Final

Quality Assurance Project Plan
Beach Dynamics Investigation
Eleven Beaches at the
Former Vieques Naval Training Range (VNTR)
and the
Former Naval Ammunition Support Detachment (NASD)

Atlantic Fleet Weapons Training Area—Vieques

Vieques, Puerto Rico

Contract Task Order 006

February 2014

Prepared for:

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Prepared under:

Navy CLEAN 8012 Program
Contract No. N62470-11-D-8012

Prepared by:

CH2MHILL

Virginia Beach, Virginia

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Executive Summary

This Quality Assurance Project Plan (QAPP) presents the Beach Dynamics Investigation to be performed at 11 beaches located at both the former Vieques Naval Training Range (VNTR) and the former Naval Ammunition Support Detachment (NASD) in Vieques, Puerto Rico (**Figure 1**). The objective of the investigation is to augment the current understanding of the dynamic nature of the beach environment and its impact on the mobility of munitions and explosives of concern (MEC) and Material Potentially Presenting an Explosive Hazard (MPPEH), by establishing correlations between measured beach changes, mobility of near-shore MEC, and meteorological and oceanographic (metocean) conditions.

Field investigations at the following beaches will be performed (**Figures 2 and 3**):

- UXO 2 (Live Impact Area [LIA] Beaches)
  - Beaches 2 (Unnamed), 3 (Playa Salinas del Sur), 4 (Turtle Beach/Playa Carrucho), 5 (Icacos/Playa Yallis), 12 (Unnamed), and 14 (Playa Brava)
- UXO 7 (North Eastern Maneuver Area [EMA]/Surface Impact Area [SIA] Beaches)
  - Beaches 22 (Puerto Diablo) and 24 (Purple Beach/Playa Campaña)
- UXO 8 (South SIA Beaches)
  - Beaches 1 (Yellow Beach/Playa Matías) and 19 (Playa Yoyé)
- Solid Waste Management Unit (SWMU) 4
  - Unnamed Beach

The multi-component Beach Dynamics Investigation will include:

1) Periodic beach surveys to evaluate relative changes of the beaches
2) Tracking of near-shore (underwater) MEC/MPPEH surrogates
3) Measurement of waves, currents, and water levels; and collection of publicly available metocean data

The data and information collected during the Beach Dynamics Investigation will be utilized to assist future decision-making processes with regards to additional investigations, remedial actions, frequency of monitoring, operation and maintenance, and other efforts that may be undertaken to minimize the likelihood and risks of encountering MEC and MPPEH. While tracking of onshore MEC/MPPEH surrogates is not part of this QAPP, once the understanding of the beach changes is augmented, this understanding may be used to develop an onshore MEC/MPPEH surrogate tracking addendum to this QAPP.

This QAPP is intended to be the primary work-planning document for the Beach Dynamics Investigation. It was developed in general accordance with the following two guidance documents:

- *USEPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA, 2002)*
- *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) (USEPA, 2005).*

The QAPP has been streamlined in accordance with Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Atlantic protocol for munitions-related QAPPs. Worksheets that are not applicable to this QAPP have been either modified or deleted to meet the intent of the worksheets with respect to the Beach Dynamics Investigation. Figures are included at the end of applicable worksheets.

The areas to be investigated have been identified under the Navy Munitions Response Program (MRP). The United States Environmental Protection Agency (USEPA), Region II is the lead regulatory agency and works in consultation with the Puerto Rico Environmental Quality Board (PREQB). The land under investigation is owned by the Department of Interior (DOI) and managed by the United States Fish and Wildlife Service (USFWS).

NOTE: THIS SUMMARY IS PRESENTED IN ENGLISH AND SPANISH FOR THE CONVENIENCE OF THE READER. EVERY EFFORT HAS BEEN MADE FOR THE TRANSLATIONS TO BE AS ACCURATE AS REASONABLY POSSIBLE. HOWEVER, READERS SHOULD BE AWARE THAT THE ENGLISH VERSION OF THE TEXT IS THE OFFICIAL VERSION.

NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HAN HECHO TODOS LOS ESFUERZOS PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

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Resumen Ejecutivo

Este Plan de Garantía de Calidad del Proyecto (QAPP por sus siglas en inglés) presenta la investigación de la Dinámica de Playas que se llevará a cabo en 11 playas localizadas en el Campo de Adiestramiento Naval de Vieques (VNTR por sus siglas en inglés) y en el Destacamento de Apoyo de Municiones Navales (NASD) en Vieques, Puerto Rico (**Figura 1**). El objetivo de esta investigación es aumentar el entendimiento sobre la naturaleza dinámica del ambiente de playas y sus impactos en la movilidad de las Municiones y Explosivos de Preocupación (MEC por sus siglas en inglés) y el Material que Potencialmente Presenta una Amenaza Explosiva (MPPEH por sus siglas en inglés), al establecer correlaciones entre los cambios medidos, la movilidad de los MEC cerca de la orilla, y las condiciones meteorológicas y oceanográficas (denominados datos metocean).

Se llevarán a cabo investigaciones de campo en las siguientes playas (**Figuras 2 and 3**):

- UXO 2 (Playas en el Área de Impacto con Bala Viva [LIA, por sus siglas en inglés])
  - Playa 2 (Sin Nombre), 3 (Playa Salinas del Sur), 4 (Turtle Beach/Playa Carrucho), 5 (Icacos/Playa Yallis), 12 (Sin Nombre), y 14 (Playa Brava)
- UXO 7 (Playas en la parte norte del Área de Maniobras del Este [EMA, por sus siglas en inglés]/Área de Impacto sobre la Superficie [SIA, por sus siglas en inglés])
  - Playa 22 (Puerto Diablo) y 24 (Purple Beach/Playa Campaña)
- UXO 8 (Playas al Sur del SIA)
  - Playa 1 (Yellow Beach/Playa Matías) and 19 (Playa Yoyé)
- Unidad de Manejo de Desperdicios Sólidos (SWMU) 4
  - Playa Sin Nombre.

La investigación de la Dinámica de Playas, la cual tiene varios componentes incluirá:

1) Monitoreo periódico de las playas para evaluar los cambios relativos de las playas
2) Rastreo de substitutos de MEC/MPPEH cerca de la orilla (debajo del agua)
3) Medición de las olas, corrientes, niveles de agua; y obtención de datos metocean que se encuentren disponibles públicamente.

Los datos y la información que se obtenga durante la Investigación de la Dinámica de Playas se usará para apoyar el proceso de toma de decisiones futuro relacionado con investigaciones adicionales, acciones de remediación, frecuencia de monitoreo, actividades de operación y mantenimiento, y otros esfuerzos que pudieran llevarse cabo para minimizar la posibilidad y los riesgos de encontrarse con MEC y MPPEH. Aunque el rastreo de substitutos de MEC/MPPEH sobre la orilla no forma parte de este QAPP, una vez se obtenga un mayor conocimiento sobre los cambios en las playas, esta información se podrá usar para desarrollar un plan de seguimiento de MEC/MPPEH sobre la orilla anejo a este QAPP.

La intención de este QAPP es servir como el documento de planificación principal para la Investigación de la Dinámica de Playas. Este documento ha sido desarrollado siguiendo las guías generales en base a los siguientes documentos:

- *USEPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA, 2002)*
- *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) (USEPA, 2005).*

El QAPP ha sido optimizado siguiendo el protocolo para el QAPP relacionados a municiones del Comando de Ingeniería de Instalaciones Navales del Atlántico (NAVFAC, por sus siglas en inglés). Las hojas de trabajo que no son aplicables a este QAPP han sido modificadas o extraídas para cumplir con el propósito de las hojas de trabajo que se relacionan a la Investigación de la Dinámica de Playas. Se han incluido Figuras al final de las hojas de trabajo que aplican.

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Las áreas a ser investigadas han sido identificadas en el Programa de Respuesta a Municiones de la Marina (MRP, por sus siglas en inglés). La Agencia de Protección Ambiental de los Estados Unidos (USEPA, por sus siglas en inglés), Región II es la agencia reguladora principal y trabaja en consulta con la Junta de Calidad Ambiental de Puerto Rico (JCA). Los terrenos bajo esta investigación son propiedad del Departamento del Interior (DOI, por sus siglas en inglés) y son administrados por el Servicio de Pesca y Vida Silvestre de los Estados Unidos (USFWS, por sus siglas en inglés).

Contents

Figures

Attachments

Abbreviations and Acronyms

ADCP	Acoustic Doppler Current Profilers
AHA	Activity Hazard Analysis
AM	activity manager
APP	Accident Prevention Plan
ASTM	American Society for Testing and Materials
ATG	air-to-ground
CA	corrective action
CD	compact disk
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action Navy
cm	centimeter
CTO	contract task order
deg	degrees
DOI	Department of the Interior
DGM	digital geophysical mapping
ECA	Eastern Conservation Area
EDD	electronic data deliverables
EMA	Eastern Maneuver Area
EQB	Environmental Quality Board
ESS	explosives safety submission
FFA	Federal Facilities Agreement
ft	feet
FTL	field team lead
FTP	file transfer protocol
GIS	geographic information system
GPS	Global Positioning System
HASP	Health and Safety Plan
IR	installation restoration
LIA	Live Impact Area
MC	munitions constituents
MD	munitions debris
MEC	munitions and explosives of concern
MOV	Municipality of Vieques
MPPEH	material potentially presenting an explosive hazard
MRA	Munitions Response Area
MRP	Munitions Response Program
MRS	Munitions Response Sites
MSL	Mean Sea Level
NASD	Naval Ammunition Support Detachment
NAVFAC	Naval Facilities Engineering Command
NPL	National Priority List
NOAA	National Oceanic and Atmospheric Administration
NTCRA	Non-Time Critical Removal Action

OB/OD	open burn/open detonation
OP	Observation Post
PAL	project action limit
PM	project manager
POC	point of contact
PQO	project quality objective
PREQB	Puerto Rico Environmental Quality Board
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
RPM	remedial project manager
RTK	real time kinematic
SIA	Surface Impact Area
SOP	standard operating procedure
SSC	Site-Safety Coordinator
SWMU	solid waste management unit
TBD	to be determined
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
VNTR	Vieques Naval Training Range
WAA	Wide Area Assessment
^{o}	degrees
‘	minutes
“	seconds

QAPP Worksheet #1—Title and Approval Page

Final

Quality Assurance Project Plan Beach Dynamics Investigation

Eleven Beaches at the Former Vieques Naval Training Range (VNTR) and the Former Naval Ammunition Support Detachment (NASD)

Atlantic Fleet Weapons Training Area—Vieques Vieques, Puerto Rico

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Prepared by:

CH2MHILL

Virginia Beach, Virginia

Review Signatures:

G. Brett Doerr
Digitally signed by G. Brett Doerr
DN: cn=G. Brett Doerr, o=CH2M HILL, ou=ACT, email=Brett.Doerr@ch2m.com, c=US
Date: 2014.01.21 10:01:10 -05'00'
Brett Doerr
CH2M HILL – Vieques Activity Manager

Tim Garretson
CH2M HILL – Vieques Munitions Response Lead

Approval Signatures:

GREEN.MICHAEL.DAVID.1042977876
Digitally signed by GREEN.MICHAEL.DAVID.1042977876
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN, cn=GREEN.MICHAEL.DAVID.1042977876
Date: 2014.01.21 10:49:45 -05'00'
Mike Green
NAVFAC Mid-Atlantic – MRP QAO

Other Approval Signatures:

HOOD.DANIEL.R.1147977103
Daniel Hood
NAVFAC Atlantic – Remedial Project Manager

Daniel Rodriguez
USEPA Region 2 – Remedial Project Manager

Wilmarie Rivera
PREQB – Remedial Project Manager

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QAPP Worksheet #2—QAPP Identifying Information

Site Name/Number: Beach Dynamics Investigation at UXO 2 (LIA Beaches), UXO 7 (EMA/SIA North Beaches) and UXO 8 (SIA South Beaches), and SWMU 4

Operable Unit: Not Applicable

Contractor Name: CH2M HILL

Contract Number: N62470-11-D-8012, Contract Task Order 006

Contract Title: Comprehensive Long-term Environmental Action Navy (CLEAN) 8012

- **This Quality Assurance Project Plan was prepared in accordance with the requirements of:**
  - Uniform Federal Policy – Quality Assurance Project Plans (USEPA, 2005)
  - United States Environmental Protection Agency (USEPA) *Guidance for Quality Assurance Project Plans (QAPPs)*
  - USEPA QA/G-5, QAMS (USEPA, 2002)
  - USEPA Guidance on Systematic Planning Using the Data Quality Objectives Process (USEPA, 2006)
- **Identify regulatory program:**

  Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
- **This QAPP is specific to:**

  The Beach Dynamics Investigation.
- **List dates of scoping sessions that were held:**

Scoping Session	Date
Technical Subcommittee Meeting	9/6/2012

- **List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.**

Title	Date

- **List organizational partners (stakeholders) and connection with lead organization:**

  Puerto Rico Environmental Quality Board (PREQB) – regulatory stakeholder

  United States Environmental Protection Agency Region 2 – regulatory stakeholder

  United States Fish and Wildlife Service (USFWS) – land owner

  National Oceanic And Atmospheric Administration (NOAA) - regulatory stakeholder
- **Lead organization (see Worksheet #7 for detailed list of data users):**

  Department of the Navy – Lead Agency

QAPP Worksheet #2—QAPP Identifying Information (continued)

- **If any required QAPP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted QAPP elements and provide an explanation for their exclusion below:**

  The following worksheets are not applicable to the format of this QAPP: Worksheets 12, 15, 18 through 21, 23 through 28, 30, and 34 through 36. These worksheets pertain to samples that are collected from a site and sent to an analytical laboratory for chemical analysis, which will not be conducted under this QAPP.

QAPP Worksheet #	Required Information	Included or Excluded
A. Project Management		
Documentation		
1	Title and Approval Page	Included
2	Table of Contents QAPP Identifying Information	Included
3	Distribution List	Included
4	Project Personnel Sign-Off Sheet	Included
Project Organization		
5	Project Organizational Chart	Included
6	Communication Pathways	Included
7	Personnel Responsibilities and Qualifications Table	Included
8	Special Personnel Training Requirements Table	Included
Project Planning/Problem Definition		
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	Included
10	Problem Definition, Site History, and Background. Site Maps (historical and present)	Included
11	Site-Specific Project Quality Objectives	Included
12	Measurement Performance Criteria Table	Excluded
13	Sources of Secondary Use Data and Information Secondary Use of Data Criteria and Limitations Table	Included
14	Summary of Project Tasks	Included
15	Reference Limits and Evaluation Table	Excluded
16	Project Schedule/Timeline Table	Included
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	Included
18	Sampling Locations and Methods/ Standard Operating Procedure (SOP) Requirements Table Sample Location Map(s)	Excluded
19	Analytical Methods/SOP Requirements Table	Excluded
20	Field Quality Control Sample Summary Table	Excluded
21	Project Sampling SOP References Table Sampling SOPs	Excluded

QAPP Worksheet #2—QAPP Identifying Information (continued)

QAPP Worksheet #	Required Information	Included or Excluded
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Included
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	Excluded
24	Analytical Instrument Calibration Table	Excluded
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Excluded
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	Excluded
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	Excluded
Quality Control Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	Excluded
Data Management Tasks		
29	Project Documents and Records Table	Included
30	Analytical Services Table Analytical and Data Management SOPs	Excluded
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	Included
32	Assessment Findings and Corrective Action Responses Table	Included
33	Quality Assurance (QA) Management Reports Table	Included
D. Data Review		
34	Verification (Step I) Process Table	Excluded
35	Validation (Steps IIa and IIb) Process Table	Excluded
36	Validation (Steps IIa and IIb) Summary Table	Excluded
37	Usability Assessment	Included

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QAPP Worksheet #3—Distribution List

Name of QAPP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
Daniel Hood	Vieques RPM/Lead Agency Point of Contact (POC)	Navy	757-322-4630	daniel.r.hood@navy.mil	A	CL	A
Kevin Cloe	Vieques RPM	Navy	757-322-4736	kevin.cloe@navy.mil	A	CL	A
Dan Waddill	Vieques Program Coordinator	Navy	757-322-4983	Dan.waddill@navy.mil	CL	CL	CL
Mike Green	Vieques Munitions Response QA Manager	Navy	757-322-8108	Micheal.green@navy.mil	A	CL	A
Madeline Rivera	Vieques Environmental Restoration Program Site Manager / On-island coordination	Navy	757-348-2689 (cell)	llamasmad@gmail.com	A	CL	A
Daniel Rodriguez	Vieques RPM/ Regulatory agency POC	USEPA	787-741-5201 787-671-9879 (cell)	rodriguez.daniel@epa.gov	A	CL	A
Julio Vazquez	Vieques RPM/ Regulatory agency POC	USEPA	212-637-4323	vazquez.julio@epa.gov	A	CL	A
Wilmarie Rivera	Vieques RPM/ Regulatory Agency POC	PREQB	787-767-8181 (x6141)	wilmarierivera@jca.gobierno.pr	A	CL	A
Richard Henry	Vieques RPM/ Land management agency POC/No project-specific role	USFWS	732-906-6987	richard_henry@fws.gov	A	CL	A
Diane Wehner	Regional Resource Coordinator/ Technical input and draft document review/No project-specific role	NOAA	732-872-3030	diane.wehner@noaa.gov	A		A
Lisamarie Carrubba	NMFS Vieques Lead/No project-specific role	NMFS	787-851-3700	Lisamarie.carrubba@noaa.gov	CL		CL
Brett Doerr	Contractor Activity Manager/ Navy contractor primary POC	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	A	A	A
Dennis Ballam	Project Manager	CH2M HILL	757-671-6251	dennis.ballam@ch2m.com	A	A	A
Monica Marrow	Administrative Record Coordinator	CH2M HILL	757-671-6272	monica.marrow@ch2m.com			A
Bill Hannah	Vieques ERP/MRP Investigation Lead	CH2M HILL	757-671-6277	bill.hannah@ch2m.com			F
Claudio Fassardi	Senior Coastal Engineer/Investigation Lead	CH2M HILL	760-258-7719	claudio.fassardi@ch2m.com			F

QAPP Worksheet #3—Distribution List (continued)

Name of QAPP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
TBD	Field Team	CH2M HILL					A
Wanda Bermudez	N/A	RAB	787-435-2841	wbromero@yahoo.com		CD	
Colleen McNamara	N/A	RAB	787-380-2545	lacolina@hughes.com		CD	
Stacie D. Notine	N/A	RAB	N/A	N/A		HC	
Jorge Fernandez – Porto	N/A	RAB	787-726-2839	jfporto@onelinkpr.net		CD	
Luis Lionel Sanchez Carambot	N/A	RAB	787-241-0063	sanchezcarambot@yahoo.com		CD	
Lirio Marquez-D'Acunti	N/A	RAB	787-726-2839	liriomarquez@gmail.com		CD	

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

QAPP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Project Role	Telephone Number (optional)	Signature/email receipt	SAP Section Reviewed	Date SAP Read
Dennis Ballam	Project Manager	757-671-6251			
Claudio Fassardi	Senior Coastal Engineer/Investigation Lead	760-258-7719			
Bill Hannah	Vieques ERP/MRP Investigation Lead	757-671-6277			
Brett Doerr	Contractor Activity Manager/Navy contractor primary POC	757-671-6219			
TBD	CH2M HILL/ Field Team Leader (FTL)				
Bhavana Reddy	Critigen Database Manager	703-462-3784			
TBD	CH2M HILL/Site Safety Coordinator (SSC)/Field Team Member				
Luce Bassetti	Project Coastal Engineer	813-386-1990			

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

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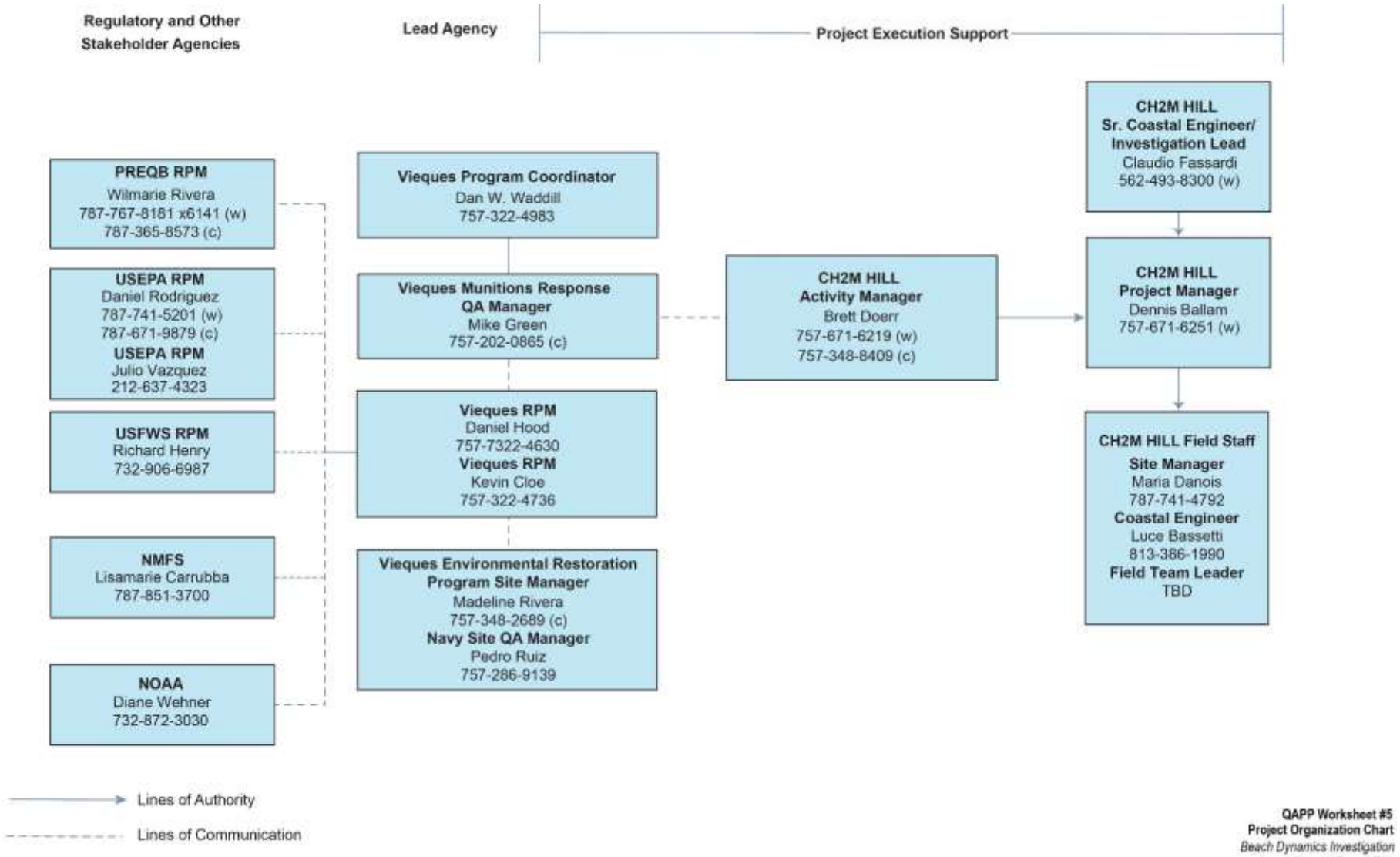
QAPP Worksheet #5—Project Organizational Chart



QAPP Worksheet #5
Project Organization Chart
Beach Dynamics Investigation
Vieques, Puerto Rico

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QAPP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Communication to/from Navy (e.g., submission of QAPP for review; receipt of regulatory comments, etc.)	Navy RPM	Daniel Hood	757-322-4630	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 QAPP 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 QAPP 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 QAPP for review; submission of PREQB comments)	PREQB RPM	Wilmarie Rivera	787-767-8181 (x6141)	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 QAPP 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)	Mike Green	757-202-0865	Provides review comments to Navy contractor on pre-draft QAPP via e-mail through Daniel Hood. Provides overall Navy guidance via direct communication with Navy contractor QAO, as warranted.
Communication to/from Navy contractor (e.g., submission of QAPP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations, etc.)	CH2M HILL Activity Manager	Brett Doerr	757-671-6219	Primary POC for Navy contractor (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other contractor staff, as appropriate. Communicates procedural changes to Navy RPM.
Project administration and logistics	CH2M HILL Project Manager	Dennis Ballam	757-671-6251	Direct communication (via e-mail, telephone, hardcopy, or in-person, as warranted) to/from CH2M HILL project staff to ensure appropriate project implementation. Communicates procedural changes to CH2M HILL Activity Manager.
Daily Field Progress Reports	CH2M HILL Field Team Leader FTL	TBD	TBD	FTL will provide daily updates to the project management team and technical staff.
Health and safety expectations and procedures	CH2M HILL Health and Safety Officer	Mark Orman	414-847-0597	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.
Technical Support and Reporting	CH2M HILL Senior Technical Consultant	Claudio Fassardi Tim Garretson Bill Hannah	760-258-7719 904-374-5633 757-671-6277	Data evaluation, analysis, and reporting. Procedural changes communicated to Project Manager and FTL.

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QAPP Worksheet #7—Personnel Responsibilities Table

Name	Title	Organizational Affiliation	Responsibilities
Daniel Hood	Vieques RPM	Navy	Munitions response program (MRP) activities implemented under this QAPP.
Mike Green	QA Lead	Navy	Navy QA and provide oversight of munitions response contractors to ensure they are completing work in accordance with QAPP.
Madeline Rivera	Vieques Site Manager	Navy	On-island Navy liaison; provides logistical support for implementation of munitions response program activities under this QAPP.
Brett Doerr	Activity Manager	CH2M HILL	Responsible for coordination of CH2M HILL's munitions response activities at Vieques; assists in data evaluation and interpretation; reviews report.
Dennis Ballam	Project Manager	CH2M HILL	Project administration; coordinates staffing; monitors project performance; ensures work is done in accordance with QAPP.
Tim Garretson	Munitions Response Technical Lead	CH2M HILL	As the technical lead, supports decision making with respect to MEC investigations and procedures.
Phil Fitzwater	Quality Assurance (QA) Lead	CH2MHILL	Assist Navy in providing UXO safety support, Quality Assurance oversight and ensuring requirements of ESS are implemented.
Claudio Fassardi	Senior Coastal Engineer	CH2M HILL	Supervises and manages all technical aspects of the Beach Dynamics Investigation, and provides QC and updates on project status.
Luce Bassetti	Project Coastal Engineer	CH2M HILL	Lead personnel for execution of the field activities; coordinates with project manager to ensure all equipment is available, surveys are performed and data is collected; analyzes, QC and archives data, and provides updates on project status.
Maria Danois	Site Coordinator	CH2M HILL	Provides overall logistics support for the implementation of munitions response activities
TBD	Field Team Leader	CH2M HILL	Will provide oversight of the Field Team and provide site information and progress reports to the Project Manager.
TBD	Field Team	CH2M HILL	Will collect data from the site.

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QAPP 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
MEC avoidance	EOD or UXO Technician Training Course	Military EOD School of the United States, Canada, Great Britain, Germany or Australia Formal Course of instruction provided by an accredited university of college or an EOD assistant course	Training will be verified as current prior to starting field activities by SSC.	UXO Technicians training and experience must meet DDESB TP 18 requirements	UXO Technicians TBD	Subcontractors records and CH2M HILL field safety files

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QAPP Worksheet #9—Project Scoping Session Participants Sheet

Project Name: Beach Dynamics Investigation at the former VNTR and NASD					
Projected Date(s) of Investigation: June 2013				**Site Name:** UXOs 2, 7, and 8 and SWMU 4	
Date of Session: September 6, 2012				**Site Location:** Vieques, Puerto Rico	
Scoping Session Purpose: Discuss investigation approach and concur upon the project objectives, technical approach, and decision structure.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Kevin Cloe	Vieques RPM	Navy	757-322-4736	kevin.cloe@navy.mil	Primary Navy POC
Daniel Hood	Vieques RPM	Navy	757-322-4630	daniel.r.hood@navy.mil	Navy POC for munitions related items
Daniel Rodriguez	Vieques RPM	USEPA	787-741-5201 787-671-9879 (cell)	Rodriguez.daniel@epamail.gov	Primary USEPA POC
Tom Hall	MEC Support Contractor to USEPA	TECHLAW	501-753-7987	THall@TechLawInc.com	Technical input and review of munitions related items on behalf of EPA
Wilmarie Rivera	Vieques RPM	PREQB	787-767-8181 x 6141	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
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
John Tomik	Activity Manager (former)	CH2M HILL	757-671-6259	john.tomik@ch2m.com	None
Tamir Klaff	Geophysicist	CH2M HILL	703- 669-9611	tamir.klaff@ch2m.com	None
Dan Waddill	NAVFAC Atlantic	Navy	757-322-4983	dan.waddill@navy.mil	Navy Vieques Coordinator
Brett Doerr	Activity Manager	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	Navy contractor primary POC

QAPP Worksheet #9—Project Scoping Session Sheet (continued)

The following is a summary of the key discussions from the September 6, 2012 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Web meeting/conference call. Note: Since the September 2012 Technical Subcommittee meeting, a senior coastal engineer has been added to the project team. Based on his input, the approach has been revised to remove the DGM/anomaly investigation component of the Beach Dynamics Investigation (at least for the initial phase) and near-shore monitoring and near-shore MEC/MPPEH surrogate tracking have been added. Therefore, the DGM/anomaly investigation aspects of the scoping session are no longer applicable.

Scoping Session

To initiate discussions on the QAPP the Navy and CH2M HILL presented a PowerPoint presentation which included:

1) a summary of the DGM Supplemental Investigation for several beach areas following the completion of the interim subsurface MEC removal actions,
2) the objectives of the Beach Dynamics Investigation, and
3) a description of the investigation tasks, and the anticipated schedule.

Characterization Approach

The following key elements of the investigation were discussed:

- The recent Supplemental DGM monitoring concluded that following the excavation of subsurface anomalies at the beaches the density of the anomalies decreased from 30-80% (the values represent reduction rates across multiple beaches).
- Beach profiles will be measured along transects perpendicular to the shoreline on a monthly basis, and following a storm event,
- DGM/anomaly excavation data will be collected on a quarterly basis,
- The results of the anomaly excavations will be utilized to amend the Master QAPP to identify optimum sampling locations for MC constituents during subsequent remedial investigations, and

Consensus Decisions

The Navy, USEPA, PREQB, and USFWS agreed with the proposed technical approach, with the following modifications:

- In addition to the beach profiles, GPS data will be collected at the end points of the beaches to approximate the areal extent of the beaches for each monitoring event. Note: This item has been eliminated from the Beach Dynamics Investigation since the information is readily available in georeferenced aerial photographs.
- The GPS coverage footprint from the quarterly DGM events will be used to augment the assessment of the size of the beaches. Note, DGM is no longer being conducted as part of this investigation (at least initially).
- In addition to the data collected during the investigation, historical aerial photos will be analyzed to assess the how the beaches have changed since the munitions activities were terminated at the former VNTR.
- Observation data collected by FWS during their monitoring of the turtle nesting beaches should be incorporated into the investigation report.

Action Items

Navy – Prepare a draft QAPP in accordance with UFP-QAPP guidance for regulatory review.

QAPP Worksheet #10—Problem Definition

Site History and Description

Vieques is located in the Caribbean Sea approximately 7 miles southeast of the eastern tip of the island of Puerto Rico and 20 miles southwest of St. Thomas, U.S. Virgin Islands (**Figure 1**). It is approximately 20 miles long and 4.5 miles wide, and has an area of approximately 33,088 acres (51 square miles).

The Navy purchased large portions of Vieques in the early 1940s to conduct activities related to military training. The eastern end of Vieques, also known as the former Vieques Naval Training Range (VNTR), was used for various aspects of naval gunfire training, including air-to-ground ordnance delivery and amphibious landings, as well as housing the main base of operations for these activities, Camp Garcia. Site operations on the western end of Vieques, within the former Naval Ammunitions Storage Depot (NASD), consisted mainly of ammunition loading and storage, vehicle and facility maintenance, and some training. The Navy ceased operations at the former NASD and VNTR prior to transferring the land to the Department of the Interior (DOI), Municipality of Vieques (MOV), and the Puerto Rico Conservation Trust, as required by the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 (Public Law 106-398), which was amended by Section 1049 of the National Defense Authorization Act for Fiscal Year 2002 (Public Law 107-107). The NASD was transferred in May 2001 and the VNTR was transferred in May 2003.

On February 11, 2005, Vieques was placed on the National Priority List (NPL) as part of the former Atlantic Fleet Weapons Training Area - Vieques, which 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, DOI, USEPA, and Puerto Rico Environmental Quality Board (EQB) executed a Federal Facility Agreement (FFA) on September 7, 2007 that established the procedural framework and schedule for implementing the CERCLA response actions for Vieques. Although the DOI is directed to protect and conserve the land transferred to it as part of the National Wildlife Refuge System, the Navy retains the responsibility for conducting environmental clean-up of the property, as warranted.

Former VNTR

The former VNTR consists of approximately 14,600 acres on East Vieques and is divided into four separate operational areas that from west to east comprise: the 11,000-acre Eastern Maneuver Area (EMA); the 2,500-acre Surface Impact Area (SIA); the 900-acre Live Impact Area (LIA); and the 200-acre Eastern Conservation Area (**Figure 2**). The Beach Munitions Response Area (MRA) comprises the beaches in the EMA, SIA, and LIA.

Former military operations at the former VNTR included ground warfare and amphibious training for Marines, naval gunfire support training, and air to ground training. Following cessation of military operations on the former VNTR, the Navy subdivided the aforementioned operational areas into 18 Munitions Response sites (MRS) based on considerations such as historic use, geographic features, and land use. The MRSs, referred to as UXO sites, were delineated in such a way as to make them more manageable for the purposes of prioritization, munitions removal, site characterization, and decision making. Three of the MRSs: UXO 2 (LIA Beaches), UXO 7 (North EMA/SIA Beaches), and UXO 8 (South SIA Beaches) are the focus of this QAPP. A summary of each operational area is provided below.

Eastern Maneuver Area (EMA)

The EMA, encompassing 10,900 acres, was established in 1947 and provided maneuvering 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.

QAPP Worksheet #10—Problem Definition (continued)

Surface Impact Area

The 2,500 acre SIA was established in the 1950s with the construction of several targets. Artillery ranging from 76mm to 175mm was directed toward these targets from artillery gun positions within the SIA and. During 1969, the construction of bulls-eye targets 1 and 2, used for inert bombing, established the eastern and western boundaries of the SIA. At that time, a permanent observation post (OP) with a helicopter pad was also constructed on Cerro Matais. In 1971, a strafing target was installed adjacent to one of the targets.

Live Impact Area

In 1965, air-to-ground (ATG) training activity began in the LIA where several mock-ups, such as old tanks and vehicles, were used as targets for aerial bombing. Since the mid-1970s, naval gunfire was practiced at the LIA, where several point and area targets for ships were constructed. Based on the naval gunfire and ATG gunfire that occurred from the 1970s though 2003, the entire 900 acres of the LIA has been impacted by MEC.

Eastern Conservation Area

The MRA-ECA, encompassing 200 acres on the eastern tip of Vieques, was not an operational area of munitions use. However, its close proximity to the MRA-LIA, where extensive naval gunfire and ATG bombing took place, identifies the MRA-ECA as a potential area of MEC impacts. In addition, the open burn/open detonation (OB/OD) area within the LIA generated an explosive hazard screening levels for the ECA.

Solid Waste Management Unit 4

SWMU 4 is approximately 400 acres in size and located in the southwest corner of Vieques within the boundaries of the former NASD, along the western shore of Vieques. SWMU 4 was used for the thermal destruction of retrograde and surplus munitions, fuels, and propellants from 1969 through 1979 and may have periodically been used for this purpose as far back as the late 1940s. Fuels, propellants, and explosives waste material were burned and/or detonated in the pits.

Summary of Previous Beach Investigations

DGM surveys and anomaly excavations have been conducted at Beaches 1, 5, 19, 22 and 25 as part of an ongoing Non-Time Critical Removal Action (NTCRA) for the subsurface MEC removal at beaches and selected roads at the former VNTR (CH2MHILL, 2009) and at SWMU 4 (CH2M HILL, 2012). DGM surveys and subsurface anomaly excavations have not been completed Beaches 2, 12 and 14. At four of the beaches to be investigated as part of the Beach Dynamics Investigation (Beaches 1, 19, 22 and 24), and at several additional beaches, a Supplemental DGM Survey has been completed following the completion of the interim subsurface removal of MEC. The purpose of the Supplemental DGM Survey was to identify the number of subsurface anomalies that were present at each of the beaches several months after the initial anomalies were excavated (CH2MHILL, 2012). The results of the Supplemental DGM survey concluded the following:

- Average reduction in the number of anomalies for the beaches between the time of the supplemental DGM and previous round of DGM and intrusive investigation was 54%.
  - A total of 47% of the 831 targets identified in the supplemental DGM of the beaches are categorized as “new” targets.
  - A total of 17% of the anomalies were identified as “enhanced” (exhibited a response of less than 2.5 mV in the initial DGM data and were therefore not included on original dig lists)
  - The remaining targets were “residual” targets which included anomalies that were: below water (21%), detected below 4 ft bgs, or located within one meter of an MEC item excavated (8%),

QAPP Worksheet #10—Problem Definition (continued)

General Problems to Address

Due to the dynamic nature of beaches, MEC/MPPEH and other metallic debris buried under the sand may surface or become closer to the surface. Beach erosion and sand transport may lead to MEC/MPPEH from the beaches being redistributed in the nearshore area. Sand transport via wave action in the nearshore may result in sand accretion on the beaches; in this case, MEC/MPPEH may be transported from offshore areas and deposited on the beaches or be transported closer to the beaches. Surface water runoff may also expose previously undetected MEC/MPPEH as well as redistribute MEC/MPPEH from higher elevations to lower areas.

Currently, little is known about the long- or short-term variations in beach conditions and their impact on the mobility of MEC/MPPEH at the former VNTR and SWMU 4. The purpose of the Beach Dynamics Investigation is to augment the current understanding of the dynamic nature of the beach environment (including the near-shore environment) at the former VNTR and SWMU 4 so that its impact on the mobility of MEC/MPPEH can be evaluated and considered in remedy decisions.

For each beach, the following questions will be addressed by this investigation:

- What is the relative change in area of the beach during the period of the investigation?
- What is the relative change of beach profiles during the period of the investigation?
- What is the relative change of beach width during the period of the investigation?
- During the period of the investigation, what are the origin and primary transport pathways of the beach sand? Is the primary transport pathway from the terrestrial environment to the underwater environment or from the underwater environment to the terrestrial beach environment? Are these transport mechanisms significant for the potential redistribution of MEC/MPPEH?
- During the period of the investigation, what coastal processes generate the beach changes, and what are their seasonality and characteristics?
- During the period of the investigation, is there significant terrestrial erosion that could reveal subsurface MEC/MPPEH?

Answers to these questions would allow for an assessment of the beach dynamics and its impact on mobility of MEC/MPPEH, but only for conditions representative of those present at the time of the investigation. Depending on the range of conditions occurring during the study period, additional studies using the results of the Beach Dynamics Investigation may be necessary to assess the beach dynamics and corresponding impacts on MEC/MPPEH for a wider range of conditions and longer duration. For example, the additional studies may include development of wave models to transform deep water waves to the nearshore at each beach of interest and using the resulting waves to force beach evolution models to estimate beach change. This would entail the use of data collected during this investigation, such as metocean data from deployed sensors and/or NOAA buoys, to force the wave models, the use of the wave/water level measurements to calibrate/verify the wave models, and the use of the measured beach profiles and grain size analyses to calibrate/verify the beach evolution models to estimate beach changes for any wave and water level condition, and for long periods of time (e.g. years or decades).

It is recognized that the most extreme beach changes likely occur during extreme events (e.g., hurricanes), which will not necessarily occur during the investigation timeframe. Beach changes due to these kind of events can be estimated using wave and beach evolution models. Long-term wind and wave hindcasts are available for the region, as well as detailed historical storm analyses. These could be used with the wave and beach evolution models to estimate beach changes for extreme events of interest of the past, as well as for beach changes due to wave and water level conditions spanning years or decades. The wave and beach evolution models are not tools to predict future events and related beach changes, but could be used to estimate beach changes in hypothetical wave and water level conditions.

