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FINAL SITE INSPECTION REPORT MUNITIONS RESPONSE PROGRAM TANGIER ISLAND TARGET SITE NAS OCEANA VA

02/01/2011

CH2M HILL

Final

Site Inspection Report
Munitions Response Program
Tangier Island Target Site, Virginia

Naval Air Station Oceana
Virginia Beach, Virginia

NAVFAC
Naval Facilities Engineering Command

Prepared for

Department of the Navy

Naval Facilities Engineering Command Mid-Atlantic

Contract No. N62470-08-D-1000
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February 2011

Prepared by

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Executive Summary

This report summarizes the results of the Site Inspection (SI) conducted for the other-than-operational (OTO) water range, Tangier Island Target, located in Virginia that is associated with Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. The SI was conducted under the United States Navy (Navy) Munitions Response Program (MRP) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The primary objective of this investigation was to evaluate the potential presence or suggested absence of munitions and explosives of concern (MEC) and munitions constituents associated with the use of the range. This SI Report was prepared under the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, Comprehensive Long-term Environmental Action—Navy (CLEAN) 1000, Contract Task Order WE03 for submittal to the Virginia Department of Environmental Quality (VDEQ), the lead regulatory agency.

The OTO water range addressed in this SI is the Tangier Island Target Site. The Tangier Island Target Site is an off-installation, former water range that was used by the Navy for air-to-ground training exercises off the coast of Tangier Island in the Chesapeake Bay. The site includes four hard targets (ships):

- Primary Target
- Navy Targets 1 and 2 (western and eastern target, respectively)
- San Marcos Target

Information from the Preliminary Assessment (PA) (Malcolm Pirnie, 2008) indicated that there is the potential for munitions to be present at the Tangier Island Target Site based on its historical use. According to the PA, the range was used from approximately 1970 until 1996 for aerial bombardment and rocketry training. The PA also indicates the San Marcos Target was utilized for bombing activities in the 1920s, which suggests it is not part of the range defined for use from 1970 until 1996. Records from 1993 through 1996 indicate only practice rockets and bombs were used at the site. Use of the training range was stopped in July 1996 because range procedures cited in the Code of Federal Regulations (CFR) could not be met (safety measures cited in the CFR were antiquated). Possible munitions used at this site include practice bombs, air-to-surface rockets, and associated spotting and witness charges.

To further assess whether MEC are present, a digital geophysical mapping (DGM) survey was conducted at the areas adjacent to potential hard target locations at the range. Results from the DGM survey are presented in the table below.

Digital Geophysical Mapping Survey Results

Target Area	Investigation Area (Acres)	Miles/ Acres Surveyed	Number of Anomalies	Estimated Anomalies per Acre (of Surveyed Area)
Primary Target	650	40 / 31.6	1,184	37
Navy Targets 1 and 2	904	53 / 42.2	2,687	64
San Marcos Target	650 [a]	20 / 15.8	277	9

[a] Initial Investigation area; however, this area was reduced during field activities

Based on the results of the DGM performed, additional investigation may be necessary for each of the target locations at the Tangier Island Target Site to determine if anomalies detected are MEC. Because this investigation was intended to be an initial data gathering and the data is not intended to be used for risk based decisions, additional data collection may be necessary to identify anomalies during future activities. The following actions should be considered for the target locations at the Tangier Island Target Site to further evaluate the potential presence of MEC.

- **Primary Target—**Inspection and identification of anomalies from high density areas to determine if MEC is present. If determined to be MEC, munitions constituents (MC) sampling may be necessary.
- **Navy Targets 1 and 2—**Inspection and identification of anomalies from high density areas to determine if MEC is present. If determined to be MEC, then MC sampling may be necessary. The presence of Navy Targets 1 and 2 has been confirmed and may need to be added to the site definition as presented in the CFR to restrict access within the vicinity of the hard targets (similar to the prohibited area defined for the Primary Target).
- **San Marcos Target—**Inspection and identification of anomalies from high density areas to determine if MEC is present. If determined to be MEC, then MC sampling may be necessary. Because of the timeframe of use for this target and the minimal anomaly densities identified during the DGM investigation, the San Marcos may not be part of the range as defined by the PA and may contain munitions that are different than those believed to have been used at the Primary Target and Navy Targets 1 and 2.

Future investigations and data collected should be performed and documented as a Remedial Investigation (RI) and will be used to determine the path forward for the site.

Contents

Photographs

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Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action—Navy
CSM	conceptual site model
DGM	digital geophysical mapping
FACSFAC	Fleet Area Control and Surveillance Facility
GPS	global positioning system
IVS	Initial Verification Study
MC	munitions constituents
MEC	munitions and explosives of concern
MMPA	Marine Mammals Protection Act
MRP	Munitions Response Program
mV	millivolt
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	United States Navy
NOAA	National Oceanographic and Atmospheric Administration
OTO	other-than-operational
PA	Preliminary Assessment
QA	quality assurance
QC	quality control
RI	Remedial Investigation
SAV	submerged aquatic vegetation
SI	Site Inspection
SOP	standard operating procedure
USGS	United States Geological Service
UXO	unexploded ordnance
VACAPES	Virginia Capes
VDEQ	Virginia Department of Environmental Quality

SECTION 1

Introduction

This report summarizes the Site Inspection (SI) activities conducted at the other-than-operational (OTO) water range, Tangier Island Target, located in Virginia that is associated with Naval Air Station (NAS) Oceana, Virginia Beach, Virginia under the United States Navy (Navy) Munitions Response Program (MRP). This report also includes relevant historical data from previous investigations such as the Preliminary Assessment (PA), as applicable, for the purposes of complete data evaluation and making site-specific determinations (Malcolm Pirnie, 2008). The investigation was conducted in accordance with the *Munitions and Explosives of Concern Uniform Federal Policy - Quality Assurance Project Plan for Tangier Island Target Phase I Site Inspection (*CH2M HILL, 2010), herein referred to as the Work Plan. Field activities were initiated at the Tangier Island Target Site on September 13, 2010 and were completed on September 27, 2010.

This SI Report was prepared under Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, Comprehensive Long-term Environmental Action—Navy (CLEAN) 1000, Contract Task Order WE03, for submittal to the Virginia Department of Environmental Quality (VDEQ), the lead regulatory agency.

1.1 Problem Definition and Objectives of the Site Investigation

The Tangier Island Target Site has been identified as an OTO water range associated with NAS Oceana. The site potentially contains munitions and explosives of concern (MEC) (including unexploded ordnance) and munitions constituents (MC). No access restrictions are in place at the site, and no reported future changes in site use are currently anticipated. The site is frequented by the public for recreational use. Hazards associated with unmarked "hard targets" (navigational hazard), potential MEC (explosive hazard), or MC (environmental hazard) may be present as a result of the range activities.

The primary objective of this investigation was to determine the potential presence or suggested absence of MEC at the OTO water range. To accomplish this, a digital geophysical mapping (DGM) survey was performed using a towed array of electromagnetic sensors to detect geophysical anomalies on or just below the seafloor sediment in the vicinity of potential hard target locations. This information was supplemented by a side-scan sonar investigation performed separately and prior to the DGM survey. The DGM investigation was performed to serve as an initial gathering of information that will be used to plan and evaluate any additional activities at the site. Although the data from this initial SI may provide a preliminary assessment of the extent of the site, it will not be used to make any quantitative risk-based decisions.

1.2 Organization of the Site Inspection Report

This SI Report is organized as follows:

- **Section 1, Introduction:** Provides the objectives of the SI and overall format of the report.
- **Section 2, Site Background:** Provides a brief description and history of the NAS Oceana facility, site description, and history of the OTO water range. This section also summarizes previous investigations relevant to the SI conducted in association with the range.
- **Section 3, Physical Characteristics:** Describes the physical characteristics, such as physiography, climate, and surface water hydrology of the OTO water range.
- **Section 4, Investigation Methodology:** Provides a detailed description of the SI and data collection activities.
- **Section 5, Conclusions and Recommendations:** Summarizes the conclusions and recommendations made for the OTO water range.
- **Section 6, References:** Lists the documents used in preparation of this SI Report.

Tables and figures are presented at the end of each section, as applicable. Appendixes are provided at the end of the report.

SECTION 2

Site Background

2.1 Facility Description and History

NAS Oceana is approximately 5,331 acres in size and is located within the southeastern portion of the city of Virginia Beach, Virginia (**Figure 2-1**). The facility has been in existence since 1940 when it was established as a small auxiliary airfield. Since 1940, NAS Oceana has grown to more than 16 times its original size and is now a Master Jet Base supporting a community of more than 9,700 Navy personnel and 12,300 dependents. The primary mission of NAS Oceana is to provide personnel, operations, maintenance, and training facilities to ensure that fighter and attack squadrons on aircraft carriers of the U.S. Atlantic Fleet are ready for deployment.

Principal operations at NAS Oceana include training and deployment of the Navy's fighter/attack squadrons of F/A-18 Hornet and Super Hornet aircraft. NAS Oceana is the only East Coast Master Jet Base and is home to all East Coast strike-fighter (VFA) squadrons (with the exception of VFA-86, Marine Corps Air Station Beaufort, South Carolina). Currently, pilots fly approximately 219,000 training sorties per year at NAS Oceana. In addition to the fighter squadrons, NAS Oceana is host to several other tenant commands, including the Strike Fighter Weapons and Tactics School, Atlantic; Navy Landing Signal Officer School; Naval Atlantic Meteorology and Oceanography Detachment; Fleet Area Control and Surveillance Facility (FACSFAC), Virginia Capes (VACAPES) Operating Area; Fleet Aviation Specialized Operational Training Group, Atlantic; and Marine Aviation Training Support Group 33 (Malcolm Pirnie, 2008).

2.2 Tangier Island Target Description and History

The Tangier Island Target Site is presented in the PA as having multiple targets used for aerial bombardment and rocketry training from approximately 1970 until 1996 as well as the San Marcos Wreck, which was utilized in the 1920s. The hard targets are ships that were on the surface when range operations occurred but now have since sunk. As defined in the Code of Federal Regulations (CFR), Title 33, Paragraph 334.210, the site consists of a prohibited area that is a 1,000-yard radius surrounding the Primary Target location, and a restricted area that is a 3-nautical mile radius around the Primary Target Location. The PA also identified a 1,000-yard prohibited area and a 3-mile restricted area surrounding the San Marcos Target. The origin of the 3-mile restricted area surrounding the San Marcos Target was not defined in the PA.

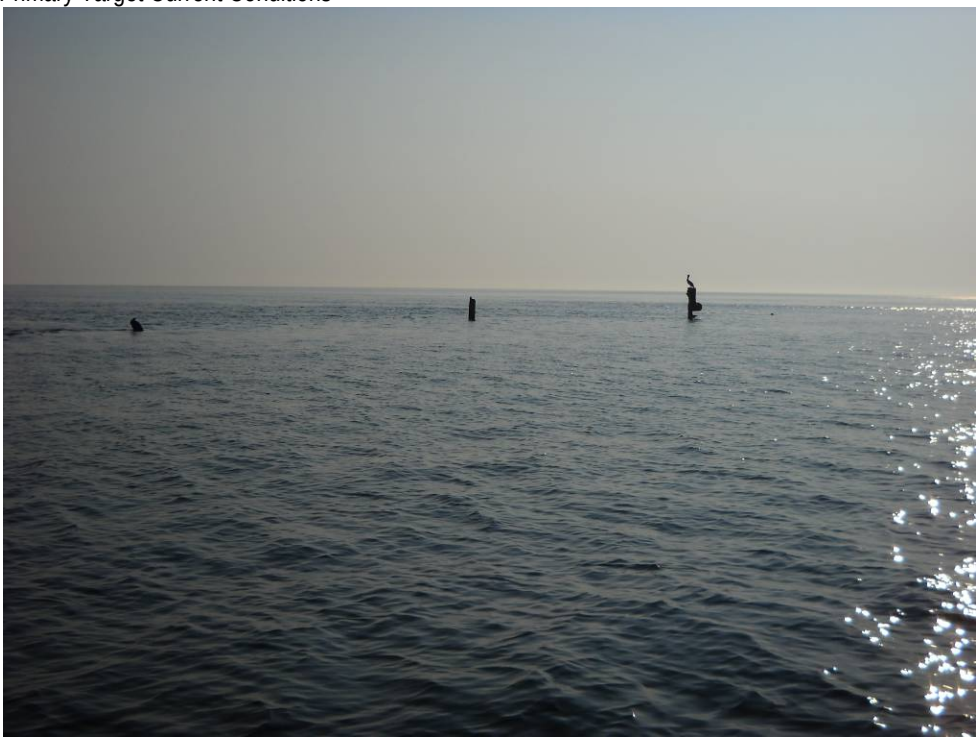
Through the review of the PA, National Oceanic and Atmospheric Administration (NOAA) Nautical Charts, and other documents, the site boundaries and definition presented in the PA were revised for the purposes of the SI (**Figure 2-2**). The 3-mile restricted area surrounding the San Marcos target was removed, as no documentation for this restricted area was identified. Additionally, it was determined that two other potential hard targets were present at the site, Navy Targets 1 and 2. The location of the Primary Target is identified in 33 CFR 334.210. Navy Targets 1 and 2 were identified through review of

NOAA Nautical Charts and are located between the Primary Target and Tangier Island, within the restricted area. The San Marcos Target was included as part of the range as identified on NOAA Nautical Charts, but is believed to have been utilized and sunk prior to the existence of the bombing range.

Utilization reports (1994–1996) identified during the PA indicate that only practice rockets and bombs were dropped on the targets; however, complete documentation of munitions usage at the site could not be identified. The practice rockets and bombs known to have been dropped may present an explosive hazard due to spotting and witness charges. Additionally, munitions usage around the San Marcos target is unknown. New York Times articles referenced in the PA indicate live munitions may have been dropped on the San Marcos in the 1920s. The PA also indicates that the site is composed of two scuttled cargo ships that were used as hard targets; however, it is not clear if the cargo ships were located at the Primary Target location or if Navy Targets 1 and 2 are the location of the cargo ships. Munitions release operations at the Tangier Island Target Site were cancelled in July 1996 because safety measures identified in the CFR were determined to be antiquated by today's standards. Anecdotal reports state that munitions have previously been pulled up by local sport fishermen around the site (Malcolm Pirnie, 2008).

The site is located approximately 2,800 yards southwest of Tangier Island (in Restricted Air Space R-6609) and approximately 65 miles north of Norfolk, Virginia (**Figure 2-1**). The range is located in the lower portion of the Chesapeake Bay in relatively shallow waters, ranging from 10 to over 30 feet deep. The Primary target is located just below the water surface and portions of the target are visible at low tide (**Photograph 2-1**) and may be a possible hazard to navigation. The depth of water in the vicinity of this target area is approximately 11 to 20 feet (**Figure 2-3**). Navy Targets 1 and 2 are located northeast of the primary target, between the primary target and Tangier Island. They are located within the 3-mile restricted area around the Primary Target. The depth of water around these targets is approximately 10 to 22 feet (**Figure 2-4**). Portions of these targets are visible above the water surface (**Photographs 2-2** and **2-3**) and may be a possible hazard to navigation. The San Marcos Target is located approximately 5.5 miles south of the Primary Target. The depth of water at this location is approximately 26 to 32 feet (**Figure 2-5**). NOAA Nautical Charts indicate that the San Marcos Target is at a depth of greater than 20 feet below water surface.

PHOTOGRAPH 2-1
Primary Target Current Conditions



PHOTOGRAPH 2-2
Navy Target 1 Current Conditions

PHOTOGRAPH 2-3
Navy Target 2 Marker and Navy Target 1

[Note: Navy Target 1 in background.]

The area of the Chesapeake Bay where Tangier Island is located is part of the Atlantic Coastal Plain where the sediments at the bottom of the Bay beneath the site are characterized as soft mud, which are underlain by marine sand, silt, and clay. The United States Geological Service (USGS) describes the occurrence of Pleistocene aged paleochannels in the vicinity of the Tangier Island Target Site, where thick sequences (of up to or greater than 15 meters thick) of unconsolidated sediment have been deposited within the channel. There are submerged aquatic vegetation (SAV) beds near the shores of Tangier Island, but no SAVs have been identified in the vicinity of the targets (Malcolm Pirnie, 2008).

2.3 Previous Studies and Investigations

2.3.1 Final Preliminary Assessment Report

The PA Report (Malcolm Pirnie, 2008) addressed description and history of the Tangier Island Target Site and munitions used at the site. Several sources were researched during the PA to determine the potential for munitions at the site. Data were collected from historical archives, personal interviews, installation data repositories, and offsite data sources and repositories. However, because the site is offshore no visual surveys were conducted for the PA.

Based upon information obtained during the PA, it was determined that the Tangier Island Target Site was suspected to contain MEC and, therefore, required further investigation.

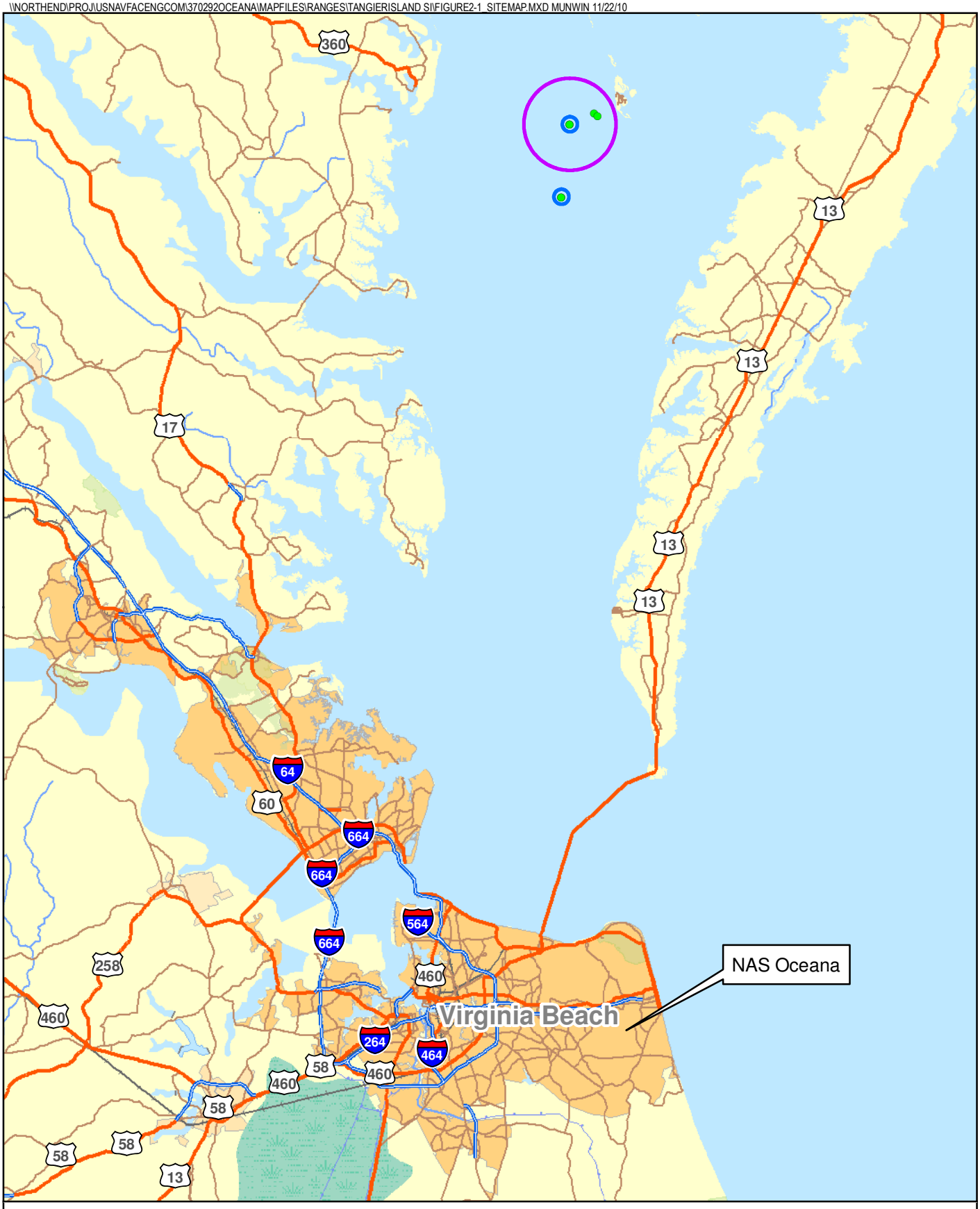
2.3.2 Side-Scan Sonar (NOAA)

A side-scan and multi-beam sonar investigation was performed by NOAA from July to December 2009 to obtain accurate, modern hydrographic survey data with which to update the NOAA Nautical Charts. This investigation was performed over a large area located around the San Marcos Target and extending up to the 1,000 yard prohibited area of the Primary Target. The side-scan data obtained during this investigation was evaluated to determine if there were any navigational hazards in the survey area. The results of the survey confirmed the location of the San Marcos Target and debris fields in the vicinity of the target.

2.3.3 Side-Scan Sonar (Navy)

The Side-Scan Sonar Report addressed the results of the side-scan sonar investigation performed at each of the Tangier Island Target Site target locations. The objective of the investigation was to confirm the hard target locations and to identify potential areas of concern where debris or other materials may be protruding above the seafloor surface and serve as a navigational hazard during the DGM survey. Data was collected at Navy Targets 1 and 2 and the Primary Target locations for this investigation. Previous side-scan data had been collected at the San Marcos location and was included in this report. The results of the side-scan survey confirmed the remnants of three hard targets within the investigation area. The results of the side-scan sonar survey can be found in the Technical Memorandum which is included as **Appendix A.**

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE2-1_SITEMAP.MXD MUNWIN 11/22/10



Legend

- NAS Oceana
- 3-Nautical Mile Restricted Area
- 1,000-Yard Prohibited Area
- Target Location

N
W E
S

0 5 10
Miles

Figure 2-1
Base and Site Map
Tangier Island Target
NAS Oceana
Virginia Beach, Virginia

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\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE2-2_VICINITYMAP.MXD MUNWIN 11/22/10

Legend
- 3-Nautical Mile Restricted Area
- 1000-Yard Prohibited Area
- Target Location

N
W E
S

0 2.5 5
Miles

Figure 2-2
Tangier Island Target Vicinity Map
NAS Oceana
Virginia Beach, Virginia

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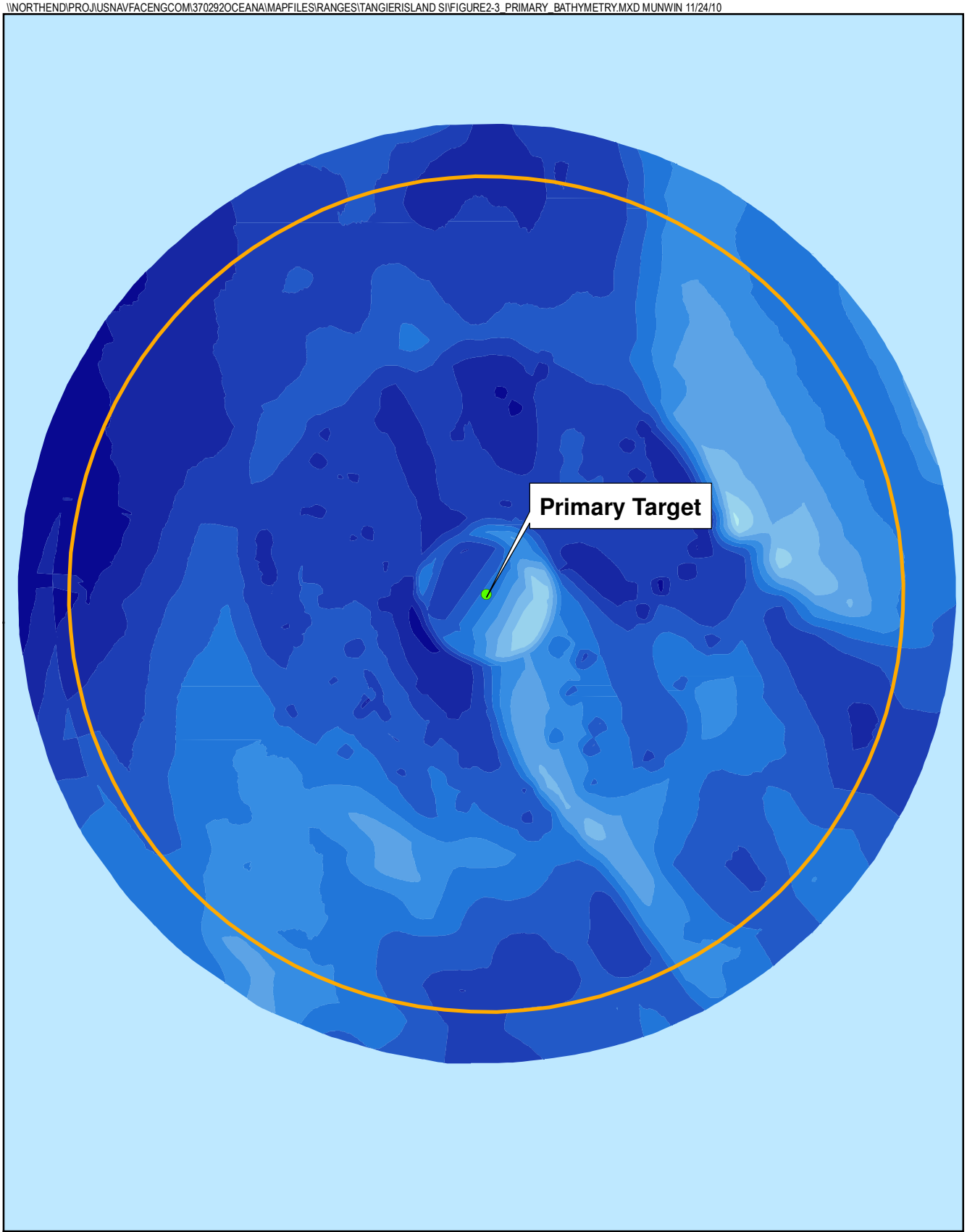
\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND S\FIGURE2-3_PRIMARY_BATHYMETRY.MXD MUNWIN 11/24/10



Legend

Investigation Area

Target Location

Depth (ft)

10
11
12
13
14
15
16
17
18
19

N
W
E
S

0 500 1,000
Feet

Figure 2-3
Primary Target Bathymetry
NAS Oceana
Virginia Beach, Virginia

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\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE2-4_NAVY1_2_BATHYMETRY.MXD MUNWIN 11/24/10

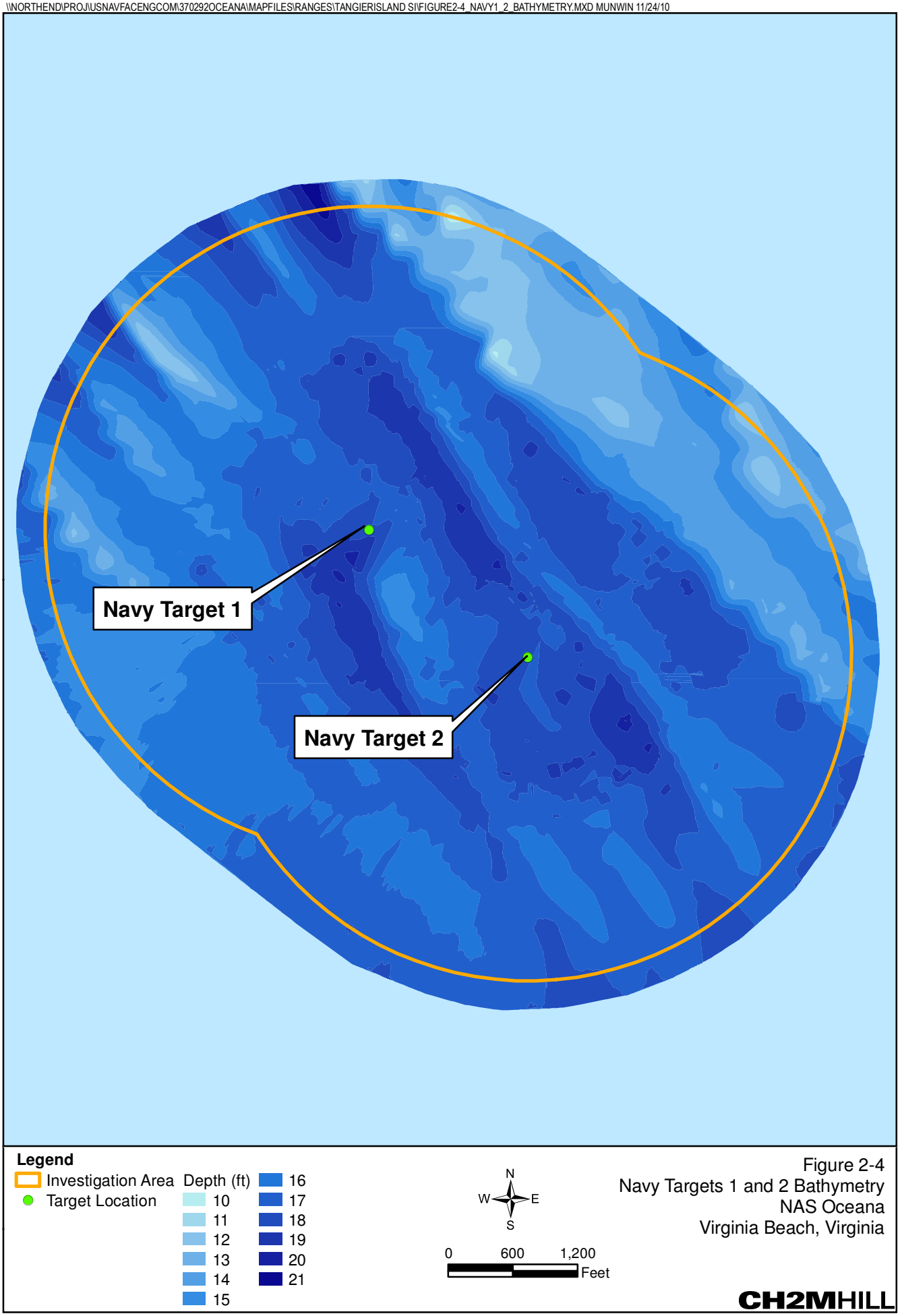

Figure 2-4
Navy Targets 1 and 2 Bathymetry
NAS Oceana
Virginia Beach, Virginia

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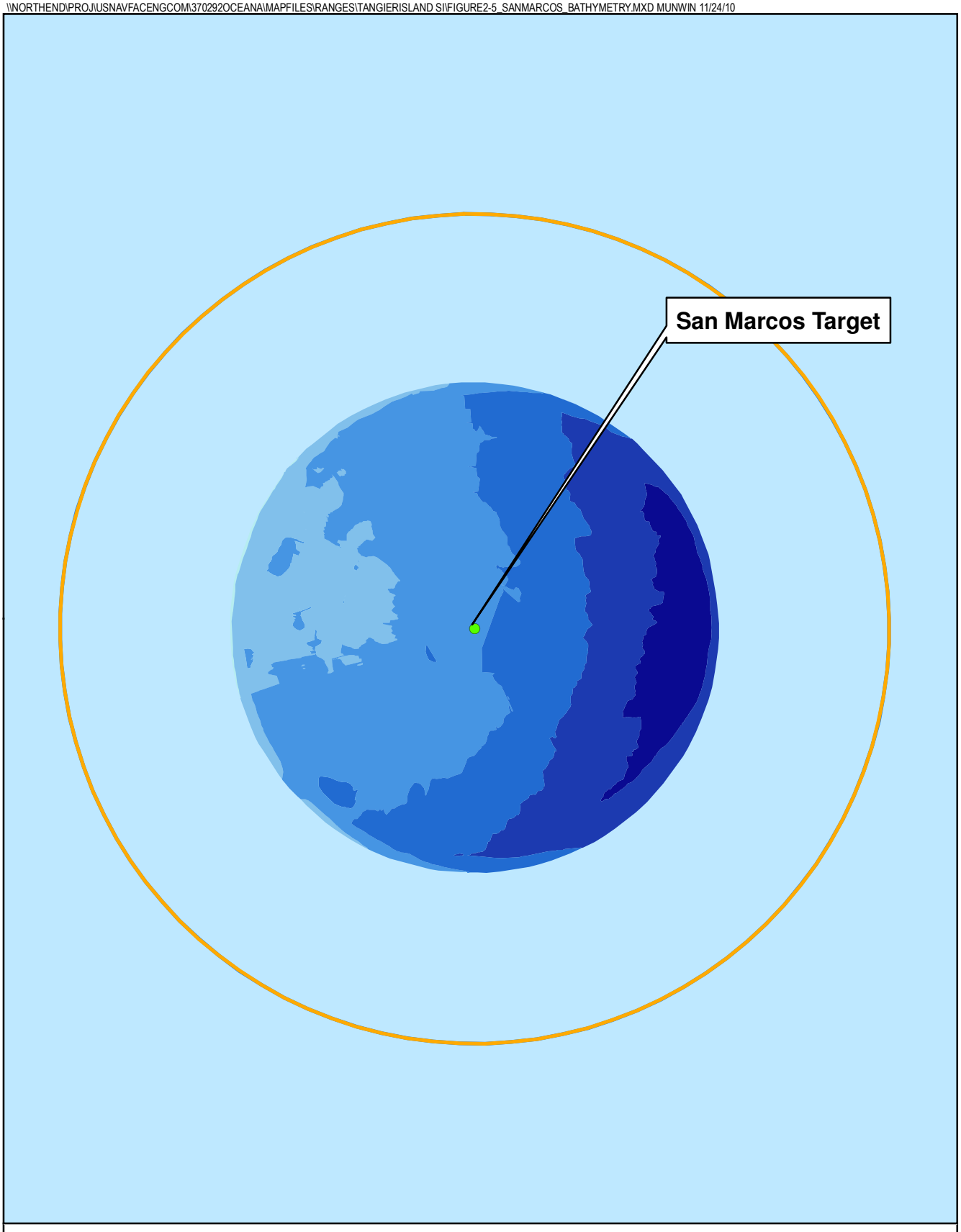
\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE2-5_SANMARCOS_BATHYMETRY.MXD MUNWIN 11/24/10



Legend

Investigation Area

Target Location

Depth (ft)

26

27

28

29

30

31

N

W E

S

0 500 1,000

Feet

Figure 2-5
San Marcos Target Bathymetry
NAS Oceana
Virginia Beach, Virginia

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SECTION 3

Physical Characteristics

3.1 NAS Oceana Regional Land Use

NAS Oceana is located in the southeastern portion of Virginia Beach, Virginia. The installation encompasses 5,331 acres of land, plus many outlying annex properties including the Tangier Island Target Site. NAS Oceana's land area includes runways, personnel, operations, maintenance, and training facilities. However, since the Tangier Island Target Site is located within the Chesapeake Bay, the main uses are commercial and recreational fishing, and boating.

3.2 Physiography, Climate, Surface Water Hydrology, and Sediment Characteristics

NAS Oceana is located in the Tidewater Region of Virginia's coastal plain. The Tangier Island Target Site is to the north of NAS Oceana in the Chesapeake Bay, off the western coast of Tangier Island.

The climate near NAS Oceana and the OTO water range is moderated from extremes by the Atlantic Ocean and is relatively mild, though humid. Winters are generally milder than inland locations. The area receives an average of 48 inches of rain per year, which is evenly distributed throughout the year, with July and August receiving slightly greater amounts. Winter and early spring months are considered the wet season because of increased evidence of standing water due to low rates of evapotranspiration (GMI, 2006).

Coastal weather events in the form of severe thunderstorms, Nor'easters, and occasional hurricanes can have significant but temporary effects on the climate of the area. Winds typically blow from a northerly direction from January through March and again in September and October. During the remaining months, winds generally blow from a southerly direction (GMI, 2006).

The Tangier Island Target is located in the lower Chesapeake Bay and was an open water range. The former targets are located in relatively shallow waters. The Chesapeake Bay is a major depositional basin that is filling from both ends (Hobbs et al., 1992). The area west of Tangier Island has been identified as a net depositional environment and the rate of deposition was estimated to be 0.55 meters per century (0.55 centimeters per year) (Carron, 1979). A detailed description of the sediment transport and hydrodynamic effects within the vicinity of the OTO targets are included in the *Tier 1 Sediment Transport Evaluation Technical Memorandum* (**Appendix B**).

3.3 Ecological Settings and Natural Resources

There are no federally listed threatened, endangered, or special concern species known to specifically inhabit the Tangier Island Target Site. However, there are listed species that may be found in the vicinity and that may use the area in and around the targets for foraging or

during migration. These include the federally endangered hawksbill sea turtle (*Eretmochelys imbricate*), Kemp's Ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), federally threatened loggerhead sea turtle (*Caretta caretta*) and green sea turtle (*Chelonia mydas*), the Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*) and the shortnose sturgeon (*Acipnser breviostrum*), which are federal species of concern. The Atlantic bottlenose dolphin (*Tursiops truncates*) is a species protected by the Marine Mammals Protection Act (MMPA) of 1972. This species is not listed as threatened or endangered but is listed as "depleted" under the MMPA. Bottlenose dolphins are seen in Virginia's waters from May through October, with limited sightings in spring and winter. The targets themselves are known to attract a variety of fish including trout, rockfish, croaker, sea bass, red drum, cobia, and sheepshead (Malcolm Pirnie, 2008).

3.4 Cultural Resources

According to the Virginia Department of Historic Resources Data Sharing System there are no cultural resources located at the Tangier Island Target Site. The site is not within a Natural Area Preserve; however, such areas are located nearby in Accomack County. The Chesapeake Bay is a well known beneficial water resource and the area surrounding the site is a popular location for recreational sport fishing, boating, and crabbing.

SECTION 4

Investigation Methodology

This section summarizes the field investigation procedures of the SI at NAS Oceana OTO range, Tangier Island Target Site. The investigation activities and data presented below summarize the field activities conducted from September 13 through September 27, 2010, in accordance with the Work Plan (CH2M HILL, 2010). The investigation activities consisted of a DGM survey of the OTO water range.

4.1 Mobilization and Site Preparation

Initial mobilization for the field activities was conducted on September 13, 2010 to Tangier Island. The investigation approach is defined in the Work Plan (CH2M HILL, 2010). A kickoff meeting was conducted with representatives from CH2M HILL and the subcontractor (NAEVA Geophysics and second tier subcontractor 3D Geophysics), prior to the commencement of field activities. During the kickoff meeting, all onsite personnel reviewed the Work Plan, as well as the standard operating procedures (SOPs) and health and safety documentation. In addition, the field team reviewed nautical charts to identify the location of the targets as well as any navigational hazards that could potentially be encountered during the survey. An inspection of the boat and safety equipment was also performed.

All site specific training was verified by CH2M HILL prior to field activities. Prior to the start of field activities, equipment was inspected and tested to ensure it was functioning properly prior to data collection. Communication requirements for all team members were established before field work began. Additionally, local agencies and emergency services (including nearby hospitals and the United States Coast Guard Rescue Coordination Center) were notified in advance of site activities by CH2M HILL, so that they would be prepared and equipped to respond to any emergencies.

4.2 Sequence of Data Collection

Data were initially collected at the Primary Target location followed by Navy Targets 1 and 2. The transects nearest to the targets were collected first, working out from the target location. Data was collected from the San Marcos Target after initial data collection from around the Primary Target and Navy Targets 1 and 2.

4.3 DGM Survey

The DGM survey was conducted using an EM61-Flex3, which is a high-resolution time-domain electromagnetic instrument designed to detect shallow ferrous and non-ferrous metallic items on or just beneath the sediment within the investigation area. The instrument was assembled in a 6.56-foot wide array and towed from a boat, with the detection coils maintained just above the seafloor. A detailed description of the DGM survey equipment, field methodology, and functionality are included in the NAEVA Geophysical Investigation Report provided as **Appendix C**.

The data collection approach was outlined in the Work Plan (CH2M HILL, 2010), and included a focused investigation of each of the known target locations. The investigation areas for the Primary Target, Navy Targets 1 and 2, and San Marcos Target locations are presented in **Figures 4-1**, **4-2**, and **4-3**, respectively. Side-scan sonar imaging from the side-scan investigation are also included on these figures. This information was used to confirm the target locations and identify any potential navigational hazards. The DGM survey focused on the target locations (an approximate radius of 1,000 yards around each target) as these areas are the most likely to show evidence of range activities. At all the target locations, transects were spaced 100 feet apart for the first 500 yards from the presumed target location. The spacing of the transects was increased to 250 feet for the remaining 500 yards, up to a total distance of 1,000 yards from the presumed target location. The interior lines (the first 500 yards) were collected first at each target location, so that the data could be assessed to determine whether it was necessary to collect the remaining data (from 500 to 1,000 yards). During the survey, the sensors were towed just above the seafloor surface, but no higher than 5 feet above the sediment; to prevent inadvertent contact with MEC and to prevent damage to aquatic habitats while obtaining quality DGM data. The average depth above the seafloor was estimated to be approximately 3 feet.

Prior to mobilization to the site, a variety of transect designs were reviewed and considered. Initially, linear transects were proposed (as detailed in the Work Plan [CH2M HILL, 2010]). However, it was determined that concentric circles at location areas containing a single target, such as the Primary Target and San Marcos Target, would be more efficient while providing the same coverage. Since the transects for the Navy 1 and 2 Targets overlapped it was decided that concentric ovals would be most efficient. Modification of the transect designs was discussed and agreed to by the Navy and VDEQ prior to mobilization to the target areas.

4.4 Deviations from the Work Plan

Efforts were taken to conduct all aspects of the investigation within the specifications established in the Work Plan (CH2M HILL, 2010). Instances where the investigation approach deviated from the Work Plan are detailed below:

- At single target locations (such as the Primary Target and the San Marcos Target), the DGM survey transects were altered from the Work Plan to improve efficiency while maintaining the same target area coverage. In these instances, concentric circles were implemented rather than the "parallel" transects as proposed in the Work Plan. For the Navy Targets 1 and 2, concentric ovals were used.
- The DGM survey from 500 to 1,000 yards at the San Marcos Target could not be conducted as originally detailed in the Work Plan. As a result of poor weather, adverse sea conditions, and limited anomalies detected from the inner transects, the Navy, CH2M HILL and NAEVA determined that adequate data had been collected and data collection from the outer transects at the San Marcos Target would not be performed.
- At the Navy Targets 1 and 2, the DGM survey was not conducted as originally detailed in the Work Plan. As a result of hazards associated with navigating the DGM equipment between the two hard targets (Navy Targets 1 and 2) data were not collected from between the hard targets.

- The launch point for the boat was at Tangier Island during the investigation. Because of the limited access to the island, the trailer used for moving the boat was not transferred to the island. Therefore, the global positioning system (GPS) and static background and static spike quality control (QC) tests, which would normally be performed on the land, were conducted in the water. The results of all QC tests were still within acceptable criteria.

Although these changes to the Work Plan (CH2M HILL, 2010) were made during field implementation, the overall objectives of the field investigation and the QC/quality assurance (QA) data quality objectives were maintained. Significant amounts of data were still collected and the modifications to the Work Plan were field determined to increase the efficiency and safety of the project. Additionally, changes to the Work Plan were reviewed with the project team and the regulators, as necessary.

4.5 Quality Assurance/Quality Control

Prior to beginning the main survey and every collection day from that point forward, a series of QC tests were performed. The purpose of the QC tests was to demonstrate the proper functionality of all instruments, methods, and personnel prior to the fieldwork and to document site-specific noise and capability of the DGM system.

The following is a list of QC procedures that were performed during the data collection process. All QC test results were reviewed by a qualified geophysicist on a daily basis.

- **GPS Check Point:** At the beginning of the day, after setting up the equipment but before data collection, the bow and stern GPS antennas were tested to check the accuracy. On the first day of data collection, the boat was secured to two pilings at the dock and multiple GPS measurements were taken. These measurements were averaged to obtain "known" points for the bow and stern. All subsequent measurements were compared to these initial readings. This QC procedure confirmed proper operation of the GPS. Results of this test showed that all recorded points were within tolerance.

- **Static Background and Static Spike:** A static test is the primary measurement of instrument functionality, and the purpose of the test is to determine whether unusual levels of ambient noise exist and to check for consistent response. To perform the static tests while the boat was in the water, the system was deployed as it would be for data collection. However, the sensor was kept at the surface of the water and data was collected for a 3-minute period. One minute of data is collected without a spike (for this test, the spike was two large clamps attached to the sensor to produce a response in the system), one minute of data with the spike, and finally a minute without the spike. All static and spike tests were within acceptance criteria.

- **Pressure Test:** Prior to data collection, the pressure sensor was tested for accuracy. The test was conducted prior to deployment of the system, with two data points recorded to verify the functionality of the sensor. Functionality was confirmed with all tests being within acceptance criteria.

- **Repeat Data:** The Instrument Verification Strip (IVS) was used to verify the repeatability of the data, due to the difficulty of accurately recollecting a line of data in the water. Because of the complexity of towing the system along the same line and height twice in

the marine environment, this test was evaluated on a qualitative basis. To confirm repeatable data, the IVS item was surveyed on the way out to the site as well as upon returning. If the location of the IVS item was repeatable, the survey data collected that day were considered acceptable. Repeat lines generally showed acceptable repeatability, with the exception of discrepancies in the response on some repeat lines which were likely a result of line path or coil height deviation. A more in-depth description of the IVS process is included in Appendix C.

