lagoon. In addition, the physical management of wastes within the open burning and open detonation (OB/OD) units through the re-working of the soils could potentially bury contaminants at depths deeper than those proposed to be sampled in the Master SAP. The Navy should consider whether the proposed sampling strategy is sufficient to allow for an adequate delineation of contaminants at the potential depth ranges that could be present in the OB/OD units. Revise the Master SAP to address this issue.

Navy Response:

The eastern discrete deeper surface soil sample (VE-UXO4-11SO05) and discrete sediment and surface water samples (VE-UXO4-10SDSW03) have been moved downgradient of the OB area.

In addition, five discrete subsurface soil samples have been added in the OD area (in addition to the existing one subsurface soil sample already proposed) and one discrete subsurface soil sample has been added in the OB area (in addition to the existing one subsurface soil sample already proposed). Note that one subsurface soil sample will also be collected from the monitoring well (MW02) in the area.

EPA Evaluation of the Response:

The response partially addresses the comment. It is understood that five additional discrete subsurface soil samples have been added in the Open Detonation (OD) area and one discrete subsurface soil sample has been added to the Open Burning (OB) area for UXO 4. However, during the ERP/MRP Technical Subcommittee Meeting on August 27, 2012, the Navy indicated that if there is evidence of contamination at four to six feet, additional samples will be taken at greater depth. In the revised Terrestrial SAP, include a statement that indicates that additional samples will be collected in the OD/OB areas if initial sampling results reveal contamination from four to six feet.

Navy Evaluation Response:

Worksheet 17c has been revised to indicate that the additional discrete subsurface soil samples at the OB/OD area will be collected in accordance with the modified Vieques protocol.

General Comment - UXO 5 - SIA Restricted Roads, Pages 49-50; 119-120

35. Figure 33, UXO 5 Sampling Approach, shows two observation posts, OP-12 and OP-13, on the northeast portion of the SIA roads. However, Figure 35a UXO 7 shows a sampling unit near OP 12, which is also near OP 13. Please provide an explanation why a sampling unit was not considered necessary near OP-12 and OP-13, within UXO 5 given the potential future use of the roads and the relative location to a bulls-eye target.

Navy Response:

One sampling unit has been added within UXO 5 downgradient of OP-13 as shown in revised Figure 33. Note that one sampling unit located at PI-22 within UXO 9 also overlaps UXO 5 in this general area (Figure 37a).

General Comments - UXO 6 - EMA/SIA Public Roads, Pages 51-52; 121-122

36. The proposed sampling units shown in Figure 34a, UXO 6 (East Portion) Sampling Approach, appear to be appropriately located within grids with the highest densities of MEC and munitions scrap; however, the locations for discrete subsurface soil samples do not appear to correspond with higher densities of subsurface metallic anomalies. Please provide an explanation why areas with greater densities of subsurface metal anomalies were not selected for additional sampling locations.

Navy Response:

The subsurface soil sample has been moved one grid to the east (see revised Figure 34a). Since this response the Subcommittee team concluded the subsurface soil samples should not be shown on the

figure and their location will be determined at a later date with concurrence from the Subcommittee team.

General Comments - UXO 7- EMA/SIA North Beaches, Pages 53-54; 123-124

37. Given the assumed future land use for four beaches as pubic recreational areas, the Master SAP should describe what site development activities would occur to accommodate public needs (i.e., parking areas and/or restroom facilities). If site development will occur, discrete soil samples at greater depths would be necessary to ensure that site construction activities will not expose site users to contaminated soils located beneath the surface soils.

Navy Response:

The Master SAP provides the intended land use as described in USFWS' Comprehensive Conservation Plan for the Vieques National Wildlife Refuge. The document does not indicate that construction activities are intended for the proposed recreational areas, with the exception of the future observation tower at UXO 6. Also note that the characterization results may influence the intended future land use on the former VNTR.

38. As with UXO 2, additional discrete soil samples at greater depths should be considered to assess and delineate contaminants potentially present at the nesting depths of all species of sea turtles that use the beaches on Vieques.

Navy Response:

Please see the response to General Comment #29.

In WS#10f, page 50, the second sentence in the last paragraph has been replaced with the following:

"The primary potential ecological receptors are the eggs of hawksbill, green, and leatherback sea turtles exposed to deeper surface soil (18 to 36 inches)."

In WS#17f (UXO 7), Sampling Approach, the third sentence in the third paragraph has been modified to update the discrete deeper surface soil depth to "(18 to 36 inches)."

Note that EPA did not comment on the collection of additional discrete samples at the beaches in UXO 8 (SIA/EMA South Beaches), though the same concern regarding leatherback nesting at UXOs 2 and 7 applies there. Therefore, the following changes have been made:

In WS#10g, page 56, the second sentence in the last paragraph has been replaced with the following:

"The primary potential ecological receptors are the eggs of hawksbill, green, and leatherback sea turtles exposed to deeper surface soil (18 to 36 inches), as well as terrestrial ecological receptors (plants, soil invertebrates, birds [including Common Ground Dove and Pearly-eyed Thrasher], mammals [including the Norway Rat and Indian Mongoose], and reptiles) exposed to surface soil at Cayo Conejo."

In WS#17g (UXO 8), Sampling Approach, the third sentence in the third paragraph has been modified to update the discrete deeper surface soil depth to "(18 to 36 inches)."

39. Provide a discussion why subsurface soil samples were not proposed for Beach 27, shown in Figure 35a, UXO 7 SIA Beach Sampling Approach, where the digital geophysical anomalies are highest.

Navy Response:

As shown in Table 2b, Beach 27 is not considered for sampling as other beaches in UXO 7 have a higher potential for contamination and receptor exposure scores based on the ranking-based decision approach. Also the type and quantity of munitions were influenced by the surface characterization as these are known, whereas the DGM data is only based on anomaly information. Since the submittal of the Draft SAP, the geophysical anomalies have been investigated at UXO 7 and Beach 27 has less or equivalent subsurface munitions as the beaches proposed for sampling.

The sample rationale in Table 2b has been revised to provide the subsurface geophysical findings.

40. No beaches in Figure 35c, UXO 7 EMA West Beach Sampling Approach, were selected as sampling units, presumably due to the absence of MEC. However, given the number of streams and ranges present in the UXO 7 EMA West Beaches area leading to potential runoff concerns and the higher risk of human receptors due to planned future use, revise the Master SAP to discuss why sampling units were not proposed.

Navy Response:

As shown in Table 2b, Beaches 25, 28, and 29 do not have a higher risk of human receptors and have the lowest scoring in this category. Other beaches within UXO 7 have a higher potential for contamination and receptor exposure based on the ranking-based decision approach. Numerous sampling units are proposed within UXO 13 that characterizes the ranges and ephemeral streams. The evaluation of these UXO 13 data will follow the 6-step decision process and step out samples may be collected to evaluate extent, if warranted.

41. As with UXO 2, sampling at subsurface depths between 2.5 inches and 18 inches should be considered due to the dynamic conditions of the coastal zone and potential contaminants in the root zone of plants found in the area. Alternatively, provide justification if such sampling is not considered necessary. Provide a description of the coastal plants likely to be found in this area along with their respective root zone.

Navy Response:

Please see the response to General Comment #30.

General Comments - UXO 8- EMA/SIA South Beaches, Pages 55-56; 125-126

42. As with UXO 2 and UXO 7, additional discrete soil samples at greater depths should be considered to assess and delineate contaminants potentially present at the nesting depths of all species of sea turtles that use the beaches on Vieques. These area are documented leatherback beaches, and therefore deeper soil samples may be warranted. In addition, sampling at subsurface depths between 2.5 inches and 18 inches should be considered due to the dynamic conditions of the coastal zone and potential contaminants in the root zone of plants found in the area. Alternatively, provide justification if such sampling is not considered necessary

Navy Response:

Please see the responses to General Comments #29 and #30.

43. If site development will occur at Playa Matias/Yellow Beach due to its consideration for recreational public use, discrete soil samples at greater depths would be necessary to ensure that site construction activities will not expose site users to contaminated soils beneath the surface soils. The Master SAP should be revised to describe what site development activities would occur to accommodate public needs (i.e., parking areas and/or restroom facilities) and how exposure to potential subsurface contaminants would not increase with these activities.

Navy Response:

Please see the response to General Comment #37.

44. Although Worksheet #17g (page 126) indicates that a discrete deeper surface soil sample will not be collected from Cayo Conejo, Figure 36 indicates that one deeper soil sample (VE-UXO8-4SB01) will be collected. Please revise figure as appropriate.

Navy Response:

Figure 36 has been updated to remove VE-UXO8-4SB01.

General Comments - UXO 9- SIA Exterior, Pages 57-59; 127-129

45. Figure 37b: An additional sampling unit, west of sampling unit #3 should be considered to characterize the potential movement of contaminants within the ephemeral stream prior to the stream entering the Caribbean Sea.

Navy Response:

The South 3 sampling unit will provide a more conservative evaluation of potential movement of contaminants within ephemeral streams in this decision unit. South 3 is located along two ephemeral streams that originate within UXO 10 (where the former artillery targets were located) and occurs adjacent to similar density of munitions within UXO 9 as the additional sampling unit suggested in the comment.

EPA Evaluation of the Response:

The comment remains; an additional sampling unit west of Sampling Unit # 3 should be added.

Navy Evaluation Response:

One sampling unit has been added within this ephemeral stream; however, as stated above the other two ephemeral streams represent areas that have a higher likelihood of a potential release to the environment.

46. Figure 37e, UXO 9 North Sampling Approach, depicts a stream on the eastern side of the area. Given the proposed recreational use of this area of UXO 9, provide the rationale why a sampling unit was not proposed in the area where the stream enters UXO 9 North. Samples should be collected in this area for an evaluation of this contaminant transport pathway.

Navy Response:

A sampling unit is included along this ephemeral stream within the UXO 10 northern decision unit. USFWS has now indicated that this area is no longer intended for recreational land use due to the sensitive nature of the vegetation and habitat. WS#10h has been revised to remove hikers as a potential receptor (please also see the response to General Comment #47). The following statement has been added to WS#10h, under the Future Land Use and Potential Receptors subheading: “Although the northern portion of UXO 9 is identified in the CCP as having land use intended for interpretive trails, USFWS has since identified this area as having sensitive vegetation and, therefore, it will not be intended for public use.”

47. North UXO 9 and Southwest UXO 9 are being considered for public recreational use as interpretive, hiking, and biking trails. Creation and maintenance of these trails may result in greater disturbance of the soils in these areas. Provide a brief discussion regarding the activities involved in creating public use trails and why additional discrete soil samples at greater depths are not warranted.

Navy Response:

Please see the responses to General Comments #37 and #46 for North UXO 9. USFWS has now indicated that the interpretive, biking, and hiking trails and observation tower within Southwest UXO 9 will only be along the road in this area (associated with UXO 6 instead of UXO 9) due to the sensitive nature of the vegetation and habitat. WS#10e (UXO 6) has been revised to include hikers (adolescent and adult only) and WS#10h has been revised to remove hikers as a potential receptor.

The following statement has been added to WS#10h, under the "Future Land Use and Potential Receptors" subheading: "Although the northern portion of UXO 9 is identified in the CCP as having land use intended for interpretive trails, USFWS has since identified this land as having sensitive vegetation that will not be intended for public use."

48. Figure 37d, UXO 9 Southeast Sampling Approach, depicts the sampling approach for the southeast portion of UXO 9 and indicates the location of the strafing target shown in the northeast corner. Provide justification why an additional sampling unit to the southwest was not assigned given the proximity to the bulls-eye target and the nature of the prevailing winds on Vieques.

Navy Response:

Note that within UXO 9 northeast there is one sampling unit located at the strafing target and bulls-eye target and four sampling units within the immediate vicinity/downwind. This information has been added to the sample rationale in Table 11. In addition, note that there is one sampling unit within UXO 4 northwest and one sampling unit within UXO 4 southwest that are at or within the vicinity of the bulls-eye target as well.

General Comments - UXO 10- SIA Interior, Pages 61-62; 131-132

49. According to Figure 38b, UXO 10 Southeast Sampling Approach, there is one gun position located along the eastern edge of the southeast UXO 10 decision unit. Revise the sampling approach for the Southwest UXO 10 to explain why it is unnecessary to include a sampling unit in the vicinity, or southwest of GP-01.

Navy Response:

A sampling unit is proposed in this general area as part of UXO 5 due to the proposed future land use in that area (see Figure 33). Note that soil samples were collected from SWMU 12, which is in this area; no explosives were detected and SWMU 12 achieved a no action determination (as discussed in WS#10i).

General Comments - UXO 12- EMA Interior, Pages 65-67; 135-137

50. The section on Soil on page 136 states in the last bullet that three lagoons are present within UXO 12. However, the first paragraph of the Sampling Approach section on page 135 and Figure 40h, UXO 12 Laguna Monte Largo Sampling Approach, indicate that there are two lagoons onsite. Revise Master SAP Worksheet #17k to address this discrepancy. Additionally, the eighth bullet indicates that no munitions were identified adjacent to the lagoon, but Figure 40h indicates that no MEC investigation was conducted for the majority of

the Laguna Monte Largo Fringe. Revise the sampling approach to justify why additional discrete soil samples are not necessary despite the limited MEC investigations that have occurred on the Laguna Monte Largo Fringe. Also, please clarify whether the lagoons receive groundwater discharge.

Navy Response:

The last bullet on page 136 has been revised to indicate there are two lagoons. MEC investigations have historically been conducted in some areas of Laguna Monte Largo and no munitions were identified. This information has been added to the sample rationale in Table 14. The NTCRA at UXO 12 is currently ongoing and additional samples may be necessary based on the findings, in accordance with the decision process presented in WS#11. If so, they will be proposed in an addendum to the Master SAP that will be provided for regulatory review.

EPA Evaluation of the Response:

Please address the comment regarding groundwater discharge to the lagoons.

Navy Evaluation Response:

The statement "Groundwater discharge is to the ocean and believed to temporally discharge to the lagoons since the lagoons are periodically dry" had been added to Worksheet 10k.

51. Within the South Central area of UXO 12, it may make sense to move sampling unit three towards the east to sample within the ephemeral stream which is also downgradient from gun position #20 (Figure 40b).

Navy Response:

Sampling Unit 3 is associated with a Site Screening Area PI-3 (a potential small arms range) (Table 14). However, Figure 40b has been revised so the labels for both PI-2 and PI-3 stand out better. Note that two other sampling units within this decision unit are located in the vicinity of numerous gun positions within ephemeral streams.

EPA Evaluation of the Response:

It is unclear why the sampling unit cannot be moved to encompass the ephemeral streams. Please explain the rationale behind not relocating the sampling unit.

Navy Evaluation Response:

Note that PI-3 is a Site Screening Area, an area identified as a potential source of contamination, which are strongly considered in the ranking-based decision approach. However, a sampling unit has been added as requested.

General Comments - UXO 13- EMA West, Pages 69-72; 139-141

52. Figure 42b, UXO 13 Central Sampling Approach, illustrates the proposed sampling units within the UXO 13 Central decision unit. The section on Soil on page 140 discusses that the sampling units are biased towards the locations of former gun positions and target areas, diversity and quantity of MEC and munitions scrap, and transport pathways. Figure 42b indicates that no sampling units are proposed in the westernmost portion of this decision unit, particularly in the southwest corner of Central UXO 13 near the ephemeral stream that appears to run through the Municipality of Vieques. The Master SAP should discuss whether any former gun positions, target areas, MEC and munitions scrap were identified in this area; if so, this stream would be considered as a potential contaminant transport mechanism to receptors in the municipality.

Navy Response:

The western border of UXO 13 is a topographic high and the ephemeral streams originate in this area and drain to the ocean and lagoons and not offsite toward the municipality. To clarify, the third sentence of the second paragraph has been revised to: "A number of ephemeral streams originate within UXO 13 that drain to the ocean and lagoons; no ephemeral streams drain toward the municipality (Figure 19)."

General Comment - UXO 14- EMA South, Pages 73-74; 143-144

53. Figure 43c, UXO 14 East Central Sampling Approach, indicates that Range 10 and G-36 occur along the eastern border of this decision unit with two additional gun positions to the east of the unit. Provide rationale why additional sampling units in the vicinity of the range and gun positions are not warranted.

Navy Response:

A sampling unit is proposed at G-36 and Range 10 within the UXO 14 East Decision Unit (VE-UXO14-1DU01) (Figure 43d).

54. As it appears that there is an ephemeral stream that begins in Lagoon 14 and discharges to the Caribbean Sea, it is recommended that one sampling unit and a discrete deeper surface soil sample be collected from this location (Figure 43 C & 43f, East Central UXO 14 fringes) and one sediment and surface water sample be collected from this lagoon.

Navy Response:

Two sediment and two surface water sample have been added to Lagoon 14, with one location positioned in the vicinity of the ephemeral stream. One lagoon fringe sampling unit and deeper discrete surface soil sample were also added to Lagoon 14. Since no munitions were identified upgradient or in the vicinity of Lagoon 14 and sediment and surface water samples will now be collected, an ephemeral stream sample is not necessary at this time, but will be reconsidered pending the results of the lagoon samples.

General Comment - UXO 17- EMA Other Sites, Pages 75; 145

55. The section on Future Land Use and Potential Receptors on page 75 states that the U.S. Fish and Wildlife Service (USFWS) identifies a public boat ramp as desirable for the area described as UXO 17. Figure 45, UXO 17 PAOC EE Sampling Approach, illustrates the location of three discrete soil samples [0 to 1 ft below ground surface (bgs)] that will be collected following the removal of subsurface MECs. Revise the Master SAP to provide the rationale for the selection of these sample locations, and what next steps will be implemented if contamination is detected in the samples. Given the planned use for this area and the increased accessibility following the installation of a boat ramp, discuss why additional subsurface discrete soil samples are not warranted for UXO 17.

Navy Response:

Note that MEC has not been identified at UXO 17 and the first sentence under the Sampling Approach subheading (WS#17n) has been revised to indicate "munitions" instead of "MEC." The following sentence has been added after the second sentence of the Sampling Approach subheading: "A discrete sampling approach at UXO 17 will be used since the presence of munitions are related to isolated munitions storage and/or discarding and not from range impact or firing activities. Discrete surface soil samples will be collected from where the munitions-related items were identified at the site, which provides the most

conservative evaluation of a potential release." Note that the rationale for the discrete approach at UXO 17 is also provided in WS#17 under the heading Sampling Method and Approach.

General Comment - UXO 18 (Cayo La Chiva), Page 147

56. Incremental and discrete soil samples will be merged and evaluated together for land crabs. As deeper soil samples (2.5 -24") are to be used for all other UXO sites to characterize land crab exposure, it is recommended that deeper soil samples be collected in the near-shore habitat and/or where land crab burrows are visible from UXO 18 in order to both characterize this exposure pathway and ensure consistency in our evaluation.

Navy Response:

The last three sentences of WS#17o are in error and have been corrected as follows: "Potential risks to human health and ecological receptors will be evaluated using the surface soil samples site-wide." As discussed in WS#10o, land crabs are not a potential receptor at UXO-18.

General Comment – Human Health Risk Assessment

57. Master SAP Worksheets #10a through #10o include a summary of future land use and potential receptors. Address the following issues:

a. Based on a cursory review, potential human health site receptors generally consist of U.S. Fish and Wildlife Services (USFWS) workers, trespassers and/or public recreational users. However, to evaluate baseline conditions, the HHRAs should quantitatively evaluate a future hypothetical residential scenario (including hypothetical potable groundwater exposures) unless there is a legally enforceable and transferable land use restriction (e.g., a covenant on the deed) to prevent residential development in perpetuity. Please note that the *Baseline HHRA Protocol for Vieques Environmental Restoration Program,* finalized February 2010 (HHRA Protocol), indicates that future residential land use will be evaluated as part of forthcoming HHRAs.

Navy Response:

Section 1.1.2 of RAGS Part A states:

"Baseline risk assessments are site-specific and therefore may vary in both detail and the extent to which qualitative and quantitative analyses are used, depending on the complexity and particular circumstances of the site…"

In addition, the endnotes for Chapter 1 of RAGS state:

"Baseline risks are risks that might exist if no remediation or institutional controls were applied at a site."

The HHRA protocol indicates that when sites cannot be released for unrestricted use (e.g., sites within lands Congressionally-mandated otherwise), the Navy may choose not to evaluate residential land use or other infeasible exposure scenarios. This is the approach that has been concurred upon and applied at West Vieques SWMU 4 and East Vieques UXO 1 (Eastern Conservation Area).

Therefore, the term "baseline" is appropriately used in reference to future HHRAs, and the existing legal land use controls accompanying the Congressional transfer of the VNTR property to the USFWS render future residential land unrealistic. An exception is a small parcel of land located within the northwest portion of UXO 13 (denoted as Parcel C), which is being considered for transfer by DOI to the Puerto Rico Conservation Trust (PRCT) for unrestricted public use.