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

The questions below address the project quality objectives (PQOs) and outline the details for conducting the Beach Dynamics Investigation.

Who will use the data?

- The Navy will use the data to assess the beach dynamics characteristics which, in turn, will be used to help assess MEC/MPPEH mobility on beaches and the near-shore environment.

What are the Project Action Limits (PALs)?

- The purpose of this investigation is to collect data to augment the current understanding of the dynamic nature of the beaches and its impact on detection thresholds of geophysical anomalies and mobility of MEC at the former VNTR and NASD. Because no quantitative risk-based decisions will be generated from this data, no specific PALs are established.

What will the data be used for?

The data collected during this investigation will be used to:

- Determine, for the range of metocean conditions collected during the period of the investigation, the impact of these on beach changes.
- Determine, for the range of metocean conditions collected during the period of the investigation, the potential impact of these on the mobility of MEC/MPPEH in the near-shore environment.
- Determine the extent of watershed run-off.
- Assist future decision-making processes with regards to potential MEC/MPPEH mobility on the beaches, remedial determinations, land use and engineering controls, frequency of monitoring and subsequent investigations, post Record of Decision operation and maintenance of the beaches.
- Provide supporting data that may be assimilated into the remedial decisions for the beaches on the VNTR and SWMU 4.

Provided that detailed modeling studies could be performed in the future, data collected during this investigation will be used to calibrate/verify modeling tools that could be used to develop long-term predictions of beach evolution and impacts on mobility of MEC/MPPEH for a wider range of conditions and longer duration.

What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?

The list below provides a summary of the data to be collected. Refer to **Worksheet #10** for additional information.

- A control benchmark will be installed at each beach to check the real time kinematic (RTK) GPS mobile units prior to the surveys. The control benchmark will be established by translation from known benchmarks in the already established network of benchmarks. Depending on logistics, line of sight and other considerations, the RTK GPS base station sending the correction signals to the mobile units would be installed either at the OP1 benchmark, or at the beach to be surveyed, in which case an additional control benchmark will be required at that beach.
- Beach profiles will be measured using a combination of RTK GPS, Total Station, and a survey vessel-based single-beam depth sounder along transects, spanning the length of the beach, and extending approximately perpendicular to the shoreline from the backshore boundary to the depth of closure in the nearshore. Depending on the beach morphology, the backshore boundary will be a bluff, vegetation line, cliff, or an arbitrary reference line. The depth of closure is defined as the location beyond which there is no significant

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

change in bottom elevation and no significant net sediment transport between the nearshore and the offshore. The objective of selecting the backshore boundary and the depth of closure are to bracket the area where the beach profile changes (i.e., where the profile lines collapse toward a single line (i.e., elevation). Because no historical profiles for the beaches are available, the depth of closure was determined empirically and by inspection of aerial photographs and may be adjusted during the beach profiling. **Figures 4 through 14** depict the proposed transect locations for each beach to be investigated. If, during the course of monitoring, it appears that the backshore boundary and the depth of closure locations have not been identified appropriately, they will be adjusted accordingly.

- If during the study, observations made at any particular beach suggest additional beach profiles are warranted (i.e., where the range of erosion and accretion occurring is not captured by the existing profiles), they will be added. The determination for the need of these additional profiles will be made by the Project Coastal Engineer based on observations of beach conditions recorded during each monitoring event, assisted by photographic records and notes from previous surveys. For a given beach and at a given time, a determination for the representativeness of beach behavior is provided by the inspection of beach profiles at neighboring transects, and spatial beach change trends by the inspection of profiles at all transects. A transect may fail to capture a localized non-representative changes of interest if located, for example, where storm water runoff, lagoons, streams or rivers discharge to the ocean, where erosion or accretion by wave energy refraction due to bathymetry or coastal features takes place, etc. and may exhibit “significant” changes. In the context of the proposed investigation “significant” is a subjective, qualitative term to express a deviation from representative beach changes according to the judgment of the Senior Coastal Engineer leading the investigation. While the proposed transects have been placed in locations that may experience “significant” changes, observations made over the course of the study will be used to modify transect locations, as warranted. For any given beach, the determination to survey additional transects will be made prior to each of the monthly surveys on the basis of a visual inspection and engineering judgment of the condition of the beach, assisted by photographic records and notes from previous surveys.
- Wave, currents and water levels will be measured with Acoustic Doppler Current Profilers (ADCPs) during the period of the investigation to correlate these parameters with the behavior of the beaches. **Figure 15** shows the preliminary location of the sensors.
- Wind, wave, water level, atmospheric pressure, and water and air temperature measured by third parties during the period of the investigation will be collected, as available and as warranted, to assess the effect of these parameters on coastal processes and potentially to calibrate wave and sediment transport models in the future. The current locations of the additional measurements that may be available for the investigation are provided in SOP #3.
- Statistical summaries of wind, wave, water level, atmospheric pressure, and water and air temperature will be collected from public sources to define baseline parameters and assess seasonality.
- MEC/MPPEH surrogates will be placed at selected beaches and tracked monthly, concurrently with the beach surveys, to assess the mobility of MEC due to the effect of waves. The number of surrogates and the beaches in which they will be deployed will be determined once the source of surrogates is confirmed.
- Sand samples will be taken along representative transects at various elevations, and grain size analyses (using ASTM D422, sieve only) performed to characterize the sand and its cross shore distribution on the beaches. The number and locations will be based on professional judgment, but are intended to provide beach-wide representation.

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

- USGS topographic data of the areas surrounding the beaches for the Beach Dynamics Investigation will be used to identify the watersheds that discharge to the ocean through the beaches.
- Rainfall data from available stations in Vieques will be collected, along with statistical summaries of rainfall, vegetation and soil characteristics of the watersheds to help assess potential transport of sediment by surface water runoff to the beaches. If a rainfall station on Vieques is identified, it will be monitored. No historical data from this station, if found, will be utilized. In addition, a rain gauge will be added at Camp Garcia.
- Bathymetry collected in March 2013 for the Wide Area Assessment (WAA) component of the project (summary of bathymetry data shown in Attachment C) will be used to characterize the nearshore and offshore areas surrounding the beaches, and for the analysis of the coastal processes that drive the behavior of the beaches.
- An inventory of morphological characteristics and features of the beaches will be conducted, for the upland and submerged areas, and including an assessment of the composition upland soil and sea bottom, and features such as reefs, headlands, islands, inlets, rivers/streams, wetlands, bluffs, dunes, cliffs, canyons, coastal lagoons, roads, etc.
- Historical aerial photos will be collected and geo-referenced to analyze the evolution of the beaches through time.
- Surveys will be documented in field notebooks and geotagged photos and/or videos.

How "good" do the data need to be in order to support the environmental decision?

The accuracy of the data provided below is based on the general equipment used and standard practices that will be utilized during the beach dynamics investigation.

- RTK GPS positional accuracy for beach profile and location of sand samples will be approximately 1 centimeter (cm) horizontal and 2 centimeter (cm) vertical.
- Positional accuracy for MEC/MPPEH tracking will be approximately 30 centimeters (cm) horizontal and 5 centimeters (cm) vertical.
- Positional accuracy of photo geotagging will be approximately 10 meters (m).
- Water depth measurement accuracy will be approximately 5 centimeters (cm). Water depth is the distance from the sea bottom to the water surface.
- Current velocity measurement accuracy will be approximately +/-0.5 centimeter/second (cm/sec).
- Wave height measurement accuracy will be approximately < 1%.
- Wave direction measurement accuracy will be approximately 2 degrees (deg).
- Water level measurement accuracy will be approximately 0.5%. Water level is the distance from the water surface to a reference datum, which will be mean sea level.
- The beach profile and wave/current/water level measurements, and MEC/MPPEH tracking will be conducted in accordance with the standard operating procedures (SOPs) provided as Attachment A to this QAPP.

Note: The accuracies of the measurements listed above will be based on accuracies provided by the various sensor manufacturers. These accuracies are typical of sensors from various manufacturers and used in applications similar to the planned Beach Dynamics Investigation. The stated accuracies are based only on manufacturer's specifications and no independent evaluation of accuracies will be conducted. Typical accuracies are listed only for comparison with manufacturer's claims and to aid with instrument selection and procurement.

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

How much data should be collected (number of samples for each analytical group, matrix, and concentration)?

- Beach profiles will be measured along transects at locations shown in **Figures 4 through 14** along the beach, every month for one year, at intervals along the transects that will ensure sufficient representation of the profile by a series of connected straight segments.
- The location (horizontal and vertical) of each MEC/MPPEH surrogate deployed will be surveyed every month for one year, concurrently with the beach surveys.
- At each beach, grab samples of the top 5 to 10 centimeters (cm) of beach sand will be taken quarterly for one year along selected transects (TBD) on the beach berm (backshore), on the foreshore at the Mean Sea Level (MSL), and at two locations between the MSL and the depth of closure.
- Offshore waves, currents and water levels will be measured during the period of the investigation from, or before, the day of the first beach profile survey to the day, or after, the last survey, at sampling rates TBD. Sampling rates for waves, currents and water levels will have an effect on the power consumption, data storage capacity, and battery type of the sensors, which vary depending on the sensor manufacturer, and data recovery intervals. However, the sampling rates will be sufficient to meet the project objectives. Once sensors are selected, sampling rates for the parameters of interest will be determined. Typical accuracies are listed only for comparison with manufacturer's claims and to aid with instrument selection and procurement.
- Existing topographic detail and extent are sufficient to adequately map the boundaries and features of the watersheds discharging to the beaches.
- Existing bathymetry detail and extent are sufficient to adequately represent bottom features such as canyons, reefs and bottom slopes in the nearshore for each beach, and offshore areas surrounding Vieques.
- Wind, wave, water level, atmospheric pressure, and water and air temperature data collected from public sources during the period of the investigation will be representative of the marine conditions in the vicinity of Vieques.
- Statistical summaries of wind and rainfall to be collected during the course of the investigation will be representative of contemporary conditions.
- The inventory of morphological characteristics and features of the beaches will be produced to the extent that it will permit the adequate characterization of the beaches.
- Historical aerial photography will be collected spanning as many years are possible to allow for the analysis of beach changes through a wide range of climate conditions.

Where, when, and how should the data be collected/generated?

- Collection of data to develop the inventory of morphological characteristics and features of each beach was performed during a site visit from March 11 to 15, 2013. A list of features will be compiled and entered into CH2M HILL's Shoreline and Nearshore Data System (SANDS) a GIS-based system for the storage and analysis of beach and coastal processes data and information, along with field notes and geotagged photos. Beach features were identified and characterized by visual inspection, and underwater features were characterized using NOAA's Biomapper (http://ccma.nos.noaa.gov/explorer/biomapper/biomapper.html?id=Vieques).
- At each beach, beach profiles will be surveyed monthly. Data will be stored in the RTK GPS data logger and field notebooks. Upon return from the field, data, notes, photos/video will be compiled and entered into SANDS.

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

- The location (vertical and horizontal) of each MEC/MPPEH surrogate deployed will be surveyed monthly. Data will be stored in the survey vessel hydrographic software and field notebooks. Upon return from the field, data, notes, photos/video will be compiled and entered into SANDS.
- Offshore wave, current and water levels will be measured during the period of the investigation by means of acoustic sensors at three locations shown in **Figure 15**; one on the south coast, the second on the east and the third one on the north coast. Data will be retrieved quarterly at the time of the beach surveys, compiled and entered into SANDS. Beach changes are mainly driven by waves and water levels. Because it is not practical to install instrumentation to perform wave/water level measurements at every beach of interest in the nearshore, measuring waves offshore and propagating them by means of numerical modeling to the beaches of interest to establish relationships between beach changes and these parameters is an alternative that is practical. The offshore wave climate in Vieques is predominantly from the east during most of the year and from the north-northeast during the winter. Because the beaches of interest are located along the north, south and east shores, there is no one offshore location that will produce measurements that will allow for the modeling of wave propagation to the beaches of interest with minimal transformation (and higher accuracy) due to bathymetry, headlands, islands and other coastal features. The three proposed wave/water level locations were selected so that measurements representative of the offshore wave climate for each shore can be collected to relate wave/water level parameters to beach changes. The wave/water level locations were selected using engineering judgment and experience. Metrics such as modeling were not used to select the locations as this is not necessary to meet the objectives stated Worksheets #10 and #11. The wave/water level sensor locations are sufficient to fulfill the objective of providing measurements adequate for wave model calibration/verification, in addition to short-term characterization of wave climate in the vicinity of Vieques. Other considerations included distance to the shore, since being too close to any particular beach may not be representative of others beaches, and being too far from the shore may not adequately represent the beaches, in addition to encountering deeper water which could potentially complicate the installation and maintenance of the sensors. With regards to vertical and temporal averaging protocols for the ADCP wave sensor, the reader is referred to Attachment B: “Wave Height Measurements Using Acoustic Surface Tracking,” which describes the technology and typical protocols for wave measurements with a Nortek AWAC sensor.
- Sand samples will be collected at selected transects (TBD), at each beach, quarterly and starting at the time of the first beach survey. Grain size analysis results will be stored in SANDS.
- The topography collected for the WAA will be used in this investigation, and will be stored in SANDS.
- The bathymetry collected for the WAA will be used in this investigation, and will be stored in SANDS.
- Wind, wave, water level, atmospheric pressure, water and air temperature, and rainfall data collected from the public domain during the course of the investigation will be stored in SANDS.
- Historical aerial photography will be collected during the course of the investigation, and will be stored in SANDS.
- Raw data, measurements and copies of relevant field notes and photos will be uploaded to a project FTP site and backed up to a CH2M HILL server location.
- QC of the data and uploads will be provided by the Senior Coastal Engineer.

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

Who will collect and generate the data? How will the data be reported?

- Beach profile measurements, field notes, photos/videos; collected metocean data; MEC/MPPEH tracking; sand samples; existing topography and bathymetry; watershed vegetation and soil characteristics; morphological characteristics and features of the beaches; and historical aerial photography will be conducted/collected by CH2M HILL.
- Within 3 weeks of a beach survey and prior to the next survey, results will be evaluated, and recommendations for changes to the next survey, if any, will be made. Substantive changes to the approach will be recorded and included in the beach dynamics investigation report. SANDS analysis and reporting features will be used to produce plots and tables. SANDS has the capability to produce numerous types of tables and plots. Which ones will be found most useful will be determined once the data begin to amass. Some likely plots are beach width evolution and beach profile changes, but others may be found to be useful. There is no one set of metrics that will be used to determine if modifications to the monitoring approach are warranted. However, the ultimate objective is to understand the dynamic nature of the beaches so they can be used to help assess their affects on MEC/MPPEH mobility. Therefore, monitoring modifications to subsequent events may be made, based on observations of the data from each event, as “tweaks” to help maximize the likelihood of achieving the objectives.
- The final report, along with the pre-processed and final processed data, will be submitted upon conclusion of the investigation. The report will include a description of the investigation objectives, methods and procedures, site conditions, results, analyses, conclusions and recommendations.

How will the data be archived?

- Raw/processed data files, hard copies, and field notes will be maintained for the duration of the investigation. Digital versions of these will be stored in SANDS.
- The data will be archived in accordance with Navy Guidance. At the end of the project, archived data will be returned to the Navy.

List the PQOs

The objective of the investigation is to augment the current understanding of the dynamic nature of the beach environment and its impact on the mobility of MEC and MPPEH, by establishing correlations between measured beach changes, mobility of near-shore MEC and MPPEH, and meteorological and oceanographic (metocean) conditions. Results of this investigation may be used during future project activities as a predictive tool associated with MEC/MPPEH mobility. Since the questions to be answered by the investigation are important only to the extent that resolve how beach dynamics affect MEC/MPPEH mobility, the PQOs focus on ensuring the data collected are of sufficient quality to effectively evaluate MEC/MPPEH mobility. Therefore, the project quality objectives associated with this beach dynamics investigation are defined by the information provided in the questions associated with the data type, quantity, and quality (i.e., questions: “What types of data are needed [matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques]?”, “How much data should be collected [number of samples for each analytical group, matrix, and concentration]?”, and “How good do the data need to be in order to support the environmental decision?”).

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

The table below provides general information on how secondary data will be used and the limitations on their use.

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	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 (CH2M HILL, 2009). Status Report, Non-Time Critical Removal Action, Interim Action for the Removal of Subsurface Munitions and Explosives of Concern at Solid Waste Management Unit 4 (SWMU 4), Former NASD, Vieques, Puerto Rico (CH2M HILL, 2012).	MEC and munitions debris (MD) items located on beaches during surface clearances.	Beaches with MEC previously identified included as a potential beach to be investigated.	None

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QAPP Worksheet #14—Summary of Project Tasks

The survey areas for this investigation are shown on **Figures 2 and 3** and in **Figures 4 through 14**. The protocols and SOPs to be used for the beach dynamics investigation are listed in **Table 14-1** and provided in the SOPs as Attachment A of this QAPP. The technical approach and sample design for the proposed field activities are discussed in **Worksheet #17**.

Mobilization

Prior to mobilization, NAVFAC Atlantic, USEPA, PREQB, and USFWS will be notified of the tentative schedule. SANDS will be set up, equipment will be secured for the field work, and staffing will be arranged.

Beach Surveys

The accuracy of the RTK GPS will be checked at the benchmark at Camp Garcia. Once the accuracy has been verified to be within approximately 1 centimeter (cm) horizontal and 2 centimeter (cm) vertical, a control benchmark will be installed at each beach to verify RTK GPS positioning prior to each survey. Subsequently, transects will be established at each beach to measure profiles on a monthly basis over a 12-month period.

At each beach, transect heads will be marked with identifiable markers like rebars, posts or pipes in the ground, and head location and heading of the transects will be documented in the field logbook. Transects will be identified by beach number and transect number. Starting from 1 from the right side of the beach looking seaward, transect numbers will be consecutive (i.e. 22-3= beach 22, transect 3). The transects will be overlaid on aerial photos or charts which will be used for navigation during the surveys.

Additional beach profile measurements will be performed at transects subjected to significant change but where transects were not available. The Beach Surveys will be conducted in accordance with **Worksheet #11** and SOP #1.

RTK GPS will be used to verify the location of each transect head prior to the survey of that transect. Positions, elevations and control benchmark data will be stored in the GPS data logger and downloaded daily. Beach profile variations will be monitored in SANDS. For a given month, the beach surveys will not be declared complete until all data gathered is declared adequate for the purposes of the investigation by the Project Coastal Engineer overseeing the surveys.

Sand samples (using ASTM D422, sieve method only) will be collected quarterly along selected transects with the number and locations based on professional judgment to provide beach-wide representation. Grab samples of the top 5 to 10 centimeters (cm) of beach sand will be taken along the selected transects on the beach berm (backshore), on the foreshore at the Mean Sea Level (MSL), and at a two locations between the MSL and the depth of closure. The samples will be placed in plastic ziplock bags and sent to a laboratory for analysis.

Survey results, field notes and processed data will be uploaded daily to SANDS.

MEC/MPPEH Tracking

MEC/MPPEH surrogates, identified by ID numbers and color, will be deployed at locations and quantities TBD. Surrogates will model weight and shape of selected MEC types. On a monthly basis, and concurrent with the beach surveys, the location of the surrogates will be surveyed by means of a survey vessel, swimmer(s), RTK GPS and depth sounder. Surrogates will be equipped with an acoustic transmitter that will allow for its identification and localization underwater by means of a hydrophone.

ME/MPPEHC locations will be stored and transport monitored in SANDS. Field notes and results will be stored in SANDS.

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

Metocean Data Collection

Over the 12-month period of the investigation waves, water level and currents will be measured at three locations (see **Figure 15**) on the south, east and north coasts of the VNTR to correlate these parameters with the behavior of the beaches.

Sensor installation, data retrieval and sensor recovery, field notes and processed data will be stored in SANDS and on a CH2M HILL network server.

Additionally, wind, wave, water level, atmospheric pressure, water and air temperature, and rainfall data will be collected from public sources and stored in SANDS and on a CH2M HILL network server. The location of measurement stations that may be available for the investigation are provided in the links included in SOP #3, Metocean Data Collection, Section III Procedures, Data Management and Quality Control. In addition, **Figure 16** has been added to the QAPP showing the locations of the identified NOAA stations.

Beach Erosion Potential

The watershed area associated with each beach will be approximated, precipitation data will be compiled on a monthly basis (from the Camp Garcia rain gauge), and visual observations will be made at each beach during each monthly monitoring event. Features that will be evaluated include sand channeling in the beach from upslope, ephemeral stream discharge locations, evidence of sheet flow (e.g., evidence of grasses and other vegetation impacted by sheet flow), the type of soil and quantity/type of vegetation within the watershed, etc. This information will be collectively evaluated to help qualify the erosion potential on any particular beach as “severe,” “moderate,” or “minor. As storm water runoff flows into the ocean, areas of the backshore would be eroded, but the sediment transported by the runoff (from upland and the backshore) would stay in the foreshore, accreting in certain areas. Eventually, some of this sediment will be transported back to the beach. This is one of the mechanisms by which beaches are naturally nourished. The objective is to measure precipitation, estimate storm water runoff, measure beach profiles (and changes by comparisons with previously measured profiles) and correlate the storm water runoff with the beach changes that cannot be explained by the effects of waves/water levels alone.

TABLE 14-1
Protocols and SOPs

Work Tasks	SOP	Supporting Document(s)
Planning and Pre-Mobilization Activities	-	QAPP
Mobilization/Site Preparation	-	QAPP
Beach Surveys	SOP #1 Beach Surveys	QAPP
MEC Tracking	SOP #2 MEC Tracking	QAPP
Metocean Data Collection	SOP #2 Metocean Data Collection	QAPP

Protective Measures for Federally Listed Species and Other Aquatic Species

Pursuant to the Endangered Species Act (ESA), the Navy has concluded that the activities associated with the Beach Dynamics Investigation will have "no effect" on ESA-listed green, hawksbill, leatherback, or loggerhead sea turtles or their nests due to the lack of intrusive actions during surveying activities, and implementation of protective measures to avoid direct impacts to sea turtle nests on the beaches and adults in offshore habitats. The Beach Dynamics Investigation will also have no effect on designated sea turtle critical habitat since none occurs on Vieques.

At each beach, transect heads will be marked with identifiable markers like rebars, posts, or pipes driven into the ground. In order to prevent any potential impact of these types of intrusive markers on sea turtle nests, one or more of the following avoidance options will be enacted, as appropriate: 1) markers will be installed between January 1st and February 15th when sea turtles are not nesting; 2) markers will be placed beyond established nesting habitat setbacks (Geo-Marine, 2007); and 3) transect heads will be located by RTK GPS during each monthly survey, thus no physical markers will be installed. With implementation of these avoidance options, installation transect head markers and beach control benchmarks will not affect sea turtle nests.

Surveying activity conducted by foot will not affect sea turtle nests since there will be no intrusive action or heavy compaction of the sand. In addition, all members of the Beach Dynamics Investigation team will receive training on identification of sea turtle nests and instructed to work around any visible nests on the beach. If a sea turtle nest is found along a transect, the nest will be noted and elevation measurements will be taken from undisturbed sand on either side of the nest. This action will avoid direct disturbance of the nest. An all terrain vehicle (ATV) may be used along some beaches to carry survey equipment and personnel long distances. In these instances, the ATV will be driven in accordance with techniques currently used for routine sea turtle nest monitoring on Vieques beaches by the USFWS and the Navy. This includes minimizing driving on any beach, and where necessary, assessing beach entry/exit points for turtle nests and only driving close to the water's edge where the sand is too compact and saturated to support sea turtle nests.

Grab samples of the top 5 to 10 centimeters (cm) of beach sand will be taken on the beach berm (backshore), on the foreshore at the Mean Sea Level (MSL), and at a two locations between the MSL and the depth of closure. Since sea turtle nests are typically located greater than 46 cm (18 inches) below the sediment surface, the collection of surface sand samples will not affect sea turtle nests.

Vessel-based surveys of the deeper water portions of beach transects and wave, currents, and water levels will be measured during the period of the investigation to correlate these parameters with the behavior of the beaches. Since coastal waters around Vieques provide habitat for adult sea turtles, measures will be taken to avoid contact with sea turtles (and marine mammals, listed coral species, hardbottom habitat, and vegetated bottom habitat) during offshore work activity or vessel movement. The SOP for Protection of Federally Listed Species and Sensitive Habitat approved for the ongoing monitoring and maintenance of the recently constructed Bahia Icacos Waterway Barrier System will be followed.

MEC/MPPEH surrogates will be placed at selected beaches and tracked monthly, concurrently with the beach surveys, to assess the mobility of MEC/MPPEH due to the effect of waves. Since the tracking of surrogates will require boating activity in shallow coastal waters, adherence to the protective procedures detailed in the SOP will result in no effect to federally listed sea turtles and other aquatic species while conducting offshore work activities.

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SAP Worksheet #16—Project Schedule/Timeline

The official schedule is the SMP schedule that is distributed and updated separately.

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QAPP Worksheet #17—Sampling Design and Rationale

The objective of the Beach Dynamics Investigation is to augment the current understanding of the dynamic nature of the beach environment at the former VNTR and SWMU 4 and its potential impact on the mobility of MEC/MPPEH. This section of the QAPP provides the design and rationale for the investigations to be completed.

Beach Surveys

Field investigations at the following beaches will be performed (**Figures 2 and 3**):

- UXO 2 (Live Impact Area [LIA] Beaches)
  - Beaches 2 (Unnamed), 3 (Playa Salinas del Sur), 4 (Turtle Beach/Playa Carrucho), 5 (Icacos/Playa Yallis), 12 (Unnamed), and 14 (Playa Brava)
- UXO 7 (North Eastern Maneuver Area [EMA]/Surface Impact Area [SIA] Beaches)
  - Beaches 22 (Puerto Diablo) and 24 (/Purple Beach/Playa Campaña)
- UXO 8 (South SIA Beaches)
  - Beaches 1 (Yellow Beach/Playa Matías) and 19 (Playa Yoyé)
- Solid Waste Management Unit (SWMU) 4
  - Unnamed Beach

These beaches were selected on the basis of a variety of reasons including:

- popular beaches for trespassers,
- MEC previously identified
- ecological significance (i.e. key turtle nesting), and
- representative of wide range of dynamic behavior due to:
  - wave exposure, and
  - nearshore bathymetry

The selected beaches are adequately representative of the remaining beaches (i.e., selected beaches cover the range of pertinent factors). While MEC may be present on beaches not selected for the study, the information from those selected can be used as a predictive tool for those not selected.

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

Summary table of the characteristics and expected dynamic behavior of the beaches					
Beach	**Orientation (facing)**	**Length (feet)**	**Wave Exposure**	**Dynamics**	**Comments**
19	southeast	1,000	protected	stable	Facing predominant southeast waves, bounded by two long headlands and protected by reefs on each side that form a narrow channel for waves to refract/break, the beach is protected and therefore expected to be stable and to exhibit small changes in a wide range of conditions. Potential future public use beach.
1	southeast	3,300	exposed	dynamic	Facing predominant southeast waves, bounded by headlands, the beach is not protected, expected to exhibit the largest changes among all south-facing beaches due to its exposure to wave climate variability (northern and trade winds, and hurricane seasons). Beach is utilized as nesting habitat for a large number of endangered sea turtles and is a potential future public use beach.
2	southeast	2,000	exposed	dynamic	Facing predominant southeast waves, bounded by a headland to the west and a tombolo formed by a small island to the east, expected to exhibit changes due to its exposure to wave climate variability (northern and trade winds, and hurricane seasons) but changes not as large as Beach 1 due to the protection offered by a reef to the southeast and an offshore island. This beach is often trespassed and experiences some endangered sea turtle nesting.
3	southeast	400	protected	stable	Facing predominant southeast waves, bounded by a small island forming a tombolo to the west and a long headland to the east, protected by a reef to the southeast and an offshore island to the south, expected to be stable and to exhibit small changes in a wide range of conditions. This beach is often trespassed and experiences some endangered sea turtle nesting.
4	southwest	1,500	protected	stable	Facing to the southwest, bounded by a headland to the northwest and a protective reef to the southeast, protected by two offshore islands that open, however, a narrow southwest wave window, expected to be stable and to exhibit small changes in a wide range of conditions. This beach is often trespassed and experiences some endangered sea turtle nesting.
14	northeast	1,500	exposed	dynamic	Facing predominant northern and eastern waves, bounded by headlands to the south and north, expected to exhibit large changes due to its exposure to wave climate variability (northern and trade winds, and hurricane seasons). This beach is a heavily used beach for endangered nesting sea turtles and will be important to the management of the Vieques National Wildlife Refuge.

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

Summary table of the characteristics and expected dynamic behavior of the beaches					
Beach	**Orientation (facing)**	**Length (feet)**	**Wave Exposure**	**Dynamics**	**Comments**
12	northeast	850	exposed	dynamic	Facing predominant northern and eastern waves, bounded by headlands to the south and north, expected to exhibit large changes due to its exposure to wave climate variability (northern and trade winds, and hurricane seasons) but changes not as large as Beach 14 due to the protection offered by reefs on each side. This beach is a heavily used beach for endangered nesting sea turtles and will be important to the management of the Vieques National Wildlife Refuge.
5	northeast	3,500	protected	stable	Facing predominant northern waves, bounded by headlands to the east and west, protected by a large reef to the north and an island to the northwest, expected to be stable and to exhibit small changes in a wide range of conditions. This beach is often trespassed and experiences some endangered sea turtle nesting.
22	north	1,500 and 950	exposed	dynamic	Actually two beaches separated by a headland in the middle, 1,500-foot long beach to the east and 950-foot long beach to the west, both beaches bounded by headlands at each side, each protected by reefs on both sides that form a narrow channel for waves to refract/break, facing northern waves, expected to be stable and to exhibit changes in winter northern wave conditions, changes larger than those at Beach 5. This beach is often trespassed and experiences some endangered sea turtle nesting.
24	north	3,500	exposed	dynamic	Facing predominant northern waves, bounded by headlands to the east and west, protected by a reef fronting the beach, exposed to northern waves and expected to exhibit changes in winter northern wave conditions, likely the largest changes among all north-facing beaches. This beach is often trespassed and experiences some endangered sea turtle nesting.
SWMU 4	Southwest and west	3,000 and 1,600	exposed	stable	Actually two beaches separated by a headland, southwest facing 3,000-foot long beach is bounded by headlands at each side, west facing 1,600-foot long beach is bounded to the south by a headland and unbounded to the north, each protected by reefs offshore, both not exposed to predominant waves, expected to be stable, however, susceptible to large changes under sporadic storm waves from the southwest, west facing beach also susceptible to large changes due to lagoon inlet breaching in heavy rainfall events. This beach is a potential future public use beach and experiences some endangered sea turtle nesting.

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

Elevations at each beach will be recorded monthly at the transects shown in **Figures 4 through 14**. Additional elevation measurements will be recorded at select locations on each beach that would appear likely to be subjected to erosion or accretion but where establishing a transect is not practical. The exact spacing of the elevations along the transects is not critical, but are at intervals that will ensure the sufficient representation of the profile by a series of connected straight segments and also by professional interpretation.

Transect locations were selected on the basis of representativeness of beach characteristics, coastal processes, nearshore bathymetry, and coastal morphology, with the objective of capturing the spatial variability that the beaches could experience. Beach characteristics were assessed during a site visit from March 11 to 15, 2013 and included observations/measurements of beach slope uniformity and the determination of possibly localized erosion or accretion. These were analyzed in conjunction with aerial photographs, the nearshore bathymetry, and coastal morphology to define, in a qualitative manner and with estimates of wave conditions, sediment transport patterns. The analyses yielded, for each beach, a layout of transects that is expected to capture the spatial variability of the beach changes. Furthermore, the offshore extents of the transects were defined on the basis of depth of closure calculations and the analysis of aerial photographs. Monthly survey intervals were determined to capture the seasonality of the beach dynamics. Among other uses, this information will help assess when favorable conditions for conducting munitions response activities in the beach areas during certain times of the year exist. Selection of transect locations is subjective; those selected for the beach dynamics study are sufficient to ensure the spatial variability of each beach is captured, extending throughout the locations were the sediment will move in the cross-shore direction. Every beach is different, affected by site-specific metocean conditions, and therefore engineering judgment is necessary. However, the objective of the investigation is not to compute sediment budgets but to measure beach changes. For each beach, the selected transects are sufficient to achieve this objective. If, during the course of the study, the information being gathered suggests additional transects are warranted, they will be added. The depth of closure is typically identified through the analysis of measured profiles. The location beyond which the depth of the seabed does not change significantly through time is the depth of closure. In the case of the beaches at Vieques these profiles do not exist, and therefore a combination of an empirical approach, aerial photos, site visit observations and practical considerations was used in the selection of the offshore end of the transects.

The formula by Hallermeier was used to provide a first estimate of the depth of closure. This formula uses the nearshore wave height exceeded 12 hours each year and associated wave period. This information was not available. Therefore, for each beach, estimates of the nearshore conditions were made analyzing wave measurements available at St. Thomas since 2011 to date and using wave transformation coefficients derived from observations during the site visit. For each beach, the estimated depth of closure was plotted on an aerial photo overlaid with the nearshore bathymetry and NOAA Biomaps. The location of the offshore end of the transects was selected not to match exactly the estimated location of the depth of closure, but to contain it. Finally, the practical consideration came into play acknowledging that the nearshore surveys will be performed by boat and that it would be inconsequential from an schedule and cost perspective to survey a transect a few more feet seaward from any given location.

It is noted that the depth of closure for the beaches of interest is not known and for practical purposes, the offshore end of the transects is referred to as the depth of closure in the QAPP.

Grain size samples will be collected quarterly along selected transects with the number and locations based on professional judgment. The grain size data will be used to: 1) help compute theoretical beach profiles; 2) characterize the sediment in sediment transport models; and 3) characterize the distribution of the sediment along the transects in sediment transport models.

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

MEC Tracking

MEC surrogates will be placed in the nearshore at beaches where MEC/MPPEH mobility and exposure has been observed, and in areas conducive for MEC/MPPEH mobility.

Metocean Data Collection

Waves, currents and water levels will be measured offshore the north, east and south shores at locations assumed to be representative of those downwave from these locations. The wave measurements will not be used directly, but indirectly for the correlation of beach changes with the wave climate. Wave modeling will be performed in the future, and wave measurements will be used to calibrate/verify the numerical models that will compute wave conditions in the nearshore at the beaches of interest. These resulting wave conditions can then be correlated to beach changes because these are the forcing that drives the changes.

Because the predominant wave climate at Vieques is from the east most of the year and from the north-northeast during the winter, a wave sensor in the vicinity of SWMU 4 is not necessary. The definition of the wave conditions at SWMU 4 will be achieved by wave modeling and relying model calibration/verification on the measurements from the wave sensor proposed for the south shore.

The rationale for the selection of locations for the additional metocean data to be collected from public sources is dictated only by the proximity to the project site, and assumed regional representativeness of the data.

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QAPP 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
GPS	Self calibrating when turned on	Recharge battery daily	Visual inspection	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	GPS gives accuracy which depends on number and position of satellites available. Use only if position shows ±2.5 M or better accuracy	Do not use if insufficiently accurate readings. Wait for better satellite positions.	FTL	None, follow manufacturer's recommendation
Hand-held magnetometer	Verify functionality u sing known locations of ferrous items	Check batteries a nd have a replace ment set on hand	During functionalit y test verify audible response to ferrou s item	Daily, before us e, and as deeme d necessary thro ughout use	Audible respon se to ferrous it em	Replace batterie s and attempt fu nctionality test a gain. Do not use individual instru ment an audible response is not h eard during func tional test.	MR Team Leader	SOP MR-2

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QAPP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field Logbooks • Field work plans • CA Forms • Electronic Data Deliverables • Equipment Maintenance, Testing, and Inspection Logs • Reported Result for QC Checks • Raw Field Data and Measurements • Photos • Daily Project Reports • Health and Safety Plan • Accident Prevention Plan • Daily safety briefing documents • Training Records • QC Documentation and reports • Meeting Agendas, Minutes, presentations, etc. • Summary Reports	• Planning documents, HASP, APP, site plans field data and measurements, field logs and photos will be kept on the project FTP site for duration of the investigation • Information on project FTP site will be backed up to CH2M HILL network server • Project administrative, planning and back-up documents will be stored on CH2M HILL network server • Beach monitoring data and results will be provided in final report • Data packages will be delivered to NAVFAC on DVD along with final report. • All hardcopies of project documents will be archived at project closeout at a private storage facility*.

- Data archiving will be done in accordance with Navy requirements. CH2M HILL will provide the Navy 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.

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QAPP 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 during the entire project if deemed necessary. Field performance audits are handled on a program level.	Internal	CH2M HILL	TBD/CH2M HILL (Program Field Auditor) or other qualified auditor	Dennis Ballam, Project Manager/CH2M HILL	Dennis Ballam, Project Manager/CH2M HILL	Brett Doerr/CH2M HILL (Activity Manager)

The Senior Coastal Engineer/Investigation Lead will provide QC oversight during the data collection efforts. A project audit will be conducted if the Senior Coastal Engineer/Investigation Lead determines one is necessary.

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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	Dennis Ballam, Project Manager/CH2M HILL	Within one week of audit	Memorandum	Field Team Leader/CH2M HILL (TBD) Brett Doerr/CH2M HILL (Activity Manager)	Within one week of receipt of CA form

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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 following audit, if performed	Submitted with report in which data are analyzed and presented	Project Manager: Dennis Ballam/CH2M HILL	Regional Health, Safety, Environment, and Quality Manager: Mark Orman/CH2M HILL Included in project files.

The Senior Coastal Engineer/Investigation Lead will provide QC oversight during the data collection efforts. A project audit will be conducted if the Senior Coastal Engineer/Investigation Lead determines one is necessary.

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QAPP Worksheet #37—Usability Assessment

Data usability evaluation comprises critical assessment of the data with respect to the project objective. The usability of the data is based upon engineering judgment by the project team (and verified by the Senior Coastal Engineer/Investigation Lead) and standard practices utilized during the beach dynamics investigation. The data is deemed usable by achieving the accuracy of the general equipment used, as detailed in Worksheet #11 subheading “How good do the data need to be in order to support the environmental decision”.