4.6 Data Processing and Analysis

Initial data processing was performed by the field team, which included reviewing the data for integrity and completeness. For preprocessing, the raw data was imported into Geosoft's Oasis Montaj where the following was performed:

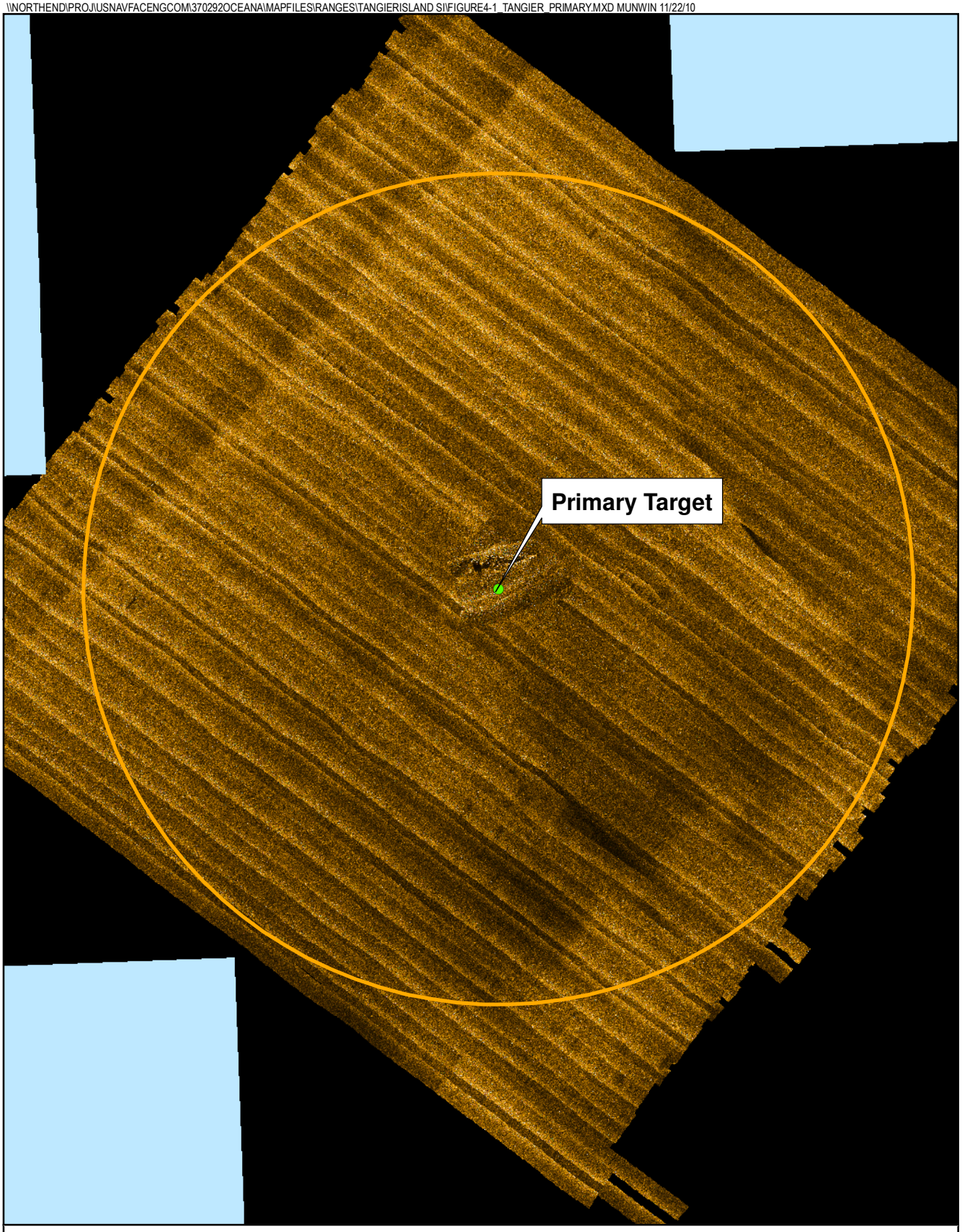
- Review and finalization of QC tests
- Evaluation of GPS accuracy and positioning
- Evaluation of data density and coil height
- Application of auto leveling and instrument drift corrections
- Application of default lag correction
- Creation of preliminary contour maps.

Once the preprocessing was complete, the data went through final processing, which included:

- Evaluation and refinement of drift and lag corrections
- Additional digital filtering and enhancement
- Targeting of data
- Generation of ASCII and final maps showing contoured gridded data, target locations and culture (man-made features affecting geophysical data).

For anomaly selection, a Geosoft algorithm was used to identify peak amplitude responses associated with, but not limited to, MEC items. Initial target selections were made based on the minimum curvature gridded data. All data profiles corresponding to the anomalies selected were then analyzed by trained geophysicists. Noise levels across all target locations were generally low, with a few areas containing slightly elevated levels due to an increased sea state. Background geophysical "noise" was determined to be less than 5 millivolts (mV). Invalid or incorrect targets were removed and any anomalies missed by the algorithm but deemed to represent a potential MEC target were manually selected by the geophysicist.

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND S\FIGURE4-1_TANGIER_PRIMARY.MXD MUNWIN 11/22/10



Legend
- Investigation Area
- Target Location

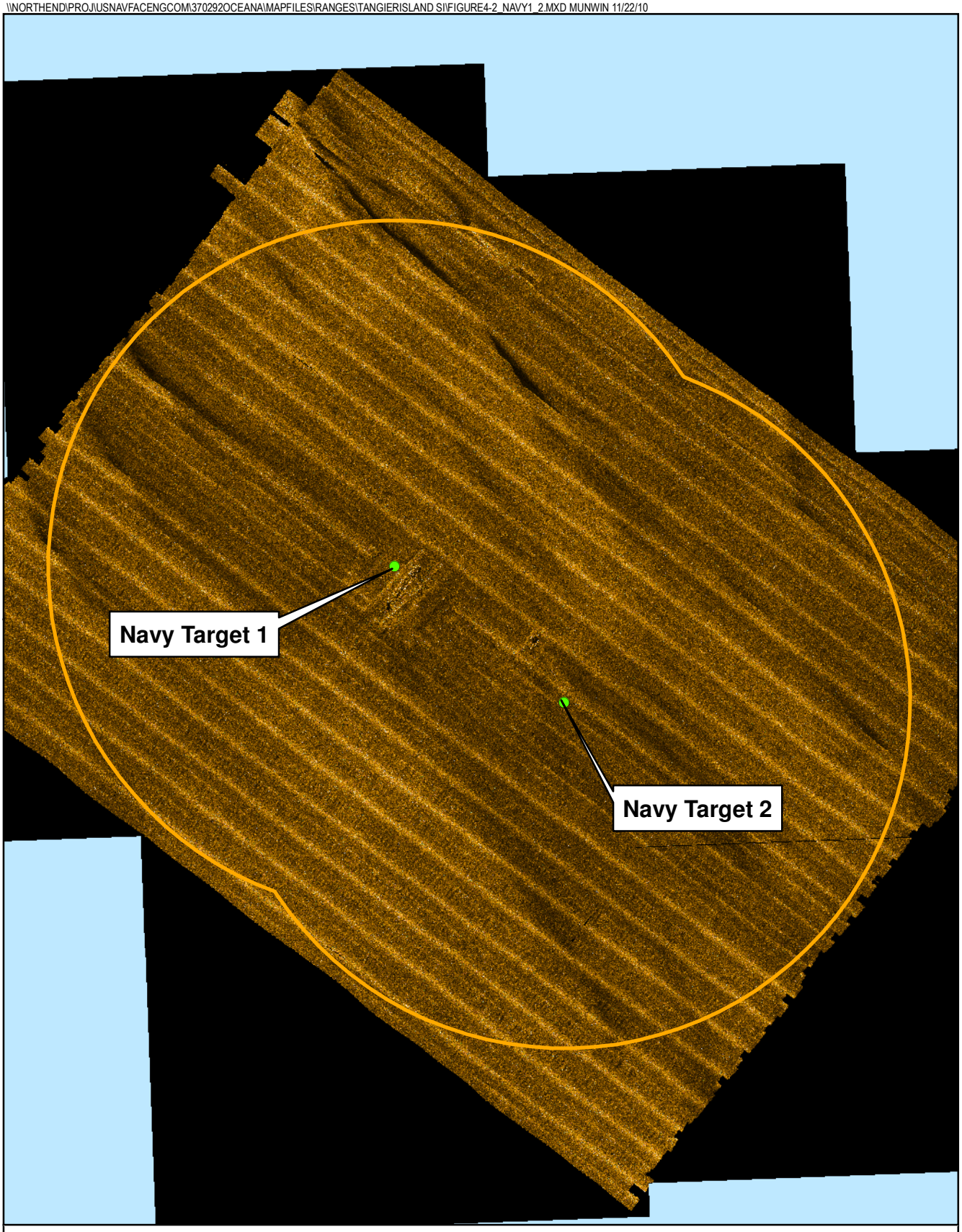
N
W E
S

0 500 1,000
Feet

Figure 4-1
Primary Target Investigation Area
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE4-2_NAVY1_2.MXD MUNWIN 11/22/10



Legend
- Investigation Area
- Target Location

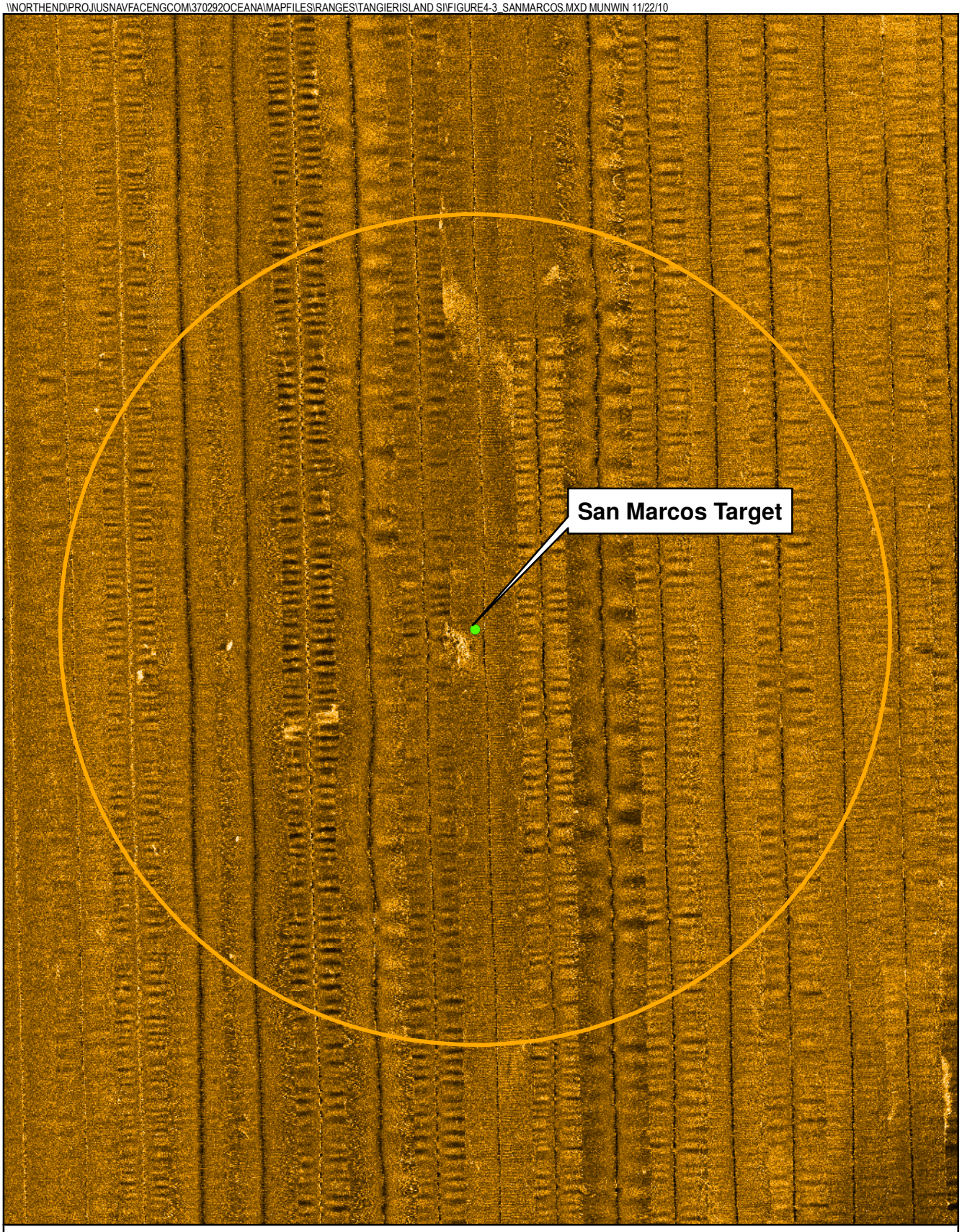
N
W E
S

0 600 1,200
Feet

Figure 4-2
Navy Targets 1 and 2 Investigation Area
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE4-3_SANMARCOS.MXD MUNWIN 11/22/10



Legend
- Investigation Area
- Target Location

N
W E
S

0 500 1,000
Feet

Figure 4-3
San Marcos Target Investigation Area
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

SECTION 5

Investigation Results

5.1 SI Activities and Data Result Summary

At the Tangier Island Target Site, 112.6 miles of transects (with an instrument detection footprint of 6.56 feet wide) were surveyed with 4,148 anomalies detected. This corresponds to 89.6 acres (approximately 4 percent of the total investigation area acreage) of data collected with an average of 46.3 anomalies per acre. **Table 5-1** outlines the distance, acreage, and number of anomalies found at each target area. The total acreage of the site is approximately 25,000 acres (which includes the 3-mile restricted area surrounding the Primary Target and the 1,000-yard radius around the San Marcos Target). However, for the purposes of this SI, the investigation focused only on the areas most likely to contain MEC (the areas surrounding the proposed target locations). Therefore the acreage of each investigation area was 650, 904, and 650 acres for the Primary Target, Navy Targets 1 and 2, and the San Marcos Target, respectively.

TABLE 5-1
Digital Geophysical Mapping Survey Results

Target Area	Investigation Area (Acres)	Miles/ Acres Surveyed	Number of Anomalies	Estimated Anomalies per Acre (of Surveyed Area)
Primary Target	650	40 / 31.6	1,184	37
Navy Targets 1 and 2	904	53 / 42.2	2,687	64
San Marcos Target	650 [a]	20 / 15.8	277	9

[a] Initial Investigation area; however, this area was reduced during field activities

Based on the findings from the DGM survey, NAEVA (DGM subcontractor) generated density maps displaying the anomaly densities within each target areas. To create the density maps a software program called Visual Sample Plan (Battelle Memorial Institute, Version 6.0) was used, as it has a module designed specifically to analyze transect surveys with applications toward unexploded ordnance (UXO). Actual transect paths and anomaly locations were imported into the program along with a selected search window diameter. The program produces an output file that is then overlain on the map of the target area (**Appendix C**).

5.1.1 Tangier Island Target Site

At the Tangier Island Target Site, a total of 112.6 miles of transect data were collected and 4,148 anomalies detected between all three target locations. This equates to 89.6 acres of data collection with an average of 46.3 anomalies per acre.

At the Primary Target, 39.7 miles of data were collected yielding 1,184 anomalies. The field data and DGM response for the Primary Target, is presented in **Figure 5-1**. The majority of

the anomalies detected are located within a cross-shaped high response area located in the vicinity of the target location. As shown in **Figure 5-2**, the anomalies in the high response area are located around the Primary Target in an east to west and north to south cross pattern, potentially suggesting flight patterns associated with range activities from two directions. The number of anomalies detected significantly diminishes outside of the high response area. Approximately 65 percent of the anomalies detected are located in the high-response area. The water depth near this target had originally been reported to be 10 to 15 feet. However, the results of the bathymetric survey from the DGM investigation show that the water depths range from 11 to 20 feet (**Figure 2-3**).

At Navy Targets 1 and 2, 53 miles of data were collected and 2,687 anomalies detected. For Navy Targets 1 and 2, field data and DGM response is presented in **Figure 5-3**. The majority of the anomalies in the vicinity of Navy Targets 1 and 2 are surrounding Navy Target 1 (the western target). As shown in **Figure 5-4**, the anomalies in this target area are located in a high response area that is distributed in a north-south direction primarily surrounding Navy Target 1. There are minimal anomalies surrounding Navy Target 2. Approximately 78 percent of the anomalies are located within the high response area of this target area. The water depth in the vicinity of Navy Targets 1 and 2 had originally been reported to be 10 to 15 feet. However, the results of the bathymetric survey from the DGM investigation show that the depths range from 10 to 22 feet (**Figure 2-4**).

Finally, at the San Marcos Target area, there were a total of 19.9 miles of data collected with 277 anomalies detected. The field data and DGM response for the San Marcos Target is presented in **Figure 5-5**. As shown in **Figure 5-6**, there is no distinguishable high concentration area located surrounding the San Marcos. The anomalies detected trend in a southwest to northeast direction, but are distributed across the site. The water depth in the vicinity of the San Marcos Target had originally been reported to be 24 to 29 feet. However, the results of the bathymetric survey from the DGM investigation show that the depths range from 26 to 32 feet (**Figure 2-5**).

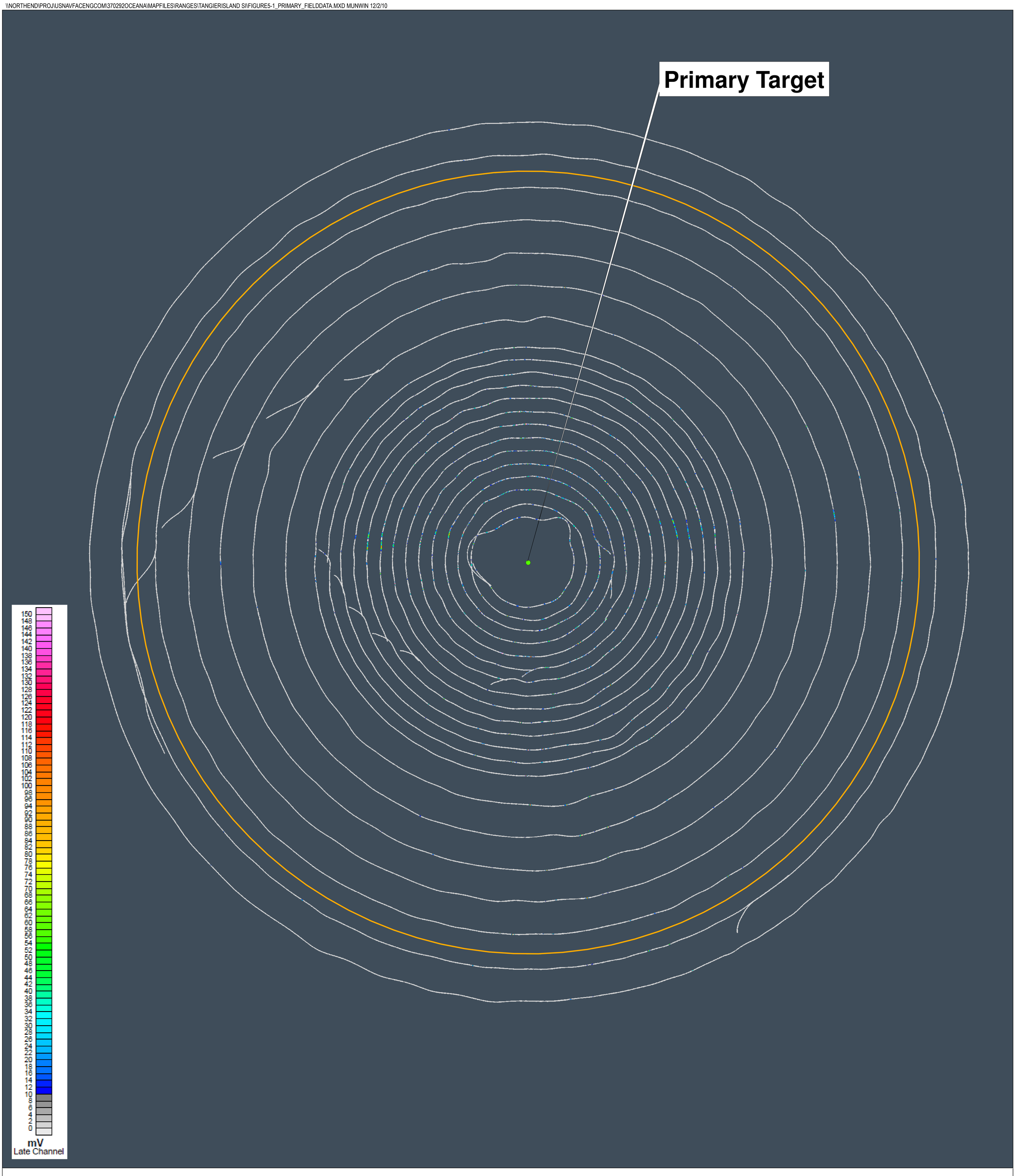
5.2 Conceptual Site Models

The data presented in the previous sections, along with the results of the SI, were used to update the conceptual site model (CSM) profile presented in the PA Report and to develop a graphical CSM. The CSM is a useful engineering management tool that helps to manage site information and guide decision making throughout the environmental restoration process. CSMs are used to scope investigations, support potential risk management decisions, and aid in defining the effectiveness of potential remedial alternatives. Each CSM summarizes the site conditions, the distribution of potential MEC and MC, potential receptors and exposure pathways, and land use data for the site.

A CSM was originally presented for the range in the PA Report (Malcolm Pirnie, 2008) as a table and flow diagram. For this report the CSM has been updated to a graphical model format. The graphical CSMs for the Tangier Island Target Site locations, Primary Target, Navy Targets 1 and 2, and San Marcos Target, are presented in **Figure 5-7** and **Figure 5-8**. The data presented on the current CSM has been updated from the information provided in the PA Report to reflect any new information obtained during the SI, including anomaly concentrations, updates to transport mechanisms (based on the Tier I Sediment Transport Evaluation) and receptors observed during the field activities. For the OTO range, human

exposure pathways include direct contact with MEC during commercial and recreational activities that could result in unintentional detonation of the item, contact with MC that has leached from MEC into the sediment and surface water, and ingestion of fish, shell fish, and other edible items from the Bay environment. Similarly, marine organisms may be impacted if an item detonates or they are exposed to MC through ingestion of the Bay water and sediment, which can bioaccumulate through the food chain as they are eaten by higher level species feeding in or on the Bay.

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE5-1_PRIMARY_FIELDDATA.MXD MUNWIN 12/2/10



Legend

- Investigation Area
- Target Location

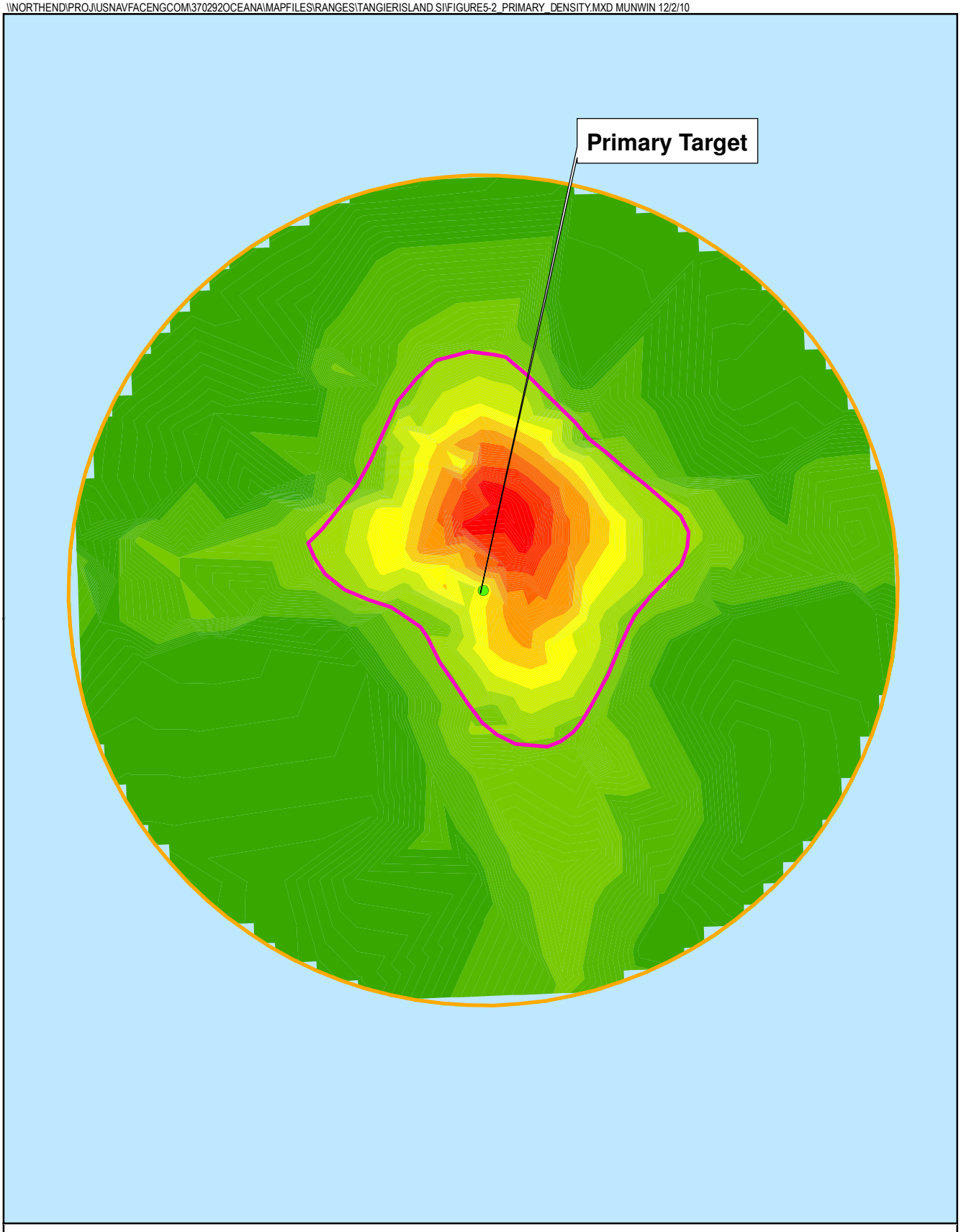
N
W E
S

0 250 500 750 1,000
Feet

Figure 5-1
Primary Target Field Data
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE5-2_PRIMARY_DENSITY.MXD MUNWIN 12/2/10



Legend

- Investigation Area
- Target Location
- High Response Area (103 acres)

Anomalies Per Acre

0 - 10	51 - 60
11 - 20	61 - 70
21 - 30	71 - 80
31 - 40	81 - 90
41 - 50	91 - 100
	101 - 107

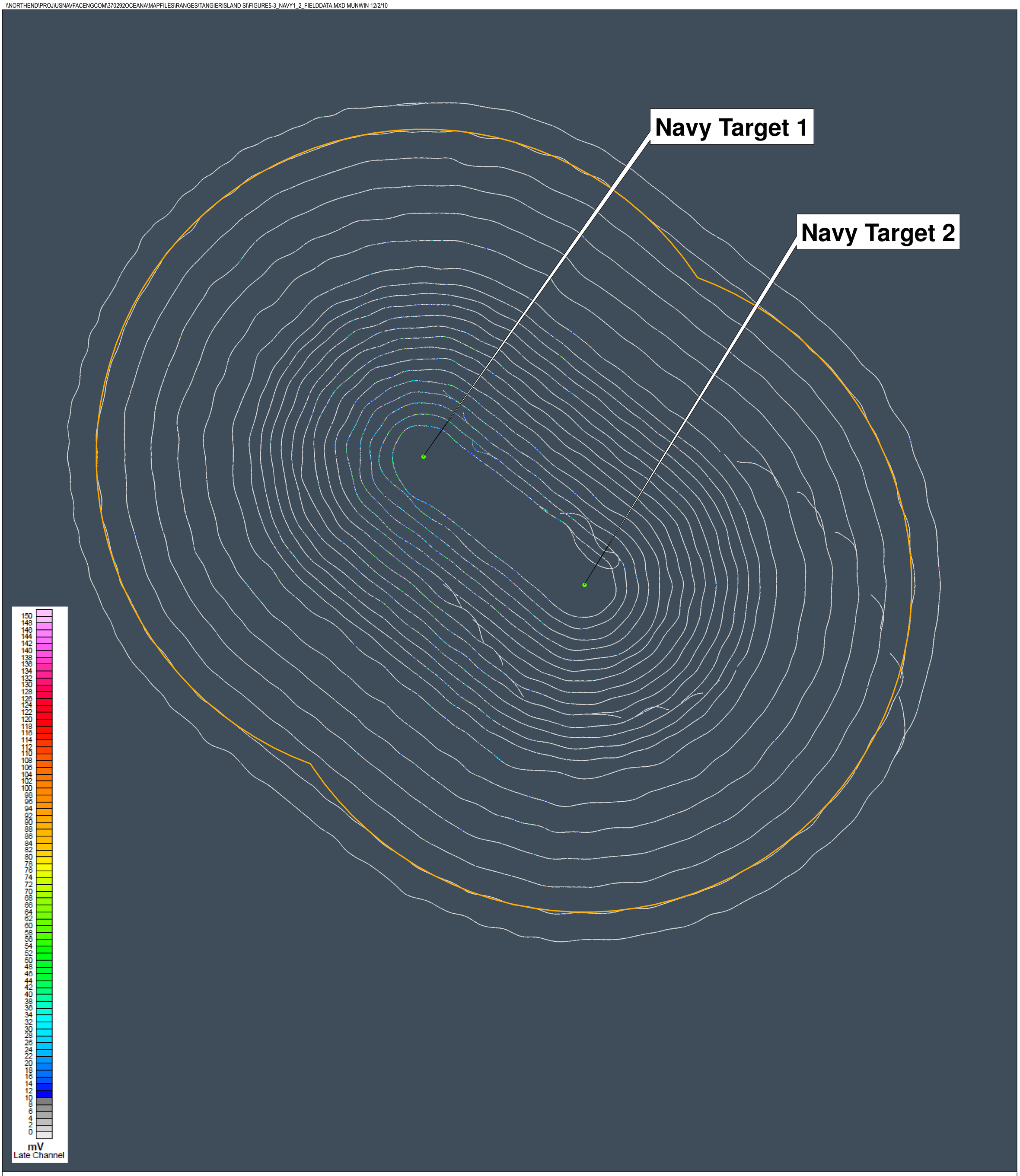
N
W E
S

0 500 1,000
Feet

Figure 5-2
Primary Target
Anomaly Density Map
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE5-3_NAVY1_2_FIELDDATA.MXD MUNWIN 12/2/10



Legend

- Investigation Area
- Target Location

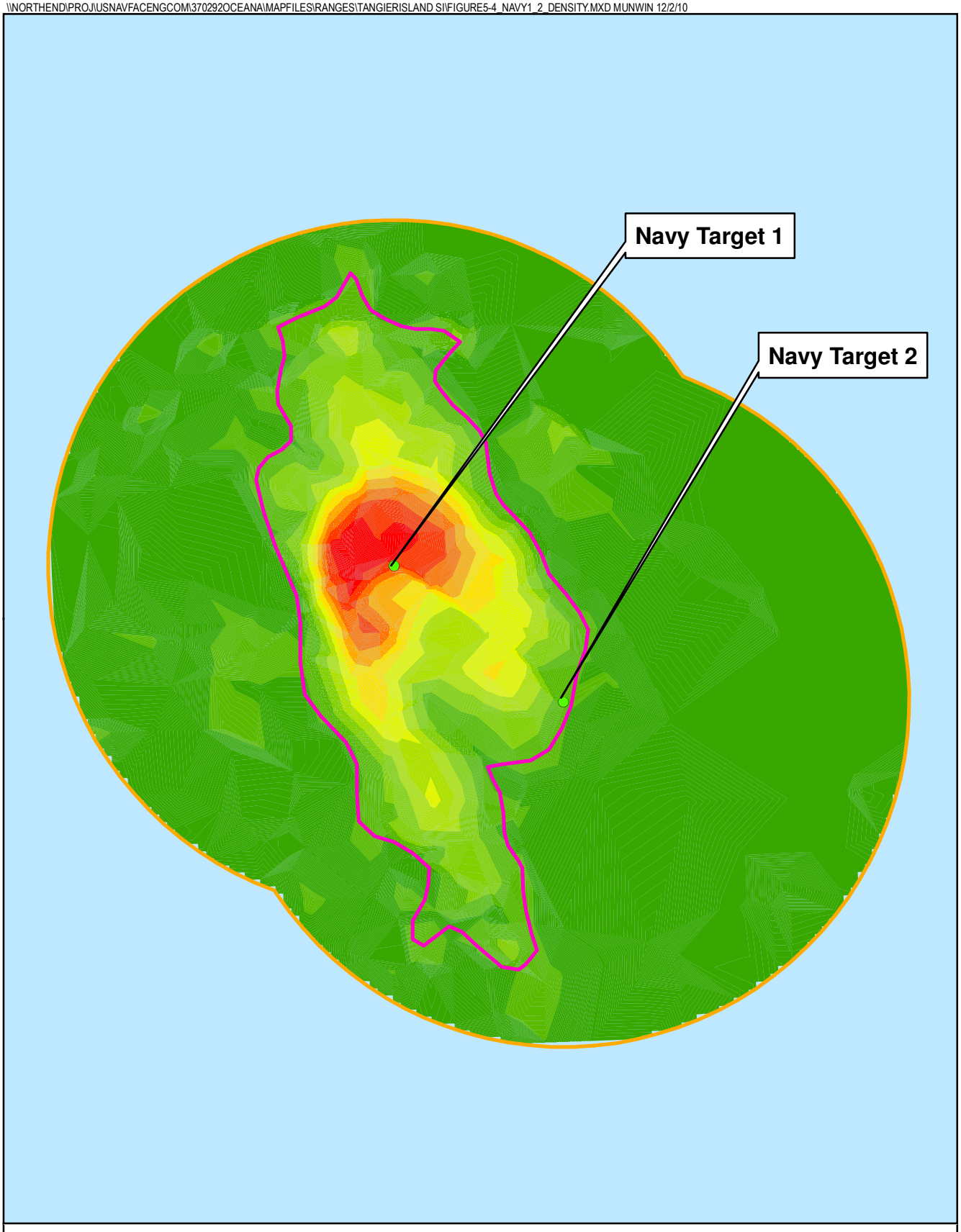
N
W E
S

0 300 600 900 1,200
Feet

Figure 5-3
Navy Targets 1 and 2 Field Data
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE5-4_NAVY1_2_DENSITY.MXD MUNWIN 12/2/10



Legend

- Investigation Area
- Target Location
- High Response Area (216 acres)

Anomalies Per Acre

- 0 - 25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 200
- 201 - 225
- 226 - 250

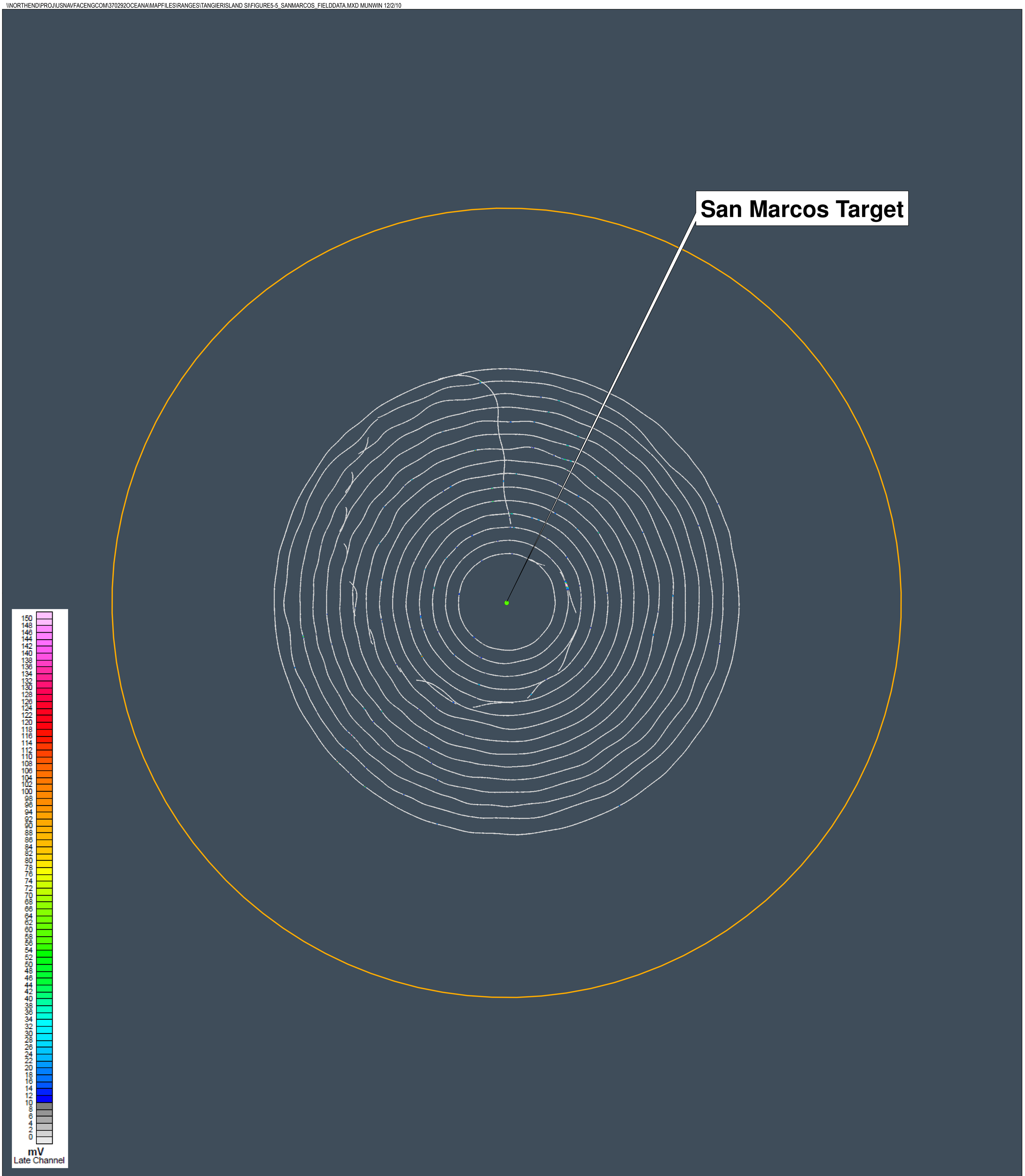
N
W E
S

0 600 1,200
Feet

Figure 5-4
Navy Targets 1 and 2
Anomaly Density Map
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE5-5_SANMARCOS_FIELDDATA.MXD MUNWIN 12/2/10



Legend

- Investigation Area
- Target Location

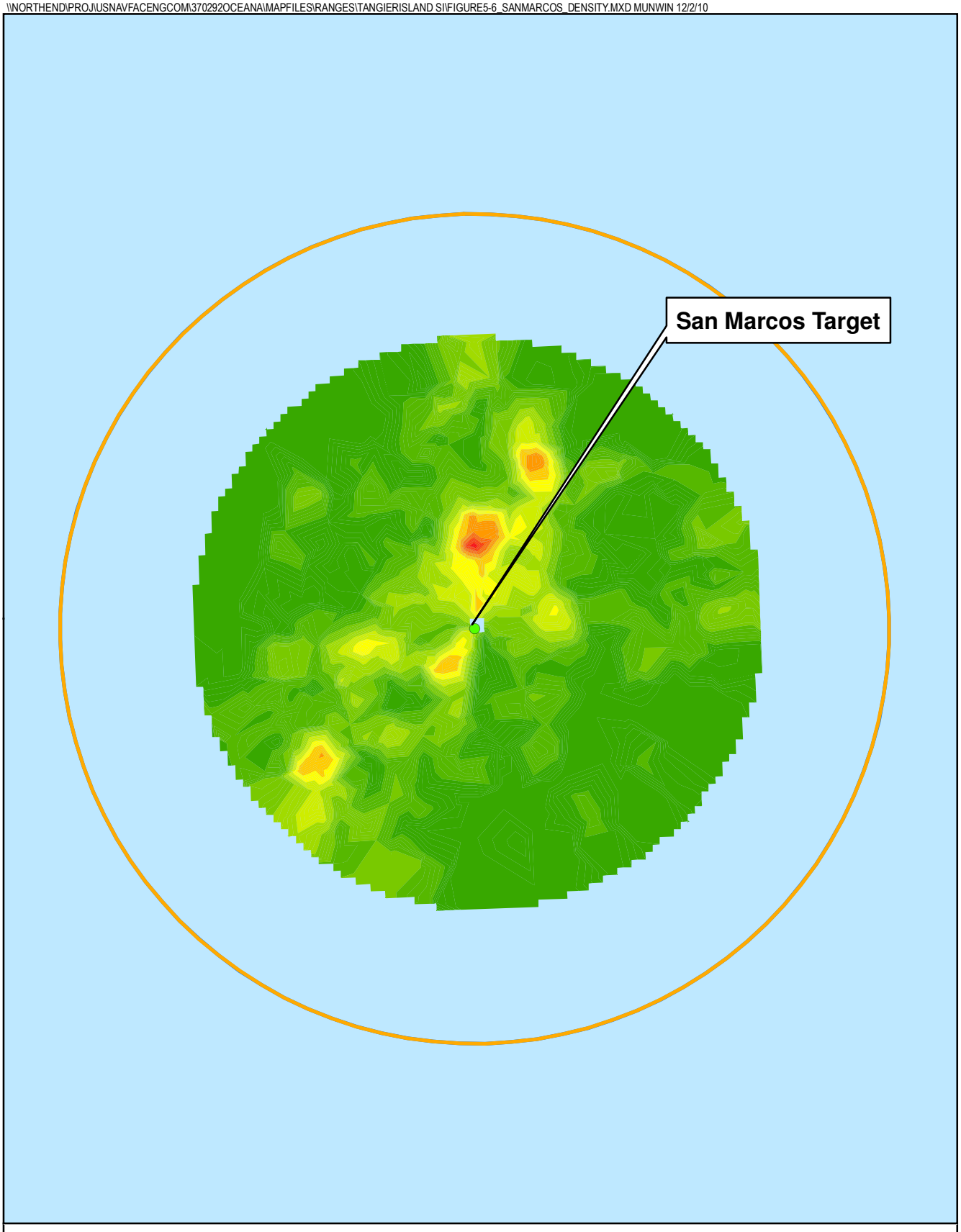
N
W E
S

0 250 500 750 1,000
Feet

Figure 5-5
San Marcos Target Field Data
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\TANGIERISLAND SI\FIGURE5-6_SANMARCOS_DENSITY.MXD MUNWIN 12/2/10



Legend

Investigation Area

Target Location

Anomalies Per Acre

0 - 5
6 - 10
11 - 15
16 - 20
21 - 25
26 - 30
31 - 35
36 - 40
41 - 45
46 - 50
51 - 54

N
W
E
S

0 500 1,000 Feet

Figure 5-6
San Marcos Target
Anomaly Density Map
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

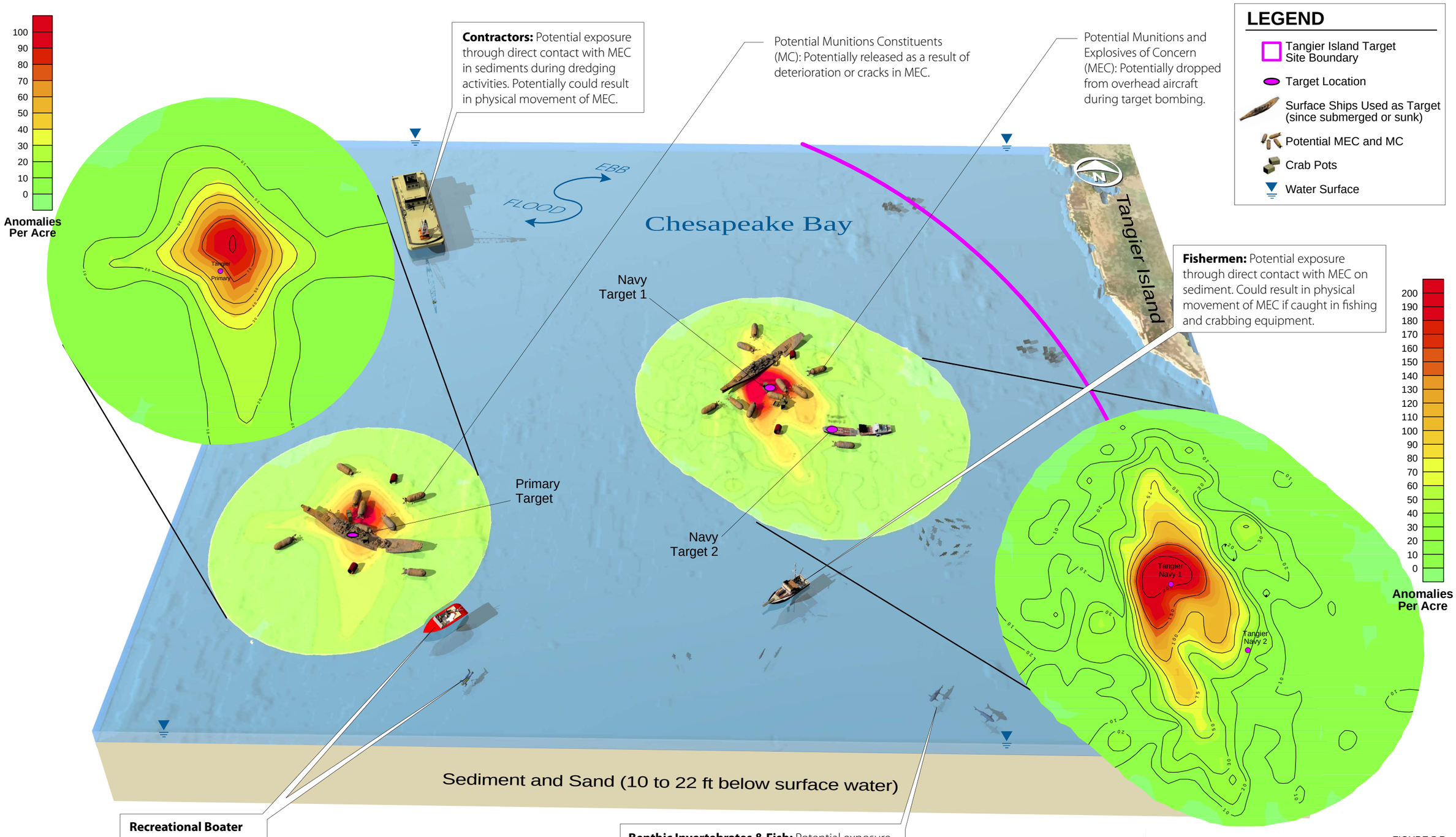


FIGURE 5-7
Tangier Island Target Site
Primary Target and Navy Targets 1 & 2 Conceptual Site Model
NAS Oceana
Virginia Beach, Virginia

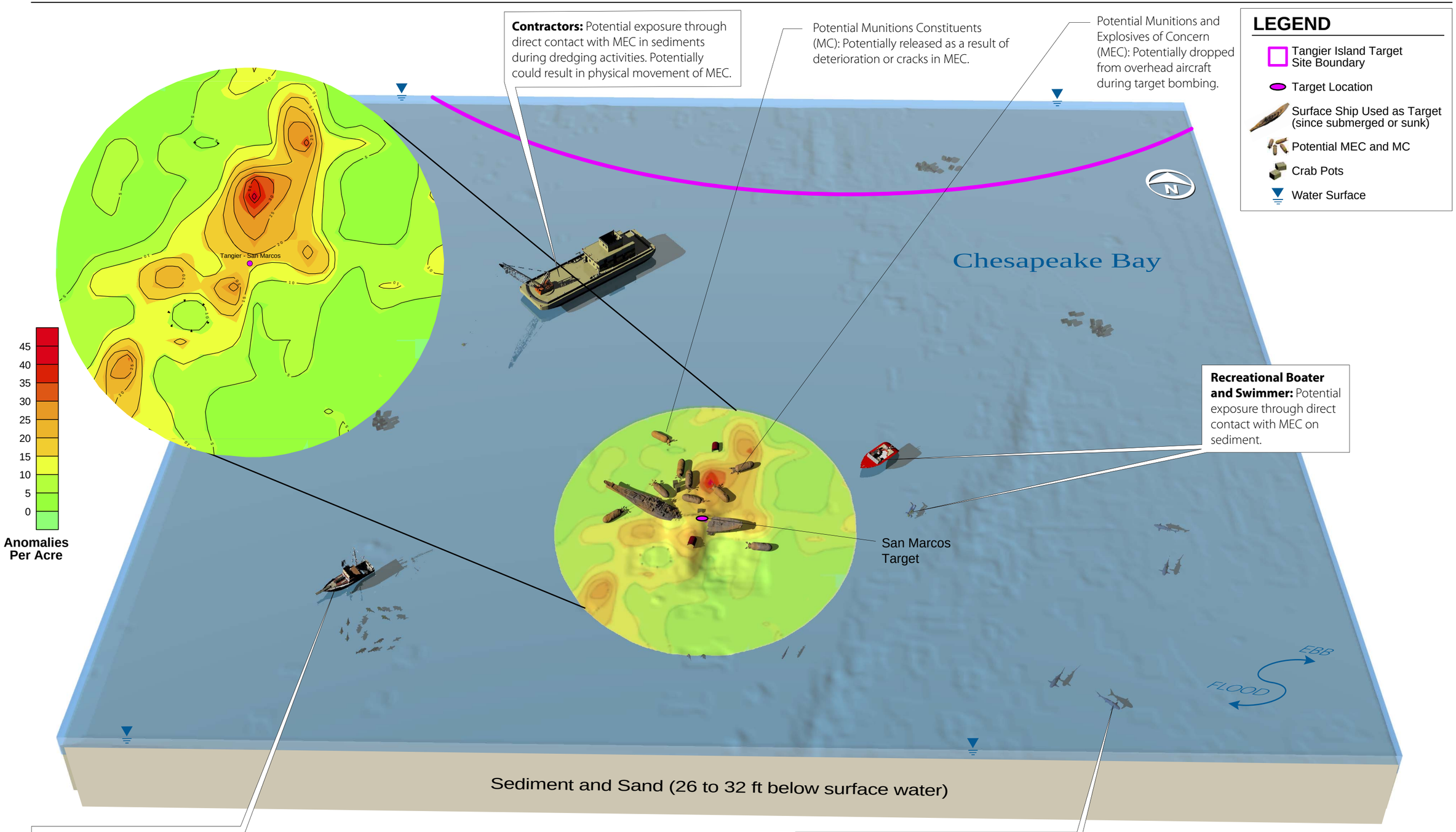


FIGURE 5-8
Tangier Island Target Site
San Marcos Target Conceptual Site Model
NAS Oceana
Virginia Beach, Virginia

SECTION 6

Conclusions and Recommendations

The SI resulted in the detection of 4,148 anomalies within the investigation areas of the Tangier Island Target Site. The majority of these anomalies are concentrated around presumed target locations, which is indicative of range usage. However, it should be noted that these anomalies only represent a metallic response and have not been confirmed to be MEC- or range-related. The results of this SI alone cannot be used to confirm the presence of MEC at the site. Additional investigation would be necessary to confirm the nature of the items in the areas of the detected anomalies.