The following text has been added to the end of the first paragraph of the "Land Use" section of Worksheet 10:

> *"The existing legal land use controls accompanying the Congressional transfer of the LIA to the USFWS as a wilderness area render future residential land use unrealistic without a subsequent Congressional act."*

The following text has been added to the end of the second paragraph of the "Land Use" section of Worksheet 10:

> *"The existing legal land use controls accompanying the Congressional transfer of the SIA and EMA to the USFWS as a wildlife refuge render future residential land use unrealistic without a subsequent Congressional act. An exception is a small parcel of land located within the northwest portion of UXO 13 (denoted as Parcel C), which is being considered for transfer by DOI to the Puerto Rico Conservation Trust (PRCT) for unrestricted public use."*

EPA Evaluation of the Response:

The response addresses the comment. The response indicates that the Terrestrial SAP will be revised to clarify that existing legal land use controls accompanying the Congressional transfer of the property (e.g., Live Impact Area [LIA], Surface Impact Area [SIA], Eastern Maneuver Area [EMA]) to the USFWS as a wilderness area render future residential land use unrealistic without a subsequent Congressional act. However, it is noted that Parcel C, located within a northwest portion of UXO 13, is being considered for transfer by the Department of Interior (DOI) to the Puerto Rico Conservation Trust (PRCT) for unrestricted public use. Ensure that residential exposures are evaluated at Parcel C (as indicated in the Response to GC 57b) in the forthcoming HHRA to demonstrate that unrestricted use is appropriate. Also, the response to Specific Comment (SC) 21 indicates that potential area of concern (PAOC) EE of UXO 17 is also considered for unrestricted use. If so, revise the Terrestrial SAP to clarify that PAOC EE of UXO 17 is considered for unrestricted use and that residential exposures will be evaluated to demonstrate that unrestricted use is appropriate.

Navy Evaluation Response:

Residential exposures will be evaluated at Parcel C in the forthcoming HHRA. In addition, the following text has been added to the end of the second paragraph of the "Land Use" section of Worksheet 10:

> *"The existing legal land use controls accompanying the Congressional transfer of the SIA and EMA to the USFWS as a wildlife refuge render future residential land use unrealistic without a subsequent Congressional act. An exception is a small parcel of land located within the northwest portion of UXO 13 (denoted as Parcel C), which is being considered for transfer by DOI to the Puerto Rico Conservation Trust (PRCT) or Municipality of Vieques (MOV) for unrestricted public use."*

b. It is unclear if subsurface soil exposures will be excluded from forthcoming HHRAs. Clarify if subsurface soil exposures are anticipated at any of the sites, or if a hypothetical construction worker scenario will be considered in the forthcoming HHRAs. Also, in the forthcoming HHRAs, please consider derivation of two separate exposure point concentrations (EPCs): one EPC based on surface soil for residents, USFWS workers, trespassers and recreational users, and a second EPC based on total soil (surface and subsurface soil) for residents and hypothetical construction workers.

Navy Response:

Subsurface soil exposures may occur at a few sites (e.g., reforestation areas, Parcel C, and UXO 6 where the future observation tower may be constructed), and will be identified in consultation with USFWS. At sites where there may be subsurface soil activities, data will be analyzed in accordance

with the HHRA Protocol. If construction is a reasonably foreseeable activity at a specific site, construction workers will be evaluated in the HHRA, with EPCs based on total soil (surface and subsurface soil), consistent with the HHRA Protocol. Residential receptors will not be evaluated in the HHRAs, with the exception of Parcel C (see response to General Comment #57a).

The following text has been added to the end of the first paragraph of the "Potential Receptors" section of Worksheet 10:

"Subsurface soil receptors may be present at a few sites (e.g., reforestation areas, Parcel C, and UXO 9), and will be identified in consultation with USFWS. At sites where subsurface soil activities are reasonably foreseeable, subsurface exposures will be evaluated for site-specific subsurface receptors (e.g., USFWS workers and/or construction workers). Residential receptors will not be evaluated in the HHRAs, with the exception of Parcel C. Subsurface soil exposures will also be evaluated for construction workers and industrial workers at Parcel C."

EPA Evaluation of the Response:

The response partially addresses the comment. The response indicates that subsurface exposures may be possible at various locations, including reforestation areas, Parcel C and UXO 9 and provides suggested revisions to the Terrestrial SAP. However, given that the Terrestrial SAP outlines sampling needs to support the HHRA, it is preferred that sites where subsurface soil exposures may occur be identified early in the process to avoid HHRA data gaps. Further, in the forthcoming HHRA, ensure that residential exposures at Parcel C are evaluated using two separate exposure point concentrations (i.e., surface soil and total soil; depth to be consistent with a standard building footing or buried utilities, whichever is deeper). Revise the Terrestrial SAP to clarify that total soil exposures, as well as surface soil exposures, will be evaluated at Parcel C of UXO 13 and PAOC EE of UXO 17.

Navy Evaluation Response:

Based on existing information, the only sites where future subsurface soil exposures may occur are reforestation areas, Parcel C, PAOC EE, and UXO 6. The following text has been added to the end of the first paragraph of the "Potential Receptors" section of Worksheet 10:

"Subsurface soil receptors may be present at a few sites (e.g., reforestation areas, Parcel C, and UXO 9), and will be identified in consultation with USFWS. At sites where subsurface soil activities are reasonably forseeable, subsurface exposures will be evaluated for site-specific subsurface receptors (e.g., USFWS workers and/or construction workers). Residential receptors will not be evaluated in the HHRAs, with the exception of Parcel C; residential exposures will be evaluated using two separate EPCs (i.e., surface soil and total soil). Subsurface soil exposures will also be evaluated for construction workers and industrial workers at Parcel C."

c. It is unclear from SAP Worksheets #10a through #10o if buildings occur or are planned in the future at any of the subject sites where volatile compounds may be present in groundwater. Clarify if buildings are present or are anticipated to be constructed in the future at any of the sites. Where applicable, clarify how the proposed sampling approach is adequate to evaluate current or future potential inhalation exposures associated with vapor intrusion.

Navy Response:

Based on the available plans from the USFWS (the landowner), no building construction is anticipated at any of the subject sites, with the exception of the observation tower at UXO 6, and there are no existing buildings. It should be noted that, for the sites addressed in this SAP, an SVOC is potentially present at only one site (i.e., hexachloroethane at Cayo la Chiva – UXO-18). Therefore, vapor intrusion is not an issue.

EPA Evaluation of the Response:

The response addresses the comment provided that the Terrestrial SAP is revised to clarify that vapor intrusion potential is not of concern and the associated complete decision rationale is presented.

Navy Evaluation Response:

The following text was added after the 2nd paragraph of the "Land Use" section:

"Based on the available plans from the USFWS (the landowner), no building construction is anticipated at any of the subject sites, with the exception of the observation tower at UXO 6, and there are no existing buildings. It should be noted that, for the sites addressed in this SAP, an SVOC is potentially present at only one site (i.e., hexachloroethane at Cayo la Chiva – UXO-18). Therefore, vapor intrusion is not an issue."

In addition, the following text was added to the end of the 1st sentence of the "Future Land Use and Potential Receptors" section of Worksheet 10e:

", with the potential construction of an observation tower."

EPA Comment

Additionally, please note that site receptors, applicable exposure pathways and exposure parameters will be reviewed in detail as part of the forthcoming Human Health Risk Assessments (HHRAs) for each site, and EPA reserves the opportunity to provide additional detailed comments on these components when HHRAs are reviewed.

Navy Response:

Note that a description as to why vapor intrusion is not considered an issue and the details for excluding the fish ingestion scenario will be added to RAGS Table 1.

The potential receptors, exposure scenarios and pathways, and analytical parameters are presented in this SAP for agency review and comment prior to preparation of the HHRAs (and ERAs) so that data collection meets the needs of the forthcoming HHRAs (and ERAs). That is one of the primary tenets of a SAP. Therefore, regulatory approval of the SAP will constitute concurrence on the potential receptors, exposure scenarios and pathways, and analytical parameters. They will not be subject to additional comment after the SAP is finalized and the fieldwork and associated laboratory analysis are completed unless new information is discovered that warrants re-evaluation of these elements. Other risk assessment elements presented in the HHRA and ERA pre-interim and/or interim deliverables, such as grouping of decision unit data, will be subject to additional regulatory review and comment, as will any site-specific modifications to the procedures and methods outlined in the final HHRA and ERA protocols that may be included in the HHRA and ERA pre-interim and/or interim deliverables.

EPA Evaluation of the Response:

The response partially addresses the comment. If potential receptors, exposure scenarios and pathways will be confirmed in the Terrestrial SAP, further detail is needed. For example, while exposure scenarios are briefly discussed in site-specific worksheets, please include a comprehensive table that presents a brief site history, potential receptors, exposure scenarios, exposure pathways (e.g., indirect/direct contact exposures such as inhalation, dermal, ingestion), *and* target analytical parameters for each site. This table is expected to be rather

lengthy but will serve as a tool to facilitate review of the forthcoming site-specific HHRAs. Also, clarify in the Terrestrial SAP if surface soil, surface water, sediment and/or fish ingestion exposures will be evaluated for public recreational users. If not, provide the complete decision rationale for not evaluating these exposures to recreational users.

Navy Evaluation Response:

The brief site history, potential receptors, exposure scenarios and exposure media are already presented in Worksheets 10a through 10o of the Master SAP and don't warrant repeating in a second location within the SAP. Exposure pathways are the standard scenarios presented in the Master SAP for the indicated media and receptors. The analytical parameters are presented in Worksheets 17a through 17o of the Master SAP and don't warrant repeating in a second location within the SAP.

Specific Comments

1. **SAP Worksheet #6, Communication Pathways, Pages 11 to 12:** The information presented in this worksheet regarding SAP changes in the field and corrective action is incomplete. Revise the worksheet to specify that the EPA will be notified when significant corrective actions or changes to the Master SAP occur, and include the form of communication and timeframe for this notification. Additionally, revise this worksheet to indicate that EPA will be notified of significant SAP changes, and provide the timeframe and method of communication for this notification.

Navy Response:

Worksheet #6, The Navy RPM procedure cell text has been appended with the following: "Stop work notices to regulators, notifying regulators of significant SAP changes or deviations, significant issues and necessary corrective actions by phone or e-mail within 2 weeks of notification of Navy RPM."

Worksheet #6, the CH2M HILL Environmental Manager procedure cell text has been appended with the following: "Stop work notices to Navy RPM, notifying Navy RPM of significant SAP changes or deviations, significant issues or corrective actions."

Worksheet #6, the CH2M HILL Field Investigation Lead row, procedure cell text has been appended with the following: "Notifying CH2M HILL EM/AQM of significant SAP changes or deviations, significant issues or corrective actions."

EPA Evaluation of the Response:

The response partially addresses the comment; however, the additional descriptions for notifications between the Field Investigation Lead to the Environmental Manager and to the Navy RPM do not indicate the timing or method of communication. Revise the Terrestrial SAP to provide the methods of communication and timeframes for the notifications of deviations from the SAP and significant corrective actions between the Field Investigation Lead, the Environmental Manager, and the Navy RPM.

Navy Evaluation Response:

Worksheet #6 has been revised as follows:

CH2M HILL Environmental Manager procedure – "Stop work notices to Navy RPM, notifying Navy RPM of significant SAP changes or deviations, significant issues or corrective actions by phone or email within one week of occurrence".

CH2M HILL Field Investigation Lead procedure – "Notifying CH2M HILL EM/AQM of significant SAP changes or deviations, significant issues or corrective actions by phone or email daily".

2. **Worksheet #11, Project Quality Objectives/Systematic Planning Process Statements, Page 79:** The text indicates that the uncertainty of results for which screening levels are below the detection limit (DL) will be discussed in data quality evaluation. However, this should be documented and assessed before samples are collected. For example the Master SAP addenda should provide a discussion for why alternate or modified methods were not proposed to lower the limit of quantitation (LOQ), if anything can be done to reduce this uncertainty (e.g., run a standard at the limit of detection [LOD]), and/or why the level of uncertainty was considered acceptable for a specific project. Revise the Master SAP to indicate that the addenda will discuss alternate methods and the uncertainty due to LOQs, LODs, and/or DLs exceeding the screening levels.

Navy Response:

As requested, the proximity of screening levels to laboratory-specific reporting limits is documented and assessed at the time of laboratory procurement, before samples are collected. This is documented in the laboratory-specific SAP addendum for a given effort(s), which includes a Worksheet #15 showing the most up-to-date screening levels and laboratory-specific reporting limits. It should be noted that the LOD (not the LOQ) is compared to the screening level for demonstrating that concentration ranges are appropriate. Discussion with respect to alternate or modified methods is not relevant in the master UFP-SAP because the laboratory information is generic; whether or not LODs are less than respective screening levels will be known as each laboratory is procured and the information included in laboratory-specific SAP addenda. Note the following statement from Worksheet #11 'What are the PALs?':

"Once the laboratory is identified, an update to WS#15 containing laboratory specific reporting limits, as well as any impact on the resulting data, will be provided in a site-specific SAP addendum."

The master SAP should discuss data use when LOD and/or DL exceeds the screening level. The sentence following the one referenced above has been replaced with:

"When the LOD is greater than the screening level, nondetects will be treated as non-exceedances and the uncertainty will be discussed in the data quality evaluation. If there are instances where the LOD and/or the DL is greater than the screening level, then the resulting uncertainty will be discussed in the data quality evaluation."

It is not typical procedure, nor warranted, to require a standard at the limit of detection. In most cases, the LOQ represents the level of the lowest standard. Periodically, LODs are verified to demonstrate that they are still valid for their intended purpose.

EPA Evaluation of the Response:

The response does not address the comment. The response does not indicate that the SAP addenda will discuss why the uncertainty associated with using results where the limits of quantitation (LOQs), limits of detection (LODs), and detection limits (DLs) are greater than project action limits (PALs) is deemed acceptable for the specific project. Additionally, the Terrestrial SAP should indicate that the SAP addenda will discuss why the proposed methods were deemed sufficient and/or whether alternate or modified methods could obtain lower DLs, LODs, and LOQs that can meet the PALs. An example discussed in the comment is analyzing the LOD verification standard as a quality control (QC) sample during the sample batch, which would verify that the contaminants would be routinely detected below the LOQ if present. Although the response indicates that the LOD is verified periodically, it is unclear if this verification will be completed at a sufficient frequency to reliably determine this for samples associated with each SAP addenda. The Department of Defense (DoD) Quality Systems Manual (QSM) indicates the laboratories will verify the LOD on a quarterly basis (see DoD QSM, Section D.1.2.1), but it is unclear if this will be sufficient for detecting the analytes with PALs at the LOD. It is recommended that the LOD is verified at the start of each project discussed in a

SAP addendum. Further, the response indicates that uncertainty associated with results where the LOD and/or DL exceed the screening level will be discussed in the data quality evaluation (DQE), but the DQE should discuss the usability of the data for analytes with LOQs above PALs. Revise the Terrestrial SAP to indicate that the SAP addenda and DQE will include these discussions.

Navy Evaluation Response:

Worksheet #11, Step 2 – Data Quality Evaluation (or another appropriate section of the SAP) will be revised to indicate that the DQE will also evaluate if the uncertainty of using LODs above the PAL is acceptable. It will also include text about the DQE discussing the rationale of not treating non-detect results above the PAL as an exceedance.

Worksheet #11 will also be revised to mention that a discussion on why alternative methods (with lower LODs) were not used when the LOD exceeds the PAL will be included in the SAP addenda since these issues are only general now and will not be specific until a laboratory is procured prior to each project.

3. **Worksheet #13, Secondary Data Criteria and Limitations Table, Page 87:** The reports listed in the Data Source column for this table do not provide the dates that the reports were published or the organization publishing the reports. Further, it is unclear if the reports are listed by the titles or the type of action (e.g., Non-time critical removal action). Finally, it is unclear if the data from the background ISM comparison included as Master SAP Appendix B have been provided in further detail (e.g., including validation and data quality assessment information) in previous report. Revise this worksheet to list the reports by title, and include the dates and publishing organizations. Further, revise the table to clarify where the data quality information for Master SAP Appendix B was presented.

Navy Response:

The requested changes have been made. Please see the revised WS#13.

4. **Worksheet #14, Summary of Project Tasks, Page 92:** This section indicates that a seven point composite sample will be collected after detonation of MEC, but it is unclear why ISM is not proposed. As noted in Worksheet #17, explosives and metal will occur as particulates and are heterogeneously distributed. Therefore, it is likely that ISM will provide a more representative sample for evaluating contamination in these areas. Revise the Master SAP to indicate that ISM will be used after detonation of MEC. This is especially recommended when MEC detonations result in debris over a large area.

Navy Response:

The post-detonation sampling approach has been revised to include the collection of one sampling unit centered upon the detonation area. The sampling unit will follow the same incremental sampling procedures of the Master SAP. Note: post-detonation sampling was removed from this SAP based on a PREQB comment.

5. **Worksheet #15, Field Sampling Requirements Table, Pages 95 to 102:** There are several analytes for which a project action limit (PAL) is not defined (e.g., 3,5-Dinitroanline). It is unclear how these analytes will be assessed. Revise this worksheet to discuss how results for analytes without PALs will be assessed.

Navy Response:

Nutrient metals (Ca, Mg, K, Na) are used for various screening purposes, such as determining soil type and, therefore, do not have PALs. Analysis for 3,5-Dinitroaniline was proposed because it is a contaminant of interest given the types of items which may be present at the site. There are no referenced toxicity

values for this chemical, and there are no screening levels; therefore, analysis for this chemical has been eliminated. It was removed from Worksheet #15-1 and Worksheet #15-6. Analysis for various SVOCs was included simply because they are part of the SOM01 list. Since they are not contaminants of interest, the following chemicals were removed from Worksheet #15-3 (soil SVOCs): 3-Nitroaniline; 4-Bromophenyl-phenylether; and Carbazole.

6. **Worksheet #15, Field Sampling Requirements Table, Pages 95 to 98:** This worksheet does not indicate whether soil and sediment samples will be reported on a wet or dry weight basis. Revise the table to soils and sediment samples will be reported as dry weight results.

Navy Response:

By default, non-aqueous samples to be collected as part of the Master SAP (i.e., soil, sediment) are always reported on a dry-weight basis. Samples which have been dried and ground (i.e. multi-incremental samples for explosives) are reported on an as-received basis, but the analysis is performed on soil which has been dried to a constant weight. This is essentially equivalent to dry-weight basis. The following footnote has been added to each of Worksheets #15-1, #15-2, and #15-3:

"Results for non-aqueous samples are reported on a dry-weight basis. For fractions which have been dried prior to analysis, results are reported on an as-received basis (for the dried fraction)."

7. **Worksheet #15-8 — Field Sampling Requirements Table, Page 103:** The PRG listed for U-238 of 1.8 pCi/g is slightly different than the PRG listed in Appendix C Table C-1, Screening Level for Radionuclides for Protection of Human Health and Ecological Receptors, on Page C-4 of 1.5 pCi/g. Revise these tables to provide one consistent value for the U-238 PRG.

Navy Response:

This was a typographical error. The value has been updated to 1.5pCi/g as requested. The PQL goal has been updated to 0.75pCi/g.

8. Worksheet #37, Data Usability Assessment, Page 259: The second bullet point in this worksheet indicates that there may be reason to use rejected data in a qualitative manner if the direction of bias and proximity to a PAL are known. The example given for use of rejected data is a case where extremely low bias caused the rejection. However, any such qualitative use of rejected data should be thoroughly discussed in the data quality assessment. Further, it is recommended that rejected data not be used for decision making. Revise the Master SAP to indicate that any qualitative use of rejected data will at a minimum be thoroughly discussed in the data quality assessment.

Navy Response:

The second bullet has been revised to delete everything following the second sentence.

9. **Figure 31a, Central UXO 4 Sampling Approach:** The legend on this figure uses the acronym "LIDAR" that is not defined here or elsewhere in the plan. Correct this omission.

Navy Response:

The definition has been added to Figure 31a.

Specific Comments – Ecological Risk Assessment

10. **Worksheet #10 Series:** The White-cheeked Pintail has been added as an aquatic receptor for UXO sites with lagoons. Revise the conceptual site model figures (e.g. Figure 15 LIA Conceptual Site Model) to include the White-cheeked Pintail and clearly indicate whether the receptor will be considered an aquatic herbivore. In addition, please ensure that the Ecological Risk Assessment Protocol is updated to include exposure parameters and toxicity reference values for this receptor.

Navy Response:

Conceptual model figures have been updated to include a call-out box and image for the white-cheeked pintail, modeled as an aquatic herbivore in the SERA portion of the ERA. Updates have been made to Figures 15, 18, 20, and 21.

Exposure parameters for the white-cheeked pintail are provided in the "Master Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program – Update 1 (Addendum), 2010, which has been included with these responses and, once approved, will be added to the Master ERA Protocol.

EPA Evaluation of the Response:

Response is appropriate; however the addendum has not been provided.

Navy Evaluation Response:

The ERA Protocol Addendum will be submitted to regulatory agencies.

11. **Worksheet #15-2, Field Sampling Requirements Table, Page 96:** The Ecological Screening Values (ESVs) provided in this table reflect the values provided in Table 18 of the Ecological Risk Assessment Protocol, and are the lower of the plant or soil invertebrate value from the US EPA Ecological Soil Screening Levels (Eco SSLs) documents. Several inorganic chemicals have avian and mammalian values available in the Eco SSLs which are less than the selected plant or soil invertebrate ESVs (Table 19 Eco SSLs for Birds and Mammals). In order to ensure that the Project QL goals meet data needs, revise this worksheet to include the more conservative of values provided in Tables 18 and 19 of the Ecological Risk Assessment Protocol.

Navy Response:

The following changes have been made to Worksheet 15-2, Ecological Soil ESVs, to reflect instances of lower screening values for birds/mammals:

Antimony = 0.27 mg/kg
Beryllium = 21 mg/kg
Cadmium = 0.36 mg/kg
Chromium = 26 mg/kg
Copper = 28 mg/kg
Lead = 11 mg/kg
Silver = 4.2 mg/kg
Vanadium = 7.8 mg/kg
Zinc = 46 mg/kg

A footnote has also been added to this table indicating that the lowest of the Eco-SSLs was used as the PAL.