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Figures

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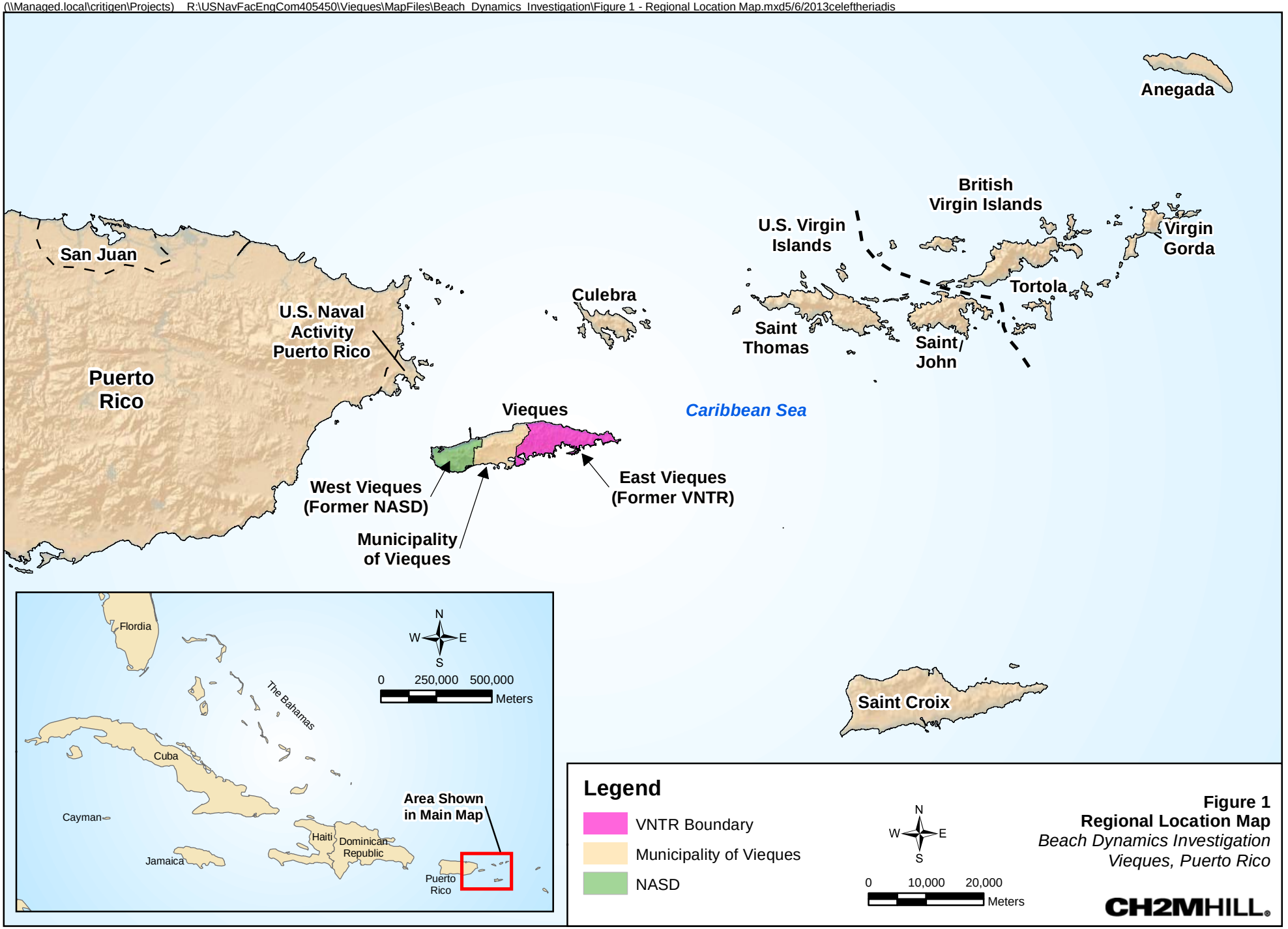


Figure 1
Regional Location Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\VIEQUES\MAPFILES\BEACH_DYNAMICS_INVESTIGATION\FIGURE_2_FORMER_VNTR_BEACH_LOCATION_MAP.MXD CELEFTHERIADIS 12/6/2013 8:51:26 AM

Pruple Beach/Playa Campaña
Beach 24

Puerto Diablo
Beach 22

Icacos/Playa Yallis
Beach 5

Playa Salinas
del Sur
Beach 2

Beach 12

Playa Brava
Beach 14

Beach 3

Turtle Beach/Playa Carrucho
Beach 4

Yellow Beach/Playa Matías
Beach 1

Playa Yoyé
Beach 19

EMA

SIA

LIA

ECA

UXO-7

UXO-2

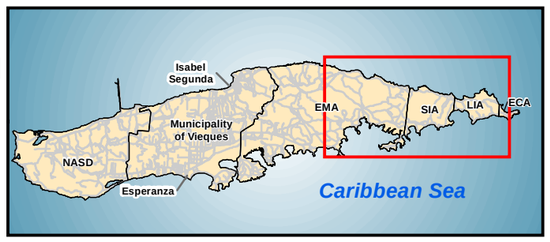
UXO-8

Legend

Munitions Response Sites

- UXO 2 - LIA Beaches
- UXO 7 - EMA/SIA North Beaches
- UXO 8 - SIA South Beaches

Beach to be Investigated



N
W E
S

0 1,000 2,000
Meters

Figure 2
Former VNTR Beach Location Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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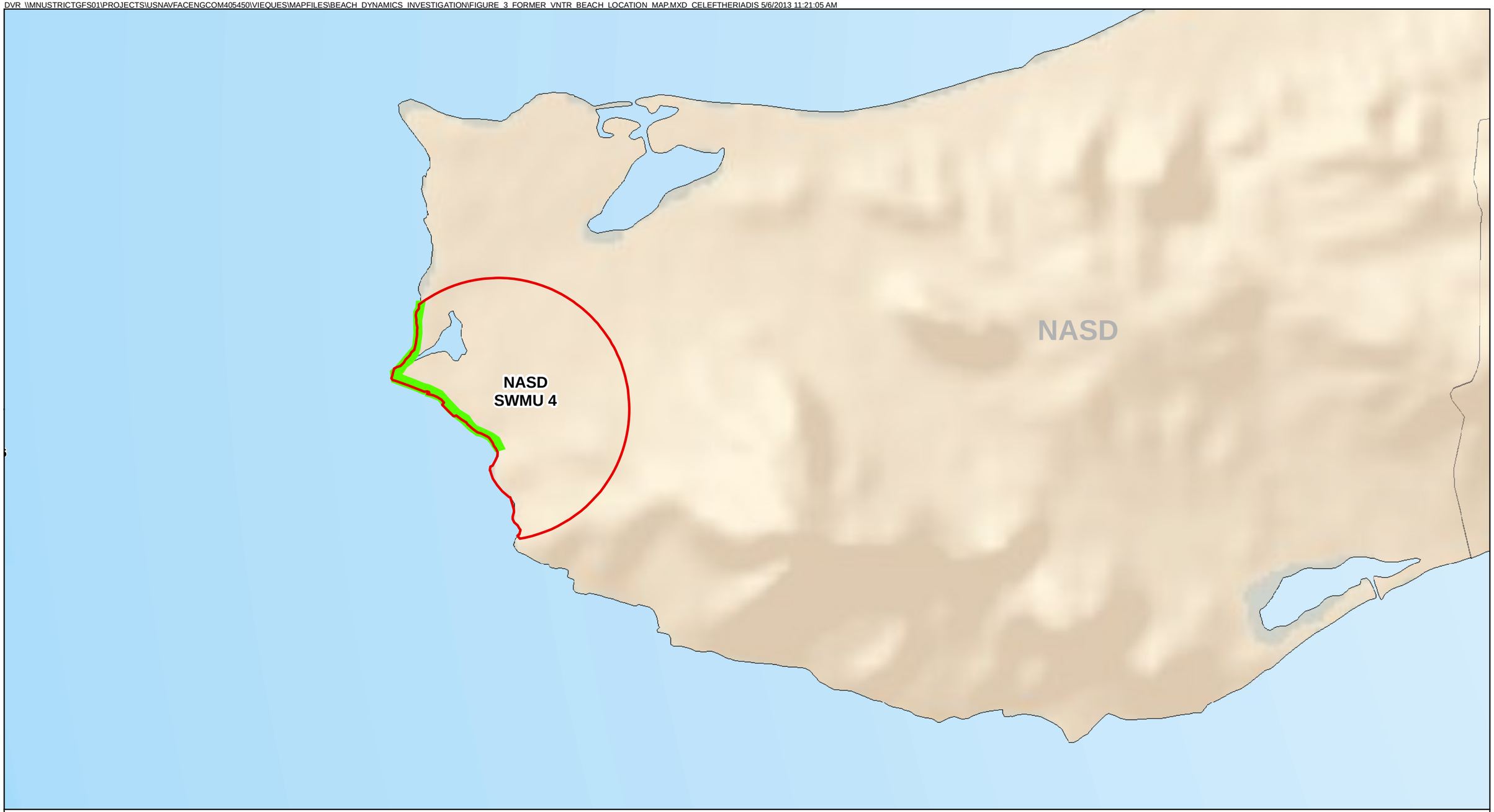
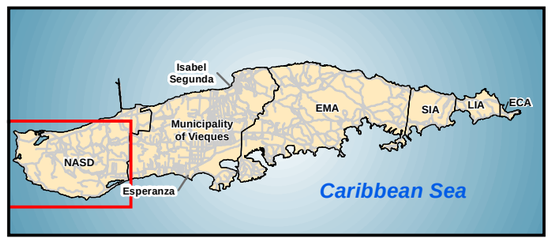
DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\VIEQUES\MAPFILES\BEACH_DYNAMICS_INVESTIGATION\FIGURE_3_FORMER_VNTR_BEACH_LOCATION_MAP.MXD CELEFTHERIADIS 5/6/2013 11:21:05 AM



Legend

- SWMU 4 Site Boundary
- Beach to be Investigated



N
W E
S

0 750 1,500
Meters

Figure 3
SWMU 4 Beach Location Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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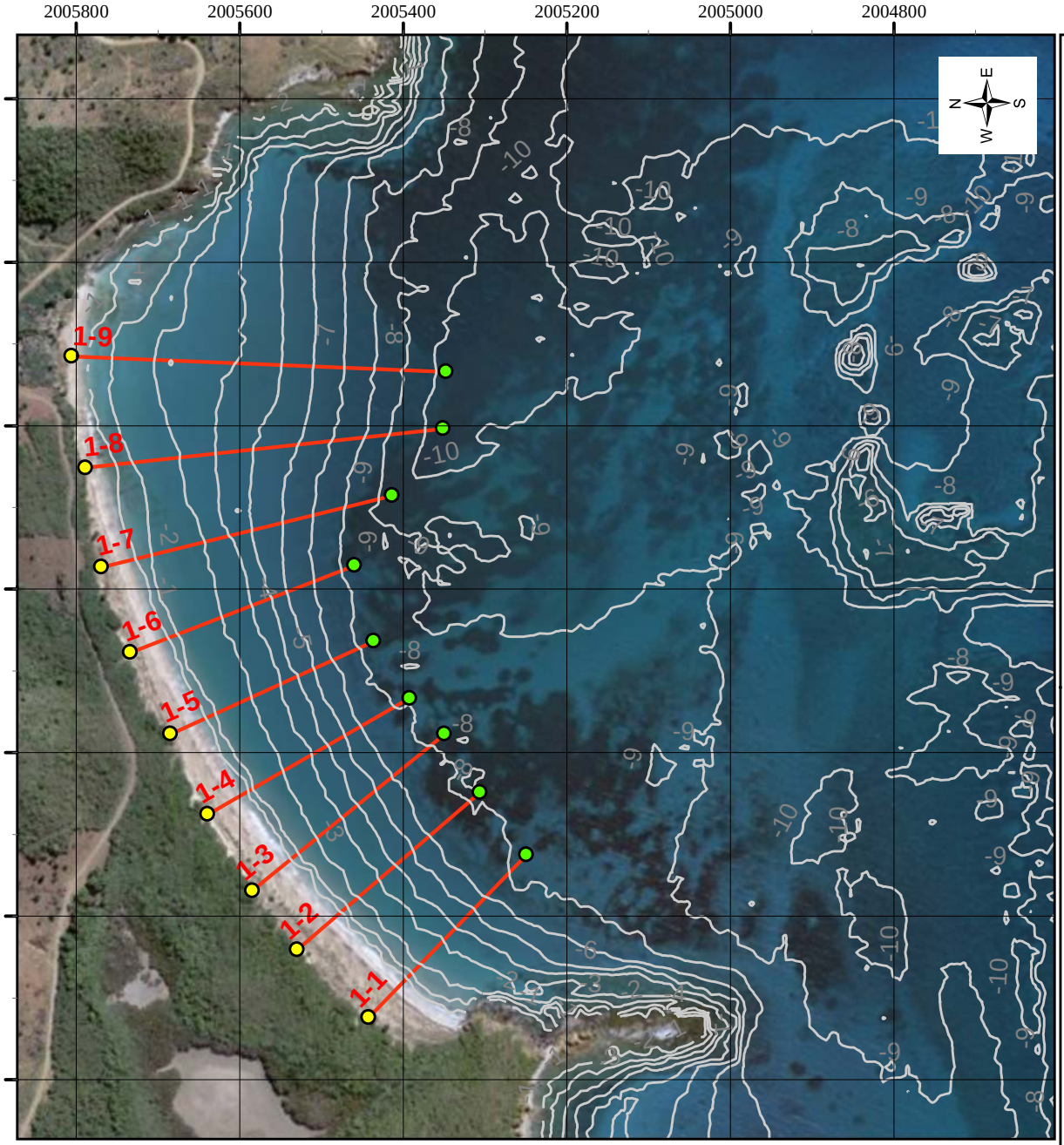

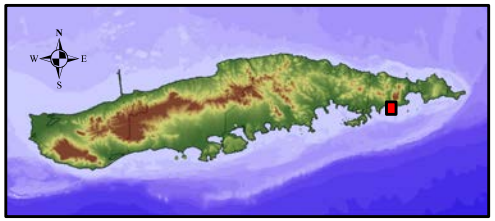

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
   Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
1-1	Head	253,676.40	2,005,442.44	277.2	134.1
	Toe	253,875.32	2,005,249.41		
1-2	Head	253,759.20	2,005,530.02	295.1	139.3
	Toe	253,951.69	2,005,306.29		
1-3	Head	253,831.33	2,005,584.90	303.4	140.8
	Toe	254,023.07	2,005,349.73		
1-4	Head	253,924.80	2,005,639.47	284.8	150.1
	Toe	254,066.86	2,005,392.65		
1-5	Head	254,023.04	2,005,685.03	273.6	155.5
	Toe	254,136.69	2,005,436.19		
1-6	Head	254,122.75	2,005,734.22	294.3	158.8
	Toe	254,229.23	2,005,459.83		
1-7	Head	254,227.24	2,005,769.37	366.3	166.2
	Toe	254,314.65	2,005,413.70		
1-8	Head	254,348.84	2,005,788.83	440.0	173.8
	Toe	254,396.45	2,005,351.36		
1-9	Head	254,485.04	2,005,805.64	458.3	182.4
	Toe	254,466.09	2,005,347.70		

Figure 4
Beach 1/Yellow Beach/Playa Matías Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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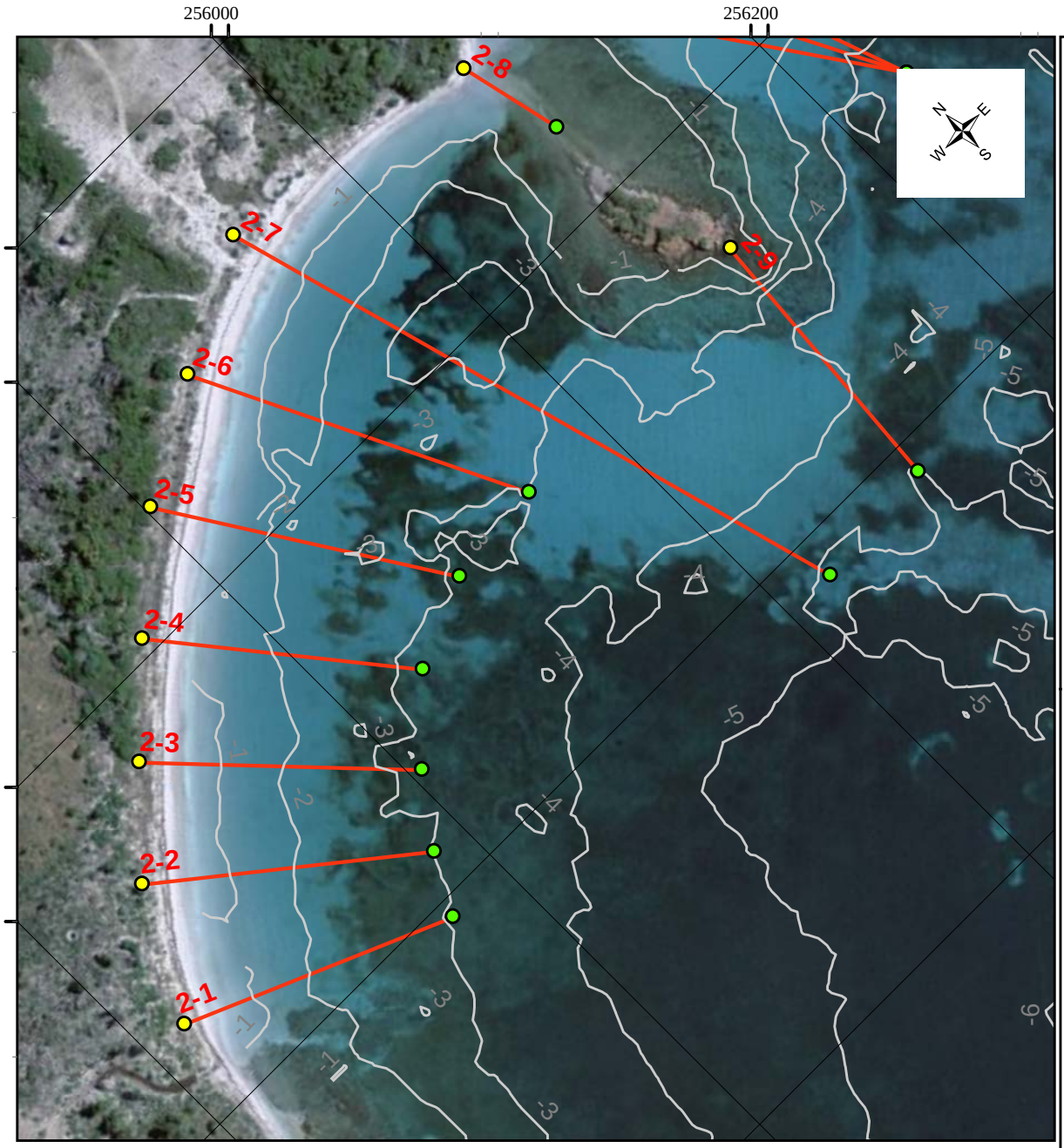

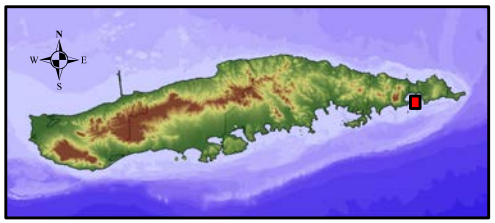

0 40 80 160
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
2-1	Head	255,624.19	2,006,450.31	151.5	113.2
	Toe	255,763.40	2,006,390.62		
2-2	Head	255,660.27	2,006,517.81	154.0	128.6
	Toe	255,780.71	2,006,421.80		
2-3	Head	255,704.42	2,006,564.26	148.3	136.5
	Toe	255,806.48	2,006,456.68		
2-4	Head	255,751.34	2,006,609.03	148.0	141.2
	Toe	255,843.99	2,006,493.64		
2-5	Head	255,803.24	2,006,654.59	166.0	147.7
	Toe	255,892.07	2,006,514.34		
2-6	Head	255,866.17	2,006,689.99	189.3	154.1
	Toe	255,948.92	2,006,519.74		
2-7	Head	255,934.79	2,006,724.74	360.1	164.7
	Toe	256,029.98	2,006,377.39		
2-8	Head	256,081.90	2,006,701.05	57.5	167.3
	Toe	256,094.53	2,006,644.93		
2-9	Head	256,114.17	2,006,535.49	152.8	185.0
	Toe	256,100.84	2,006,383.26		

Figure 5
Beach 2/Playa Salinas Del Sur Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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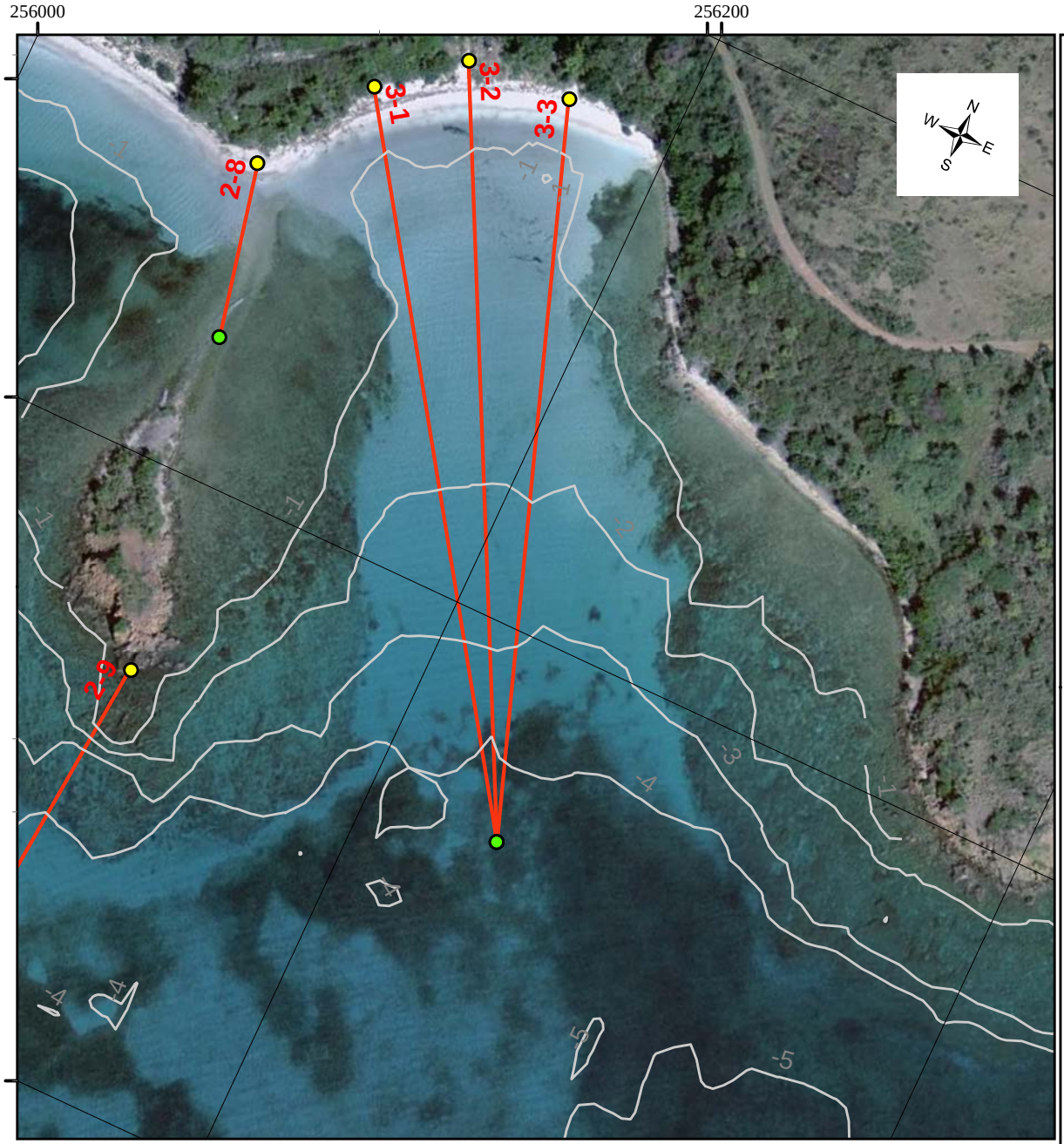

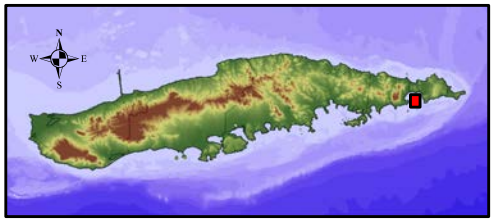

0 25 50 100
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
3-1	Head	256,105.75	2,006,739.43	246.8	145.8
	Toe	256,244.50	2,006,535.19		
3-2	Head	256,129.89	2,006,759.84	252.0	153.0
	Toe	256,244.50	2,006,535.19		
3-3	Head	256,164.43	2,006,762.21	240.5	160.6
	Toe	256,244.50	2,006,535.19		

Figure 6
Beach 3 Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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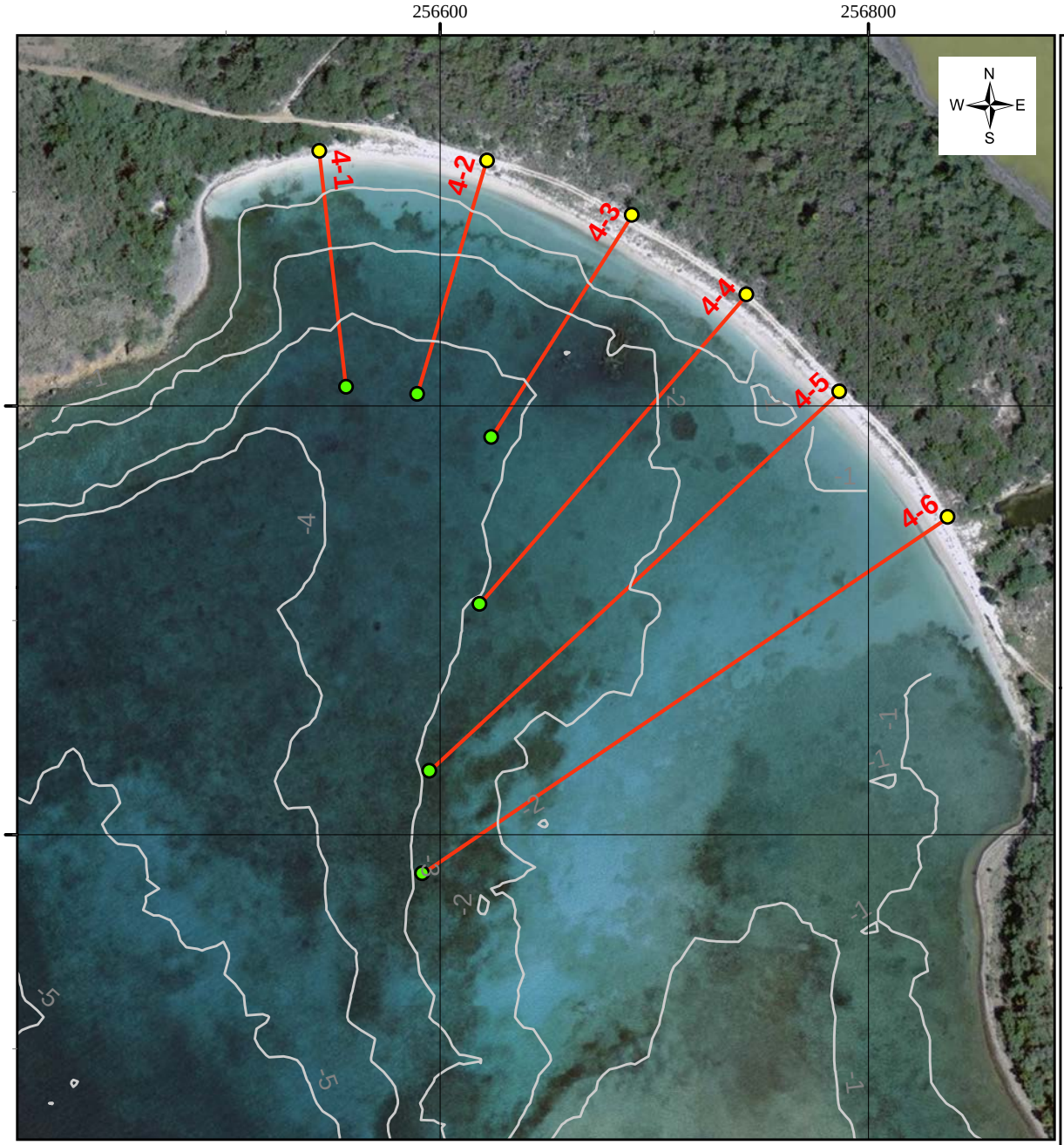

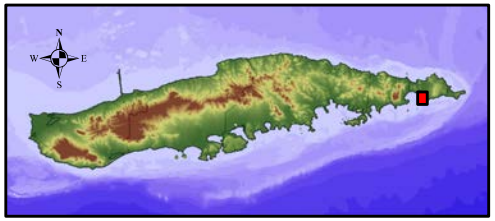

0 35 70 140
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
4-1	Head	256,543.77	2,006,718.89	110.7	173.6
	Toe	256,556.20	2,006,608.90		
4-2	Head	256,621.94	2,006,714.56	113.8	196.6
	Toe	256,589.41	2,006,605.50		
4-3	Head	256,689.66	2,006,689.03	122.6	212.3
	Toe	256,624.07	2,006,585.43		
4-4	Head	256,743.00	2,006,651.95	190.6	220.7
	Toe	256,618.61	2,006,507.57		
4-5	Head	256,786.51	2,006,606.64	260.8	227.2
	Toe	256,595.00	2,006,429.56		
4-6	Head	256,836.98	2,006,548.13	296.3	235.9
	Toe	256,591.76	2,006,381.84		

Figure 7
Beach 4/Turtle Beach/Playa Carrucho Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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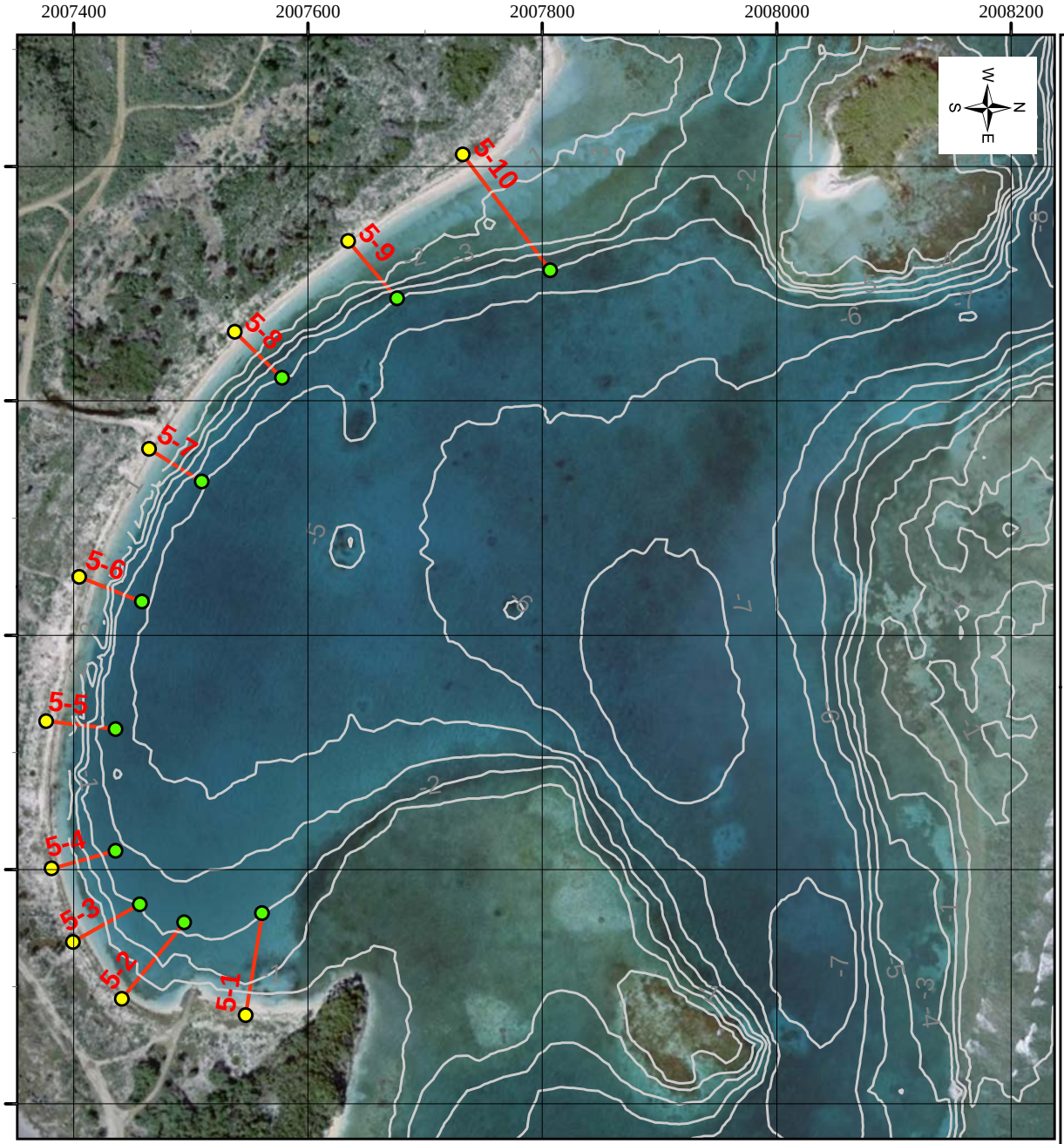

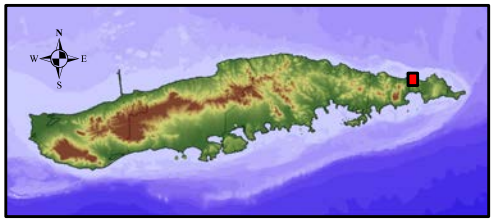

0 50 100 200
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
5-1	Head	256,524.42	2,007,547.11	88.0	279.2
	Toe	256,437.58	2,007,561.22		
5-2	Head	256,510.62	2,007,441.43	84.2	309.3
	Toe	256,445.44	2,007,494.80		
5-3	Head	256,462.05	2,007,399.65	65.7	330.7
	Toe	256,429.90	2,007,456.94		
5-4	Head	256,399.38	2,007,381.59	56.5	344.4
	Toe	256,384.18	2,007,436.05		
5-5	Head	256,273.49	2,007,376.78	59.7	6.7
	Toe	256,280.42	2,007,436.05		
5-6	Head	256,150.32	2,007,405.11	57.5	21.8
	Toe	256,171.66	2,007,458.55		
5-7	Head	256,041.32	2,007,464.85	52.9	31.8
	Toe	256,069.15	2,007,509.81		
5-8	Head	255,941.21	2,007,537.75	56.5	44.3
	Toe	255,980.65	2,007,578.17		
5-9	Head	255,863.75	2,007,634.61	64.4	49.6
	Toe	255,912.80	2,007,676.34		
5-10	Head	255,789.79	2,007,732.39	124.0	53.0
	Toe	255,888.77	2,007,807.04		

Figure 8
Beach 5/Bahia Icacos Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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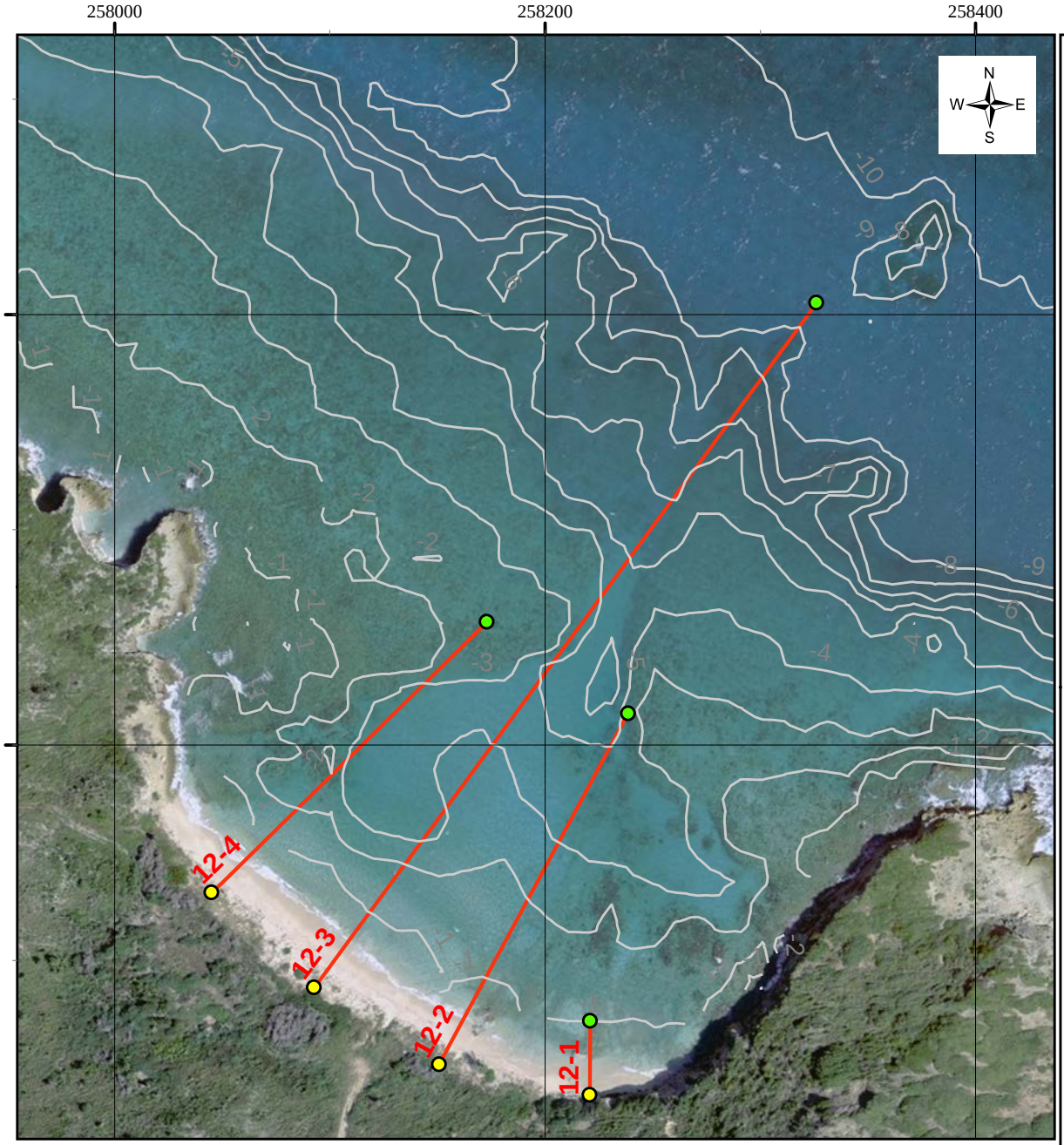

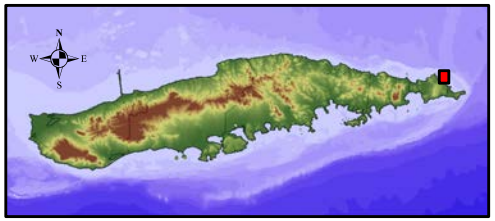

0 25 50 100
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
12-1	Head	258,220.83	2,007,637.35	34.4	0.1
	Toe	258,220.90	2,007,671.72		
12-2	Head	258,150.74	2,007,651.60	185.1	28.3
	Toe	258,238.55	2,007,814.56		
12-3	Head	258,092.69	2,007,687.28	394.4	36.3
	Toe	258,326.00	2,008,005.31		
12-4	Head	258,045.09	2,007,731.41	179.3	45.5
	Toe	258,172.88	2,007,857.14		