Based upon the results of the DGM investigation, a significant number of anomalies were detected at each of the target locations within the range. The lowest anomaly densities were observed at the San Marcos Target location and the highest anomaly densities were observed surrounding Navy Target 1.

According to the data collected during the DGM investigation, there is a significant concentration of anomalies in the vicinity of the Primary Target location and Navy Target 1, suggesting use as bombing targets at the range. At the Primary Target location, the majority of the anomalies are located in a 103-acre, cross-shaped high response area surrounding the hard target. At Navy Target 1, the majority of the anomalies are located in a 216-acre north-south trending high response area surrounding the target. Anomalies were also identified surrounding the San Marcos Target and Navy Target 2, but at a significantly lower concentration that is distributed across the target area. As indicated in the PA, the San Marcos was sunk in the 1920s. Therefore, this target may have been used for bombing activities other than those performed at the Primary Target and Navy Targets 1 and 2.

The origin and identity of the Primary Target and Navy Targets 1 and 2 is not fully understood; however, at each of the target locations (as well as the San Marcos Target location), side-scan sonar data confirmed the presence of a ship that was utilized as a hard target. At the Primary Target and Navy Target 1, remnants of these hard targets protrude from the water and are navigational hazards.

As discussed in the Tier I Sediment Transport Evaluation Technical Memorandum, the targets are in a sandy, shallow water environment that is exposed to wind and wave action. Although the sandy sediments may be resuspended during storm events and fine-grained particles are likely to be transported away from the site, it is suggested that MEC (if present at the site) is likely to remain in place near the targets due to their large size and weight. The relatively shallow sandy area of the Target site has been identified as a net depositional environment based on bathymetric differences measured over the past 100 years (Hobbs et al., 1992). MEC, if present at the site, is likely to be gradually buried if it remains in place. In addition, the sandy sediments surrounding the potential MEC objects may be eroded during storm events, facilitating the burial process.

Therefore, additional investigation may be necessary to inspect and identify anomalies at each of the targets located at the Tangier Island Target Site. Inspection of a representative

sample of anomalies may aid in the determination of whether or not additional anomalies should be investigated. As previously discussed, this investigation was performed as an initial data gathering and cannot be used to identify specific anomalies. The data provides evidence areas of concentrated anomalies that may be useful in identifying where to further investigate, but does not provide locations for individual anomalies. Additional data collection may be necessary to reacquire and inspect individual anomalies. As part of this investigation, anomalies would have to be visually inspected to determine if the anomalies are MEC or MEC related. If a significant number of the items identified are determined to be MEC, MC sampling of the sediments may also be necessary.

Navy Targets 1 and 2 have been confirmed as hard targets that exist at the site. These targets are shown on NOAA Nautical Charts but are not included in the PA or the CFR citation. Therefore, they may need to be added to the site definition as presented in the PA for this MRP site, and in the CFR to restrict access within the vicinity of the hard targets (similar to the prohibited area defined for the Primary Target). Additionally, placing signage or buoys near the hard targets may be necessary to warn boaters of the potential navigational hazards associated with the former targets. Finally, the Munitions Response Site Prioritization Protocol scoring should be revised and updated based upon any changes to the initial scoring which are impacted by future investigations.

SECTION 7

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Geo-Marine, Inc. (GMI). 2006. *Integrated Natural Resources Management Plan (Final), Naval Air Station Oceana, Dam Neck Annex and Naval Air Station Oceana, South Virginia Beach Annex (Camp Pendleton).*

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Appendix A
Side-Scan Sonar Investigation Technical Memorandum

Side-Scan Sonar Investigation Results for the Tangier Island Target Site, NAS Oceana, Virginia Beach, VA

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PREPARED BY: Adam Forshey /CH2M HILL

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Mike Green/NAVFAC Atlantic
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Tamir Klaff/CH2M HILL
Timothy Garretson/CH2M HILL

DATE: August 12, 2010

Introduction

This Technical Memorandum documents the activities and findings for the side-scan sonar investigation in support of a Site Inspection (SI) at the Tangier Island Target site associated with Naval Air Station (NAS), Oceana, Virginia Beach, Virginia.

Under NAVFAC CLEAN Contract N62470-08-D-1000, Contract Task Order (CTO) WE03, CH2M HILL is tasked with conducting an SI to evaluate the potential presence of munitions and explosives of concern (MEC) at this site. The scope of the SI includes the collection of bottom feature data for the target areas, including side-scan sonar imagery.

The objective of the side-scan sonar investigation was to confirm hard target locations and to identify potential areas of concern where debris or other materials may be protruding from the seafloor that could tangle and foul equipment used during future underwater geophysical investigations. The side-scan sonar survey data collection, processing and interpretation were performed by Sonographics, Inc. of Walton Manors, Florida, under subcontract to CH2M HILL.

Site Description/Background

The Tangier Island Target Site is an off-installation, other-than-operational water range that consists of multiple former hard targets utilized for air-to-ground training exercises. There are currently four hard targets assumed to be located at the site. The total site area encompasses approximately 18,095 acres. However, only a portion of this area is being investigated as part of the SI. The primary focus of the SI will be on the known hard target locations (**Figure 1**) and will include a 1000-yard radius investigation area around each target. This investigation area was selected to encompass the known hard target locations. The San Marcos Wreck target was not included in this investigation because it has already been investigated by a separate contractor as part of a National Oceanic and Atmospheric Administration (NOAA) project. The results of the NOAA investigation however, are briefly discussed in this report, as they pertain to the SI activities.

According to the Preliminary Assessment (PA) (Malcolm Pirnie, 2008), the targets consisted of two scuttled cargo ships located 2,800 yards west of Tangier Island in the Chesapeake Bay, approximately 65 miles north of Norfolk, Virginia.

The range was reportedly used from approximately 1970 until 1996 for aerial bombardment and rocketry training. Records from 1993 through 1996 indicate practice rockets and bombs were used at the site (primarily 25 pound bombs). Use of the training range was stopped in July 1996 because range procedures cited in the Code of Federal Regulations (CFR) could not be met. The site is currently not in use by the Navy, but commercial and recreational fishing occur in the vicinity of the target areas. Numerous crab pot buoys were evident at the site during the site reconnaissance in May 2009. Additionally, the air space over the target (R-6609) is restricted for aerial training by the Navy.

Investigation Activities

A side-scan sonar investigation was conducted to confirm hard target locations and to identify potential areas of concern where debris or other materials may be protruding from the seafloor. Details of the equipment, approach, methods, operation procedures, results and quality control methods are presented in the side-scan sonar subcontractor report (**Attachment 1**).

The following is a summary of the events associated with the investigation:

- **April 19, 2010:** A safety meeting was held in Onancock, Virginia, and attended by Adam Forshey of CH2M HILL, Rick Horgan of Sonographics and Mark Crockett (the captain of the survey vessel Joyce Marie II).
- **April 20- 23, 2010:** The side-scan sonar investigation was performed. The area investigated (see Figure 2) consisted of two rectangular areas around the CFR identified target and the two "Navy Targets" identified on NOAA Nautical Charts.

Results

Side-scan sonar imagery and data collected during the site investigation has been used to identify hard target locations and potential obstructions that may interfere with future DGM operations. Objects detected that were larger than 24-inches cubed were identified as contacts (**Figure 3**). Three known potential hard target locations were investigated, including the two "Navy Targets" and CFR identified target (**Figure 4**). The coordinates, dimensions, and descriptions are listed below and summarized in **Table 1**.

- Navy Target West: The target is located in Target Area 2 and is located at 37° 48.5725' N, 76° 01.7849' W or at Universal Transverse Mercator (UTM)[1] coordinates E1343025, N13730888. The approximate dimensions are 442 feet long in a northeast-southwest alignment and 72 feet wide. Parts of the structure are still protruding from the water.

[1] North American Datum (NAD) 83, meters

- Navy Target East: The target is located in Target Area 2 is located at 37° 48.4856' N, 76° 01.5524' W or at UTM coordinates E1344143, N13730349. The approximate dimensions are 116 feet long in a northeast-southwest alignment and 67 feet wide. There is a day marker adjacent to this wreck.
- CFR Target (CFR Target): The target is located at 37° 47.9344' N, 76° 03.7885' W or at UTM coordinates E1333341, N13727125. The approximate dimensions are 470 feet long in an east-west alignment and 79 feet wide. Parts of the structure are still protruding from the water.

TABLE 1
Tangier Island Target Coordinates as Depicted on the Sonar Mosaic

Target Name	W. Longitude	N. Latitude	Easting*	Northing*	Dimensions
Navy Target West	76° 01' 47.09"	37° 48' 34.35"	1343025	13730888	442 x 72 feet
Navy Target East	76° 01' 33.14"	37° 48' 29.14"	1344143	13730349	116 x 67 feet
CFR Target	76° 03' 47.31"	37° 47' 56.06"	1333341	13727125	470 x 79 feet

* Universal Transverse Mercator, North American Datum (NAD) 83, meters

The side-scan activities included 200 percent bottom coverage of the identified areas of concern (1,920 acres). Objects identified as equal as or greater than the size of a crab pot (assumed dimensions of 24 inches cubed) were considered a contact. In summary, 528 contacts were identified in the vicinity of the Navy Targets (Target Area 2), while 1,099 contacts were identified in the vicinity of the CFR cited target (Target Area 1). The side-scan sonar imagery of the contacts identified in Target Areas 1 and 2 is presented in **Figure 3**. The majority of contacts are believed to show evidence that they are related to the bombing range due to the north and south patterns concentrated throughout the wreck sites.

Detailed side-scan sonar imagery of the contacts found in Target Areas 1 and 2 are presented in the figures listed below:

- **Figure 5**: Navy Target West and East with identified contacts
- **Figure 6**: CFR Target with identified contacts

Detailed side-scan sonar imagery of the NOAA investigation of the San Marcos area is presented in the figures listed below:

- **Figure 7**: NOAA side-scan sonar area
- **Figure 8**: NOAA side-scan sonar area with identified contacts
- **Figure 9**: San Marcos wreck area

Additional information regarding the NOAA side-scan sonar survey and results can be found in the NOAA Descriptive Report[2] (not included as part of this document).

It was noted during the side-scan investigation of the CFR target that additional contacts were identified further south outside the Primary Target 1 search box. Some of these contacts are also identified in the NOAA reports as shown in **Figure 8**.

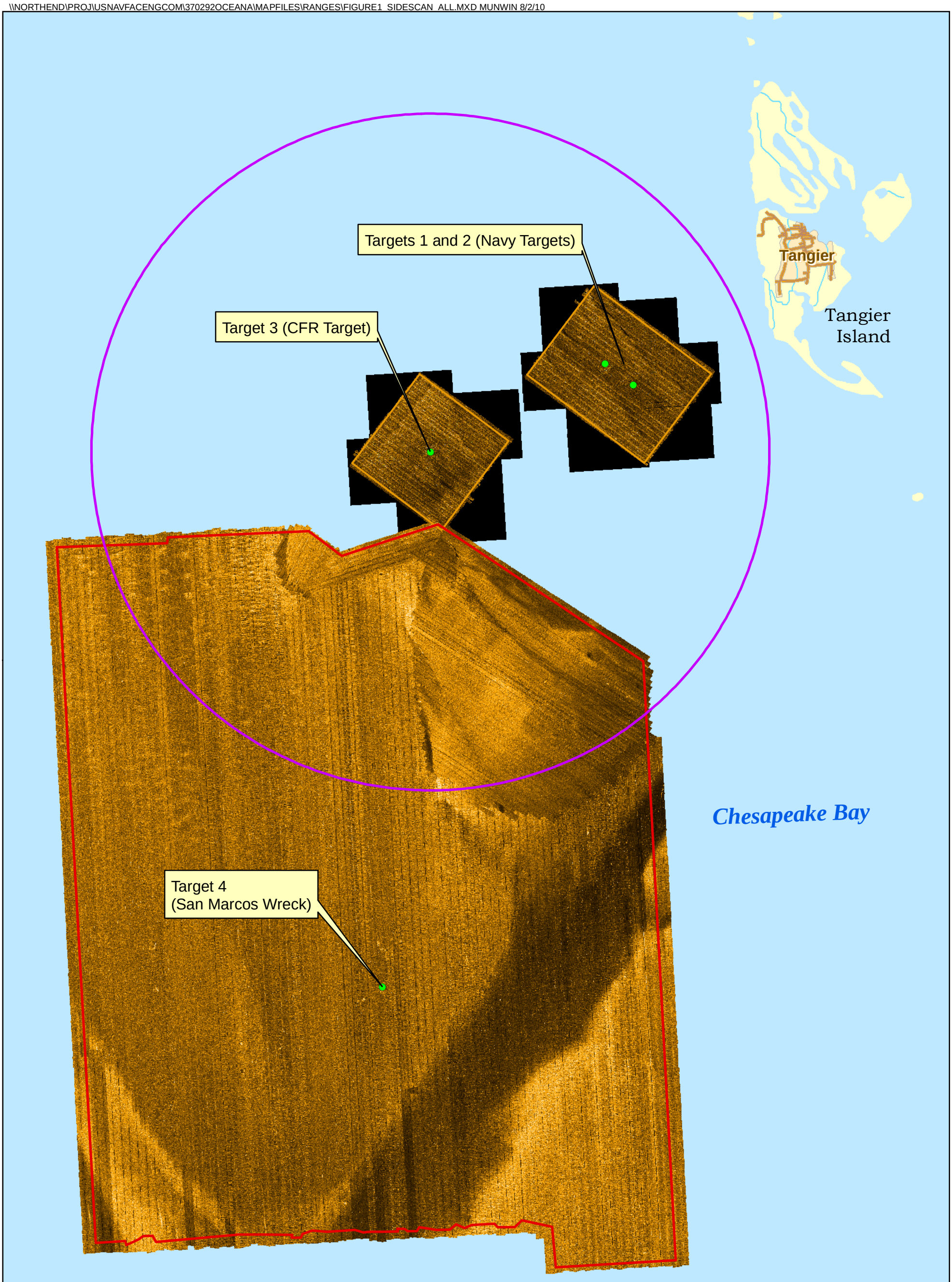
[2]Survey: H12044 Descriptive Report, Southern Chesapeake Bay, Virginia. December 2009

Conclusions

The three known potential hard target locations (Navy Target West, Navy Target East and the CFR Target) were investigated during the side-scan sonar investigation. The results of the survey confirmed remnants of three hard targets within the investigation area (remnants were also identified at the San Marcos Wreck during the NOAA investigation). It is possible, but has not yet been confirmed that the two larger targets identified (Navy Target West and CFR Target) may be the two scuttled cargo ships which were identified in the PA. Additional investigation would be necessary to confirm the origin of the targets.

There are a significant number of contacts that were identified in the vicinity of each of the identified hard targets. The pattern of the majority of contacts identified around the targets indicate that, if they are related to the bombing range activities , the bombers flew primarily in a north-south orientation, which is perpendicular to the east-west alignment of the targets. Based on the results of the investigation, these targets are considered navigational hazards to vessels that have impaired or lacking navigational skills or tools. While the two larger targets (the CFR Target and Navy Target West), are still exposed at the surface in a few places, they are difficult to see and could be easily missed, especially in bad weather. All three targets, as well as the San Marcos wreck to the south, will be included in the upcoming DGM investigation.

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE1_SIDESCAN_ALL.MXD MUNWIN 8/2/10



Legend

- 3-Nautical Mile Restricted Area
- Side-Scan Area
- NOAA Side-Scan Area*
- Approximate Target Locations

*Data obtained from "Survey: H12044 Descriptive Report, Southern Chesapeake Bay, Virginia. December 2009"

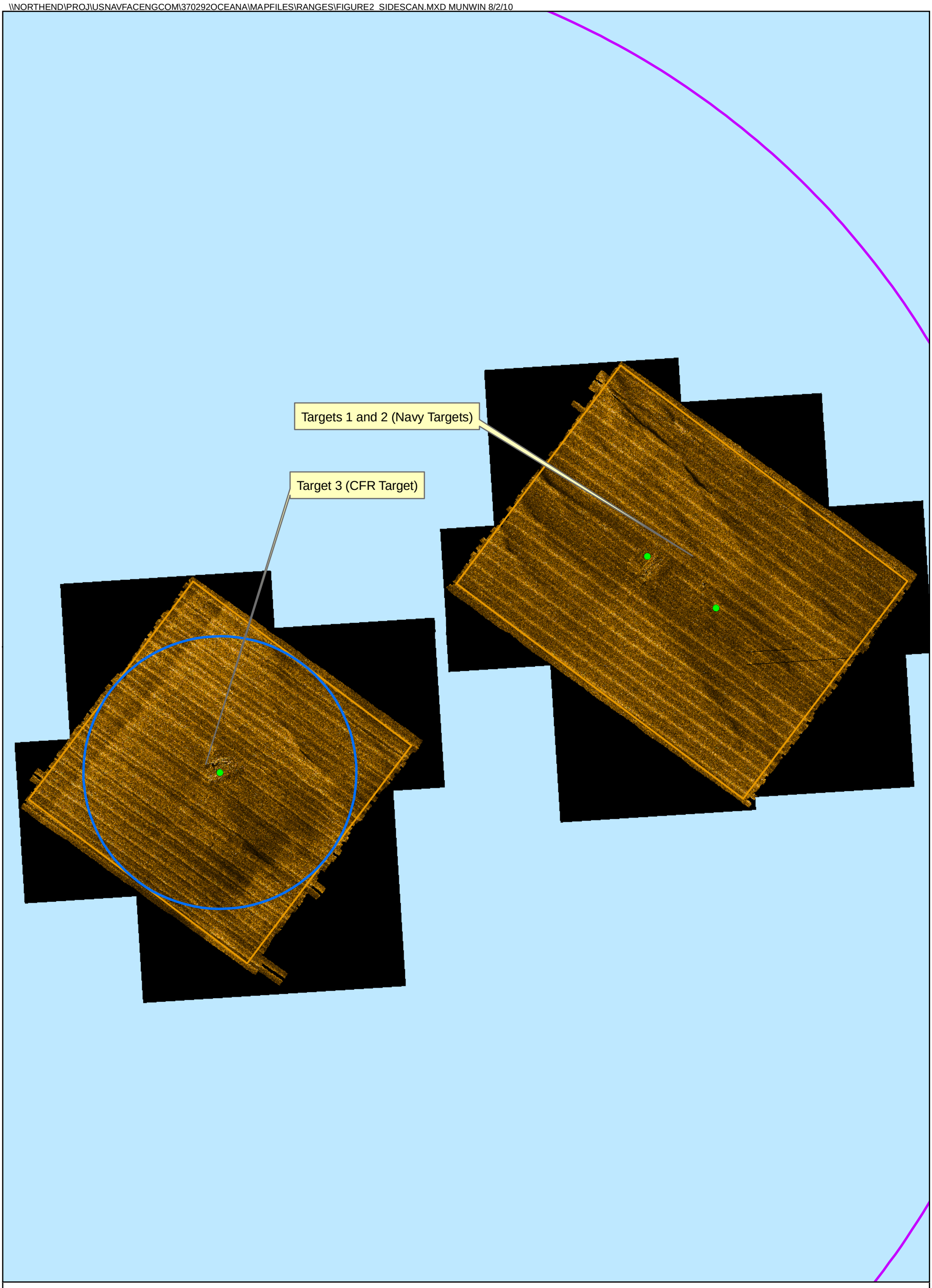
N
W E
S

0 5,000 10,000
Feet

Figure 1
Tangier Island Side-Scan Sonar Area
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE2_SIDESCAN.MXD MUNWIN 8/2/10



Legend

- 1,000-Yard Prohibited Area
- 3-Nautical Mile Restricted Area
- Side-Scan Area
- Approximate Target Locations

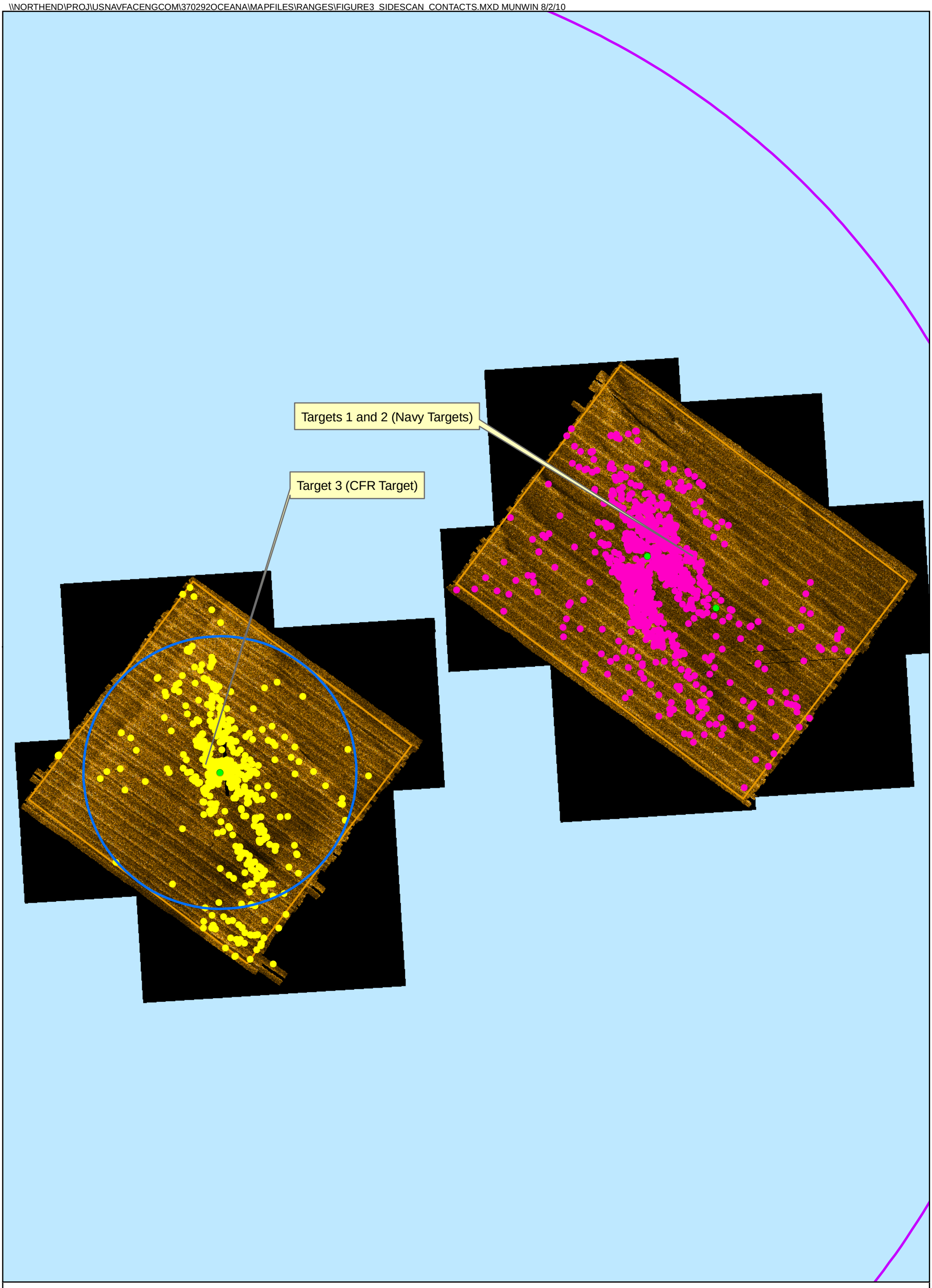
N
W E
S

0 2,000 4,000
Feet

Figure 2
Tangier Island Side-Scan Sonar Area
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE3_SIDESCAN_CONTACTS.MXD MUNWIN 8/2/10



Legend

- 1,000-Yard Prohibited Area
- 3-Nautical Mile Restricted Area
- Side-Scan Area
- Approximate Target Locations
- Targets 1 and 2 Contacts
- Target 3 Contacts

N
W E
S

0 2,000 4,000 Feet

Figure 3
Tangier Island Side-Scan Sonar Area with Contacts
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE4_TARGETS_EASTWEST.MXD MUNWIN 8/2/10

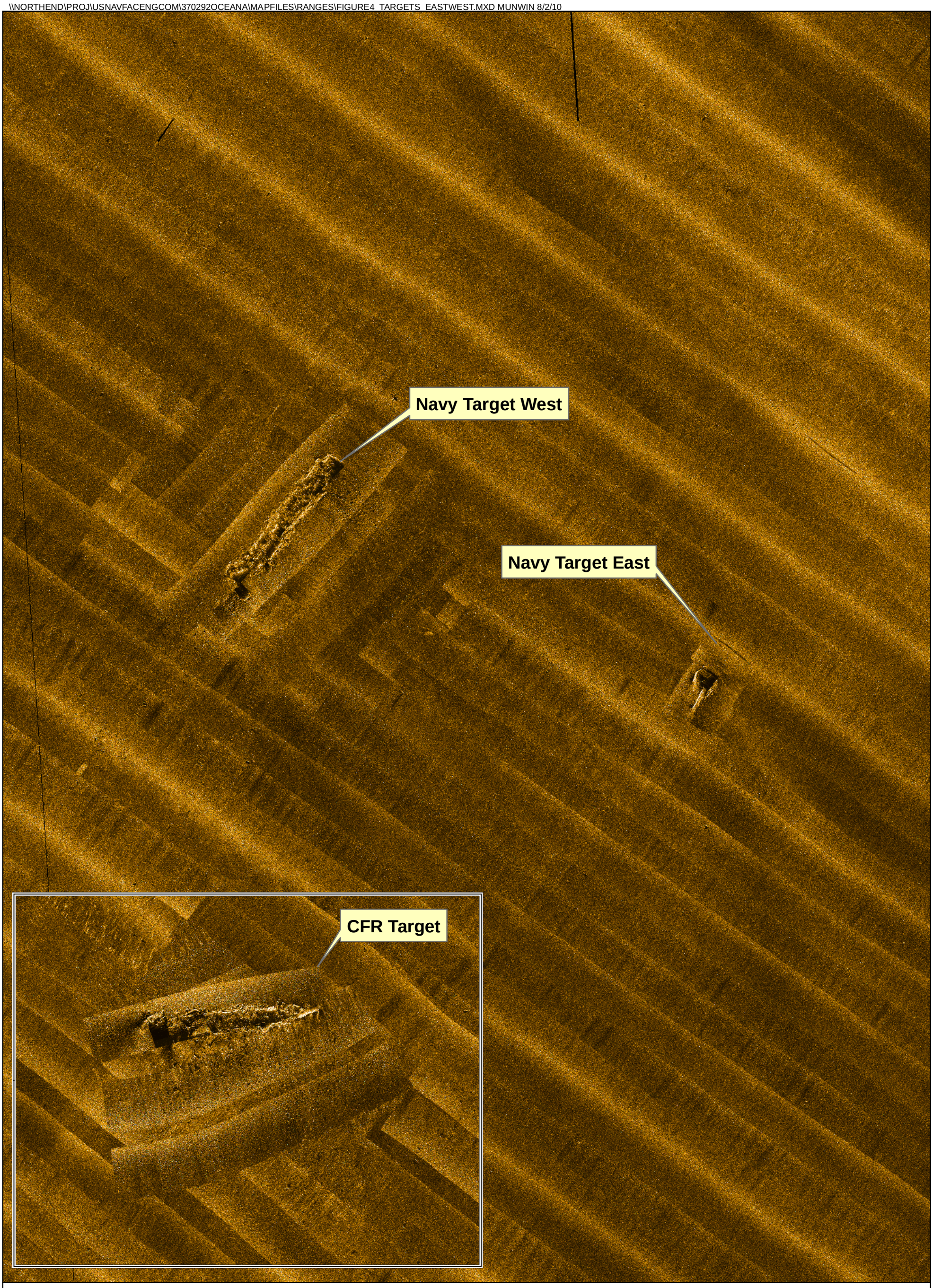
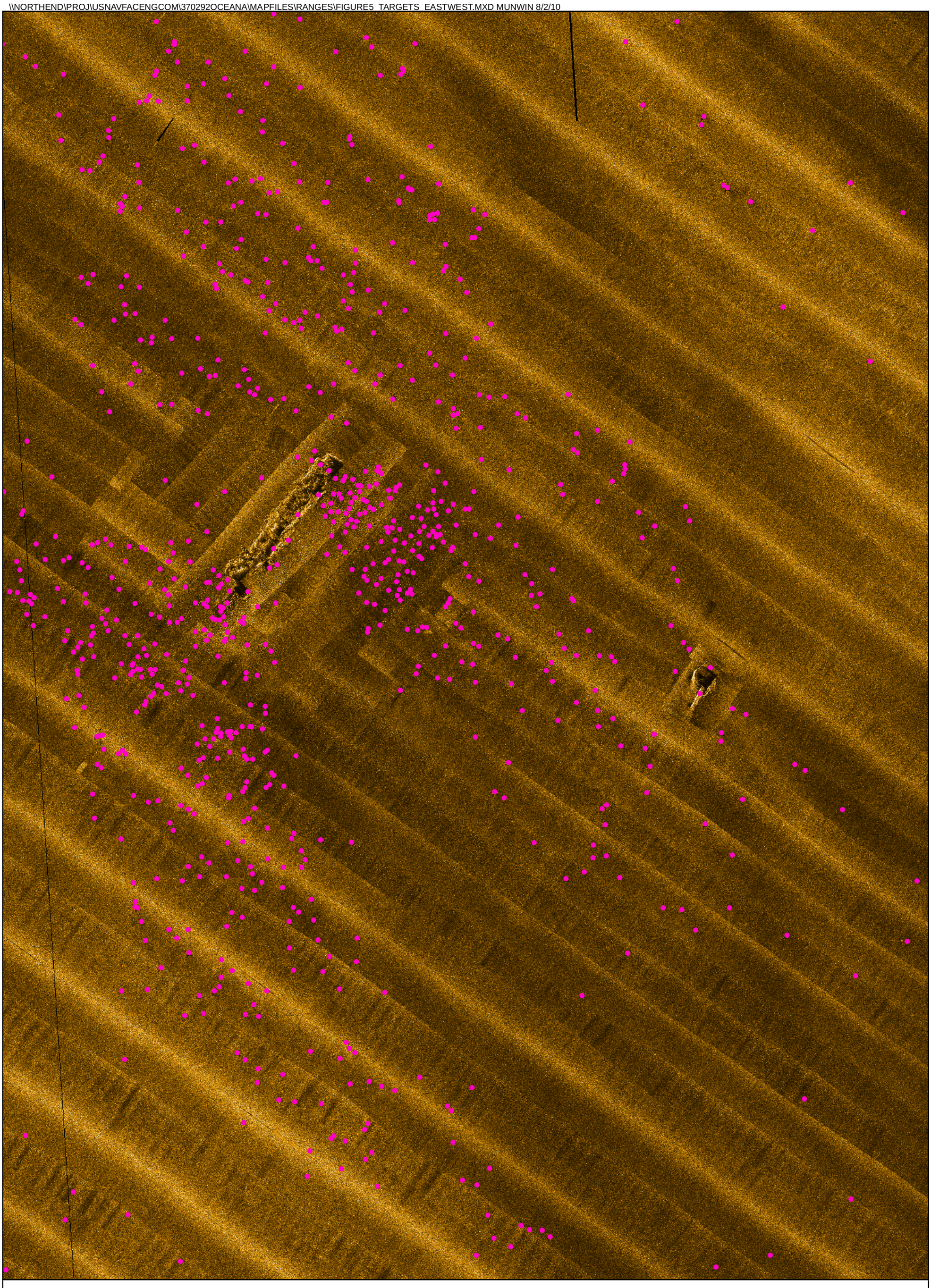


Figure 4
Close Up of Targets
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE5_TARGETS_EASTWEST.MXD MUNWIN 8/2/10



Legend

- Targets 1 and 2 Contacts

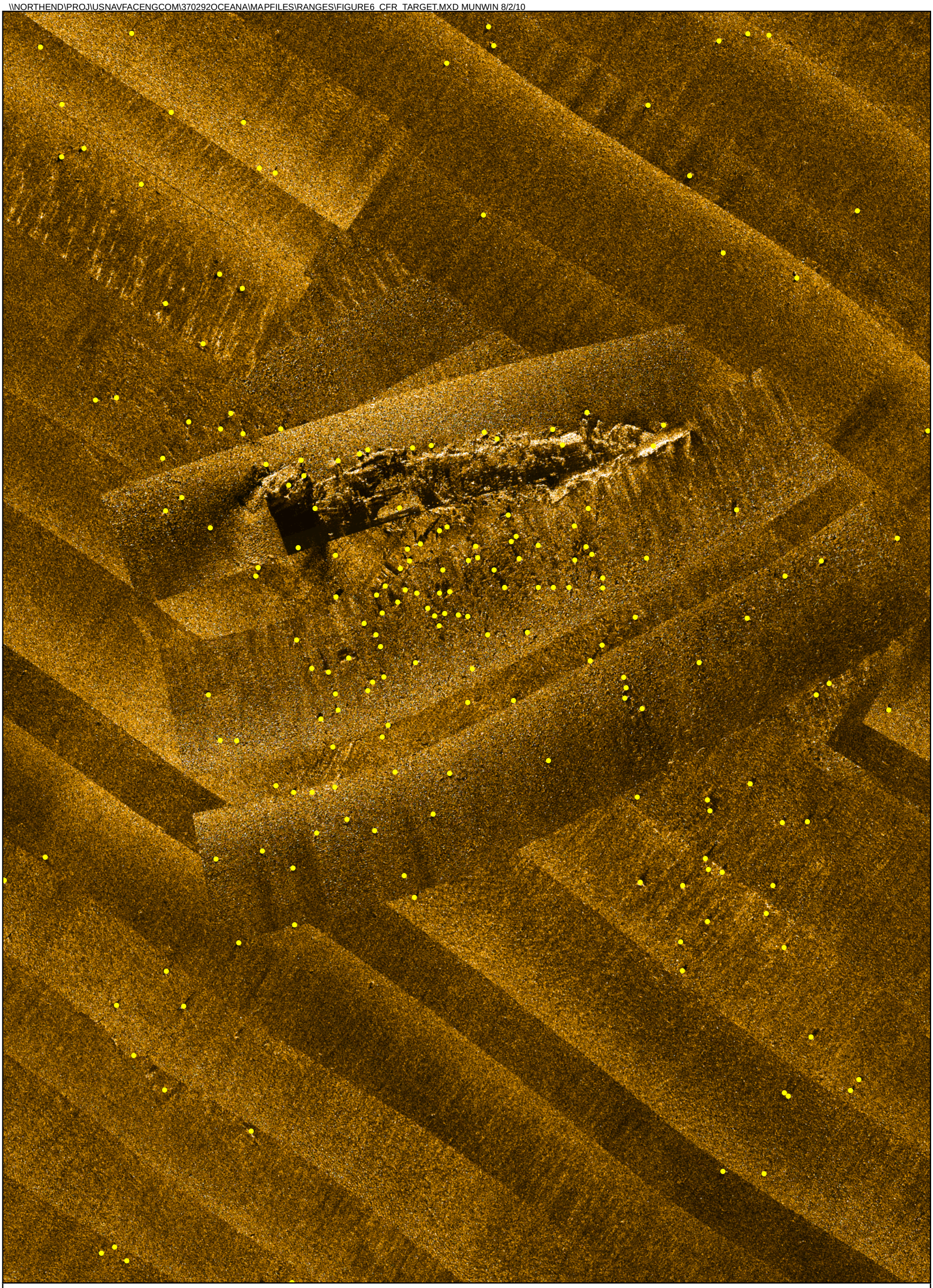
N
W E
S

0 250 500
Feet

Figure 5
Navy Targets West and East with Contacts
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE6_CFR_TARGET.MXD MUNWIN 8/2/10



Legend

- Target 3 Contacts

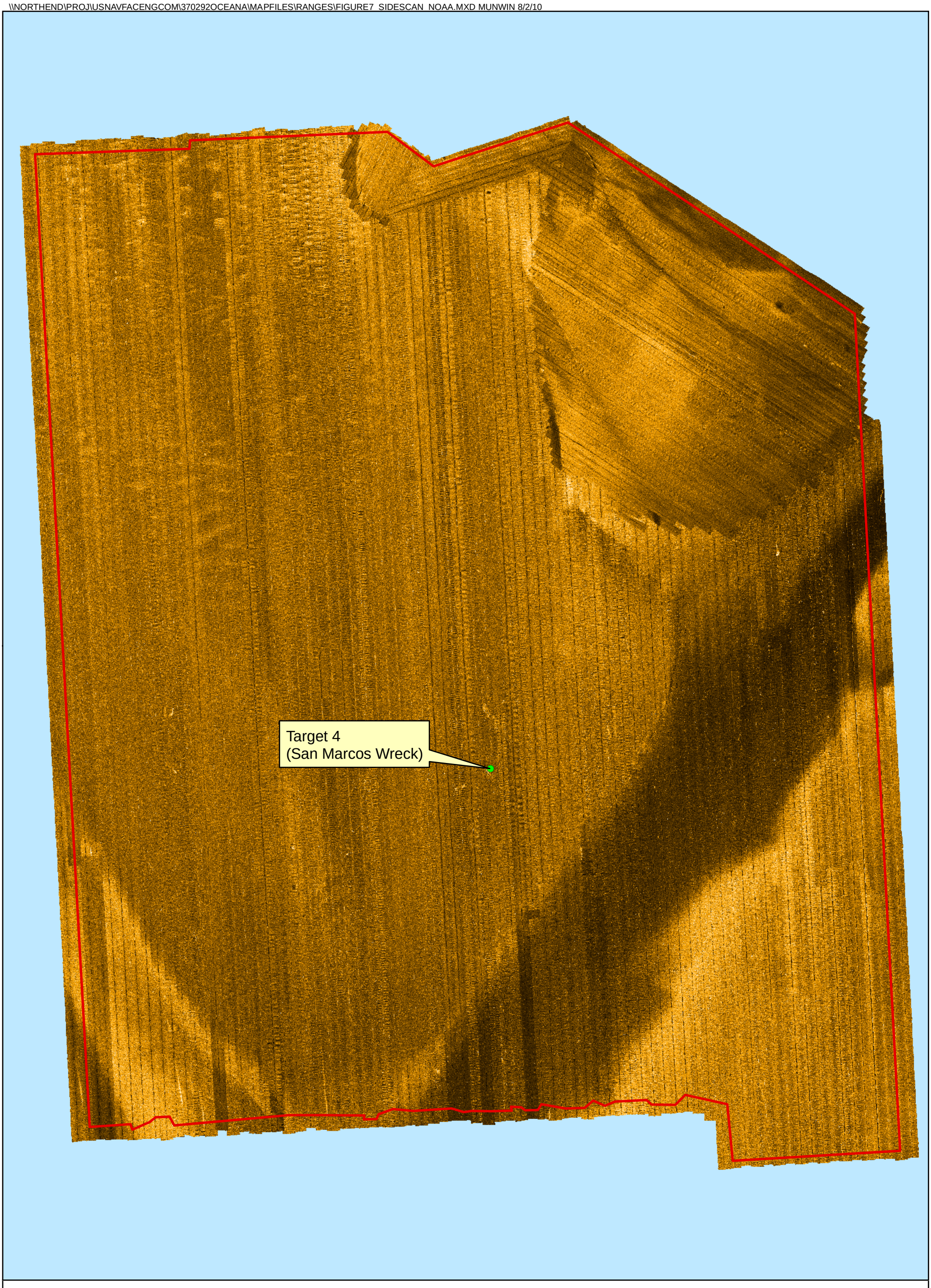
N
W E
S

0 100 200
Feet

Figure 6
CFR Target with Contacts
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE7_SIDESCAN_NOAA.MXD MUNWIN 8/2/10