EPA Evaluation of the Response:

Response is appropriate; in addition please indicate that the chromium value is for chromium III.

Navy Evaluation Response:

In Worksheet 15-2, footnote (#3) the following sentence has been added to clarify the Ecological Soil ESV chromium value (26 mg/kg):

"3. The value of 26 mg/kg represents chromium (III)"

12. Worksheet #15-7 - Field Sampling Requirements Table, page 102: Marine Surface Water ESVs for aluminum, chromium and cobalt could not be verified; these values are not included on Table 13 Marine Surface Water Ecological Screening Values (Ecological Risk Assessment Protocol). Please provide the appropriate reference(s) for these values.

Navy Response:

Marine surface water ESVs for aluminum and cobalt are not available; therefore, the existing values for these metals in Worksheet 15-7 have been deleted and left as blank (no screening value). For chromium, the correct value (50 µg/L) has been added to the table in place of the incorrect value (81).

EPA Evaluation of the Response:

Please ensure that the reference for this value is provided.

Navy Evaluation Response:

The source of the chromium value, as well as the other marine surface water ESVs in Worksheet 15-7, is the Master Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program – Update 1 (Addendum), 2010. This document is cited in the reference section of the Master SAP.

Three additional marine surface water ESV updates have been made in Worksheet 15-7 to be consistent with the ERA Protocol - Update 1, as follows:

Antimony = 500 µg/L
Arsenic = 36 µg/L
Silver = 2.24 µg/L

13. Worksheet #15-8 Field Sampling Requirements Table, page 103: The BSV for Uranium-235 in sediment should be 4000 pCi/g rather than 3000 pCi/g. Please update the Ecological Risk Assessment Protocol to include these radiological values for sediment and soil.

Navy Response:

The Ecological Sediment BSV for Uranium-235 has been changed to 4,000 pCi/g. However, because it is unlikely that radiological ESVs will be required for any future sites at Vieques, a protocol update will not be issued solely to include these values. The source and derivation of these ESVs will be included in the interim deliverable(s) for the UXO sites addressed by this SAP.

14. Worksheet #17l, UXO 13 (EMA West), Page 139: This worksheet details the sampling of soil, surface water, and sediment at UXO 13. Surface water and sediment are only collected in Laguna Algodones, even though Worksheet #10l –UXO 13 (EMA West) mentions a number of ephemeral streams which occur within UXO 13. Worksheet #17 – Sampling design and Rationale states that "sampling will be conducted in potential transport pathways (such as ephemeral streams), within depositional environments (such as lagoons) and discrete subsurface soil samples…" Include collecting surface water in the ephemeral streams if they contain water at the time of sampling. Revise Worksheet #17l accordingly.

Navy Response:

Discrete surface water samples will be collected at sampling units within the ephemeral streams, if water is present. This information has been added to WS#17 and applies to each site with ephemeral stream samples proposed.

15. **Worksheet #17m, UXO 14 (EMA South), Page 143:** This worksheet details the sampling of soil, surface water, and sediment at UXO 14. Surface water and sediment are only collected from three lagoons, even though Worksheet #10m –UXO 14 (EMA South) mentions a number of ephemeral streams which occur within UXO 14. Worksheet #17 – Sampling design and Rationale states that "sampling will be conducted in potential transport pathways (such as ephemeral streams), within depositional environments (such as lagoons) and discrete subsurface soil samples…". Include collecting surface water in the ephemeral streams if they contain water at the time of sampling. Revise Worksheet #17m accordingly.

Navy Response:

Please see the response to Specific Comment #14.

16. **Worksheet #17b, UXO 3 (LIA Roads), Page 114:** The sampling approach at this location is to collect one incremental surface soil sample and one discrete deeper surface soil sample at each of the eight sampling units. The text states that the incremental soil samples will be evaluated to assess potential risks to human health and the environment but does not mention the use of the discrete deeper samples. The reason for collecting the deeper soil samples is unclear. Revise this section to explain how the discrete deeper surface soil samples will be applied in the ecological evaluation at UXO 3.

Navy Response:

Note that the discrete soil samples proposed are subsurface soil samples and not deeper surface soil samples. The rationale of the discrete subsurface soil samples is presented in Worksheet #17 under the Discrete Soil Sampling Design, in which the samples will be collected to evaluate the vertical extent of contamination.

17. **Appendix C, Table C-1:** Please note that the BCG in sediment for U-235 is 4000 pCi/g as per Table 6.2 Biota Concentration Guides (BCGs) for Water and Sediment (in Special Units) for Use in Aquatic System Evaluations (DOE STD 1153 2002).

Navy Response:

Appendix C has been corrected to show the BCG for U-235 in sediment is 4,000 pCi/g.

Specific Comments – Human Health Risk Assessment

18. **Worksheet #10, Problem Definition, Objectives and General Characterization Approach, Page 39:** Both discrete soil sampling and incremental soil sampling are proposed at the East Vieques Terrestrial UXO Sites. Please review Incremental Sampling Methodology Technical Regulatory Guidance prepared by Interstate Technology Regulatory Council (ITRC) dated February 2012, to include Section 8.0, Regulatory Concerns with Incremental Sampling Methodology, pp. 160 - 183 of the guidance. Given that some of the compounds of interest are volatile (e.g., nitrobenzene, naphthalene, etc.), ensure that VOC samples are collected in accordance with the guidance. Revise the applicable SAP worksheets to detail how sampling methodology will consider collection of volatile compounds and cite/reference this information in Master SAP Worksheet #10. Additionally, identification of potential hotspots should also be considered in the sampling approach. Clarify

how the incremental sampling density and decision unit sizes will be adequate to identify potential hot spots. Ensure data quality is sufficient for risk assessment purposes.

Navy Response:

The incremental samples will be collected in accordance with the incremental sampling protocol and discrete samples will be collected in accordance with the Master Vieques protocols. Note that the analyte list only includes PAHs (SVOCs), which tend to bind to the soil. The evaluation of potential hotspots is a component of Step 4 in the 6-step decision process.

EPA Evaluation of the Response:

The response addresses the comment. However, it should be noted that various polynuclear aromatic hydrocarbons (PAHs) are sufficiently volatile to be analyzed as a volatile organic compound (VOC) (i.e., naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, fluorene and pyrene are listed as VOCs in the EPA Regional Screening Levels [RSL] table based on their Henry's Law constants and molecular weights).

Navy Evaluation Response:

SVOCs (PAHs) are the analytes of interest, not VOCs. Although some SVOCs have a volatile component, the standard sampling approach is to collect the PAH samples in accordance with SVOC collection procedures, not VOC sample collection procedures.

19. Worksheet #11, Project Quality Objectives (PQOs)/Systematic Planning Process Statements, Page 79: Master SAP Worksheet #11 states, "The PALs [project action limits] are defined in the Master Standard Operating Procedures, Protocols, and Plans (CH2M HILL, 2010b)…." Clarify in bullets #1 and #2 if the selected PAL is the lowest human health risk-based screening criterion for soil and groundwater, respectively.

Navy Response:

Bullets 1 and 2 have been further clarified that the selected PAL is the lowest of applicable screening levels.

20. Worksheet #11, Project Quality Objectives/Systematic Planning Process Statements, Step 3 (MC) – Release, Nature and Extent, and Risk Assessments, Page 83: This section states the following PQO: "If any inorganics not attributable to background or non-inorganics (e.g., explosives) are detected, use the data to conservatively evaluate the nature and extent of contamination and assess potential human health and ecological risks; otherwise, make a final decision of the adequacy of the data set (see Step 5) prior to preparation of the RI Report." This PQO as presented is not entirely consistent with the HHRA Protocol (CH2M HILL, 2010b), which indicates that inorganic compounds will be carried forward in the quantitative risk assessment and then as part of the risk characterization, total risk will be presented as risk attributable to background and site-related risk. Revise this bullet to clarify the role of background data in the forthcoming risk assessments.

Navy Response:

The text has been revised to indicate that chemicals within background will be addressed in the HHRA. However, if the only chemicals exceeding RSLs are inorganic constituents within background levels, a HHRA will not be prepared, which is in accordance with agreements made for Vieques sites.

EPA Evaluation of the Response:

The response addresses the comments provided that the Terrestrial SAP is revised consistent with the response. Also, it is recommended that the specific meetings/agreements be cited appropriately.

Navy Evaluation Response:

The following text was added as the last sentence of Step 3 in Worksheet #11:

"Inorganics detected within background will be addressed in the HHRA. However, if the only chemicals exceeding RSLs are inorganic constituents within background levels, a HHRA will not be prepared."

21. **Worksheet #15-1 through #15-3, Field Sampling Requirement Tables, Soils and Sediment, Explosives, Metals and Semi-volatile Organic Compounds (SVOCs), Pages 95 to 98:** These tables present adjusted EPA Industrial Soil RSLs, but not adjusted EPA Residential Soil RSLs. While the constituent PQL is ½ the lesser applicable screening level, Master SAP Worksheets #15-1 through #15-3 should include a comparison to adjusted EPA Residential Soil RSLs. PQLs should be low enough to meet residential risk-based screening criteria. Also, in the forthcoming HHRAs, the chemical of potential concern (COPC) selection process should be predicated on adjusted EPA Residential Soil RSLs. Please note that the latest EPA RSLs are presented in the November 2011 RSL table; however, updated RSLs are anticipated in early June 2012. Ensure the most current RSLs are used in the COPC selection process.

Navy Response:

The PALs have been revised to the most current RSLs. Additionally, residential RSLs have been added to the worksheets, but please note that residential RSLs apply only to:

- Areas where unrestricted use is a potential (i.e., Parcel C of UXO 13 and PAOC EE of UXO 17), which are the only areas where the residential scenario will be considered
- Areas where recreational use by a child receptor is a potential (e.g., beaches, picnic areas, scenic views), where residential RSLs are used in the recreational

Please note that residential RSLs have been added to Worksheet #11.

22. **Worksheet #15-8, Field Sampling Requirement Tables, Soils and Sediment, Radiological, Page 103:** Similarly to Master SAP Worksheets #15-1 through #15-3, worker scenario radionuclide PRGs are presented and used to derive PQLs, which are ½ the worker PRGs. However, the PQLs are higher than the residential PRGs. Revise SAP Worksheet #15-8 to incorporate residential PRGs. In forthcoming HHRAs, the radionuclide COPC selection process should be predicated on residential PRGs (as presented in Appendix C, Screening Levels for Radionuclides).

Navy Response:

The residential scenario does not apply to the depleted uranium area of UXO 4.

23. **Appendix C, Screening Levels for Radionuclides, Table 1:** The human health risk-based screening levels for radionuclides (Uranium-234, U-235, and U-238) presented in Table 1 appear appropriate. However, clarify why migration-to-groundwater screening levels are not also incorporated in Table 1.

Navy Response:

Migration-to-groundwater soil screening levels (SSL) for uranium isotopes (shown below) have been incorporated into Table 1. Note that the SSLs based on a tap water risk of 10-6 are below the reporting limits for analytical methods for soil. The Project Action Limits (PALs) for these radionuclides will be the lower value of the SSL for protection of human health from direct contact with soil and the SSL based on the MCL in groundwater.

Radionuclide	SSL based on 10^{-6} Tap Water Risk (pCi/g)	SSL based on MCL (pCi/g)
U-234	0.009	2,240
U-235	0.009	0.8
U-238	0.007	0.12

Source: http://epa-prgs.ornl.gov/radionuclides/download/res_soil2GW_rad_prg_august_2010.pdf

EPA Evaluation of the Response:

The response partially addresses the comment. The response indicates that migration-to-groundwater soil screening levels (SSLs) for uranium isotopes that are predicated on a tap water risk of 1E-06 are below the reporting limits for analytical methods, therefore PALs for these radionuclides will be the lower of the SSL for protection of human health from direct contact with soil and the SSL based on the groundwater maximum contaminant level (MCL). This is acceptable provided that the Terrestrial SAP is revised to specify that the HHRA uncertainty analysis will discuss and address any associated uncertainties relating to the reporting limits not being low enough to meet these risk-based SSLs for uranium isotopes.

Navy Evaluation Response:

The following text has been added as the last sentence of the "SSLs for Protection of Groundwater" section of Appendix C:

"The HHRA uncertainty analysis will discuss and address uncertainties relating to the reporting limits not being low enough to meet the risk-based SSLs for uranium isotopes."

Minor Comments

1. The SAP does not clarify if a decision unit (DU) is synonymous with exposure unit (EU). Please clarify why the term decision unit (DU) is used rather than exposure unit (EU) in the context of data collection for use in risk assessment

Navy Response:

The following sentence has been added as the last sentence of the second paragraph of the Decision Unit subheading within WS#17: "The term decision unit is synonymous with exposure unit."

2. Please include a list of all terrestrial receptors in the Worksheet 10 series; while the majority indicates the specific receptors, some simply indicate terrestrial mammals and avian receptors (e.g. UXO 17 and UXO 18).

Navy Response:

In WS#10n and #10o, the last sentence in Future Land Use and Potential Receptors has been replaced with the following:

"Potentially complete exposure pathways for terrestrial ecological receptors exposed to surface soil include plants, soil invertebrates, birds, mammals, and reptiles. Potential birds and mammals consuming invertebrates, plants, and/or small mammals include the Fruit Bat, Velvet Free-tailed Bat, Norway Rat, Indian Mongoose, Common Ground Dove, Pearly-eyed Thrasher, Cave Swallow, and Red-tailed Hawk."

3. Worksheet #10e - UXO 6 refers to Figure 18 for the Conceptual Site Model (CSM). However Figure 18 is the CSM for UXOs 9 & 10. Please include an appropriate CSM for this UXO.

Navy Response:

WS#10e correctly refers to Figures 18 and 19, as Figure 18 is the CSM for the SIA sites and Figure 19 is the EMA site features; UXO 6 is the EMA and SIA public roads, which can be seen on Figures 18 and 19.

4. Refer to Attachments A through D, rather than Appendices A through D.

Navy Response:

This change has been made globally.

Additional Comments - e-mail from Danny Rodriguez to Kevin Cloe on 6-20-12

1. **General –**

The document should include a discussion of the approach for determining site-specific impact to groundwater values for soil.

Navy Response:

Soil-to-groundwater leaching screening values have been added to WS#11 and #15.

2. Worksheet 14 –

"Following installation of all wells, a round of groundwater level measurements will be collected to verify the groundwater flow direction."

Given that in many cases each watershed (or sub-watershed area) will only have one monitoring well, it may not be possible to use elevation data to determine groundwater flow directions. Please modify the text to reflect this.

Navy Response:

Comment noted for the evaluation of the data. The following sentence has been added to WS#14: “The groundwater levels from the monitoring wells along with other physical characteristics (such as elevations of dry lagoons, etc.) may be used to evaluate the regional groundwater flow direction.”

3. Worksheet 14 (and in 17)-

"The total depth and well screen intervals of 23 new monitoring wells will be at the first encountered water within the saturated zone. Each monitoring well will be screened across a 10 ft interval."

Please correct to reflect the discussion during the May 7-9, 2012, meeting in NYC. The Navy agreed to consider increasing the screen intervals to 15' to ensure the wells would have enough water for sampling.

Navy Response:

Worksheet 14, Monitoring Well Installation and Development, second paragraph, 3rd sentence has been changed to: “Each monitoring well will be screened at the first encountered groundwater using a screen length appropriate for providing sufficient water to facilitate sampling. This will be a judgment call made

in the field based on water production observed during drilling and may include screen lengths up to 15 feet." The same revision has been made to Worksheet 17, Discrete Soil Sampling Design and Regional Groundwater Characterization, second paragraph, 3rd sentence.

4. Worksheet 17 –

"In addition, subsurface soil samples will be collected from a depth of 1 to 2 ft bgs from each incremental sampling unit (except at the lagoon fringe and beach) and from a depth of 4 to 6 ft bgs at each of the monitoring well locations, to evaluate the vertical extent of contamination and will not be used in the risk assessment evaluation."

Please correct to reflect the discussion during the May 7-9, 2012, meeting in NYC. The subsurface soil samples should be collected in a worst case location within the borehole. Worst case locations can be based on visual observations or at the top of water. If neither of these conditions exist then the predetermined 4-6 ft should collected.

Navy Response:

Please see the response to General Comment #11.

5. Worksheet 17 –

"Monitoring wells are conservatively focused in areas with the highest potential for contamination and downgradient of potential release areas (to evaluate migration). The majority of the monitoring wells are located within the LIA, since this area likely has the highest potential for a release to groundwater. The rationale for each monitoring well is summarized in Table 3. Monitoring well locations may be adjusted in the field based on site conditions and munitions safety at the time of mobilization."

Please include a sentence that reflects previous discussions on the approach for groundwater assessment at this site. For example - "The need for additional future groundwater assessment will be evaluated based on the 1) results of soil sampling and 2) results from monitoring wells from the proposed field efforts outlined in this document."

Navy Response:

The following sentence has been added as the last sentence of the second paragraph: "Regional groundwater characterization will follow the 6-step decision analysis and the need for additional future groundwater assessment will be determined by the results of the monitoring well sampling and reviewing soil data to determine the potential for contaminants to leach to groundwater (i.e., fate and transport mechanisms)."

Final Responses to

PREQB Technical Review of the

Draft Master Sampling and Analysis Plan
East Vieques Terrestrial UXO Sites,
Former Vieques Naval Training Range,

Vieques, Puerto Rico

General Comments

1. For all Sampling Approach figures, please identify the features used that influenced the sampling unit (SU) location within each decision unit. For example, Worksheet 17C indicates that features such as depositional areas for surrounding drainage features influenced SU locations for UXO 4 Northwest; however this feature is not shown on Figure 31c for UXO 4 Northwest. If topographic lows were the basis for determining these depositional areas, the contour lines are difficult to see either on the digital or hardcopy versions of the figures. Similarly, drainage areas influenced the selection of SUs for UXO 4 Southwest but no drainage feature is shown on Figure 31d.

   Navy Response:

   The figures have been revised to emphasize the features that influenced each sampling unit rationale. In addition, the topographic contours were made thicker.

2. For those DUs where MEC clearance has not completed, please clarify if contingency SUs are planned to be added. Currently, for many of these areas, only one SU is currently proposed.

   Navy Response:

   Additional SUs may be added in accordance with the 6-step decision analysis and associated PQOs, if warranted, as discussed in WS#11. Note that for many of the DUs with only one SU proposed, there was historically a lack of munitions found. The following text has been added to the appropriate site-specific WS#17s that have ongoing munitions characterization. “The preliminary sampling approach may be modified based on the collection of additional munitions-related data prior to sampling. In these instances, the additional sampling will be provided in a site-specific SAP addendum provided for regulatory review prior to collecting the samples.”

3. At two specific areas, Parcel C and PAOC EE, discrete samples are being proposed to characterize MEC whereas for the remaining UXOs, multi-incremental sampling (MIS) is proposed. Please add text to relevant sections of the RI SAP that provides the rationale for selecting discrete sampling in these areas and MIS sampling elsewhere.

   Navy Response:

   Note that WS #17 under Sampling Method and Approach states that incremental sampling is planned for all of the UXO sites, except for UXO-17 (PAOC EE) and that a discrete soil sampling approach will be used at UXO 17 since the presence of munitions is related to isolated munitions storage and/or discarding and not from range impact or firing activities. This information has been added in WS #17n.

   The following sentence has been added in WS#10l prior to the Investigation and Release History heading: “Munitions are not expected at Parcel C as the site was not historically used as a range, target, or firing point.”

4. It is unclear from this SAP how the decision unit data will be grouped to characterize risks to human health and the environment. This information is needed in order to evaluate proposed decision unit (DU) and sampling unit (SU) quantities and locations as part of the review of the SAP, rather than as part of a subsequent risk assessment deliverable. For example, for a specific UXO where multiple DUs are proposed, will risks be characterized for each DU or will DUs be combined as a general rule for each UXO? For the ECA, the receptors and exposure areas were defined prior to establishing the DUs. This level of detail needs to be added to this SAP since the data generated from this investigation will be used to characterize risks to human health and the environment.

   Navy Response:

   The data groupings will be determined after the site-specific data are available and reviewed. As indicated in the HHRA Protocol, data must be evaluated spatially prior to determination of data groupings for the HHRA. This step will be performed and documented in the HHRA Pre-Interim Deliverable and discussed with the agencies prior to preparation of the HHRA Interim Deliverable, consistent with the HHRA Protocol.

   For the ERA, the data groupings will also be determined after the site-specific data are available and will consider factors such as habitat type. The data groupings will be documented as part of the ERA Interim Deliverable and may differ from the groupings used in the HHRA.

   Risk assessment elements presented in the HHRA and ERA pre-interim and/or interim deliverables, such as grouping of decision unit data, will be subject to additional regulatory review and comment, as will any site-specific modifications to the procedures and methods outlined in the final HHRA and ERA protocols that may be included in the HHRA and ERA pre-interim and/or interim deliverables.

   This information has been added to WS#17 under a new subheading “Risk Evaluation.”

   PREQB Evaluation of Response:

   PREQB understands that for areas with low potential for MC that are selected as sampling units because of the presence of a unique human health exposure area (such as OP-1), these areas will be evaluated as separate exposure areas or a discussion of why the proposed sampling unit data are appropriate for use in characterizing these unique exposure areas will be provided (such as in the Case of OP-1 where the majority of the exposure unit is covered with concrete). Please note that the response pertaining to the ERA approach is accepted, pending resolution of Comment 5 below.