Figure 9
Beach 12 Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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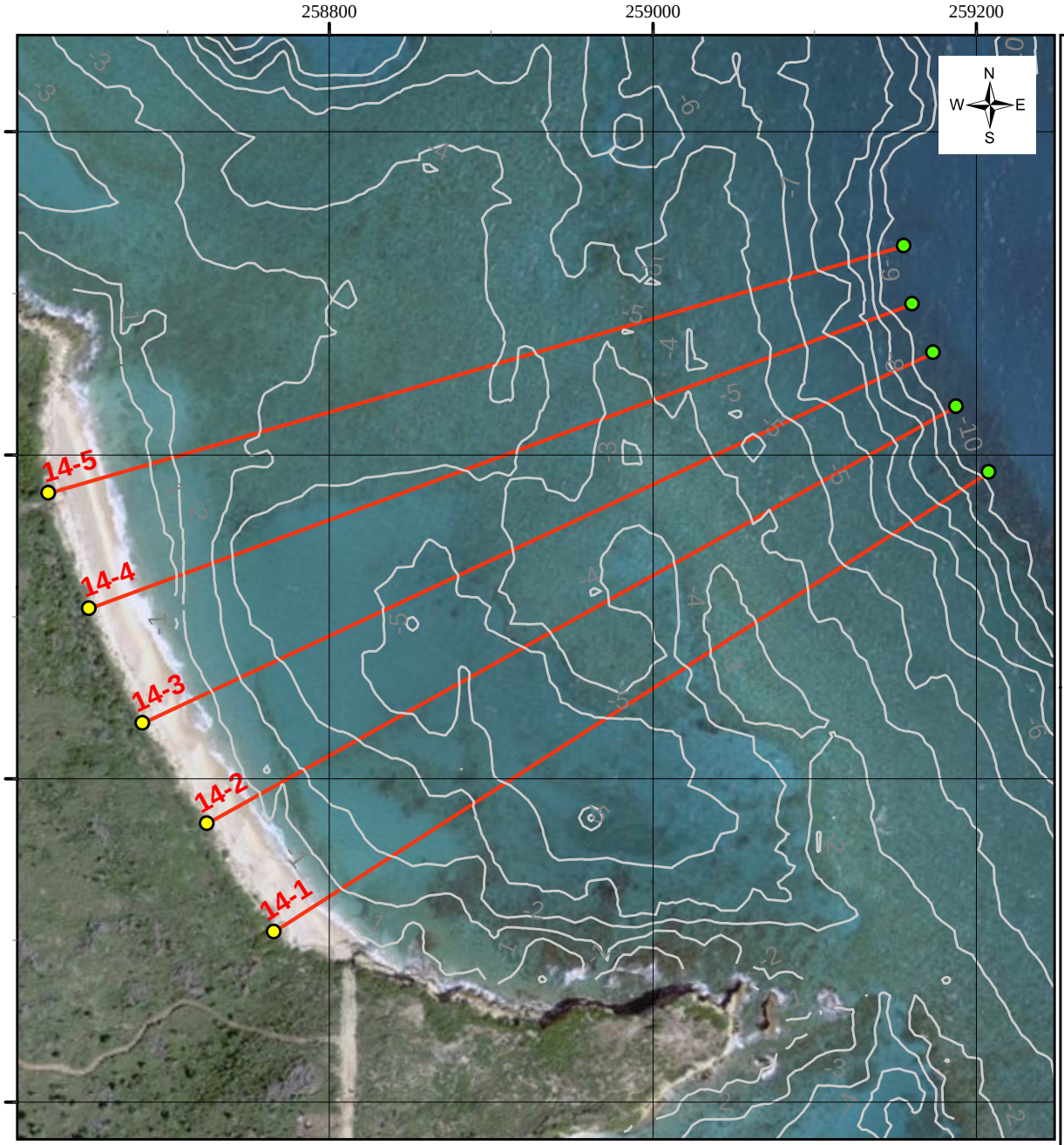

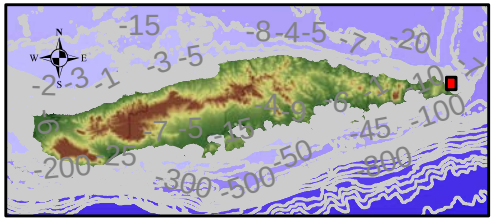

0 50 100 200
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
14-1	Head	258,765.65	2,007,105.32	525.5	57.3
	Toe	259,207.71	2,007,389.43		
14-2	Head	258,724.31	2,007,172.26	530.1	60.9
	Toe	259,187.45	2,007,430.12		
14-3	Head	258,684.43	2,007,234.32	539.8	64.9
	Toe	259,173.24	2,007,463.35		
14-4	Head	258,651.39	2,007,305.27	542.8	69.7
	Toe	259,160.51	2,007,493.41		
14-5	Head	258,626.31	2,007,376.65	550.6	73.9
	Toe	259,155.24	2,007,529.52		

Figure 10
Beach 14/Playa Brava Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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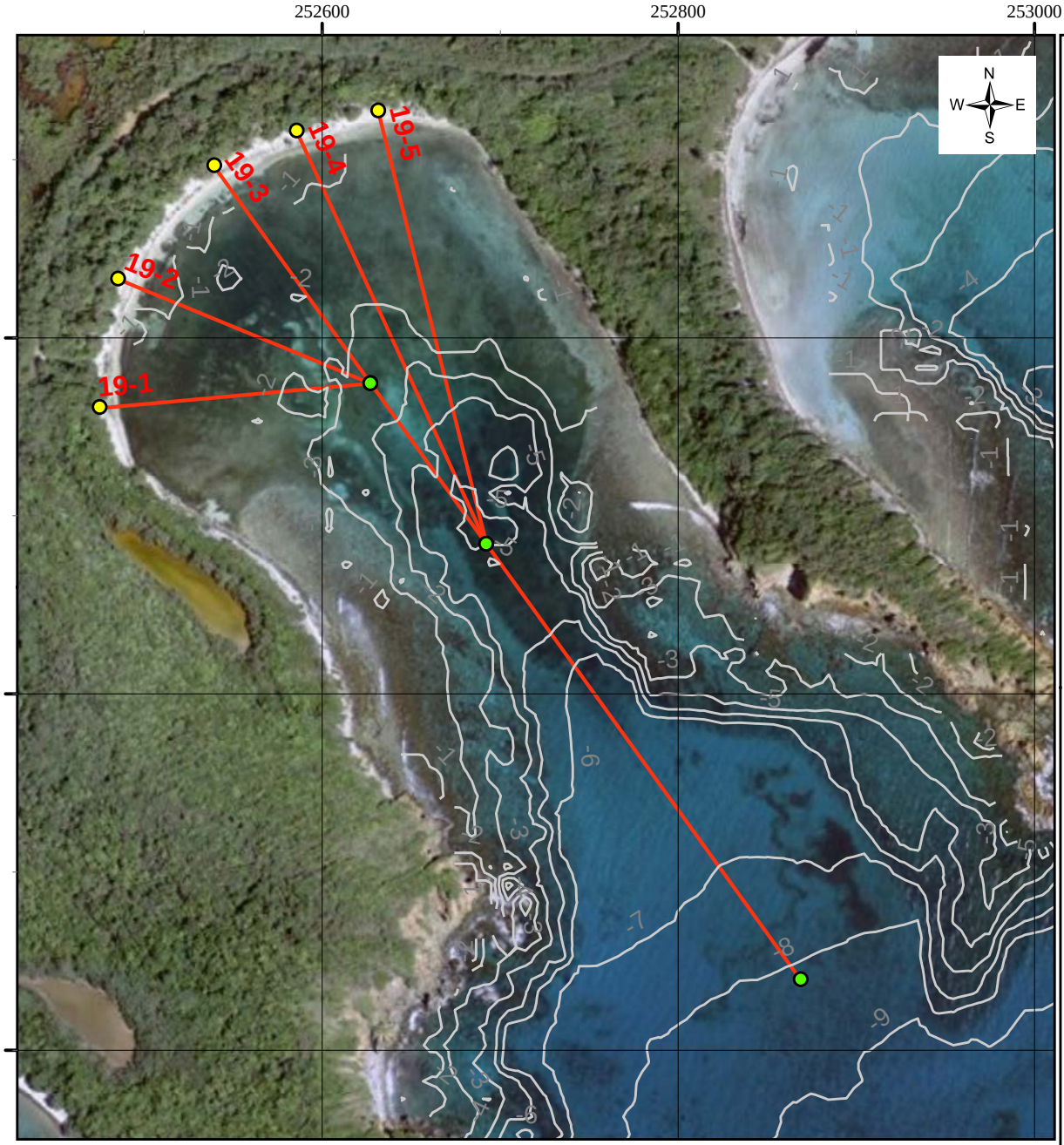

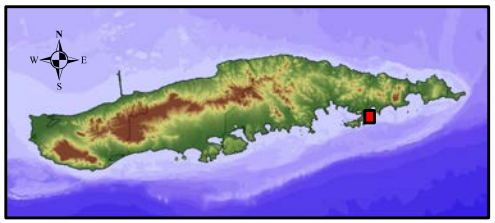

0 37.5 75 150
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
19-1	Head	252,475.15	2,004,960.88	153.0	85.0
	Toe	252,627.28	2,004,974.24		
19-2	Head	252,485.67	2,005,033.17	153.5	112.6
	Toe	252,627.28	2,004,974.24		
19-4	Head	252,585.93	2,005,116.25	255.1	155.4
	Toe	252,692.24	2,004,884.12		
19-3	Head	252,539.52	2,005,096.61	563.4	144.2
	Toe	252,868.93	2,004,639.59		
19-5	Head	252,631.71	2,005,127.52	250.6	166.0
	Toe	252,692.24	2,004,884.12		

Figure 11
Beach 19/Playa Yoyé Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

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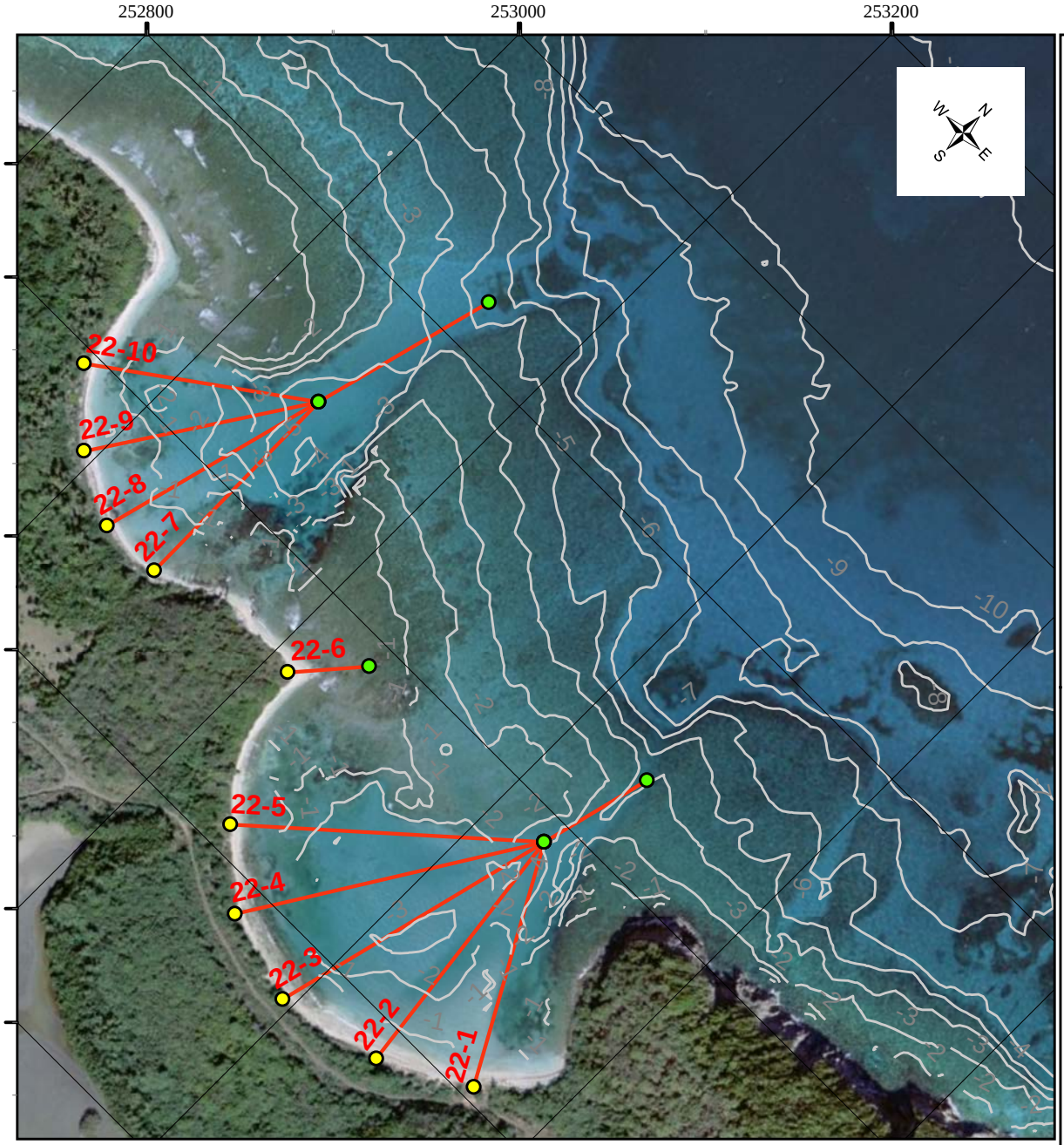
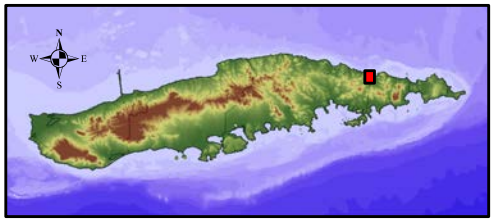




0 50 100 200
Meters

Notes:
1. All dimensions are in meters

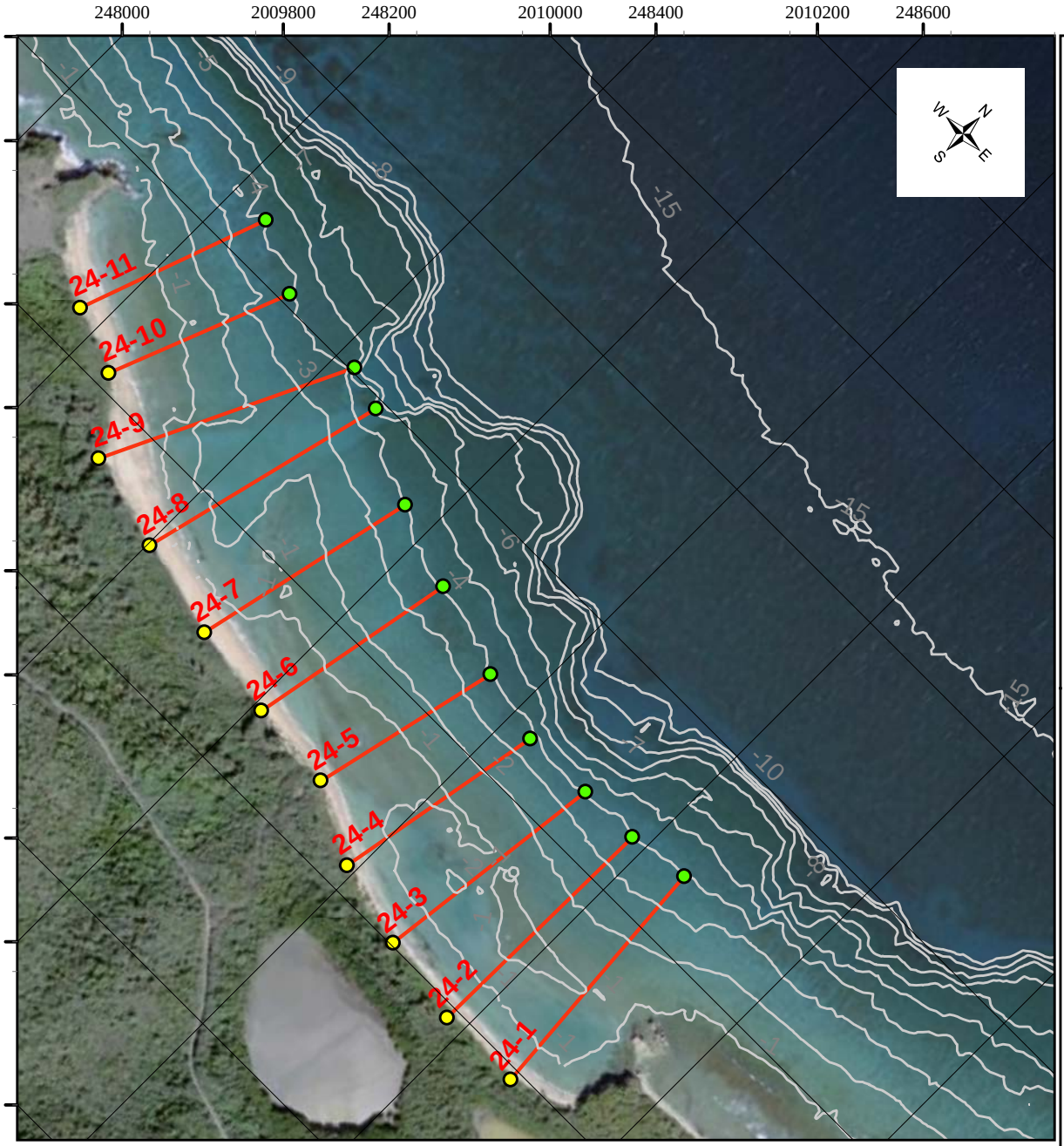
2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
22-1	Head	253,540.99	2,008,010.26	193.8	331.0
	Toe	253,447.08	2,008,179.54		
22-2	Head	253,473.39	2,007,973.26	208.2	352.7
	Toe	253,447.08	2,008,179.54		
22-3	Head	253,391.19	2,007,954.68	322.8	14.0
	Toe	253,469.24	2,008,267.94		
22-4	Head	253,319.84	2,007,975.17	241.1	31.9
	Toe	253,447.08	2,008,179.54		
22-5	Head	253,269.19	2,008,020.66	238.9	48.2
	Toe	253,447.08	2,008,179.54		
22-6	Head	253,218.29	2,008,133.22	61.9	41.0
	Toe	253,258.92	2,008,179.96		
22-7	Head	253,092.30	2,008,116.02	179.1	359.2
	Toe	253,089.79	2,008,294.79		
22-8	Head	253,042.63	2,008,114.73	335.9	14.7
	Toe	253,127.95	2,008,439.58		
22-9	Head	252,990.37	2,008,142.51	182.2	33.1
	Toe	253,089.79	2,008,294.79		
22-10	Head	252,943.25	2,008,189.40	180.9	54.3
	Toe	253,089.79	2,008,294.79		

Figure 12
Beach 22/Playa Diablo Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



0 75 150 300
Meters

Notes:
1. All dimensions are in meters

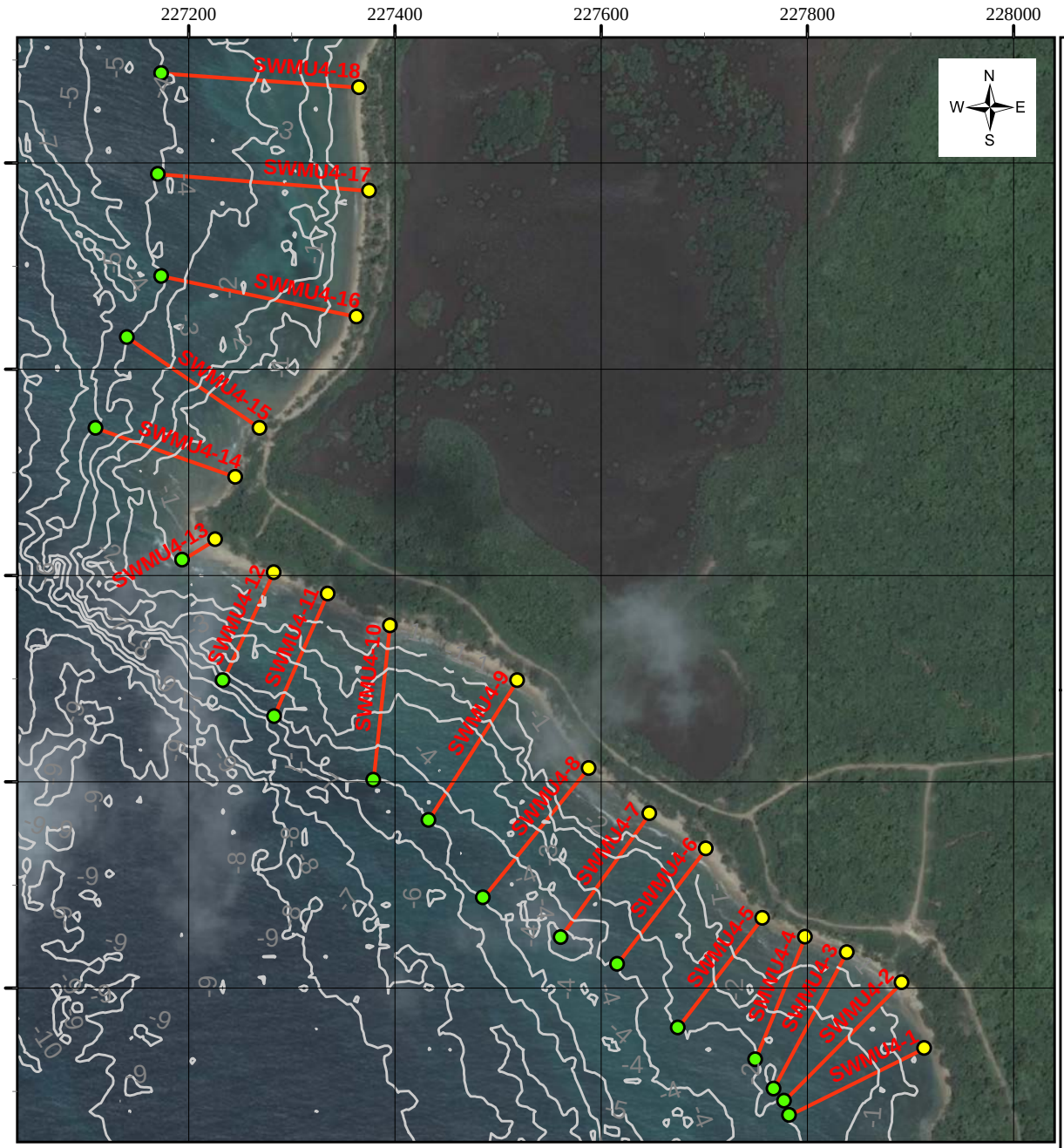
2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

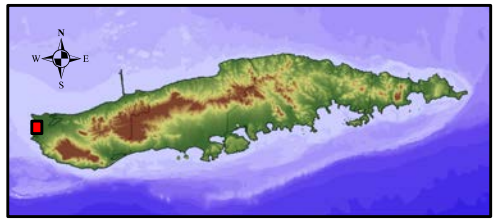
Legend
- Head
- Toe
- Depth Contours
- Transects

		Easting	Northing	Length	Heading (°N)
24-1	Head	249,072.96	2,009,188.48	283.3	355.5
	Toe	249,050.58	2,009,470.86		
24-2	Head	248,979.17	2,009,187.30	274.3	0.7
	Toe	248,982.41	2,009,461.62		
24-3	Head	248,882.56	2,009,202.92	259.1	6.9
	Toe	248,913.58	2,009,460.16		
24-4	Head	248,790.02	2,009,226.51	235.7	10.3
	Toe	248,832.26	2,009,458.38		
24-5	Head	248,707.03	2,009,270.28	212.0	12.9
	Toe	248,754.27	2,009,476.95		
24-6	Head	248,610.05	2,009,277.87	233.6	10.6
	Toe	248,653.21	2,009,507.41		
24-7	Head	248,508.76	2,009,293.85	252.2	12.5
	Toe	248,563.47	2,009,540.00		
24-8	Head	248,402.76	2,009,318.30	279.9	13.8
	Toe	248,469.47	2,009,590.18		
24-9	Head	248,299.22	2,009,345.31	287.5	25.5
	Toe	248,423.03	2,009,604.74		
24-10	Head	248,242.98	2,009,416.65	209.2	21.4
	Toe	248,319.44	2,009,611.37		
24-11	Head	248,172.53	2,009,444.03	217.8	19.7
	Toe	248,246.06	2,009,649.04		

Figure 13
Beach 24/Purple Beach/Playa Campaña Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL





0 100 200 400
Meters

Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
Vertical datum: Mean Sea Level (MSL)

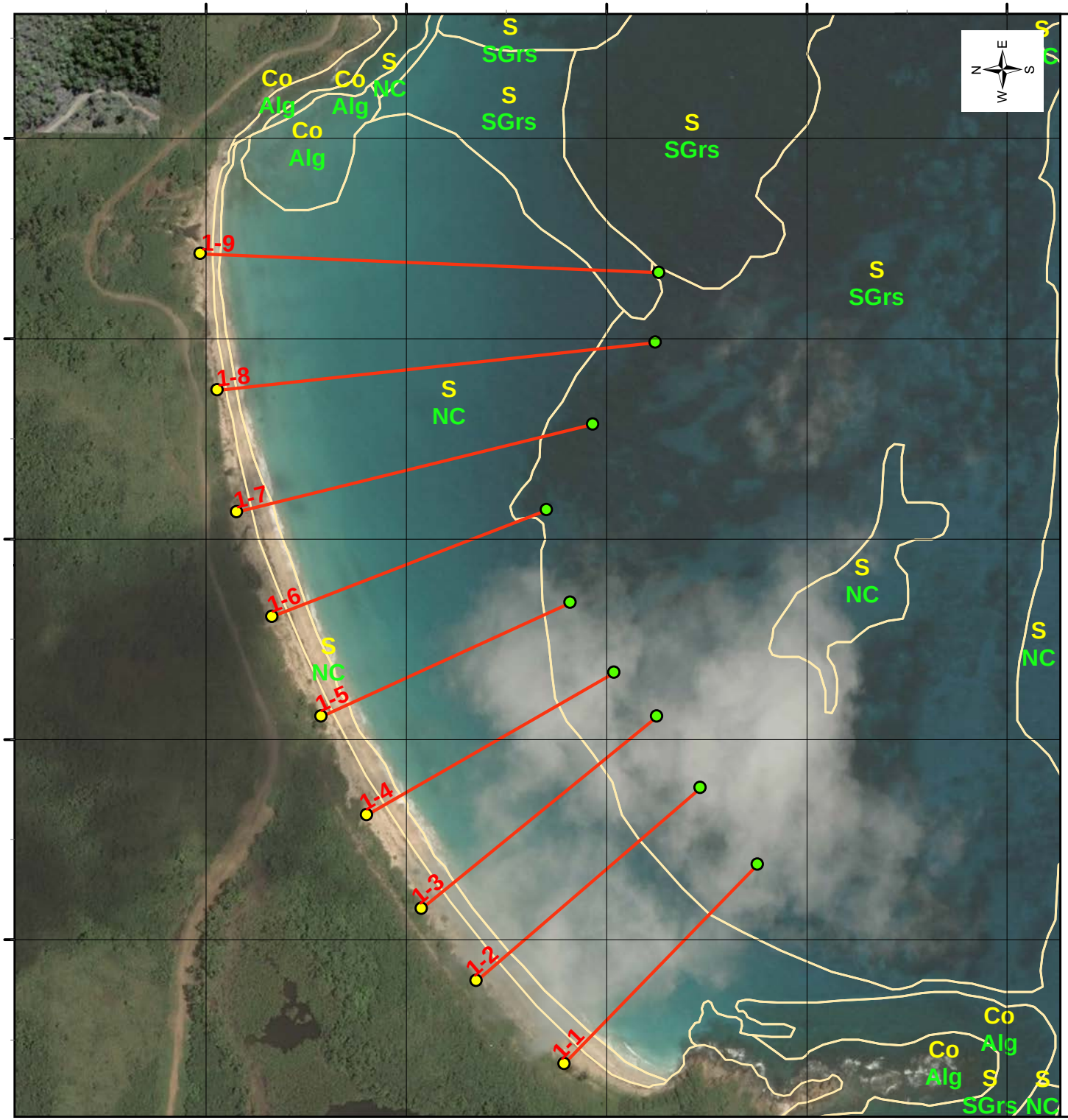
Legend

- Head
- Toe
- Transects
- Depth Contours

		Easting	Northing	Length	Heading (°N)
SWMU4-1	Head	227,913.39	2,002,941.73	35.5	243.7
	Toe	227,782.34	2,002,876.85		
SWMU4-2	Head	227,891.40	2,003,005.44	115.8	224.8
	Toe	227,777.71	2,002,890.86		
SWMU4-3	Head	227,838.28	2,003,034.58	129.6	208.2
	Toe	227,767.44	2,002,902.54		
SWMU4-4	Head	227,797.98	2,003,049.74	150.4	202.0
	Toe	227,749.81	2,002,930.75		
SWMU4-5	Head	227,756.53	2,003,068.02	134.4	217.6
	Toe	227,674.49	2,002,961.54		
SWMU4-6	Head	227,701.89	2,003,135.35	162.0	217.5
	Toe	227,615.74	2,003,023.16		
SWMU4-7	Head	227,647.15	2,003,169.36	147.7	215.7
	Toe	227,560.95	2,003,049.42		
SWMU4-8	Head	227,588.14	2,003,213.26	141.5	219.2
	Toe	227,485.67	2,003,087.74		
SWMU4-9	Head	227,518.95	2,003,298.47	134.4	212.4
	Toe	227,432.85	2,003,162.95		
SWMU4-10	Head	227,395.46	2,003,351.52	128.4	186.1
	Toe	227,379.44	2,003,201.99		
SWMU4-11	Head	227,334.96	2,003,382.42	149.8	203.6
	Toe	227,283.17	2,003,263.60		
SWMU4-12	Head	227,282.79	2,003,402.88	161.4	205.2
	Toe	227,233.47	2,003,298.15		
SWMU4-13	Head	227,193.94	2,003,415.22	146.2	238.5
	Toe	227,225.97	2,003,434.87		
SWMU4-14	Head	227,245.56	2,003,495.40	192.0	289.4
	Toe	227,110.07	2,003,543.07		
SWMU4-15	Head	227,269.13	2,003,542.75	205.7	304.5
	Toe	227,140.47	2,003,631.02		
SWMU4-16	Head	227,363.11	2,003,650.75	193.6	281.7
	Toe	227,173.52	2,003,689.99		
SWMU4-17	Head	227,375.38	2,003,773.06	156.0	274.5
	Toe	227,170.25	2,003,789.09		
SWMU4-18	Head	227,365.35	2,003,873.23	143.6	274.1
	Toe	227,173.83	2,003,886.84		

Figure 14
Beach SWMU4 Transect Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 70 140 280
Meters

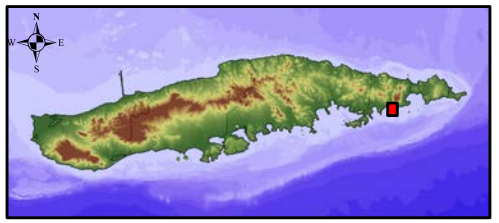
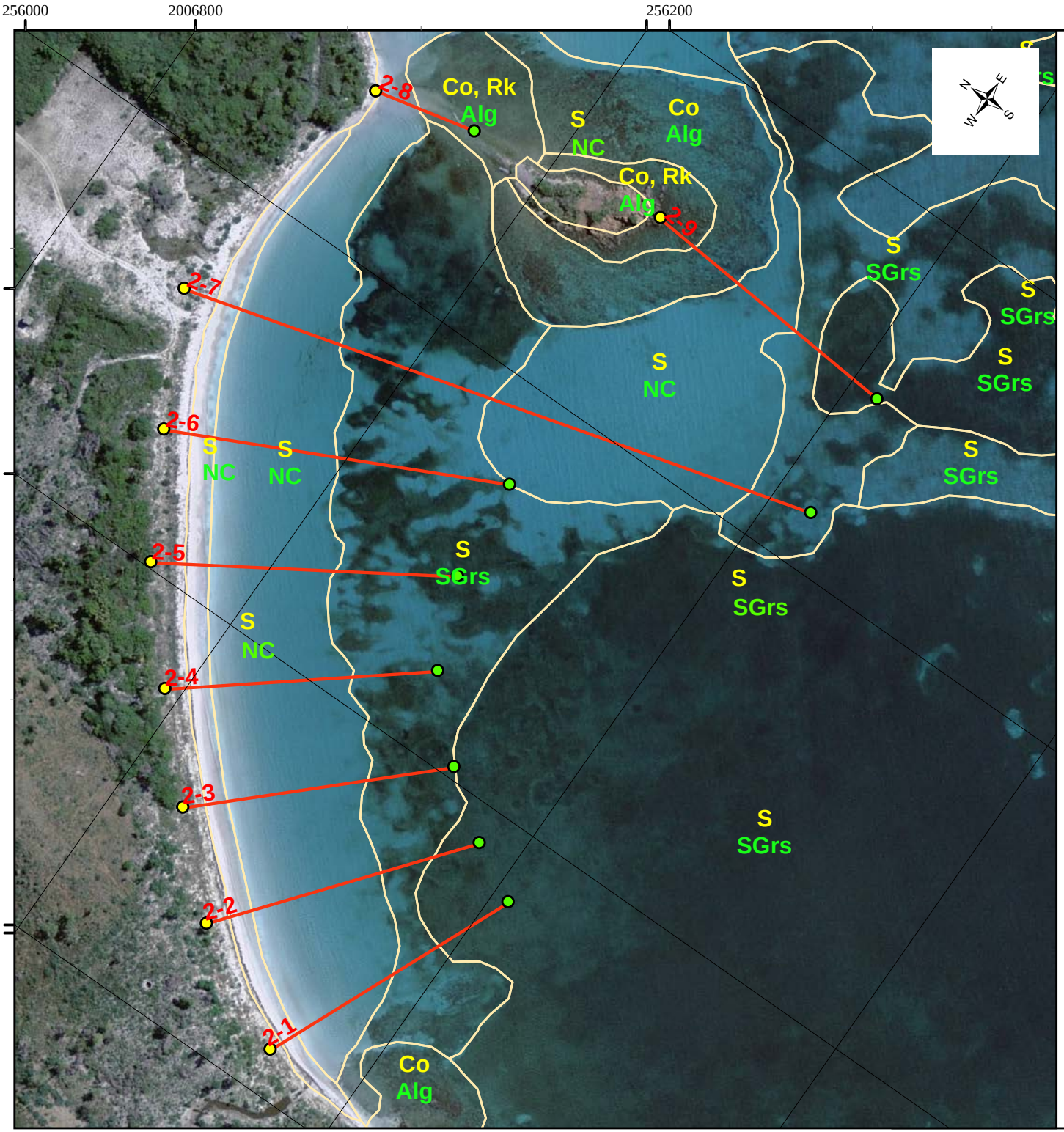


Figure 15
Beach 1/Yellow Beach/Playa Matías
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 35 70 140
Meters

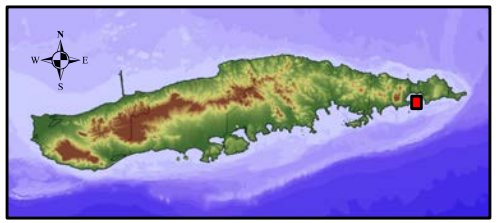
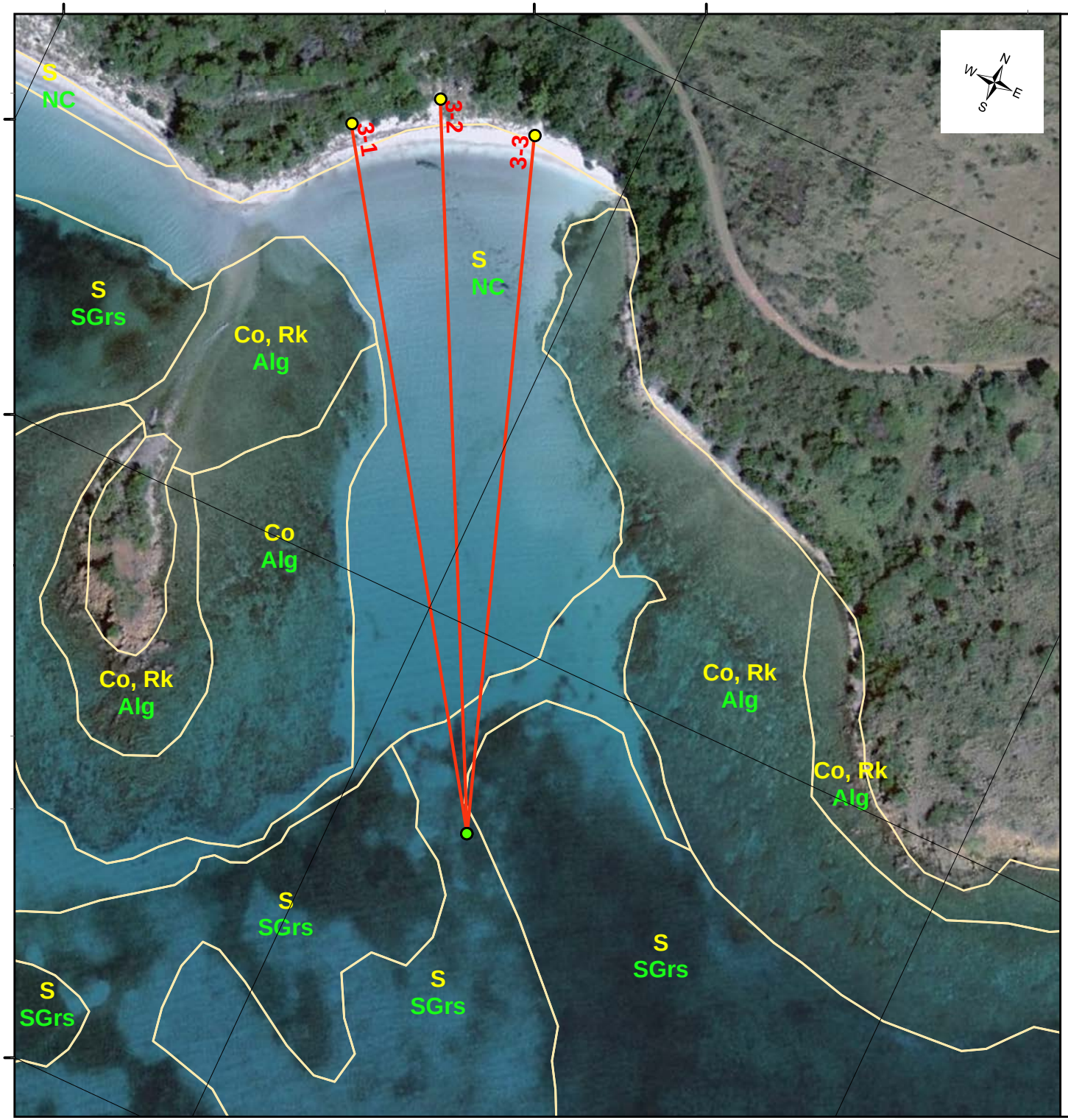


Figure 16
Beach 2/Playa Salinas Del Sur
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

0 20 40 80
Meters

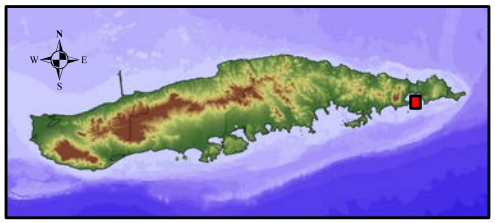
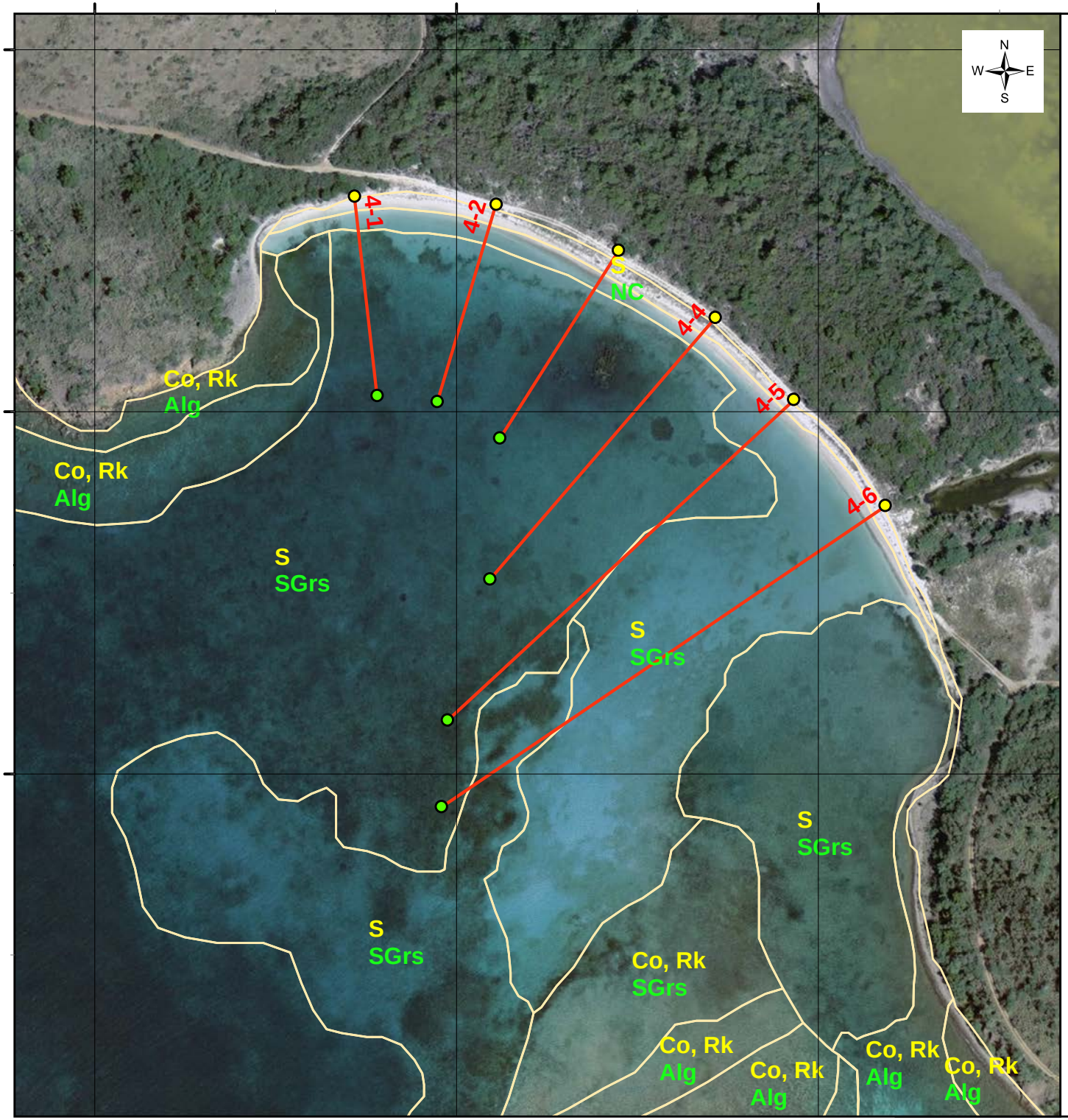