Legend

NOAA Side-Scan Area*

Approximate Target Locations

*Data obtained from "Survey: H12044 Descriptive Report, Southern Chesapeake Bay, Virginia. December 2009"

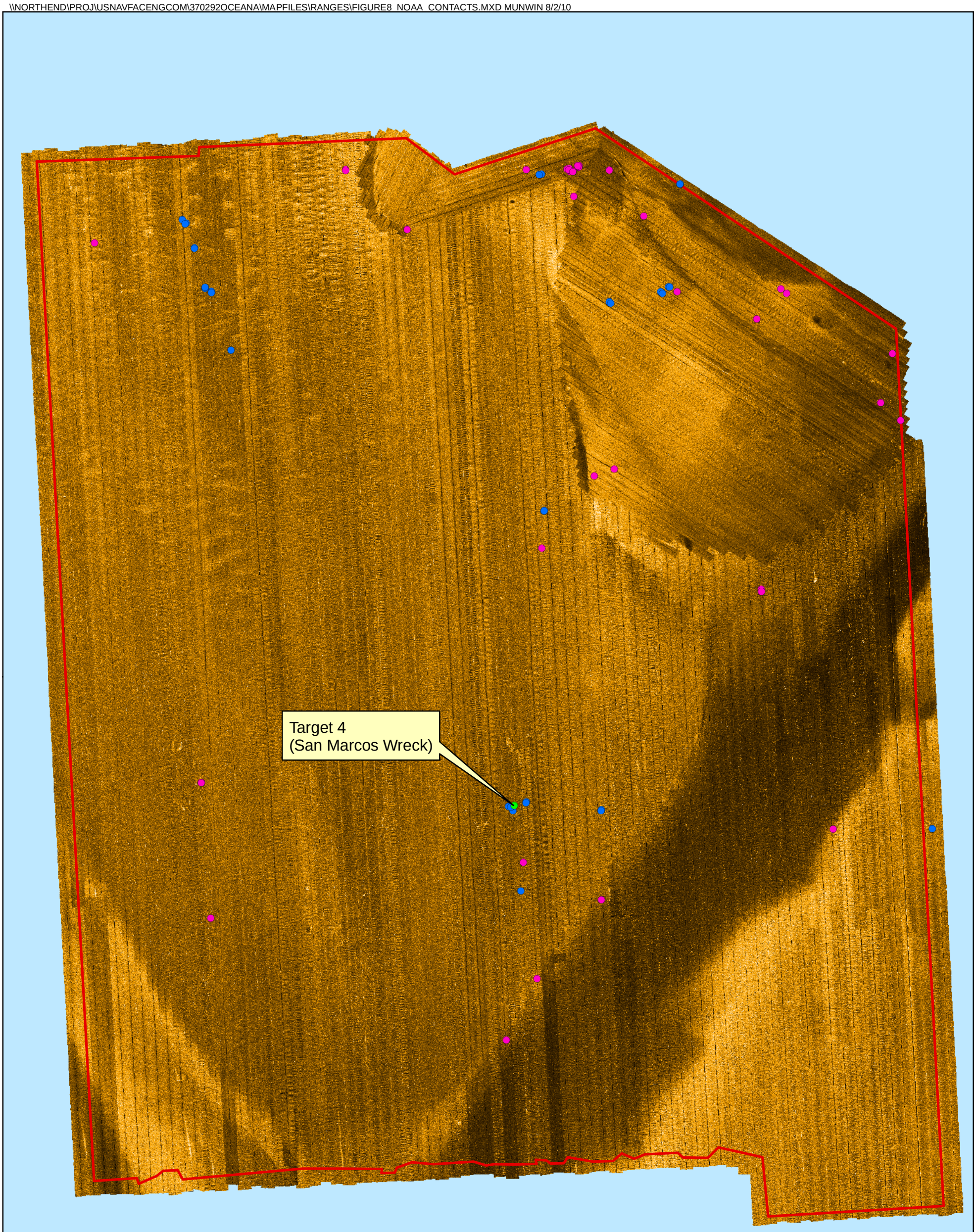
N
W E
S

0 3,500 7,000
Feet

Figure 7
NOAA Side-Scan Sonar Area
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE8_NOAA_CONTACTS.MXD MUNWIN 8/2/10



Legend

- NOAA Side-Scan Area*
- Approximate Target Locations
- Significant Contacts
- Insignificant Contacts

*Data obtained from "Survey: H12044 Descriptive Report, Southern Chesapeake Bay, Virginia. December 2009"

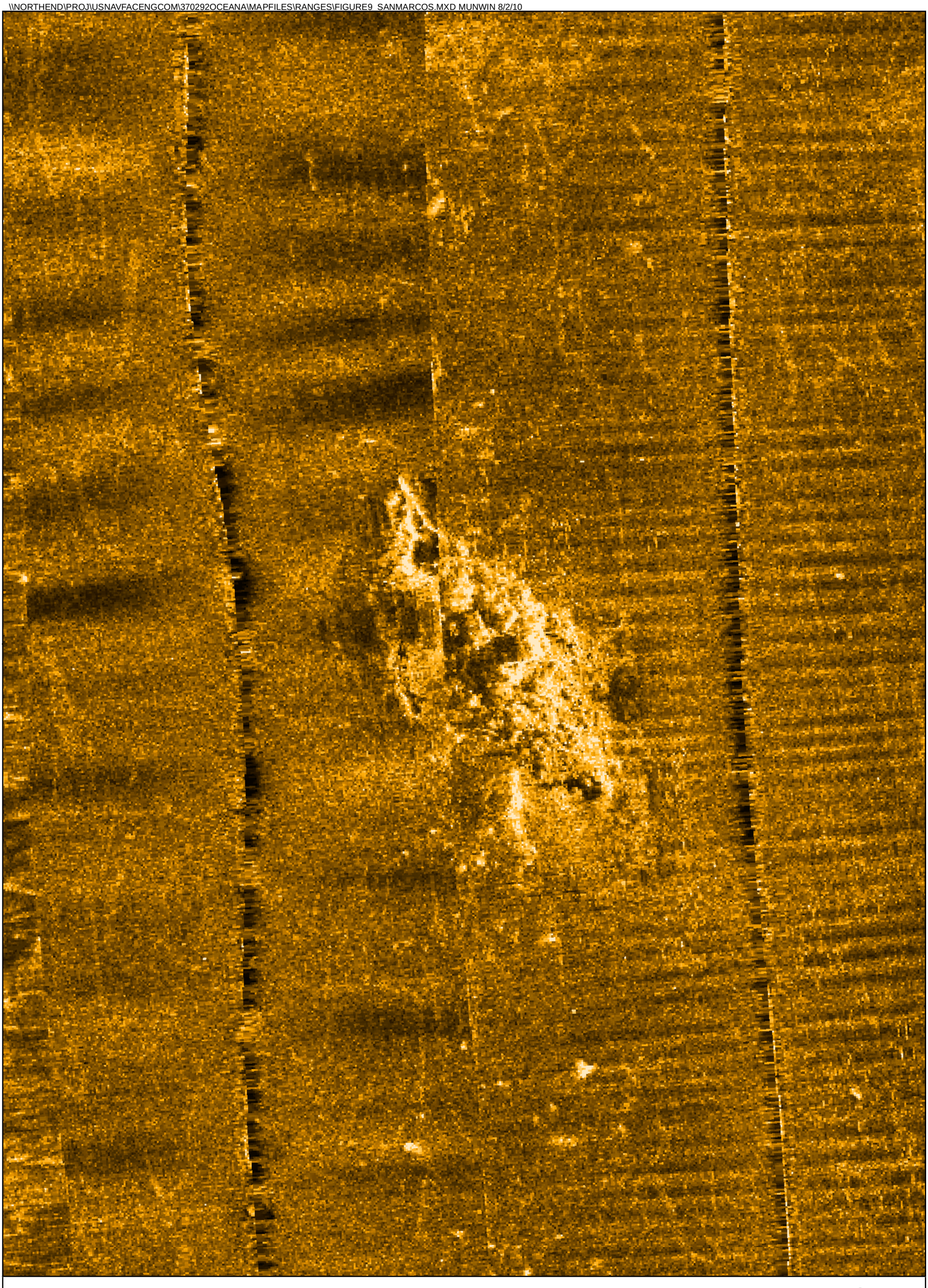
N
W E
S

0 3,500 7,000
Feet

Figure 8
NOAA Side-Scan Sonar Area Contacts
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE9_SANMARCOS.MXD MUNWIN 8/2/10



*Data obtained from "Survey: H12044 Descriptive Report, Southern Chesapeake Bay, Virginia. December 2009"

N
W E
S

0 75 150
Feet

Figure 9
San Marcos Wreck Area
Tangier Island Target Site
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

Final Report

Side-Scan Sonar Investigation of the Tangier Island Target Site Preliminary Assessment/Site Inspection

Tangier Island Target Site, Naval Air Station Oceana Virginia Beach, VA

Contract Task Order WE03

August 2010

Prepared For:

Prepared By:

SONOGRAPHICS, INC.

Contents

Attachments

Acronyms and Abbreviations

AHA	Activity Hazard Analysis
CFR	Code of Federal Regulations
DGPS	Differential Global Positioning System
ECL	Emergency Contact List
GPS	Global Positioning System
HDOP	Horizontal Dilution of Position
NAD 83	North American Datum 1983
NAS	Naval Air Station
NOAA	National Oceanographic and Atmospheric Administration
PA	Preliminary Assessment
USCG	United States Coast Guard
UTM	Universal Transverse Mercator Projection

Introduction

SONOGRAPHICS, INC. has completed an underwater geophysical survey. The purpose of the survey is a Preliminary Site Assessment/Site Inspection at the Tangier Island Target Site offshore Tangier Island, Virginia. This report describes the plan of work, the implementation of the plan and the results obtained. The statement of work was issued on October 21, 2009. The following section includes the pertinent excerpts.

A. Initial Goal & Project Plan

A-1: Site Description/Background

The Tangier Island Target Site is an off-installation water range that consists of multiple former hard targets utilized for air-to-ground training exercises, see Figure 1 (attached). The total site area encompasses approximately 18,750 acres. However, only a portion of this area, a 0.9 kilometer radius around three known potential hard target locations, was investigated during this side-scan investigation. According to the Preliminary Assessment (PA), the targets consisted of two scuttled cargo ships located 2.56 kilometers west of Tangier Island in the Chesapeake Bay, approximately 104.6 kilometers north of Norfolk, Virginia.

The locations of these targets are identified on the NOAA nautical charts (http://www.charts.noaa.gov/OnLineViewer/12225.shtml) and on Figure 2 (attached). The two northern-most hard targets (possibly the scuttled cargo ships referenced in the PA) are identified as "Navy Targets" on the nautical charts. These targets are located in approximately 4.5 meters of water. The third target (the center point of the prohibited area identified on the nautical chart) is identified in 33 Code of Federal Regulations (CFR) 334.210, and it is located just west of the "Navy Targets." This target is a scuttled ship located in approximately 4.5 meters of water; some features of this ship still protrude from the water surface (Photograph 1). Photograph 2 is an image taken from the PA that depicts the condition of one of the hard targets when it was still intact (date unknown). The fourth and southern-most target is identified as the San Marcos wreck on the NOAA nautical charts and is located in 9 meters of water. This target (the San Marcos Wreck) was not included as part of the scope performed by this contract. The approximate location of the three targets of concern can be seen on the NOAA nautical chart identified above or in Figure 2 (attached). Approximate coordinates for each target are provided in Table 1 below.

TABLE 1
Tangier Island Target Coordinates are North American Datum 1983 (NAD 83)
Universal Transverse Mercator (UTM), North Zone 18, meters.

Target Name	UTM Easting Coordinate	UTM Northing Coordinate
"Navy Targets"	409335	4185234
	409771	4184859
Primary Target	406386	4183973

PHOTOGRAPH 1
Target Remnants, Helicopter Tour May 12, 2009

PHOTOGRAPH 2
Target from PA

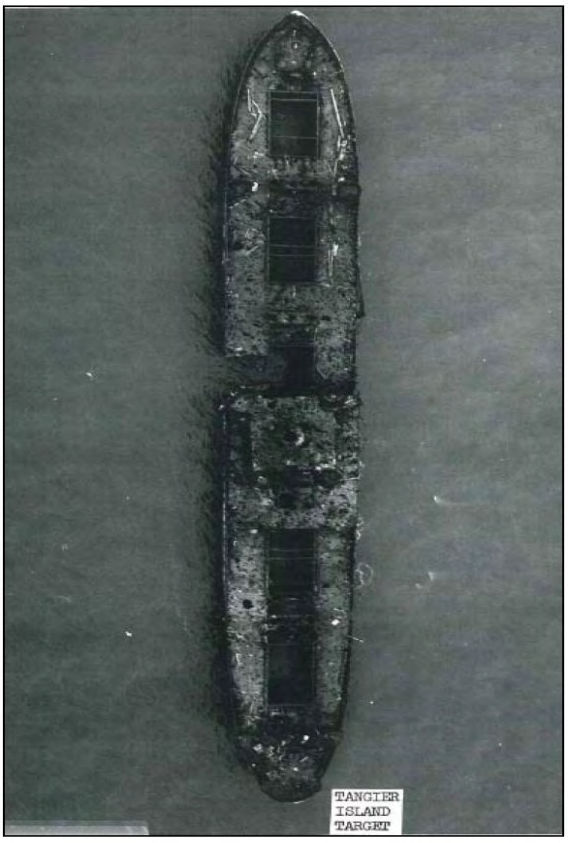


Figure 5.12-1: National Archives photo of one of the Tangier Island target ships (undated).


Legend
NAS Oceana
3-Mile Restricted Area
1,000-Yard Prohibited Area
Target Location
N
W
E
S
0
4.5
9
Miles
Figure 1
Tangier Island Site Location
NAS Oceana
Virginia Beach, Virginia
CH2MHILL
Virginia Beach
NAS Oceana
Smithfield
Suffolk
17
13
64
60
664
564
460
58
264
464
258


Target 2
Target 1
Tangier
Tangier Island
Chesapeake Bay
San Marcos
Legend
3-Mile Restricted Area
1,000-Yard Prohibited Area
Target Location
Side-Scan Area
0
0.65
1.3
Miles
Figure 2
Tangier Island Side-Scan Locations
NAS Oceana
Virginia Beach, Virginia
CH2MHILL

The range was used from approximately 1970 until 1996 for aerial bombardment and rocketry training. Records from 1993 through 1996 indicate practice rockets and bombs were used at the site (primarily 11.3 kilograms in size). Use of the training range was stopped in July 1996 because range procedures cited in the CFR could not be met. Possible munitions used at this site include practice bombs, air-to-surface rockets, and associated spotting and witness charges. The site is currently not in use by the Navy, but commercial and recreational fishing occur in the vicinity of the target remnants. Numerous crab pot buoys were evident at the site during the site reconnaissance in May 2009. Additionally, the air space over the target (R-6609) is restricted for aerial training by the Navy.

The Statement of Work as issued by CH2M HILL is included as Attachment A.

A-2: Work Plan

After Sonographics, Inc. was selected as the subcontractor by CH2M HILL, task 1 was the submittal and acceptance of the Work Plan and Activity Hazard Analysis (AHA). The Work Plan (Attachment B) was then submitted and subsequently accepted on Jan. 28, 2010. The AHA (Attachment C) was accepted by CH2M HILL on Feb. 24, 2010.

B. Equipment

B-1: Navigation System

The Differential Global Positioning System (DGPS) employed on this survey was the Trimble model DSM-232. It is a 12 channel survey quality unit that receives the Coast Guard Beacon transmitted differential corrections to provide sub meter positions. The brochure for the DSM-232 is included in Attachment D.

B-2: Side-Scan Sonar System

The Side-Scan Sonar System employed on this survey was the EdgeTech 4200-FS digital "chirp" simultaneous dual frequency unit. This unit is the stainless steel model and employs the 300 kHz and 600 kHz frequencies. The survey was conducted using the HDM (High Definition Mode). The brochure for the 4200-FS is included in Attachment E.

EdgeTech 4200-FS Side-Scan Sonar System

C. Methodology

C-1: Mobilization

Weather services with 7-day models and forecasts were monitored until a promising weather window was predicted in the survey area. On April 18, 2010 the operator and equipment transited to Onancock, VA, where on April 19, 2010 a safety meeting was held. The safety meeting was attended by Adam Forshey of CH2M HILL, Rick Horgan of Sonographics, Inc. and Mark Crockett the captain of the survey vessel Joyce Marie II (Attachment F). The vessel was mobilized with the Trimble DSM-232 DGPS System, the Navigation Computer with Hypack software and the EdgeTech 4200-FS Side-Scan System (above photo). A remote monitor driven by the Hypack computer was installed as a helm display to guide the helmsman through the project grids. The Hypack program was preloaded with the project grids and background files. The Hypack program was set up to receive the DGPS antenna positions and output the side-scan tow-fish positions to the side-scan topside computer. A test line was set up for the transit from Onancock to Tangier Island. After getting underway the side-scan tow-fish was deployed and the test line was run to establish that all systems were functioning and ready to start the survey. The offsets from the antenna to the transducers on the tow-fish were measured and entered into Hypack software. After making these entries, the positions of the antenna and the tow-fish were monitored on the display to confirm that they were positioned properly. As the vessel docked at Tangier Island a piling was selected as a reference point to verify the repeatability and integrity of the DGPS and grid data.

C-2: Survey

On April 20, 2010, following a safety check on board the vessel Joyce Marie II at 07:19, the Float Plan (Attachment G) was implemented. Survey operations commenced at 08:13. The sea state started at 0.3-0.6 meters from the northwest and improved to nearly flat by mid-day. The first survey line was at the southwest edge of the grid, surrounding target 1 as depicted in the statement of work excerpt above. The grid was set up with lines 30 meters apart. The survey was run such that every third line was skipped. This method allowed the nadir under the tow-fish to be covered by an adjacent line and provided overlap to cover more than 200% of the bottom with the high frequency channels. The survey was conducted with the low frequency channels of the side-scan set at the 75 meter range and the high frequency at the 50 meter range. This allowed the operator to monitor the adjacent lanes for hazardous targets which might obstruct our progress or present a danger to our vessel. We did in fact detect target 1 near the center of the grid and marked the extents on our grid. We discovered that it was 143 meters long. It was aligned east-west across our grid lines which were aligned northwest-southeast. This required us to stop our survey lines that would take us through the target and continue them on the opposite side. A new grid was setup in Hypack in the east-west alignment based on the detected extents. The new grid was surveyed starting at a safe distance from the wreck and working closer with each line until the entire side of the wreck was mapped. This step was repeated on the opposite side until there was sufficient data to map the circumference of the wreck. After mapping the wreck and filling in the partial lines leading up to it, the survey continued toward the northeast side of the grid until 19:13. It was observed that most of the targets associated with the bombing range were concentrated in a north-south pattern that was centered on the wreck. As indicated on the Float Plan, we returned safely to the dock at 19:35 with no safety issues to report for April 20, 2010.

On the morning of April 21st, the winds were strong from the South and the survey was postponed until the wind subsided at 13:30. Following the safety check, the Float Plan was implemented at 14:10. The continuation of the target 1 survey grid occurred at 14:53. The target 2 grid was started at the southwest edge at 16:10. The wind became strong again from the southwest and the sea state started to adversely affect the data and the survey was aborted at 16:30. As indicated on the Float Plan, we returned safely to the dock at 16:53 with no safety issues to report for April 21, 2010.

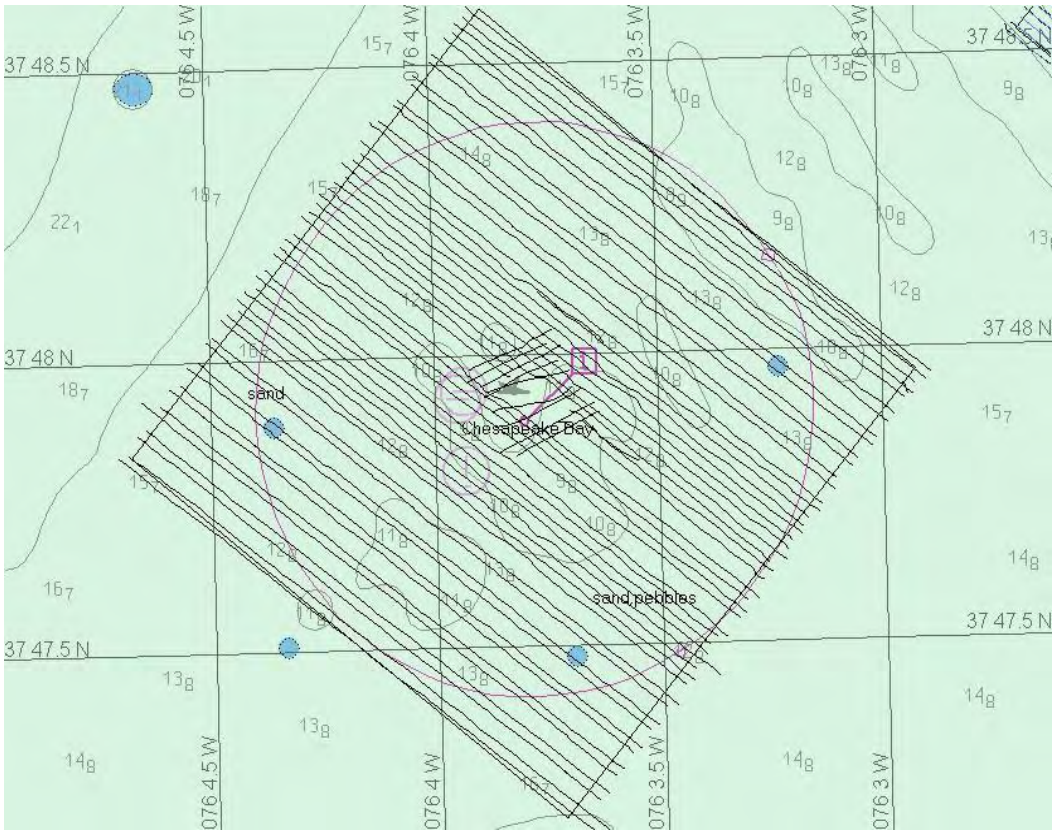
On April 22, 2010, the Float Plan was implemented at 06:51 following a safety check of the vessel. The survey of the target 2 grid continued on April 22nd at 07:11 with 0.3-0.6 meter seas from the northwest that improved to nearly flat by mid-day. The procedure was the same as in grid 1 as the first large target was encountered near the center of the grid. It was aligned southwest-northeast across the grid and a new northeast-southwest grid was set up around it as well. This target was approximately 135 meters long and 22 meters wide. The second smaller target was encountered further east and south of the larger target and a small grid was set up around it as well. The second target was approximately 35 meters by 20 meters and there is a day marker adjacent to it. After mapping the wrecks and filling in the partial lines the survey continued toward the northeast side of the grid until 18:47. The same north-south pattern of concentrated targets through the wrecks was observed. As indicated on the Float Plan, we returned safely to the dock at 19:02 with no safety issues to report for April 22, 2010.

April 23, 2010, a safety check was completed, and the Float Plan was implemented at 07:06. The survey continued on April 23rd at 07:21 with 0.3-0.6 meter seas from the Northwest dropping to 0.3 meters by mid morning but increasing to 0.6 meters by noon. The target 2 grid was completed at 10:43. Additional lines were then run in target area 1 to fill in possible gaps in the high frequency 200% coverage due to drifting off line in opposite directions on adjacent lines. The last survey line was completed at 12:14. As indicated on the Float Plan, we returned safely to the dock at 12:58 with no safety issues to report for April 23, 2010.

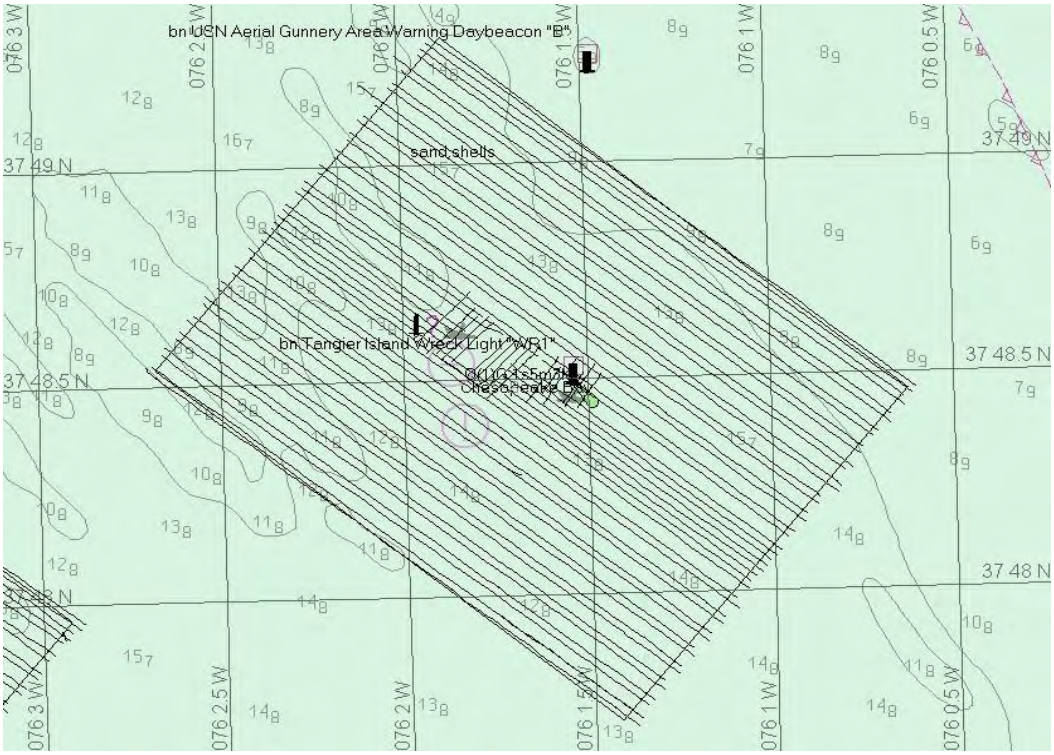
C-3: Data Processing and Interpretation

The side-scan data was recorded as native EdgeTech (.jsf) files and Triton Extended Format (.xtf) files to hard disk on the computer and backed up on external hard drives. The individual line files were imported into the Chesapeake Technologies SonarWizMap program where they were smoothed navigationally and adjusted with time variable gain and bottom tracking. The water column was removed, and they were cut and pasted electronically to form georeferenced tiff images smaller than 100 megabytes each. Targets were marked, measured and added to a target report containing 528 targets in target area 1 and a target report containing 1,100 targets in target area 2.

Area 1



Area 2



D. Results

D-1: Summary of Work Performed

The vast majority of the targets appear to be related to the bombing range, and they are aligned in a pattern that is concentrated through the wreck sites extending predominantly north and south. The target ship in target area 1 (Primary Target) is located at UTM 406403E, 4184036N. The approximate dimensions are 143 meters long in an east-west alignment and 24 meters wide. Parts of the structure are still protruding from the water. The navy target ship in target area 2 (Navy Target 2A) is located at UTM 409356, 4185183. The approximate dimensions are 135 meters long in a northeast-southwest alignment and 22 meters wide. Parts of the structure are still protruding from the water. The target barge in target area 2 (Navy Target 2B) is located at UTM 409696E, 4185019. The approximate dimensions are 35 meters long in a northeast-southwest alignment and 20 meters wide. There is a day marker adjacent to this wreck.

TABLE 2
Tangier Island Target Coordinates as Depicted on the Sonar Mosaic

Target Name	Easting	Northing	Dimensions
Navy Target 2A	409356	4185183	135 x 22 meters
Navy Target 2B	409696	4185019	35 x 20 meters
Primary Target 1	406403	4184036	143 x 24 meters

Eastings and Northings are NAD 83, U.T.M. North, Zone 18, Meters

E. Quality Control

E-1: Navigation System Validation

The piling closest to the DGPS antenna when the vessel was in its' slip at Tangier Island was chosen as a reference point. The dock was depicted on the electronic NOAA chart that had been preloaded into the Hypack program. The position recorded matched the position within the slip opposite the piling on the chart. The position of the antenna was 183 centimeters from the piling with the vessel in the slip and was recorded just prior to getting underway on each survey day and upon arrival at the end of each survey day. The geographic position (Lat. Lon.) and NAD83 UTM North Zone 18 – Meter coordinates were recorded each time. Table 3 displays the positions as recorded. All positions were within 0.385 meters of the average of all the positions. Table 4 displays the X, Y positions as converted from the geographic positions.

TABLE 3
Positions as Recorded

Date	Time	X	Y	Dx	Dy
4/20/2010	07:03	412565.504	4187393.724	-0.058	0.082
4/20/2010	19:34	412565.484	4187393.787	-0.078	0.145
4/21/2010	14:08	412565.715	4187393.411	0.153	-0.231
4/21/2010	16:52	412565.869	4187393.467	0.307	-0.175
4/22/2010	06:45	412565.177	4187393.707	-0.385	0.065
4/22/2010	19:01	412565.789	4187393.775	0.227	0.133
4/23/2010	06:50	412565.484	4187393.787	-0.078	0.145
4/23/2010	12:56	412565.474	4187393.482	-0.088	-0.160
		Avg X	Avg Y		
		412565.562	4187393.642		

X = NAD83 UTM North Zone 18, meters easting coordinate.

Y = NAD83 UTM North Zone 18, meters easting northing coordinate.

Dx = The difference in meters from the recorded easting to the average (Avg X) of all the recorded eastings.

Dy = The difference in meters from the recorded northing to the average (Avg Y) of all the recorded northings.

TABLE 4
X, Y Positions as Converted from the Geographic Positions

Date	Time	Lat 37°	Lon 75°	X	Y	Dx	Dy
4/20/2010	07:03	49.7866	59.6138	412565.447	4187393.643	-0.220	0.002
4/20/2010	19:34	49.7867'	59.6138'	412565.449	4187393.828	-0.218	0.187
4/21/2010	14:08	49.7865'	59.6135'	412565.885	4187393.454	0.218	-0.187
4/21/2010	16:52	49.7865'	59.6135'	412565.885	4187393.454	0.218	-0.187
4/22/2010	06:45	49.7866'	59.6138'	412565.447	4187393.643	-0.220	0.002
4/22/2010	19:01	49.7867'	59.6135'	412565.889	4187393.824	0.222	0.183
4/23/2010	06:50	49.7866'	59.6137'	412565.594	4187393.642	-0.073	0.001
4/23/2010	12:56	49.7866'	59.6136'	412565.741	4187393.640	0.074	-0.001
				Avg X	Avg Y		
				412565.667	4187393.641		

X = NAD83 UTM North Zone 18, meters easting coordinate.

Y = NAD83 UTM North Zone 18, meters easting northing coordinate.

Dx = The difference in meters from the recorded easting to the average (Avg X) of all the recorded eastings.

Dy = The difference in meters from the recorded northing to the average (Avg Y) of all the recorded northings.

The day marker at the Target 2b site also matched the electronic chart position, however, we were unable to come as close as the dock piling and measure it precisely. Its' position in the mosaic (409711.836E, 4185023.177N) is within 2.4 meters of the NOAA Chart position (409711.076E, 4185020.781N).

E-2: Side-Scan Sonar System Validation

Several unique targets were selected for confidence checks of the sonar. Those targets were listed in the Quality Control target report (Attachment H) that was submitted with the preliminary data. Targets 1-3 and 1-4 in that report show images of the same round target from two independent passes. The positions listed with them have layback, heading and latency issues due to the navigation not being smoothed in the Discover program and an inadvertent layback setting in that program. The saved raw data did not have these issues as it was already corrected for offsets and the smoothing done by the SonarWizMap program provided accurate positions in the mosaic. The mosaic position for this target is 406399E, 4182980N. Both of these target detections plotted the target 40 meters distant from the A1-28NW track-line. Both were detected on the starboard side of the tow-fish confirming that the velocity setting for the range of the sonar on the starboard channel was correct.
Targets 1-11 and 1- 12, in that report present images of a common target from the port side of the tow-fish. The mosaic position of this target is 406408E, 4182978N. Both targets were plotted 34 meters from the A1-57SE track-line confirming that the velocity setting for the range of the sonar on the port channel was correct.

E-3: Navigation System Quality Control

The DGPS receiver was set to mask satellites below 8º above the horizon. The age limit of pseudo-range corrections was set to 20 seconds such that if the limit were exceeded, the DGPS data string would report "stand alone" vs. "differential" position to the Hypack computer. The Hypack computer was set to show an alarm and ignore non-differential positions. The Horizontal Dilution of Position (HDOP) alarm was set at 2.5 and the number of satellites alarm was set at 5. During the survey of both Target areas none of the alarms were activated. These parameters were frequently monitored visually and always read as acceptable. The HDOP, number of satellites and DGPS mode were all continuously recorded in Hypack throughout the survey.

E-4: Side-Scan System Quality Control

Maintenance and calibration checks were performed immediately prior to mobilization. Wet tests were performed at mobilization and on the morning of the first survey day. Confidence checks were made using the targets in the Quality Control report (Attachment H). These targets were collected daily by the EdgeTech Discover program by right clicking on a target. The target image displayed in the Quality Control report is then generated and saved to disk. The sonar output was continuously monitored for interference with data quality. Some minor sea state, surface clutter and thermal effects were observed during the course of the survey. The sea state became too big an issue on day 2, when the operation was aborted at 16:20 on April 21st. The tow-fish position was displayed on the screen for both the helmsman and the sonar operator. The distance off line, which was prominently displayed, was the full time task of the helmsman to keep it within 8 meters of the track-line. The track-lines were reviewed at the end of each day to determine if any gaps needed to be covered. Several intermediate lines were run on the final day to fill in any areas that looked like potential gaps in the 200+ % high frequency coverage. The longer range setting of the low frequency channels provided a backup coverage insurance as that frequency was providing 50% more coverage (300+ %) than the high frequency.

While there was a current encountered it did not adversely affect the sonar as it was always from the northwest and did not cause yawing or crabbing of the tow-fish.

F. Conclusions

All the main targets at the center of the search boxes are dangerous navigational hazards to vessels that have impaired or lacking navigational skills or tools. While the two larger targets (Primary 1 and Navy Target 2A), are still exposed in a few places they can still be easily missed especially in bad weather. They will likely not remain exposed for long.

The vast majority of the targets mapped appear to be associated with the bombing range. None appear to be hazards to navigation. The approaches by the bombers were apparently from the north or south as the anomalies are scattered more in those directions than east or west from the target ships. That may be because the ships are generally aligned east to west. It was noted that there are apparent bombing range targets further south outside the Primary 1 search box. Those were encountered in the turns made south of that area.

Attachment A
Statement of Work

Statement of Work/Technical Specifications

Side-scan Sonar of Tangier Island Targets

Revision 1

Site Inspection

Tangier Island Target Site

Naval Air Station, Oceana

Virginia Beach, VA

Contract Task Order WE03

Introduction

CH2M HILL is requesting a proposal to perform side-scan sonar activities in support of a Site Inspection at the other-than-operational Tangier Island water range associated with Naval Air Station (NAS), Oceana, Virginia Beach, VA.

Site Description/Background

The Department of the Navy has issued Contract Task Order (CTO) WE03 to CH2M HILL to conduct a site inspection (SI) to evaluate the potential presence of munitions and explosives of concern (MEC) at the Tangier Island Target Site, a former bombing range associated with NAS Oceana (Figure 1). The scope of the SI includes the collection of bottom feature data for the target areas, including side-scan sonar imagery. The objective of the investigation is to confirm hard target locations and to identify potential areas of concern where debris or other materials may be protruding from the seafloor surface that could tangle and foul equipment used during future underwater geophysical investigations. The side-scan sonar activities will be used to identify items which are proud of the sediment surface at and near known target areas. A description of each of the target areas within the Tangier Island Target Site is presented below.

Tangier Island Target Site

The Tangier Island Target Site is an off-installation water range that consists of multiple former hard targets utilized for air-to-ground training exercises. The total site area encompasses approximately 18,750 acres. However, only a portion of this area, a 1,000-yard radius around three known potential hard target locations, will be investigated during this side-scan investigation. According to the Preliminary Assessment (PA), the targets consisted of two scuttled cargo ships located 2,800 yards west of Tangier Island in the Chesapeake Bay, approximately 65 miles north of Norfolk, Virginia. However, there are currently four hard targets assumed to be located at the site. The locations of these targets are identified on the NOAA nautical charts

(http://www.charts.noaa.gov/OnLineViewer/12225.shtml) and on Figure 2 (attached). The two northern-most hard targets (possibly the scuttled cargo ships referenced in the PA) are identified as "Navy Targets" on the nautical charts. These targets are located in approximately 10-15′ of water. The third target (the center point of the prohibited area identified on the nautical chart) is identified in 33 CFR 334.210 (Attachment 1) and is located just west of the "Navy Targets". This target is a scuttled ship also located in approximately 10-15′ of water; some features of this ship still protrude from the water surface (Photograph 1). Photograph 2 is an image taken from the PA that depicts the condition of one of the hard targets when it was still in tact (date unknown). The fourth and southern-most target is identified as the San Marcos wreck on the NOAA nautical charts and is located in 24-29′ of water. This target (the San Marcos Wreck) will not be included as part of this scope of work. The approximate location of the three targets of concern can be seen on the NOAA nautical chart identified above or in Figure 2 (attached). Approximate coordinates for each target are provided in Table 1 below.

Photograph 1 – Target Remnants, Helicopter Tour May 12, 2009

Photograph 2 – Target from PA

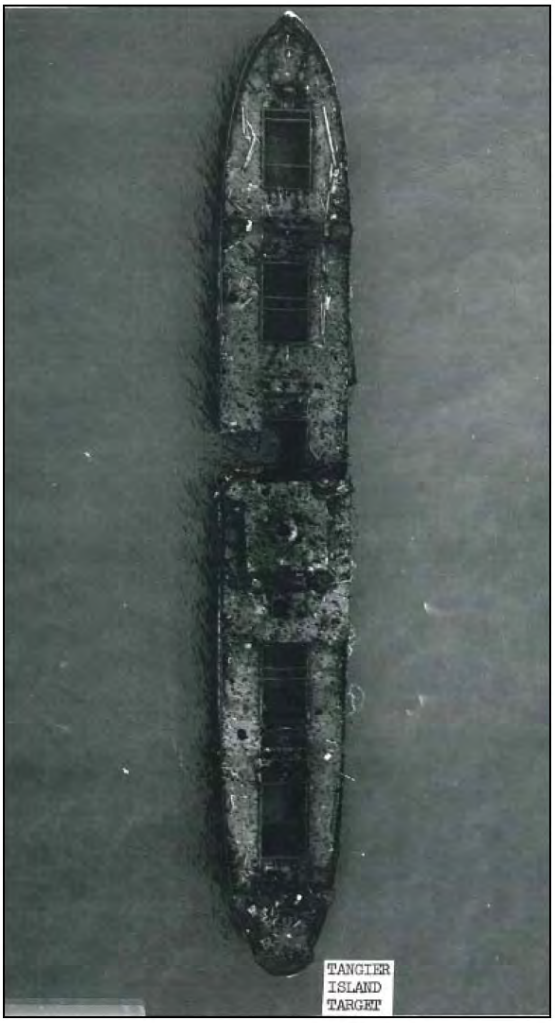


Figure 5.12-1: National Archives photo of one of the Tangier Island target ships (undated).

Table 1 – Tangier Island Target Coordinates

Target Name	Longitude	Latitude
"Navy Targets"	76° 01′ 48″	37° 48′ 36″
	76° 01′ 30″	37° 48′ 24″
Primary Target	76° 03′ 48″	37° 47′ 54″

The range was used from approximately 1970 until 1996 for aerial bombardment and rocketry training. Records from 1993 through 1996 indicate practice rockets and bombs were used at the site (primarily 25 lbs in size). Use of the training range was stopped in July 1996 because range procedures cited in the Code of Federal Regulations (CFR) could not be met. Possible munitions used at this site include practice bombs, air-to-surface rockets, and associated spotting and witness charges. The site is currently not in use by the Navy, but commercial and recreational fishing occur in the vicinity of the target remnants. Numerous crab pot buoys were evident at the site during the site reconnaissance in May 2009. Additionally, the air space over the target (R-6609) is restricted for aerial training by the Navy.

Task 1: Pre-Mobilization Planning Documents

The SUBCONTRACTOR shall provide a work plan document and Standard Operating Procedures (SOPs) for conducting the side-scan sonar work. The document shall be provided in electronic format (MS Word or ASCII text) within two weeks of subcontract award and will detail the procedures for conducting site activities, operation of equipment to be used, QC procedures for equipment, and data generation/deliverables.

The subcontractor shall perform quality control per applicable QC tests. *Applicable QC tests for the system used by the SUBCONTRACTOR must be described in the proposal document.* Acceptance criteria for each test must also be specified in the proposal.

The SUBCONTRACTOR will also prepare an Activity Hazard Analysis (AHA) for each recognized significant task/operation for review by the CH2M HILL Health and Safety Manager. In an effort to improve the standard of safety on CH2M HILL projects all contractors will be required to submit an *Activity Hazard Analysis* (AHA) for work being performed. This analysis will include a detailed list of all activities that will be conducted to complete the scope of work, the hazards associated with each activity and the measures put in place to minimize these hazards.

CH2M HILL will assist contractors by providing samples of AHAs (if requested), definitions, explanations and some general guidance on how to complete this task.

Work may not begin until the AHA has been reviewed and accepted by CH2M HILL.

Task 2: Mobilization/Demobilization

The SUBCONTRACTOR shall arrange for mobilization of all necessary personnel and equipment, including the side-scan equipment and boat, to the Tangier Island Target Site for use on the project. The SUBCONTRACTOR shall identify where boat access will occur for investigation of each target location. Following contract award to the successful bidder, planning for equipment and personnel mobilization activities should commence as soon as notice-to-proceed is provided by CH2M HILL. Following completion of the tasks described below, the SUBCONTRACTOR shall be responsible for demobilizing its crew and equipment from each site.

The SUBCONTRACTOR shall be responsible for transportation to and from the boat launch site, equipment storage during non-working hours, and lodging should all be included in

the Mob/Demob costs. Office and storage facilities will NOT be provided by CH2M HILL or NAVFAC.

Task 3: Side-scan Sonar of Target Areas

The SUBCONTRACTOR shall provide all personnel and equipment necessary for performing the side-scan of the designated areas of the Tangier Island Target Site. The focus of the Site Investigation shall be the suspected hard target locations and a 1,000-yard radius surrounding each of the hard targets. Therefore, for the purposes of the side-scan activities, the area of concern will be approximated as a square around each of the targets (see Figure 2). The total area of concern for the side-scan activities is approximately 1,920 acres. The boundaries of the area to be investigated are identified on Figure 2 and have been provided separately as GIS Shapefiles. The target locations identified in Table 1 and on Figure 2 are approximate (based upon NOAA Nautical Charts and 33 CFR 334.210); however the boundaries of the investigation will not be changed. Investigation of the proposed area will be used to confirm the location of any remaining hard targets.

The SUBCONTRACTOR shall provide complete bottom coverage of the identified areas of concern (1,920 acres) to a resolution capable of locating objects similar in size (or larger than) a crab pot (assume dimensions of 24" length, 24" width, and 24" height). Estimated costs and schedule for performing the side-scan activities should take into consideration the water depth in the areas to be inspected. Mapping accuracy must be sufficient to identify the location of any obstructions (similar in shape and size as noted above) identified during the side-scan activities. Additionally, data provided should be of such a quality that an image can be generated to identify the location of obstructions and areas of concern.

SUBCONTRACTOR must include the proposed accuracy of the equipment, describe the instrumentation to be used, provide a description and limitations of the proposed equipment, provide Standard Operating Procedures for equipment use and Quality Control checks to confirm equipment functionality, and the methodology proposed.

All production data, including initial data imaging, contact positions, and QC data are to be processed, interpreted and delivered to the CH2M HILL Project Geophysicist within five days of data collection. The deliverable must include georeferenced tiff images appropriate for import into Geographic Information System software. Images must be broken into blocks of no greater than 100 megabytes each.

Task 4: Data Processing and Reporting

Within 30 days of the completion of survey activities the SUBCONTRACTOR shall provide the CH2M HILL project manager all final side-scan maps, supporting interpretations, and a narrative description of the field activities that includes data collection methodology, processing, interpretation, and results. The files shall be delivered in hard copy and electronic format on CD. All text files should be delivered in Microsoft Word 6.0 or higher format. The following sections (at a minimum) are to be provided in the report:

Table of Contents
Acronyms List
Introduction
Background and Project Objectives

Scope of Work
Site Location and Description

Equipment

Methodology

Side-scan Sonar Survey Activities
Data Processing and Interpretation

Results

Summary of Work Performed
Mobilization and Site Setup
Side-scan Survey Activities
Data Processing and Interpretation

Quality Control

System Validation
Instruments and Positioning System Quality Control

Conclusions

References

Attachments

Examples of data deliverables (maps, QC results for each type of QC test, etc.)
E-size mosaic plate(s) showing Sidescan results
E-size mosaic plate(s) showing anomaly/obstruction locations
Photographs of side-scan equipment and operations
CD (or DVD) with all data and deliverables, including pdf describing contents of folders

Standby Time

Standby time is defined as time during normal working hours in which work is scheduled but is not performed due to actions of CH2M HILL once crew and equipment have mobilized. Circumstances qualified as standby time include delays within normal scheduled working hours caused by site access restrictions; unavailability of CH2M HILL-provided equipment, materials, labor, or technical determination; and weather delays in excess of one (1) hour.