   Navy Evaluation Response:

   The following has been added to Worksheet #17 under the Risk Evaluation subheading as the first sentence of the first paragraph: “Each decision unit is evaluated separately from one another and is not combined. For areas with a low potential for munitions constituents but were selected as a sampling unit because of the presence of a unique human health exposure area, will generally be evaluated as separate exposure areas. However, in some cases, the proposed sampling unit data are appropriate for use in characterizing these unique exposure areas and the details are provided in the site-specific discussions in Worksheet #17”. Please see the response to General Comment 5 pertaining to the ERA approach.

5. Although a discussion of the ecological risk assessment methodology was not specifically provided in the SAP, it is assumed that the Ecological Risk Assessment Protocol (CH2MHill, 2010) will be followed. However, the decision units for the terrestrial habitats are very large with relatively few sampling units present for each decision unit. Constituents detected at a single sampling unit would represent exposure for ecological receptors throughout most of their foraging range. Therefore, PREQB is requesting that the maximum concentrations detected within each decision unit be used in assessing ecological risk throughout the

assessment rather than the mean concentrations as typically conducted and discussed in Step 3A of the protocol when much smaller areas are being evaluated.

Navy Response:

The approach, methods, and assumptions used for the ERA will be based upon the final ERA protocol presented in the Master Standard Operating Procedures, Protocols, and Plans (CH2M HILL, 2010) and the Master Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program – Update 1 (Addendum) (CH2M HILL, 2010), the latter of which is included with these responses.

In accordance with the ERA protocol, the exposure point concentration (EPC) at the screening level (SERA; Step 2) will be the maximum detected concentration, while at the baseline level (BERA; Step 3) the EPC will be a central tendency estimate (arithmetic mean and the 95 percent upper confidence limit [UCL] of the arithmetic mean). Therefore, the ERA will be conducted per the protocol, which includes evaluations of both maximum and mean exposure concentrations, and uncertainties related to the sizes of decision units versus the number of sampling units will be addressed in the risk characterization. Also, please note that the placement of sampling units is biased toward worst-case exposures so that central tendency estimates for particular receptor populations will still include a substantial level of conservatism.

This information has been added to WS#17 under a new subheading “Risk Evaluation.”

PREQB Evaluation of Response:

As discussed at the August ERP Technical Subcommittee meeting, the maximum detected concentrations for a decision unit will be used in Step 3 for those receptors with small home ranges as significant adverse effects to the population may occur from the results obtained from a single sampling unit. For those receptors with small home ranges and even for receptors with larger home ranges, the areas represented by each sampling unit relative to the decision unit size needs be evaluated with respect to home range size to determine whether the central tendency estimate (arithmetic mean and the 95 percent UCL of the arithmetic mean) would be protective of the population within each decision unit. If each sampling unit within a decision unit contains sufficient area to include the entire home range (or multiple home ranges) for a particular receptor then the maximum detected concentrations detected within the sampling units would be representative of exposure in Step 3 of a BERA. If the areas represented by sampling units within a decision unit are too small to encompass the home range of a receptor, then the central tendency estimates would be appropriate to evaluate risk to these receptors in Step 3. However, the central tendency estimate for ecological receptors with large home ranges should be the same as the central tendency estimate for human health exposure for each decision unit. As discussed during the ERP meeting, sampling units associated with a specific human receptor (e.g., a proposed observation tower) that may be biased toward low contaminant exposure will not be included in calculating a central tendency estimate for that decision unit for human and ecological receptors.

Navy Evaluation Response:

Where an individual sampling unit associated with a specific human receptor is biased towards low contaminant concentrations, the sampling unit will not be included in the central tendency estimate for other receptors in the larger decision unit.

In Step 3 of the BERA, the area represented by each sampling unit relative to the area of the associated decision unit will be considered with respect to the home range size of each target wildlife receptor. For receptors with small home ranges such that their entire range is less than that of a sampling unit (approximately 1 acre), maximum detected sampling unit concentrations would be considered representative of decision unit exposure. For wider ranging receptors with home ranges greater than the area of a sampling unit, central tendency estimates (arithmetic mean and the 95 percent UCL) would be considered representative of decision unit exposure. For each decision unit a description of the decisions made for identifying Step 3 wildlife exposure

concentrations will be included in the BERA, along with any potential deviations required based on site specific conditions.

Decision unit central tendency estimates will be the same for the ecological and human health risk assessments.

6. Incremental sampling is being used for surface soil at most sites in order to reduce the variability that would be inherent with discrete surface soil sampling at such large sites. It is understood that incremental sampling is not ideal for subsurface or deeper surface soil samples. However, in most cases, the number of discrete subsurface or deeper surface soil samples being collected at each site is equivalent to the number of sampling units. Please clarify how the reduced number of discrete subsurface soil samples will be representative and without variability at such large sites. At least for the first sites being investigated using this SAP, it is recommended that additional subsurface soil samples be collected (the number to be determined based on UXO-specific conditions) to evaluate the variability to determine if the number of subsurface soil samples can be reduced for future site investigations.

Navy Response:

Energetic and inorganic chemicals associated with munitions releases have the highest concentrations present near the ground surface with the vast majority in the top inch or two, as discussed in WS#17. Therefore, surface soil sampling units to a depth of 2.5 inches will conservatively characterize the depth interval with the highest potential for contamination. This interval also best represents the majority of potential exposures. Note that over 170 sampling units are proposed.

Subsurface soil samples are proposed at each sampling unit even though these depth intervals have a lower potential for contaminant presence. Further, to more conservatively characterize the subsurface, sample locations are biased toward a subsurface munitions item (if encountered and deemed safe). In addition, subsurface soil samples will be collected from each monitoring well location and additional subsurface soil samples have been added in the OB/OD area (please see response to EPA General Comment #34). Therefore, the number of subsurface soil samples proposed is appropriate to characterize the vertical extent of contamination at each site.

PREQB Evaluation of Response:

As agreed during the August 2012 ERP Technical Subcommittee meeting, initially, two subsurface samples will be collected within each sampling unit, where each subsurface sample will be located at areas of anticipated highest subsurface impacts. The data from the subsurface soil samples will be evaluated to determine the need for additional subsurface soil samples or if the subsurface is sufficiently homogeneous as to only require the collection of one subsurface soil sample for adequate characterization.

Navy Evaluation Response:

The appropriate worksheets have been revised to include the collection of two subsurface soil samples within each sampling unit. As the data collected from the sites are evaluated on a continuing basis, the number of subsurface soil samples with each sampling unit will be adjusted, as warranted, with consensus from the ERP Technical Subcommittee. The subsurface soil samples will be focused in areas with the highest potential for a subsurface release using a geophysical instrument-aided technique and if deemed safe. Each subsurface soil sample will be collected in accordance with the modified Vieques protocol.

7. Worksheet 10 (page 39) states that since soil background data are not available for the beaches, soil background data will be collected from representative background beaches. This is also mentioned in Worksheet 11. Worksheet 17 (page 109) states that soil background data for the beaches will be compared to the adjacent terrestrial lithologic unit from the background study. During the May 6 ERP subcommittee

meeting, the Navy mentioned that the decision to collect representative samples from background beaches would be done after the results of the beach sampling unit investigations were obtained (to determine if background sampling is needed). Please revise the SAP to reflect the current approach for collecting background samples for beaches. Please clarify and update worksheets in the QAPP accordingly, if these additional samples are to be collected. Please clarify the locations and numbers of samples. Also, please note that the USACE document referenced in the Executive Summary (Interim Guidance 09-02, Implementation of Incremental Sampling of Soil for the Military Munitions Response Program, 2009) states that all sampling units used to determine site-specific background of analytes should be sampled in triplicate. Please clarify if this will followed for the beach sampling.

Navy Response:

WS#17 is correct in that background data for the beaches will be compared to the adjacent terrestrial lithologic unit background data, similar to what was done for the ECA RI. However, the sentence has been modified to read "Soil background data for the beaches will be compared to the adjacent terrestrial lithologic unit from the background study or to data collected from a representative background beach(es), if identified. If a representative background beach(es) is identified, it will be included in an addendum to the Master SAP for regulatory review." In addition, the third sentence of the third paragraph following the bullets under "Objectives and General Characterization Approach" in WS#10 has been revised to: "Since soil background data are not available for the beaches, soil background data will be compared to the adjacent terrestrial lithologic unit background data or to data collected from a representative background beach(es), if identified. If a representative background beach(es) is identified, it will be included in an addendum to the Master SAP for regulatory review." This information has also been added to fourth bullet under "What are the Project Action Limits (PALs)?" in WS#11.

PREQB Evaluation of Response:

As discussed during the ERP Technical Subcommittee meeting, the comparison of soil data collected from beaches to background data from an adjacent terrestrial lithologic unit will only be presented as one line of evidence. PREQB's concern is that terrestrial soils are expected to have higher concentrations of metals than beach sands; therefore, concentrations of metals identified in soil samples collected from beaches may be within the range of background for terrestrial soils but may still be considered elevated.

Navy Evaluation Response:

The appropriate worksheets have been revised to indicate that a multiple lines of evidence approach will be used to evaluate potential inorganic releases at the beaches. One line of evidence would be to compare the beach soil data to the adjacent terrestrial lithologic unit background data. If the multiple lines of evidence approach is unclear, background data would be collected from representative background beach(es), if identified, and would be included in an addendum to the Master SAP for regulatory review.

8. According to Worksheet 10, many of the sites (UXO 2, UXO 7, UXO 8, UXO 12, UXO 13, UXO 17, and UXO 18) contain groundwater which is saline due to seawater intrusion. Based on this, there is concern about the use of routine sample digestion methods and/or the use of SW-846 method 6010B for the analysis of select metals in groundwater. Samples influenced by salt water can contain many interferences (elevated levels of sodium, chloride, potassium, aluminum, chromium and/or vanadium) and in many instances, do require dilutions when using SW-846 method 6010B to eliminate or reduce these interferences. When dilutions are performed, there is the potential for the limits of detection (LOD) to exceed the project action levels. Please discuss the potential for elevated detection limits to affect the data quality objectives for the investigation.

Navy Response:

It is difficult to demonstrate the absence of metals, at trace levels, in groundwater affected by saltwater intrusion or in saline surface water. At this stage in an investigation, when particular metals have not yet been identified as constituents of concern, routine analysis via SW-846 6010C and 6020A is appropriate because no metal is more important than any other. At a later stage, when particular metals have been identified as constituents of concern, specialty analytical methods can be used to eliminate interferences, if deemed necessary. In general, these may be ultra-trace methods, where heavily diluted LODs are still less than screening levels, or specialty preparation methods where analytes are 'removed' from the problematic matrix prior to analysis. At that time, only analysis for particular metals will be needed versus full TAL.

Also note that, as per footnote #7 on Worksheet #15-7, there is flexibility to report metals via 6010 or 6020, if it provides better results (at sample-specific dilution factors).

The impact of elevated reporting limits is always considered and discussed in the data quality evaluation report section.

PREQB Evaluation of Response:

PREQB is concerned that due to dilutions required to address interferences, metals that could be identified as constituents of potential concern (i.e., above background and risk screening criteria) would not be considered detected due to elevated detection limits. It is PREQB's preference that groundwater samples likely to be saline first be treated using special preparatory methods (i.e., chelate extraction or reductive precipitation) to deal with these interferences followed by analysis using SW-846 method 6020A. These special preparatory techniques remove the interferences so significant dilutions do not have to be performed; however, PREQB will defer to EPA on this issue.

Navy Evaluation Response:

Comment noted. The Navy is not averse to performing these specialty analytical methods when warranted. However, it is not necessary to go to such difficulty and expense until potential constituents of concern have been identified and it is actually necessary to demonstrate their absence at less than action limits. At the initial stages of an investigation, typical metals analysis via 6010/6020 is sufficient, and uncertainty due to elevated reporting limits is discussed in the data quality evaluation report section. If it is determined that data are not usable for their intended purpose, then specialty analytical methods for specific analytes would be considered at that time (additional samples may or may not be required). Therefore, the first round of groundwater sampling will be conducted with standard methods, and the results will be used to determine if specialty methods are warranted for particular analytes.

9. Please update worksheets, as appropriate, to reflect the decision made during the May ERP meeting concerning the depth at which subsurface soil sampling will be conducted.

Navy Response:

Discrete subsurface soil samples will be collected in accordance with the Vieques Master Protocols; this has been revised throughout the document.

PREQB Evaluation of Response:

As agreed during the August ERP Technical Subcommittee meeting, the subsurface soil sampling protocol will be revised to be consistent with the Master SAP SOP and text will be added to the SOP indicating that subsurface soil samples will coincide with depth and location at which MEC was identified and removed or at depth and location of highest anomaly readings.

Navy Evaluation Response:

Change made as requested.

10. For decision units which contain multiple sampling units, please clarify if the concentrations of analytes in each sampling unit will be compared to the risk-based screening levels or if the mean concentration of results in all sampling units within a decision unit will be compared to the risk-based screening levels.

Navy Response:

The statement "Each incremental sampling unit sample and discrete sample will be compared to the applicable PALs" has been added to WS#11, Project Action Limits.

11. It is also unclear if the incremental sampling procedure is applicable to hexavalent chromium. Please clarify if methods or references have demonstrated that this is an acceptable approach for hexavalent chromium.

Navy Response:

Note that the document entitled Site Characterization for Munitions Constituents (EPA, 2012) states: "if low metal concentrations are anticipated or levels close to a regulatory value then sample pulverization should be considered. It should be noted that an optimum grinding interval and identification of appropriate grinding equipment has not be completed. Another issue to consider when using metallic grinding apparatus is the possibility of the introduction of metal into the sample from the grinding equipment…Preliminary studies suggest this may be an important issue to consider if chromium, iron, manganese, or tungsten are constituents of interest. Research into this topic is ongoing..". A grinder suitable for metals analysis will be used as outlined in the Master SAP and includes both the analysis of chromium and hexavalent chromium.

The incremental sampling procedure with analysis of hexavalent chromium was successfully implemented during the ECA RI. Also note that although chromium may be associated with munitions, it is reportedly used in minute quantities.

12. Please clarify the sample ID strategy for all sampling units and subsurface soil samples. Tables 4 and 5 appear to have different sample IDs even though there is only one decision unit for UXO 2 and UXO 3.

Navy Response:

The nomenclature for the sampling units at the beach sites has been revised in WS#18 and Tables 2, 9, and 10. Note that the road site nomenclature is correct.

Page-Specific Comments

1. Worksheet 2, Page 3, Dates of Scoping Sessions: Please add March 15, 2012 to this table, as per Worksheet #9 on page 30.

Navy Response:

WS#2, item 4. Dates of scoping sessions table has been appended with: "Environmental Restoration Program/Munitions Response Program Technical Subcommittee Site Visit-Vieques, Puerto Rico March 15, 2012"

2. Worksheet 5: Please revise Wilmarie Rivera's extension to 6129.

Navy Response:

SAP WS#5, Wilmarie Rivera's extension has been revised to 6129.

3. Worksheet 8: DoD is indicated as the only training provider for UXO Technicians. This isn't correct as UXO Tech IIs on Vieques have originated out of the Texas A&M courses taught on Vieques. Please add civilian training programs for UXO Technicians to this table. The training and qualification requirements in the DDESB TP 18 should also be referenced here.

Navy Response:

The training for UXO technicians has been revised to reflect the potential external training courses that the on-site workers may have attended. The table entries for the UXO technicians have been changed to the following:

Project Function	Specialized Training by Title or Description of Course	Training Provider	Training Date	Personnel/ Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
Field Activities	UXO Technician Training to meet minimum requirements of DDESB TP 18 for the relevant UXO Technician level	• U.S. military EOD school • Canada, Great Britain, Germany, or Australia military EOD school • Formal UXO training course of instruction or EOD assistant courses	Training will be verified as current prior to starting field activities by SSC; training will not be provided by CH2M HILL	Subcontracted UXO Tech II or higher	Subcontracted UXO Tech TBD	Subcontractors records and CH2M HILL field safety files. Records to include resume (as demonstrated experience), qualifications, and copies of certifications

4. Worksheet 9-3, Key Discussion (October 27, 2011/Action Item): The Key Discussion and Action Item sections for the October 27, 2011 Scoping Session are duplicated on this page.

Navy Response:

The duplication has been removed.

5. Worksheet 10:

   a. Page 35: Please update the description of UXO 1. UXO 1 is part of the arc for the OB/OD area and it was part of the range fan for activities in the LIA. These are not "misfires". The current description minimizes the MEC involvement for the ECA and needs to be revised to convey the actual MEC impacts on UXO 1.

   Navy Response:

   The text has been revised as follows: "The ECA, which was wholly designated UXO 1, was established as a conservation area and not used as an operational area for munitions; however, the site is located adjacent to the LIA, where MEC and other munitions-related material identified in the ECA were most likely from munitions directed toward the LIA that missed their intended target."

   b. Page 35, VNTR Investigation and Interim Action History: Please add the historical investigation discussed on page 61 for UXO 10 to this discussion.

   Navy Response:

   The SWMU 12 PA/SI has been added the Section titled VNTR Investigation and Interim Action History in Worksheet 10.

   c. Page 36, VNTR Investigation and Interim Action History, Paragraph 3: Please add a statement when discussing why tris(2-ethylhexyl)phosphate is expected not to be present regarding what is known about the persistence of this chemical in the environment.

   Navy Response:

   The last sentence of the first paragraph has been modified as follows: "Since the activities were conducted almost 40 years ago and for only a few days on the beaches, which are a dynamic

environment, and based on what is known about the persistence of this chemical in the environment, tris(2-ethylhexyl)phosphate is not expected to be present."

d. Page 38, Land Use: Please revise the last sentence of the first paragraph to state that there are no plans for groundwater use (or similar text) rather than stating that groundwater cannot be developed. This comment applies to all worksheets where this statement is made.

Navy Response:

The statement throughout the Master SAP has been revised to indicate that groundwater is not intended for use.

PREQB Evaluation of Response:

Please add "at this time" to the end of the statement so the text reads "… groundwater is not intended for use at this time…"

Navy Evaluation Response:

Change made as requested.

e. Please clarify why only trespassers are assumed to ingest land crabs. The crabs may be taken home and prepared for a family; therefore, a separate exposure scenario is recommended to evaluate land crab ingestion by others (adult, youth and child) in addition to evaluating land crab ingestion as part of the cumulative exposure for the trespassers. Also, crab issue is also an exposure medium for those UXOs where landcrabbing occurs.

Navy Response:

The "Future Land Use and Potential Receptors" section of WS#10c, first sentence of the 2nd paragraph, was replaced with the following sentence:

"USFWS workers and trespassers (adolescents and adults) may be exposed to soil, surface water, and sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue."

The "Future Land Use and Potential Receptors" section of WS#10h, third sentence of the 1st paragraph, was replaced with the following sentence:

"USFWS workers, trespassers (adolescents and adults), hikers (adolescents and adults only along interpretive trails within the northern portion of the site), and construction workers (during construction of a future observation tower) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue."

The "Future Land Use and Potential Receptors" section of WS#10i, second sentence of the 1st paragraph, was replaced with the following sentence:

"USFWS workers and trespassers (adolescents and adults) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue."

The "Future Land Use and Potential Receptors" section of WS#10k, third sentence of the 1st paragraph, was replaced with the following sentence:

"USFWS workers and trespassers (adolescents and adults) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue."

The "Future Land Use and Potential Receptors" section of WS#10l, first sentence of the 2nd paragraph, was replaced with the following sentence:

"USFWS workers and trespassers (adolescents and adults) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC, while land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue; at Parcel C only, residential receptors will also be evaluated in the HHRA."

The "Future Land Use and Potential Receptors" section of WS#10m, fourth sentence of the 1st paragraph, was replaced with the following sentence:

"USFWS workers, trespassers (adolescents and adults), and hikers (adolescent and adult) may be exposed to soil, surface water, and/or sediment and potentially exposed to the explosive hazard associated with MEC; in addition, land crab consumers (adults, adolescents, and children) may be exposed to land crab tissue."

f. Please provide the depth to which surface and subsurface MEC removal occurred for each relevant worksheet 10.

Navy Response:

The following breakdown of clearance depths has been included/clarified as appropriate in the WS#10 for each applicable site:

- For surface removal the clearance depth was limited to items located on or protruding from the ground surface (UXOs 2, 3, 4, 5, 6,7,8, 9, 10, 11, and 12)
- Subsurface removal on the roads and road buffers was conducted to 2 ft below ground surface bgs (UXOs 3 [minimal], 5, 6, and 11)
- Subsurface removal on the sandy beaches and buffers was conducted to 4 ft bgs at the time of the removal action (UXOs 2, 7, and 8)

g. For beach UXOs, please clarify how the waterline is determined.

Navy Response:

For the UXO sites with sandy beach areas, the beach is considered the area from the low tide water line to the heavy vegetation line on the inland side of the beach at the time of the DGM survey. This information has been added to the beach UXO site discussions.

h. Page 39, Objectives and General Characterization Approach: Please add March 2012 to the list of meeting dates.

Navy Response:

WS#10, Objectives and General Characterization Approach, first sentence has been modified to: "…August, October 2011, and March 2012 to jointly scope the rationale, sampling approach,…"

i. Various versions of Worksheet 10 provide data for MPPEH. However providing data for MPPEH is not appropriate because this term refers to a classification prior to determination of its explosives safety status (see definitions on Page 37). Since the explosive safety status of all of the MPPEH found on Vieques is now known all of these items can be classified as UXO, DMM, MDAS, and MDEH.