Figure 17
Beach 3/Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 35 70 140
Meters

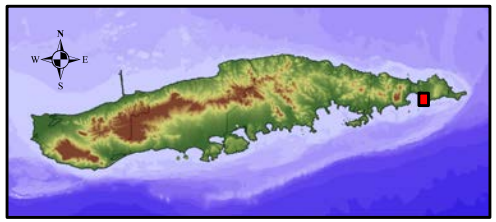
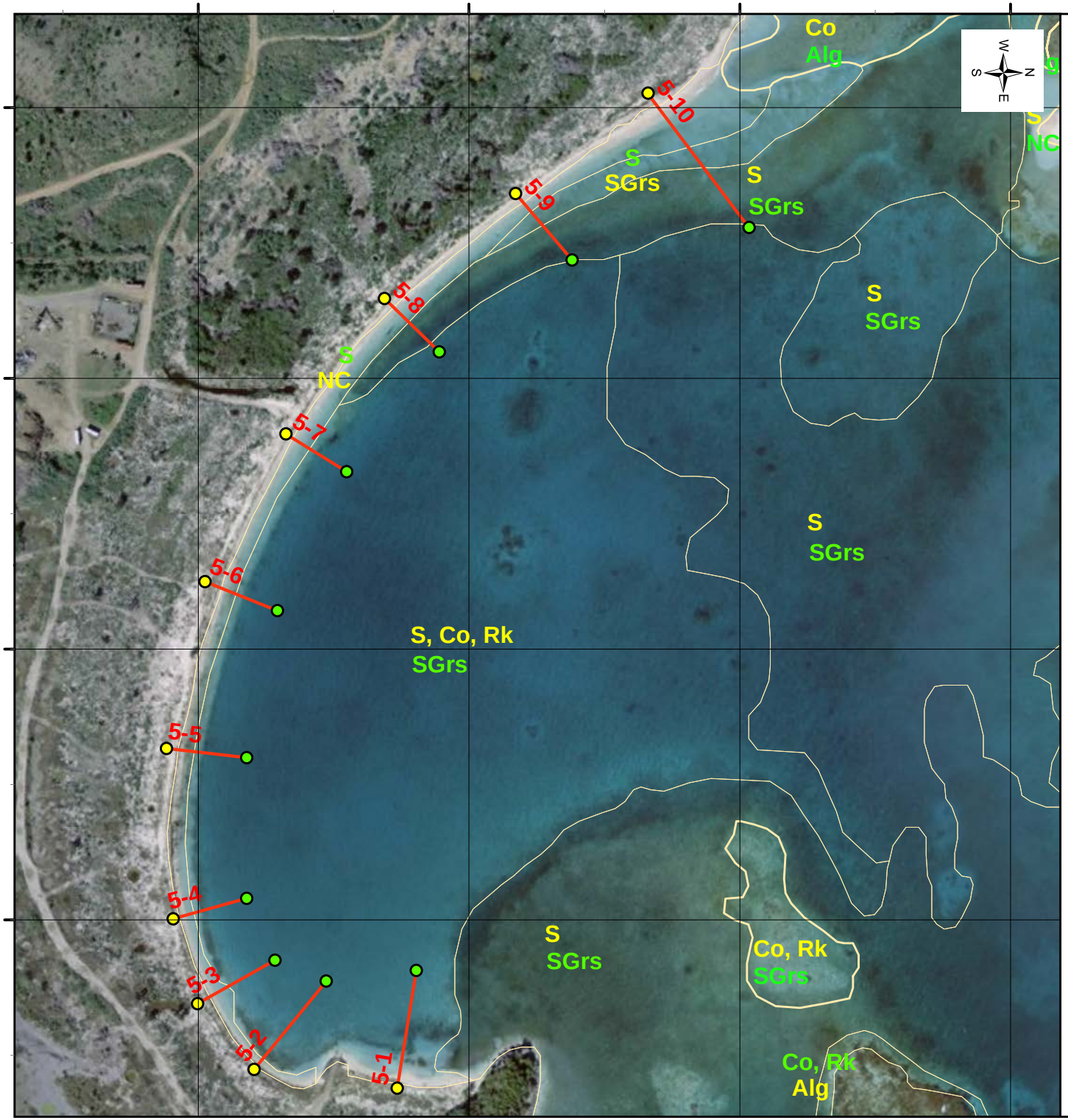


Figure 18
Beach 4/Turtle Beach/Playa Carrucho
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 45 90 180
Meters

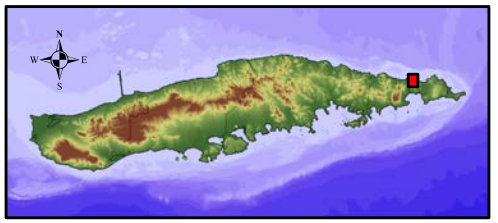
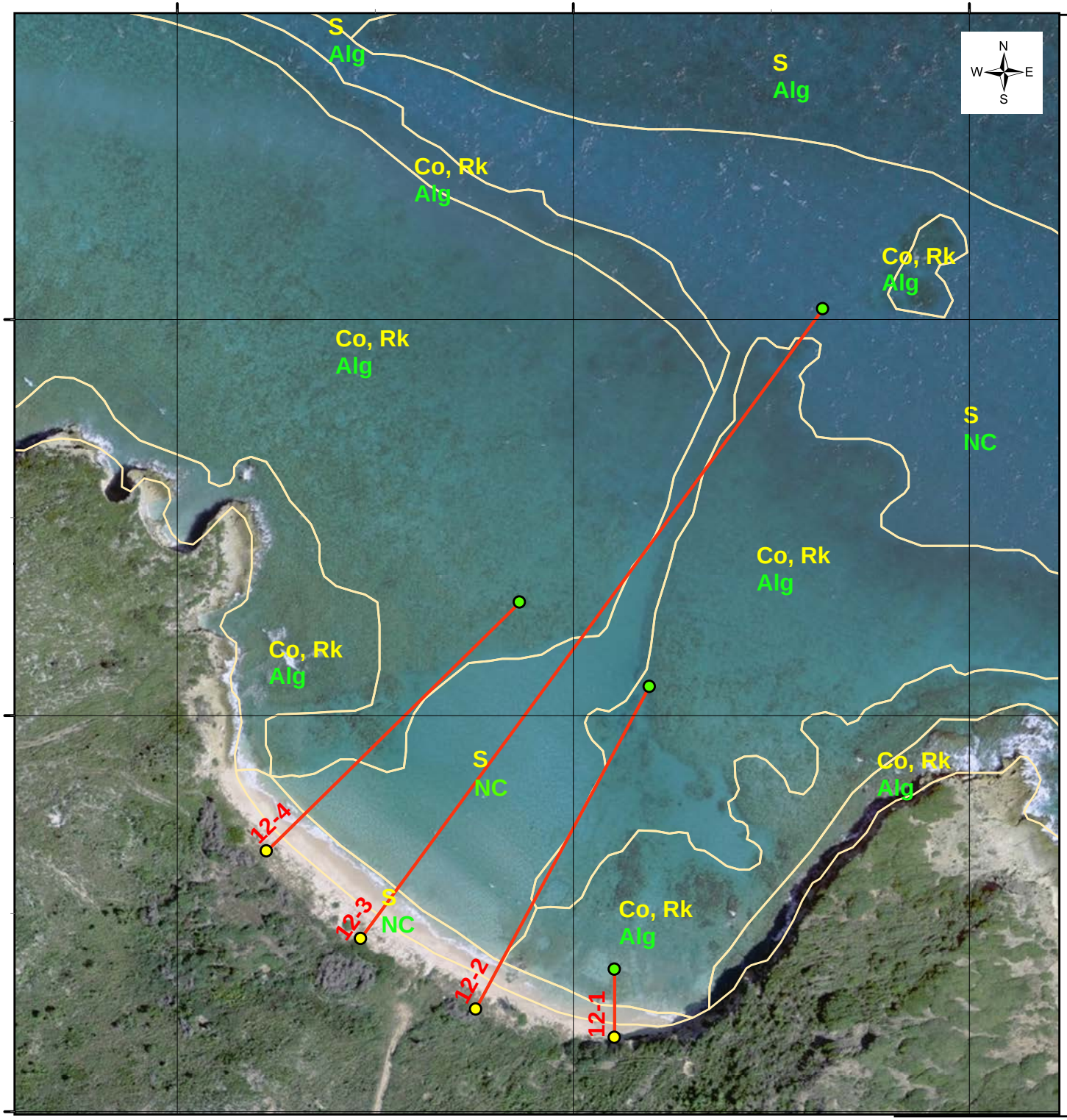


Figure 19
Beach 5/Bahia Icacos
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 25 50 100
Meters

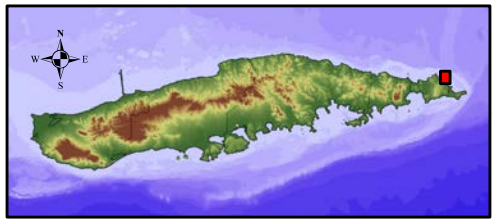
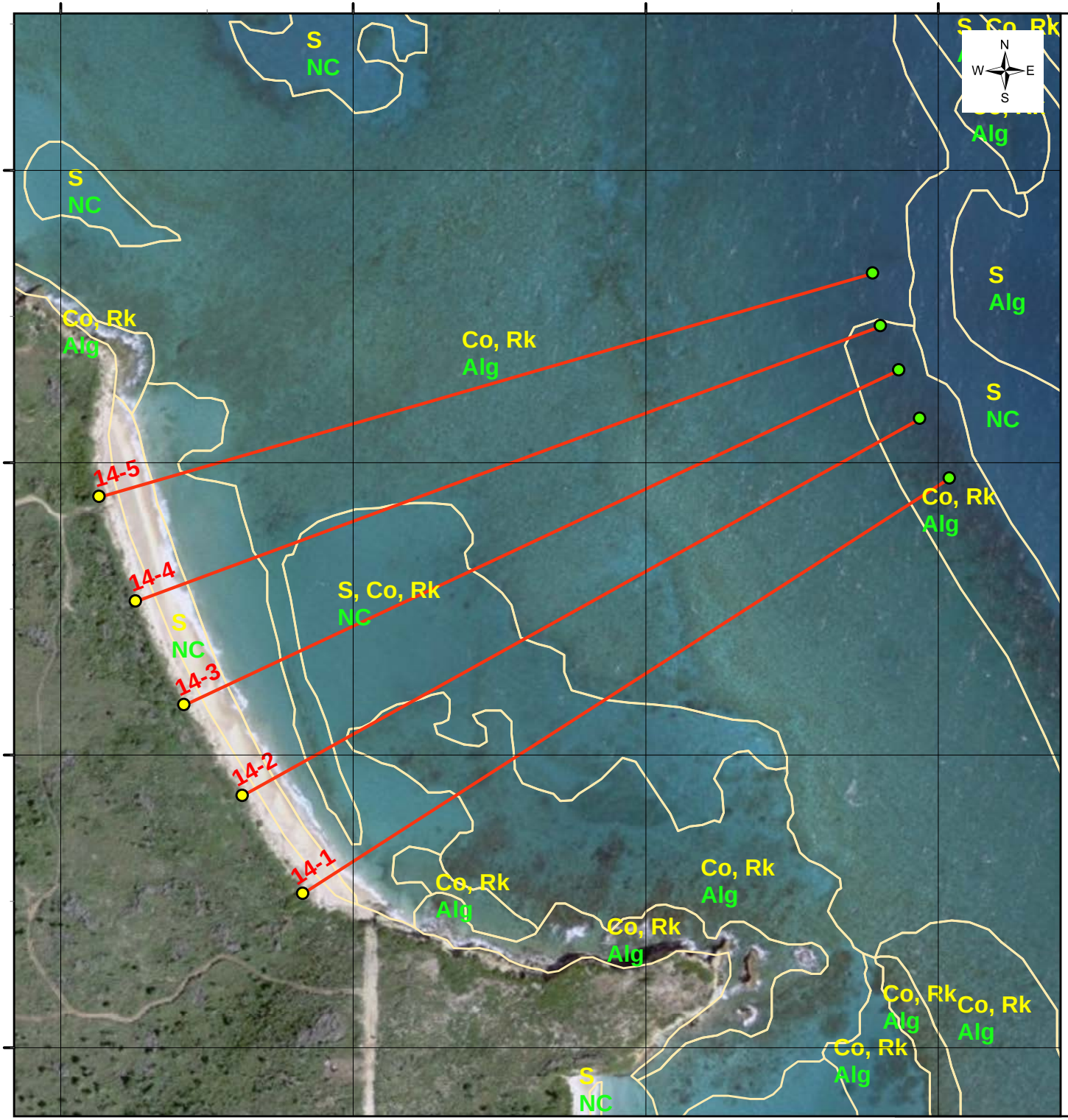


Figure 20
Beach 12/Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 45 90 180
Meters

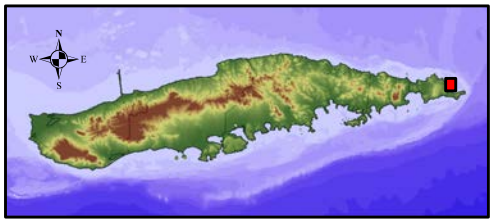
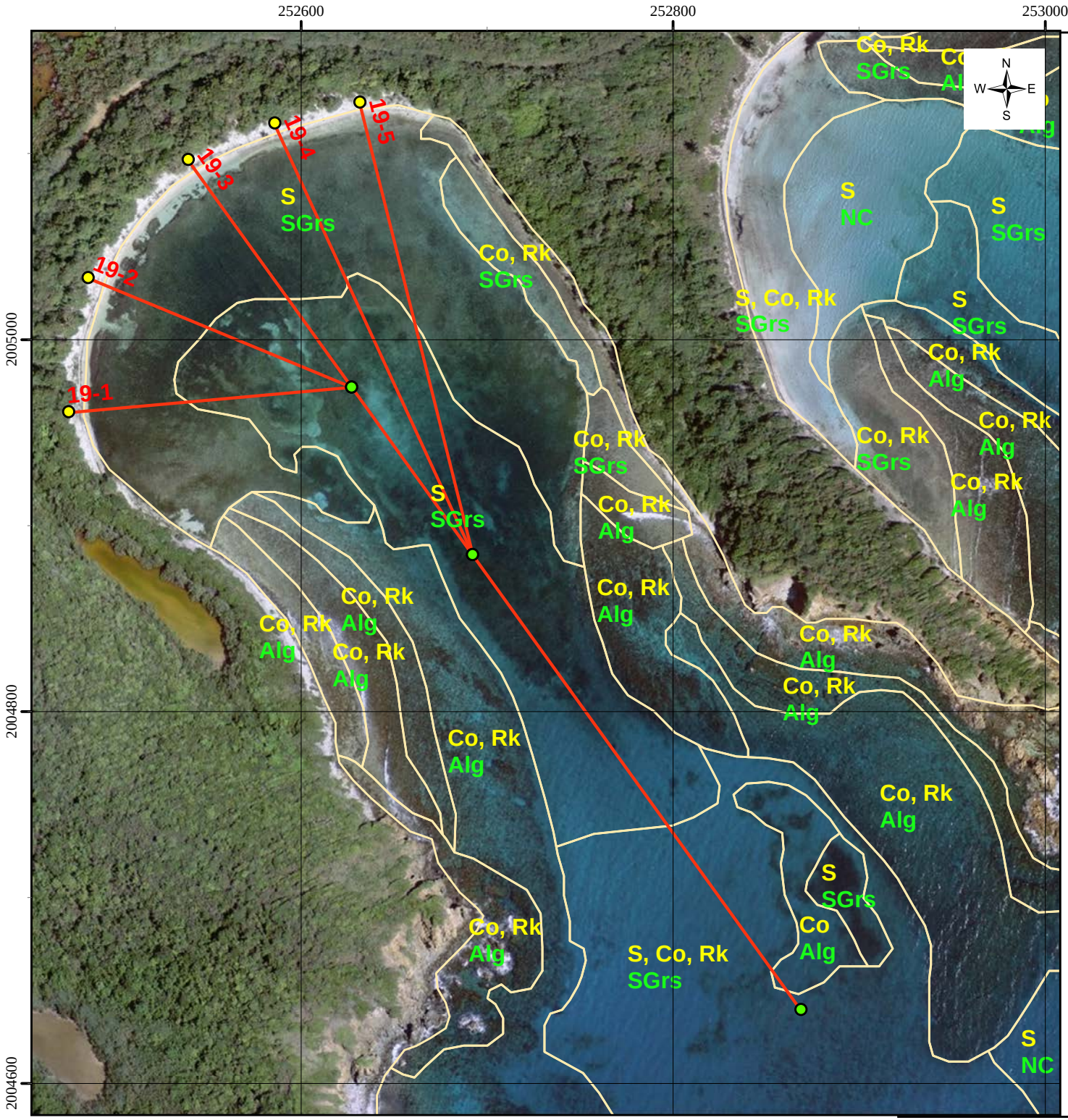


Figure 21
Beach 14/Playa Brava
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 30 60 120
Meters

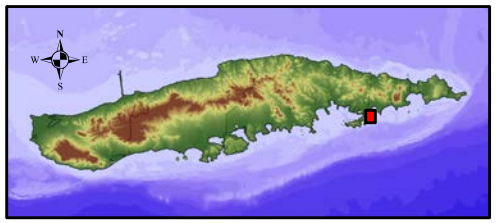
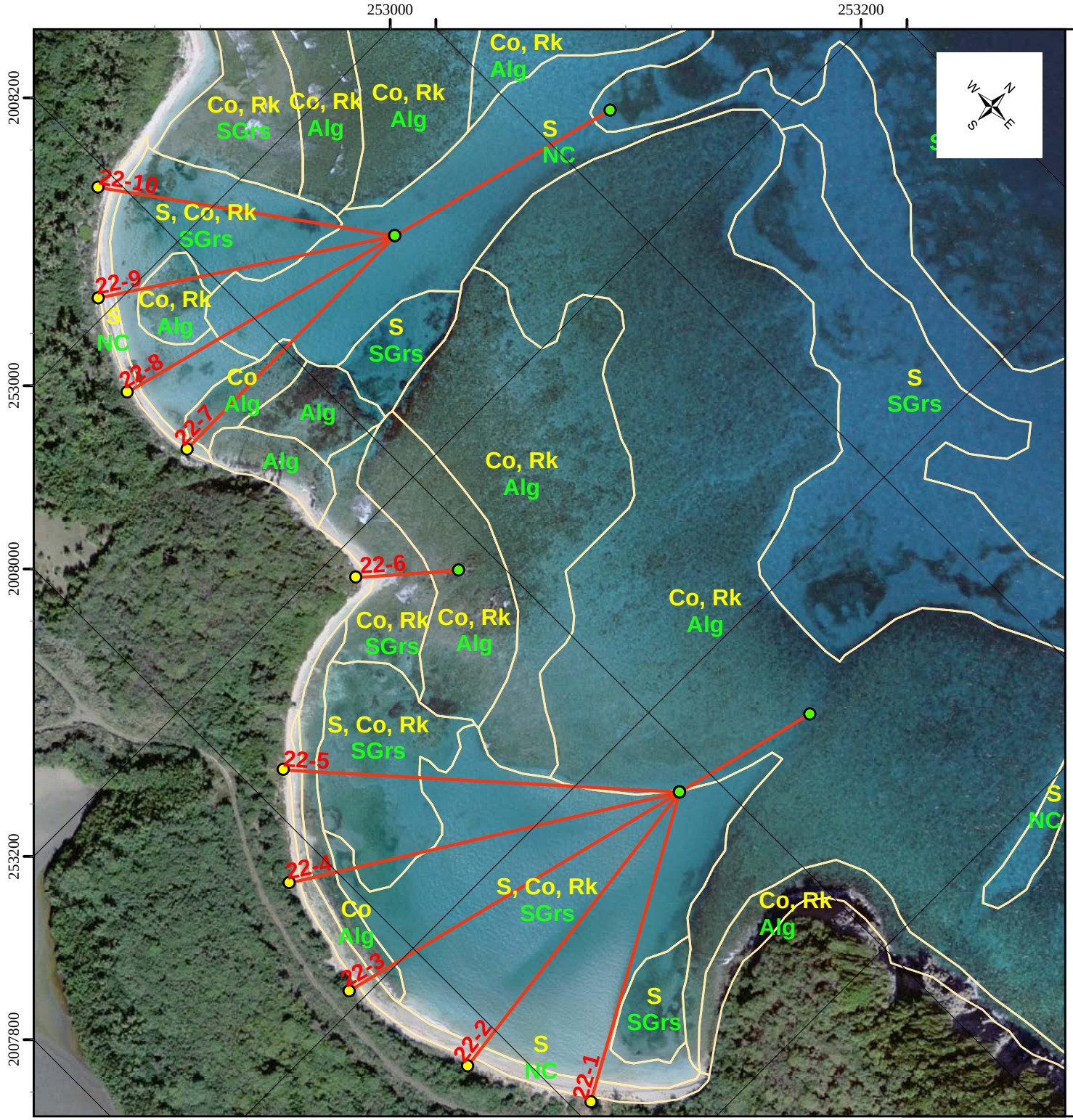


Figure 22
Beach 19/Playa Yoyé
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 35 70 140
Meters

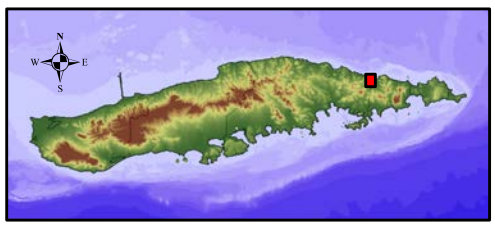


Figure 23
Beach 22/Playa Diablo
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL

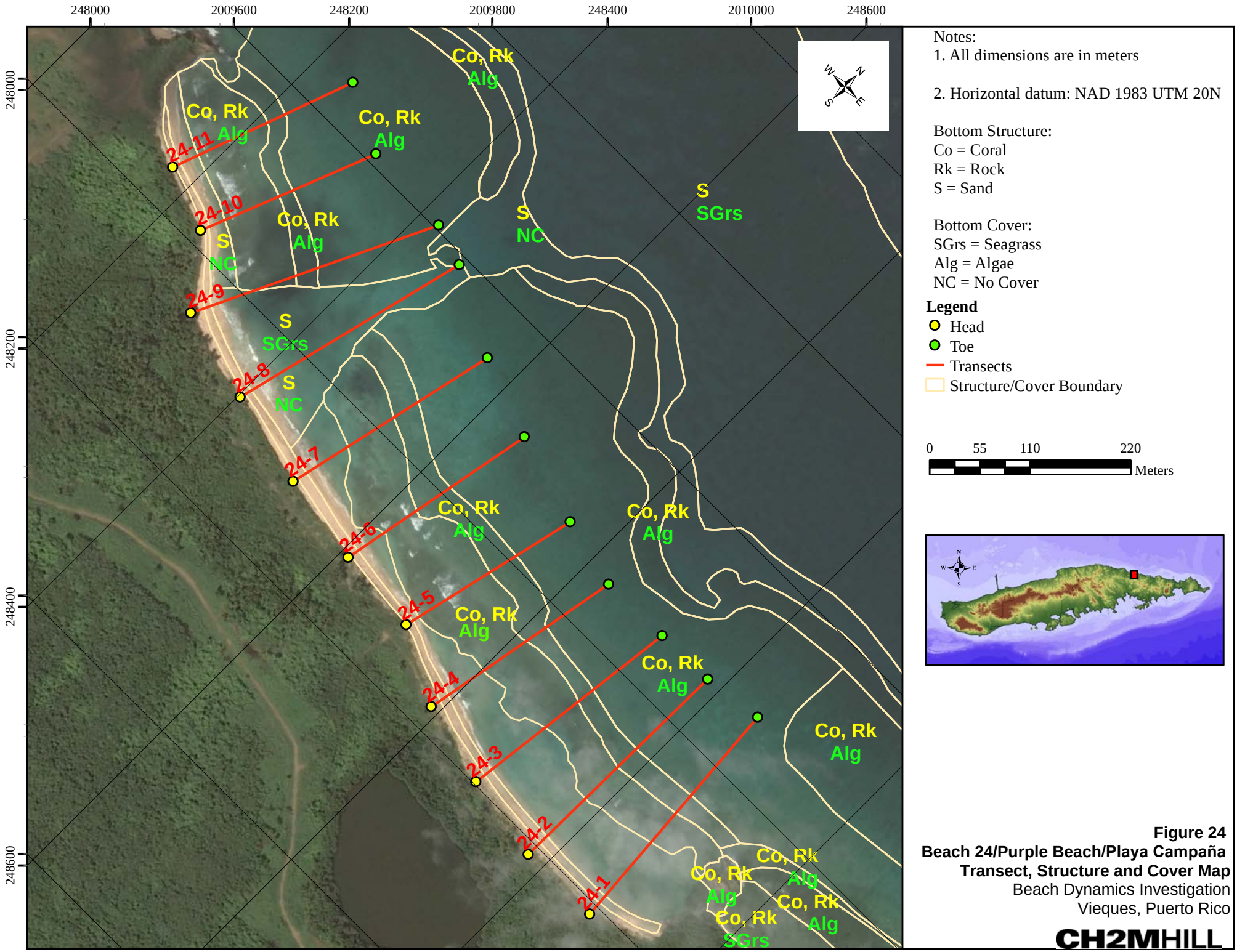
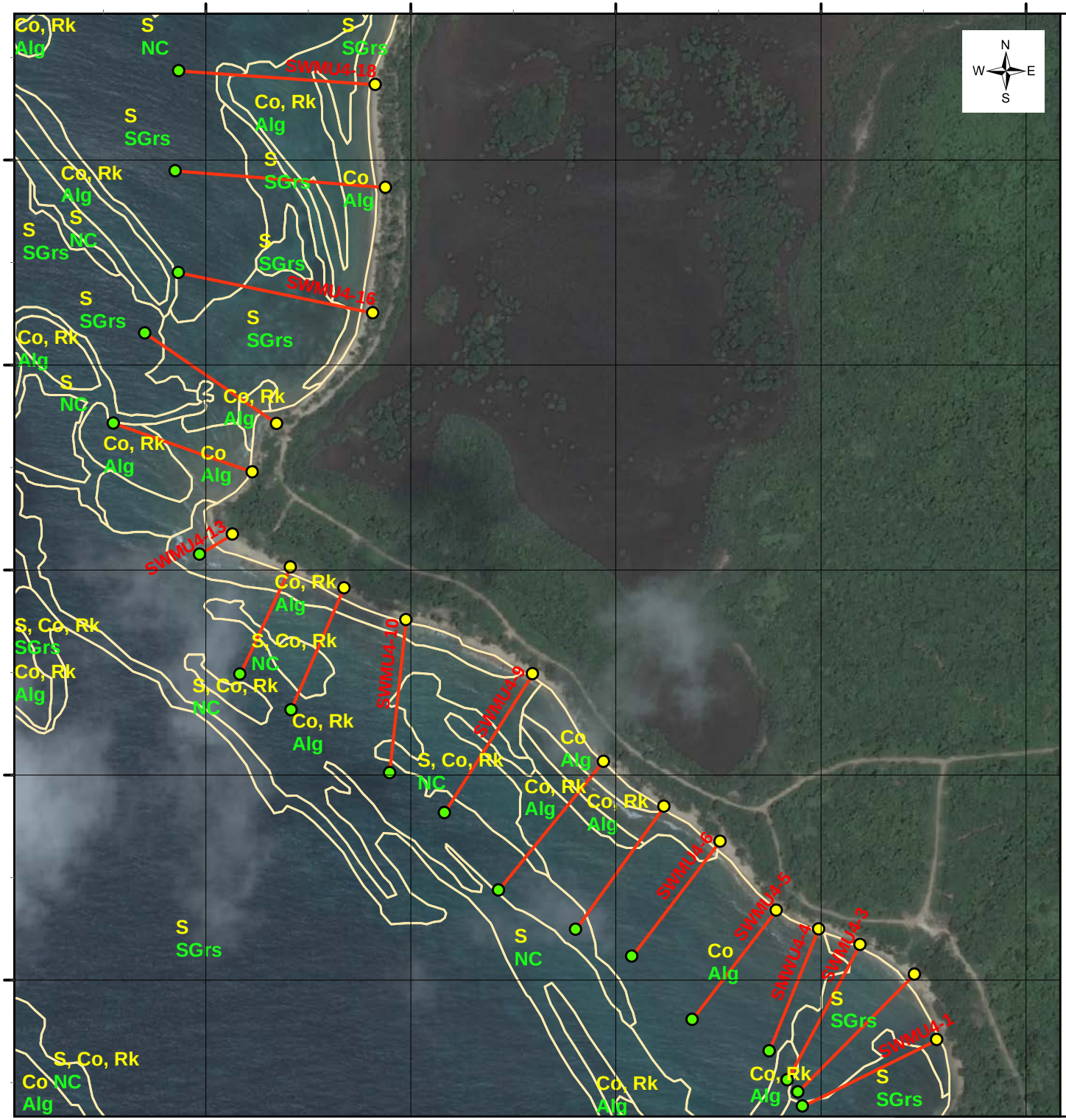


Figure 24
Beach 24/Purple Beach/Playa Campaña
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Notes:
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N

Bottom Structure:
Co = Coral
Rk = Rock
S = Sand

Bottom Cover:
SGrs = Seagrass
Alg = Algae
NC = No Cover

Legend
- Head
- Toe
- Transects
- Structure/Cover Boundary

0 75 150 300
Meters

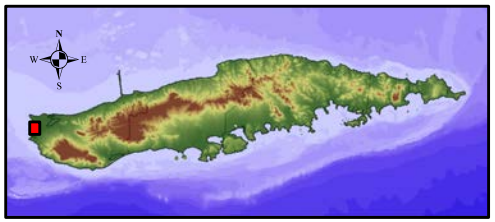
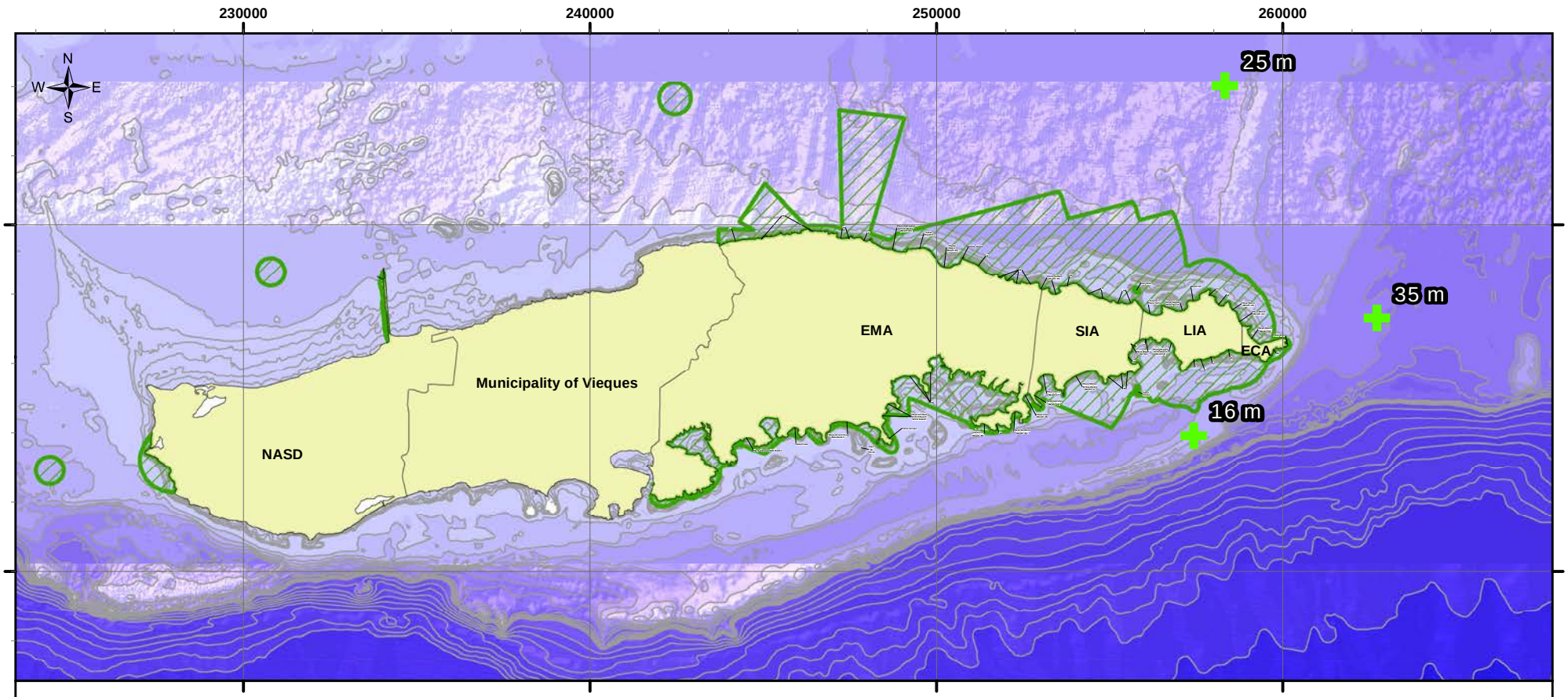


Figure 25
Beach SWMU 4
Transect, Structure and Cover Map
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL



Legend

- Wave/Current/Water Level Sensors
- UXO 16 Boundary
- Bathymetry Contours

Depth (m MSL)

- < -2,500
- -2500 - -2,000
- -2,000 - -1,500
- -1,500 - -1,000
- -1,000 - -500
- -500 - -200
- -200 - -100
- -100 - -50
- -50 - -40
- -40 - -35
- -35 - -30
- -30 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5

Notes:

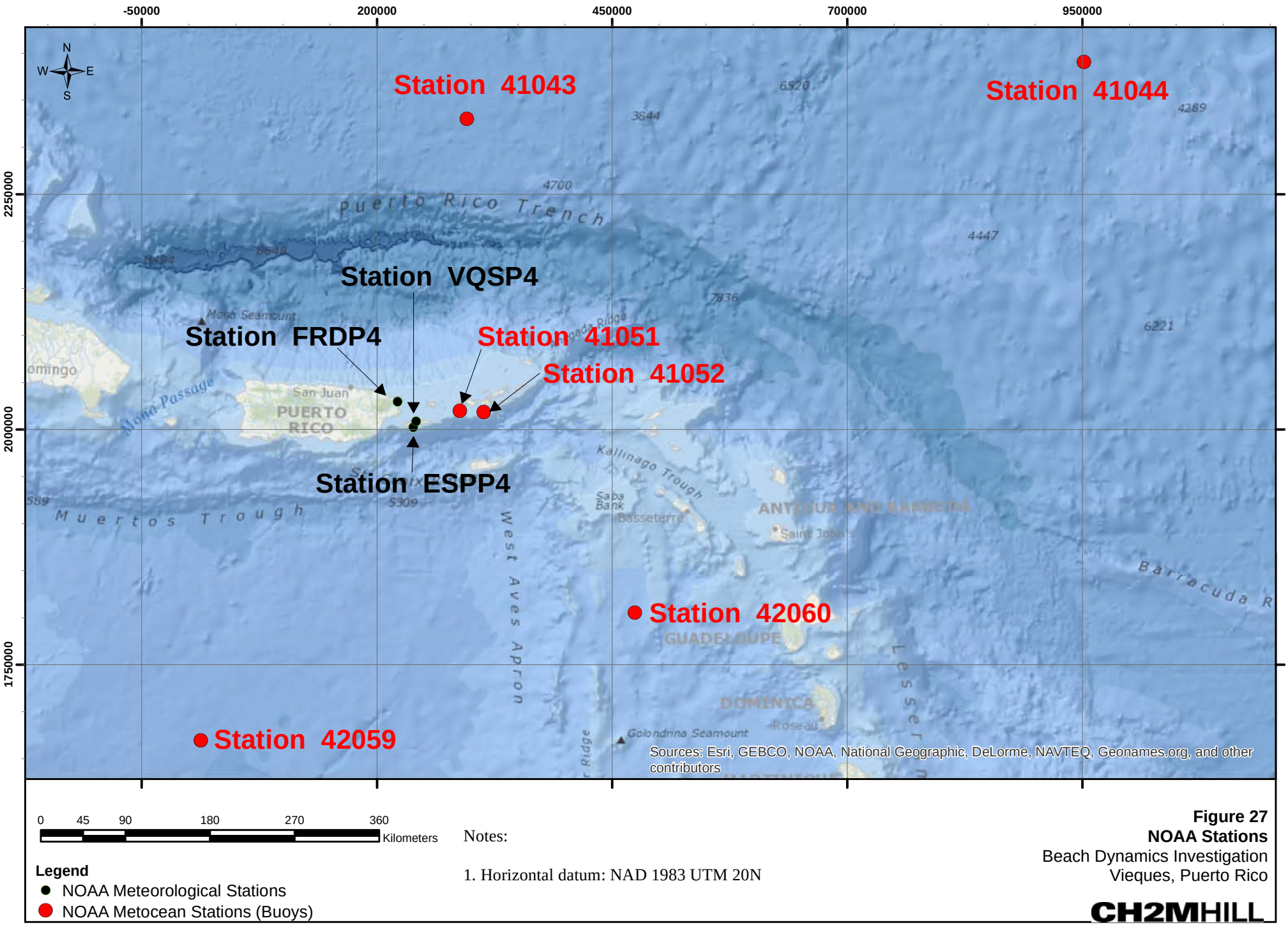
1. All dimensions are in meters

2. Horizontal datum: NAD 1983 UTM 20N
   Vertical datum: Mean Sea Level (MSL)

3. The bathymetry contours are shown as follows:
   From 0 m to 5 m - 1 m intervals
   From 5 m to 50 m - 5 m intervals
   From 50 m to 100 m - 10 m intervals
   From 100 m to 1000 m - 100 m intervals
   From 1000 m to 2000 m - 500 m intervals

Figure 26
Wave / Current / Water Level Sensor Locations
Beach Dynamics Investigation
Vieques, Puerto Rico

CH2MHILL


-50000
200000
450000
700000
950000
2250000
2000000
1750000
N
W
E
S
Station 41043
Station 41044
Station VQSP4
Station FRDP4
Station 41051
Station 41052
Station ESPP4
Station 42060
Station 42059
Puerto Rico Trench
Mona Seamount
Mona Passage
San Juan
PUERTO RICO
Kallinago Trough
Saba Bank
Basseterre
Saint John's
ANTIGUA AND BARBUDA
Muertos Trough
West Aves Apron
Barracuda R
GUADELOUPE
DOMINICA
Roseau
Golondrina Seamount
Lesser
6520
3844
4289
4700
4447
7836
6221
5309
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors
0 45 90 180 270 360
Kilometers
Legend
NOAA Meteorological Stations
NOAA Metocean Stations (Buoys)
Notes:
1. Horizontal datum: NAD 1983 UTM 20N
Figure 27
NOAA Stations
Beach Dynamics Investigation
Vieques, Puerto Rico
CH2MHILL

Attachment A
Standard Operating Procedures

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STANDARD OPERATING PROCEDURE #1

Beach Surveys

I. Purpose and Scope

This standard operating procedure (SOP) provides a general overview of the Beach Surveys component of the Beach Dynamics Investigation to be conducted at the former VNTR and NASD. It includes a description of equipment and personnel required, procedures to be followed, and reporting.