If a delay occurs after work has started, the first 30 minutes of the delay shall be considered downtime. CH2M HILL, in conjunction with the SUBCONTRACTOR vessel captain, shall evaluate conditions after 30 minutes and determine whether to continue work or cancel work activities for the remainder of the day. If CH2M HILL decides to wait for conditions to improve, additional standby time shall be compensated at the hourly standby rate. Other scenarios in which the bidder anticipates payment for standby time must be included as part of the proposal. A detailed explanation and description of costs (including bid sheet summary) are required to be included. Multiple standby rates may apply. If standby time is incurred as a result of weather conditions, compensation will be paid to the subcontractor based on the negotiated standby rate.

Standby time does not included time to execute any work specifically identified in the Scope of Work, commencement of work following weather or base-related delays (in excess of thirty minutes), or required attendance at project and safety meetings.

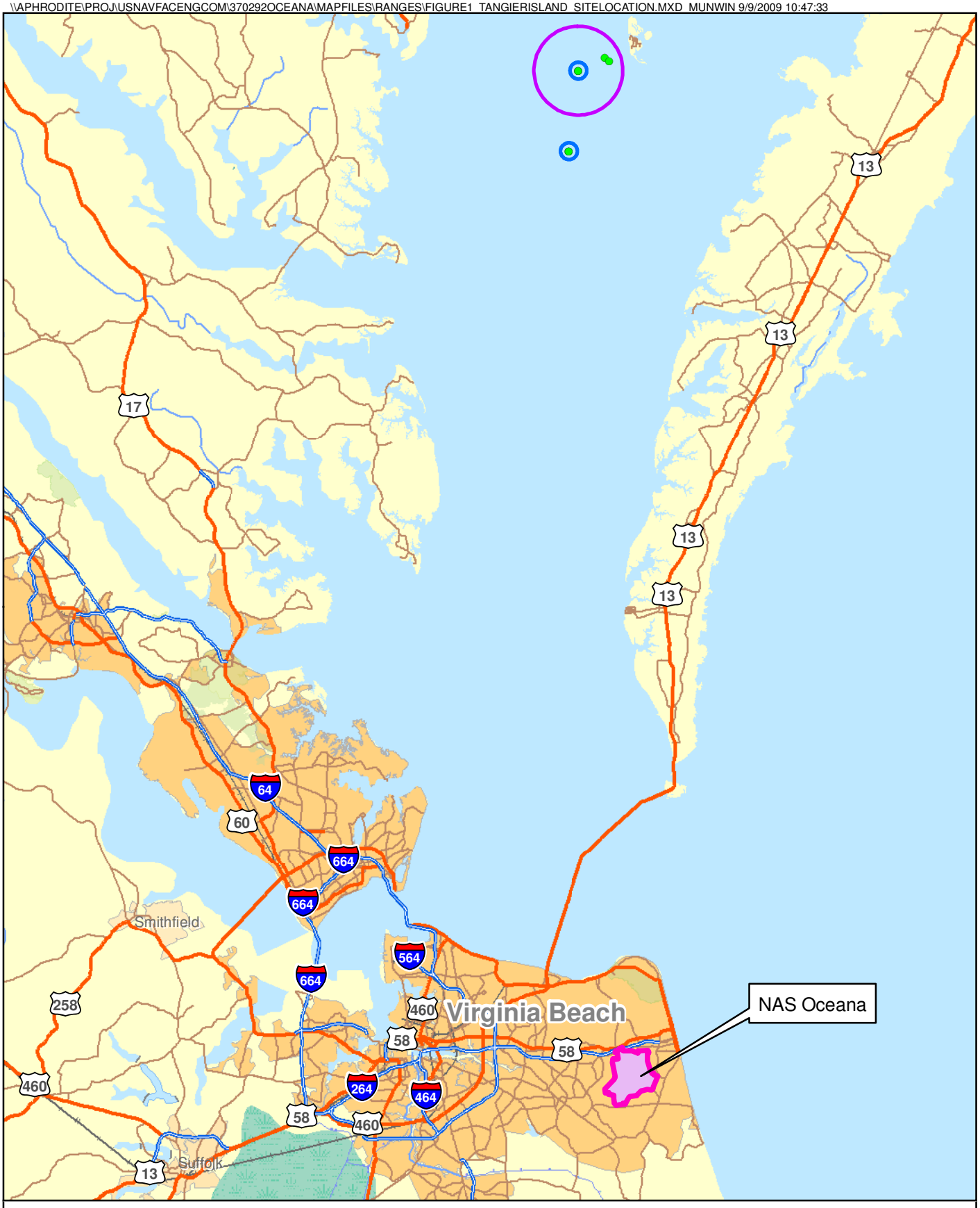
Non Standby work delays:

In the event of mechanical or equipment failure, the event will be classified as a Non Standby work delay at no charge to CH2M HILL.

General Requirements

1) The SUBCONTRACTOR will provide standard operating procedures for all survey, quality control and data processing to be performed.
2) An anticipated schedule must be provided as part of the proposal, including a description of field working hours and alternative work schedules should weather delays occur during the scheduled work week. Field activities are anticipated to occur between November 2009 and February 2010.
3) All assumptions must be detailed in the proposal.
4) A technical approach section must be included as part of the proposal specifying technical details of the approach proposed by SUBCONTRACTOR.

\\APHRODITE\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE1_TANGIERISLAND_SITELOCATION.MXD MUNWIN 9/9/2009 10:47:33



Legend

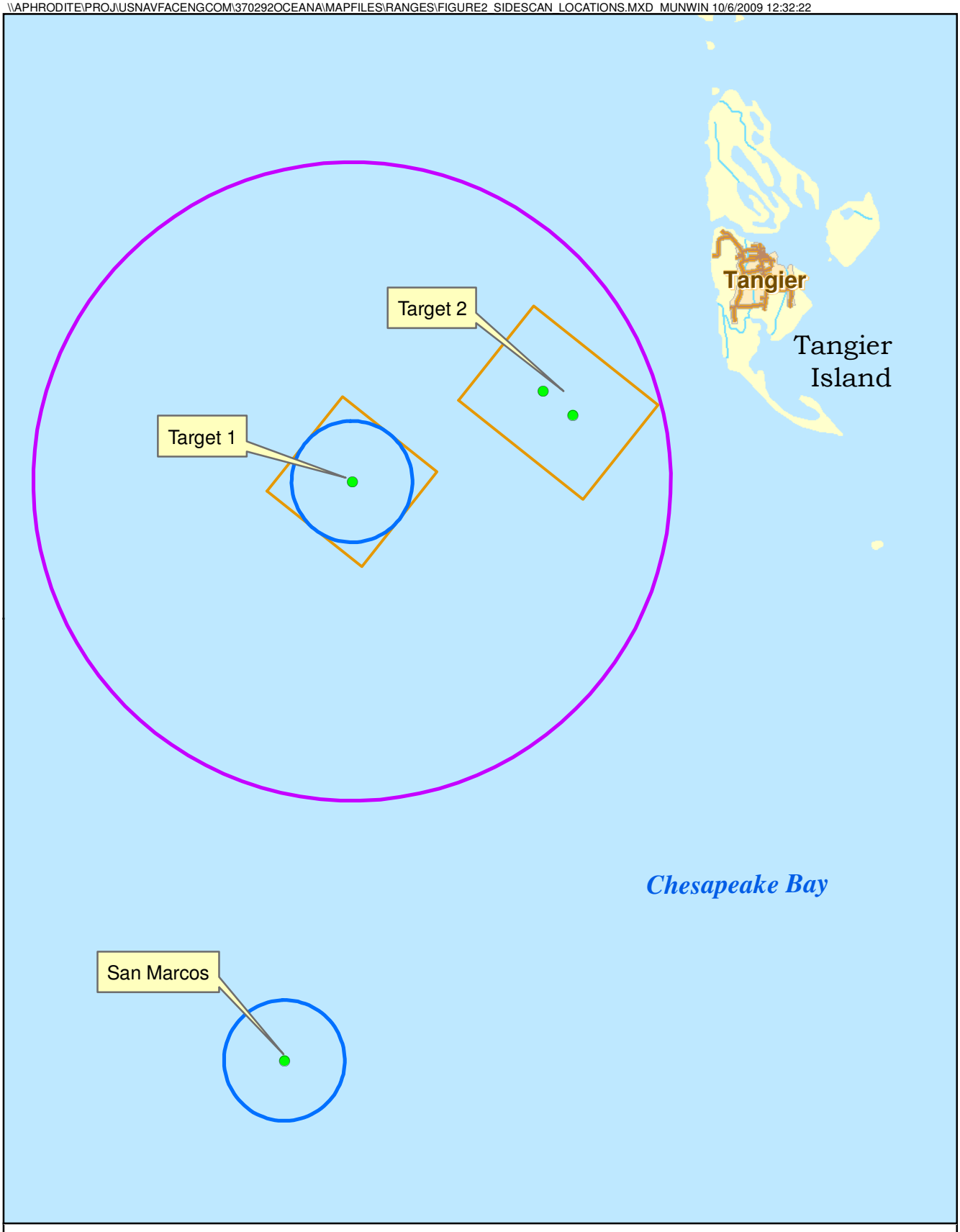
- NAS Oceana
- 3-Mile Restricted Area
- 1,000-Yard Prohibited Area
- Target Location

N
W E
S

0 4.5 9
Miles

Figure 1
Tangier Island Site Location
NAS Oceana
Virginia Beach, Virginia

CH2MHILL



Legend
- 3-Mile Restricted Area
- 1,000-Yard Prohibited Area
- Target Location
- Side-Scan Area

N
W E
S

0 0.65 1.3
Miles

Figure 2
Tangier Island Side-Scan Locations
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

§ 334.210 Chesapeake Bay, in vicinity of Tangier Island; naval guided missiles test operations area.

(a) *The danger zone*—(1) *Prohibited area.* A circle 1,000 yards in radius with its center at latitude 37°47′54″, longitude 76°03′48″.

(2) *Restricted area.* A circle three nautical miles in radius with its center at latitude 37°47′54″, longitude 76°03′48″, excluding the prohibited area.

(b) *The regulations.* (1) Persons, vessels or other craft shall not enter or remain in the prohibited area at any time unless authorized to do so by the enforcing agency.

(2) Except as otherwise provided in paragraph (b)(6) of this section, persons, vessels or other craft shall not enter or remain in the restricted area when firing is or will soon be in progress unless authorized to do so by the enforcing agency.

(3) Advance notice will be given of the date on which the first firing is to be conducted and such notice will be published in ''Notice to Mariners.'' Thereafter, the danger zone will be in use intermittently throughout the year and no further notice is contemplated that firing is continuing.

(4) Warning that firing is or will soon be in progress will be indicated by a red flag displayed from one of six dolphin platforms on the perimeter of the prohibited area, and by patrol vessels within the danger zone or by aircraft employing the method of warning known as ''buzzing'' which consists of low flight by the airplane and repeated opening and closing of the throttle. Surface or air search of the entire area will be made prior to the commencement of firing on each scheduled day. During periods of firing a patrol vessel will remain in the approaches to the restricted area and maintain continuous contact with the firing planes to warn when the area is not clear.

(5) Upon observing the warning flag or upon receiving a warning by any of the patrol vessels or aircraft, persons, vessels or other craft shall immediately vacate the restricted area and remain outside the area until the conclusion of firing for the day.

(6) This section shall not deny traverse of portions of the restricted area by commercial craft proceeding in established steamer lanes, but when firing is or will soon be in progress all such craft shall proceed on their normal course through the area with all practicable speed.

(7) All projectiles, bombs and rockets will be fired to land within the prohibited area, and on or in the immediate vicinity of a target in the restricted area located adjacent to the west side of Tangier Island. The Department of the Navy will not be responsible for damages by such projectiles, bombs, or rockets to nets, traps, buoys, pots, fishpounds, stakes, or other equipment which may be located within the restricted area.

(8) The regulations of this section shall be enforced by the Commander, Naval Air Bases, Fifth Naval District, Norfolk, Virginia, and such agencies as he may designate.

[13 FR 6918, Nov. 24, 1948, as amended at 22 FR 3706, May 25, 1957; 24 FR 3760, May 6, 1959. Redesignated at 50 FR 42696, Oct. 22, 1985, as amended at 62 FR 17552, Apr. 10, 1997]

Attachment B
Work Plan

Attachment B: Work Plan

Side-Scan Sonar of Tangier Island Targets

Work Plan

Tangier Island Target Site

Virginia Beach, VA

Contract Task Order WE03

January 2010

Prepared For:
CH2M HILL, INC.

Prepared By:
SONOGRAPHICS, INC.

Table of Contents

List of Acronyms

PFD Personal Flotation Device
GPS Global Positioning System
DGPS Differential Global Positioning System
ECL Emergency Contact List
USCG United States Coast Guard
HDOP Horizontal Dilution of Position

1. Work Plan

1.1. Mobilize

Select a start date based on 7 day weather models. Transit equipment and personnel to Tangier Island. Install on vessel Joyce Marie II (Attachment A): Trimble DSM232 Differential Global Positioning System (Attachment B), Navigation Computer with helm display and Hypack Navigation Software and EdgeTech FS4200 digital dual frequency (300 kHz and 600 kHz) Side-Scan Sonar System (Attachment C). Establish an emergency contact on Tangier Island (i.e. Joyce Crockett, spouse of boat captain). Relay this contact information to the emergency contacts on the Emergency Contact List (Attachment F).

1.2. Data Collection

Start the survey on the first good weather day. Continue survey operations as weather permits. Standby and process data during weather delays.

1.3. Demobilize

Uninstall the equipment from the vessel. Transit equipment and personnel back to Florida.

1.4. Data Deliverables and Reports

Process Digital sonar Mosaics in the form of Geo-Tiff files. Create CAD files of digitized sonar features and targets. Finalize the side-scan and feature maps as hard copies and onto compact discs. Provide a narrative description of the field activities including maps and photographs as hard copies and on CDs or DVDs.

2. Safety Procedures

2.1. Safety Equipment

Safety equipment on board the vessel Joyce Marie II will include Personal Flotation Devices (PFDs), throw cushions, first aid kit, fire extinguisher, survival suits and communication equipment. Communication equipment will include an Iridium Satellite phone, a VHF radio, and an air horn. There is no cellular phone service available on Tangier Island.

2.2. Safety Methods

Once an emergency contact on Tangier Island has been established, information will be exchanged with the emergency contacts on the Emergency Contact List (Attachment F). Prior to departure the Float Plan will be implemented (see 2.3, Attachment D). Float Plan information will be relayed to the emergency contacts (Attachment F) via Satellite phone. Crew will take precaution to ensure there is safe footing while loading and unloading equipment to and from the vessel. Once on board the vessel the equipment will remain secured and clear to allow safe movement of the crew at all times prior to deployment and again after it is recovered. Boat will be operated in accordance with United States Coast Guard Regulations (USCG) for safe boating procedures (speed, lighting, right-of-way, navigational markers, etc.). During deployment and recovery of equipment, Surveyor will wear a PFD and be vigilant of deployment lines. The survey will begin outside target area 2 (Attachment G, Figure 2) on the southeast corner of the box nearest Tangier Island. From the southeast corner, the Surveyor can "see" targets and obstructions to navigation using the side-scan sonar equipment. For example, heading on a line parallel to the box line the bottom features will be apparent up to 75 meters distance from the side-scan sonar and boat with the low frequency array set to the 75 meter range scale and the high frequency array set to the 50 meter range scale. Using this survey method, the surveyor will be able to avoid possible hazards to the vessel in a timely manner. Once hazardous targets have been identified, the surveyor will direct the boat captain to alter the course of the following survey line. This alteration will provide a safe distance from the shallow target to the side-scan sonar and boat. The hazardous target

coordinates will be documented for future reference on later survey days. Potential hazards will be plotted on the helm display immediately.

2.3 Emergency Contacts & Procedures

Prior to departure, the "Float Plan" (Attachment D) will be set in place. An emergency contact on Tangier Island will be informed of the departure time and expected return time to the dock next to Parks Marina Tangier Island. The ECL persons (Attachment F) will also be informed of the Float Plan via Satellite phone. Following the completion of the survey day and return to the dock, the surveyor will check in with the Tangier Island emergency contact. If the vessel crew does not check in within one half hour of expected return time, the Tangier Island emergency contact will attempt to contact the vessel via satellite phone and/or VHF radio. If no contact can be made, the Tangier Island emergency contact will refer to the steps in the Emergency Boating Guide (Attachment E).

In the event a person is severely injured on board while away from the dock, the injured person will be transported to the Tangier Health Center for treatment. In the event a person falls overboard, a throw cushion attached to 50 feet of rope will be launched. The man overboard will be rescued as quickly as possible and transported to the Tangier Health Center for treatment. The survey areas vary in distance from the dock between 2 and 4.5 miles. The vessel can make 22-23 miles per hour making the time to the dock vary between 6 and 14 minutes. Tangier Health Center is within 5 minutes of the dock.

2.4 Qualifications

The boat Captain is Coast Guard Licensed (Attachment H) and has more than 40 years of local knowledge and experience operating in the area of the survey sites offshore Tangier Island. He has first aid and CPR certification required by the Coast Guard. He is a former Fire Chief of the Tangier Fire Department.

2.5 Daily Inspection Checklist

Review at least once daily prior to departing the dock.

___Review weather conditions

If conditions are inclement (Lightning, thunder, winds greater than 20mph or tornado warnings in effect), call postponement of survey to the next day.

___Locate PFDs

___Locate Survival Suits

___Locate Throw Cushions & Rope

___Locate First Aid Kit

___Locate Fire Extinguisher

___Test VHF radio, channel 16

___Test Air Horn

___Test Satellite phone, sufficiently charged

___Navigation Lights are in Working Order

___Inspect Boat for Damage

___Ensure there is Adequate Fuel

___Equipment is Stowed Securely

___Implement Float Plan

___All Crew Members know the location of and how to use each safety device

3. Standard Operating Procedure

3.1. Navigation

The GPS (Global Positioning System) will be differential with a published accuracy of plus or minus 1 meter. The DGPS (Differential Global Positioning System) corrections will be obtained through the nearest USCG Beacon, which is located in Driver, VA. The coordinates are 36°57'N and 76°33'W. The reference Station ID is 012/013. The Nominal Range is 130NM at 75 μV per meter. This station is the first choice because it is 56 nautical miles distance from the survey site and has a higher nominal range than the second beacon. The first alternative, at 53 nautical miles distance from the survey site, has a weaker nominal range and is located in Portsmouth, VA. The coordinates are 36°52'54"N and 76°21'42"W. The nominal range is 75NM at 75 μV per meter. The second alternative beacon is located at Annapolis, MD. The coordinates are 39°40.2'N

and 76°36’21”W. The nominal range is 150NM at 100 μV per meter. This beacon is located 77 nautical miles from the survey site. The towfish will be positioned by entering the cable layback and offset from the DGPS antenna into a layback and offset adjustment in the Hypack Program. The towfish position will be supplied to the side-scan computer by the Hypack computer. The DGPS antenna will be located as close as possible to the towfish.

3.2. Sonar

The Towfish will be connected to a nylon line that will be tied off to a cleat on the boat. A minimum amount of line will be let out in order to maintain the depth of the towfish no deeper than 4 feet. The towfish will be prevented from going any deeper than 4 feet by not allowing any more than 4 feet of line out. The 4200-FS sonar has sufficient along track resolution (<1.5 feet @ 100 meter range) to satisfy the 24 x 24 x 24 spec at 100 meters range. This specification assumes ideal conditions such as a perfectly straight course and flat calm sea state. In consideration of a safety factor and the NOAA spec of 12.5 times towfish altitude the range scale will be 50 meters providing a swath of coverage of 100 meters (328 feet) on each survey line. The survey will be conducted as a grid of parallel lines at each site with an alternate spacing of 100 and 200 feet. The alternate spacing will provide 200% coverage of the bottom and provide coverage of the nadir area under the towfish of adjacent lines. 200% coverage will provide multiple passes on potential targets to facilitate interpretation and help eliminate returns caused by fish and other extraneous sources. The towfish will be towed near the water surface to maximize height of the sensor above the bottom. Dual frequency mode will be used for differential comparison between high and low frequency signatures which will facilitate interpretation and help eliminate returns caused by fish and other extraneous sources. Survey speed will be between 2 and 5 knots. All operations will occur during daylight.

3.3. Data Processing

Post processing will be conducted using the Chesapeake SonarWizMap program to import the geo-encoded sonar files where they will be smoothed navigationally and adjusted with time varied gain and bottom tracking prior to water column removal. They

will then be cut and pasted electronically to form the georeferenced tiff images smaller than 100 megabytes each. Targets will be outlined, measured, and added to a target report. These along with Quality Control data and raw data (.jsf files) will be provided as preliminary deliverables.

3.4 Vessel

The 36 foot vessel Joyce Marie II is home based at Tangier Island. The vessel is licensed and insured to carry passengers for ferry service to the island (Attachment I). The base of operations for the survey will be at Tangier Island where the boat is docked. We will depart from the Parks Marina on Tangier Island prior to survey each day. At the survey sites the vessel operator will be guided through the pre-plotted survey grids displayed on the helm monitor.

4. Quality Control

4.1. Navigation

The DGPS receiver will be configured such that satellites below 8° above the horizon will not be used in position computations. The age of pseudo-range corrections used in position computation will not exceed 20 seconds. Horizontal Dilution of Precision (HDOP) will be monitored and recorded. If corrections exceed 20 seconds or HDOP exceeds 2.5 nominally the survey will be delayed until conditions improve. A minimum of four satellites will be used to compute all positions. All of these can be monitored by the Hypack program and provide an alarm if exceeded. A control point such as a “dock piling”, will be selected to check the geographic and projected grid position by moving the DGPS antenna in close proximity to it prior to departure and upon return to port each day.

4.2. Side-scan Sonar Survey

Side-scan maintenance and calibration checks will be performed per the system manual prior to the start of the survey. A wet test will be performed at the dock prior to departure to ensure all channels are operating and detecting targets. Confidence checks of the side-scan sonar system shall be conducted at least once daily. These checks will be

accomplished at the outer limits of the range scales being used based on a target near or on the bottom. Each sonar channel (i.e., port and starboard channels) shall be checked to verify proper system tuning and operation. Confidence checks can be made on any discrete object, offshore structure, or bottom feature, which is convenient or incidental to the survey area. Targets can include wrecks, offshore structures, navigation buoy moorings, distinct trawl scours, or sand ripples.

Confidence checks can be made during the course of survey operations by documenting the check feature as a saved target in the acquisition program. These documented check targets can be included in the target report supplied with the preliminary mosaics. Data will be monitored for the effects of sea state, surface clutter, thermal layering and other possible interference with data quality. If interference is encountered the survey will be modified or stopped until it can be corrected**.** The vessel will not exceed 25 feet departure from the pre-plotted survey lines to ensure the design coverage of the survey area. If such departure is exceeded, the survey line shall be restarted or appended to cover the potential gap in the data. (Attachment J).

If currents are affecting the heading of the tow-fish, the grid may need to be adjusted to avoid having to correct for that in post processing

5. Schedule

5.1 Field Operations

Day 1: Transit of Equipment and personnel from Ft Lauderdale, FL to Tangier Island.
Day 2: Transit of Equipment and personnel from Ft Lauderdale, FL to Tangier Island.
Day 3: Commence survey ops at 1st site.
Day 4: Continue ops at 1st site.
Day 5: Weather delay*, Commence post processing the collected data.
Day 6: Complete ops at 1st site, Commence ops at 2nd site.
Day 7: Weather delay*, post processing continues.
Day 8: Weather delay*, post processing continues.
Day 9: Continue ops at 2nd site.
Day 10: Complete ops at 2nd site.
Day 11: Operator transit and Shipping of Equipment back to Ft. Lauderdale.
Day 12: Transit of shipped equipment.

*If there is no weather delay, the survey ops will continue.

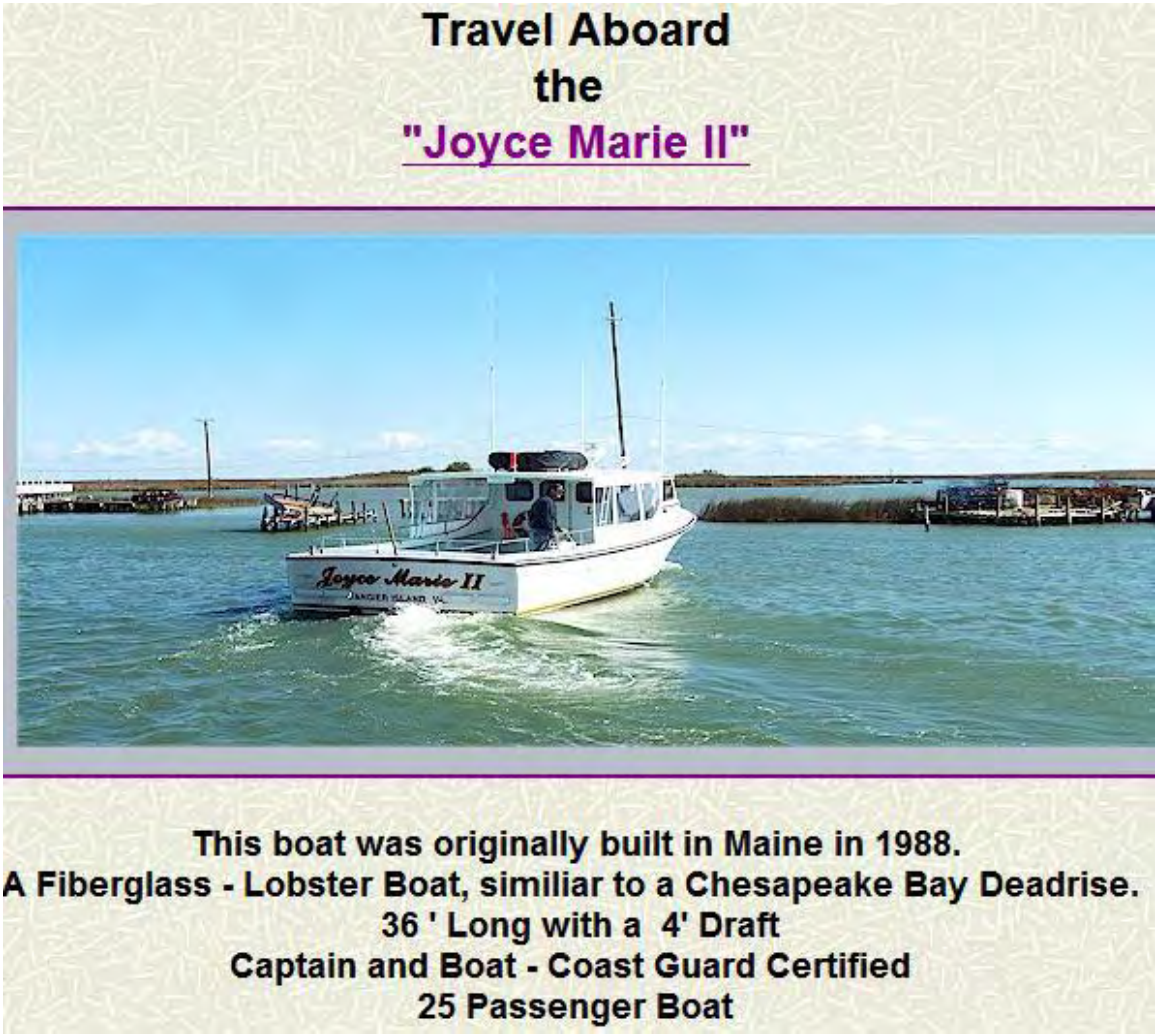
5.2. Post Processing

Day 13: Shipment delivered, post processing continues.
Day 14: Preliminary geo-referenced tiffs and drawings completed.
Day 15: Delivery of processed and interpreted data to project geophysicist.
Day 35: Delivery of Final Maps and Report**

** Delivery of Final Reports may be sooner or later depending on weather delays or lack thereof.

6. Attachments

6.1. Attachment A: Vessel Joyce Marie II



6.2. Attachment B: Trimble DSM 232 Differential Global Positioning System

TRIMBLE DSM 232 MODULAR GPS RECEIVER

STANDARD SYSTEM FEATURES

- Modular receiver (separate antenna and receiver unit) for installation flexibility and security of investment
- Integrated display and keypad for system configuration and status checking without external software
- External GPS antenna choices for single frequency, dual frequency or DGPS base station operation
- IALA Beacon, Satellite Based Augmentation Systems (SBAS) such as WAAS, EGNOS compatible
- Accepts RTCM and CMR (optional) corrections from external radio link
- upgradable to and available as 24-channel L1/L2 GPS receiver for improved accuracy performance, allowing for:
  - 3D decimeter accuracy OmniSTAR XP and HP service capable
  - 3D centimeter accuracy RTK capable
- Up to 10 Hz measurement update rate (NMEA and TSIP Protocols)
- Two physical connectors allow for 3 programmable RS-232 serial ports and 2 NMEA 2000® capable ports
- 1PPS signal
- Waterproof and dustproof
- -30° C to +65° C (-22° F to +140° F) operating temperature range
- 9V to 28V DC input power range with over-voltage protection
- Backward compatibility with DSM132 – same antenna cable, single frequency / beacon antenna, power and data cable, and mounting bolt pattern
- Suitable for permanent / semi permanent as well as short term installations

ANTENNA SPECIFICATIONS

DGPS Antenna

Size	15.5 cm (6.1 in) D x 14.0 cm (5.5 in) H
Weight	0.55 Kg (1.2 lb)
Operating Temperature	-30°C to +65°C
Usage	L1 GPS, Beacon, SBAS and L-Band

Dual Frequency Antenna

Size	16 cm (6.25 in) D x 7.5 cm (3 in) H
Weight	0.55 Kg (1.2 lb)
Operating Temperature	-30°C to +65°C
Usage	L1/L2 GPS, SBAS and L-Band

Geodetic Reference Station Antenna

Size	34.3 cm (13.5 in) D x 7.6 cm (3 in) H
Weight	1.31 Kg (2.88 lb)
Operating Temperature	-40°C to + 70°C
Usage	L1/L2 GPS and SBAS

Humidity/Case. . . . All antennae are 100% condensing, unit fully sealed. Dust-proof, waterproof, shock resistant

OPTIONS

- Upgrade DGPS receiver to OmniSTAR XP/HP (includes dual frequency antenna)
- Upgrade OmniSTAR XP/HP receiver to RTK rover
- Upgrade for DGPS Reference Station

HARDWARE SPECIFICATIONS

Physical

Size (WxHxD)	14.8 cm (5.7 in) x 5.6 cm (2.2 in) x 21.6 cm (8.6 in)
Receiver Weight	0.96 kg (2.13 lb)
Keyboard and display	LCD backlight display 16 characters by 2 rows, 4 button keypad
Antenna Mounting	All accept 5/8"-11 UNC male bolt

Environmental

Operating temperature	-30° C to +65° C (-22° F to +140° F)
Storage temperature	-34° C to +85° C (-29° F to +185° F)
Humidity	Complies with MIL 810E. Unit sealed to +/- 5 PSID
Water	Waterproof and dustproof

Electrical

Power	9V to 28V DC external power input with over-voltage protection
Power consumption	Nominal 350 mA at 12 V DC
Certification	Class B Part 15, 22, 24 FCC certification, CE mark approval, C-tick approval, WEEE

Communications

- Two CONXALL connectors on the back plane, Port A and B
- 3 programmable RS232 outputs
- 2 CAN (NMEA 2000®) outputs

Receiver position update rate	1,2,5,10 Hz
Correction Data Input and Output	CMR II, CMR+, RTCM 2.1, RTCM 2.3, RTCM 3.0
RS232 Outputs	NMEA – GGA, GLL, GRS, GSA, GST, GSV, MSS, RMC, VTG, ZDA, various Proprietary NMEA TSIP format
CAN Outputs	J1939, NMEA 2000®

PERFORMANCE SPECIFICATIONS

Measurements

- Trimble EVEREST multi-path mitigation technology
- DGPS: 12 Channel L1 plus 2 channels for Beacon
- DGPS with SBAS (WAAS / EGNOS / MSAS): 11 GPS channels plus 1 for SBAS
- RTK or OmniSTAR VBS/XP/HP: 24 channel L1/L2 plus 1 channel L Band

Code differential GPS positioning

Horizontal accuracy	±(0.25m + 1 ppm) RMS ±(0.8 ft + 1 ppm)
Vertical accuracy	±(0.50m + 1 ppm) RMS ±(1.6 ft + 1 ppm)

WAAS / EGNOS / MSAS[1]

Horizontal accuracy	Typically 1m (3 ft)
Vertical accuracy	Typically <5m (<16 ft)

OmniSTAR Positioning

VBS Service Accuracy	Horizontal typically better than 1 m (3 ft)
XP Service Accuracy	Horizontal 10cm (.3 ft), Vertical 20cm (.7 ft)
HP Service Accuracy	Horizontal 5cm (.2 ft), Vertical 10cm (.3 ft)
OmniSTAR XP/HP Convergence	Cold start - Typically 10 to 40 minutes depending on satellite geometry

Real Time Kinematic (RTK) positioning[2]

Horizontal accuracy	±(10mm + 1 ppm), ±(.03 ft +1ppm)
Vertical accuracy	±(20mm + 1 ppm), ±(.07 ft +1ppm)

Initialization time

Regular RTK operation with base station	Single/Multi-base minimum 10 sec + 0.5 times baseline length in km, <30 km
Initialization reliability[3]	Typically >99.9%

1 Depends on WAAS / EGNOS / MSAS system performance
2 Accuracy and reliability may be subject to anomalies such as multipath, obstructions, satellite geometry and atmospheric conditions. Always follow recommended practices.
3 May be affected by atmospheric conditions, signal multipath and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.

Specifications subject to change without notice.

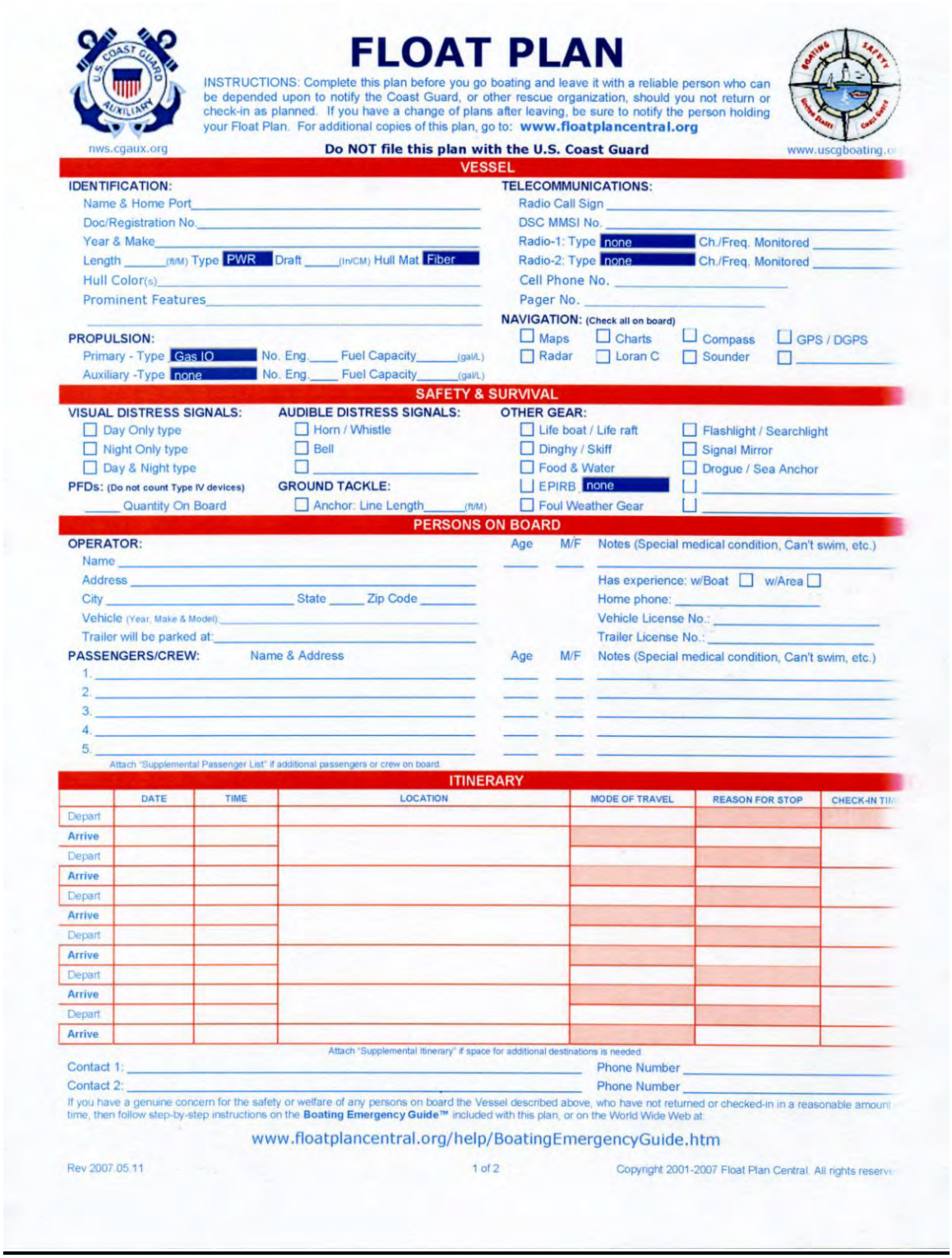
6.3. Attachment C: EdgeTech FS4200 Digital Dual Frequency Side-scan Sonar System

4200 SERIES SIDE SCAN SONAR SYSTEMS

Key Specifications

System Specifications		
Frequency	100/400 kHz	300/600 kHz
Modulation	Full Spectrum chirp frequency modulated pulse with amplitude and phase weighting	
Operating Range (typical maximum with good imagery)	100 kHz: 500 meters/side 400 kHz: 150 meters/side	300 kHz: 230 meters/side 600 kHz: 120 meters/side
Towing Speed (max safe)	12 knots	
Towing Speed *	4.8 knots in HDM, 9.6 knots in HSM	
Output Power	100 kHz: 4 joules, 400 kHz: 2 joules	300 kHz: 2 joules, 600 kHz: 1 joule
Pulse Length	100 kHz up to 20 ms 400 kHz up to 10 ms	300 kHz up to 10 ms 600 kHz up to 5 ms
Resolution Across Track	100 kHz: 8 cm, 400 kHz: 2 cm	300 kHz: 3 cm, 600 kHz: 1.5 cm
Resolution Along Track	100 kHz: 2.5m @ 200 meter range 400 kHz: 0.5m @ 100 meter range	300 kHz: 1.0 m @ 200 meter range 600 kHz: 0.45 m @ 100 meter range
Horizontal Beam Width (HDM)	100 kHz: 0.64°, 400 kHz: 0.3°	300 kHz: 0.28°, 600 kHz: 0.26°
Horizontal Beam Width (HSM)	100 kHz: 1.26°, 400 kHz: 0.4°	300 kHz: 0.54°, 600 kHz: 0.34°
Optional CW Pulse Short Range	Yes	
Digital Link	4 MBits/sec (typical), 4 channels of side scan data + sensor data	
Dynamic Range	24 Bits	
Depression Angle	Tilted down 20°	
Vertical Beam Width	50°	
Operating Depth (meters)	2000 (SS) / 300 (Alum) tow bodies	
Operating Temperature	0°C to 45°C	
Power In (4200-P portable topside processor)	18-36 VDC or 110/240 VAC (auto-ranging); 300 Watts maximum	
Power In (4200 rack mount topside processor)	80-140 VAC or 175-265 VAC (auto switching); 300 Watts maximum	
Optional Sensor Port	(1) Serial - RS 232C, 9600 Baud, Bi-directional & 27 Vdc	
Heading/Pitch/Roll	Heading Accuracy: < 1.5° RMS Heading Resolution: 0.1° Roll, Pitch Angle Accuracy: ± 0.4° Roll, Pitch Angle Repeatability: 0.2° Roll, Pitch Angle Resolution: 0.1°	
Options	Pressure, Temperature, Magnetometer, USBL Acoustic Tracking System, Acoustic Responder, Depressor and Custom Sensors	
Towfish Specifications	**4200-FS**	**4200-FSL (lightweight)**
Towfish Material	Stainless Steel	Aluminum
Diameter	11.4 cm (4.5 inches)	
Length	125.6 cm (49.5 inches)	
Weight in Air/Saltwater	48 / 36 kg (105 / 80 pounds)	30 / 18 kg (66 / 40 pounds)
Tow Cable Length	6,000 meters typical	
Tow Cable Type	Co-axial	
Operating Depth (maximum)	2000 meters	300 meters
System Options	4200-P portable topside processor, 701-DL to interface to third party topside processors (see EdgeTech website for specs)	

6.4. Attachment D: Float Plan



FLOAT PLAN

INSTRUCTIONS: Complete this plan before you go boating and leave it with a reliable person who can be depended upon to notify the Coast Guard, or other rescue organization, should you not return or check-in as planned. If you have a change of plans after leaving, be sure to notify the person holding your Float Plan. For additional copies of this plan, go to: **www.floatplancentral.org**

nws.cgaux.org

Do NOT file this plan with the U.S. Coast Guard

www.uscgboating.org

VESSEL

IDENTIFICATION:

Name & Home Port _____
Doc/Registration No. _____
Year & Make _____
Length _____(ft/M) Type PWR Draft _____(In/CM) Hull Mat Fiber
Hull Color(s) _____
Prominent Features _____
_____

PROPULSION:

Primary - Type Gas IO No. Eng.____ Fuel Capacity_____(gal/L)
Auxiliary -Type none No. Eng.____ Fuel Capacity_____(gal/L)

TELECOMMUNICATIONS:

Radio Call Sign _____
DSC MMSI No. _____
Radio-1: Type none Ch./Freq. Monitored _____
Radio-2: Type none Ch./Freq. Monitored _____
Cell Phone No. _____
Pager No. _____

NAVIGATION: (Check all on board)

☐ Maps ☐ Charts ☐ Compass ☐ GPS / DGPS
☐ Radar ☐ Loran C ☐ Sounder ☐ _____

SAFETY & SURVIVAL

VISUAL DISTRESS SIGNALS:

☐ Day Only type
☐ Night Only type
☐ Day & Night type

AUDIBLE DISTRESS SIGNALS:

☐ Horn / Whistle
☐ Bell
☐ _____

OTHER GEAR:

☐ Life boat / Life raft ☐ Flashlight / Searchlight
☐ Dinghy / Skiff ☐ Signal Mirror
☐ Food & Water ☐ Drogue / Sea Anchor
☐ EPIRB none ☐ _____
☐ Foul Weather Gear ☐ _____

PFDs: (Do not count Type IV devices)

_____ Quantity On Board

GROUND TACKLE:

☐ Anchor: Line Length_____(ft/M)

PERSONS ON BOARD

OPERATOR: Age M/F Notes (Special medical condition, Can't swim, etc.)

Name _____
Address _____ Has experience: w/Boat ☐ w/Area ☐
City _____ State ____ Zip Code _____ Home phone: _____
Vehicle (Year, Make & Model): _____ Vehicle License No.: _____
Trailer will be parked at: _____ Trailer License No.: _____

PASSENGERS/CREW: Name & Address Age M/F Notes (Special medical condition, Can't swim, etc.)

1. _____
2. _____
3. _____
4. _____
5. _____

Attach "Supplemental Passenger List" if additional passengers or crew on board.

ITINERARY

	DATE	TIME	LOCATION	MODE OF TRAVEL	REASON FOR STOP	CHECK-IN TIME
Depart						
Arrive						
Depart						
Arrive						
Depart						
Arrive						
Depart						
Arrive						
Depart						
Arrive						
Depart						
Arrive						

Attach "Supplemental Itinerary" if space for additional destinations is needed.

Contact 1: _____ Phone Number _____
Contact 2: _____ Phone Number _____

If you have a genuine concern for the safety or welfare of any persons on board the Vessel described above, who have not returned or checked-in in a reasonable amount time, then follow step-by-step instructions on the **Boating Emergency Guide™** included with this plan, or on the World Wide Web at:

www.floatplancentral.org/help/BoatingEmergencyGuide.htm

Rev 2007.05.11 1 of 2

6.5. Attachment E: <u>Boating Emergency Guide</u>

Step 1:

- ❖ Do you have a concern for the safety of any persons on board the Joyce Marie II, who have not checked-in in a reasonable amount of time?
- ❖ If YES, then continue.

Step 2:

- ❖ On the Float Plan, locate the two contact lines below the itinerary at the bottom of the Float Plan.
- ❖ Call Contact Number 1.
- ❖ This will be the Tangier Island Emergency Contact. This person will likely be Joyce Crockett.)

Step 3:

- ❖ If the Tangier Island Contact has not been able to make contact with the vessel and ensure the safety of all persons on board, then the Tangier Island contact should notify local emergency personnel (Contact 2 on the Float Plan).
- ❖ If you are satisfied emergency personnel have been notified then Stop.
- ❖ Otherwise continue to Step 4.

Step 4:

- ❖ Call Contact 2 on the Float Plan.
- ❖ Explain that you are responding to a late return or check-in by persons on board the vessel.
- ❖ After you have given all your information, it is important to stay off the phone so emergency personnel can contact you with more information.