Navy Response:

The purpose of providing the MPPEH data was to identify MEC that could have potentially contained explosives and been a potential source of MC. The worksheets have been updated with information on the recovered data through June 30, 2012. The quantities have been split among the appropriate item groups.

6. Worksheet 10a: Children may be brought to beaches accessible by boats or vehicles. Please add the child trespasser as a receptor for those beaches accessible by boat or vehicle.

Navy Response:

The "Future Land Use and Potential Receptors" section of WS#10a, first sentence of the 2nd paragraph, was replaced with the following sentence:

"USFWS workers (for turtle monitoring) and trespassers (adults, adolescents, and children) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC."

7. Worksheet 10b:

a. Investigation and Release History: Please add information concerning the depths to which the surface and subsurface MEC clearance was conducted. This comment applies to all relevant Worksheet 10s.

Navy Response:

As discussed in the response to page-specific comment 5f, the depths of clearance for each UXO site have been included in the discussion of those sites.

b. Worksheet 10b and many other worksheets list investigation results through October 2011. Please clarify why more recent results are not included in this document. Also, the text on 10b says that only 10 subsurface anomalies were identified and removed while nearly 5,000 UXO were found. Please verify that this data is correct. Finding 10 subsurface anomalies indicates that the LIA roads are very lightly contaminated but this is not likely to be the case. This text should be updated and revised to present a more accurate description of the investigation history of UXO 3.

Navy Response:

Because the various NTCRA activities at the former VNTR are and have been ongoing, the cutoff date of October 31, 2011 was selected for the date when preparing the draft SAP as this was the time at which the sampling strategy was initiated. Should future NTCRA activities provide data that may impact the selection of optimum sample locations, a SAP Addendum will be prepared to provide the most up to date information and any proposed revisions to the sampling plan. However, the data in the text and figures has been revised to reflect the work completed through June 30, 2012. As the NTCRAs are completed for each site, the data will continue to be evaluated to determine if modifications to the planned sample locations are warranted.

As of October 31, 2011, a relatively minimal amount of subsurface MEC removal activities were conducted in UXO 3; therefore, the number of anomalies detected and investigated is disproportionately low when comparing this site to other sites. This is due to the safety issues and cost for investigating the detected geophysical anomalies and the fact that there is not concurrence among the stakeholder agencies that the NTCRA activities will suffice as a final MEC-related action for the site.

PREQB Evaluation of Response:

Please add the information in the second part of the response to the SAP saying that very little work has been performed in UXO 3 and that this is the reason that so few anomalies have been detected and resolved. This will provide the context needed to understand why this number of anomalies is so low.

Navy Evaluation Response:

The paragraph referenced for UXO 3 has been changed as follows:

The LIA roads were surface cleared of munitions as part of the TCRA. Through October 2012, DGM has been conducted at approximately 14 of the 39 acres as part of the NTCRA

(Figure 6). Approximately 0.3 acres have been subsurface investigated; however, the NTCRA is currently ongoing. The DGM anomalies were investigated to a maximum depth of 2 ft bgs; the investigation of the anomalies was abandoned if the water table or refusal was encountered prior to reaching 2 ft bgs. The items found at the at the ground surface through October 2012 are summarized below. Due to the evaluation of the Metal Mapper System for potential use in future munitions response activities, the items recovered from the subsurface at UXO 3 have not been made available at the time of this SAP in order to maintain the integrity of the evaluation and not potentially impact the data evaluation.

8. Worksheet 10c:

   a. Conceptual Site Model: Please note that Figure 15 presents the CSM for this UXO rather than Figure 16.

      Navy Response:

      The text has been revised to call out Figure 15.

   b. Physical Characteristics and Transport Pathways: Although vegetation may be present now, please discuss whether sufficient vegetation was present during military activities to limit wind dispersion (and other transport mechanisms, as appropriate).

      Navy Response:

      Vegetation was present at the time of military operations; this information has been added to WS#10c.

9. Worksheet 10d: Please add trespassers as receptors for this UXO.

   Navy Response:

   The "Conceptual Site Model" section of WS#10d, fourth sentence of the 3rd paragraph, was replaced with the following sentence:

   "USFWS workers, public recreators, and trespassers (adults and adolescents) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC."

10. Worksheet 10h:

    a. The text states that interpretive trails are intended for public use in the northern portion of UXO 9; however, Figure 17 shows an interpretive trail area in the south, near Playa Fanduca. Please clarify. Please clarify the difference between receptors who use hiking trails and receptors who use the interpretive trails. The text states that hikers are present only along interpretive trails within the northern portion of the site; however, trails are intended in the south as well.

       Navy Response:

       USFWS has now indicated that the interpretive trail in North UXO 9 is no longer intended for recreational land use due to the sensitive nature of the vegetation and habitat. In addition, USFWS has now indicated that the interpretive, biking, and hiking trails and observation tower in Southwest UXO 9 will only be along the road in this area (associated with UXO 6 instead of UXO 9) due to the sensitive nature of the vegetation and habitat. WS#10e (UXO 6) has been revised to include hikers (adolescent and adult only) and WS#10h has been revised to remove hikers as a potential receptor.

       The following statement has been added to WS#10h, under the "Future Land Use and Potential Receptors" subheading: "Although the northern portion of UXO 9 is identified as having land use

intended for interpretive trails within the CCP, USFWS has since identified this land as having sensitive vegetation that will not be intended for public use."

An observation tower is noted on Figure 17 near Beach 38. Please clarify if this structure has already been constructed. If not, please add a construction worker as a potential receptor for UXO 9.

Navy Response:

The observation tower has not yet been constructed. Construction workers were added as potential future receptors (see response to Comment 5e).

b. Physical Characteristics and Transport Pathways: Ephemeral streams are stated to originate and drain from UXO 10 (LIA interior). Please correct this typographical error to SIA interior.

Navy Response:

Revised as requested.

11. Worksheet 10k:

a. Please clarify why Worksheet 10j includes public recreators as receptors for the roads within the EMA, but only trespassers are included for the interior portions of the EMA. Note that Figure 19 shows rest areas, an observation tower, and a parking area within UXO 12, indicating that recreational use of the interior is planned.

Navy Response:

The rest areas, observation tower, and parking area are associated with the roads (UXO 12) and not within the interior of the EMA.

PREQB Evaluation of Response:

Please refer to PREQB's Evaluation of Page-Specific Comment 60.

Navy Evaluation Response:

Please see the response to Page-Specific Comment 60

b. Please clarify the difference in exposure scenarios for a public recreator and a hiker, which is a recreational receptor identified for other UXOs.

Navy Response:

The potential exposure scenarios for public recreators and hikers are expected to be the same. Hikers were identified as potential receptors where USFWS maps designate future hiking trails.

PREQB Evaluation of Response:

As discussed during the August 2012 ERP Technical Subcommittee meeting, no new trails are planned at this time, only current roads and trails will be used for recreational purposes. Please revise the response accordingly.

Navy Evaluation Response:

Hikers were reclassified as recreators on Worksheets 10e, 10h, and 10m to avoid confusion since potential exposure scenarios are expected to be the same for both receptor groups

c. Please clarify whether construction activities will occur based on the proposed land uses shown on Figure 19 (observation tower, parking areas, etc.)

Navy Response:

The Master SAP provides the intended land use as described in the Comprehensive Conservation Plan for the Vieques National Wildlife Refuge completed by USFWS. The document does not indicate that

construction activities are intended for the proposed recreational areas, with the exception of the observation tower at UXO 6.

d. Please clarify the purpose of the parking area. Is this area designated for public use other than sitting in a parked car?

Navy Response:

Please see the response to Page-specific Comment #11c.

PREQB Evaluation of Response:

Typically, a parking area is created for recreators to park their cars in the vicinity of a recreational area. Please clarify whether recreational activities will occur in the vicinity of this location or whether the location for additional parking areas is not known.

Navy Evaluation Response:

The first sentence under the Future Land Use and Potential Receptors subheading of UXO 11 Worksheet 10j has been revised as follows: "In the CCP, UXO 11 is shown as desired for public use and also includes an observation tower, picnic areas, and parking area, but will be managed as part of the wildlife refuge. The specific details regarding these activities are not known at this time, and the locations of these areas shown on the figures are not necessarily representative of the actual location where proposed recreational uses may occur".

12. Worksheet 10l:

a. Page 72, Physical Characteristics and Transport Pathways, Paragraph 1: In order to better support the statement regarding the topographic high along the western boundary between UXO 13 and the MOV, it would be helpful to the reader to have access to a figure which more clearly shows the topography. Although the topographic lines are shown on several figures, including Figure 19, the color coding used for the definition of the various areas and features does not allow for them to be easily seen.

Navy Response:

Figure 8, the East Vieques Topographic/ Hydrologic Map, has been updated to more clearly show the topographic lines.

b. Page 72, Future Land Use and Potential Receptors: Please clarify why residential receptors are not included for UXO 13 for Parcel C when unrestricted land use is proposed for this parcel.

Navy Response:

Residential receptors were added for Parcel C (see response to Page-specific Comment 5e).

13. Worksheet 10o, Future Land use and Potential Receptors: This section indicates that receptors will be evaluated for exposure to surface water and sediment. Please clarify where the surface water features are as none are indicated on Figure 24.

Navy Response:

No surface water or sediment samples will be collected at this site since there are no surface water features. The "Conceptual Site Model" section of WS#10o, fourth sentence of the 2nd paragraph, was replaced with the following sentence:

"USFWS workers and trespassers (adults, adolescents, and children) may be exposed to soil and potentially exposed to the explosive hazard associated with MEC."

14. Worksheet 11, Page 80, Question 3:

    a. Please provide more detail on the quantity and quality of data needed to support future decision-making. For example, the description of the data needed to determine the nature and extent of MEC contamination in Step 1 on Page 81 isn't complete. This portion of this worksheet describes the actions to be taken "If the MEC nature and extent have been sufficiently delineated …", but it doesn't define the data quality and quantity needed to achieve sufficient delineation of the MEC contamination. Specific DQOs defining the quantity and quality of MEC-related data needed to support future decision-making are needed to define the end-point for data collection.

Navy Response:

As discussed and shown in each of the site-specific worksheets, the site-specific sampling proposed in the SAP is based on the cumulative information available for the site, including the current understanding of the nature and extent of MEC (the potential contaminant source), which includes not only actual identification of MEC, but also other elements of the CSM, such as historical site use, release mechanisms, fate and transport, and potential exposure pathways. This cumulative information has been deemed sufficient for each site contained in this SAP to identify conservative sampling locations. However, the SAP provides for continual scrutiny of this conclusion in that as additional MEC data are gathered at any particular site (e.g., via NTCRAs) following issuance of this SAP, the data are evaluated to determine if they suggest the understanding of the nature and extent of MEC has been altered such that the MC characterization and/or MEC remedial determinations could be affected. If the former occurs, modifications to the sampling approach at the affected site will be proposed in a site-specific addendum. Ultimately, the conclusions drawn that the nature and extent of MC and MEC have been sufficiently delineated will be subject to review by the regulatory agencies in the corresponding report. This information has been added as a final paragraph prior to Step 2 (MEC) in WS#11.

PREQB Evaluation of Response:

As discussed at the August 2012 technical meetings in New York, it was agreed that MEC DQOs will be developed for the MEC investigation and they will be added to Worksheet 10.

Navy Evaluation Response:

The following information has been added to Worksheet #11:

What types of data are needed.."The classification, quantity, and distribution of MEC, MPPEH, MD, RRD, and cultural debris observed during removal actions and/or transect inspections, as applicable to each UXO site and recorded by UXO qualified personnel".

How good do the data need to be…"The MEC, MPPEH, MD, RD, and cultural debris will be identified by qualified UXO Technicians to provide technically sound and defensible assessments regarding the nature and distribution of MEC across each UXO site".

How much data should be collected…"During removal actions and investigations, the MEC classification, type, quantity, and grid location for MEC, MPPEH, MD, RRD, or cultural debris found should be documented".

Where, when, and how should the data be collected…"MEC, MPPEH, MD, RRD, and cultural debris classifications, quantities, and locations will be recorded during removal actions and/or transect inspections as described in SOP MR-3".

How each of the DQOs will be achieved has been added to the site-specific Worksheets #17. This information was submitted for review to Jim Pastorick on November 13, 2012 and edits were incorporated into the draft final version of the SAP.

b. Page 80, Question 5: Please add groundwater to the bullet discussing the water quality parameter measurements. These parameters will be measured in groundwater as well as surface water.

Navy Response:

WS#11, question 5, third bullet has been added which states: "Field measurements of the groundwater and surface water salinity,…"

c. SVOCs are listed as chemicals of interest. Based on Worksheets 17 and 18, this should be noted as PAHs only (and not SVOCs). There were no sites where the analysis of the full list of SVOCs was discussed.

Navy Response:

WS#11, second bullet has been revised to "…elemental and radiological uranium, PAHs, and inorganic constituents, as shown in worksheets #15, and #18."

d. Hexachloroethane is listed as a VOC in this discussion. This analyte is measured using SW-846 Method 8270C, which is a SVOC method. Please change VOC to SVOC. Please note that this analyte is correctly listed as a SVOC on Worksheets 15 and 18.

Navy Response:

Hexachloroethane has been removed from WS#11, second bullet.

15. Worksheet 14:

a. Page 89, Incremental Soil Sampling: Please clarify on this worksheet if the collection of surface soil samples will include the surface vegetation and plant matter. Please note that Worksheet #28 states that whether or not the vegetation is included in the sieving process is a project-specific requirement. PREQB's preference is that it is not included.

Navy Response:

The following sentence has been added to the end of the paragraph under "Incremental Sample Collection" in WS#14: "Vegetation will not be intentionally included in the soil samples. Where vegetation is present at the ground surface, it will be pushed aside before collecting the soil sample."

b. Pages 90-91, Groundwater Sampling: Please include a specific reference in this section to the EPA Region 2 protocol for low flow purging and sampling. Also, per the protocol, the turbidity readings must stabilize to within +/- 10% for three consecutive readings. Please reflect this in the text.

Navy Response:

Master Protocol SOP B-1 Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling (CH2M HILL, 2010b), which is based on the EPA Region 2 protocol, and which has been accepted by the regulatory agencies as the groundwater sampling SOP for the Vieques Environmental Program, will be followed for this sampling event. The sentence "Parameters will be considered stabilized over three consecutive readings when measurements generally agree as follows:" and the subsequent list of parameters have been replaced with: "Groundwater samples will be collected following SOP B-1, Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling (CH2M HILL, 2010b)."

c. Page 91, Groundwater Sampling: Please delete the reference to trip blanks in the discussion of QA/QC samples. Trip blanks will not be required since there are no samples being collected for VOCs.

Navy Response:

Neither trip blanks nor field blanks will be collected. Both have been removed from the sentence in WS#14, "Groundwater sampling."

d. Page 92, Munitions Characterization Procedures: Paragraph 3 states that grab samples will be collected and analyzed for explosives by SW-846 8330. Please clarify why perchlorate using SW-846 6850 is not included for these samples.

Navy Response:

The statement has been deleted from Worksheet 14 and listed in Worksheet 23 and 28 to indicate that perchlorate will be analyzed using SW-846 6850.

e. Page 92 describes performing MEC disposal. Please clarify why this procedural information for disposal shots is discussed yet similar information is not provided for other procedures such as DGM, surface removal, etc. Please consider providing SOPs containing the important field procedures that will be used. Also, the procedure described on this worksheet includes tamping every shot with 3-ft. of soil and sifting the area to remove all fragments following the disposal detonation. Is this the procedure that will be implemented? Please clarify where this procedure is described in detail for guidance to the field personnel.

Navy Response:

As stated in the text, "the details about the equipment, work approaches, and quality control requirements that will be employed [during the investigation of subsurface anomalies in UXOs 13 and 17] can be found in the Final Work Plan for Munitions and Explosives of Concern, Subsurface Interim Removal Action Beaches and Select Roadways, Former Vieques Naval Training Range (VNTR) and Former Naval Ammunition Support Detachment (NASD), Solid Waste Management Unit 4, Vieques, Puerto Rico (CH2M HILL, 2008)."

The details about the demolition events, however, are specific to the actions that will take place if an item requiring destruction is found after collecting the environmental samples for the RI. The proposed disposal procedures described in the SAP are not typical disposal actions that have taken place on Vieques and are therefore included in the SAP. These procedures have been developed to help ensure that demolition events following the environmental sampling for the RI do not (re-)contaminate the site or otherwise alter the conclusions based on the RI sample results. This procedure is consistent with the post-RI MEC demolition activities that occurred at SWMU 4.

PREQB Evaluation of Response:

As discussed at the August 2012 technical meetings in New York, the current description of MEC disposal in Worksheet 17 requires the Navy to bury every detonation with 3-ft. of soil or sandbags, excavate every site following the detonation and remove all of the fragments by soil sifting. It was pointed out that these procedures are extreme and were only used on SWMU 4 after the investigation was complete and the Navy wanted to prevent any recontamination caused by a few final BIPs. The Navy confirmed that they don't intend to implement these extreme procedures during the RI and it was agreed that this text will be deleted and replaced with the expanded sampling approach in response to Comment 20a below.

Navy Evaluation Response:

The text has been deleted and a SOP describing the practices for post-demolition sampling has been added.

f. Page 93 provides additional information on two MRS: UXO 13 and UXO 17. Please clarify why this information is provided here rather than in the UXO-specific Worksheets 17 where the technical approach to every MRS is provided.

Navy Response:

The information from WS#14 has been moved to WS#17l and WS#17n.

16. Worksheet 15:

    a. Please update the RSLs to the current version (May 2012) prior to finalizing the document.

    Navy Response:

    The RSLs have been revised to the current version.

    b. Worksheet 15-8: Please clarify in the text of Appendix C how the PRGs were calculated (i.e., using the PRG calculator and default input parameters for a worker?). Also, the values could not be confirmed for U-234, U235+D and U-238+D for an outdoor worker, although the U-234 and U-235+D values presented in this table could be reproduced if a composite worker was selected. Appendix C states that only an outdoor worker is considered (i.e., no external shielding). Please confirm the values and add text to Appendix C explaining how the values were calculated.

    Navy Response:

    Text has been added to Attachment C to further explain how the values were calculated. Note that the composite worker and outdoor worker use the same assumptions regarding shielding (no shielding, or GSF = 1), but the composite worker uses a slightly greater exposure frequency. Therefore, the composite worker values will be lower than the outdoor worker values. The U-238 PRG in Worksheet 15-8 should be 1.5 pCi/g for a composite worker rather than 1.8 pCi/g; it has been updated accordingly.

    c. According to these worksheets, the analysis of hexavalent chromium will also be performed when metals analyses are designated. PREQB requests that all solid samples being analyzed for hexavalent chromium also be analyzed for pH and ORP. These two analyses (pH and ORP) are very important in determining the reducing nature of the sample and help to interpret the hexavalent chromium data especially when matrix spike recoveries are low. These data are typically plotted on the graph provided at the back of the associated preparation method (SW-846 3060A) to determine whether the sample is reducing in nature. Please revise the SAP and associated worksheets to include the ORP analysis of each soil/sediment sample, as pH is already included.

    Navy Response:

    As noted, analysis for pH is already proposed on solid samples. Analysis for ORP has been added for solid samples designated for hexavalent chromium analysis.

    d. The full list of SVOCs is included on these worksheets. However, based on Worksheets #17, only analysis of PAHs and/or hexachloroethane will be required. Please clarify and revise, as needed.

    Navy Response:

    WS #15 has been revised to only include PAHs and/or hexachloroethane.

17. Worksheet 15-7: Marine surface water ESVs are presented incorrectly for several inorganics. Please present corrected values for the following constituents (correct ESV is indicated after each inorganic): antimony (500 µg/L), arsenic (36 µg/L), and silver (2.24 µg/L). In addition, please identify the reference for the ESVs presented for aluminum, chromium and cobalt.

    Navy Response:

    The identified corrections for antimony, arsenic, and silver have been made in Worksheet 15-7.

    Marine surface water ESVs for aluminum and cobalt are not available; therefore, the existing values for these metals in Worksheet 15-7 have been deleted and left as blank (no screening value). For chromium, the correct value (50 µg/L) has been added to the table in place of the incorrect value (81).

18. Worksheet 15-8: Ecological soil and sediment BSVs are presented in this table. Please reference the source of these screening values and identify the BSV acronym.

Navy Response:

The following notes have been added to Worksheet 15-8:

- #2 Values for protection of human health are based on EPA's Radionuclide PRGs http://epa-prgs.ornl.gov/radionuclides/
- #4 Values for protection of ecological receptors are based on DOE's Biota Concentration Guides (BCGs), http://www.hss.doe.gov/nuclearsafety/techstds/docs/standard/1153.htm
- #3 BSV – Biota Screening Value

PREQB Evaluation of Response:

The response for the footnotes is acceptable pending review of the revised worksheet. However, please correct the ecological sediment BSV for Uranium-235 (should be 4,000 pCi/g).

Navy Evaluation Response:

The BSV for Uranium-235 has been updated to 4,000 pCi/g in Worksheet 15-8.

19. Worksheet 15-9: Ecological water BSVs are presented in this table. Please reference the source of these screening values and identify the BSV acronym.