This SOP was prepared as part of the MEC Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) for the Beach Dynamics Investigation. This SOP and the MEC UFP-QAPP were prepared on behalf of the Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Atlantic.

II. Equipment and Personnel

Two crews will perform the beach surveys. A land crew which will survey the dry and wading portion of the beaches, and a boat crew which will survey the surf zone and beyond portions of the nearshore.

The following is a list of minimum equipment and personnel needed to conduct the Beach Surveys:

Shared by both crews:

- A base RTK GPS unit including all necessary accessories.
- Chargers, cables for RTK GPS's, and tools.
- Miscellaneous consumable supplies (e.g. bottled water, ropes, zip ties, fuel, batteries, markers, resealable plastic bags, garbage bags).
- Project Coastal Engineer.
- 1 (one) UXO-qualified personnel for performing MEC avoidance as needed with diving permit.

Land Crew:

- RTK GPS mobile unit including all necessary accessories
- Total Station
- Measuring tapes (metric)
- Snorkeling equipment
- Dedicated field notebook
- Miscellaneous stakes, marker cones, etc.
- Radio to communicate with boat crew
- 1 (one) survey lead
- 1 (one) survey assistant
- 1 (one) survey swimmer

Boat Crew:

- Small inflatable boat equipped with:
  - life jackets
  - outboard motor, gas tanks and batteries
  - single-beam depth sounder
  - motions compensation package
  - RTK GPS mobile unit including all necessary accessories

  - compass
  - laptop for data collection/processing and with hydrographic software
  - speed of sound in water sensor

- Dedicated field notebook
- Radio to communicate with land crew
- 1 (one) survey lead
- 1 (one) boat driver/survey assistant

III. Procedures

Prior to mobilization to the project site, field personnel will have received, reviewed, submitted (where applicable) and have a thorough understanding of the following project documents.

- Investigation objective
- Site maps
- Health and Safety Plan (HASP)
- Accident Prevention Plan (APP)
- Activity Hazard Analysis (AHA)
- This SOP

Mobilization and Demobilization

CH2M HILL will mobilize survey equipment and personnel to the project site. Upon completion of the investigation, CH2M HILL will demobilize survey equipment, materials and personnel from the project site and return rental items or materials to the appropriate vendor.

Prior to the surveys, a control benchmark will be installed at each beach to check the RTK GPS mobile units before a survey is performed. The control benchmark will be established by translation from known benchmarks in the already established network of benchmarks.

Depending on logistics, line of sight and other considerations, the RTK GPS base station sending the correction signals to the mobile units would be installed either at the OP1 benchmark, or at the beach to be surveyed, in which case an additional control benchmark will be required at that beach.

Prior to the surveys, transects heads will be marked at each beach with identifiable markers like rebars, posts or pipes in the ground, and head location and heading of the transects will be documented in the Beach Surveys work plan. Transects will be identified by beach number and transect number. Starting from 1 from the right side of the beach looking seaward, transect numbers will be consecutive (i.e. 22-3= beach 22, transect 3).

Upon completion of the investigation the control benchmarks and transect heads will be removed, if necessary.

Health and Safety

Field personnel will be expected to fully comply with the HASP, AHA, APP and CH2M HILL requirements (e.g. distracted driving policy).

Upon their arrival to the site, CH2M HILL will provide a mandatory site orientation and training to field personnel new to the former VNTR and NASD. No work may commence until orientation and necessary training has been provided.

Required safety briefings will be provided each work day.

Survey Procedures

The following are minimum steps to be undertaken by the Beach Survey crew throughout the investigation. Two crews will perform the beach surveys. A land crew which will survey the dry and wading portion of the beaches, and a boat crew which will survey the surf zone and beyond portions of the nearshore. Additional details can be found in the MEC UFP-QAPP.

- Site safety and health briefing and review weather forecast.
- Inspection and testing of RTK GPS, Total Station, and all survey boat equipment for obvious defects.
- Repair/replacement of sensors and replacement of defective transmitters is planned. If there are data gaps resulting from equipment malfunction, and if the data gaps prevent the project objectives from being met, the beach dynamics monitoring period will be extended accordingly.
- Confirm planned survey area for the day.
- Assessment of weather conditions and preliminary decision on the feasibility of performing the surveys that day at each beach.
- Check RTK GPS mobile units at the control benchmark at Camp Garcia.
- Travel to first beach to survey, land crew by truck and boat crew by water.
- Assessment of weather conditions at the site and final decision on the feasibility of performing the surveys that day at that beach.
- If necessary, the RTK GPS base station is setup.
- Land and boat crews check their RTK GPSs' at the control benchmark.
- Land crew navigates to the first transect head location, identified with a marker, and verify location with RTK GPS.
- Boat crew performs a depth check of the single beam depth sounder (bar check), and measures the speed of sound in water.
- Boat crew navigates to the first transect on the water and surveys transect, repeats for all transects.
- Land crew surveys the dry beach section (backshore) of the transects by foot, then wading into the water to survey in the surf zone (foreshore) to a depth manageable by the rodman, uses RTK GPS or Total Station depending on wave conditions, repeats for all transects.
- Land crew locates sand samples locations, collects samples and stores in plastic resealable bags (quarterly only).
- Land and boat crews document survey including date, start and end times, weather conditions and equipment used; inaccessible areas or site-specific conditions that adversely impact or impede the survey, and relevant observations.
- Crew documents data quality issues.
- Crew documents equipment hardware or software problems.
- Land and boat crews travel to the next beach and surveys per the steps described above.
- Upon completion of the surveys planned for the day, travel to equipment storage area.
- Secure equipment for overnight storage and place devices on charge.
- Project Coastal Engineer QCs survey data and makes determination if any survey needs to be repeated.

Data Management and Quality Control

The following procedures apply to data management for the Beach Surveys. Additional details can be found in the MEC UFP-QAPP.

Project Coastal Engineer:

- Downloads survey data
- Reviews field notes

- Inputs of all survey data and field notes into SANDS database and relevant forms
- QC's survey data, notes deficiencies and determines surveys that need to be repeated

IV. Reporting

The following will be included in the final report:

- Description of the investigation and Beach Surveys component objectives
- Description of methodology and equipment used
- Description of procedures
- Description of results
- Analysis of results
- Summary of field notes
- Raw data files
- Processed data files

STANDARD OPERATING PROCEDURE #2

MEC Tracking

I. Purpose and Scope

This standard operating procedure (SOP) provides a general overview of the MEC Tracking component of the Beach Dynamics Investigation to be conducted at the former VNTR and NASD. It includes a description of equipment and personnel required, procedures to be followed, and reporting.

This SOP was prepared as part of the MEC Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) for the Beach Dynamics Investigation. This SOP and the MEC UFP-QAPP were prepared on behalf of the Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Atlantic.

II. Equipment and Personnel

The following is a list of minimum equipment and personnel needed to conduct the MEC Tracking:

- RTK GPS base unit.
- Small inflatable boat equipped with:
  - life jackets
  - outboard motor, gas tanks and batteries
  - single-beam depth sounder
  - motions compensation package
  - RTK GPS mobile unit including all necessary accessories
  - compass
  - laptop for data collection/processing and with hydrographic software
  - speed of sound in water sensor.
- MEC surrogates, each equipped with an acoustic transmitter
- 1 (one) acoustic receiver
- Snorkeling equipment
- Dedicated field notebook
- Radio to communicate with land crew
- 1 (one) survey lead
- 1 (one) boat driver/survey assistant
- 1 (one) swimmer
- 1 (one) UXO-qualified personnel for performing MEC avoidance as needed with diving permit.

III. Procedures

Prior to mobilization to the project site, field personnel will have received, reviewed, submitted (where applicable) and have a thorough understanding of the following project documents.

- Investigation objective
- Site maps
- Health and Safety Plan (HASP)
- Accident Prevention Plan (APP)
- Activity Hazard Analysis (AHA)
- This SOP

Mobilization and Demobilization

CH2M HILL will mobilize survey equipment, materials and personnel to the project site. Upon completion of the investigation, CH2M HILL will demobilize survey equipment, materials and personnel from the project site and return rental items or materials to the appropriate vendor.

At the time of the first survey, MEC surrogates, in quantity and type TBD, will be placed in the nearshore at selected beaches. For each surrogate, location (vertical and horizontal), date/time and seafloor composition will be recorded.

Upon completion of the investigation the surrogates will be removed.

Health and Safety

Field personnel will be expected to fully comply with the HASP, AHA, APP and CH2M HILL requirements (e.g. distracted driving policy).

Upon their arrival to the site, CH2M HILL will provide a mandatory site orientation and training to field personnel new to the former VNTR and NASD. No work may commence until orientation and necessary training has been provided.

Required safety briefings will be provided each work day.

Survey Procedures

The following are minimum steps to be undertaken by the MEC Tracking crew throughout the investigation. Due to the similarities in procedures and equipment required, it is envisioned that the boat crew performing the nearshore surveys of the Beach Surveys will also perform the MEC Tracking. Additional details can be found in the MEC UFP-QAPP.

- To take advantage of recently calibrated/checked equipment, the boat crew could perform the MEC Tracking upon completion of the survey of the nearshore portion of the transects at a given beach.
- Provided that at a given beach the steps required to perform the surveys of the nearshore portion of the transects by boat have been completed, the boat crew can survey the MEC surrogate positions at the completion of the beach survey. If not, all required boat survey setup and checks need to be performed (refer to SOP #1).
- Boat crew navigates to the location of the first MEC surrogate, swimmer jumps in the water with hydrophone and locates MEC surrogate guided by signal strength and heading. If a surrogate cannot be found with the hydrophone, a visual underwater search will be performed. If the MEC surrogate cannot be found by hydrophone or visual search, it will be declared lost and last known position recorded.
- Boat navigates to the location of the found MEC surrogate and locates RTK GPS mobile unit approximately on top, records date/time, horizontal location, water depth and seafloor composition on field notebook, and on the onboard laptop by means of the hydrographic software. Note that this requires the RTK GPS mobile unit and depth sounder to be vertically aligned.
- Repeat for every MEC surrogate at a given beach.
- Crew documents data quality issues.
- Crew documents equipment hardware or software problems.
- Crew travels to the next beach to perform nearshore beach surveys and MEC Tracking, if applicable.
- Upon completion of the surveys planned for the day, travel to equipment storage area.
- Secure equipment for overnight storage and place devices on charge.
- Project Coastal Engineer QCs survey data and makes determination if any survey needs to be repeated.

Data Management and Quality Control

The following procedures apply to data management for the MEC Tracking. Additional details can be found in the MEC UFP-QAPP.

Project Coastal Engineer:

- Downloads survey data
- Reviews field notes
- Input of all survey data and field notes into SANDS database and relevant forms
- QC's survey data, notes deficiencies and determines surveys that need to be repeated

IV. Reporting

The following will be included in the final report:

- Description of investigation and MEC Tracking component objectives
- Description of methodology and equipment used
- Description of procedures
- Description of results
- Analysis of results
- Summary of field notes
- Raw data files
- Processed data files

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STANDARD OPERATING PROCEDURE # 3

Metocean Data Collection

I. Purpose and Scope

This standard operating procedure (SOP) provides a general overview of the Metocean Data Collection component of the Beach Dynamics Investigation to be conducted at the former VNTR and NASD. It includes a description of equipment and personnel required, procedures to be followed, and reporting.

This SOP was prepared as part of the MEC Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) for the Beach Dynamics Investigation. This SOP and the MEC UFP-QAPP were prepared on behalf of the Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Atlantic.

II. Equipment and Personnel

The following is a list of minimum equipment and personnel needed to conduct the Metocean Measurements :

- 3 (three) acoustic doppler wave/current/water level sensors
- Alkaline batteries
- Mounting hardware to secure sensor to the seafloor (tripod, jetted pipe, screw anchor, ballast, etc.)
- Tools
- A Zodiac Hurricane rigid-inflatable boat (RIB) boat, or comparable, sufficient to navigate all offshore areas included in the study will be used. The boat will be equipped with:
  - life jackets
  - outboard motor, gas tanks and batteries
  - depth sounder
  - GPS
  - compass
  - anchor
- Dedicated field notebook
- 1 (one) laptop computer for data collection
- Radio
- 1 (one) Project Coastal Engineer
- 1 (one) boat driver
- Dive team including all gear
- 1 (one) UXO-qualified personnel for performing MEC avoidance as needed with diving permit.

III. Procedures

Prior to mobilization to the project site, field personnel will have received, reviewed, submitted (where applicable) and have a thorough understanding of the following project documents.

- Investigation objective
- Site maps
- Health and Safety Plan (HASP)
- Accident Prevention Plan (APP)
- Activity Hazard Analysis (AHA)
- This SOP

Mobilization and Demobilization

CH2M HILL will mobilize survey equipment, materials and personnel to the project site. Upon completion of the investigation, CH2M HILL will demobilize survey equipment, materials and personnel from the project site and return rental items or materials to the appropriate vendor.

Prior to the first beach survey, 3 (three) acoustic wave/current/water level sensors will be installed at the selected locations. For each sensor, geographical location, water depth, date/time, anchoring hardware used and seafloor composition will be recorded, and underwater photos taken.

Upon completion of the investigation sensors and all anchoring hardware will be removed.

Health and Safety

Field personnel will be expected to fully comply with the HASP, AHA, APP and CH2M HILL requirements (e.g. distracted driving policy).

Upon their arrival to the site, CH2M HILL will provide a mandatory site orientation and training to field personnel new to the former VNTR and NASD. No work may commence until orientation and necessary training has been provided.

Required safety briefings will be provided each work day.

Data Collection Procedures

The following are minimum steps to be undertaken to maintain the sensors, recover data and collect third party metocean data throughout the investigation. Additional details can be found in the MEC UFP-QAPP.

- Quarterly and for each sensor, crew navigates to the selected deployment location
- Divers take photos of the sensor and mounting hardware
- Divers recover sensor and brings it to the surface
- Project Coastal Engineer:
  - downloads data to laptop computer
  - replaces old batteries with new ones
  - verifies correct performance of the sensor
- Divers:
  - inspect sensor mounting hardware and perform any necessary repairs
  - reinstall sensor
  - take photos of installation
- Project Coastal Engineer documents operation including date, start/end times, metocean conditions, mounting hardware conditions and any repairs made, seafloor conditions, and any other relevant observations.

Data Management and Quality Control

The following procedures apply to the metocean data management. Additional details can be found in the MEC UFP-QAPP.

Project Coastal Engineer:

- On a monthly basis and for the duration of the investigation, download:
  - wind, atmospheric pressure, air temperature, water temperature and water level from Esperanza (ESPP4) NOAA's National Ocean Service Station 9752695 (http://www.ndbc.noaa.gov/station_realtime.php?station= ESPP4 and http://tidesonline.nos.noaa.gov/data_read.shtml?station_info=9752695+Esperanza,+PR)
  - wind and air temperature from Isabel Segunda (VQSP4) NOAA's National Ocean Service Station 9752619 (http://www.ndbc.noaa.gov/station_realtime.php?station= VQSP4 and http://tidesonline.nos.noaa.gov/data_read.shtml?station_info=9752619+Isabel+Segunda,+Vieques,+PR)

  - wind, atmospheric pressure, air temperature, and water levels from Fajardo (FRDP4) NOAA's National Ocean Service Station 9753216 (http://www.ndbc.noaa.gov/station_realtime.php?station=FRDP4 and http://tidesonline.nos.noaa.gov/data_read.shtml?station_info=9752619+Isabel+Segunda,+Vieques,+PR)
  - wind, wave, atmospheric pressure, air temperature, and water temperature from NDBC Station 41043 (http://www.ndbc.noaa.gov/station_realtime.php?station= 41043)
  - wind, wave, atmospheric pressure, air temperature, and water temperature from NDBC Station 41044 (http://www.ndbc.noaa.gov/station_realtime.php?station= 41044)
  - wind, wave, atmospheric pressure, air temperature, and water temperature from NDBC Station 42060 (http://www.ndbc.noaa.gov/station_realtime.php?station= 42060)
  - wind, wave, atmospheric pressure, air temperature, and water temperature from NDBC Station 42059 (http://www.ndbc.noaa.gov/station_realtime.php?station= 42059)
  - wind, wave, atmospheric pressure, air temperature, and water temperature from NDBC Station 41051 (http://www.ndbc.noaa.gov/station_realtime.php?station= 41051)
  - wind, wave, atmospheric pressure, air temperature, and water temperature from NDBC Station 41052 (http://www.ndbc.noaa.gov/station_realtime.php?station= 41052)

- On a quarterly basis and upon recovery of wave/current/water level data from sensors
  - Reviews field notes
  - Input of all measured data and field notes into SANDS database and relevant forms
  - QC's survey data and notes deficiencies

IV. Reporting

The following will be included in the final report:

- Description of investigation and Metocean Data Collection component objectives
- Description of methodology and equipment used
- Description of procedures
- Description of results
- Analysis of results
- Summary of field notes
- Raw data files
- Processed data files

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Attachment B
Wave Height Measurements Using Acoustic Surface Tracking

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Wave Height Measurements Using Acoustic Surface Tracking

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Abstract - **Nortek has improved upon its AWAC, a current and wave measurement sensor package, by introducing a vertical, acoustic beam that detects the surface. This added functionality allows for directly measuring waves as opposed to inferring wave estimates from wave energy spectra.**

Traditionally, wave measurements from bottom-mounted instruments, such as the combined pressure-velocity (*PUV*) approach, are limited in their frequency response. This is due to attenuation of the surface signal with increasing depth. Recent advances employ the alternative solution of measuring orbital velocities close to the surface and incorporating the Maximum Likelihood Method (MLM) estimate technique [1]. This improves the accuracy at higher frequencies. However, for deployment depths of 10 meters or deeper, these methods cannot resolve waves periods that are 3 seconds or shorter. Moreover, these bottom-mounted systems do not measure the real surface time series, which makes it difficult to calculate extreme value statistics.

The following paper provides an overview of the process of (1) developing the surface track algorithms, (2) comparing with a Datawell wave buoy off the coast of Carqueiranne, France (3) and testing limiting conditions such as breaking waves and greater depths (35 meters).

I. INTRODUCTION

Nortek's AWAC (Acoustic Wave and Current, Fig. 1) has traditionally measured both the pressure and orbital velocities to estimate the wave frequency and directional spectrum. Recently, we have modified the firmware to allow us to detect the free surface using the vertical beam. The modification eliminates the constraint from the attenuation of wave properties with depth. Therefore the AWAC is now capable of measuring higher frequency waves in deeper water with a greater degree of accuracy.

This approach of measuring waves is not necessarily a new concept [2]. However it represents a considerable step forward from existing bottom mounted sensors now available, which generally rely just on the pressure and velocity measurements.

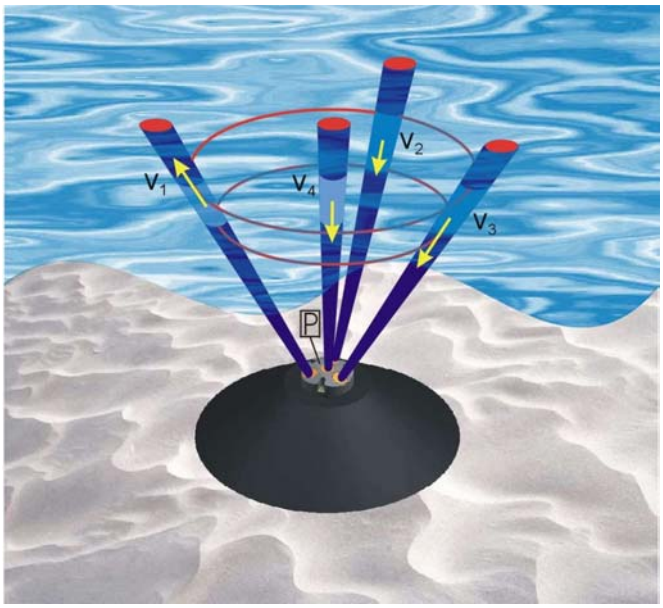

Fig. 1 Deployed AWAC with four 1 MHz beams

The development and validation of the surface tracking was performed over the course of three separate experiments. The first was performed at Drøbak, a site located in the fjord just south of Oslo. The second experiment was performed in Carqueiranne, France. Here we were able to directly compare to a DataWell WaveRider buoy. Once we established that the surface track measurements were in good agreement with the wave buoy, we implemented the surface track firmware in an AWAC online in Hwa Lien, Taiwan. This last site demonstrated that the AWAC is capable of measuring waves in depths of 35 meters, with little compromise in data quality.

II. SYSTEM OVERVIEW

The AWAC is designed to measure both the current profile and the wave directional spectrum using acoustic Doppler technology. It can be used in stand-alone and online mode. The target application is long term coastal monitoring of waves and currents along the coast. The wave measurement process employs a single cell per

beam to minimize data volume and extend deployment duration. Furthermore the cells are adaptively located to ensure maximum signal strength.

The AWAC has four, 1 MHz transducers. One center and the other three are equally spaced around it, angled 25° off the vertical axis. Beam width is 1.7° (3 dB point).

The instrument employs a fixed point DSP. Normal memory size is 20-80 MB of flash, which provides several months of current and wave data.

Other specifications:

- Pressure sensor, 50 m range
- Compass
- Tilt sensor
- Temperature sensor
- 1 Watt typical power consumption
- 9-16 Volts DC
- 1, 2, or 4 Hz Sampling
- 512, 1024, or 2048 samples per burst

III. PROCESSING

The approach used to detect the surface is relatively simple. It can be broken down into the following sequence of steps. (1) Transmit a pulse of a given length; (2) Specify a receive window covering the range of all possible wave heights; (3) Discretise the receive window into multiple cells (~5 cm); (4) Apply a match filter over series of cells to locate surface; (5) Use quadratic interpolation to precisely estimate surface location. An example of the amplitude time series for the discretised signal is provided in Fig. 2.

Clearly we had to consider the prospect of false detects and no detects. No detects were easily noted since they did not exceed a specified threshold level for detection. False detects on the other hand required special determination. This began by identifying samples that exceeded a specified bound relative to the mean of the ensemble. This boundary was defined as some multiple of the standard deviation of the ensemble. This clean up step was iteratively performed with increasingly tighter bounds to ensure all false detects were removed. Finally, if the cumulative number of false and no detects exceeded 10% of the total number of samples in the ensemble, the ensemble was considered corrupt and discarded.

Once the time series for the surface has been established, we carry on with the traditional zero-upcrossing method of estimating wave statistic.

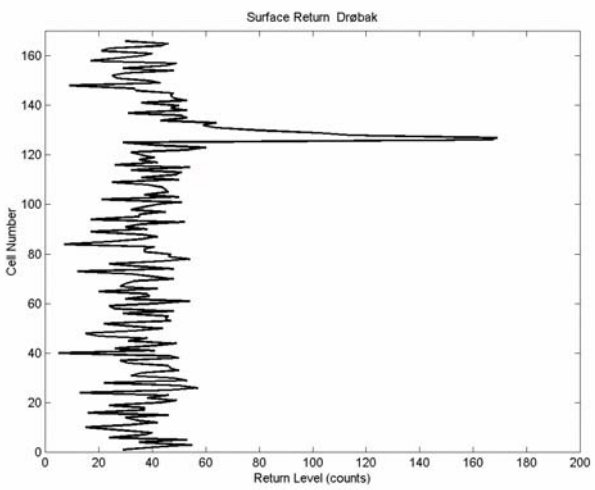

Fig. 2 Example of a echo return from the surface.

The frequency limitation for the measurable waves does not just lie with the Nyquist limit, but also with the "footprint" created by vertical beam intersecting the surface. Naturally, as the deployment depth increases, the footprint increases. As a general rule, we follow a Nyquist like reasoning; the frequency limit associated with the footprint is when half the wavelength is on the order of the diameter of the footprint.

IV. RESULTS

The organization of the results is presented in terms of the objective of each experiment. Therefore the data collected in Norway, France, and Taiwan is organized in relation to the development of the surface tracking algorithms and the subsequent validation.

A. Algorithm/Firmware Development

The first test was performed at Drøbak, a site local to Nortek in Norway. The site offers the luxury of having an AWAC online. This affords us the opportunity to quickly test out new algorithms since we can both install new firmware and upload collected data online. The site was interesting in the sense that it is virtually unexposed to the open ocean as it is still in the Oslo Fjord (Fig. 3). This means that there are three possible mechanisms for wave generation. These are (1) locally wind generated waves, (2) transient waves from local shipping traffic on way to Oslo, and perhaps if the direction was right, (3) waves from open sea.

The AWAC is located on the sill of the fjord in 21 meters of water. Data was sampled at 4 Hz and collected for over 17 minutes (1024 seconds). The receive window was set at 8 meters in length and subdivided into smaller bins so that there were 170 cells, each of which 4.7 cm long. We did not expect to ever see any waves requiring such a large receive window, however it provided ample opportunity for false detects.

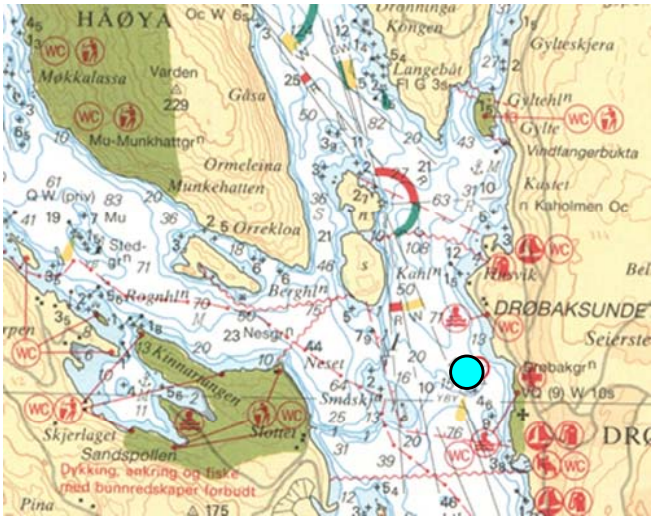

Fig. 3 AWAC test location noted by large circle, Drøbak Norway.

Initial testing was quite encouraging since we immediately noted higher frequency waves in the time series and that transient events were regularly detected since the location is exposed to considerable shipping traffic. An example of this is presented in Fig. 4. Here one can see that a passing ship's wake. The attenuated pressure signal is plotted as well. Additionally, the locally generated wind waves are clearly evident in the surface track but not in the pressure signal. The spectrum of the surface track is presented in the subsequent plot, demonstrating that energy is detectable up to 1 Hz for the given setup.

The beam casts a footprint with a diameter of 0.62 meters on the surface. Therefore the limit associated with the footprint is 1.1 Hz.

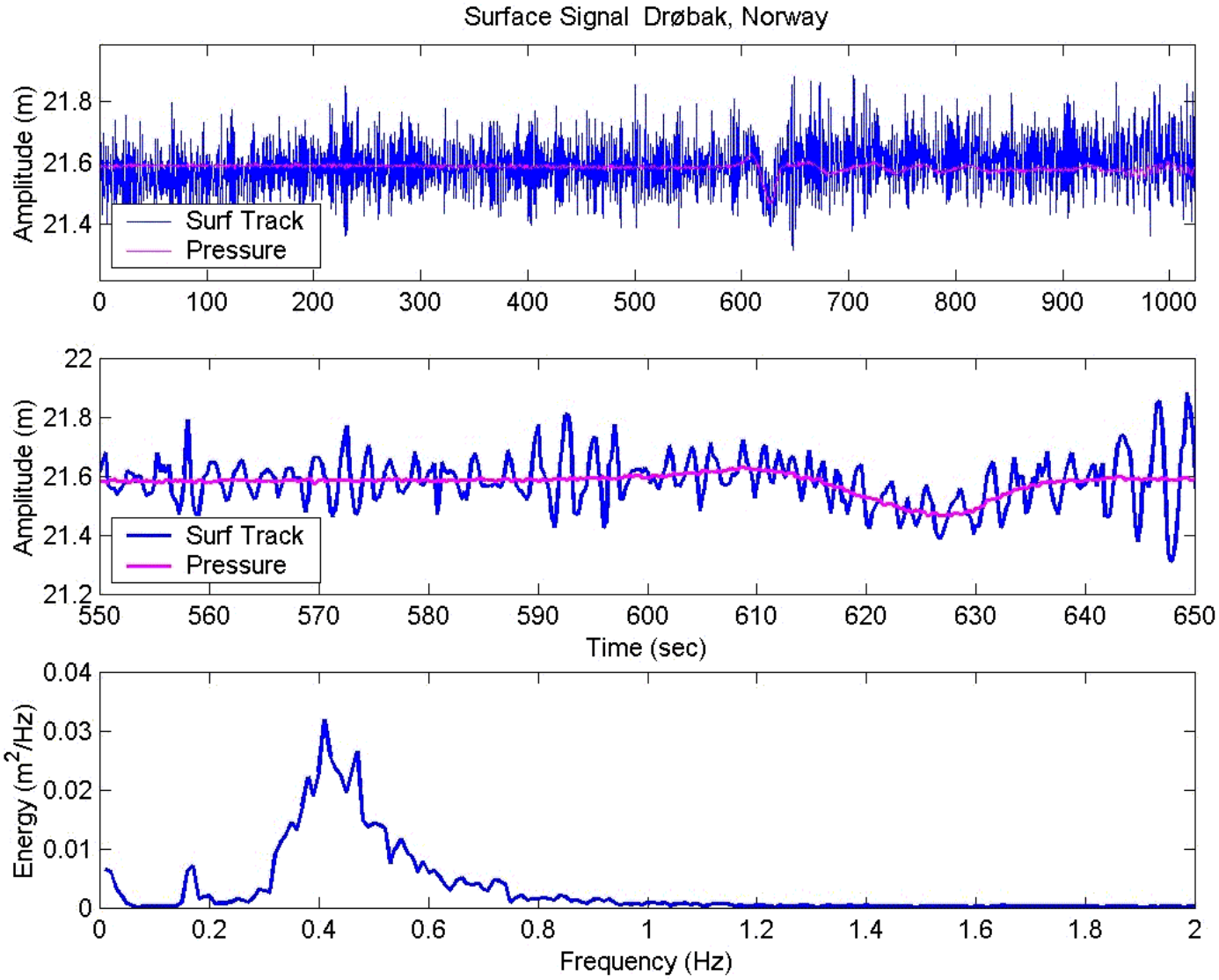

Fig. 4 Surface Track (blue) and Pressue (Purple) time series indicating a passing ship. Bottom pane shows energy spectrum for the surface track, note detectable energy up towards 1 Hz.

Surprisingly, there were very few false or no detects for the surface tracking. We attributed this to the fact that the wave environment here is only exposed to small waves and which are rarely breaking. Breaking waves seem to be the most threatening to accurate surface detection since there is greater possibility to falsely detect the entrained bubbles below the waves. The value of the tests in Drøbak was the realization of a match filter and threshold level for which we had confidence. We concluded that the next logical step was to verify the accuracy of the measurements and expose the method to both larger and breaking waves.

B. Validation

Once the algorithms and firmware were in place, we set out to compare to a reference. Nortek teamed with Thetis in the south of France off of Carqueiranne for this next phase. The wave environment was characterized by a calm period of approximately a day before a strong, persistent wind blew for two days out of the southwest. At times the wave field was rather complex, since the local wind waves and swell arrived from different directions. The days during the high winds provided breaking waves.

An AWAC and a non-directional DataWell Waverider buoy were deployed in 14 meters of water off the coast of Carqueiranne. Fig. 5 shows both the AWAC (center of the triangular frame) and the wave buoy before deployment. The instruments were located approximately 20 meters laterally from one another. Again the AWAC used 4 Hz sampling for 1024 seconds. Wave data was collected once an hour for nearly four days. The wave buoy was setup to collect wave data every half hour, with a 2.56 Hz sampling rate, and a duration of 20 minutes. The startup time for both instruments was synchronized, however since the wave buoy measured for slightly longer, only the identical sampling time was used for the subsequent analysis and comparison.

Estimates for significant wave height are presented in Fig. 6. Note that the difference is rarely more than a few centimeters. Spectra for the two instruments are also presented for the pressure, surface track and wave buoy (Fig. 7), again indicating strong agreement. The spectra associated with the pressure show near perfect agreement with the surface track, however it is only valid for the lower frequency range before the signal falls into the noise floor and the transformation to surface spectra is no longer applicable. The wave buoy shows a slight difference, but in general has favorable agreement.

It appears that the surface track detected a little more energy at the higher frequencies than the wave buoy. This difference is illustrated with estimate for the mean period (Fig. 6). Here the surface track nearly always has a lower mean period than the wave buoy. This is also noted in the spectra; the energy for surface track always exceeds that of the wave buoy above 0.75 Hz. This is probably due to the fact that buoy has an unwanted response near 1 Hz and the signal is most likely low passed filtered just below this point to handle this unwanted effect. Therefore we expect the buoy to measure waves out to some frequency just below 1 Hz.

The limitation for the frequency response of the surface track is the footprint of the vertical beam. Clearly for the shallow depths in Carqueiranne, we will be capable of measuring waves of shorter period. The footprint has a diameter of 0.42 meters and therefore the upper frequency limit is 1.4 Hz.

The concern of falsely detecting a breaking wave's bubble plume instead of the surface did not seem to be realized. A strong south westerly wind induced continuous breaking of the waves. This did not seem to negatively influence estimates, as the wave heights between the two instruments seem to be in close agreement throughout the experiment. The waves never exceeded much more than 1 meter in significant wave height since the waves were limited by the relatively short fetch along the French coast. Therefore the surface track remains to be tested for extreme wave events.

Fig. 5 Waverider and AWAC (center of triangular frame) prior to deployment, Carqueiranne, France.

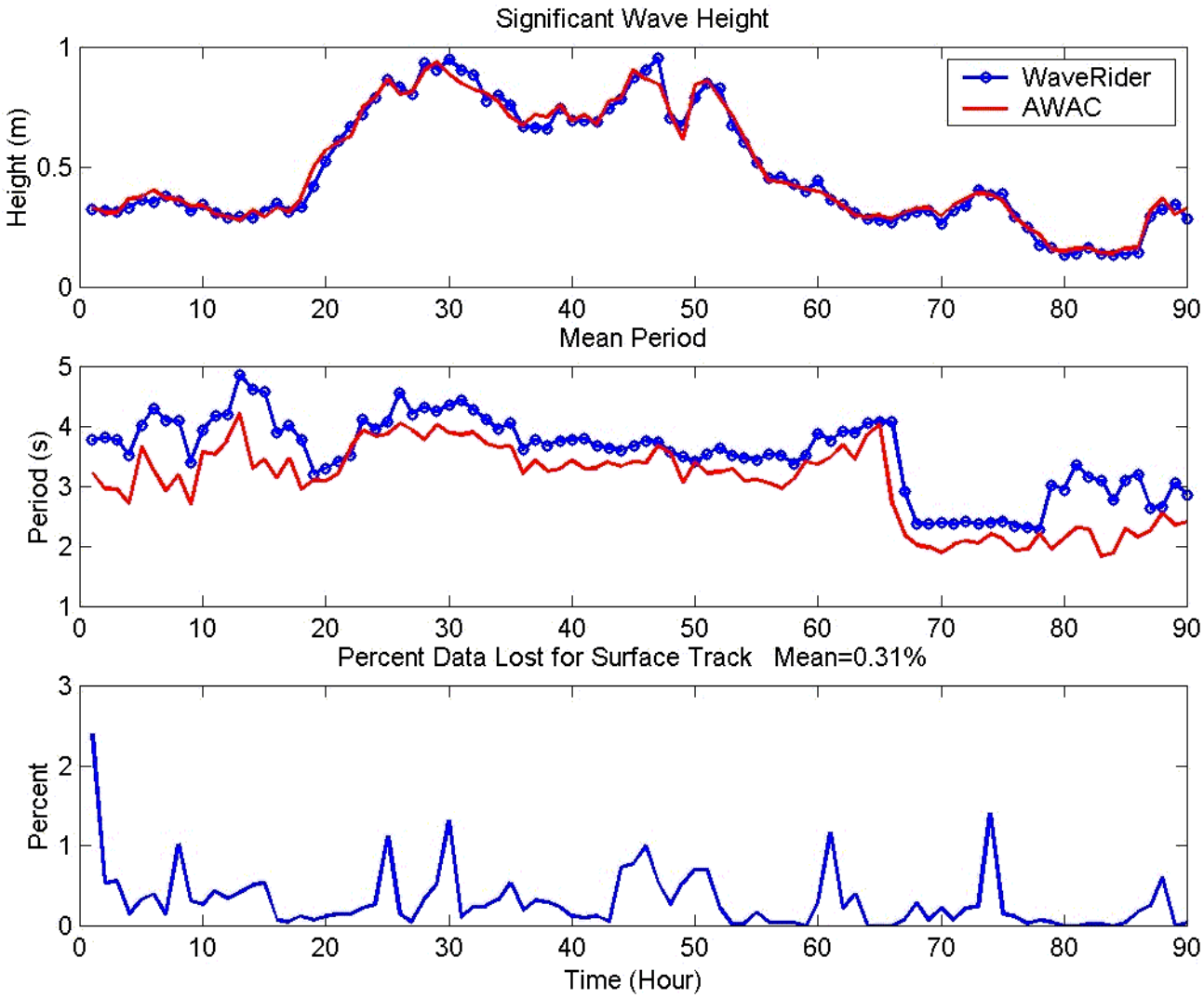

Fig. 6 Estimates of significant wave height, mean period for both surface track (red) and Waverider (blue). The bottom pane show percentage of data loss for surface track.

C. Testing Limitations

Once the AWAC's surface tracking accuracy was verified to be comparable to the wave buoy, we decided to expose the surface detection to a more rigorous environment that would indicate some limits of performance. This was carried out in cooperation with the Taiwan Institute of Harbor and Marine Technology (IHMT), who has a national network of AWACs for wave measurement. These instruments are all online. Therefore it was once again relatively easy to upload the surface track firmware and monitor the results.

The AWAC at Hwa Lien was used for this test and is located in 34 meters of water. This test however used a smaller sample rate of 2 Hz. At this depth, waves above 0.9 Hz are limited by the footprint of the vertical beam, so it does not appreciably improve estimates to sample at a higher rate.

The estimates for the significant wave height indicate how the pressure and velocity estimates will underestimate the wave heights (Fig. 8). This is particularly true when there is wave energy above 0.2 Hz.

The results presented in Fig. 9 show that there is favorable agreement once again between the pressure, velocity, and surface track spectra. The pressure and velocity spectra are limited by the depth attenuated response. Recall this result in Fig. 7, when the pressure based surface spectra was grossly overestimated as the frequency increased. This is generally handled by finding some local minimum below where the spectra dramatically increases and extrapolating downwards according to the Pierson-Moskowitz Spectrum.