6.6. Attachment F: Emergency Contact List

Emergency Contact #1:

Joyce Crockett (spouse of boat captain)
At the dock location on Tangier Island
Phone: 757-891-2505

Emergency Contact #2:

Laura Gilbert
Sonographics, Inc.
Office: 954-566-0620
Cell: 954-242-9986
Email: llhorgan@aol.com

Emergency Contact #3:

Stephen Falatko
CH2M HILL, Inc.
Project Manager
Office: 703-376-5099
Cell: 571-286-0787
Fax: 703-376-5599
Email: Stephen.Falatko@CH2M.com

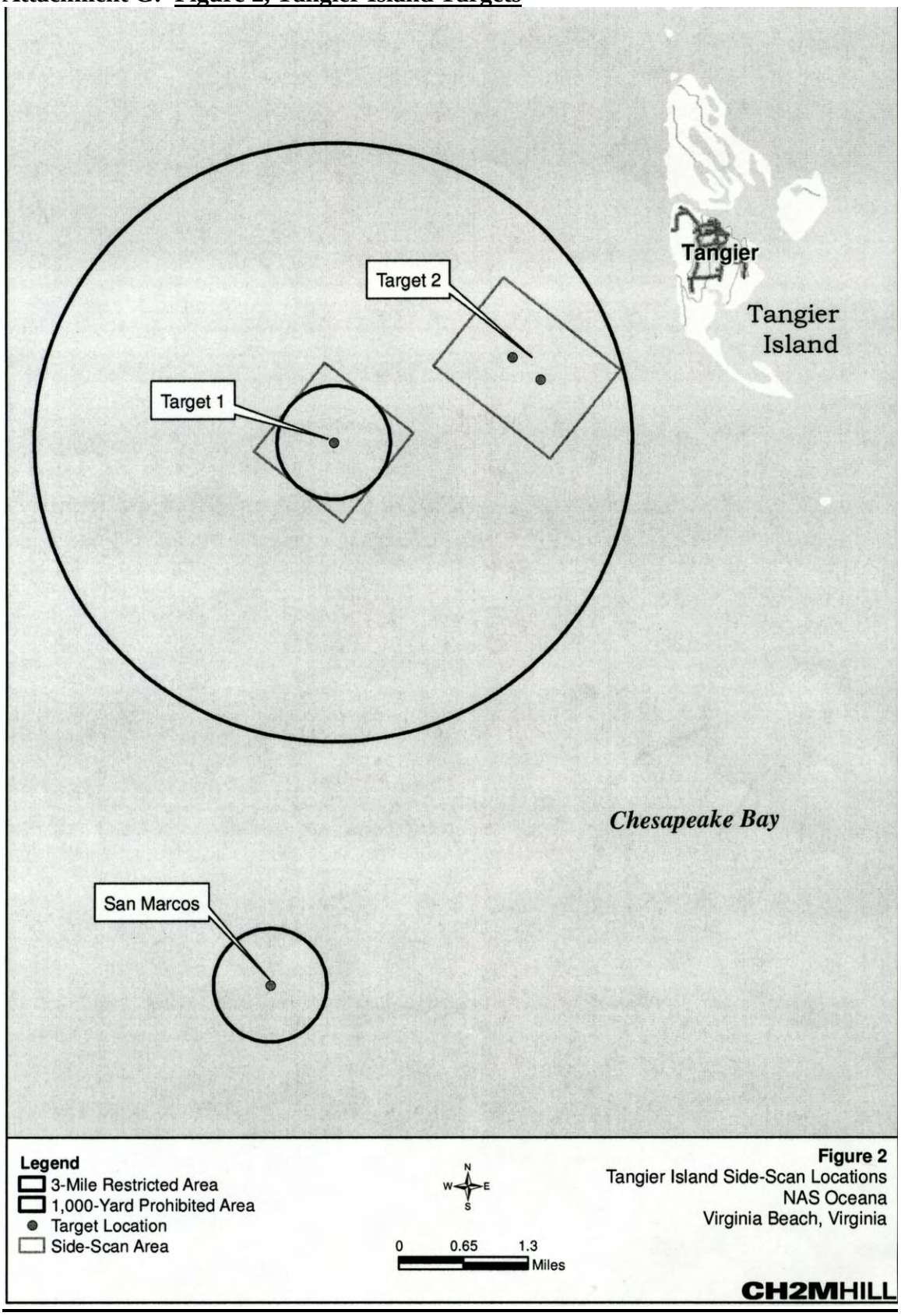
For Medical Emergency Contact:

Tangier Health Center
Tangier Island, VA
804-438-6600

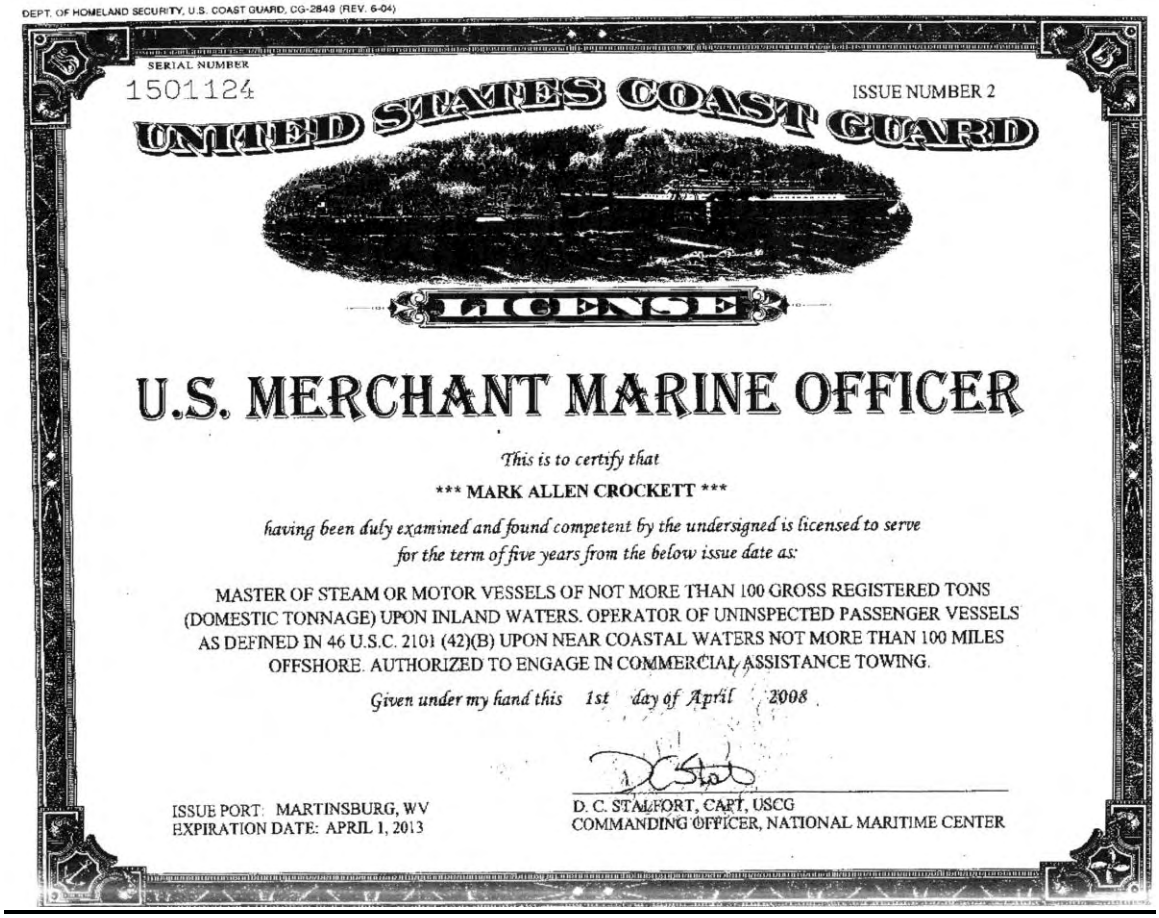
Tangier Fire Department
757-891-2347

Mccready Foundation
Crisfield, MD
757-655-4364
410-968-1200

Attachment G: Figure 2, Tangier Island Targets



Attachment H: <u>Boat Captain Coast Guard License</u>



DEPT. OF HOMELAND SECURITY, U.S. COAST GUARD, CG-2849 (REV. 6-04)

SERIAL NUMBER
1501124

ISSUE NUMBER 2

UNITED STATES COAST GUARD

LICENSE

U.S. MERCHANT MARINE OFFICER

This is to certify that

*** MARK ALLEN CROCKETT ***

having been duly examined and found competent by the undersigned is licensed to serve for the term of five years from the below issue date as:

MASTER OF STEAM OR MOTOR VESSELS OF NOT MORE THAN 100 GROSS REGISTERED TONS (DOMESTIC TONNAGE) UPON INLAND WATERS. OPERATOR OF UNINSPECTED PASSENGER VESSELS AS DEFINED IN 46 U.S.C. 2101 (42)(B) UPON NEAR COASTAL WATERS NOT MORE THAN 100 MILES OFFSHORE. AUTHORIZED TO ENGAGE IN COMMERCIAL ASSISTANCE TOWING.

Given under my hand this 1st day of April 2008

ISSUE PORT: MARTINSBURG, WV
EXPIRATION DATE: APRIL 1, 2013

D. C. STALFORT, CAPT, USCG
COMMANDING OFFICER, NATIONAL MARITIME CENTER

Attachment I: Coast Guard Inspection Report

United States of America
Department of Homeland Security
United States Coast Guard

Certification Date: 07 A[illegible] 2009
Expiration Date: 07 A[illegible] 2014
IMO Number:

Certificate of Inspection

For ships on international voyages this certificate fulfills the requirements of SOLAS 74 as amended, regulation V/14, for a SAFE MANNING DOCUM[illegible]NT.

Vessel Name	Official Number	Call Sign	Service
JOYCE MARIE II	1064433	WCY9585	Recreational

Hailing Port	Hull Material	Horsepower	Propulsion
TANGIER VA	FRP (Fiberglass)	350	Diesel

Place Built	Delivery Date	Date Keel Laid	Gross Tons	Net Tons	DWT	Length
BROOKLIN, ME	01Jun1998		R-22 I-	R-18 I-		R-35.6 I-

Owner	Operator
MR. MARK A CROCKETT BOX 64 W RIDGE RD TANGIER VA 23440	MR. MARK A CROCKETT BOX 64 W RIDGE RD TANGIER VA 23440

This vessel must be manned with the following licensed and unlicensed personnel. Included in which there mus[illegible] be 0 certified lifeboatmen, 0 certified tankermen, 0 HSC type rating, and 0 GMDSS Operators.

1 Master	0 Master & 1st Class pilot	0 Radio Officer(s)	0 Chief Engineer	0 QME - Rating
0 Chief Mate	0 Mate & 1st Class Pilot	0 Able Seamen/ROANW	0 1st Asst. Engr/2nd Engr.	0 Oiler
0 2nd Mate/OICNW	0 Lic. Mate/OICNW	0 Ordinary Seamen	0 2nd Asst. Engr/3rd Engr.	
0 3rd Mate/OICNW	0 1st Class Pilot	0 Deckhands	0 3rd Asst. Engr.	
			0 Lic. Engr.	

In addition, this vessel may carry 23 passengers, 0 other persons in crew, 0 persons in addition to crew, and no other Tota[illegible] persons allowed: 25

Route Permitted and Conditions of Operation:

---Lakes, Bays, and Sounds---

CHESAPEAKE BAY AND ITS TRIBUTARIES.

IF THE VESSEL IS AWAY FROM THE DOCK, OR PASSENGERS ARE ON BOARD OR HAVE ACCESS TO THE VESSEL FOR A PERIOD EXCEEDING 12 HOURS IN ANY 24 HOUR PERIOD, AN ALTERNATE CREW SHALL[illegible]E PROVIDED.

THE MINIMUM NUMBER OF CHILD-SIZE LIFE PRESERVERS REQUIRED IS FOUR. IF MORE THAN FOUR CHILDREN (OR PERSONS WEIGHING 90 POUNDS OR LESS) ARE CARRIED, ADDITIONAL CHILD-SIZE LI[illegible]E PRESERVERS SHALL BE CARRIED SO THAT THE VESSEL HAS AN APPROVED LIFE PRESERVER SUITABL[illegible] FOR EACH CHILD ONBOARD.

SEE NEXT PAGE FOR ADDITIONAL CERTIFICATE INFORMATION

With this Inspection for Certification having been completed at Baltimore, MD, the Officer in Charge, Marine Inspection, BALTIMORE, MARYLAND certified the vessel, in all respects, is in conformity with the applicable vessel inspection laws an[illegible]he rules and regulations prescribed thereunder.

Annual/Periodic/Quarterly Reinspections

Date	Zone	A/P/Q	Signature
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

This certificate issued by:

K.M. POST CDR, USCG By Direction
Officer in Charge, Marine Inspection

BALTIMORE, MARYLAND
Inspection Zone

Dept. of Home Sec., USCG CG-841 (Rev 4-2000)(V2)

OMB No. 2115-00[illegible]

Department of Homeland Security
United States Coast Guard

Certificate of Inspection

JOYCE MARIE II

Certification Da
07Apr2009

WHEN OPERATING AS AN UNINSPECTED PASSENGER VESSEL (UPV), THIS VESSEL SHALL CARRY NO MO THAN SIX PASSENGERS FOR HIRE. NO ALTERATIONS SHALL BE MADE FROM THE EQUIPMENT AND CONDITIONS REQUIRED BY THIS CERTIFICATE OF INSPECTION (COI), UNLESS AUTHORIZED BY THE COGNIZANT OFFICER IN CHARGE, MARINE INSPECTION. THE MINIMUM MANNING SHALL BE ONE LICENSED MASTER.

Overnight accommodations for 0 passengers.

---Hull Exams---

Exam Type	Next Exam	Last Exam	Prior Exam
Drydock	31Jul2010	31Jul2008	-

---Lifesaving Equipment---

	Number	Persons		Required
Total Equipment for		24	Life Preservers(Adult)	24
Lifeboats(Total)	0	0	Life Preservers(Child)	4
Lifeboats(Port)*	0	0	Ring Buoys(Total)	1
Lifeboats(Starbd)*	0	0	With Lights*	1
Motor Lifeboats*	0	0	With Line Attached*	1
Lifeboats W/Radio*	0	0	Other*	0
Rescue Boats/Flatforms	0	0	Immersion Suits	0
Inflatable Rafts	0	0	Portable Lifeboat Radios	0
Life Floats/Buoyant App	1	12	Equipped with EPIRB?	No
			(* included in totals)	

---Fire Fighting Equipment---

Fixed Extinguishing Systems

Capacity	Agent	Space Protected
300	Halocarbon (Formerly: FM 200, FE241)	Machinery Space

Fire Extinguishers - Hand portable and semi-portable

Qty	Class Type
1	A-II
1	B-I
1	B-II

END

Attachment J: Quality Control Acceptance Criteria Table

Procedure	Acceptance Requirements	Corrective Action
Navigation: Satellite Elevation	Must be 8 Degrees Above Horizon	Set GPS Mask at 8 Degrees or Above
Pseudorange Age	Not To Exceed 20 Seconds	Set GPS Mask
Horizontal Dilution Of Position Quality	Not To Exceed 2.5	Set Hypack To Mask & Alarm
Satellite Constellation	Minimum of 4 Satellites	Set GPS Mask Set Hypack Alarm
Control Point Check	Position Within 10 Feet of Previous Checks	Determine Cause of Error Redo Any Survey Work Done Under Questionable Navigation
Confidence Checks	Must See Check Features At Navigation Range on Both Channels	Determine Cause of Failure Take Corrective Action Redo Any Survey Work Since Last Successful Check
Interferance From Sea State Thermal Layering, Etc.	Must Be Able to Detect Targets Specified for Detection	Make Judgement Decision & Stop Survey Redo Any Sub Par Data
Vessel Proximity To Track Line	Must Not Exceed 25 Feet	Restart Line or Append Line To Cover Gap

Attachment C
AHA

SONOGRAPHICS, INC.

Safety Activity Hazard Analysis

Activity: Side-Scan Sonar Services	**Date: March 2, 2010**
	Project: Navy Clean 1000 CTO-WE03 **Tangier Island Bombing Range** **Virginia Beach, Virginia**
Description of the work: Side-scan Sonar operations: Onsite Side-scan sonar investigation of target areas outlined in the scope of work. Loading and unloading of equipment onto vessel for the purpose of sonar surveying operations.	**Site Supervisors:** **CH2M Hill, Adam Forshey** **SONOGRAPHICS, INC., Rick Horgan**
	Site Safety Officers:
	Review for latest use: Before the job is performed.

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
Review **emergency** procedures Review of weather conditions	Delays/Inadequate response to emergency situations. Abrupt or unexpected weather changes	Communication Plan Pre-Task Safety Plan Safety Equipment Checklist
Load side-scan sonar equipment onto boat Testing of equipment.	Slips & Trips Fires	Ensure safe footing, Keep area around boat clear of obstructions. Maintain good housekeeping inside and outside of boat. Maintain two operational (inspected prior to launch fully charged, tamper seal affixed, etc.) Fire extinguishers on the boat.
Check **communication** equipment	Delays/Inadequate response to emergency response	Ensure satellite phone is fully charged Bring spare phone battery Radio Check on VHF Radio Channel 16 prior to launch. Vessel has one 25-Watt VHF Radio with 8' antenna. Maintain VHF volume while boat is underway. Air horn on the boat and functional. Implement "Float Plan" daily.

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)
Boat use **Launching and retrieval of side-scan sonar equipment**	Man-over-board	Technician must be vigilant of deployment lines and abort efforts if sea state is not conducive to safe deployment. Passengers will need to maintain proper safety regulations under USCG laws. Wear flotation device when launching & retrieving equipment.
	Passenger injury (materials and equipment)	Properly secure all materials and equipment before vessel gets underway. All items will need to be on the main floor of the boat and secure.
	Injuries and illnesses	First aid kit required in boat. Located under drivers seat.
	Struck-by hazard, run into equipment or debris	Aware of proper boat operation (who has right-a-way), drive defensively, keep wide berth from other boats/equipment. Observe and comply with safety markers. Boat must be operated in accordance with U.S. Coast Guard regulations for: speed, lighting, right a way, etc.
	Drowning	PFD required in vessel at all times. Throw cushion with 50 feet of 3/8 inch braided polypropylene (or equal) rope must be provided for emergency rescue Survival Suits ready for use. Hand held and parachute flares ready.
	Poor visibility	PRIOR TO ANY BOAT ACTIVITY CONDUCTED AT NIGHT, MUST AGREE TO ACTIVITY. Flashlights required for employees (dawn/dusk). PFD must have reflective material
	Inclement Weather	Any “observable” lightning or thunder – stop work and return to shore. Team leader must monitor appropriate sources to track developing potential for lightning, high winds, tornado’s. Sustained wind speeds of 20 mph or wind gusts of 25 mph will cease boat operations – return to shore.

SONOGRAPHICS, INC.

Safety Activity Hazard Analysis

Equipment to be used (List equipment to be used in the work activity)	**Inspection Requirements** (List inspection requirements for the work activity)	**Training Requirements** (List training requirements including hazard communication)
Boat	Inspect boat for damage, ensure push pole and other equipment are in boat, ensure there is adequate fuel, tool kit, and items are secure, etc.	Qualified/Experienced boat operator and crew
First Aid Kit	Inspect contents to ensure all supplies are available	At least one person first aid and CPR trained
Satellite phone **VHF Radio**	Ensure phone is fully charged and have emergency phone number on-person Channel 16 during boat operations. Volume check.	
Fire Extinguishers	Inspect prior to boat launch	
Throw Cushion, PFD's, Survival suits, Flares, & Air Horn	Inspect prior to boat launch	

SONOGRAPHICS, INC.

Safety Activity Hazard Analysis

	PRINT NAME	SIGNATURE	COMPANY	
Supervisor Name:				**Date:**
Safety Officer Name:				**Date:**
Employee Name(s):				**Date/Time:**
				Date/Time:
				Date/Time:
				Date/Time:
				Date/Time:
				Date/Time:
				Date/Time:
				Date/Time:
				Date/Time:

Attachment D
Trimble DSM-232 GPS Receiver

Attachment D: Trimble DSM 232 Differential Global Positioning System

TRIMBLE DSM 232 MODULAR GPS RECEIVER

STANDARD SYSTEM FEATURES

- Modular receiver (separate antenna and receiver unit) for installation flexibility and security of investment
- Integrated display and keypad for system configuration and status checking without external software
- External GPS antenna choices for single frequency, dual frequency or DGPS base station operation
- IALA Beacon, Satellite Based Augmentation Systems (SBAS) such as WAAS, EGNOS compatible
- Accepts RTCM and CMR (optional) corrections from external radio link
- upgradable to and available as 24-channel L1/L2 GPS receiver for improved accuracy performance, allowing for:
  - 3D decimeter accuracy OmniSTAR XP and HP service capable
  - 3D centimeter accuracy RTK capable
- Up to 10 Hz measurement update rate (NMEA and TSIP Protocols)
- Two physical connectors allow for 3 programmable RS-232 serial ports and 2 NMEA 2000® capable ports
- 1PPS signal
- Waterproof and dustproof
- -30° C to +65° C (-22° F to +140° F) operating temperature range
- 9V to 28V DC input power range with over-voltage protection
- Backward compatibility with DSM132 – same antenna cable, single frequency / beacon antenna, power and data cable, and mounting bolt pattern
- Suitable for permanent / semi permanent as well as short term installations

ANTENNA SPECIFICATIONS

DGPS Antenna

Size ..... 15.5 cm (6.1 in) D x 14.0 cm (5.5 in) H
Weight ..... 0.55 Kg (1.2 lb)
Operating Temperature ..... -30°C to +65°C
Usage ..... L1 GPS, Beacon, SBAS and L-Band

Dual Frequency Antenna

Size ..... 16 cm (6.25 in) D x 7.5 cm (3 in) H
Weight ..... 0.55 Kg (1.2 lb)
Operating Temperature ..... -30°C to +65°C
Usage ..... L1/L2 GPS, SBAS and L-Band

Geodetic Reference Station Antenna

Size ..... 34.3 cm (13.5 in) D x 7.6 cm (3 in) H
Weight ..... 1.31 Kg (2.88 lb)
Operating Temperature ..... -40°C to + 70°C
Usage ..... L1/L2 GPS and SBAS

Humidity/Case. . . . All antennae are 100% condensing, unit fully sealed. Dust-proof, waterproof, shock resistant

OPTIONS

- Upgrade DGPS receiver to OmniSTAR XP/HP (includes dual frequency antenna)
- Upgrade OmniSTAR XP/HP receiver to RTK rover
- Upgrade for DGPS Reference Station

HARDWARE SPECIFICATIONS

Physical

Size (WxHxD) ..... 14.8 cm (5.7 in) x 5.6 cm (2.2 in) x 21.6 cm (8.6 in)
Receiver Weight ..... 0.96 kg (2.13 lb)
Keyboard and display . . . LCD backlight display 16 characters by 2 rows, 4 button keypad
Antenna Mounting ..... All accept 5/8"-11 UNC male bolt

Environmental

Operating temperature ..... -30° C to +65° C (-22° F to +140° F)
Storage temperature ..... -34° C to +85° C (-29° F to +185° F)
Humidity ..... Complies with MIL 810E. Unit sealed to +/- 5 PSID
Water ..... Waterproof and dustproof

Electrical

Power ..... 9V to 28V DC external power input with over-voltage protection
Power consumption ..... Nominal 350 mA at 12 V DC
Certification ..... Class B Part 15, 22, 24 FCC certification, CE mark approval, C-tick approval, WEEE

Communications

- Two CONXALL connectors on the back plane, Port A and B
- 3 programmable RS232 outputs
- 2 CAN (NMEA 2000®) outputs

Receiver position update rate ..... 1,2,5,10 Hz
Correction Data Input and Output ..... CMR II, CMR+, RTCM 2.1, RTCM 2.3, RTCM 3.0
RS232 Outputs ..... NMEA – GGA, GLL, GRS, GSA, GST, GSV, MSS, RMC, VTG, ZDA, various Proprietary NMEA TSIP format
CAN Outputs ..... J1939, NMEA 2000®

PERFORMANCE SPECIFICATIONS

Measurements

- Trimble EVEREST multi-path mitigation technology
- DGPS: 12 Channel L1 plus 2 channels for Beacon
- DGPS with SBAS (WAAS / EGNOS / MSAS): 11 GPS channels plus 1 for SBAS
- RTK or OmniSTAR VBS/XP/HP: 24 channel L1/L2 plus 1 channel L Band

Code differential GPS positioning

Horizontal accuracy ..... ±(0.25m + 1 ppm) RMS ±(0.8 ft + 1 ppm)
Vertical accuracy ..... ±(0.50m + 1 ppm) RMS ±(1.6 ft + 1 ppm)

WAAS / EGNOS / MSAS[1]

Horizontal accuracy ..... Typically 1m (3 ft)
Vertical accuracy ..... Typically <5m (<16 ft)

OmniSTAR Positioning

VBS Service Accuracy ..... Horizontal typically better than 1 m (3 ft)
XP Service Accuracy ..... Horizontal 10cm (.3 ft), Vertical 20cm (.7 ft)
HP Service Accuracy ..... Horizontal 5cm (.2 ft), Vertical 10cm (.3 ft)
OmniSTAR XP/HP Convergence . . . Cold start - Typically 10 to 40 minutes depending on satellite geometry

Real Time Kinematic (RTK) positioning[2]

Horizontal accuracy ..... ±(10mm + 1 ppm), ±(.03 ft +1ppm)
Vertical accuracy ..... ±(20mm + 1 ppm), ±(.07 ft +1ppm)

Initialization time

Regular RTK operation with base station . . Single/Multi-base minimum 10 sec + 0.5 times baseline length in km, <30 km
Initialization reliability[3] ..... Typically >99.9%

1 Depends on WAAS / EGNOS / MSAS system performance
2 Accuracy and reliability may be subject to anomalies such as multipath, obstructions, satellite geometry and atmospheric conditions. Always follow recommended practices.
3 May be affected by atmospheric conditions, signal multipath and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.

Specifications subject to change without notice.

Attachment E
4200-FS Side-Scan Sonar System

Attachment E: <u>EdgeTech FS4200 Digital Dual Frequency Side-scan Sonar System</u>

4200 SERIES SIDE SCAN SONAR SYSTEMS

Key Specifications

System Specifications		
Frequency	100/400 kHz	300/600 kHz
Modulation	Full Spectrum chirp frequency modulated pulse with amplitude and phase weighting	
Operating Range (typical maximum with good imagery)	100 kHz: 500 meters/side 400 kHz: 150 meters/side	300 kHz: 230 meters/side 600 kHz: 120 meters/side
Towing Speed (max safe)	12 knots	
Towing Speed *	4.8 knots in HDM, 9.6 knots in HSM	
Output Power	100 kHz: 4 joules, 400 kHz: 2 joules	300 kHz: 2 joules, 600 kHz: 1 joule
Pulse Length	100 kHz up to 20 ms 400 kHz up to 10 ms	300 kHz up to 10 ms 600 kHz up to 5 ms
Resolution Across Track	100 kHz: 8 cm, 400 kHz: 2 cm	300 kHz: 3 cm, 600 kHz: 1.5 cm
Resolution Along Track	100 kHz: 2.5m @ 200 meter range 400 kHz: 0.5m @ 100 meter range	300 kHz: 1.0 m @ 200 meter range 600 kHz: 0.45 m @ 100 meter range
Horizontal Beam Width (HDM)	100 kHz: 0.64°, 400 kHz: 0.3°	300 kHz: 0.28°, 600 kHz: 0.26°
Horizontal Beam Width (HSM)	100 kHz: 1.26°, 400 kHz: 0.4°	300 kHz: 0.54°, 600 kHz: 0.34°
Optional CW Pulse Short Range	Yes	
Digital Link	4 MBits/sec (typical), 4 channels of side scan data + sensor data	
Dynamic Range	24 Bits	
Depression Angle	Tilted down 20°	
Vertical Beam Width	50°	
Operating Depth (meters)	2000 (SS) / 300 (Alum) tow bodies	
Operating Temperature	0°C to 45°C	
Power In (4200-P portable topside processor)	18-36 VDC or 110/240 VAC (auto-ranging); 300 Watts maximum	
Power In (4200 rack mount topside processor)	80-140 VAC or 175-265 VAC (auto switching); 300 Watts maximum	
Optional Sensor Port	(1) Serial - RS 232C, 9600 Baud, Bi-directional & 27 Vdc	
Heading/Pitch/Roll	Heading Accuracy: < 1.5° RMS Heading Resolution: 0.1° Roll, Pitch Angle Accuracy: ± 0.4° Roll, Pitch Angle Repeatability: 0.2° Roll, Pitch Angle Resolution: 0.1°	
Options	Pressure, Temperature, Magnetometer, USBL Acoustic Tracking System, Acoustic Responder, Depressor and Custom Sensors	
Towfish Specifications	**4200-FS**	**4200-FSL (lightweight)**
Towfish Material	Stainless Steel	Aluminum
Diameter	11.4 cm (4.5 inches)	
Length	125.6 cm (49.5 inches)	
Weight in Air/Saltwater	48 / 36 kg (105 / 80 pounds)	30 / 18 kg (66 / 40 pounds)
Tow Cable Length	6,000 meters typical	
Tow Cable Type	Co-axial	
Operating Depth (maximum)	2000 meters	300 meters
System Options	4200-P portable topside processor, 701-DL to interface to third party topside processors (see EdgeTech website for specs)	

Attachment F
Survey Vessel “Joyce Marie”

Attachment F: Vessel Joyce Marie II

Travel Aboard the "Joyce Marie II"

This boat was originally built in Maine in 1988.
A Fiberglass - Lobster Boat, similiar to a Chesapeake Bay Deadrise.
36 ' Long with a 4' Draft
Captain and Boat - Coast Guard Certified
25 Passenger Boat

Attachment G
Float Plan

Attachment G: Float Plan

FLOAT PLAN

INSTRUCTIONS: Complete this plan before you go boating and leave it with a reliable person who can be depended upon to notify the Coast Guard, or other rescue organization, should you not return or check-in as planned. If you have a change of plans after leaving, be sure to notify the person holding your Float Plan. For additional copies of this plan, go to: **www.floatplancentral.org**

nws.cgaux.org

Do NOT file this plan with the U.S. Coast Guard

www.uscgboating.org

VESSEL

IDENTIFICATION:
Name & Home Port: JOYCE MARIE II / TANGIER ISLAND, VA
Doc/Registration No.: 1064433
Year & Make: 1998 BUM (ATLANTIC BOAT CO.)
Length: 36 (FT) Type: PWR Draft: 4.6 (FT) Hull Mat: Fiber
Hull Color(s): WHITE
Prominent Features: LOBSTER STYLE CABIN FORWARD

TELECOMMUNICATIONS:
Radio Call Sign: WCY 9585
DSC MMSI No.:
Radio-1: Type: none Ch./Freq. Monitored: 16
Radio-2: Type: none Ch./Freq. Monitored:
Cell Phone No.: 757-999-2505 / OR SATELLITE
Pager No.:

NAVIGATION: (Check all on board)
☑ Maps ☑ Charts ☑ Compass ☑ GPS / DGPS
☑ Radar ☐ Loran C ☑ Sounder ☐

PROPULSION: DIESEL
Primary - Type: Gas IO No. Eng: 1 Fuel Capacity: 120 (gal/L)
Auxiliary -Type: none No. Eng.: Fuel Capacity: (gal/L)

SAFETY & SURVIVAL

VISUAL DISTRESS SIGNALS:
☐ Day Only type
☐ Night Only type
☑ Day & Night type

AUDIBLE DISTRESS SIGNALS:
☑ Horn / Whistle
☐ Bell
☐

OTHER GEAR:
☑ Life boat / Life raft ☑ Flashlight / Searchlight
☐ Dinghy / Skiff ☐ Signal Mirror
☑ Food & Water ☐ Drogue / Sea Anchor
☐ EPIRB none ☐
☑ Foul Weather Gear ☐

PFDs: (Do not count Type IV devices)
27 Quantity On Board

GROUND TACKLE:
☑ Anchor: Line Length: 200 (FT)

PERSONS ON BOARD

OPERATOR:
Name: MR. MARK A. CROCKETT Age: 50 M/F: M Notes (Special medical condition, Can't swim, etc.): NONE
Address: BOX 64 W RIDGE RD
City: TANGIER State: VA Zip Code: 23440
Has experience: w/Boat ☑ w/Area ☑
Home phone: 757-891-2505
Vehicle (Year, Make & Model): SEE ABOVE
Vehicle License No.:
Trailer will be parked at: NA
Trailer License No.:

PASSENGERS/CREW: Name & Address

	Age	M/F	Notes (Special medical condition, Can't swim, etc.)
1. MR. RICK HORGAN	64	M	NONE
2. SONOGRAPHICS INC			
3.			
4.			
5.			

Attach "Supplemental Passenger List" if additional passengers or crew on board.

ITINERARY

	DATE	TIME	LOCATION	MODE OF TRAVEL	REASON FOR STOP	CHECK-IN TIME
Depart	4/20/10	7:19				
Arrive	4/20/10	19 35	[redacted]			
Depart	4/21/10	14.10				
Arrive	4/21/10	16.53	Chesapeake Bay			
Depart	4/22/10	6.51				
Arrive	4/22/10	19.02	Chesapeake Bay			
Depart	4/23/10	7.06				
Arrive	4/23/10	12.58				
Depart						
Arrive						
Depart						
Arrive						

Attach "Supplemental Itinerary" if space for additional destinations is needed.

Contact 1: JOYCE CROCKETT Phone Number: 757-891-2505
Contact 2: LAURA GILBERT Phone Number: 954-242-9986 / 954-566-0620

If you have a genuine concern for the safety or welfare of any persons on board the Vessel described above, who have not returned or checked-in in a reasonable amount time, then follow step-by-step instructions on the **Boating Emergency Guide™** included with this plan, or on the World Wide Web at:

www.floatplancentral.org/help/BoatingEmergencyGuide.htm

Rev 2007.05.11 1 of 2

ADAM FORSHEY 757-285-9028 (C) / 757-671-6267 (O)

Attachment H
Quality Control Target Report

Attachment H: Quality Control Report

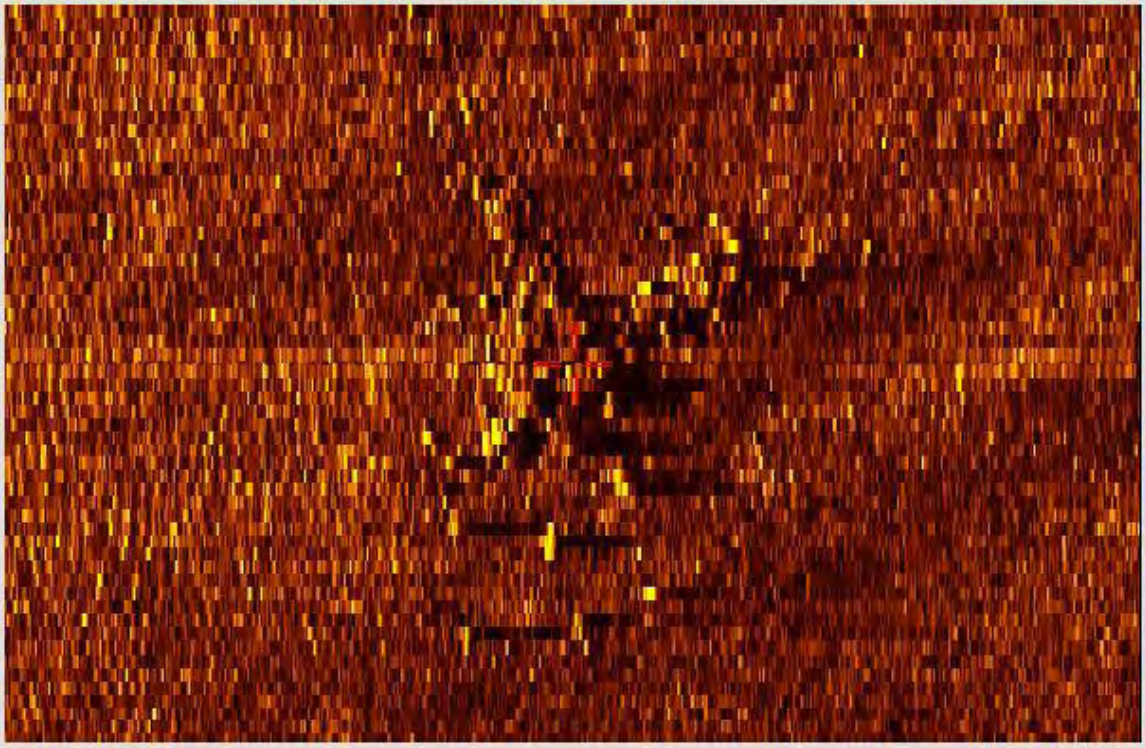
Side-Scan Quality Control Data

The following targets were marked during the collection of the Side-Scan data as confidence checks to verify proper system tuning and operation.

April 20, 2010

Target 1-3 is an apparent cross shaped debris cluster marked on the starboard side of line A1-22NW.

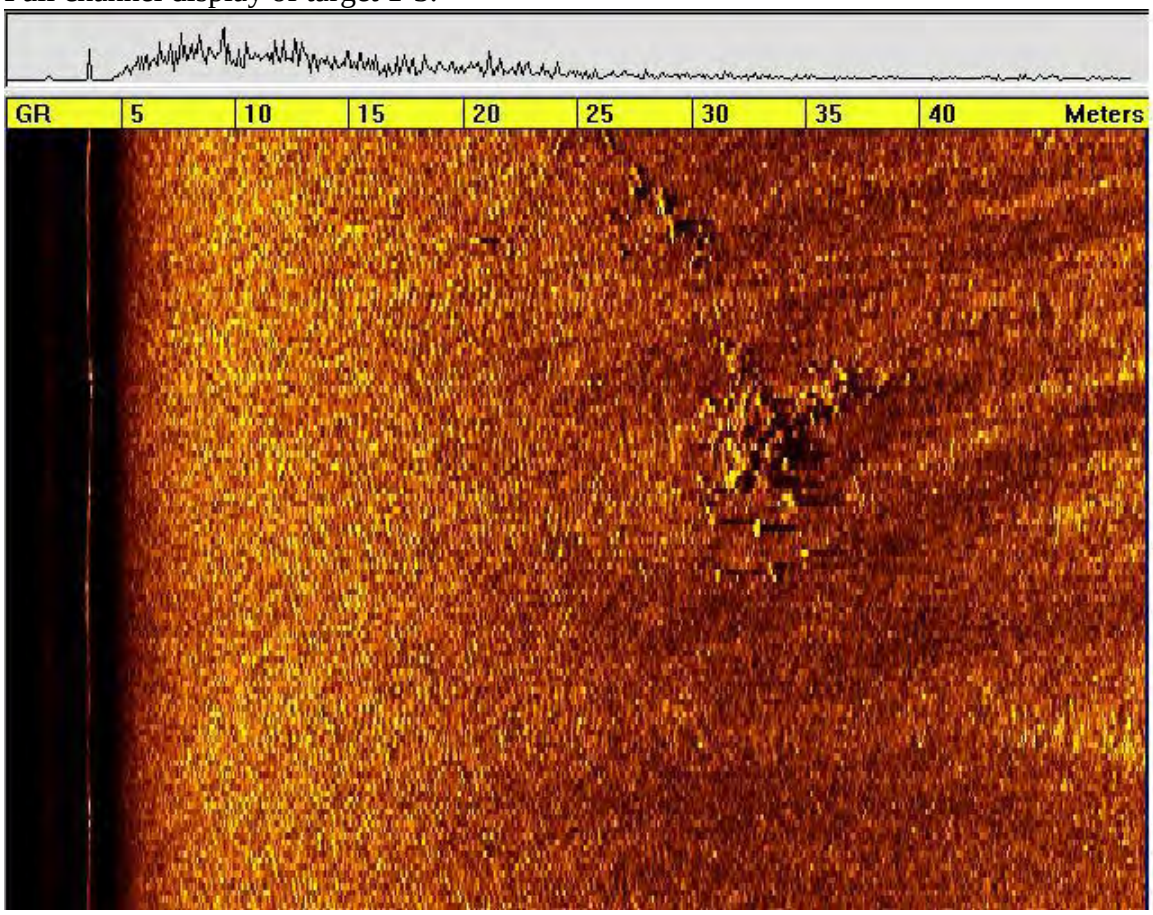
Target-1-3



Target Latitude: 37:47.7552 N Target Longitude: 76:03.2410 W

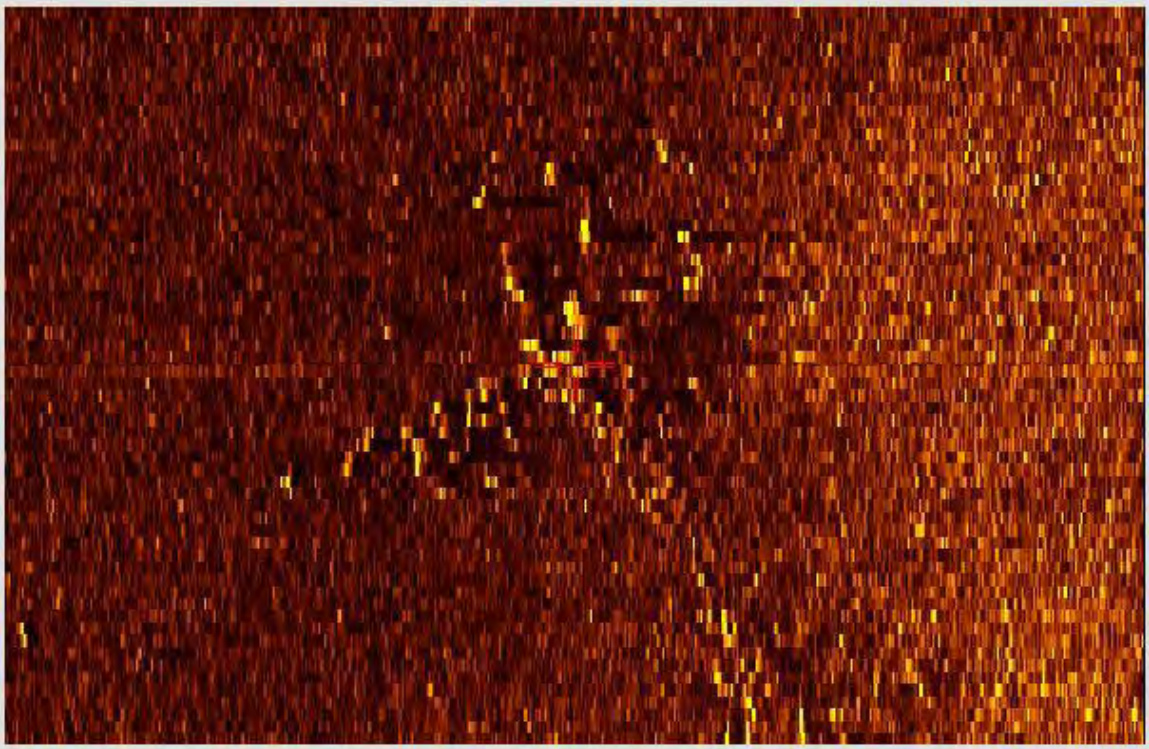
Heading: 321.39 Degrees Ground Range: 33.4 Meters to Starboard

Full channel display of target 1-3.



Target 1-4 is the same cross shaped debris cluster as Target 1-3 and is marked again here on the starboard side of Line A1-20 SE.001.