Navy Response:

The following notes will be added to Worksheet 15-9:

- #2 Values for protection of human health are based on EPA's Radionuclide PRGs http://epa-prgs.ornl.gov/radionuclides/
- #3 Values for protection of ecological receptors are based on DOE's Biota Concentration Guides (BCGs), http://www.hss.doe.gov/nuclearsafety/techstds/docs/standard/1153.htm
- #4 BSV – Biota Screening Value

20. Worksheet 17:

a. Please add the proposed MEC sample design and rationale to this worksheet.

Navy Response:

It is assumed the comment is asking how the sampling units are to be selected for DGM because the phrase “MEC sample design” is not understood. The rationale (i.e., focused in areas with the highest quantity of munitions) is included in WS#17, but additional text has been added to the discussion regarding each site for clarity.

PREQB Evaluation of Response:

As discussed at the August 2012 technical meetings in New York, it was agreed that the various Worksheets 17 will be modified to present the MEC sampling procedures that will be developed to fill the data gaps identified during the review of the DQOs that will be developed (see the previous comment 14a. for the agreement to develop the DQOs).

Navy Evaluation Response:

Worksheet #17 has been modified as requested.

b. Many 17-series worksheets (for example, 17c, 17h, 17i, 17k, 17l, and 17o,) demonstrate the need for MEC DQOs. These worksheets all make statements such as:

"…, it is anticipated that upon completion of the TCRA and subsurface MEC characterization, information will have been collected to sufficiently characterize the nature and extent of MEC; therefore, there are no additional MEC investigations or removal actions anticipated at UXO 4 prior to making final remedy determinations for the site. However, if information gathered during the TCRA or other site-related investigations indicates additional MEC investigation is warranted prior to making final remedy determinations for the site, appropriate inter-agency discussions and preparation of pertinent documentation will be conducted.

Because of the significant amount of munitions-related activities conducted at UXO 4, available information is sufficient to plan the sampling approach. However, if additional information is gathered during the TCRA that warrants a modification to the sampling approach, the modification will be made via an addendum to this SAP, or other mechanism that demonstrates formal concurrence by the Navy and regulatory agencies."

This and the similar statements referenced indicate that there are no specific end-point or goal requirements (DQOs) for MEC data. Development of adequate MEC DQOs for each MRS is recommended to define and achieve concurrence on the specific MEC-related data that is required to support future decision-making.

Navy Response:

Please see the response to Page-Specific Comment #14a.

PREQB Evaluation of Response:

Please see comment 14a for the resolution to this comment resulting from discussions during the New York technical meetings and agreement to include MEC DQOs in worksheet 10 and to evaluate the existing data to identify data gaps that will be filled through the MEC sampling plan for each MRS in the various Worksheets 17.

Navy Evaluation Response:

Please see the response to Comment 14a.

c. It was noted during the May ERP meeting that the subsurface soil sampling protocol presented in the Master SAP will be used rather than collecting samples from 1-2 feet bgs and 4-6 feet bgs as the MIS samples from 0-2 inches have been determined to be a conservative estimate of surface soil chemical concentrations. Please ensure that the revised approach takes into account data concerning the location and depths of MEC identified within the sampling unit, as noted in the Discrete Soil Sampling Design and Regional Groundwater Characterization section. Please update all relevant worksheets accordingly.

Navy Response:

Please see the response to General Comment #9.

d. Decision Units: Please add a section to each specific UXO Worksheet 17 that describes in detail each decision unit selected within each UXO. General Worksheet 17 only indicates that watersheds were the initial areas selected for each decision unit then and potential receptor exposure pathways that are unique from other areas (with a few examples provided) further refines some decision units. The rationale for how each specific decision unit within each UXO site was defined needs to be discussed in each UXO worksheet.

Navy Response:

This information has been added to each UXO worksheet. Please see the revised worksheets for the additional information.

e. Sampling Units:

i. The second sentence of the second paragraph indicates that the sampling unit size was selected to be representation of the assumed exposure unit area for each receptor. Please add text supporting the selection of 1 acre as the exposure area for all receptors being evaluated in the HHRA or BERA.

Navy Response:

The second sentence of the 2nd paragraph has been revised as follows:

"The proposed sampling units are generally approximately 1 acre in size to account for ecological receptors with smaller exposure areas; since larger exposure areas are typically applicable for human receptors, data from multiple sampling units will be grouped as appropriate for use in the HHRAs."

ii. Please clarify the statement made at the end of the second paragraph which states that "Subsamples will be collected in a systematic random sampling approach, where the subsamples are collected in a general uniform grid across the sampling unit."

Navy Response:

Subsamples will be collected similar to what was done for the ECA RI. The following sentence has been added after the fifth sentence of WS#14, "Incremental Sample Collection": "Each 1-acre sampling unit consists of four quarter-acre grids that were used for munitions characterization. The coordinates of each quadrant are located in the field using a GPS. In general, 25 subsamples will be collected within four transects across the quarter-acre grids."

f. Discrete Soil Sampling Design and Regional Groundwater Characterization: Please clarify the lagoon fringe and beach sampling design in paragraph 1, as it is noted that the soil design excludes these areas but does not state what type of design will be used at these areas.

Navy Response:

The size of the sampling units is discussed under the sampling unit subheading. Lagoon fringe and beach sampling units are 1 acre in size; note that the lagoon fringe sampling units have been revised to reflect this.

21. Worksheet 17a: The Sampling Approach for UXO 2 starts with a discussion of the 4 sampling units selected within UXO 2 (with no mention of decision units). Worksheet 17 states that three decision units were selected for each of the 3 beach UXOs, including UXO 2. Figure 29 for UXO 2 shows four decision units, with between 1 and 3 sampling units per decision unit. Please clarify.

Navy Response:

Figures 29, 35a, 35b, 35c, and 36 have been revised to show that the black line is the beach boundary instead of decision unit. On page 108, it states that since the beach and road UXO sites generally act as drainage areas, each beach and road UXO site is its own decision unit. In the last paragraph in WS#17 under "Decision Units," it has been further clarified that each beach and road is its own decision unit, and that is why there are three decision units for the three beach UXO sites and four decision units for the four road UXO sites.

PREQB Evaluation of Response:

Please add text to this worksheet clarifying that UXO 2 consists of 1 decision unit which comprises all of UXO 2.

Navy Evaluation Response:

The following text has been added to the first sentence of the second paragraph of the Sampling Approach subsection of Worksheet 17a: "…acts as a drainage area; therefore, UXO 2 consists of one decision unit".

22. Worksheet 17c:

a. Please clarify whether the Submunitions Area is designated as a decision unit that will be sampled. The text of this worksheet indicates that the previous removal of numerous submunitions from around the perimeter of the high density area provides a characterization of the types of munitions anticipated to be present within this area. Is the intent to use surrounding DU results to characterize the high density submunitions area? It is unclear that the density of items is captured with the information from the surrounding DUs. The lack of sampling within this DU appears to be a datagap for the RI. Please address.

Navy Response:

Sampling in the submunitions area is dependent on the timing of vegetation clearance approval. If approval is not received prior to initiating the sampling, it is possible that this area could be designated as its own site or operable unit so that it does not affect the decision making process for the remainder of UXO 4.

PREQB Evaluation of Response:

Please revise the text of this worksheet for consistency with the response.

Navy Evaluation Response:

The following has been added as the last paragraph of Worksheet 17c under the Sampling Approach subheading: "Sampling in the submunitions area is dependent on the timing of vegetation clearance approval. If approval is not received prior to initiating the sampling, it is possible that this area could be designated as its own site or operable unit so that it does not affect the decision making process for the remainder of UXO 4".

b. Sampling Approach:

i. Please clarify if solvents were used to facilitate open burning activities at 1DU07. If so, please analyze the subsurface soil sample for SVOCs, rather than PAHs.

Navy Response:

Solvents were not reportedly used. This information has been added to WS#10c.

ii. Figure 31 shows 9 decision units, but the text states 7 decision units were selected and Table 6 and Worksheet 18 indicate 8 decision units. Please clarify and revise as appropriate.

Navy Response:

WS#17c, Sampling Approach, second sentence has been revised to "Eleven decision units….". Additionally, the legend in Figure 31 has been revised so that the submunitions area is not associated with a decision unit.

iii. Please revise text to show 42 incremental samples, as per Table 6 and Worksheet 18 (and verify per comment above)

Navy Response:

WS#17c, Sampling Approach, Soil, second sentence has been revised to say "In total, 46 incremental samples (one in each of 46 sampling units),…"

iv. Please include the approximate sizes of the sampling units on this worksheet, as was done for the majority of the other UXO sites. Please note that this comment applies to Worksheets #17h, i, k, l, m and o also.

Navy Response:

The text has been revised as requested.

v. Surface Water and Sediment:

1. Surface water and sediment samples are proposed to be collected for aquatic habitats associated with the lagoons present within UXO 4. In addition to these aquatic habitats, it was noted during a previous site visit that numerous craters containing standing water are present within UXO 4 that are being utilized by various receptors including waterfowl and shorebirds. These areas are not being sampled or being evaluated for ecological risk. It is suggested that these numerous craters represent another decision unit and that a small subset of these areas be evaluated for risk to ecological receptors by conducting sampling of surface water and sediment.

Navy Response:

One surface water and one sediment sample has been added to be collected from each of the three field identified craters with potential aquatic habitats. Each surface water and sediment sample will be analyzed for metals and explosives.

2. Lagoon surface water and sediment data will be compared to background data collected from a similar lagoon (if identified). Please indicate the process that will be used to select the background lagoon(s) and obtain regulatory concurrence.

Navy Response:

If appropriate background lagoons are identified, they will be proposed to the regulatory agencies in a SAP addendum prior to sampling activities. This information has been added under "Background Dataset" in WS#17.

vi. Depleted Uranium Area: The last paragraph states that the samples from Laguna Anones will be analyzed for uranium. However, Worksheet #18 shows that uranium will be analyzed in samples from all lagoons. Please clarify.

Navy Response:

Lagoon samples for uranium analysis will only be collected from Laguna Anones. WS#18 has been revised accordingly.

23. Worksheet 17d, Sampling Approach: The text notes that one unique exposure area is likely for UXO 5 – a scenic overlook and historical site. Please clarify how risks associated with this unique area within the SIA Restricted Roads decision unit will be evaluated.

Navy Response:

This sample will be evaluated similar to the other sampling units within UXO 5 since the site is identified as having public recreators.

PREQB Evaluation of Response:

Please refer to PREQB's Evaluation of Response to General Comment 4.

Navy Evaluation Response:

Please see the response to General Comment 4.

24. Worksheet 17f, Sampling Approach: The second paragraph states that each of these beaches has the highest quantity and diversity of MEC and munitions scrap, but Table 2b indicates that all beaches selected have lower MEC scores than other beaches. Please clarify.

Navy Response:

The rationale has been further clarified in Table 2b. The beaches proposed for sampling have the highest quantity and diversity of MEC (except Beach 33, which was selected for sampling because it is intended for public use.

PREQB Evaluation of Response:

Please refer to PREQB's Evaluation of Response to General Comment 4.

Navy Evaluation Response:

Please see the response to General Comment 4.

25. Worksheet 17g: The Sampling Approach for UXO 8 discusses 7 sampling units within UXO 8 (with no mention of decision units). Worksheet 17 states that three decision units were selected for each of the 3 beach UXOs, including UXO 8. Figure 36 for UXO 8 shows three decision units (assuming a typographical error in the legend of this figure, as commented on below) with one sampling unit in each DU and one island which is a sampling unit. Please clarify the apparent differences between the text of Worksheet 17, Worksheet 17g and Figure 36.

Navy Response:

Please see the response to Page-specific Comment #21. UXO 8 is considered one decision unit. Note that the Sampling Approach for UXO 8 discusses 5 sampling units.

PREQB Evaluation of Response:

Please ensure consistency between this response and the Navy's response to PREQB Comment 49, which states that there are 4 decision units.

Navy Evaluation Response:

UXO 8 consists of one decision unit as it is a beach site.

26. Worksheet 17h:

a. The Sampling Approach for UXO 9 states that 12 DUs were established, but Figure 37 only identified 11. Please clarify.

Navy Response:

The figure has been revised to show all 12 decision units.

b. Soil: The sampling units for UXO 9 Southeast decision unit are incorrectly presented in Figure 37d or Table 11. Sample VE-UXO9-3DU01 represents the sample collected within the ephemeral stream on Figure 37d while Table 11 indicates sample VE-UXO9-3DU03 is collected from the ephemeral stream. Please verify and correct as appropriate.

Navy Response:

In Table 11, the sample rationales for VE-UXO9-3DU01 and VE-UXO9-3DU03 were inadvertently transposed and have been corrected.

27. Worksheet 17i, Figures 38b through 38e: These figures depict the density of MEC found in each grid while grids are shaded areas in yellow where no MEC investigation has been conducted. However, each of these figures has unshaded grids where the number of MEC has not been provided. Please correct or clarify.

Navy Response:

These figures have been corrected.

28. Worksheet 17k, Page 136, UXO 12: The description of the decision unit Laguna Monte Largo Fringe states that 1 sampling unit was selected at the largest of the 3 lagoons. However, page 125 and Worksheet #10 state that there are only 2 lagoons at this decision unit. Please clarify.

Navy Response:

WS#17k, page 136 last bullet has been changed to: "…at the largest of the two lagoons…"

29. Worksheet 17l:

a. Please provide more detail on the rationale for collecting discrete soil samples within Parcel C rather than MIS samples in this worksheet.

Navy Response:

Please see the response to General Comment #3.

b. Please provide the rationale for not collecting groundwater samples from this area, considering it is proposed for unrestricted use (i.e., potential residential development). Please summarize prior investigations, and address the depths to which prior monitoring wells in the area were installed and screened. It would be helpful to document whether the wells were screened in the first water-bearing unit or targeted deeper groundwater and discuss whether the results from prior investigations are appropriate for characterizing groundwater potentially contaminated by surface releases.

Navy Response:

The text has been revised as requested and includes the results of the previous hydrogeologic investigation including the well screen intervals and that explosives were not detected in groundwater from the monitoring wells located at the Parcel C boundary and in the vicinity of the decision unit.

c. Page 139, UXO 13: This worksheet states that UXO 13 is approximately 2,434 acres. However, Worksheet 10 states that UXO 13 is approximately 1,871 acres. Please clarify and revise worksheets accordingly.

Navy Response:

WS17l, Sampling Approach, first sentence has been revised to "UXO 13 is approximately 1,871 acres in size."

30. Worksheet 17m, Pages 143 and 144, UXO 14: Sampling Approach: Paragraph 2 includes West Central UXO 14 as a decision unit. However, prior text and the summaries on page 144 include East Central UXO 14. Please clarify and revise worksheets accordingly.

Navy Response:

The previous paragraph is not intended to include a discussion of East Central UXO 4. The previous paragraph discusses unique differences between the decision units where West and West Central UXO 4 have public land use and East UXO 4 has the highest potential for a release. All of the decision units including both West Central and East Central UXO 4 are discussed in the soil subheading.

31. Worksheet 17o, Page 147, UXO 18: Hexachloroethane is listed as a VOC in this discussion. This analyte is measured using SW-846 Method 8270C, which is a SVOC method. Please change VOC to SVOC. Please note that this analyte is correctly listed as a SVOC on Worksheets #15 and 18.

Navy Response:

Worksheet 17o, Sampling Approach, second paragraph, 4th sentence has been changed to "…hexachloroethane (an SVOC)…"

32. Worksheet 18c, Pages 154-160, UXO 4:

    a. Decision Unit 1: Please add 1 field duplicate and 1 MS/MSD for the PAH analyses in order to meet the required frequencies shown on Worksheet #28.

    Navy Response:

    A field duplicate and MS/MSD for PAH analysis has been added for sample VE-UXO4-1SB07-0102.

    b. Decision Unit 1: Please clarify why the subsurface soil depths for uranium analysis are "To Be Determined". Worksheet 17c states that these depths will be 12-24 inches bgs. If "To Be Determined" is accurate, please provide text on Worksheet 17c as to the rationale for the selection of the depth interval. Otherwise, please update this worksheet accordingly.

    Navy Response:

    As agreed to in the May Environmental Technical Subcommittee Meeting, soil sampling will follow the Vieques soil sampling protocol, so the subsurface soil samples will be collected in the subsurface zone above 6 ft bgs if contamination is suspected or at 4-6 ft bgs (in the absence of suspected contamination) or above bedrock or the water table if shallower than 6 ft bgs (and in the absence of suspected contamination). Sampling depths in WS#18 and throughout the document have been adjusted to reflect that.

    PREQB Evaluation of Response:

    Please refer to PREQB's Evaluation of Response to General Comment 9.

    Navy Evaluation Response:

    Please see the response to General Comment 9.

    c. Decision Unit 10: In the column labeled "Number of Samples", please remove the surface water samples for samples SD06 through SD14.

    Navy Response:

    Revised as requested.

    d. Decision Unit 10: In the column labeled "Number of Samples", please remove the sediment sample for sample SW15.

    Navy Response:

    The SW has been revised to SD in Worksheet 18.

33. Worksheet 18m, Pages 183-186, UXO 14:

    a. Decision Units 5 and 7: Please replace "NA" for depth with 0-6 inches bgs for sediment and mid-depth for surface water.

    Navy Response:

    Revised as requested.

    b. Decision Unit 9: Please note that sample SDSW06 was repeated three times at the bottom of the page.

Navy Response:

The repeats have been deleted.

34. Worksheet 18o, Page 188, UXO 18: Please change the identification of the last sample to S003, as it currently is the same identification as the first sample.

Navy Response:

Revised as requested.

35. Worksheet 19, Pages 189-191:

a. Please revise the holding time for TOC from 28 days to 14 days, in accordance with the cited Lloyd Kahn method.

Navy Response:

The holding time for Lloyd Kahn TOC, specified on WS#19, has been updated from 28 days to 14 days.

b. Please revise the holding time for hexavalent chromium in soil and sediment samples to 30 days until extraction and 7 days until analysis, in accordance with SW-846 3060A.

Navy Response:

The holding time for hexavalent chromium in solid samples, specified on WS#19, has been updated from “28 days / 24 hours” to “30 days / 7 days.”

c. Please clarify the sample weights for the SMI soil samples.

i. According to the explosives method (SW-846 8330B) and other cited documents above, the appropriate weight for this analysis is 10 grams, not 30 grams as listed. Please clarify why the higher mass is proposed.

Navy Response:

The sample volume, specified on WS#19, has been updated from 30g to 10g for solid samples and SW-846 8330B.

ii. According to Section 9.1.4.2 of the 2009 USACE document referenced in the Executive Summary, the recommendation to analyze a 10-gram aliquot should be implemented for all propellant/explosive analyses, including perchlorate. Therefore, please clarify if the sample weight for perchlorate should be increased from 1 gram to 10 grams to allow for a more representative sample. Also, a case study in Appendix A4 of the EPA Federal Facilities Forum Issue Paper, Site Characterization for Munitions Constituents (January 2012) shows that 10 grams was used for perchlorate.

Navy Response:

The 1g sample volume for perchlorate in solid samples via SW-846 6850 was proposed for consistency with Vieques East UXO-1 (ECA), where it worked well. However, it would not put an undue burden on the laboratory to require a 10g mass for a potentially more-representative sample. The sample volume, specified on WS#19, has been updated from 1g to 10g for SS, SB, SD, and SMI samples via SW-846 6850. It should be noted that this may necessitate a modification to the analytical laboratory SOP, which would be documented in WS#23 of a laboratory-specific SAP addendum.

iii. Please clarify if 2.5 grams for the metals and hexavalent chromium analysis will allow for a representative sample. Hawaii guidance (Technical Guidance Manual Notes: Decision Unit and Multi-Increment Sample Investigations, March 2011) recommends the use of 10 grams for metals.

Navy Response:

The sample volume, specified on WS#19, has been updated from 2g to 10g for SMI (multi-incremental) samples and 6010/6020. The sample volume, specified on WS#19, has been updated from 2.5g to 10g for SMI (multi-incremental) samples and hexavalent chromium. These are proposed for consistency with Vieques East UXO-1 (ECA), where they worked well.

36. Worksheet 20, Pages 193-199:

    a. Regional Groundwater Sampling: Please revise the number of MS/MSD pairs to 2 for metals and explosives, as per Worksheet 18.

    Navy Response:

    On WS#20 for Regional Groundwater Sampling, the number of MS/MSD pairs for METALs, FMETALs, and EXPLOs in GW has been updated from 1 to 2, which is appropriate for 23 groundwater samples. The number of field duplicates in this instance has also been updated from 2 to 3. The total number of samples to lab has also been updated from 40 to 43.

    b. UXO 4, Surface Water/Sediment: According to this worksheet, only 14 of 20 locations will be analyzed for uranium. However, according to Worksheet 18c, all 20 sediment samples will be analyzed for uranium. Please clarify.

    Navy Response:

    WS#20 is correct, as it implies that only UXO-4 DU10 (Laguna Anones) requires analysis for uranium. WS#18c was updated to remove references to uranium in surface water and sediment samples from DU6 (Laguna Gatos) and DU7 (Laguna Icacos).

    c. UXO 13, Soil:

        i. Please add 2 locations for PAH analysis in subsurface soil samples, as per Worksheets 17l and 18l.

        Navy Response:

        In UXO-13 for SB samples (these correspond to decision unit 1), the SVOC analysis group was added with two locations, one field duplicate, one MS/MSD, and one equipment blank, for a total of six samples to the lab.

        ii. UXO 13, Soil: Please add pH and TOC to the 8 discrete surface soil samples, as per Worksheet 18l.