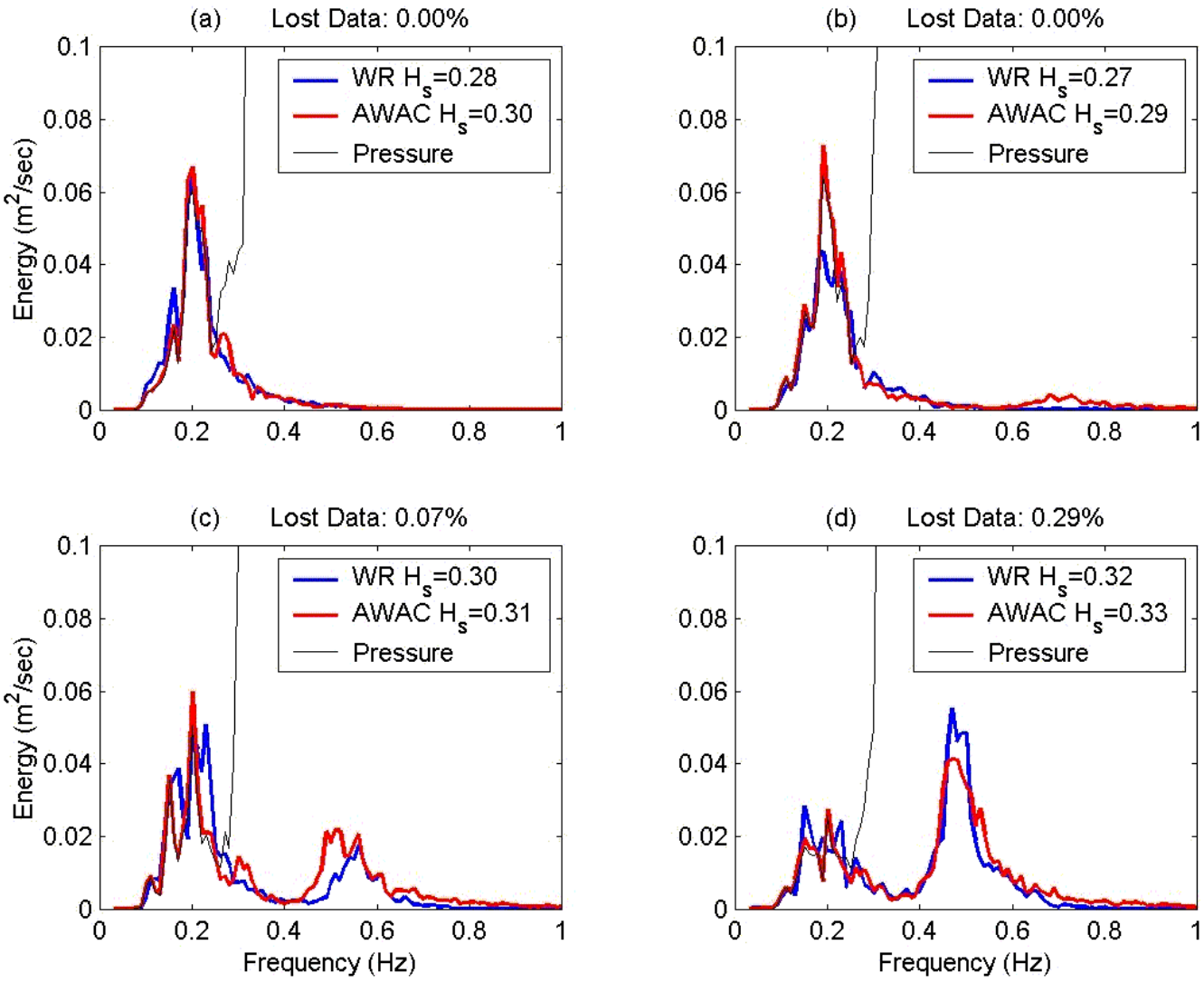

Fig. 7 Spectra for four consecutive wave ensembles from the surface track, pressure, and Waverider

The amount of lost data for a depth of 35 meters is noticeably greater than that of the tests in France. In Taiwan it was on average 1.25%, and peaked near 10% for two of 46 ensemble measurements; whereas in France, for a depth of 14 meters, we noted less than 0.5% data loss on average.

V. CONCLUSIONS

Surface tracking for coastal wave measurements has been developed and added to Nortek's AWAC sensor. This added feature provides a useful compliment to the pressure and velocity wave measurements; so that there are three independent estimators. More importantly it does not suffer from the attenuation effects associated with increasing depth and therefore estimates waves directly using the time series, opposed to spectral inferred estimates. This fact means we are now able to offer time series wave statistics such as top 10% (H_{10}) and max wave heights (H_{max}).

The surface track's ability to measure energy at higher frequencies (shorter period waves) suggests that we will be less likely to underestimate wave heights in general.

This series of tests first began with the algorithm development in Drøbak. Testing confirmed the ability to measure energy at higher frequencies and the ability to detect transient events as local shipping traffic was continuously noted.

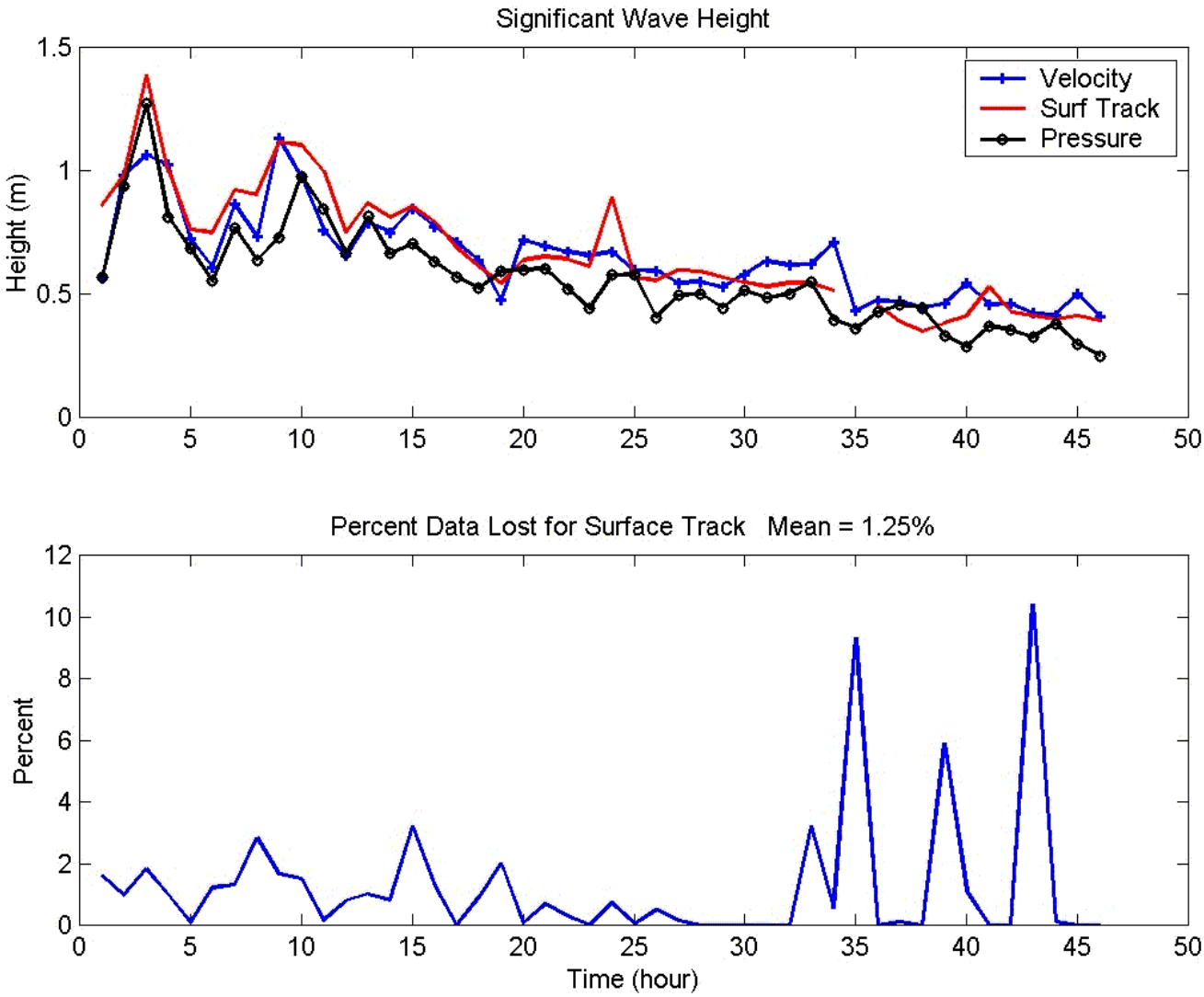

Fig. 8 Significant wave height estimates for surface track (red), pressure (black), and velocity (blue). Lower pane shows data loss for the surface track for each ensemble.

The development stage was followed up with tests in the south of France to compare to wave buoy measurements. The test validated that the surface track achieves nearly identical height estimates to that of a wave buoy. It was also noted during this test that breaking waves (H_s = 1m) did not negatively influence estimates.

Lastly, the surface track was tested at 35 m in Taiwan. This test was initiated to consider the effects of increased depth on data loss. Data loss was greater than prior tests, however the level did not exceed a loss rate that would have required us to discard the time series.

Future work includes looking at the possibility of using the vertical beam to measure the surface velocity (using Doppler estimates) as yet another independent estimator. However, as it stands now, the AWAC represents a complete wave measurement system for coastal waters with several internal data quality checks.

Other objects in consideration are to develop a better understanding of the limitations of the surface track with regard to depth and exposure to larger breaking waves.

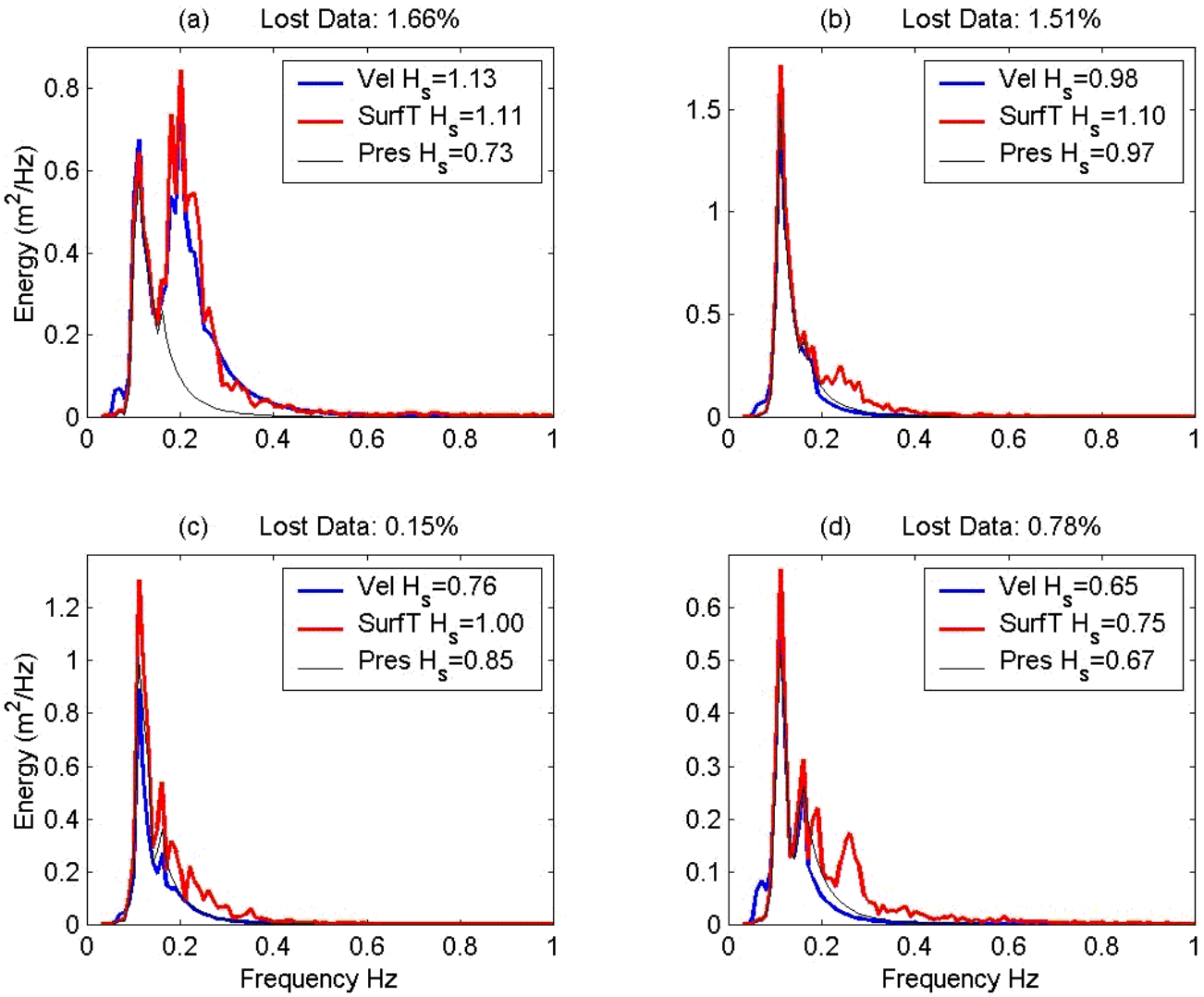

Fig. 9 Spectra for Hwa Lien, Taiwan

Acknowledgments

Nortek would like to thank the University of Oslo for allowing us to use their station in Drøbak, and IHMT and WinSquare for support in Hwa Lien.

References

[1] H.E. Krogstad, R.L. Gordon, and M.C. Miller, "High-resolution directional wave spectra from horizontally mounted acoustic doppler current mters," *J. Atmos. Ocean. Techn.,* Vol. 5, no. 4, pp. 340-352, 1988.

[2] T. Takayama, N. Hashimoto, T. Nagai, T. Takahashi, H. Sasaki, and Y. Ito, "Development of a submerged Doppler-type directional wave meter," *Coastal Engineering,* Chapter 46, pp. 624-634, 1994.

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[5] O. Haug, H.E. Krogstad, "Estimation of directional spectra by ML/ME methods," Proc. Ocean Wave Measurements and Analysis, New Orleans, pp. 394-405, 1993.

Attachment C
Review of Existing Vieques Bathymetry Data

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Review of Existing Bathymetry Data for Vieques, Puerto Rico

PREPARED FOR: NAVFAC Atlantic

PREPARED BY: CH2M HILL

DATE: December 10, 2013

This memorandum summarizes the existing bathymetry data review for Vieques performed by CH2M HILL. The data review was conducted on behalf of the Department of the Navy, Naval Facilities Engineering Command (NAVFAC), Atlantic Division in support of initial preparations for the Wide Area Assessment (WAA) and Beach Dynamics Investigation.

Purpose of Data Review

The Navy has adopted an iterative approach for both the WAA and the Beach Dynamics Investigation. Each component of these investigations requires supporting data and information from the previous stage(s) to be used during planning of subsequent stages and refinement of the Conceptual Site Model (CSM). For the WAA, Beach Dynamics Investigation, and CSM, knowledge of water depth was identified as an initial planning necessity.

For the WAA of Site UXO 16, bathymetry data will be used primarily to help plan the side scan sonar survey. The objective of the side scan sonar survey is to map environmentally sensitive areas and underwater navigational obstructions (e.g., reefs, shipwrecks) to be used for planning the follow-up underwater digital geophysical mapping (DGM). The objective of the DGM is to identify anomalies consistent with underwater munitions.

For the Beach Dynamics Investigation, the bathymetry data will be used for various purposes during planning and data analysis. During the planning stage, nearshore bathymetry will be used to help determine the locations of the beach transects that will be surveyed to monitor the evolution of the beaches throughout the investigation. Offshore bathymetry data will be used to help determine the location of sensors that will collect wave, current, and water level data for the purpose of correlating these parameters with the beach evolution. During the analysis stage, bathymetry data around the island will be used to help develop wave and sediment transport models that will be used to predict beach changes in a wide range of conditions.

CH2M HILL conducted a review of existing bathymetry data obtained from a variety of sources in order to determine whether existing bathymetry data are sufficient to satisfy the aforementioned objectives or whether a new, stand-alone bathymetry survey is warranted as the first phase of the WAA and Beach Dynamics Investigation. The data were reviewed for resolution, Site UXO 16 coverage, ability to incorporate the data into the Vieques program GIS, and overall usability.

Data Sources

Table 1 presents the data sources and metadata compiled to produce the comprehensive bathymetric dataset for Vieques.

TABLE 1
Existing Bathymetry Data Sources and Metadata
Vieques, Puerto Rico

Data Source	Date	Data Type	Spatial Resolution	Horizontal Accuracy	Vertical Accuracy	Original Horizontal Datum	Original Vertical Datum	Publisher
NOAA[a]	2007	Digital Elevation Model /Bathymetry	1 arc-second (~30m)	Dependent on DEM cell size of data inputs	Dependent on DEM cell size of data inputs	WGS 84	MHW	NOAA
NOAA[b]	2007	Digital Elevation Model /Bathymetry	1/3 arc-second (~10m)	Dependent on DEM cell size of data inputs	Dependent on DEM cell size of data inputs	WGS 84	MHW	NOAA
JALBCTX/USACE (SHOALS)	2001	Airborne LiDAR Bathymetry	5m posting	~3m	~15cm	WGS 84	MLLW	JALBCTX/USACE
JALBCTX/USACE (SHOALS)	2000	Airborne LiDAR Bathymetry	5m posting	~3m	~15cm	WGS 84	MLLW	JALBCTX/USACE
NOAA Nautical Chart 25650 – Edition 36[c]	2011	Soundings	N/A	N/A	N/A	NAD83	MLLW	NOAA
NOAA Nautical Chart 25663 – Edition 28[c]	2012	Soundings	N/A	N/A	N/A	NAD83	MLLW	NOAA
NOAA Nautical Chart 25664 – Edition 17[c]	2011	Soundings	N/A	N/A	N/A	NAD83	MLLW	NOAA

Table Notes:
[a] Reference/URL: http://www.ngdc.noaa.gov/dem/squareCellGrid/download/1561
[b] Reference/URL: http://www.ngdc.noaa.gov/dem/squareCellGrid/download/689
[c] Charts used for quality control purposes; Reference/URLs:
http://www.charts.noaa.gov/OnLineViewer/25650.shtml
http://www.charts.noaa.gov/OnLineViewer/25663.shtml
http://www.charts.noaa.gov/OnLineViewer/25664.shtml

Table Abbreviations:
cm = centimeter
DEM = Digital Elevation Model
ft = foot
JALBCTX = Joint Airborne LiDAR Bathymetry Technical Center of Expertise
LiDAR = Light Detection and Ranging
m = meter
MHW = Mean High Water
MLLW = Mean Low Water
NAD83 = North American Datum 1983
NOAA = National Oceanic and Atmospheric Administration
USACE = United States Army Corps of Engineers
UTM = Universal Transverse Mercator
WGS = World Geodetic System

Additional data sets were reviewed as part of this effort. They are not presented in **Table 1** because they were determined to be redundant, did not meet general usability requirements, or were of coarser resolution or lesser quality than those in **Table 1**. These included the following:

- University of Puerto Rico: Digitization of National Ocean Survey Hydrographic Survey "Smooth" Sheets for Puerto Rico and the U.S. Virgin Islands
- C-MAP: soundings from digital charts
- NOAA: Vieques Bathymetry Survey W00235 2012

- NOAA: Vieques Bathymetry Survey W00207 2008
- NOAA: Vieques Bathymetry Survey W00214 2009

Review Findings

CH2M HILL obtained the actual data for each data set listed in **Table 1** and compiled the information in GIS to assess the coverage and usability. Based on evaluation of the compiled data, the data sets listed in **Table 1** were determined to meet the initial planning needs for the WAA and Beach Dynamics Investigation.

The results of the compilation are presented as **Figures 1 through 3**. **Figure 1** presents a comparison of each data set listed in **Table 1**. This figure is intended to demonstrate that extensive data coverage exists around Vieques and, in the case of the NOAA digital elevation model (DEM) data, all of Puerto Rico. However, for purposes of evaluating the suitability of the data for the WAA and Beach Dynamics Investigation, Site UXO 16 is the focus. Therefore, the Site UXO16 boundary is shown in red on each of the four maps presented as **Figure 1**.

Figure 2 presents the compilation of the bathymetry data for Vieques performed by CH2M HILL. The Site UXO 16 boundary is also shown in red. Depths are presented in reference to mean seal level (MSL). Coordinates and datum were translated to UTM Zone 20 North, NAD83, meters, because this coordinate system adopted for the project.

Because the data sets were of varying resolution, the contour interval used to generate the map in **Figure 2** varies depending on the resolution of the existing data. In general, the nearshore data are of the highest resolution (e.g., 5 meters) whereas the offshore data are of generally coarser resolution (e.g., 10 – 30 meters). It is important to note that in **Table 1**, references to "posting" in the LiDAR data refers to the smallest anticipated distance between data points during acquisition. It specifically refers to the distance between LiDAR pulses during the survey, although it does not necessarily equate to the data point station at the ground surface due to effects from aircraft altitude changes, clouds, and other factors that may impact actual data point spacing at the ground surface when performing airborne LiDAR surveys. CH2M HILL determined that it was possible to present both of the airborne LiDAR data sets using a 5-meter grid (**Figure 2**) and minimize data gaps in coverage within these data sets, which is sufficient for the current needs of the WAA and Beach Dynamics Investigation.

NOAA nautical charts were used as a quality control (QC) check during the data compilation. The QC check essentially consisted of comparing interpolated water depths on a random basis to the NOAA nautical chart data using an acceptance criterion of ±0.5 meters. In addition, spot soundings collected by CH2M HILL during a site visit the week of March 11, 2013 were also used for QC. The average difference between the 2000 and 2001 LiDAR data and the spot soundings was determined to be ±0.3 meters and ±0.5 meters, respectively. All QC efforts were performed using tide-adjusted data and information.

As evidenced in **Figure 3**, the majority of Site UXO 16 is covered by the available data with the highest resolution. Locations within Site UXO 16 that are covered only by available coarser resolution data are still deemed acceptable for purposes of planning the WAA and Beach Dynamics Investigation because these areas constitute a relatively small percentage of Site UXO 16 and include primarily the outermost extents of the site. If it is determined at a later phase of the WAA or Beach Dynamics Investigation that higher resolution data are desired in a specific location than what is currently available, small, focused bathymetry surveys can be performed in conjunction with other data collection efforts. In so doing, overall costs will be reduced by eliminating the need for new site-wide coverage or separate mobilizations for just bathymetry data collection. **Table 2** presents the estimated percent coverage by each of the reviewed data sets within Site UXO 16 depicted on **Figure 3**.

TABLE 2

Existing Bathymetry Data and Estimated Coverage Within Site UXO 16

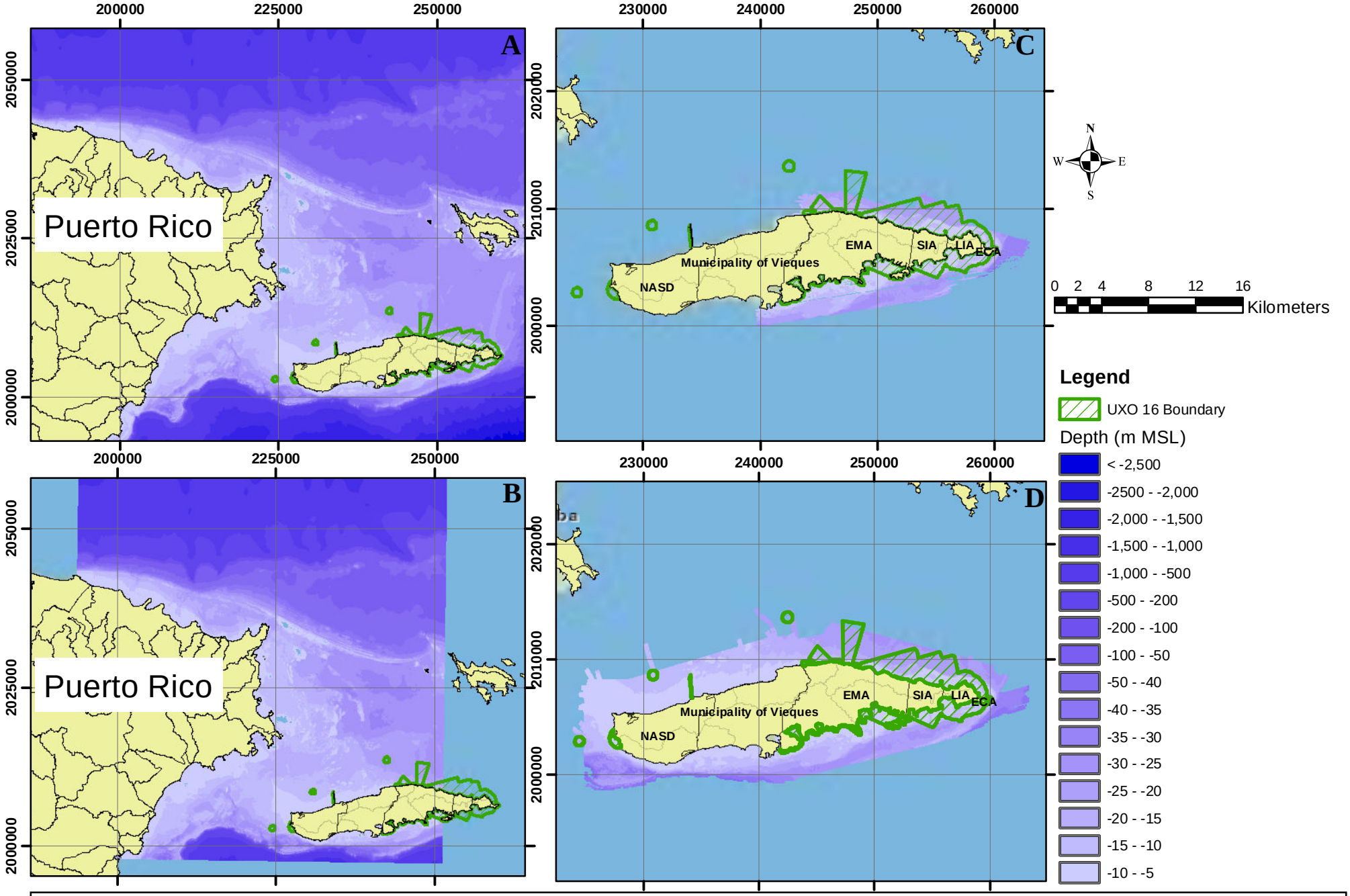
Vieques, Puerto Rico

Data Set	Spatial Resolution	Estimated UXO 16 Coverage
NOAA 1 arc-second DEM Bathymetry	~30m	1%
NOAA 1/3 arc-second DEM Bathymetry	~10m	5%
2000 Airborne LiDAR	5m posting	76%
2001 Airborne LiDAR	5m posting	18%

The review of existing data also determined that the maximum water depth within Site UXO 16 is less than 37 meters (120 feet).

Conclusions

CH2M HILL has determined that existing bathymetry data coverage, resolution, and overall quality are sufficient for planning the side scan sonar survey for the Site UXO 16 WAA and Beach Dynamics Investigation. In addition, the existing bathymetry data will be incorporated into the program GIS.



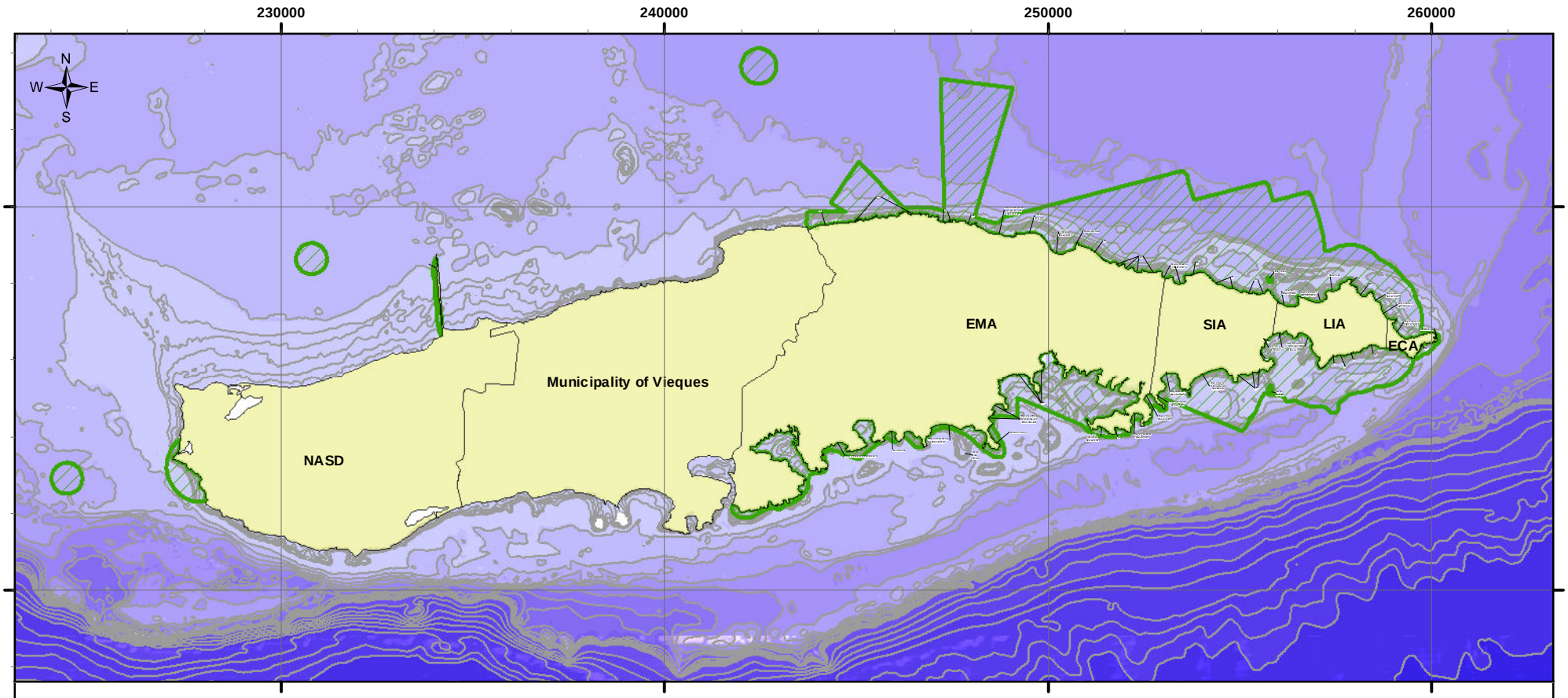
A. NOAA 1 arc-second DEM - 06/22/2007
B. NOAA 1/3 arc-second DEM - 06/22/2007
C. USACE LiDAR 5 m posting- 08/2000
D. USACE LiDAR 5 m posting- 08/2001

Notes:
1. All dimensions are in meters unless otherwise noted

2. Horizontal datum : NAD 1983 UTM 20N
Vertical datum : meters Mean Sea Level (MSL)

Figure 1
Availble Bathymetric Data Coverage
Vieques Puerto Rico

CH2MHILL



0 1.25 2.5 5 7.5 10 Kilometers

Legend

UXO 16 Boundary

Bathymetry Contours

Depth (m MSL)

- < -2,500
- -2500 - -2,000
- -2,000 - -1,500
- -1,500 - -1,000
- -1,000 - -500
- -500 - -200
- -200 - -100
- -100 - -50
- -50 - -40
- -40 - -35
- -35 - -30
- -30 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5

Notes:

1. All dimensions are in meters unless otherwise noted

2. Horizontal datum : NAD 1983 UTM 20N
   Vertical datum : meters Mean Sea Level (MSL)

3. The bathymetry contours are shown as follows:
   From 0 m to 5 m - 1 m intervals
   From 5 m to 50 m - 5 m intervals
   From 50 m to 100 m - 10 m intervals
   From 100 m to 1000 m - 100 m intervals
   From 1000 m to 2000 m - 500 m intervals

Figure 2
Bathymetric Contours
Vieques Puerto Rico

CH2MHILL

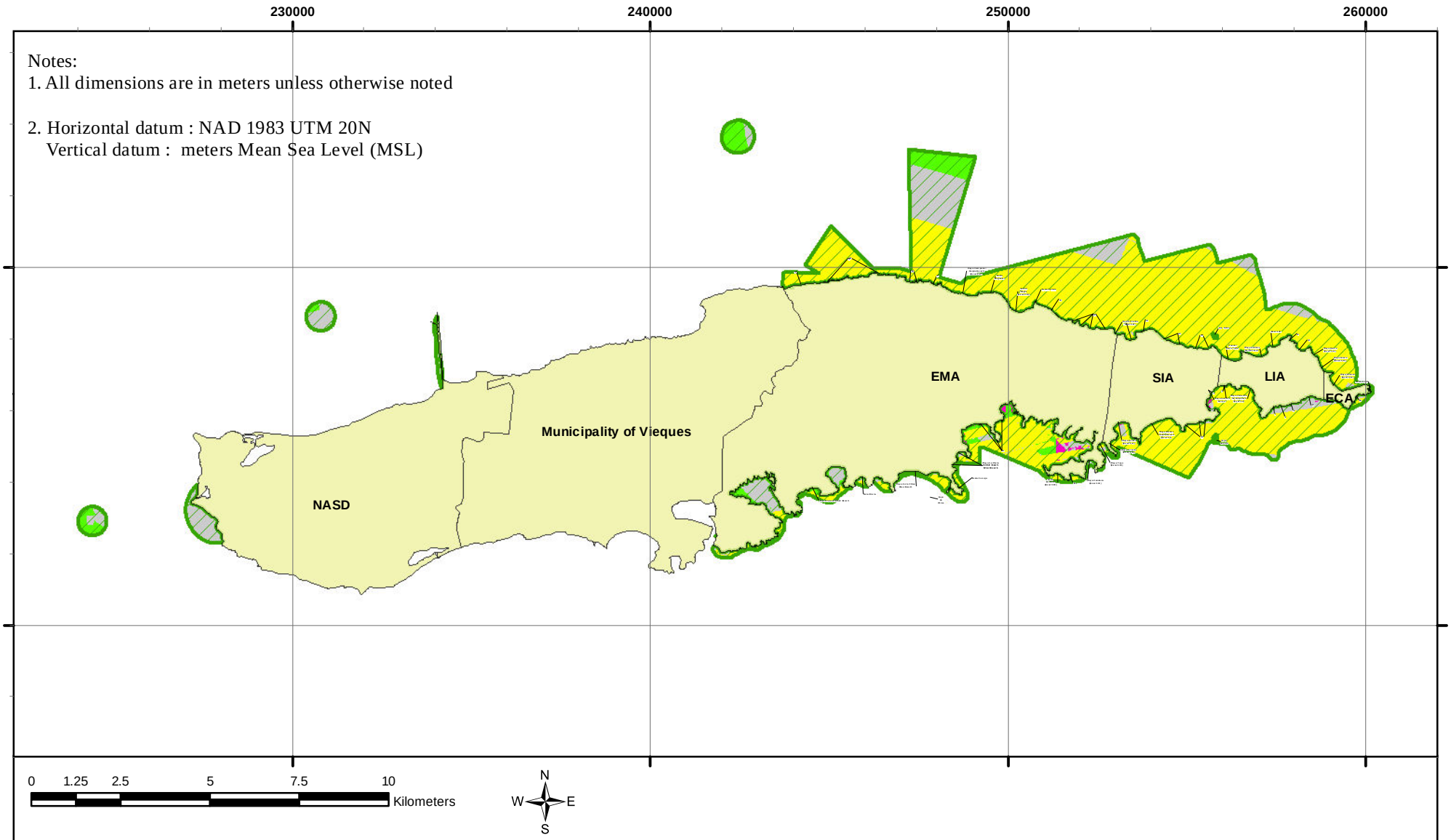


Figure 3
UXO 16 Bathymetric
Coverage and Resolution
Vieques Puerto Rico

CH2MHILL

Attachment D
Responses to USEPA and PREQB Comments

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Responses to USEPA Comments on the

Revised Draft Quality Assurance Project Plan Beach Dynamics Investigation – Eleven Beaches at the Former Vieques Naval Training Range (VNTR) and the Former Naval Ammunition Support Detachment (NASD)

Atlantic Fleet Weapons Training Area
Vieques, Puerto Rico

Evaluation of the Response to General Comment (GC) 1:

The response partially addresses the comment. The QAPP does not provide the rationale for the all of the data proposed for collection, including the frequency and location of the grain size sampling, monitoring of munitions and explosives of concern (MEC) and Material Potentially Presenting an Explosive Hazard (MPPEH) surrogates, and meteorological and oceanographic (metocean) data. For example, it is unclear how it was determined that the sensor locations for the metocean data are sufficient to meet project objectives. Also, Worksheet #11 (page 26) indicates the locations and number of MEC/MPPEH surrogates will be determined once the source of the surrogates is identified, but it is unclear if the locations, number, and associated rationale will be submitted in a QAPP Addendum. Revise the QAPP to provide additional detail regarding the rationale for the items discussed above, and to indicate whether a QAPP addendum will be submitted once the MEC/MPPEH surrogate locations are determined.

Navy Response:

Additional detail regarding rationale has been added to key elements of the beach dynamics study in Worksheet #17. No addenda to the Beach Dynamics QAPP are anticipated. However, if there are details that are "to be determined" at this time, they will be provided for informational purposes to the regulatory agencies when they are finalized.

Evaluation of the Response to GC 2:

The response partially addresses the comment. The response indicates Worksheet #34 is not necessary for the proposed investigation. However, this worksheet is applicable to the proposed spatial monitoring (i.e., verification procedures for the data collected) and should be provided in the QAPP. Further, the QAPP indicates grab soil samples collected from each beach will be analyzed by ASTM D422 (see Worksheet # 14, Beach Surveys). Therefore, the sample collection and analytical worksheets should be provided. Revise the QAPP to provide this information. Also, the QAPP should be revised to specify who will analyze the grain size samples and to provide a standard operating procedure for this test. Finally, revise the QAPP to provide explanations for why excluded worksheets are not presented.

Navy Response:

Analytical worksheets are required for chemical analyses on which risk-based decisions will be made for a specific site. Since only grain size analysis is being conducted to aid with understanding the physical characteristics of the beach, the analytical worksheets are not necessary for this type of investigation. General standard procedures and professional interpretation by the Senior Coastal Engineer and staff under his direction will be used and this information has been updated in the Worksheets provided. Therefore, specific verification procedures are not applicable for this type of investigation and as a result Worksheet #34 is not applicable. Note that the QAPP format was used when the initial draft was prepared only because MEC evaluation was part of the original scope and that format is required for investigations involving MEC. Although the format was retained for the revised draft, it is not necessary for this type of investigation.

Evaluation of the Response to GC 4:

The response partially addresses the comment. Worksheet #11 (page 28) indicates that data will be entered into the Shoreline and Nearshore Data System (SANDS) system and uploaded to the file transfer protocol (FTP) website, but no quality control (QC) reviews of the data and uploads are discussed. Revise the QAPP to include QC reviews of the entered and uploaded data to verify accuracy and to identify the personnel who will perform these QC reviews.

Navy Response:

The following has been added as the last bullet: "QC of the data and uploads will be provided by the Senior Coastal Engineer."

Evaluation of the Response to GC 5:

The response does not address the comment. The response indicates that the discussion of the Beach #22 data gap from the October 2012 QAPP has been removed because the QAPP no longer addresses digital geophysical mapping (DGM). However, the October 2012 QAPP was presenting a consensus decision on the Beach #22 data gap that was agreed to by the parties present at the scoping session, and so the revised Worksheet #9 should document why it is not being addressed by the current QAPP. Revise the QAPP to include the consensus decision regarding the data gap at Beach #22 and to discuss why it is no longer necessary to address this in the current QAPP.

Navy Response:

As noted in Worksheet #9, several of the consensus statements were "overcome by events" given that the DGM and intrusive anomaly investigation have been removed. The beach dynamics investigation has been redesigned to focus on the changing physical conditions of the beach themselves and the factors that influence those changes. Any other objectives previously discussed or included in the QAPP are no longer relevant to the revised QAPP and will not be included in the revised document.

Evaluation of the Response to GC 6:

The response partially addresses the comment. The archival procedures discussed in Worksheet #29 indicate that project files will be archived at a private storage facility at project closeout for a period of ten years, but Worksheet #11 indicates data will be returned to the Navy at the end of the project. Revise the QAPP to clarify this apparent discrepancy in the archival procedures.