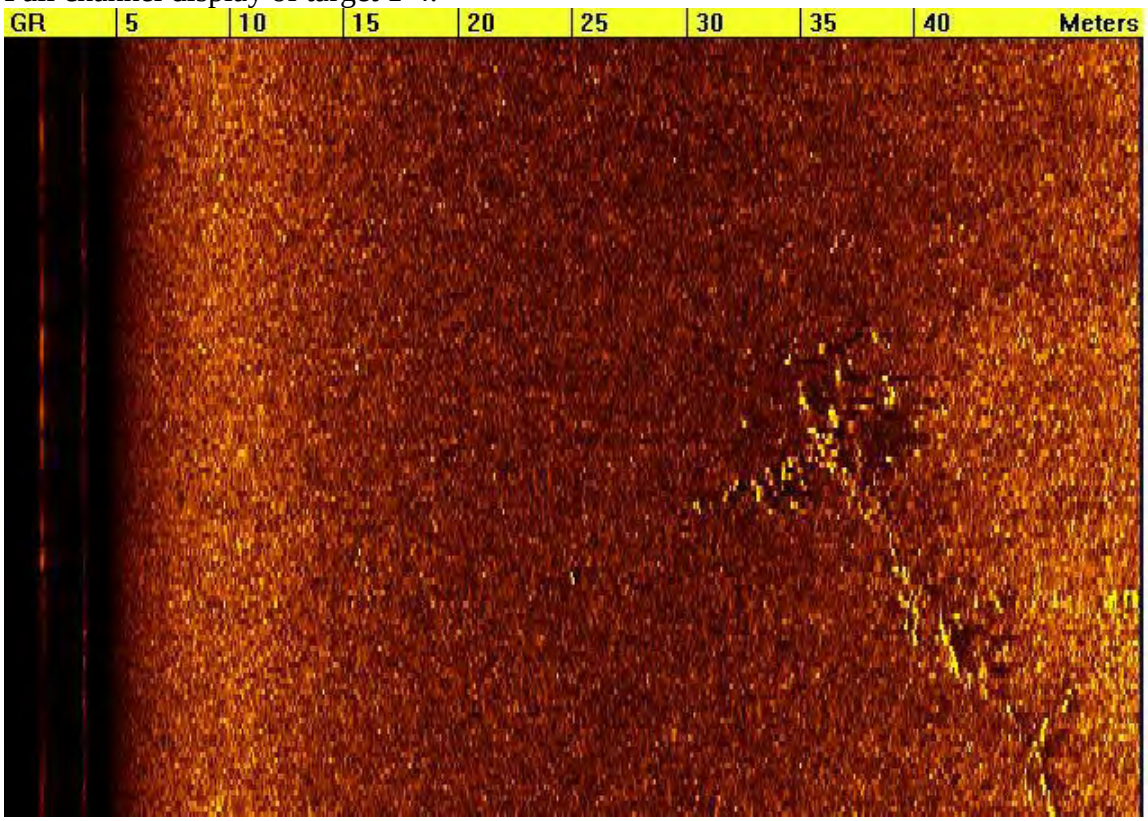
Target-1-4



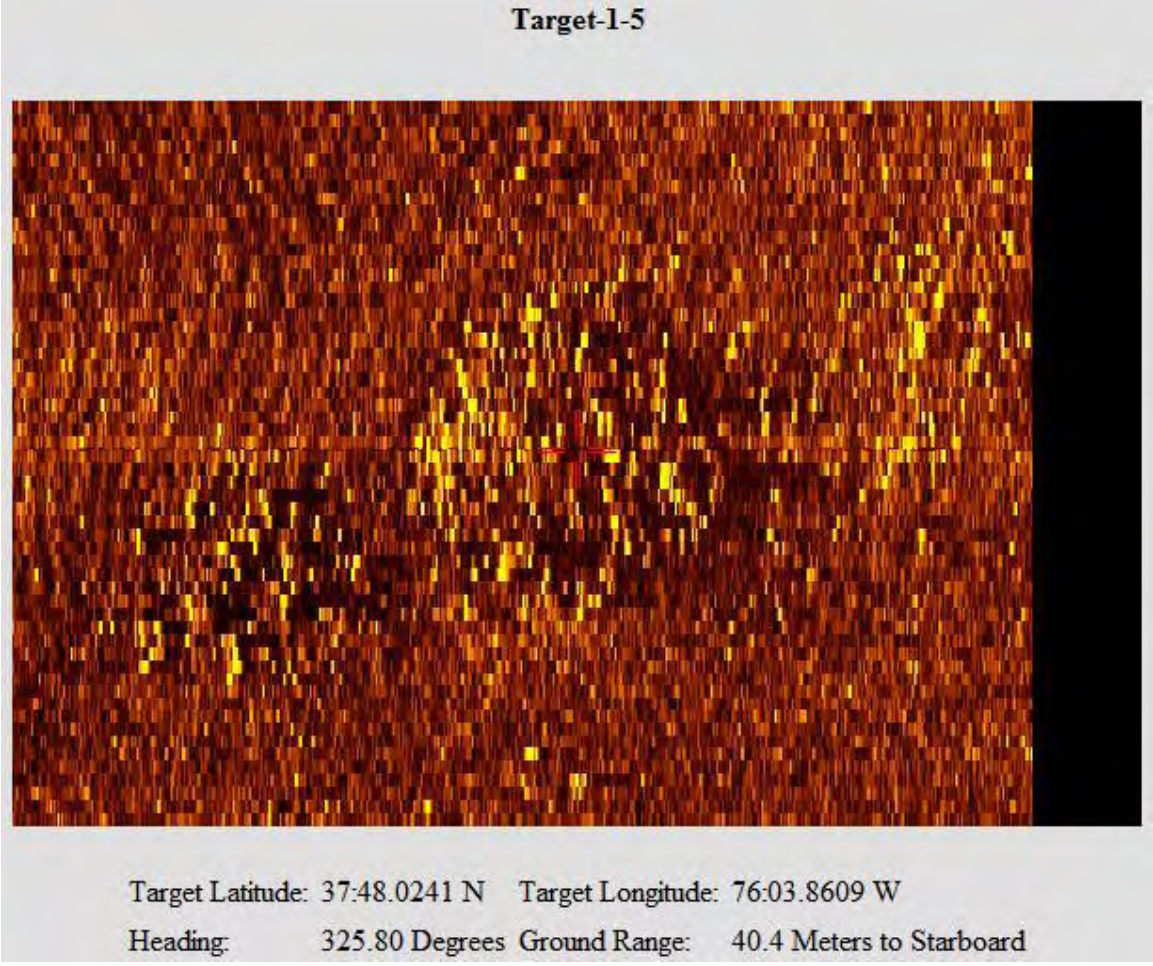
Target Latitude: 37:47.7687 N Target Longitude: 76:03.2610 W

Heading: 130.29 Degrees Ground Range: 36.4 Meters to Starboard

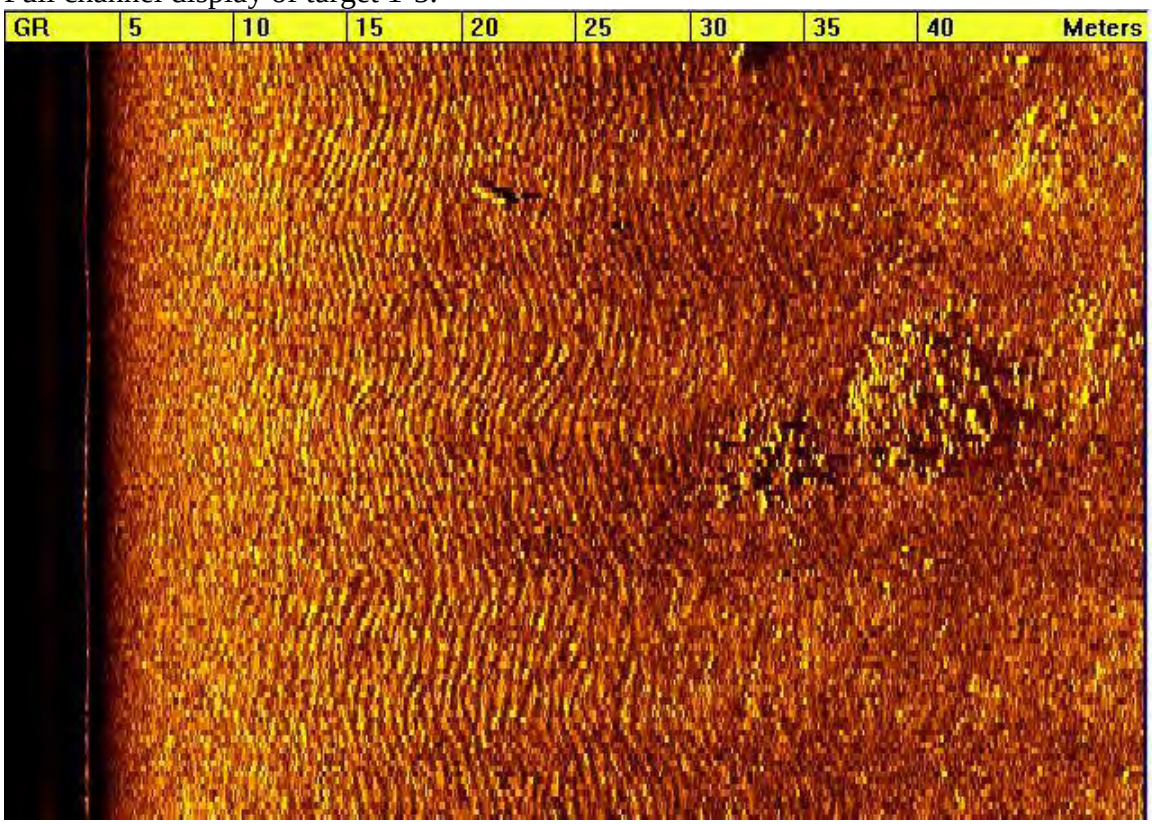
Full channel display of target 1-4.



Target 1-5 is an apparent circular debris cluster marked on the starboard side of line A1-28NW.

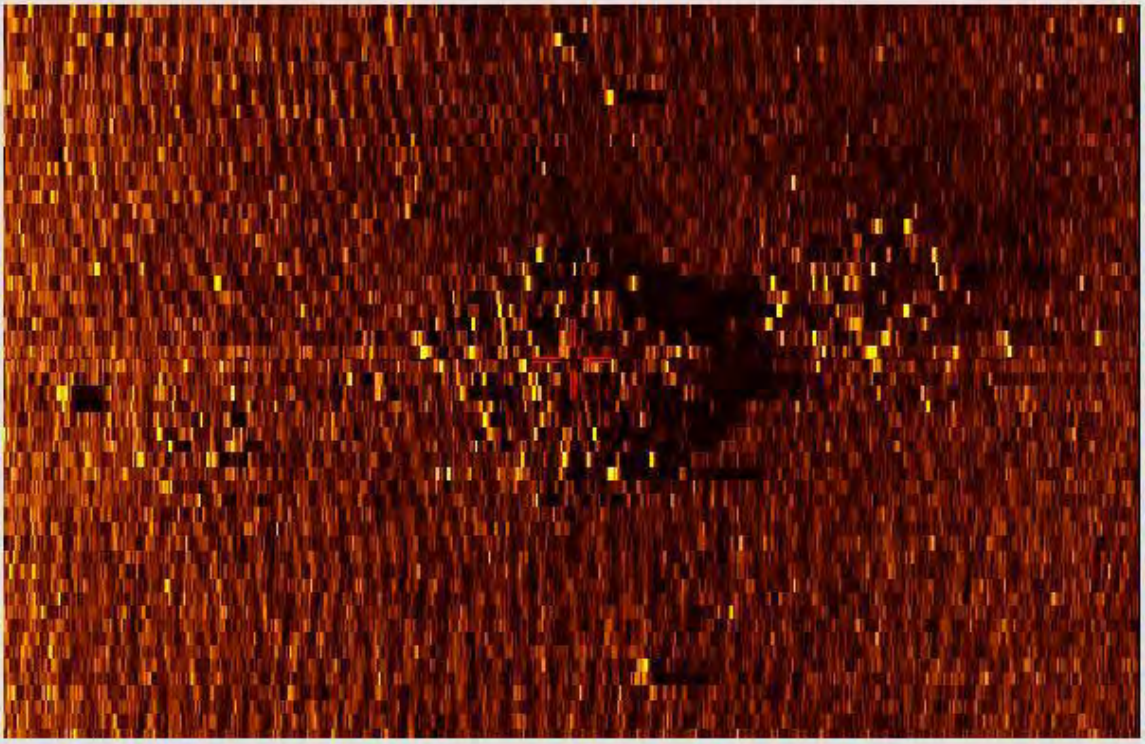


Full channel display of target 1-5.



Target 1-6 is the same circular debris cluster as Target 1-5 and marked again here on the starboard side of Line A1-26 SE.

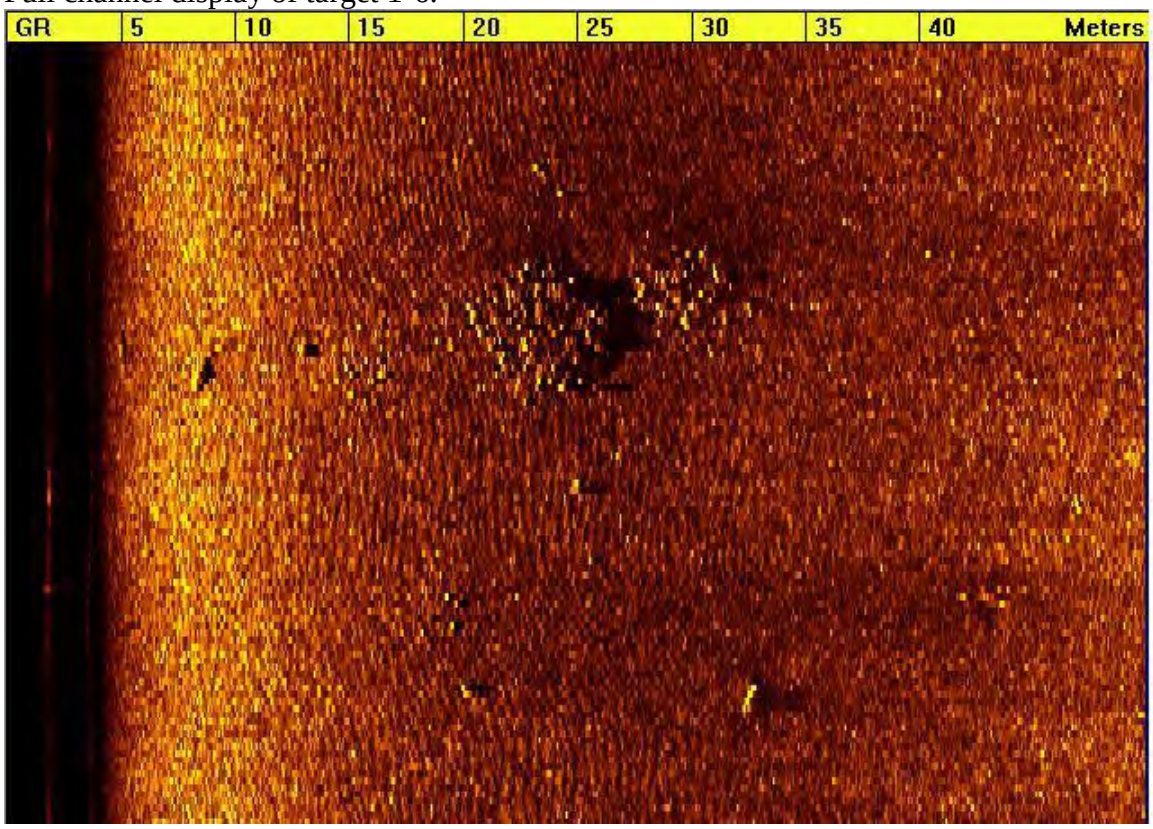
Target-1-6



Target Latitude: 37:48.0372 N Target Longitude: 76:03.8783 W

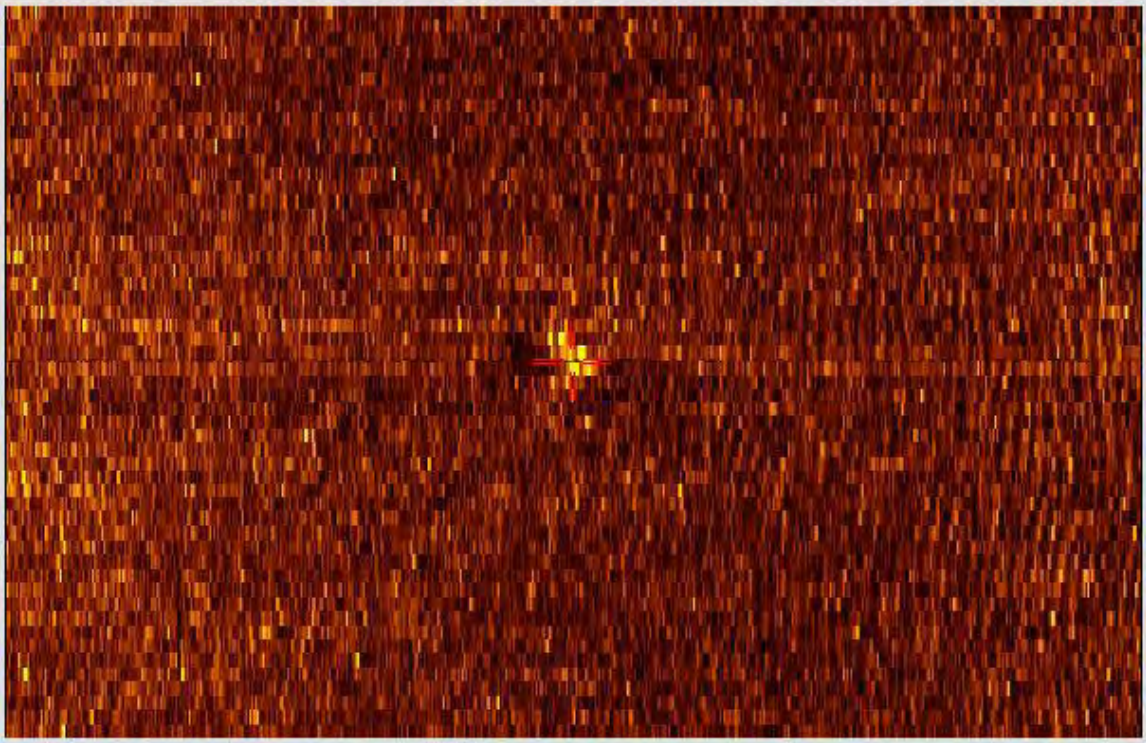
Heading: 124.29 Degrees Ground Range: 23.4 Meters to Starboard

Full channel display of target 1-6.



Target 1-11 is a small target with acoustic shadow marked on the port side of line A1-57SE.

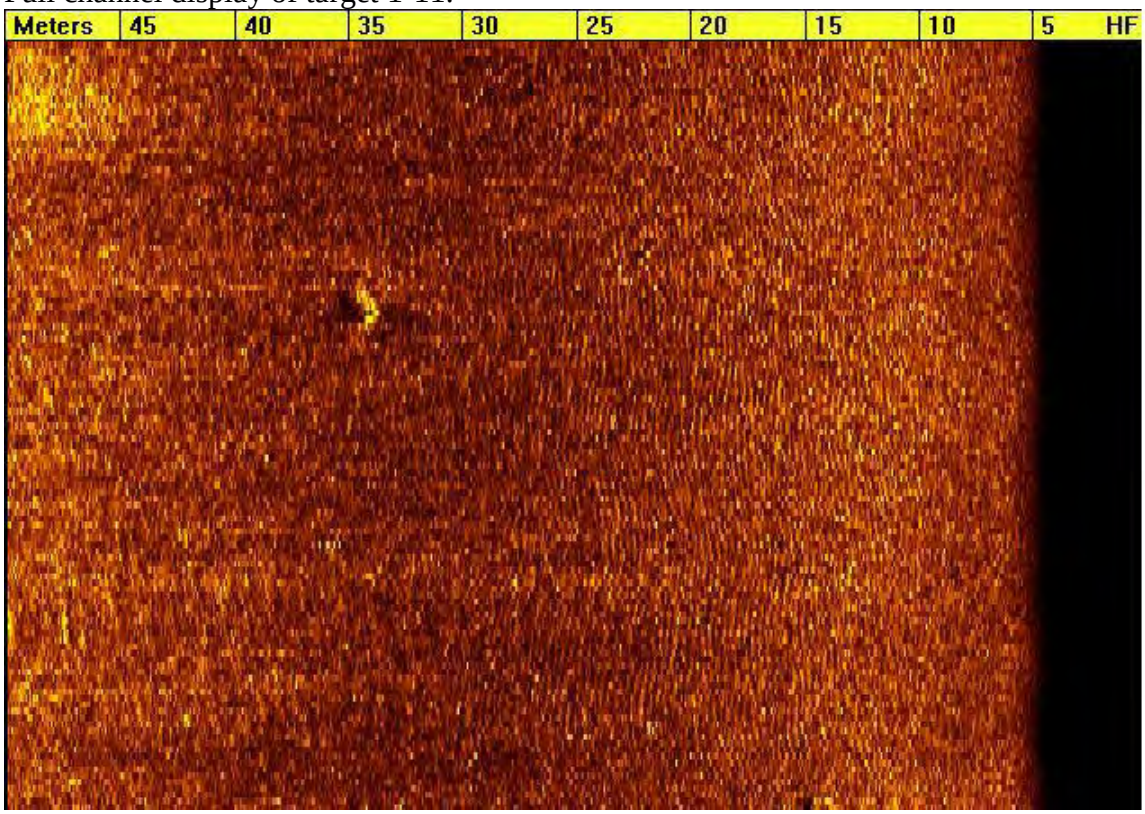
Target-1-11



Target Latitude: 37:47.3661 N Target Longitude: 76:03.7875 W

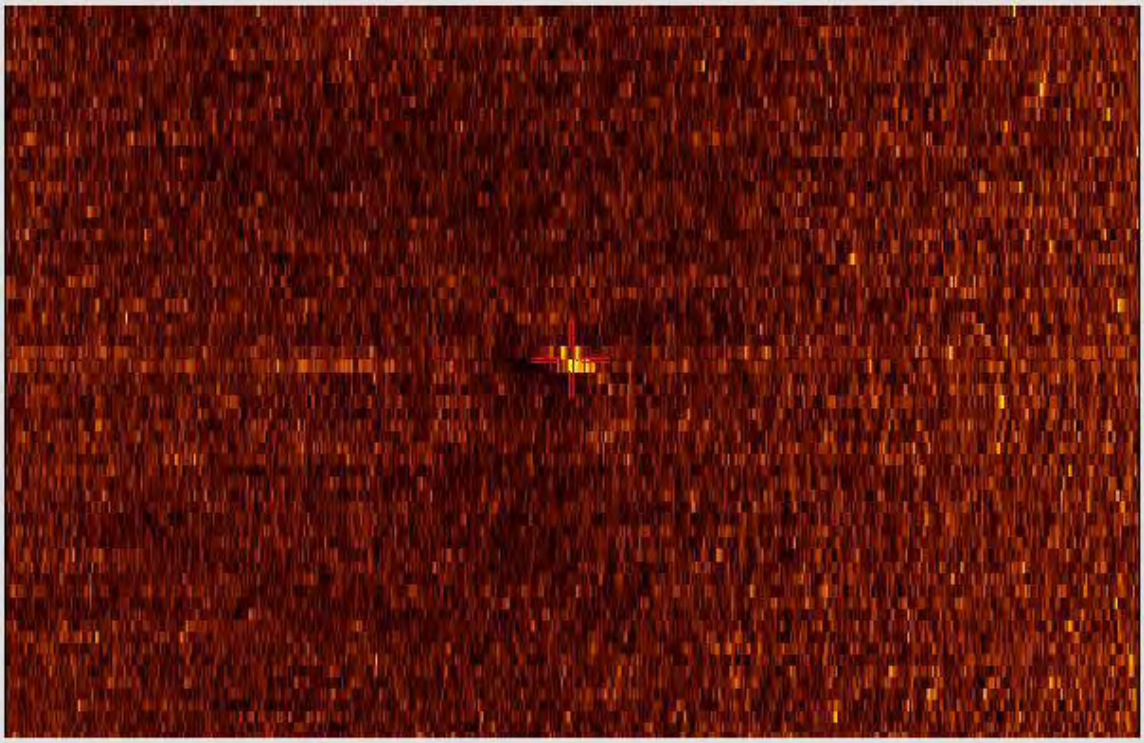
Heading: 113.39 Degrees Ground Range: 34.0 Meters to Port

Full channel display of target 1-11.



Target 1-12 is the same small target with shadow as Target 1-11 and marked again here on the port side of Line A1-55NW.

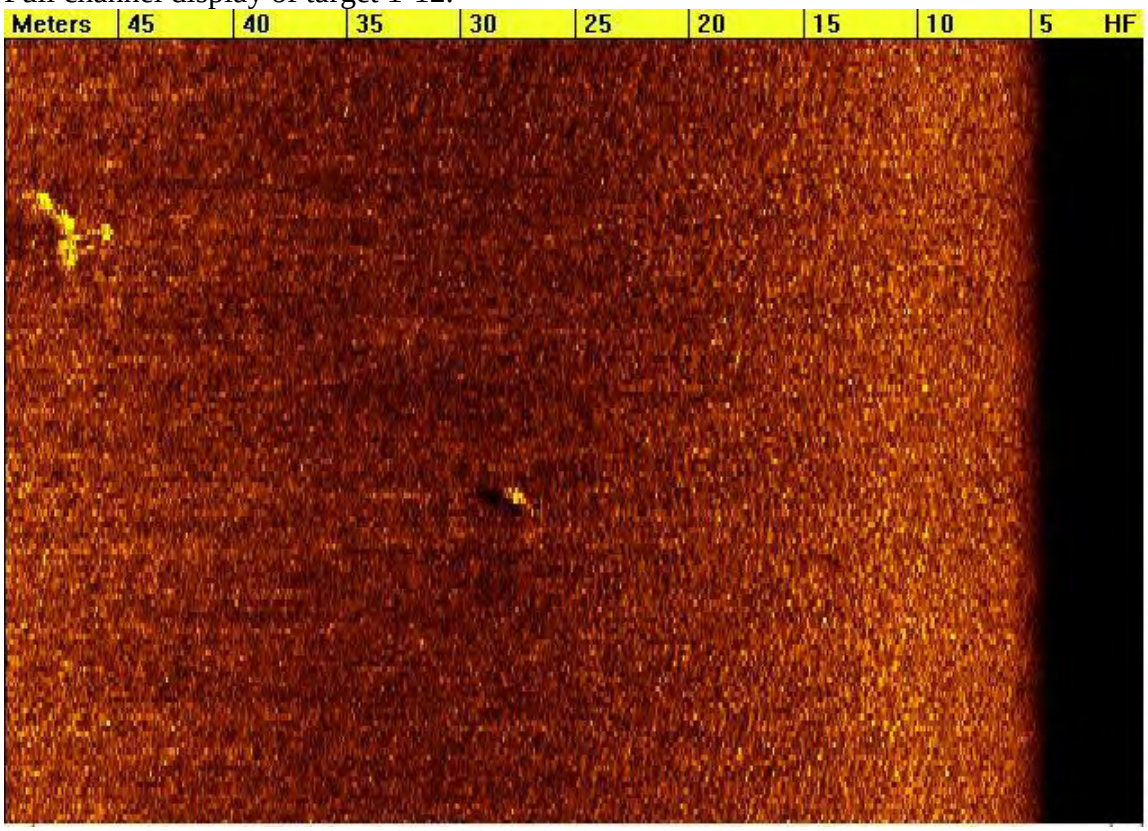
Target-1-12



Target Latitude: 37:47.3606 N Target Longitude: 76:03.7790 W

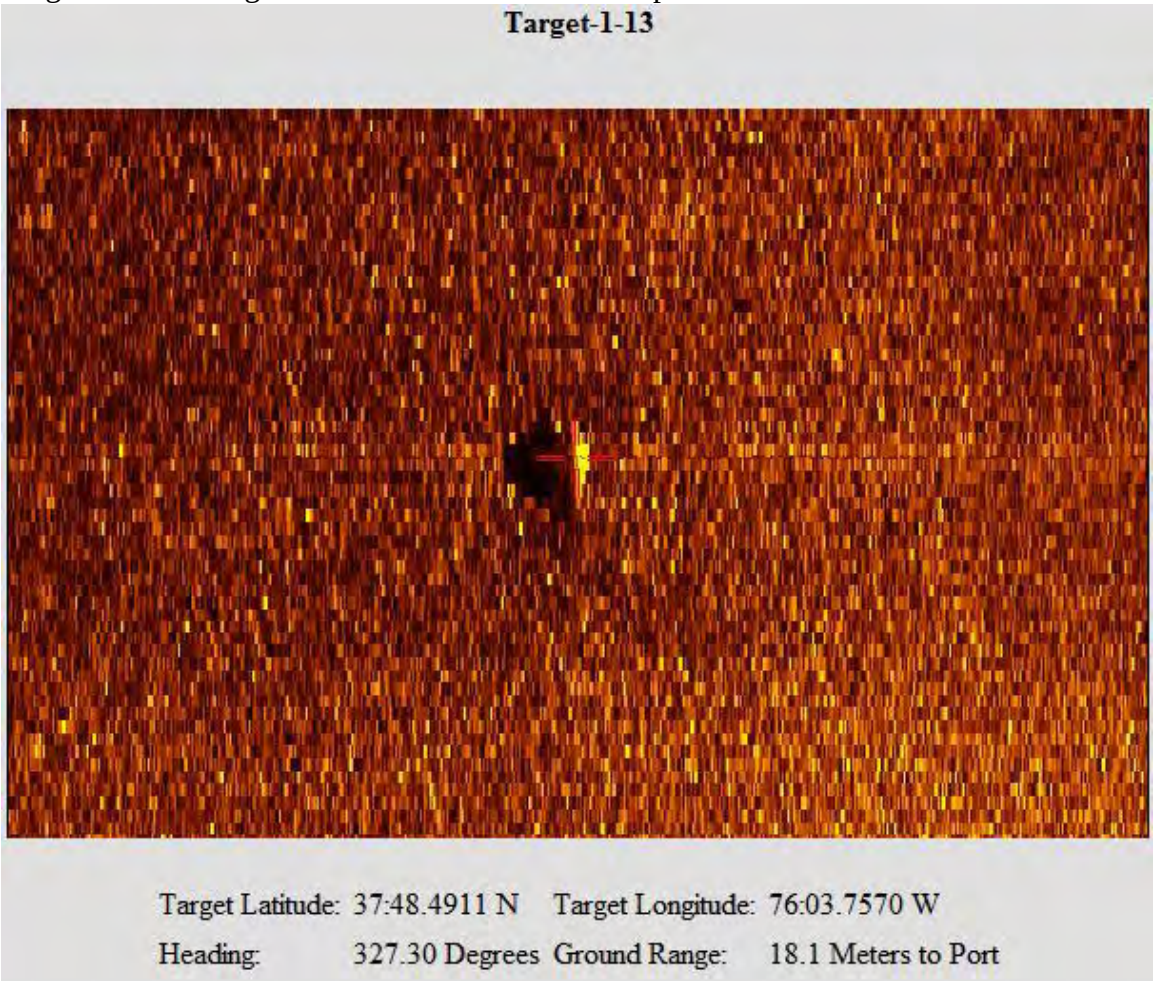
Heading: 326.89 Degrees Ground Range: 27.5 Meters to Port

Full channel display of target 1-12.

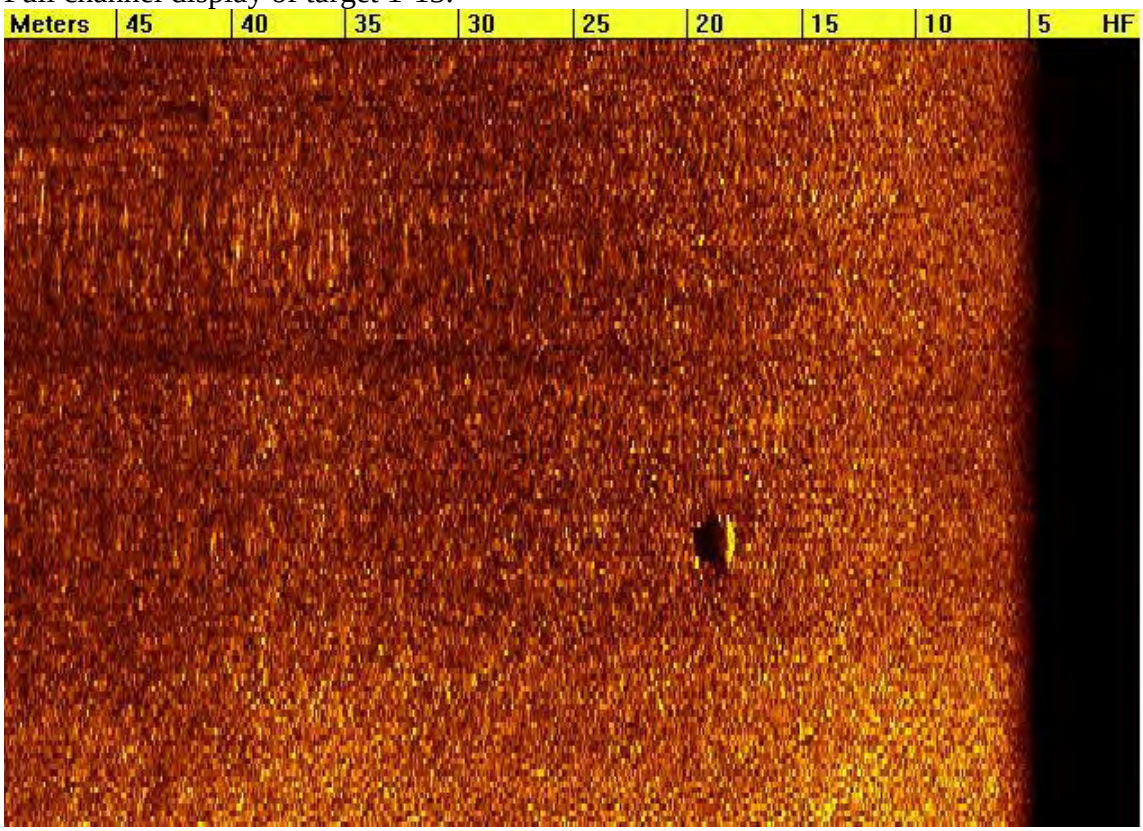


April 21, 2010

Target 1-13 is a target with shadow marked on the port side of line A1-1NW.

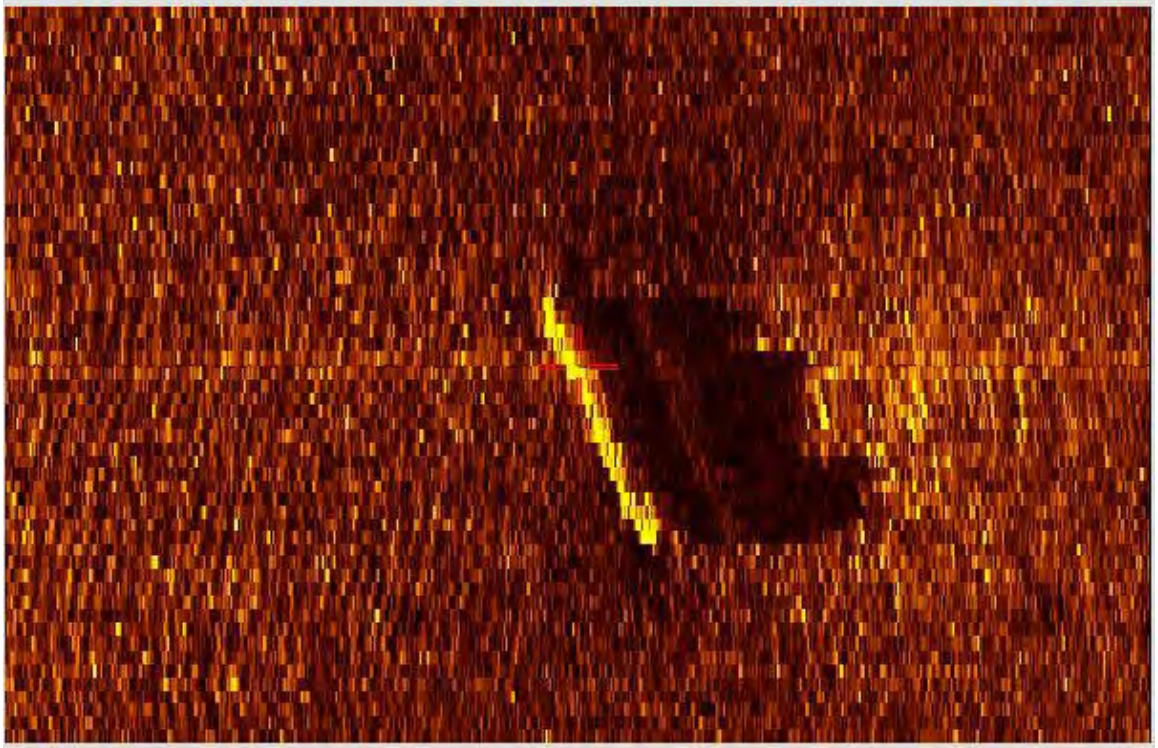


Full channel display of target 1-13.



Target 1-14 is the same target with shadow as Target 1-13 and marked again here on the starboard side of Line A1-2SE.

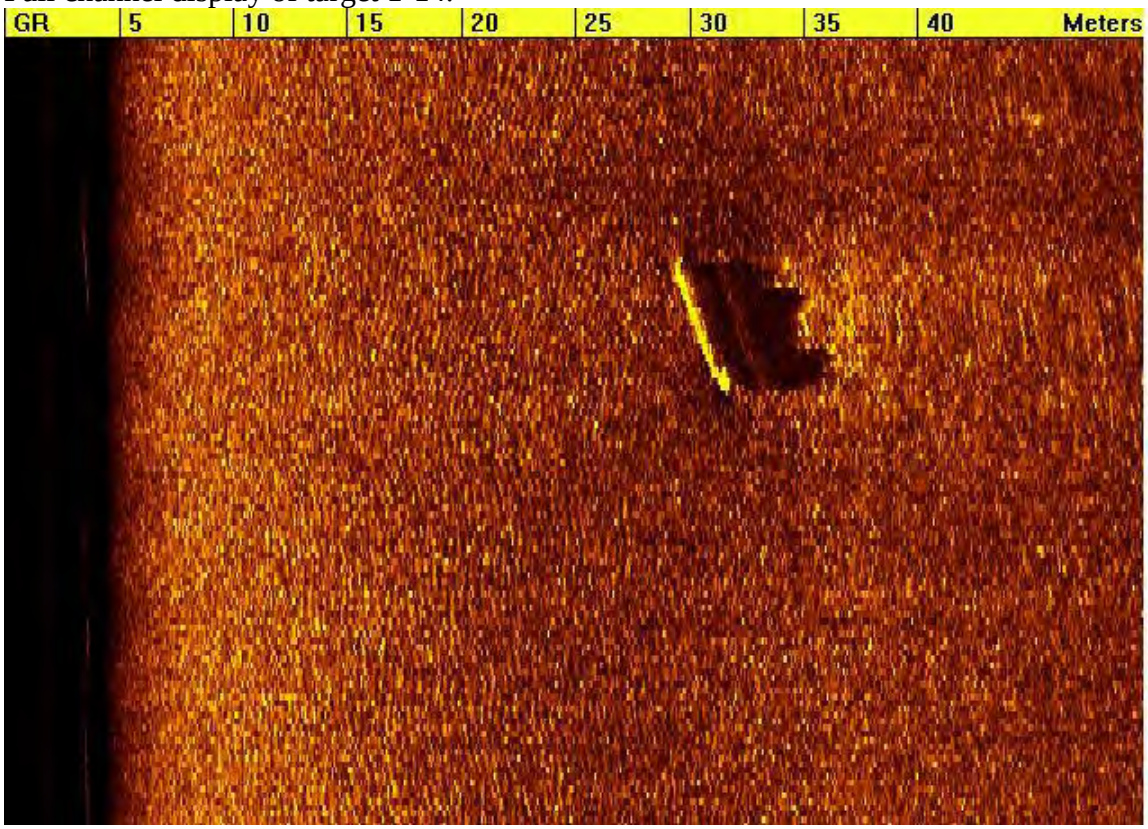
Target-1-14



Target Latitude: 37:48.4934 N Target Longitude: 76:03.8021 W

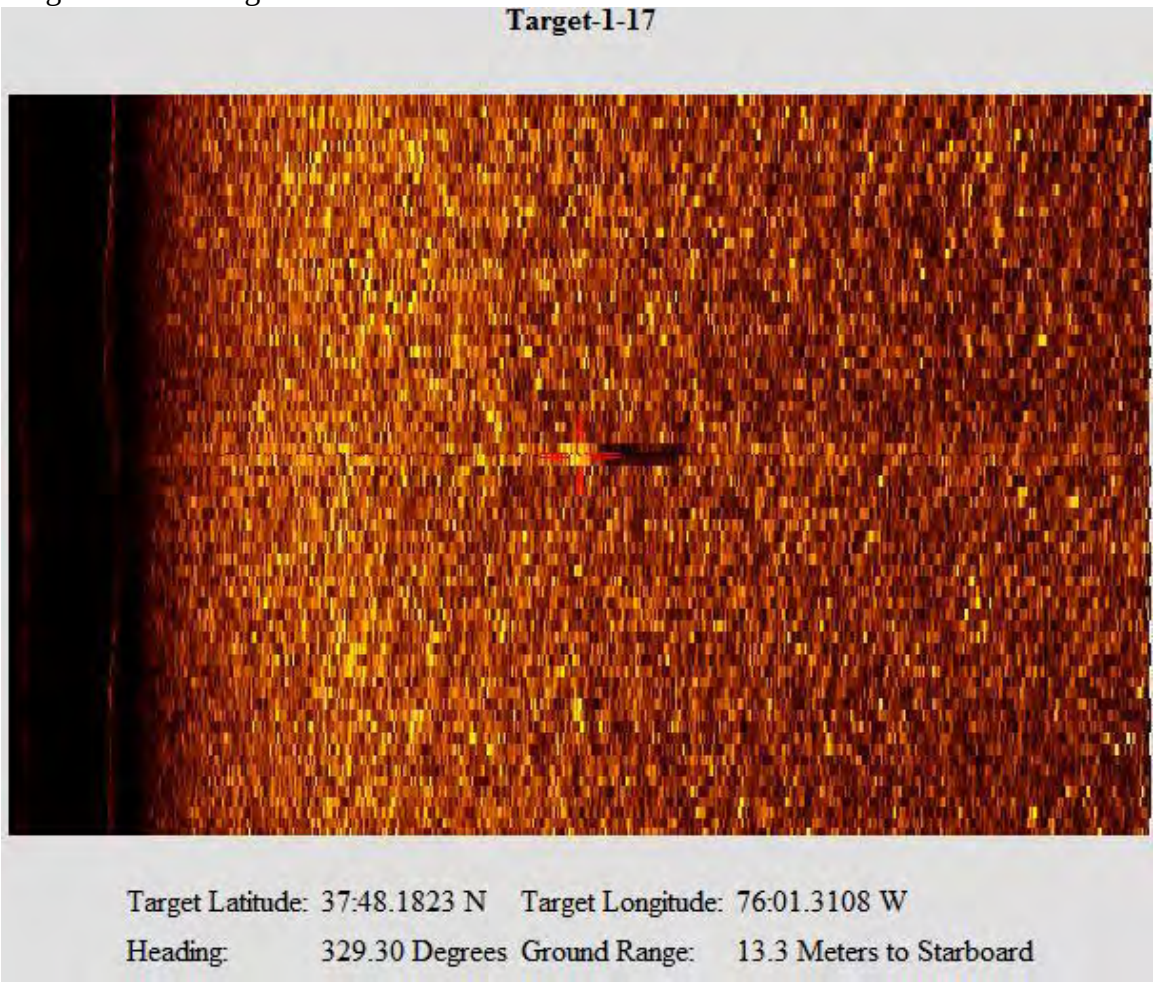
Heading: 123.50 Degrees Ground Range: 30.0 Meters to Starboard

Full channel display of target 1-14.

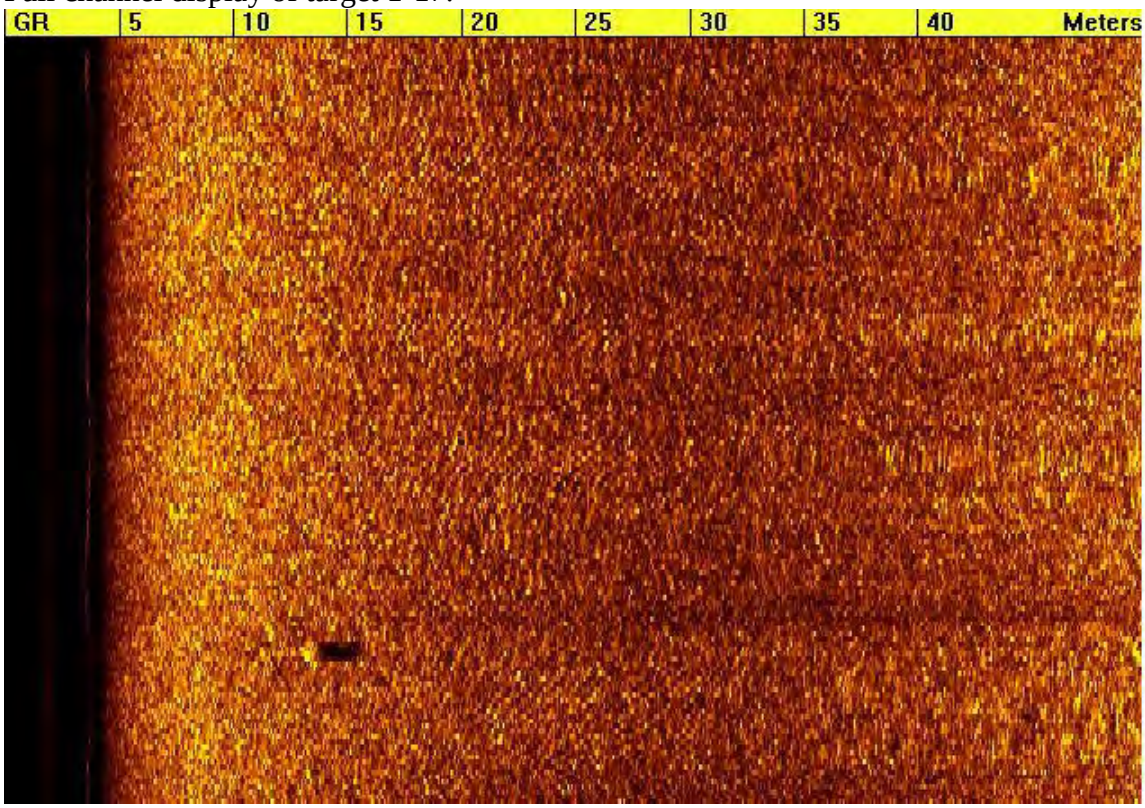


April 22, 2010

Target 1-17 is a target with shadow marked on the starboard side of line A2-26NW.