        Navy Response:

        In UXO-13 for SS samples, the WCHEM (pH and TOC) analysis group was added with eight locations for a total of eight samples to the lab. In UXO-13 for SB samples, the WCHEM (pH and TOC) analysis group was updated from 28 locations to 36 locations for a total of 36 samples to the lab, for consistency with the total number of SB locations among decision units.

        iii. Please add 1 MS/MSD for PAHs.

        Navy Response:

        In UXO-13 for SMI samples, one MS/MSD pair was added for the two SVOC locations. The total number of samples to the lab is six. As per response to page-specific comment 36 c iv, above, an MS/MSD pair was added for SB samples.

37. Please clarify why Worksheet 21 does not reference any MEC SOPs. MEC is an important part of the SAP. Please develop SOPs rather than referencing documents that were developed for other purposes. This comment applies to Worksheet 22 (equipment calibration, maintenance and testing), Worksheet 29 (documents and records), Worksheet 31 (planned assessments), Worksheet 32 (assessment findings and

corrective actions), Worksheet 33 (QA management reports), and Worksheet 34, 35 and 36 (data verification and validation, which should be used to describe the MEC QC and QA program).

Navy Response:

Worksheet 21 is the Project Sampling SOP Reference Table and is not applicable to MEC. Work plans for the MEC characterization activities have already been prepared and references to where the information contained in the remaining worksheets referenced above can be found have been added to the worksheets, as applicable.

PREQB Evaluation of Response:

37. As discussed at the August 2012 technical meetings in New York, the response was modified during discussions at the meeting. During the meeting EQB explained the need for MEC SOPs in the SAP. After discussion all agreed with this and it was decided that the Navy and the contractor will review this issue and decide how to incorporate MEC SOPs in the SAP. It is possible that the SOPs will be included in a new appendix.

Navy Evaluation Response:

SOPs for the munitions response activities have now been included and referenced throughout the SAP where appropriate. The SOPs will be developed based on the approved work approaches presented in *Final Work Plan for Munitions and Explosives of Concern, Subsurface Interim Removal Action Beaches and Select Roadways, Former Vieques Naval Training Range (VNTR) and Former Naval Ammunition Support Detachment (NASD), Solid Waste Management Unit 4, Vieques, Puerto Rico* (CH2M HILL, 2008).

38. Worksheet 22, Page 203: The acceptance criterion for dissolved oxygen is listed as ±3 mg/L in this worksheet. However, the SOP provided in Attachment D lists an acceptance criterion of ±0.3 mg/L. Please clarify and update accordingly

Navy Response:

WS#22, YSI dissolved oxygen and temperature probes, Acceptance Criteria has been changed to "±0.3 mg/L."

39. Worksheet 23, Page 205:

a. Please clarify which analytical method will be utilized for the analysis of the metal, uranium, in all matrices.

Navy Response:

Uranium, along with the rest of the metals, is scheduled for analysis via 6010/6020, as documented in WS#15-2 and #15-7. Method assignment for each analyte is laboratory-specific depending on that laboratory's capabilities, and will be documented in each laboratory-specific SAP addendum.

b. Please note that Worksheet 23 and the associated SOPs will need to be submitted for review for each laboratory, each parameter, each preparation method, each analytical method and each homogenization method for each UXO Site investigation prior to the onset of the investigation.

Navy Response:

As part of each laboratory-specific addendum, all of the referenced SOPs will be assembled and summarized in WS#23. The SOPs themselves, however, are proprietary and confidential. They are not available to the general public. They are available upon request with the permission of the analytical laboratory that owns them.

40. Worksheet 28, Pages 217-245:

    a. Worksheet 28 states that triplicates are performed at a frequency of 1 per 10 samples per matrix for incremental sampling. The SOP provided in Attachment D states that triplicates are performed at a frequency of 1 per 10 samples from each decision unit. Please clarify.

    Navy Response:

    Field triplicates are performed at a frequency of 1 per 10 samples (for SMI samples) per site (not per decision unit). For consistency, this change has been made to WS#28-1, #28-2, #28-3, Attachment D, WS#18, and WS#20.

    b. Worksheets 28-1 and 28-2: Please add the "SS" matrix to the list of matrices for explosives analyses and to the field duplicate QC sample, as this is being done in UXO 13.

    Navy Response:

    The requested change was made.

    c. Worksheets 28-1 through 28-3 and Worksheet #28-9: The description of the corrective action for field duplicates needs to also include an assessment of field homogenization procedures in addition to laboratory homogenization procedures.

    Navy Response:

    Corrective action for field duplicates on WS#28-1, #28-2, #28-3, and #28-9 (those that correspond to solid samples subject to field duplicates) was updated to "Assess laboratory homogenization procedures and precision. Examine laboratory replicate. Assess field homogenization procedures. Qualify as per Worksheet #36."

    d. Worksheets 28-1 and 28-6: Please include the requirements for surrogates in the explosives analysis.

    Navy Response:

    A requirement for surrogates as part of SW-846 8330B is not specified by DoD QSM v. 4.2 Table F-3. Because this SAP is generic with respect to laboratory information (as opposed to the laboratory-specific addenda), requirements are not stated if there is not reasonable certainty that any qualified laboratory could adhere to them. Surrogates will be used as specified by the analytical laboratory's SOP written for consistency with SW-846 8330B. This information will be included in each laboratory-specific SAP addendum.

    e. Worksheet 28-3: Please remove the "SD" matrix" as SVOC analyses are not currently proposed for any sediment samples.

    Navy Response:

    The requested change was made.

    f. Worksheet 28-4: Please add the "SS" and "SD" matrices to the list of matrices for pH and TOC analyses.

    Navy Response:

    The requested change was made.

41. Worksheet 29, Page 247: Please revise "water quality field parameters collected during groundwater sampling" to also include surface water sampling.

    Navy Response:

    The requested change was made.

42. Worksheet 30, Page 249: For the "SB" matrix, please add "METAL (Add U to above)" as this analysis is being performed on subsurface soil samples collected during monitoring well installation, as per Worksheets #18 and 20.

Navy Response:

The requested change was made.

43. Table 1a, UXO 4:

a. Decision Units 1-5: Please include the number of planned discrete samples in addition to the SMI samples. This comment applies to Tables 1b, 1c, 1d 9(Decision Units 1-7), 1e (Decision Units 1,2,3 and 5), and 1f (Decision Units 1-4).

Navy Response:

The requested change has been made.

b. Decision Unit 10: Per Worksheets 17 and 18, the recommended number of samples is 15 sediment and 6 surface water. Please confirm and update accordingly.

Navy Response:

Table 1a has been updated as noted above.

44. Table 1b, UXO 9/12: Decision Unit 8: Per Worksheet 17, the recommended number of SMI samples should be 2. Please confirm and update accordingly.

Navy Response:

Table 1b has been updated as noted above.

45. Table 1f, UXO 14: Decision Unit 7: For the recommended number of samples, please replace "SMI-3" with "Discrete SW/SD-3".

Navy Response:

The requested change has been made.

46. Table 2a, UXO 2: The recommended number of samples for the first 3 decision units is different than the number of samples listed in Worksheet 17a. Please revise the table to ensure consistency with the worksheets.

- Playa Salinas Del Sur: should be 2 SMI and 2 discrete samples
- Playa Carucho/Turtle Beach: should be 3 SMI and 3 discrete samples
- Icacos/Playa Yallis: should be 2 SMI and 2 discrete samples

Navy Response:

Table 2a has been updated as noted above.

47. Table 2b, UXO 7: The recommended number of samples for Puerto Diablo/Captain Bill's Beach and Playa Compania/Purple Beach is different than the number of samples listed in Worksheet 17f and Table 9. Please revise the table to ensure consistency within all tables and worksheets.

- Puerto Diablo/Captain Bill's Beach: should be 2 SMI and 2 discrete samples
- Playa Compania/Purple Beach: should be 2 SMI and 2 discrete samples

Navy Response:

Table 2b has been updated as noted above. Note that the term "Captain Bill's Beach" has been removed throughout the SAP because it is not an official name.

48. Table 9, UXO 7: This table shows only 1 decision unit in UXO 7. However, per Worksheets 17f and 18f, there should be 3 decision units. Please revise the table to ensure consistency with the worksheets.

Navy Response:

There is only one Decision Unit for UXO 7 which is the beaches.

49. Table 10, UXO 8: This table shows only 1 decision unit in UXO 8. However, per Worksheets 17g and 18g, there should be 4 decision units. Please revise the table to ensure consistency with the worksheets.

Navy Response:

There is only one Decision Unit for UXO 8 which is the beaches.

50. Table 18, UXO 18: Please revise the title of the table to reflect UXO 18 instead of UXO 14.

Navy Response:

Table 18 has been revised as requested.

51. Figure 13: The following items appear to be in error on this figure. Please verify and correct, if needed.
    a. Please remove the arrow under the diamond which states "Conduct additional MEC delineation activities and return to Step 1 (MEC)".
    b. Please add an arrow with "Yes" from Step 1 (MEC) to Step 2 (MEC).
    c. Please remove the arrow which goes from Step 1 (MEC) to Step 6 (MC and MEC).

Navy Response:

The flow chart is correct as presented. Note that a "No" arrow has been added to Step 2 (MEC), as requested by EPA.

52. Table 4: Please clarify the rationale for selecting beaches with low MEC scores and receptor scores as decision units. Since data from the decision units will be used to characterize all trespasser exposures, it appears that the inclusion of this data may result in a lower exposure point concentration. If a unique exposure area is identified, then it appears that these areas need to be evaluated as separate decision units so that data from unique but unimpacted areas does not lower the exposure point concentration. Please address.

Navy Response:

Please see the response to Page-specific Comment #24. Note that only one beach is selected for sampling that has a lower MEC and receptor score as compared to other beaches. The Navy is proposing to sample this beach due to historical trespassing activities observed.

PREQB Evaluation of Response:

Please refer to PREQB's Evaluation of Response to Comment 4.

Navy Evaluation Response:

Please see the response to Comment 4.

53. Table 5: Please clarify if a higher density area in a low lying area is present that could replace the LIA Roads 8 SU location, as it appears that it does not meet the selection criteria, with the exception of being a low-lying area.

Navy Response:

Note that the LIA Roads 8 SU is located at a LIDAR identified target feature and has the highest number of rockets/guided missiles identified of the road SUs; therefore, the sampling location is recommended to be retained.

54. Table 6:

a. Please clarify why SUs Central 13 and Central 16 locations were selected when many SUs with in the Central UXO DU have higher values across all categories. The inclusion of this data may result in a less conservative exposure point concentration.

Navy Response:

SU Central 13 is recommended for sampling as it is located at the mock Fuel Farm target. SU Central 16 was positioned at a LIDAR identified target feature, but has been moved further to the south to be located at a former air-to-ground target with a higher density of MEC.

b. Please clarify if a higher density of MEC area is present within Decision Unit 5 that could replace East 1, as it does not appear to meet the selection criteria (identified as having low density of MEC and munitions scrap, craters).

Navy Response:

Note that SU East 1 is located at an air-to-ground target feature with the highest density of MEC in the eastern portion of the decision unit; therefore, it is recommended that the sampling location be retained. The rationale in Table 6 has been further clarified with this information.

55. Table 7:

a. Please clarify whether other areas within UXO 5 were identified as low-lying areas with higher density of MEC that could replace sampling units located in low-lying areas with low density MEC.

Navy Response:

The majority of UXO 5 has a low density of munitions. Two smaller areas within the site have higher densities. Sampling units are focused in both the areas with the highest density of munitions, and also in the lower density areas considered to be low-lying. The rationale in Table 7 has been further clarified with this information.

b. Please clarify whether UXO 5 Roads 7 data will be included in the calculation of the COPC concentrations for the decision unit. It appears that this area is not impacted by MEC or MD; therefore, the inclusion of this data in the dataset is likely to lower the EPC. It appears that this area is a unique exposure area that needs to be evaluated as a separate decision unit.

Navy Response:

Please see the response to General Comment #4. Sampling Unit 7 is located in the general area of a proposed scenic overlook and also located in the vicinity of a gun position; however, the sampling unit was biased toward potential receptor exposure. The rationale in Table 7 has been further clarified with this information.

PREQB Evaluation of Response:

As discussed during the August ERP Technical Subcommittee meeting, this area will be evaluated as a separate exposure area.

Navy Evaluation Response:

Please see the response to General Comment 4.

c. Figure 10: Minor Comment – Suggest removing AOC E from this figure as this figure only shows the aquifers and major towns.

Navy Response:

The figure has been revised as requested.

56. Table 9: Please clarify why SU 24 is identified as having a high MEC score when this table shows that no MEC were removed from this area.

Navy Response:

Munitions debris (scrap) is included in the munitions scoring. The Table 1 category description has been revised to further clarify that the scoring is based on both MEC and munitions debris.

57. Figures, General Comments:

a. Please consider using different color schemes for the SU outlines and the digital geophysical anomalies by grid.

Navy Response:

The sampling unit outline has been changed to be more pronounced.

b. Please add all selection criteria features to the DU figures. For example, SUs are located at PAOC and PI sites; recreational areas are also preferentially selected for SU locations; and production well locations (e.g., Figure 40b) were selected as SU locations. It would be helpful to identify these on the applicable figure.

Navy Response:

Please see the response to General Comment #1.

58. Figure 14: Please indicate the location of the open detonation in relation to the text “Open Detonation Area” shown on the figure. It does not appear that the cross-hatched symbol is shown on the figure.

Navy Response:

The open detonation area hatching has been added.

59. Figure 15: Please clarify why this figure only shows the trespasser being exposed to UXO 2 (beaches). The worksheets indicate trespassers will be evaluated at UXOs 3 and 4 as well.

Navy Response:

The human receptor arrows have been updated to point to all applicable UXO sites in the figure.

60. Figure 17: Rest areas, scenic view areas and an historic site are shown on Figure 17 in areas not directly connected to a designated road. Please clarify whether roads or trails are planned to access these proposed

land use areas, and if so, why the roads or trails are not shown on this figure and included in either this UXO 5 or UXO 9.

Navy Response:

The western portion of UXO 5 overlaps with UXO 7. The area was designated to be associated with the beach UXO sites due to the more conservative exposure scenarios (i.e., munitions clearance to 4 ft bgs at the beaches whereas it is 2 ft bgs at the roads). Note that this area is also designated for sampling at UXO 7.

PREQB Evaluation of Response:

Please revise the response for consistency with the discussion during the August ERP Technical Subcommittee meeting. The Navy indicated that the USFWS does not have plans to develop additional trials and the location of proposed future recreational areas, such as hiking trails and scenic areas, are not known at this time. The figure will be footnoted to indicate that the icon placement on the figures is not representative of the actual location where proposed recreational uses may occur.

Navy Evaluation Response:

The following has been added to Worksheet #10 under the Land Use subheading as the last sentence of the second paragraph: "The exact location of the proposed future recreational areas, such as hiking trails and scenic areas, are not known at this time. USFWS does not have plans to develop additional recreational areas and trails than what is shown in the CCP". Each figure with the land use icon has been footnoted as requested.

61. Figure 19:

a. Rest areas, a parking area and an observation tower are shown on Figure 19 in areas not directly connected to a designated road. Please clarify whether roads or trails are planned to access these proposed land use areas, and if so, why the roads or trails are not shown on Figure 19 and included in either UXO 11 or UXO 12.

Navy Response:

Please see the response to Page-specific Comment #60.

PREQB Evaluation of Response:

Please refer to PREQB's Evaluation of Page-Specific Comment 60.

Navy Evaluation Response:

Please see the response to Page-Specific Comment 60

b. Please clarify if specific areas have been identified for reforestation (i.e., is the symbol placed in the specific area where reforestation activities are planned? How large of an area will be reforested?)

Navy Response:

This information is not known at this time.

PREQB Evaluation of Response:

Please add this information to the text.

Navy Evaluation Response:

The following has been added to Worksheet 10l, after the first sentence of the second paragraph of the Future Land Use and Potential Receptors subheading: "A portion of UXO 13 has been identified for reforestation; however, the exact location and size of the area is not known at this time".

62. Figure 23: Please add the location of the proposed boat launch (if known) on this figure.

Navy Response:

The figure has been revised as requested.

63. Figure 27: Sampling is not proposed within Parcel C, which is a separate decision unit. Considering that this area is proposed for unrestricted use, it appears warranted to include sampling within this decision unit in order to make appropriate risk management decisions.

Navy Response:

Note that the sampling approach for Parcel C is discussed in WS #17l and the discrete sample locations are identified in Figure 42e.

64. Figure 31d: Please clarify if the number of munitions scrap items influences the selection of sampling unit locations more so that the number of MEC within a particular quandrant. For example, Sampling Unit identified as VE-UXO4-4DU01 appears to have lower quantities of MEC in comparison to quandrants nearer to SAM West, but higher munitions scrap counts. If this is the case, please provide the rationale for preferentially locating SUs in quadrants with high munitions scrap counts even though MEC counts for those quandrants may be low. Also, it would be helpful if the figures show two numbers: munitions scrap/MEC items (e.g., 3908/12 for 3908 items of munitions scrap and 12 MEC items identified in a particular quandrant). Also, pointing out depositional and drainage features that influenced an SU location would also be helpful, as Worksheet 17c states that these features influence SU locations.

Navy Response:

Please see the response to Page-specific Comment #56. All of the munitions categories identified on Table 1a are used to select sampling locations, which includes munitions scrap. For instance, note that VE-UXO4-4DU01 has the highest number of projectiles/mortars (2,301 items), more than at any other sampling unit within UXO 4 (Table 6), including the quadrants in the vicinity of SAM West (note that VE-UXO4-3DU03 provides a summary of the MEC items in this location; Table 6). Providing two numbers on the figures is complicated; however, Tables 4 through 18 was designed to aid in understanding the quantity of MEC and munitions scrap at each sampling unit. Additional details have been added to Tables 4 through 18 to describe the depositional and drainage features that influenced SU locations.

65. Figure 31e:

a. Please revise the legend to define diagonal red lines as the dense submunitions area. It appears that this feature defines the northern boundary of this decision unit rather than a topographic high (i.e., watershed boundary). Please confirm and clarify why this is the case if the figure is correct.

Navy Response:

The legend has been revised as requested.

b. This figure shows a drainage feature at the northern edge of this DU, but an SU is not located in this area. Please clarify why a SU is not located at this drainage feature.

Navy Response:

This area has a lower density of munitions than other locations within UXO 4. Sampling units in the vicinity of the submunitions area and with a higher density of munitions are located in the central and north UXO 4 decision units. These sampling locations also provide less risk to the field teams by not having to mobilize through the submunitions area.

66. Figure 31g: Please clarify the rationale used to select the location for VE-UXO4-8SO01. It appears to be located in an area absent of MEC items. Please consider moving this sample location to an area with higher MEC counts and higher MEC diversity.

Navy Response:

MEC items were identified in the vicinity of the sample location. However, the sample location has been moved to the southwest (in the grid with 1,276) in accordance with the comment request.

67. Figure 31h: Please clarify the rationale used to select the location for VE-UXO4-9SO01. The quadrant 6 quadrants to the north has higher counts and it appears to have a higher diversity of MEC as compared to the current quadrant selected, including pyrotechnics/flares.

Navy Response:

An additional sampling unit and deeper surface soil sample have been added to this lagoon fringe (please see the response to EPA General Comment #22). The discrete deeper surface soil is located in the quadrant requested.

68. Figure 35a:

a. Please clarify why no sampling units are identified in the western Beach 33 DU shown on this figure (or is this one-half of the Beach 33 DU?).

Navy Response:

The eastern beach has a much higher density of munitions. This information has been added to the associated text in WS#17f.

b. It appears that with respect to MC sources (i.e., MEC), the western outlined area for Beach 33 has higher MEC density than the eastern outlined area selected as the SU location. Please clarify why the eastern area was selected rather than the western area.

Navy Response:

Please see the response to Page-specific Comment #68a.

69. Figure 36: Please revise the legend to indicate that the black outline denotes a decision unit (not a sampling unit, which is outlined in green).

Navy Response:

Figure 36 has been revised to denote the black line as “Beach selected for sampling”.

70. Figure 37a: Please clarify if SU 1SB05 is at a topographic high area. If so, please clarify why this area was selected over other, more low-lying areas in the vicinity.

Navy Response:

The sampling unit was selected because it includes the grenade MEC category. The interior portions of UXO 9 are at higher topographic areas than near the beaches. Note that 6 of the 8 sampling units within this decision unit are in low-lying areas.

71. Figures 37e and f: Please identify the area proposed for recreational use on these figures.

Navy Response:

Figures 37e and 37f have been revised as requested.

72. Figure 37f: As unique site uses such as proposed recreational use has been used at other UXOs to select sampling unit locations, please clarify why only 1 SU is considered for this site. An observation tower, interpretive trail, biking trail and hiking trail are proposed for this DU. It seems that additional SUs are warranted to characterize these areas. Table 1b indicates that only 1 SU is planned for this DU.

Navy Response:

Two sampling units have been added in this area to address the comment; note that the sampling units are associated with UXO 6 (please see the response to Page-specific Comment #10a).

73. Figure 38a: Please clarify the rationale for selecting the location of SU 1DU02 over other areas in the vicinity with high MEC.

Navy Response:

The sampling unit has been moved to an area with a higher density of munitions based on recent munitions characterization activities (see revised Figure 38a).

74. Figure 39b: Figure 19 shows several recreational areas within UXO 11 that are currently not connected to the existing roads. Please clarify how the access roads to be built to reach the parking area, picnic areas, and the observation tower shown on Figure 19 will be addressed in the RI.