Navy Response:

Worksheet #29 has been revised as follows: "Data archiving will be done in accordance with Navy requirements. CH2M HILL will provide the Navy 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."

Evaluation of the Response to GC 7:

The response addresses the comment. However, the noted acronym "MD" (munitions debris) is used without being defined in the QAPP in SAP Worksheet #13 – Secondary Data Criteria and Limitations Table (page 31). Correct this as requested in the EPA comments.

Navy Response:

MD – Munitions Debris has been added to the acronyms list.

REVIEW OF THE QAPP

GENERAL COMMENT

1. Worksheet #9 states that the QAPP no longer includes the DGM, and instead includes a near-shore (underwater) investigation of MEC and MPPEH surrogates. However, both the October 2012 QAPP and the QAPP indicate that only one scoping session was held in September 2012, yet the QAPPs present differing consensus decisions regarding DGM and MEC/MPPEH. Clarify if additional scoping sessions were held regarding removal of the DGM investigations, or if the original QAPP contained erroneous information regarding DGM investigations and use of MEC/MPPEH surrogates. If additional scoping meetings were held, revise the QAPP to include the dates of the meetings, participants and consensus decisions.

   Navy Response:

   No additional scoping sessions were conducted to remove the DGM component; however, the ERP Technical Subcommittee was informed during the May 7, 2013 meeting. Please note that the first paragraph of the scoping session documentation in Worksheet 11 includes a statement that the approach was changed, which is why notations were added to two of the consensus statements because they are no longer applicable.

SPECIFIC COMMENT

1. QAAP Worksheet #8 – Special Personnel Training Requirements Table, Page 17: The cited worksheet indicates that the "Training Provider" is "DDESB TP 18." DDESB TP 18 (Minimum Qualifications for Unexploded Ordnance [UXO] Technicians and Personnel) does not provide training. It does list the training required and the sources from which such training may be obtained. Revise the listed table to correct this

   Navy Response:

   Worksheet #8 has been revised as requested.

Responses to PREQB Comments on the

Revised Draft Quality Assurance Project Plan Beach Dynamics Investigation – Eleven Beaches at the Former Vieques Naval Training Range (VNTR) and the Former Naval Ammunition Support Detachment (NASD)

Atlantic Fleet Weapons Training Area
Vieques, Puerto Rico

I. GENERAL COMMENTS

1. Additional detail on the methodology used for selecting transect locations is needed, and in many cases it appears that additional transects, particularly focused on headland areas and/or other beach "endpoints" would provide useful information that would allow better closure of the sediment budget. In particular, headland areas can often be focal points for wave energy resulting in enhanced erosion. Even if limited upland beach areas are present, erosion/deposition processes can occur below the water line, which can affect sediment transport processes. Depending on the directionality of incoming waves, headlands can also serve as depositional areas for eroded beach sand carried by alongshore currents. Site-specific comments on individual beach locations are provided below.

   Navy Response:

   The following has been added at the end of the next to last paragraph under "Beach Surveys" in Worksheet #17: "Selection of transect locations is subjective; those selected for the beach dynamics study are sufficient to ensure the spatial variability of each beach is captured, extending throughout the locations were the sediment will move in the cross-shore direction. Every beach is different, affected by site-specific metocean conditions, and therefore engineering judgment is necessary. However, the objective of the investigation is not to compute sediment budgets but to measure beach changes. For each beach, the selected transects are sufficient to achieve this objective. If, during the course of the study, the information being gathered suggests additional transects are warranted, they will be added."

   PREQB Evaluation of Response:

   The response partially addresses the comment. While it is agreed that every beach is different, it is also true that an evaluation of beach changes, the stated goal of the study, is difficult to do successfully without some understanding of the sediment budget. Further detail is provided below with regards to individual beach locations.

   Navy Response:

   While the Navy respects the professional opinion provided, as noted previously, the goal of the study is not to compute sediment budgets, but to measure beach changes, which can be accomplished by implementing the study as designed. While it is always possible to collect additional data, the amount of data to be collected is an appropriate balance that factors in survey objectives, availability of resources and funding, safety, and the time required to collect, compile, and evaluate the data.

2. The document provides details on data collection at eleven beaches in the VNTR and NASD areas, and collection of METOCEAN data from deployed sensors and publicly available sites. However, goals for the project also include linking the METOCEAN data to observed beach dynamics (e.g. Page 23), but no

methodology is provided for accomplishing these tasks. Please provide a methodology for how the subsequent data analysis will be conducted. This information is important in establishing an effective measurement/sampling plan, even if the actual analysis will be conducted under other, future contracts.

Navy Response:

The additional studies referred to in the last paragraph of Worksheet #10 include the development of wave models to transform deep water waves to the nearshore at each beach of interest and using the resulting waves to force beach evolution models to estimate beach change. These studies are not part of this investigation but will be conducted in the future. The proposed Beach Dynamics Investigation will provide the foundation for those studies, in addition to answering the questions listed under "General Problems to Address."

The development of the models would entail the use of data collected during this investigation such as metocean data from NOAA buoys to force the wave models, the use of the wave/water level measurements to calibrate/verify the wave models, and the use of the measured beach profiles and grain size analyses to calibrate/verify the beach evolution models to estimate beach changes for any wave and water level condition, and for long periods of time (e.g. years or decades).

The following has been added to the end of the last paragraph of Worksheet #10 under the General Problems to Address subsection: "For example, the additional studies may include development of wave models to transform deep water waves to the nearshore at each beach of interest and using the resulting waves to force beach evolution models to estimate beach change. This would entail the use of data collected during this investigation, such as metocean data from deployed sensors and/or NOAA buoys, to force the wave models, the use of the wave/water level measurements to calibrate/verify the wave models, and the use of the measured beach profiles and grain size analyses to calibrate/verify the beach evolution models to estimate beach changes for any wave and water level condition, and for long periods of time (e.g. years or decades).

It is recognized that the most extreme beach changes likely occur during extreme events (e.g., hurricanes), which will not necessarily occur during the investigation timeframe. Beach changes due to these kind of events can be estimated using wave and beach evolution models. Long-term wind and wave hindcasts are available for the region, as well as detailed historical storm analyses. These could be used with the wave and beach evolution models to estimate beach changes for extreme events of interest of the past, as well as for beach changes due to wave and water level conditions spanning years or decades. The wave and beach evolution models are not tools to predict future events and related beach changes, but could be used to estimate beach changes in hypothetical wave and water level conditions."

3. Please clarify why Lisa Carter, Program Field Auditor, has a specific QC responsibility on Worksheet 31 yet she is not listed on any of the other Worksheets including Worksheet 4 (Personnel Sign-off Sheet), Worksheet 5 (Organization Chart), Worksheet 6 (Communication Pathways) and Worksheet 7 (Personnel Responsibilities).

Navy Response:

Lisa Carter has been replaced with "TBD" in Worksheet #31.

4. There are no QC personnel listed on WS 4 (Personnel Sign-off Sheet), WS 5 (Organization Chart), WS 6 (Communication Pathways) and WS 7 (Personnel Responsibilities). Phil Fitzwater, the QA lead, is listed on WS 7 but QC personnel aren't addressed. Since important data is being collected and quality specifications are provided in WS 11, more information on the QC staff and their responsibilities should be provided to ensure that the QC requirements in WS 11 are achieved and documented.

Navy Response:

Worksheet #7 has been revised to include QC as part of the Senior Coastal Engineer's role, who is already included in Worksheets #4, #5, and #6.

II. PAGE-SPECIFIC COMMENTS

1. Worksheets 3 and 5: Please change Wilmarie Rivera phone extension to 6141.

   Navy Response:

   Recent correspondence from EQB indicates x6129 is the correct extension.

2. Worksheet 9, Project Scoping Session Sheet: Page 20, Characterization Approach: Please clarify what is meant by "the densities of the anomalies decreased from 30-80%" (i.e., do these values represent an uncertainty, or a range representing reduction rates across multiple beaches?)

   Navy Response:

   The referenced text of Worksheet #9 has been revised to read: "The recent Supplemental DGM monitoring concluded that following the excavation of subsurface anomalies at the beaches the density of anomalies decreased from 30-80% (the values represent reduction rates across multiple beaches)."

3. Worksheet 10, Problem Definition

   a. Page 22, Summary of Previous Beach Investigations: Please clarify what is meant by "below depth" at the bottom of the page.

      Navy Response:

      The referenced text has been changed from "below depth" to "detected below 4 ft bgs."

   b. Page 23, General Problems to Address: It is likely that the most dramatic beach transformations will happen during extreme events (e.g., hurricanes), which will not necessarily be sampled with the current sampling plan. Please provide an indication of how these types of events will be addressed in future studies. Please clarify if sediment transport models will be incorporated?

      Navy Response:

      Please see the response to General Comment #2.

4. Worksheet 11, Project Quality Objectives/Systematic Planning Process Statements:

   a. Page 26, first line: Please define "no significant change in bottom elevation'" and identify how "no significant net sediment transport" is determined from available data.

      Navy Response:

      There is an inland location (i.e., the backshore boundary) and a seaward location (depth of closure) where the net contribution of sand either to erosion or accretion is insignificant, relative the area between these two points. Conceptually, if monthly profiles are plotted, the backshore boundary and the depth of closure should show as locations where the profile lines collapse toward a single line (i.e., elevation). The key to the beach profile monitoring is to ensure the endpoint locations selected for monitoring provide this envelope. It is not the objective of the beach dynamics study to determine bottom elevation changes and net

sediment transport; rather, the objective is to estimate the profile changes along the beach to help understand the dynamic nature of the beaches that may affect munitions transport. Therefore the second bullet under "What types of data are needed . . . " has been revised to read:

"Beach profiles will be measured using . . . . between the nearshore and the offshore. The objective of selecting the backshore boundary and the depth of closure are to bracket the area where the beach profile changes (i.e., where the profile lines collapse toward a single line (i.e., elevation). Because no historical profiles . . . . for each beach to be investigated. If, during the course of monitoring, it appears that the backshore boundary and the depth of closure locations have not been identified appropriately, they will be adjusted accordingly."

b. Page 26, first bullet: Please identify when the determination of significant erosion/accretion will be assessed. Please clarify if this is based on conditions during the first survey, so that baseline conditions can be incorporated into the sampling plan, or based on conditions only after erosion/accretion has occurred during the sampling period.

Navy Response:

As noted in the response to General Comment #1, the proposed transects are anticipated to be sufficient to meet the objectives of the study. However, it is recognized that observations made during the course of the study may indicate additional (or different) transects are warranted in order to meet the objective. As noted previously, this determination is subjective and will be made using engineering judgment.

The bullet was modified as follows: "If during the study, observations made at any particular beach suggest additional beach profiles are warranted (i.e., where the range of erosion and accretion occurring is not captured by the existing profiles), they will be added. The determination for the need of these additional profiles will be made by the Project Coastal Engineer based on observations of beach conditions recorded during each monitoring event, assisted by photographic records and notes from previous surveys. For a given beach and at a given time, a determination for the representativeness of beach behavior is provided by the inspection of beach profiles at neighboring transects, and spatial beach change trends by the inspection of profiles at all transects. A transect may fail to capture a localized non-representative changes of interest if located, for example, where storm water runoff, lagoons, streams or rivers discharge to the ocean, where erosion or accretion by wave energy refraction due to bathymetry or coastal features takes place, etc. and may exhibit "significant" changes."

c. Page 26, second bullet: Please identify what types of instruments will be utilized for these measurements. Are you referring to acoustic Doppler current profilers (ADCPs)?

Navy Response:

Wave, currents and water levels will be measured with Acoustic Doppler Current Profilers (ADCPs) during the period of the investigation. This information has been added to the second bullet.

d. Page 26, third bullet: Please identify existing or proposed locations of these additional measurements.

Navy Response:

As noted in the bullet, the information would be from third parties and, therefore, may or may not be available at the time of the study. The current locations of the additional measurements that may be available for the investigation are provided in SOP #3, Metocean Data Collection, Section III Procedures, Data Management and Quality Control. The third bullet has been revised to reference SOP #3.

e. Page 26, fourth bullet: Please provide station information for these publicly available data sets.

Navy Response:

Please see the response to Page-specific Comment #4d.

f. Page 26, seventh bullet: Please identify how the watershed analysis will be performed. Please clarify if TR-55 or similar hydrologic modeling packages will be used.

Navy Response:

The seventh bullet is not intended to indicate a watershed analysis will be performed, only that existing topographic data from USGS will be used to characterize the watersheds. To help avoid confusion, the word "characterize" has been revised to "identify."

g. Page 26, eighth bullet: Please indicate location of available rainfall stations. Also, please clarify if historical data from these stations will be utilized.

Navy Response:

If a rainfall station on Vieques is identified, it will be monitored. No historical data from this station, if found, will be utilized. In addition, a rain gauge will be added at Camp Garcia. This information has been added to the eighth bullet.

h. Page 26, ninth bullet: Please indicate the resolution of the bathymetry data, and the extent of the bathymetric surveys. Please clarify if any maps of bottom type have been generated (e.g., grain size, reef areas, etc.).

Navy Response:

The bathymetry compiled in March 2013 for the Wide Area Assessment (WAA) component of the UXO 16 characterization is composed of bathymetries from several sources, with varying resolutions, which are adequate for the purposes of the Beach Dynamic Investigation. The Technical Memorandum "Review of Existing Bathymetry Data for Vieques, Puerto Rico" summarizes the existing bathymetry data review and has been added as Attachment C to the Beach Dynamics QAPP. In addition, the ninth bullet has been revised to reference Attachment C for a summary of bathymetry data.

Maps of bottom type have been generated by third-parties and available at NOAA's Biomapper: (http://ccma.nos.noaa.gov/explorer/biomapper/biomapper.html?id=Vieques)

i. Page 27, "How good do the data need to be . . .": Please indicate how these accuracies will be evaluated. In particular, the velocity and wave accuracy standards may be difficult to constrain and/or effectively evaluate. Reaching these accuracies may also require significant tradeoffs with respect to temporal and spatial averaging. Please provide a more informed discussion of these issues, and an explanation of the basis for the accuracy limits.

Navy Response:

The following has been added at the bottom of the bulleted list: "Note: The accuracies of the measurements listed above will be based on accuracies provided by the various sensor manufacturers. These accuracies are typical of sensors from various manufacturers and used in applications similar to the planned Beach Dynamics Investigation."

j. Page 27, Wave height accuracy: Please indicate whether evaluation is based on significant wave height, or components of the wave energy spectra.

Navy Response:

Please see the response to the previous comment.

k. Page 27, Wave direction accuracy: Please indicate whether evaluation is based on the dominant wave direction of components of the wave directional spectra.

Navy Response:

Please see the response to the previous comment.

l. Page 27, Water level measurement: Please explain the definition of water level vs. water depth.

Navy Response:

Water level is the distance from the water surface to a reference datum, which will be mean sea level. Water depth is the distance from the sea bottom to the water surface. This information has been added to the associated bullets.

PREQB Evaluation of Responses to (4)(i) through (l):

The responses partially address the comments. Please clarify in the text that stated accuracies are based only on manufacturer's specifications, and that no independent evaluation of accuracies will be conducted. As written, many of the accuracy benchmarks appear unrealistic and/or unattainable under normal field conditions. For example, ADCP velocity measurements based on single ping data have accuracies far worse than the stated 0.5 cm/s. Temporal and/or spatial (i.e., vertical) averaging is essential to decrease noise, but no discussion of averaging protocol or other aspects of the measurement approach is included. If the intent is only to list specifications for comparison with manufacturer's claims, to aid with instrument selection and procurement, this needs to be clearly stated.

Navy Response:

The following has been added at the end of the text provided in the response to Comment 4(i) above: "The stated accuracies are based only on manufacturer's specifications and no independent evaluation of accuracies will be conducted. Typical accuracies are listed only for comparison with manufacturer's claims and to aid with instrument selection and procurement."

m. Page 27, "How much data", Offshore waves . . .: Sampling rates for waves and currents is listed as TBD. Please indicate when and how these determinations will be made. This is related to the comment above regarding accuracy, and the tradeoffs between spatial/temporal averaging and accuracy.

Navy Response:

The following has been added at the end of the bullet: "Sampling rates for waves, currents and water levels will have an effect on the power consumption, data storage capacity, and battery type of the sensors, which vary depending on the sensor manufacturer, and data recovery intervals. However, the sampling rates will be sufficient to meet the project objectives."

PREQB Evaluation of Response:

In conjunction with the previous response, the settings necessary to achieve the accuracies presented at the beginning of Worksheet #11 may conflict with other project objectives. Further clarification is needed, as the phrase "project objectives" in the proposed text is not well defined. It is unclear whether the project objectives include meeting the accuracy benchmarks, which may conflict with other objectives.

Navy Response:

The following has been added at the end of the text provided in the original response to this comment: "Once sensors are selected, sampling rates for the parameters of interest will be determined. Typical accuracies are listed only for comparison with manufacturer's claims and to aid with instrument selection and procurement."

n. Page 27, "How much data", Topography detail . . .: Previous information indicated that topography would be obtained from existing USGS maps. Please indicate if additional topographical surveys will be conducted to satisfy this constraint.

Navy Response:

The bullet has been revised to read: "Existing topographic detail and extent are sufficient to . . . ."

o. Page 27, "How much data", Bathymetry detail . . .: Previous information indicated that bathymetric data would be obtained from previous surveys. Please indicate if additional bathymetric surveys will be conducted to satisfy this constraint.

Navy Response:

The bullet has been revised to read: "Existing bathymetry detail and extent are sufficient to . . ."

p. Page 28, "Where, when, and how", Offshore waves . . .: Please provide rationale for the three selected sampling locations for offshore wave, current, and water levels. Please also provide more details regarding the acoustic sensors, including frequency, depth range, bin size, temporal/spatial averaging, etc.

Navy Response:

The following has been added at the end of the referenced bullet: "Beach changes are mainly driven by waves and water levels. Because it is not practical to install instrumentation to perform wave/water level measurements at every beach of interest in the nearshore, measuring waves offshore and propagating them by means of numerical modeling to the beaches of interest to establish relationships between beach changes and these parameters is an alternative that is practical. The offshore wave climate in Vieques is predominantly from the east during most of the year and from the north-northeast during the winter. Because the beaches of interest are located along the north, south and east shores, there is no one offshore location that will produce measurements that will allow for the modeling of wave propagation to the beaches of interest with minimal transformation (and higher accuracy) due to bathymetry, headlands, islands and other coastal features. The three proposed wave/water level locations were selected so that measurements representative of the offshore wave climate for each shore can be collected to relate wave/water level parameters to beach changes. Other considerations included distance to the shore, since being too close to any particular beach may not be representative of others beaches, and being too far from the shore may not adequately represent the beaches, in addition to encountering deeper water which could potentially complicate the installation and maintenance of the sensors."

The wave/current/water level sensors (ADCPs) have not been acquired yet. However, the specification from Nortek (attached to these responses), a leading manufacturer of these sensors, is representative of sensors that will be acquired. The specifications for the sensors ultimately acquired will be included in the beach dynamics report.

PREQB Evaluation of Response:

The response partially addresses the comment. Please clarify what metrics were used to establish the location of the wave stations. For example, please clarify if preliminary models have been run to identify anticipated changes in wave profiles as waves propagate onshore, and to provide insight into the most effective sampling locations. Please note that regardless of the instruments acquired, there are a number of user-defined settings (including vertical bin resolution, and averaging parameters) that are necessary. As discussed above (comments 4i-m) these setting can have a profound impact on the quality of the collected

data. Please provide anticipated vertical and temporal averaging protocols for the ADCP wave sensor deployments.

Navy Response:

The following has been added before the last sentence of the original response: "The wave/water level locations were selected using engineering judgment and experience. Metrics such as modeling were not used to select the locations as this is not necessary to meet the objectives stated Worksheets #10 and #11. The wave/water level sensor locations are sufficient to fulfill the objective of providing measurements adequate for wave model calibration/verification, in addition to short-term characterization of wave climate in the vicinity of Vieques."

In addition, the following has been added at the end of the original response: "With regards to vertical and temporal averaging protocols for the ADCP wave sensor, the reader is referred to Attachment B: "Wave Height Measurements Using Acoustic Surface Tracking," which describes the technology and typical protocols for wave measurements with a Nortek AWAC sensor."

q. Page 28, "Who will collect", Within 3 weeks of a beach survey . . .: Please explain what plots and tables will be produced, and what evaluations/analyses will be conducted. A reference is made to "recommendations for changes to the next survey", but no approach or metrics are provided for identifying changes based on collected data.

Navy Response:

The following has been added at the end of the second bullet: "SANDS has the capability to produce numerous types of tables and plots. Which ones will be found most useful will be determined once the data begin to amass. Some likely plots are beach width evolution and beach profile changes, but others may be found to be useful. There is no one set of metrics that will be used to determine if modifications to the monitoring approach are warranted. However, the ultimate objective is to understand the dynamic nature of the beaches so they can be used to help assess their affects on MEC/MPPEH mobility. Therefore, monitoring modifications to subsequent events may be made, based on observations of the data from each event, as "tweaks" to help maximize the likelihood of achieving the objectives."

5. Worksheet 14, Summary of Project Tasks:

a. Page 33, "Beach Surveys": The QAPP indicates that "additional beach profile measurements will be performed at transects subjected to significant change but where transects were not available". Please clarify this statement, and define what is meant by "significant change". Also, are these determinations to be made prior to the first measurements, based on existing beach structure and visual evidence of recent changes, or are these determinations made on each quarterly visit? If the latter is the case, please clarify how these new measurements will be compared to baseline conditions.

Navy Response:

Please see the response to Page-specific Comment #4b.

PREQB Evaluation of Response:

Please define what is meant by "significant change" in the response.

Navy Response:

The following has been added to the end of the original response to Page-specific Comment #4b: "In the context of the proposed investigation "significant" is a subjective,

qualitative term to express a deviation from representative beach changes according to the judgment of the Senior Coastal Engineer leading the investigation. While the proposed transects have been placed in locations that may experience "significant" changes, observations made over the course of the study will be used to modify transect locations, as warranted. For any given beach, the determination to survey additional transects will be made prior to each of the monthly surveys on the basis of a visual inspection and engineering judgment of the condition of the beach, assisted by photographic records and notes from previous surveys."

b. Page 34, "Metocean Data Collection": Please identify the location of measurement stations for wind, wave, water level, atmospheric pressure, water and air temperature available from public sources.

Navy Response:

The location of measurement stations that may be available for the investigation are provided in the links included in SOP #3, Metocean Data Collection, Section III Procedures, Data Management and Quality Control.

PREQB Evaluation of Response:

Please revise the response for consistency with the Navy's response to Comment 13, which indicates a figure has been provided.

Navy Response:

The original response has been modified to read: "The following has been added to the end of the last paragraph under "Metocean Data Collection": "The location of measurement stations that may be available for the investigation are provided in the links included in SOP #3, Metocean Data Collection, Section III Procedures, Data Management and Quality Control. In addition, Figure 16 has been added to the QAPP showing the locations of the identified NOAA stations."

c. Page 34, "Beach Erosion Potential": Please identify the methods to be utilized for the stormwater run-off estimates. Also, please provide additional detail regarding the "estimates for erosion potential". Are these ratings designed to indicate erosion potential under average events, or extreme events? Are the ratings designed to be representative of the entire watershed (i.e., upland erosion that may bring new material to the beach area), the beach area only, or specific regions within the beach area?

Navy Response:

Given that the potential for beach erosion is to be qualified as "severe," "moderate," or "minor," the runoff estimates will be conceptual in nature rather than quantified, as this is not necessary to achieve the objective of the beach dynamics study. Therefore, the paragraph under "Beach Erosion Potential" has been modified to read: "The watershed area associated with each beach will be approximated, precipitation data will be compiled on a monthly basis (from the Camp Garcia rain gauge), and visual observations will be made at each beach during each monthly monitoring event. Features that will be evaluated include sand channeling in the beach from upslope, ephemeral stream discharge locations, evidence of sheet flow (e.g., evidence of grasses and other vegetation impacted by sheet flow), the type of soil and quantity/type of vegetation within the watershed, etc. This information will be collectively evaluated to help qualify the erosion potential on any particular beach as "severe," "moderate," or "minor."

PREQB Evaluation of Response:

Please provide further details on whether the qualitative metric is associated with average or extreme events, whether they are representative of the entire beach or subareas, and whether they include erosion within the watershed in general.

Navy Response:

It is unclear what is meant by the comment about whether the qualitative metric is associated with average or extreme events; it is associated with whatever storm water runoff events occur, to the extent they are observable. The qualitative metric will not include erosion estimates within the watershed in general, as this is not necessary to meet the objectives of the study. Further, regarding representativeness, storm water runoff on beaches is typically channeled, so these are not representative of the entire beach but of the area where they took place; hence, they are localized. It is also noted that the potential effects of storm water runoff will include both erosion and accretion.

Based on the above, the following has been added at the end of the original response: "As storm water runoff flows into the ocean, areas of the backshore would be eroded, but the sediment transported by the runoff (from upland and the backshore) would stay in the foreshore, accreting in certain areas. Eventually, some of this sediment will be transported back to the beach. This is one of the mechanisms by which beaches are naturally nourished. The objective is to measure precipitation, estimate storm water runoff, measure beach profiles (and changes by comparisons with previously measured profiles) and correlate the storm water runoff with the beach changes that cannot be explained by the effects of waves/water levels alone."

6. Worksheet 17, Sampling Design and Rationale:

   a. Page 37: The QAPP indicates that beach surveys will be conducted at specific beaches (11 total) within the UXO 2, UXO 7, UXO 8, and SWMU areas. Please provide additional information as to why these particular beaches were selected for sampling and whether these beaches are adequately representative of the beaches not selected for sampling. Please clarify if these are the only beaches believed to be impacted by MEC.

   Navy Response:

   The rationale for the individual beaches selected is included in the table in Worksheet #17. In addition, the following sentence has been added just before the table: "The selected beaches are adequately representative of the remaining beaches (i.e., selected beaches cover the range of pertinent factors). While MEC may be present on beaches not selected for the study, the information from those selected can be used as a predictive tool for those not selected."

   b. Page 38 and Figures 4-14: Please delineate extent of reef areas on figures. In some cases the reef areas are obvious, but in others, the extent of the reef area is not clear and may be confused with other bottom types.

   Navy Response:

   Bottom types at each beach were considered in the placement of the proposed transects. However, the delineation of the bottom types, including reefs, was omitted in the figures for the sake of clarity. The overlay of image, transects, bathymetry, labels, bottom types and delineation of these would make the figures difficult to interpret.

PREQB Evaluation of Response:

Bottom type is needed in order to adequately interpret the figures. Please include this information on the figures.

For each beach, two figures, one showing transects and bathymetry and one showing transects, bottom structure and cover have been prepared. The updated list of figures is the following:

1 Regional Location Map
2 Former VNTR Beach Location Map
3 SWMU 4 Beach Location Map
4 Beach 1/Yellow Beach/Playa Matías Transect Map
5 Beach 2/Playa Salinas Del Sur Transect Map
6 Beach 3 Transect Map
7 Beach 4/Turtle Beach/Playa Carrucho Transect Map
8 Beach 5/Bahia Icacos Transect Map
9 Beach 12 Transect Map
10 Beach 14/Playa Brava Transect Map
11 Beach 19/Playa Yoyé Transect Map
12 Beach 22/Playa Diablo Transect Map
13 Beach 24/Purple Beach/Playa Campaña Transect Map
14 Beach SWMU 4 Transect Map
15 Beach 1/Yellow Beach/Playa Matías Transect, Structure and Cover Map
16 Beach 2/Playa Salinas Del Sur Transect, Structure and Cover Map
17 Beach 3 Transect, Structure and Cover Map
18 Beach 4/Turtle Beach/Playa Carrucho Transect, Structure and Cover Map
19 Beach 5/Bahia Icacos Transect, Structure and Cover Map
20 Beach 12 Transect, Structure and Cover Map
21 Beach 14/Playa Brava Transect, Structure and Cover Map
22 Beach 19/Playa Yoyé Transect, Structure and Cover Map
23 Beach 22/Playa Diablo Transect, Structure and Cover Map
24 Beach 24/Purple Beach/Playa Campaña Transect, Structure and Cover Map
25 Beach SWMU 4 Transect, Structure and Cover Map
26 Wave / Current / Water Level Sensor Locations
27 NOAA Stations

Figures 4 to 14 show the transects and bathymetry, and Figures 15 to 25 show the transects, bottom structure and cover. Bottom structure and cover shown in Figures 15 to 25 were obtained from surveys performed by NOAA and presented in Vieques Biogeography Integrated Online Mapper (BIOMapper) available at: http://maps.coastalscience.noaa.gov/biomapper/biomapper.html?id=Vieques.

Bottom structure at the beaches of interest in Vieques has been identified as coral, rock or sand; cover has been identified as seagrass, algae or no cover. In the figures, only the dominant bottom structure and cover are described. It should be noted that given the dynamic nature of the bottom, and the different times the aerial photos were taken and surveys performed, bottom structure and cover descriptions provided by BIOMapper may not match exactly what is observed in the aerial photos.

c. Page 38, Beach 1: Additional below water transects emanating from headlands on east and west ends of beach could be useful in helping to close the sediment budget.

Navy Response:

The information is not necessary to meet the project objectives. Transects at headlands were deliberately avoided, given the fact that the underwater areas fronting them are mostly rock and no sediment, and the relative small and localized non-representative profile changes that may occur along them. In addition, at several locations, wave breaking on the reefs offshore from the headlands represents a safety hazard for the survey boat/crew and wading rodman.

d. Page 38, Beach 2: Please add an additional transect intersecting the tombolo to the east, and into the sandy bottom region towards the toe of existing transect 2-7 to evaluate sediment transport and closing the sediment budget.

Navy Response:

Transect 2-8 was added as requested.

e. Page 38, Beach 3: Transects could extend farther to the west, to the small sandy headland. Although it may be protected from enhanced erosion by the tombolo, the dynamics of any longshore currents may drive enhanced accretion at this point. Also please clarify why no transects are positioned along the narrow sandy beach to the east.

Navy Response:

An additional transect, Transect 2-9, was added from the headland to the island to the south to monitor changes in the tombolo. No transects were placed on the narrow beach to the east because this is not a targeted beach for the study as other beaches adequately represent this beach.

f. Page 38, Beach 4: Please clarify why no transects are identified in the approximately 150 m of beach southeast of 4-6. The area may be considered sufficiently protected from erosion by the adjacent reefs. However, depending on the directionality of the waves, it may be a potential location for deposition associated with sediment transport by alongshore currents.

Navy Response:

The area to the southeast of transect 4-6 is a shallow rocky reef. No transects were located in that area given that observations during the site visit, aerial photography, and bottom type maps showed that this area is rocky and not covered by sand, and therefore would not add valuable information to the investigation.

g. Page 38, Beach 14: Transects from both headland areas might be useful (below water only at the SE end), as the presence/continuity of reefs are unclear in the figure. Providing headland transects may provide useful information with respect to closing the sediment budget.

Navy Response:

Transects at headlands were avoided per the reasons described in the response to Page-specific Comment #6c above.

h. Page 39, Beach 12: Please clarify why there are no transects east of 12-1. The beach width in this area suggests that this region may be susceptible to enhanced erosion, possibly due to the interaction of waves with the headland further to the east, and westward transport by alongshore currents.

Navy Response:

Transects to the east of 12-1 were not included because the nearshore area is a reef where wave breaking is a hazard for surveying boat/crew and wading rodman. Further, the three transects proposed for this beach are expected to show the representative behavior of this beach.

PREQB Evaluation of Response:

Given the narrow nature of the beach east of 12-1, the region may be particularly susceptible to erosion. Despite the fact that strong wave breaking in the offshore regions preclude sampling, there may be value in performing an upland (dry) transect only in this location. Beach erosion is not always a two-dimensional process, and sand eroded from the beach at this location may be transported along shore prior to deposition, thus explaining the lack of sand immediately offshore.

Navy Response:

An upland (dry) transect has been added east of the former transect 12-1 which is now transect 12-2.

i. Page 39, Beach 22: A transect at the dividing headland appears useful, despite the apparent protection from adjacent reefs. This area appears to be a potential site of deposition due to sediment transport by alongshore currents, and the relative calm provided by the reefs.

Navy Response:

Transect 22-6 at the headland dividing the beaches has been added, but the nearshore area is hazardous for survey boat/crew and wading rodman. Therefore, only the dry portion of the beach will be surveyed.

j. Page 39, Beach 24: Please clarify reef location in this figure. It is not clear from the present aerial image. Below water transects from the small headlands framing the beach may also be useful with regards to constraining the sediment budget.

Navy Response:

The reef is bounded roughly by the -1 and -2m water depth contours. Transects from the headlands will not be included due to safety reasons and little value of resulting surveys for the purposes of the investigation.

k. Page 39, Beach SWMU 4: A transect from the central headland is suggested to characterize what appears to be an area of enhanced deposition (presumably from W/NW waves). Perhaps analysis of sediment cores from the lagoon area could provide historical perspective on the frequency and nature of lagoon breaches during sporadic (i.e. hurricane) events.

Navy Response:

The area for the suggested transect is a very shallow reef and a beach profile in that area would not add useful information to characterize the beaches to the north and east. In addition, the study of frequency and nature of lagoon breaches is not part of the Beach Dynamics Investigation.

PREQB Evaluation of Response:

The central headland area exhibits the widest beach profile in the region, and needs to be evaluated given the nature of the study, even if only dry portions of the transect are surveyed. In this dynamic region, it is quite likely that beach erosion related to lagoon breaching could dominate over wave induced sediment transport processes. Although it is

recognized that such a study is beyond the scope of the current contract, there may be significant value in pursuing such a study under separate contract.

Navy Response:

Transect 4-13 from the central headland has been added. It should be noted that there is no lagoon inlet breaching as there is a berm with a road that separates the lagoon from the ocean.

l. Page 40, second paragraph: Please clarify how the depth of closure calculations identifying the offshore extent of transects was performed.

Navy Response:

The following has been added at the end of the second paragraph: "The depth of closure is typically identified through the analysis of measured profiles. The location beyond which the depth of the seabed does not change significantly through time is the depth of closure. In the case of the beaches at Vieques these profiles do not exist, and therefore a combination of an empirical approach, aerial photos, site visit observations and practical considerations was used in the selection of the offshore end of the transects.

The formula by Hallermeier was used to provide a first estimate of the depth of closure. This formula uses the nearshore wave height exceeded 12 hours each year and associated wave period. This information was not available. Therefore, for each beach, estimates of the nearshore conditions were made analyzing wave measurements available at St. Thomas since 2011 to date and using wave transformation coefficients derived from observations during the site visit. For each beach, the estimated depth of closure was plotted on an aerial photo overlaid with the nearshore bathymetry and NOAA Biomaps. The location of the offshore end of the transects was selected not to match exactly the estimated location of the depth of closure, but to contain it. Finally, the practical consideration came into play acknowledging that the nearshore surveys will be performed by boat and that it would be inconsequential from an schedule and cost perspective to survey a transect a few more feet seaward from any given location.

It is noted that the depth of closure for the beaches of interest is not known and for practical purposes, the offshore end of the transects is referred to as the depth of closure in the QAPP."

m. Page 40, Metocean Data Collection: Please explain why no wave data collection will occur off the west side of Vieques Island. It appears that such information would be critical for correlation with the SWMU 4 transect observations.

Navy Response:

The following has been added at the end of the first paragraph under "Metocean Data Collection": "The wave measurements will not be used directly, but indirectly for the correlation of beach changes with the wave climate. Wave modeling will be performed in the future, and wave measurements will be used to calibrate/verify the numerical models that will compute wave conditions in the nearshore at the beaches of interest. These resulting wave conditions can then be correlated to beach changes because these are the forcing that drives the changes.

Because the predominant wave climate at Vieques is from the east most of the year and from the north-northeast during the winter, a wave sensor in the vicinity of SWMU 4 is not necessary. The definition of the wave conditions at SWMU 4 will be achieved by wave modeling and relying model calibration/verification on the measurements from the wave sensor proposed for the south shore."

7. Page 45, Worksheet 31, Planned Project Assessments Table:

   a. The frequency of the field audit on this worksheet is not clear. Please clarify if field audits are conducted once per sampling event or once per the entire project.

   Navy Response:

   The worksheet has been revised so that one field audit may be conducted during the entire project.

   b. Please clarify under what circumstances this audit is considered necessary, as the text states that it is conducted only "if deemed necessary". This comment also applies to the field audit ("if performed") on WS 33. Some level of QC oversight of the data collection under this QAPP is preferred.

   Navy Response:

   The following has been added to Worksheets #31 and #33: "The Senior Coastal Engineer/Investigation Lead will provide QC oversight during the data collection efforts. A project audit will be conducted if the Senior Coastal Engineer/Investigation Lead determines one is necessary."

8. Worksheet 32, Assessment Findings and Corrective Action Responses Table: This worksheet references a "checklist and written audit report" but there are no checklists provided in the QAPP including in the SOPs and the audit isn't mandatory. Please add the checklists to be used by QC to document that the project specifications are being met to the SOPs.

   Navy Response:

   The audit would be situation-specific, so the checklist would be developed when the audit is planned.

9. Worksheet 37, Usability Assessment: 4: Please provide additional information on the data usability assessment, including guidelines describing the minimum documentation required to demonstrate conformance to project requirements.

   Navy Response:

   Project documentation is provided in Worksheet #29. As noted in Worksheet #37, data usability is subjective and based on engineering judgment. The second sentence of Worksheet #37 has been revised to read ". . . based upon engineering judgment by the project team (and verified by the Senior Coastal Engineer/Investigation Lead) . . . "

10. Attachment A, MEC Tracking SOP, Page 2: Please identify the procedure that will be followed if the surrogate cannot be located with a hydrophone.

    Navy Response:

    The following text has been added to the MEC Tracking SOP: "If a surrogate cannot be found with the hydrophone, a visual underwater search will be performed. If the MEC surrogate cannot be found by hydrophone or visual search, it will be declared lost and last known position recorded."

11. Attachment A, Metocean Data Collection SOP, Page 1: Please clarify that a small inflatable boat is sufficient to navigate up to 8 km offshore and deploy/retrieve the ADCP tripods.

Navy Response:

The following has been added to the Metocean Data Collection SOP: A Zodiac Hurricane rigid-inflatable boat (RIB) boat, or comparable, sufficient to navigate all offshore areas included in the study will be used."

12. Attachment A, Metocean Data Collection SOP:

    a. Page 2: Please clarify any contingencies which may exist in the event of instrument failure, or other events which limit data collection for part or all of the deployment period.

    Navy Response:

    SOP #1, III Procedures describes the activities to be performed to verify the correct functioning of the surveying equipment, and contemplates the repair or replacement of defective components.

    For the instrumentation to be installed underwater like acoustic transmitters and wave/current/water level sensors, the SOP has been modified to indicate repair/replacement of sensors and replacement of defective transmitters is planned.

    PREQB Evaluation of Response:

    Please clarify whether there are additional contingencies for cases where data is not collected due to malfunction (e.g., extension of sampling period)

    Navy Response:

    The following has been added to the end of the original response: "If there are data gaps resulting from equipment malfunction, and if the data gaps prevent the project objectives from being met, the beach dynamics monitoring period will be extended accordingly."

    b. Project Coastal Engineer is identified as performing QC in SOP 2; however, Project Coastal Engineer is responsible for production of the data. Therefore, there appears there is a conflict of interest. Please address.

    Navy Response:

    QAPP Worksheet #7 describes the responsibilities of the Project Coastal Engineer, which are to "Lead personnel for execution of the field activities; coordinates with Project Manager to ensure all equipment is available, surveys are performed and data is collected; analyzes, QC and archives data, and provides updates on project status." The Project Coastal Engineer does not "produce the data" but has an oversight role during the surveys. The survey data is produced by the survey crew using instrumentation, and this activity, by its nature, is essentially blind to all involved.

13. Attachment A, Metocean Data Collection SOP, Pages 2-3: Please provide a figure with the locations of the identified NOAA stations.

    Navy Response:

    A Figure 27 has been added to the QAPP showing the locations of the identified NOAA stations.