Navy Response:

Please see the response to Page-specific Comment #60.

PREQB Evaluation of Response:

Please refer to PREQB's Evaluation of Page-Specific Comment 60.

Navy Evaluation Response:

Please see the response to Page-Specific Comment 60.

75. Figure 40b: This area contains a higher density of drainage features than other DUs. Please consider adding SUs to characterize these areas, taking into account MEC clearance information as it becomes available.

Navy Response:

The need for additional sampling units will follow the 6-step decision analysis. Note that munitions have generally not been identified in the vicinity of these drainage features and sampling units are currently focused in areas adjacent to numerous gun positions.

76. Figure 40f and g: It appears that a picnic area is proposed to the south of Range 8. It is unclear if this proposed recreational area is in UXO Southwest or UXO North Central. Please clarify why this area is not proposed as a SU, consistent with other DUs containing recreational areas.

Navy Response:

The picnic area is associated with UXO 11; a sampling unit will be added in this area if/when the intended location is better identified by FWS; further, note that munitions characterization activities are still ongoing.

77. Figure 42: Worksheet 17l indicates there are seven DUs however, Figure 42 shows only six. Please clarify.

Navy Response:

Figure 42 legend has been revised to show the 7th DU, the lagoon fringes.

78. Figure 42b: Please clarify whether any SUs are in the area designated for reforestation (as shown on Figure 19).

Navy Response:

The exact location of the reforestation area is not known at this time. However, the sampling locations are intentionally conservative and, based on evaluation of the data, may appropriately represent the site as a whole.

79. Table 1: As discussed in the May 2012 ERP meeting, please add a column for explosive weight as an additional criteria for scoring MEC Items as consideration should be given to ensure that sampling units are located in areas with high explosive weight MEC.

Navy Response:

The agreement from the May 2012 ERP meeting was to provide the net explosive weight used for the controlled detonations. This information has been included as part of the Draft Final Master SAP.

PREQB Evaluation of Response:

Please note that although our recollection of the May 2012 ERP meeting is not consistent with the Navy's, this topic was discussed at the August ERP Technical Subcommittee meeting and the team decided that MD and MEC should be equally considered in selecting Sampling Unit locations.

Navy Evaluation Response:

Comment noted. Also note that as discussed during the August ERP Technical Subcommittee meeting that is as likely that high quantities of MD represent conservative areas to sample as areas of much lower MD, but more MEC; therefore, adding net explosive weight to the selection criteria would not necessarily result in more conservative sampling.

80. Table 1a: There is a reference in column 3 to a note which does not appear. Please clarify.

Navy Response:

The reference to the note has been removed.

81. Table 1f: Please include a reference to Lagoons 14 and 16 in the second column under the Decision Unit 7 entry. Also, for clarity, please reference Lagoons 12 and 13 in column 2 under the Decision Unit 9 entry.

Navy Response:

Table 1f has been revised as requested. Note that Decision Unit 7 is Lagoons 14 and 15.

82. Table 2a:

a. This table indicates that Beach 2 will not be sampled but Figure 29 shows a subsurface and DU at this beach. Please clarify.

Navy Response:

Table 2a is correct and Beach 2 will not be sampled. Beach 3 has 2 samples which are shown on Figure 29.

b. Beach 6: Please verify the text of column 10 as samples are proposed for this beach.

Navy Response:

The sample rationale has been further clarified in Table 2a (see revised table). Sampling is proposed based on the quantity and diversity of munitions.

83. Table 2b:

a. Please complete the text for UXO 7, Beach 21 under MEC Rationale.

Navy Response:

The text in Table 2b has been revised to: "Beach clearance not complete. If MEC clearance indicates high MEC score, proposal not to sample will be revisited."

b. Please clarify what is meant by "but MEC type not addressed" for Beach 22, Rationale (after column 8).

Navy Response:

That statement has been removed.

Appendix B: Background Soil Comparison

84. Page B-2: Central tendency comparisons for the multi-incremental and discrete populations were conducted using nonparametric tests only. It is unclear why a more statistically powerful parametric test (e.g., t-test) was not conducted on normally distributed data sets to determine whether statistical differences are present between constituents under the multi-incremental and discrete sample sets. Please clarify.

Navy Response:

Central tendency comparisons gain statistical power for testing a shift in mean when a parametric test based on normality (i.e., Student t test) is used in place of a nonparametric test (i.e. Wilcoxon Rank Sum and Gehan tests) assuming the assumption of a normal distribution is valid. That increase in power is typically modest and the statistical power for testing a shift in a median is higher with the nonparametric tests (U.S. Navy, 2002). It should also be noted that since the two tests do differ mathematically, differences between the two tests can involve more than just statistical power.

For past Vieques projects, central tendency comparisons have been primarily performed with site to background comparisons. When comparing site data to background data, it is typically rare to find both site and background data sets passing a test of normality (such as the Shapiro Wilk test) so an effort to choose between parametric and nonparametric options for the chosen test predominately leads to the nonparametric approach. Given that familiarity, the nonparametric approach for multi-incremental and discrete comparisons was then pursued with the same methods (Wilcoxon Rank Sum and Gehan tests).

With both of these populations being background, however, there was a greater chance that both would be normally distributed, particularly because only metals are considered which carry higher percentages of detected results. A run of the comparisons, giving the opportunity for the student t test (parametric two-sample comparison test) is presented in Appendix B, Table B-4. This table reveals that the conclusions of significant differences (between multi-incremental and discrete results) are very similar when the Student t approach is applied for cases where both populations pass a Shapiro-Wilk Test of normality. The only two differences are for vanadium (where the Student t approach indicated no significant difference

whereas the nonparametric approach indicated a significant difference) and for zinc (where the Student t approach indicated a significant difference whereas the nonparametric approach indicated no significant difference). Thus, the overall conclusions using either approach are the same.

U.S. Navy. Guidance for Environmental Background Analysis, Volume I: Soil, Naval Facilities Engineering Command, Washington, DC. 2002.

PREQB Evaluation of Response:

The response is acceptable although it should be noted that the overall conclusions using the parametric and nonparametric tests, although very similar are not the same. As noted in the response, no statistical difference was noted for vanadium using the parametric student t test while a difference was indicated by the nonparametric test. Please clarify whether the statistical differences noted for zinc using the parametric and nonparametric tests refer to zinc data sets with outliers included or excluded. If outliers are included, then there is no difference between the tests for zinc.

Navy Evaluation Response:

Note that the previous response agrees that the individual conclusions between the parametric and nonparametric test outputs are not the same. As mentioned earlier, "It should also be noted that since the two tests do differ mathematically, differences between the two tests can involve more than just statistical power." The statement regarding conclusions being the same was "the overall conclusions using either approach are the same." This appears to be true since the overall conclusion of whether the multi-incremental and discrete populations appeared the same would not change based upon an inversion of the individual vanadium and zinc conclusions at a 0.05 significance level. The individual conclusions for most constituents do not change and the individual vanadium and zinc probabilities for each hover about 0.05 regardless of which test is performed. The statistical tests were performed using both an all-nonparametric approach and then again using a mixture of nonparametric and Student t (where appropriate) approaches. The same overall conclusion was found using either approach which is the same approach one would probably draw from a non-statistical review of the data or from the comparative plots provided.

As for zinc the statistical difference between the parametric and nonparametric tests occurred when the outlier from the incremental data was excluded.

85. Table B-4: The statistical decision column appears to have incorrectly inverted the multi-incremental and discrete results (i.e., "multi-incremental > discrete" should be "discrete > multi-incremental" and "discrete > multi-incremental" should be "multi-incremental > discrete"). Please correct.

Navy Response:

Table B-4 has been revised as requested.

86. SOP A-2, Paragraph 1: Please note that any soil samples collected for VOC analysis should be collected in accordance with EPA Method 5035 protocols, as opposed to filling a jar such that no headspace remains (as is referenced in the final sentence of the first paragraph).

Navy Response:

VOCs are not proposed for analysis.

87. SOP A-7, Systematic Random Increment Sampling:

    a. The SOP states that this procedure does not apply to aliquots collected for SVOCs. However, there are several incremental samples being collected for PAHs at UXO 4 and UXO 13. Please clarify.

Navy Response:

The SOP has been revised to include explosives, metals, and SVOCs. The last sentence has been removed.

b. The SOP refers to explosives but only refers to SW-846 8330. Is this SOP applicable to perchlorate by SW-846 6850? If yes, please update SOP accordingly. If not, please clarify.

Navy Response:

SW-846 6850 has been added to the SOP.

c. The SOP states that triplicate samples are collected from each decision unit at a frequency of 1 per 10 samples. However, this frequency is not followed, as per Worksheet 18. Please clarify.

Navy Response:

Please see response to Page-specific Comment #40a.

E-mail from
Wilmarie Rivera/PREQB with Jim Pastorik comments
sent to Brett Doerr/CH2M HILL on 1-10-13

Review of the
Draft Final Master Sampling and Analysis Plan
for East Vieques Terrestrial UXO Sites,
Former Vieques Naval Training Range, Vieques, Puerto Rico
Dated November 2012

1. Worksheet 10, Page 52, says that the CPC was taken out of service. However, the SOP for MPPEH/MD Collection and Inspection references the CPC several times. Please correct this discrepancy and add the location where MD processing will occur.

   Navy Response:

   The last sentence of the referenced paragraph has been revised to read:

   "The CPC was taken out of full-time service in 2011 because the amount of metal/debris being recovered during ongoing investigations and munitions response activities is significantly less than that recovered during past TCRA and NTCRA activities. However, once the volume of material reaches the point that makes processing viable, processing equipment will be mobilized to the CPC to process and ship the explosive-free metals."

2. Worksheet 10a, Page 59, says that this MRS (LIA Beaches) was surface cleared except within the submunitions area. Since the reason for not completing TCRA work within the submunitions area is that the vegetation is too dense to allow for safe performance of the TCRA please explain why the TCRA was not completed on the beaches where there is no vegetation. Also, Figure 29 appears to show at least some of the beaches within the submunitions area were completed so the statement on Page 59 doesn't appear to be correct. Figure 14 appears to show that there is very little beach area remaining within the submunitions area (a small portion of Playa Barco, Beach 13) that wasn't completed. Please evaluate this statement and determine if the TCRA can be completed in what appears to be small but accessible beach areas.

   Navy Response:

   The portion of the sentence stating the beaches within the submunition area were not completed has been removed from the text on page 59. The beach area that the figure suggests has not been addressed under the TCRA did not exist during the TCRA. The aerial photos used to create the figure appear to show that there is an open sandy beach area that is workable. However, no sandy area in those locations existed (i.e., were likely washed away or under water during the TCRA).

3. Worksheet 10o, Page 95, should mention that 5-in. Zuni rockets were also found in the waters surrounding Cayo La Chiva. Although not part of UXO 18 this is an indicator that the use of the island as a target is greater than may be indicated by the 5 rockets identified in the text as being found within MRS UXO 18.

   Navy Response:

   The following text has been added at the end of the "Investigation and Release History" paragraph of Worksheet 10o:

   "In addition, the Navy conducted several visual surveys using Navy EOD divers/snorkelers to identify locations of underwater munitions off Cayo La Chiva. The Navy EOD divers identified several MEC

items west of the island, including 5-in Zuni rockets. While these items will not be addressed as part of UXO 18, they do provide another line of evidence that Cayo La Chiva may have been used for training activities."

4. Worksheet 14, Page 110, only covers environmental sampling under "Quality Control". This section should reference the SOPs listed in Worksheet 21 and provided in Appendix D as the source for the QC requirements and procedures for MEC tasks in a manner similar to how Worksheet 21 and the SOPs are referenced for "munitions characterization procedures".

   Navy Response:

   The following text has been added to the Quality Control subsection of Worksheet #14:

   "All munitions response activities will take place in general accordance with the procedures described in the SOPs (see Worksheet #21 and Appendix D) for the tasks performed. The UXO team leader, UXOQCS, and or QA officer will be responsible ensuring the quality control processes identified in the SOPs are implemented, as appropriate, and the quality control metrics identified in MR contractor's site specific work plan are achieved."

5. Worksheets 17a, 17f, 17g should note that data on beach mobility is being collected under the beach monitoring program and this data will be used to further characterize beach mobility and determine the adequacy of the 4-ft. investigation and the results of the beach monitoring will be included in the RI.

   Navy Response:

   The following paragraph has been added to the end of the "Future Munitions Activities" sections of Worksheets 17a, 17f, and 17g:

   "An investigation to study the dynamics at several beaches within UXOs 2, 7, and 8 is being conducted in support of the RI investigations. The intent of the beach dynamics investigation is to augment the current understanding of the dynamic nature of the beach environment at the former VNTR and its impact on the potential distribution and removal /deposition of MEC. As part of the beach dynamics investigation, the selected beaches will be surveyed using DGM several times throughout a 1-year period and the resulting anomalies with a reading above 2.5 mV will be intrusively investigated following each DGM survey. Data from the investigation will be included in the RI, as appropriate, to help assess the nature, extent, and mobility of MEC contamination at the beaches."

6. Worksheet 17a, Page 130, says, "…, there are no MEC removal actions anticipated at UXO 2 prior to making final remedy determinations for the site". This isn't technically correct as significant removal action was performed during the NTCRA where removal to a depth of 4-ft. was performed on UXO 2. This can be corrected by adding the word "additional" between the words "MEC" and "removal".

   Navy Response:

   The sentence has been changed to read, "Based on this information, there are no additional MEC removal actions anticipated at UXO 2 prior to making final remedy determinations for the site."

7. On Worksheet 21, Page 232:

   - The title of SOP 5 should be corrected to "Geophysical System Verification";
   - The equipment listed on the worksheet for SOP 7 is significantly different than the equipment listed on the SOP (EM61 and hand tools vs. heavy equipment, hammermill and thermal treatment furnace).

Also, an introductory note should be added to this worksheet to note that the MEC contractors are expected to develop their own SOPs and that the SOPs in this document represent the basic minimum standards that will be achieved by the MEC contractors.

Navy Response:

The title of SOP 5 has been corrected in the table and the equipment listed for SOP 7 has been corrected to match that in the SOP.

As suggested, a note has been added to the table stating: "The SOPs related to the munitions response activities provided in this SAP present the minimum standards through which MR work will be completed at the former VNTR. MEC removal contractors will develop specific SOPs for conducting their respective scope that meet, or exceed, the standards presented in the SOPs provided in this SAP."

8. Worksheet 22, Page 233, should include the location of calibration, maintenance, testing and inspection requirements for the radiation detector and the SOP reference for operating requirements for the hand-held magnetometer should be added to the worksheet.

Navy Response:

The information for the calibration, maintenance, testing and inspection requirements for the radiation detector and the SOP reference for the hand-held magnetometer have been added to the worksheet.

9. Worksheet 29, Page 277, doesn't include any MEC-related documents or records except for "DGM data". There are many other requirements for documentation including, for example, QC inspections, explosives inventory records, and certification of MDAS for shipment off-site. The required documents and records for the MEC aspects of the RI should be added to this table.

Navy Response:

The list of MR-specific documentation has been expanded to include instrument QC inspections, DGM data, explosives inventory records, MDAS certification, and MDAS shipping container COCs.

10. Worksheets 31 through 36 contain no information on quality for the MEC investigation. Please either add the MEC QC requirements to these tables or (the preferable alternative) reference the SOPs where this information can be found.

Navy Response:

Summaries of the QC requirements for the MEC investigations have been added to the tables in the worksheets and the SOPs are referenced, as appropriate.

11. It is difficult to link the SOPs in Appendix D with the discussion of them on Worksheet 21 because the "reference number" on Worksheet 21 isn't used on the SOPs in Appendix D and the Table of Contents in Appendix D uses different numbers than those used on Worksheet 21. Also, the individual SOPs in Appendix D aren't identified by their reference numbers. Please correct this to make it easier to locate relevant SOPs.

Navy Response:

The reference number from Worksheet 21 has been added to the SOPs and corrected in the Table of Contents for Appendix D.

12. There are different seeding requirements in the SOPs for DGM (one seed every 0.75 acres for man-portable instruments), while the SOPs for Subsurface Anomaly Inspection and Subsurface Anomaly Removal and

require one seed every 3-acres for towed arrays and 1 seed per acre for man-portable instruments. Please correct these requirements to make them consistent.

Navy Response:

The standard seeding rate for the work on Vieques has been one seed every 3 acres for towed arrays and one seed per acre for man-portable instruments. The seeding rate is intended to align with the production rate of the DGM activities to ensure that at least one QC seed is encountered for every day of data collection. As noted in PREQB Comment 7, the SOPs provided in this SAP present the minimum requirements for the contractor(s) performing the MEC related work at the site. Because site conditions may change drastically from one site to the next, the DGM work may be conducted at a rate greater/less than the rate provided in the SOPs. As such, the discussion of the seeding rates in the SOPs has been changed to indicate that QC seeds will be placed at a rate commensurate with the DGM production capabilities for the given site.

Final Responses to

US Fish and Wildlife Service Comments Regarding the

Draft Master Sampling and Analysis Plan,
East Vieques Terrestrial UXO Sites,
Former Vieques Naval Training Range,

Vieques, Puerto Rico,
April, 2012

Presented below are the US Fish and Wildlife Service (FWS) thoughts and comments on the subject document. As the US Environmental Protection Agency (EPA) and the PR Environmental Quality Board (EQB) have provided extensive comments regarding analytical methods, numbers of samples, and other specific areas of the study design, we will limit our comments to refuge, habitat, and wildlife concerns.

General Comments

1. **Munitions and Chemical Contaminant Characterization** Prior to conducting surface and subsurface munitions and chemical contaminant studies, the FWS suggests that the Navy, in consultation with the FWS, EPA, and EQB, determine if a specific area is a candidate for a less intrusive investigation. As discussed in Worksheet 10 and in other places, the surficial geology of east Vieques is composed of volcanic rock, and shallow or exposed limestone and dolomite rock. In uplands, in areas with exposed rock surfaces, on cliffs, and in other areas of high relief, the soils are typically a shallow veneer overlying rock and have a very low probability of containing subsurface munitions. Deeper soils are only found in quebradas and lowlying areas near lagoon and beach fringes and these areas should be the focus of subsurface investigations. Sampling for chemical contaminants should be aimed at depositional areas down slope of steep topography where contaminants would naturally accumulate. As was done for UXO-15, these characteristics should be considered when developing a site specific approach to an investigation as well as when determining the technical feasibility of successfully implementing an intrusive investigation.

   Navy Response:

   Comment noted. Note that subsurface soil is also encountered in other low lying areas, not just adjacent to lagoons and beach fringes. Also note that the sampling activities focus on areas with the highest potential for contamination, such as in low lying areas and depositional environments.

2. **Habitat Preservation** The Navy is conducting a comprehensive Biological Assessment (BA) of East Vieques to identify and map the location of protected species, sensitive habitats, and other high value resources. This information will be used to develop and/or modify the design and approach of investigations to avoid or minimize impacts to important or protected ecological resources. The specific approach for each response action will be discussed in site specific planning documents. While each area may possess unique features and resources, the FWS suggests the following general approach to response planning:

   - Careful consideration of BA results and site specific knowledge to plan response actions to minimize impacts to ecological resources.
   - Mangrove stands, wetlands, dense native vegetation, areas of high relief and other inaccessible areas should typically not be intrusively investigated for subsurface MEC, as these areas are usually inaccessible to the public.
   - Some lagoons on Vieques dry out at times leaving large open areas that can easily be investigated.

- Use of natural breaks in vegetation to access sensitive areas such as mangrove wetlands.
- The FWS stands ready to offer assistance throughout the investigation and is committed to work with the Navy, EPA and EQB regarding the preservation of ecological resources.

Navy Response:

Comment noted. Note that the results of the Biological Assessment are included as part of this Master SAP.

Specific Comments

1. **SAP Worksheet 10, 17 and Various Figures Depicting Conceptual Site Models and Potential Receptors** As indicated at various places in the document, potential ecological receptors at UXO sites with beaches, include nesting adult sea turtles, sea turtle eggs, and sea turtle hatchlings. Three species utilize the sand beaches of Vieques for nesting including the hawksbill, green, and leatherback sea turtles. The various work sheets relating to UXO sites with beaches infer that nesting occurs in the 18 to 24 inch depth range. While this is true for hawksbill and green sea turtles, leatherback sea turtles dig substantially deeper nests. To assure that sampling takes into consideration the potential exposure of leatherback sea turtles, the FWS suggests that an additional discrete sample in the 32 to 36 inch depth be collected where appropriate.

Navy Response:

Considering the variability of nesting depths that occur amongst the three turtle species (hawksbill, green, and leatherback sea turtles), the depth interval of the discrete deeper surface soil sample will be expanded to range from 18 to 36 inches. The lower end of this depth interval may be adjusted in the field should conditions be found unsuitable for sea turtle nests, such as the presence of groundwater, clay, or bedrock.

In Worksheet 10, conceptual model text for UXO's 2, 7, and 8 have been updated to indicate the following:

"The primary potential ecological receptors are the eggs of hawksbill, green, and leatherback sea turtles exposed to deeper surface soil "(18 to 36 inches)."

In Worksheet 14, under heading Discrete Surface Soil Sampling, the first sentence has been updated as follows:

"Discrete surface soil samples from the beaches (18 to 36 inches), ….."

In Worksheet 17, the sampling approach text has been modified for UXO's 2, 7, and 8 to update the discrete deeper surface soil depth to "(18 to 36 inches)."