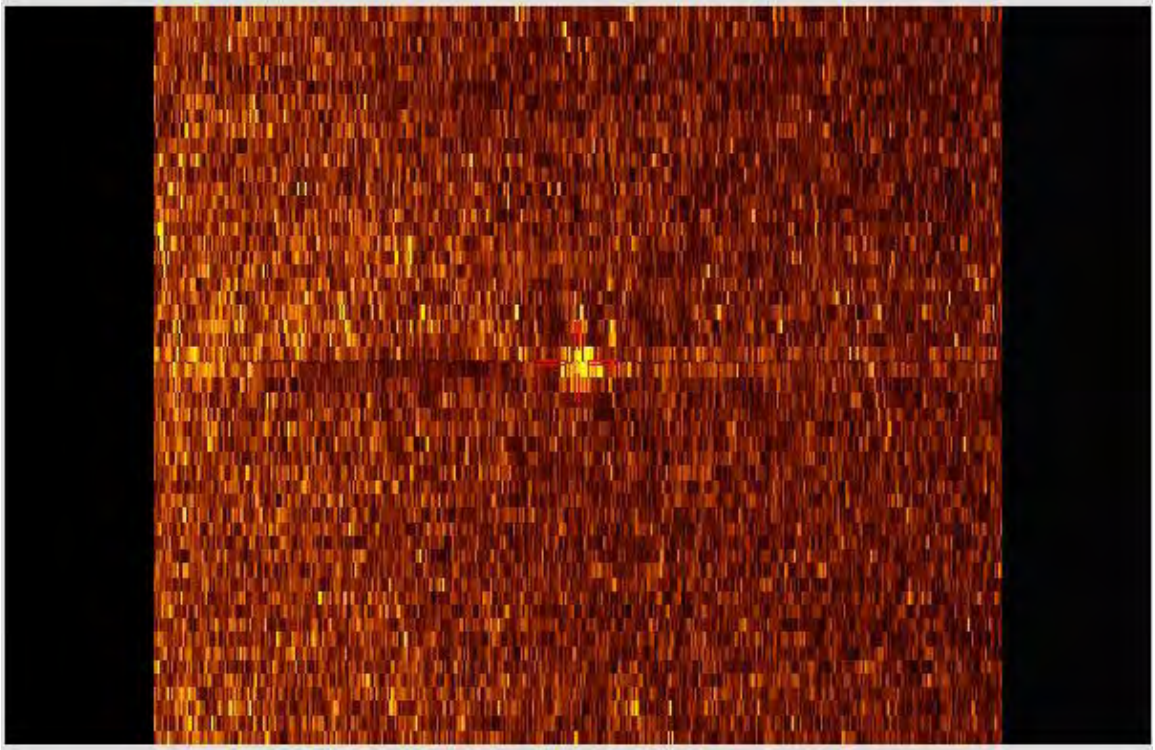


Full channel display of target 1-17.



Target 1-18 is the same target with shadow as Target 1-17 and marked again here on the port side of Line A2-25SE.

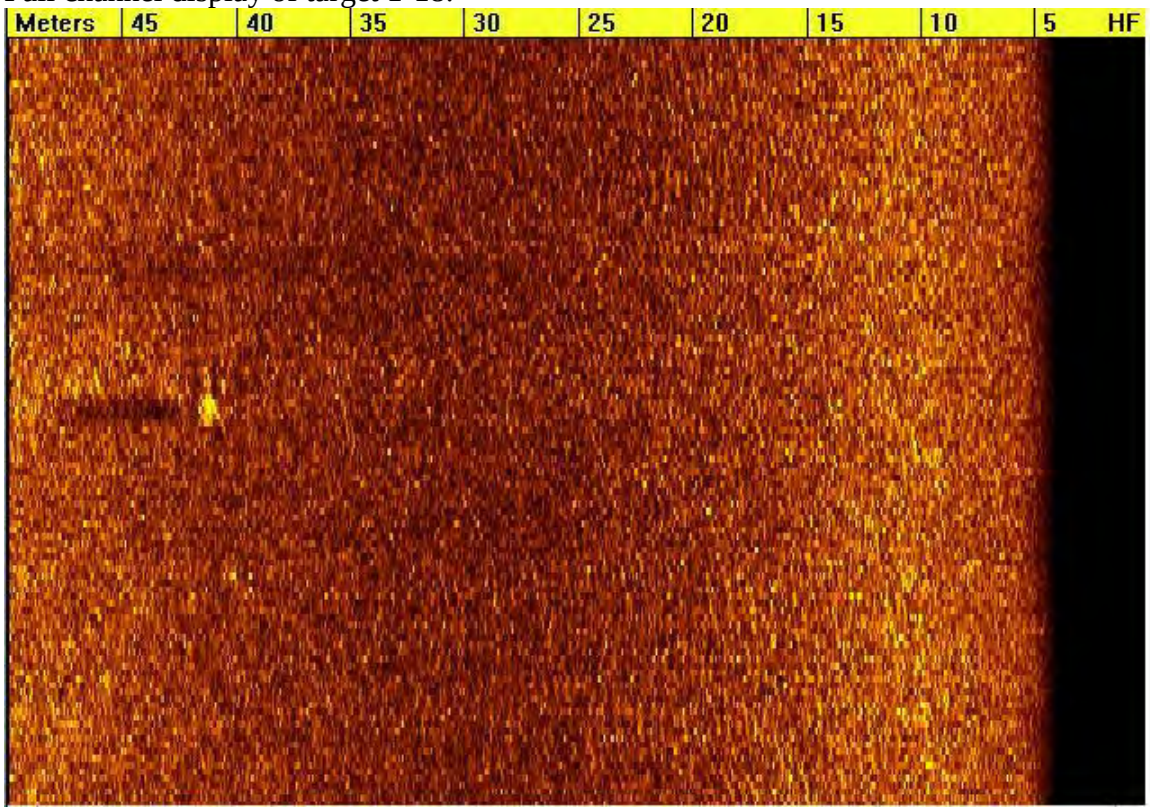
Target-1-18



Target Latitude: 37:48.1930 N Target Longitude: 76:01.3228 W

Heading: 126.00 Degrees Ground Range: 41.2 Meters to Port

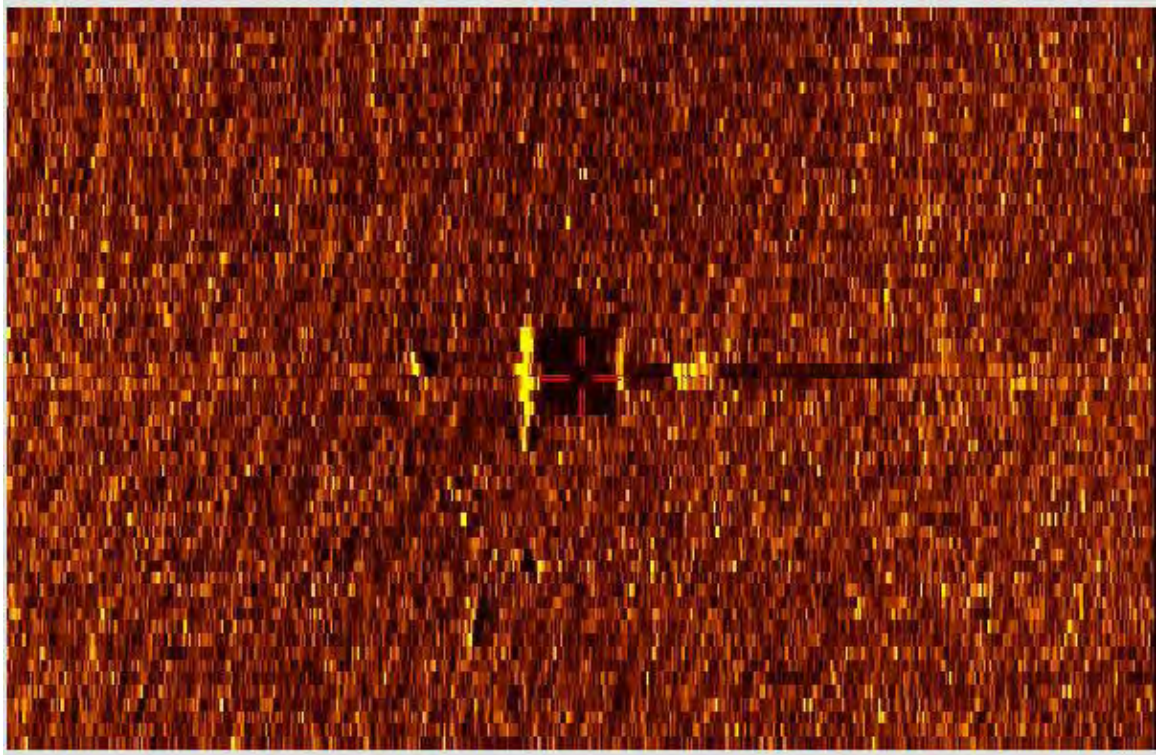
Full channel display of target 1-18.



April 23, 2010

Target 1-26 is several targets with shadows marked on the starboard side of line A2-49SE.

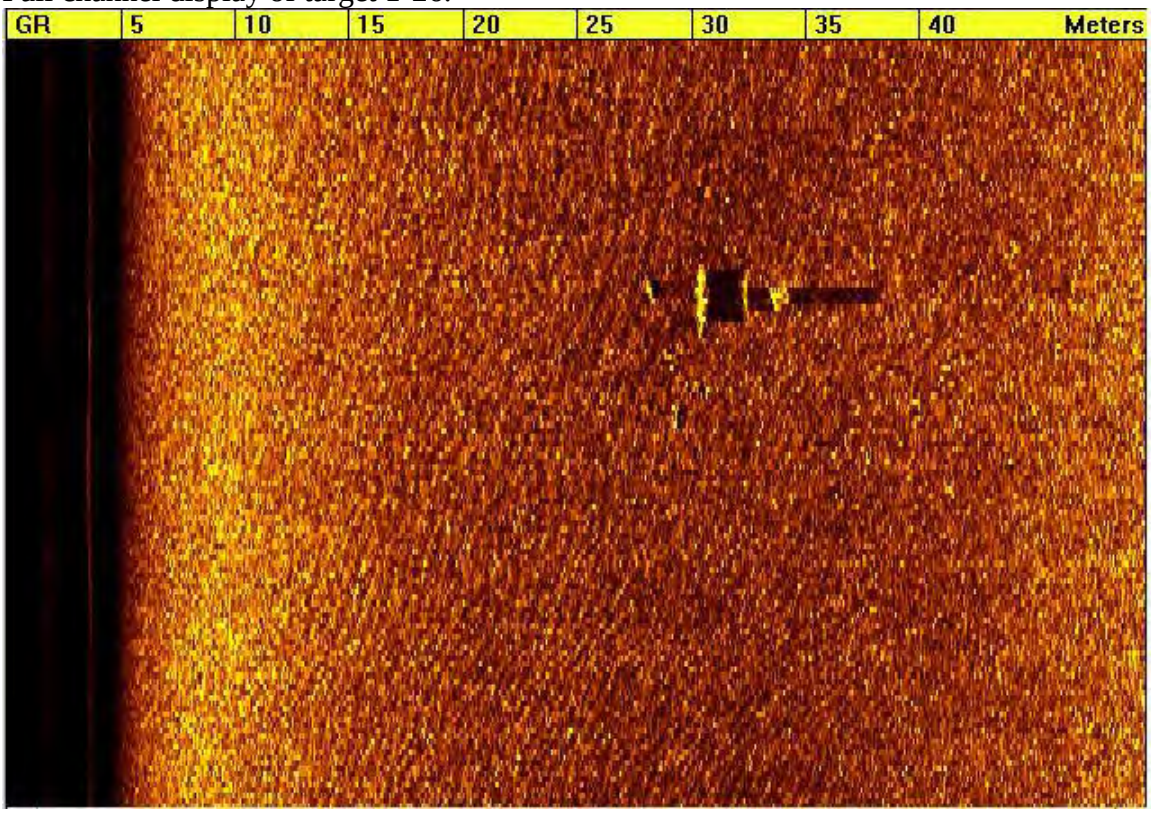
Target-1-26



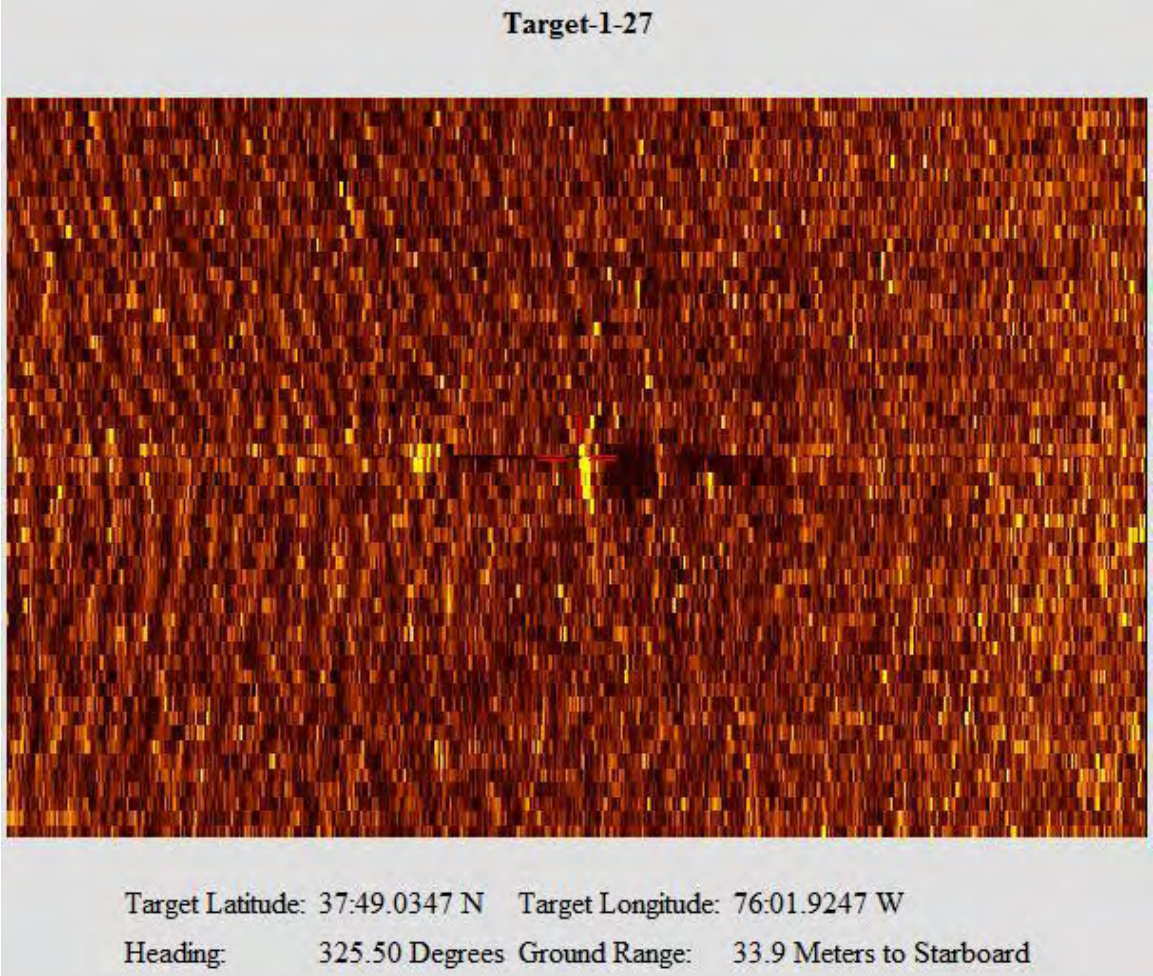
Target Latitude: 37:49.0489 N Target Longitude: 76:01.9432 W

Heading: 131.60 Degrees Ground Range: 31.5 Meters to Starboard

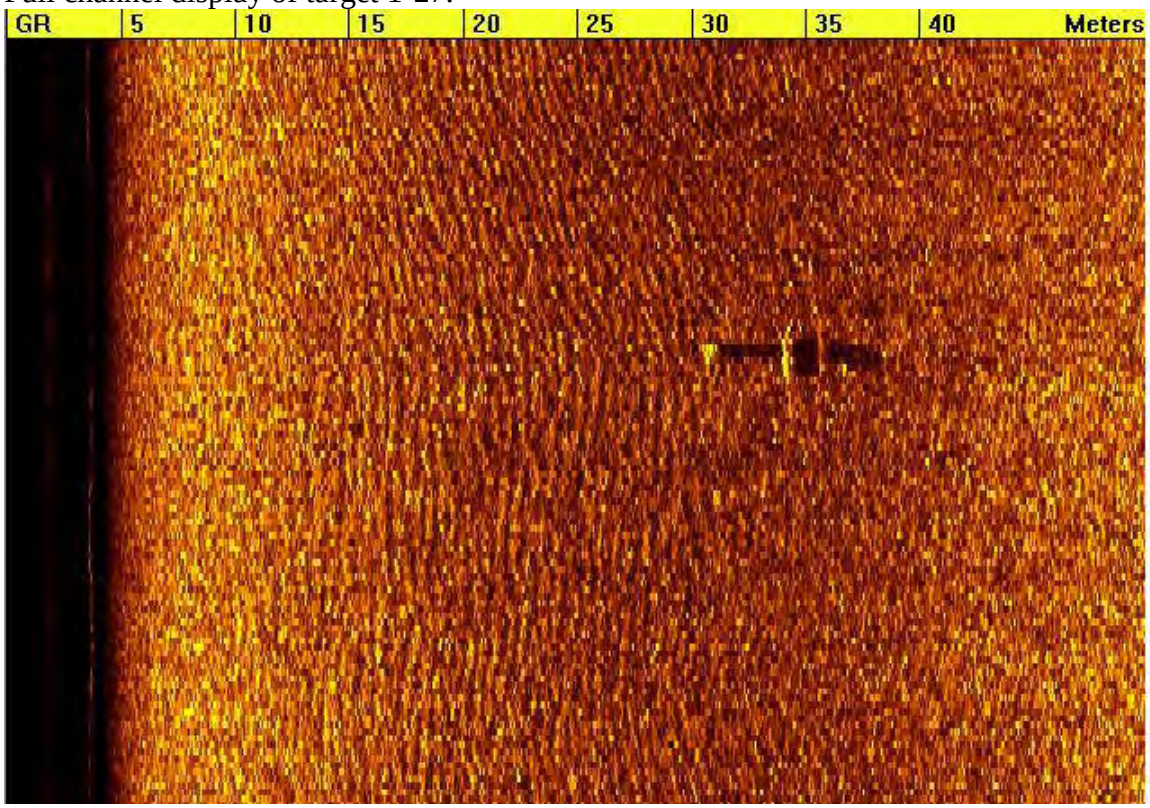
Full channel display of target 1-26.



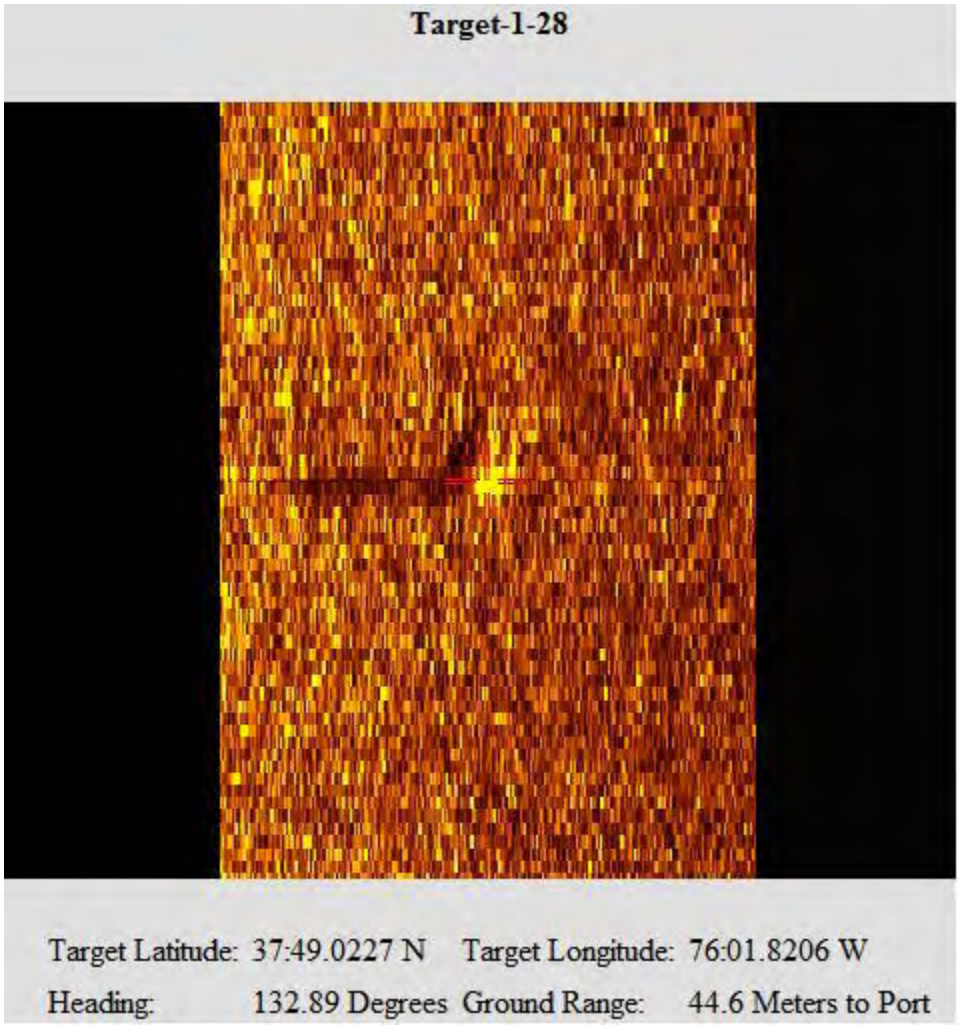
Target 1-27 is the same several targets with shadows as Target 1-26 and marked again here on the starboard side of Line A2-47NW.001.



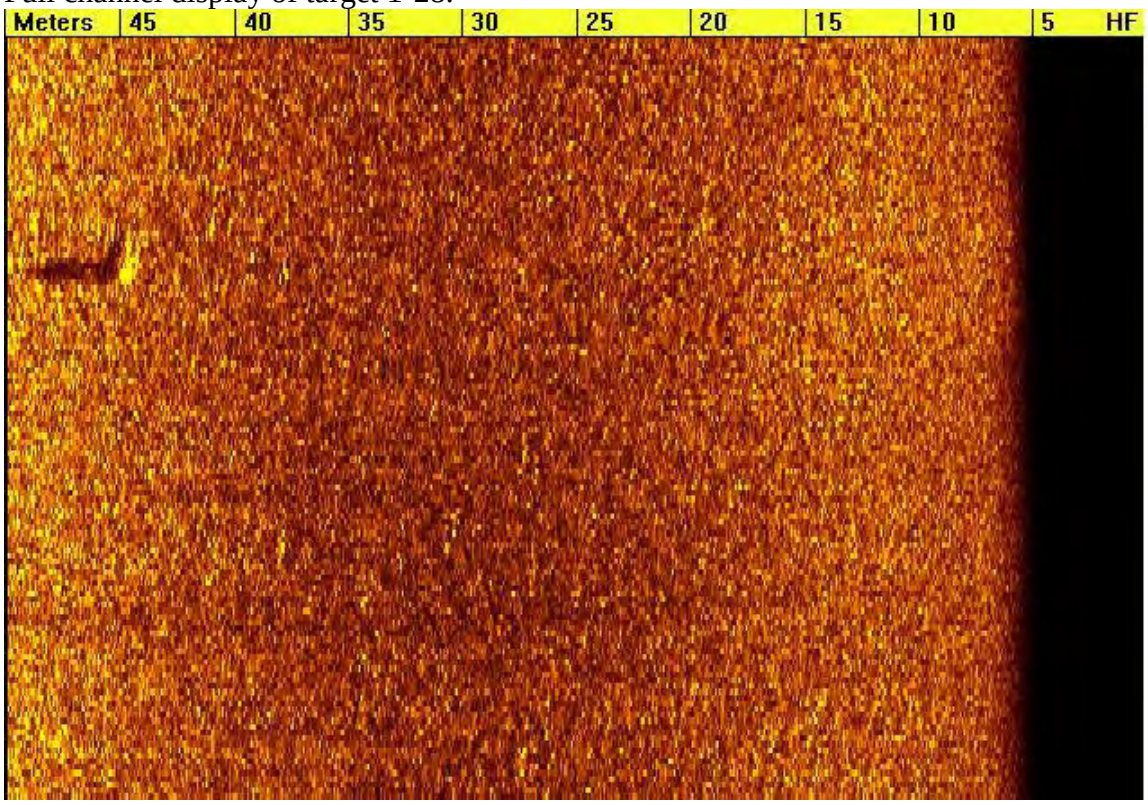
Full channel display of target 1-27.



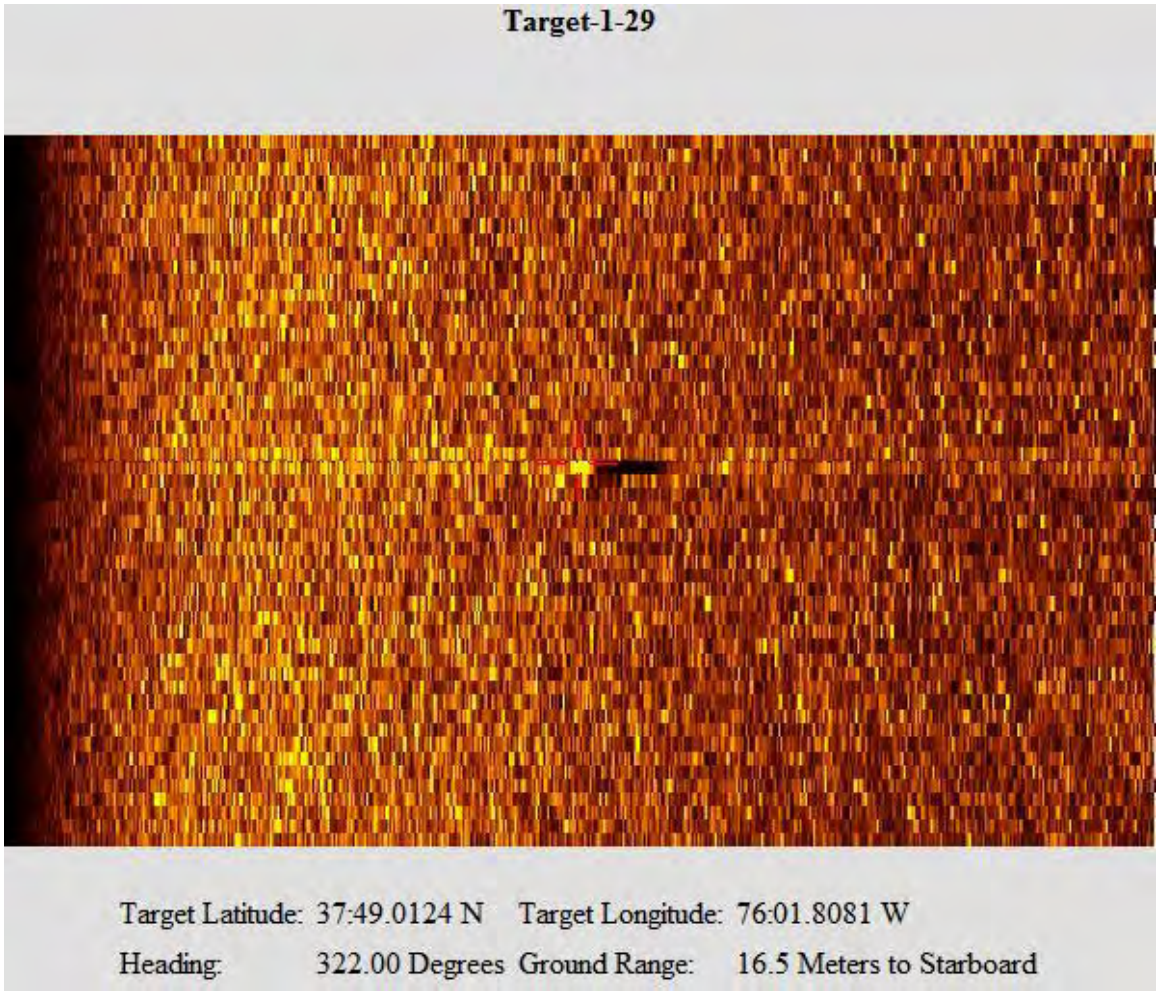
Target 1-28 is a small target with acoustic shadow marked on the port side of line A2-49SE.



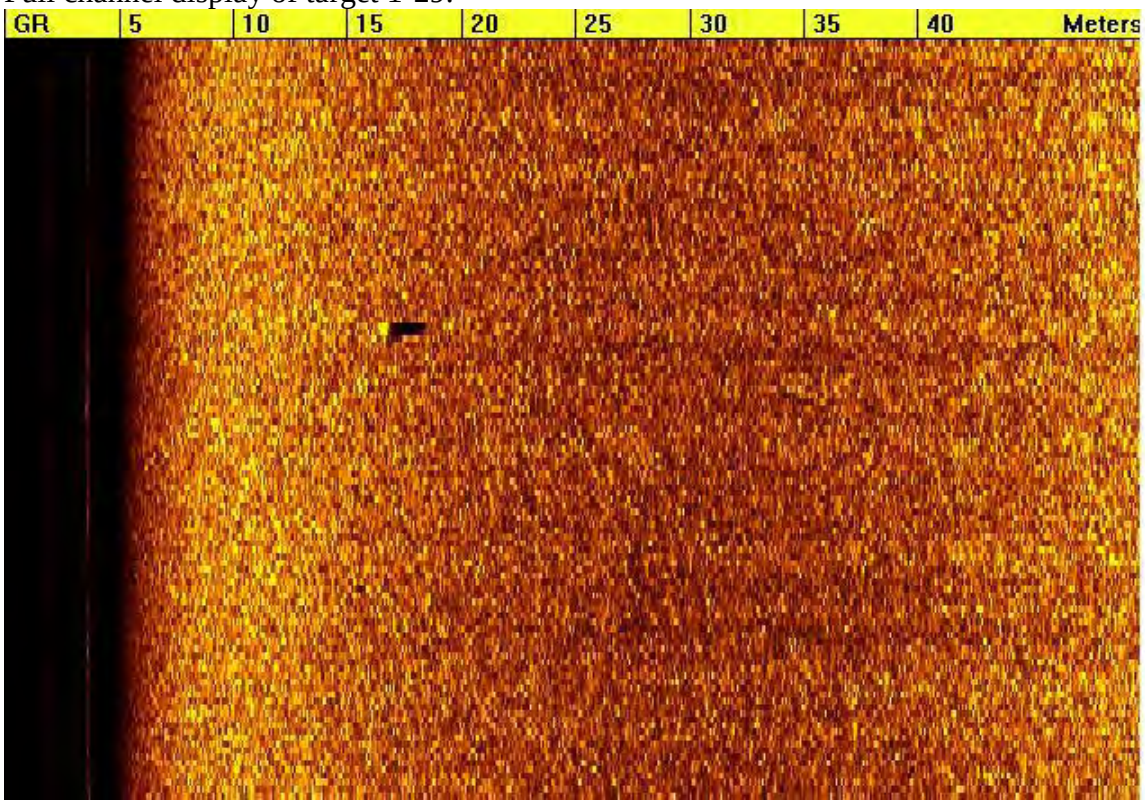
Full channel display of target 1-28.



Target 1-29 is the same small target with shadow as Target 1-28 and marked again here on the starboard side of Line A1-50NW.001.



Full channel display of target 1-29.



Appendix B
Tier I Sediment Transport Evaluation Technical Memorandum

Tier 1 Sediment Transport Evaluation, Tangier Island Target Site, Naval Air Station Oceana, Virginia

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DATE: October 1, 2009

PROJECT NUMBER: 381273.RP.DR

1. Introduction and Background

CH2M HILL has been tasked with performing Site Inspections (SIs) of four other than operational ranges (water ranges) associated with Naval Air Station (NAS) Oceana in Virginia Beach, VA. One of the ranges is the Tangier Island Target site in the Chesapeake Bay. The purpose of this sediment transport evaluation is to assess how the hydrodynamics of the Chesapeake Bay over the past 40 to 50 years may have influenced the transport and fate of the ordnance that was dropped on the site.

The sediment transport evaluation follows guidance provided in the *User's Guide for Assessing Sediment Transport at Navy Facilities* (Blake et al., 2007). The evaluation focuses on two management questions related to sediment transport in the vicinity of the Tangier Island Target:

- Will sediment transport lead to the redistribution of munitions and explosives of concern (MEC) within the danger zone, or movement of MEC outside of this area?
- Will natural processes lead to the burial and isolation of MEC by newly deposited sediment?

These questions are addressed in this evaluation using Tier 1 analysis methods. A Tier 1 evaluation is based on available data from regional studies and other publicly available sources, and relatively uncomplicated data analysis methods. This memorandum is organized according to the framework provided in Section 1.1 of the User's Guide. Section 2 presents a site description and conceptual site model (CSM) for sediment transport. Section 3 presents the Tier 1 sediment transport evaluation and discusses the application of the results to sediment management questions. Conclusions and recommendations are presented in Section 4, and references are provided in Section 5.

The Tangier Island Target consisted of two scuttled cargo ships that were used as surface targets located west of Tangier Island, approximately 65 miles north of Norfolk, VA. The northern target is defined in 33 CFR 334.210 as a "Naval Guided Missile Test Operations Area for the Chesapeake Bay" in the vicinity of Tangier Island as follows:

(1) The danger zone – (1) Prohibited area. A circle 1,000 yards in radius with its center at latitude 37°47′54″, longitude 76°03′48″.

(2) Restricted area. A circle three nautical miles in radius with its center at latitude 37°47′54″, longitude 76°03′48″, excluding the prohibited area.

The southern target is consistent with the location of what is identified as the "San Marcos Wreck" on National Oceanic and Atmospheric Administration (NOAA) nautical charts. The coordinates of the southern target are latitude 37° 43' 17"N, longitude 76° 4' 34"W. The locations of the northern and southern targets are shown on Figure 1.

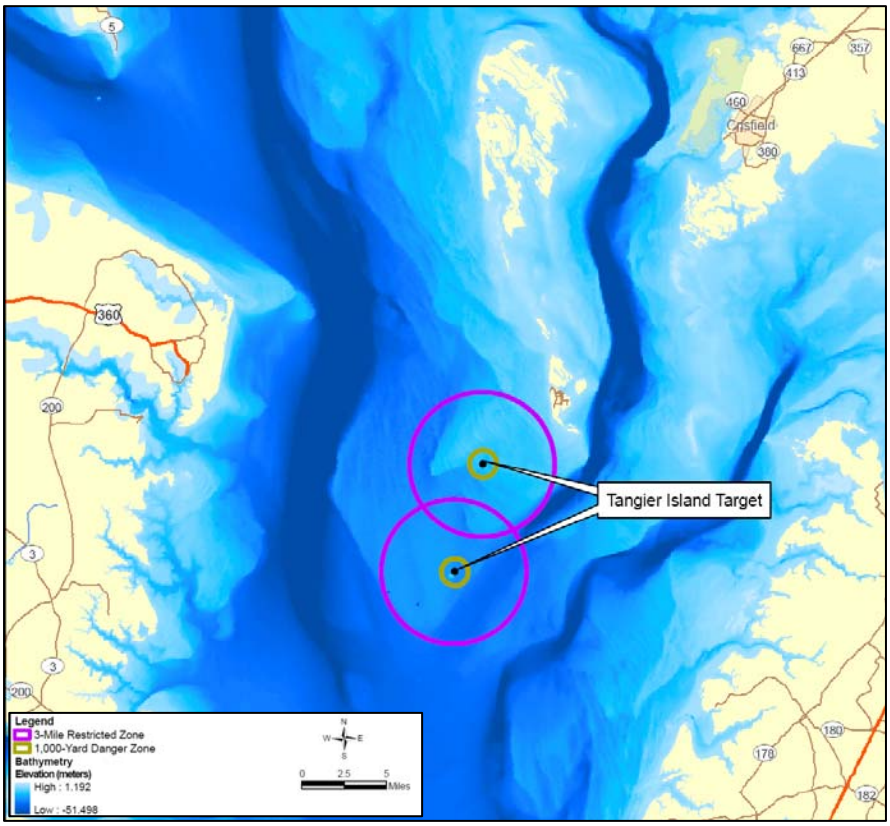

FIGURE 1
Bathymetric Map of the Chesapeake Bay in the Vicinity of the Tangier Island Target

According to the Preliminary Assessment (PA) of the Tangier Island Target (Malcolm Pirnie Inc., 2008), the surface targets were used from approximately 1970 until 1996 for aerial bombardment and rocketry training using inert practice rockets and bombs. Currently, the targets are not visible at the surface. However, they are reportedly located just beneath the water surface and pose a hazard to navigation. Anecdotal information indicates that ordnance has been recovered by local sport fishermen; therefore, the entire target area was classified in the PA as a suspected MEC area. A geophysical survey of the target sites will be performed as part of the SI to characterize the presence and distribution of munitions-related material remaining at the target sites.

The most commonly used ordnance was 25 pound, non-fragmenting practice bomb. This type of bomb has a signal cartridge that is inserted into the body of the bomb through a

central opening. The signal cartridge contains a primer, a 3-gram black or smokeless powder ejection charge, and an approximately 10-gram, red phosphorus, titanium tetrachloride, or inert mixture that serves as the spotting charge. On impact, the primer fires initiating the ejection charge which expels the spotting charge rearward. The spotting charge provides a visual observation of where the bomb hit. A small closure disc (< 1 inch) from the signal cartridge is the only metal that is expelled from the bomb. Therefore, the majority of the MEC present at the target sites is expected to be intact bomb bodies and relatively small amounts of bomb-related scrap.

2. Site Description

Sediment transport is caused by interactions between hydrodynamic forces (e.g. tides, currents, waves, gravitational forces) and bottom sediments. The following sections describe the regional setting and the nature of the bottom sediments and hydrodynamic forces near the Tangier Island Target site, and present a sediment transport CSM.

2.1 Regional Setting

The Tangier Island Target site is located on a broad, shallow subtidal plain west of Tangier Island. Water depths range from about 10 to 15 feet (3.6 m) at the northern target, and about 20 to 25 feet (8.5 m) at the southern target (Figure 1). The main channel of the Bay is located to the west of the Tangier Island Target site. According the U.S. Army Corps of Engineers (USACE) Norfolk District web site, there are no federal navigational dredging projects in the vicinity of the site.

The Chesapeake Bay is a major depositional basin that is filling from both ends (Hobbs et al., 1992). The three major sources of sediment to the Bay are 1) fine-grained sediment delivered by the major tributaries; 2) an influx of sediment from the Atlantic Ocean that forms a wedge of sediment extending almost to Tangier Island; and 3) shoreline erosion of terraces, islands and bluffs that has progressed as the water level has risen in the Chesapeake Bay over the past 8,000 years (USGS, 2004). According to a sediment source map prepared by the U.S. Geological Survey (USGS), the sediment to the west of Tangier Island originates primarily from coastal erosion (USGS, 2004). Shoreline erosion is more significant in the wider reaches of the Bay because of greater exposure to wave action (USGS, 2003). Shoreline erosion averages 20 cm/year in Virginia, with Tangier Island experiencing shoreline erosion in excess of 3 m/year (Hobbs et al., 1992). Sea level is continuing to rise at a rate of about 0.3 to 0.4 m/century, and the rate may accelerate due to global warming (USGS, 2003). Therefore, shoreline erosion will continue in the low-lying area in the vicinity of Tangier Island, providing an ongoing supply of sediment to the Tangier Island Target site.

Sediment accumulation in the Virginia part of the Bay was determined based on bathymetric differences over a 100-year period (Hobbs et al., 1992). This study determined that the majority of the deposited sediment is sand. The average linear rate of deposition was estimated to be 0.55 m/century (0.55 cm/year) (Carron, 1979). The fringes of the sand shield west of Tangier Island were identified as one of the prominent areas of sand deposition. This deposition rate is consistent with rates determined by radioisotope

profiling for the southern part of the Bay in waters 4 to 13 m deep, which were estimated as 0.1 to 0.8 cm/year (Officer et al., 1984 as cited in USGS, 2003).

2.2 Sediment Characteristics

Hobbs and other (1992) created a map depicting the distribution of sediment types in the Chesapeake Bay based on 6,000 grab samples collected on a 1.4-km grid. The sediments in the vicinity of the Tangier Island Target site were classified as greater than 75 percent sand, with a median grain size of 0.188 mm (fine sand).

2.3 Hydrodynamic Processes

The Chesapeake Bay is a partially mixed estuarine system. Circulation is driven primarily by the tides, density differences between the saline water from the ocean and the fresh water from the tributaries, and the wind. Circulations patterns are complex and variable due to the interactions between these processes. The Bay has mixed diurnal tides, comprising two high tides and two low tides of unequal height each tidal day. At Tangier Island, the mean tide range is 0.43 m and the spring tide range is 0.52 m.

Salinities in the region of the Tangier Island target are approximately 15 to 20 parts per thousand (ppt). No site-specific information about salinity gradients west of Tangier Island was found; however, vertical salinity stratification is expected to be more pronounced in the deeper parts of the bay (i.e., in the channels). Turbulent mixing generated by the wind disrupts density stratification in shallow water, so the water column may be well mixed near the Tangier Island Target site.

At the Tangier Sound Light (latitude 37°47.03"N, longitude 76°05.68"W), the average tidal current velocity at flood tide is 0.5 knots (0.26 m/s) to the north (344°), and the average ebb tide is 0.7 knots (0.36 m/s) to the south (185°)[1]. An analysis of current records throughout Bay from 1977-1983 was used to assess bay-wide mean circulation (Goodrich and Blumberg, 1991). A number of the current moorings from which data were obtained were on the sandy plain west of Tangier Island. Results indicate that the direction of mean flow in surface waters (0-6 m depth) west of Tangier Island is south to southwest.

Prevailing winds in the Chesapeake Bay region are from the northwest in the winter, and southwest in the summer (Lucy et al., 1980). In the winter, storms and cold fronts with northerly winds up to 50 knots (26 m/s) that can persist for several days. In the summer, winds tend to be light to moderate, with shorter duration high winds during squalls and thunderstorms. Summer winds rarely exceed 30 knots (15 m/s).

At the NOAA National Ocean Survey (NOS) weather buoy at Rappahannock Light[2], three major wind events occurred in 2008. A major wind event is defined as greater than gale force winds (39 miles per hour, 17 m/s) for more than 3 hours in duration. These events are summarized in Table 1.

These conditions appear to be representative of typical storms. The Chesapeake Bay is also affected by hurricanes on a less frequent basis. If the center of the storm passes to the east of

[1] National Oceanic and Atmospheric Administration (NOAA) Tides and Currents, http://tidesandcurrents.noaa.gov/currents08/tab2ac5.html#44

[2] NOAA National Buoy Data Center Station RPLV2, http://www.ndbc.noaa.gov/station_page.php?station=RPLV2

the Chesapeake Bay (the more common scenario), the winds are northerly and tend to push water to the south, towards the mouth of the Bay. If the center of the storm passes to the west of the bay, the winds are southerly and tend to push water north towards the head of the Bay. Hurricane Isabel (September 2003) was characterized by strong southeasterly winds that moved water northward as a single layer, resulting in massive flooding at the northern end of the Bay (Li, et al., 2006).

TABLE 1
Major Wind Events in the Lower Chesapeake Bay, 2008

Date	Wind Speed (m/s)	Direction
May 12	19.2	North
September 6	19.0	Southeast
November 5	18.7	Northwest

The Virginia Institute of Marine Sciences (VIMS) collected systematic wave observations at three stations in the Chesapeake Bay from 1988-1995[3]. The station closest to Tangier Island Target site was at Wolf Trap Light (37°24.8'N, 76°11.8'W). Data were collected at this station for one winter season, from December 1989 through April 1990. The maximum significant wave height (the average height of the one third highest waves recorded during the sampling period) recorded during this period was 1.5 m, for waves moving southward. In a typical winter season, south-southwesterly moving waves with a 4-5 second period were characteristic of Wolf Trap Light. Waves in hurricane conditions are expected to be larger.

The bottom sediments in most shallow areas of the Bay are subject to resuspension above the wave base during large storms (USGS, 2004). Following erosion, the winnowing action of waves, tides and currents sort the fine and coarse sediment. The fine sediment (i.e., silt and clay) is transported to and ultimately deposited in the deeper depositional areas of the Bay (i.e., the channels).

2.4 Sediment Transport Conceptual Site Model

A sediment transport CSM for the Tangier Island Target site is provided in Figure 2. The subtidal plain to the west of Tangier Island is relatively shallow and sandy. The site is in an energetic hydrodynamic setting, exposed to prevailing winds from the north and south and subject to wave and tide interactions. Average current speeds are approximately 30 to 40 cm/sec, with residual flow to the south. The large fetch to the north and south of the Tangier Island Target site is conducive to the formation of large waves under storm conditions. Sediments are likely to be resuspended by waves and tidal action, and finer-grained silts and clays are likely to be transported away from the site and eventually deposited in deeper areas of the Bay.

[3] VIMSWAVE – VIMS Directional Wave Data; http://web.vims.edu/physical/research/VIMSWAVE/VIMSWAVE.htm?svr=www

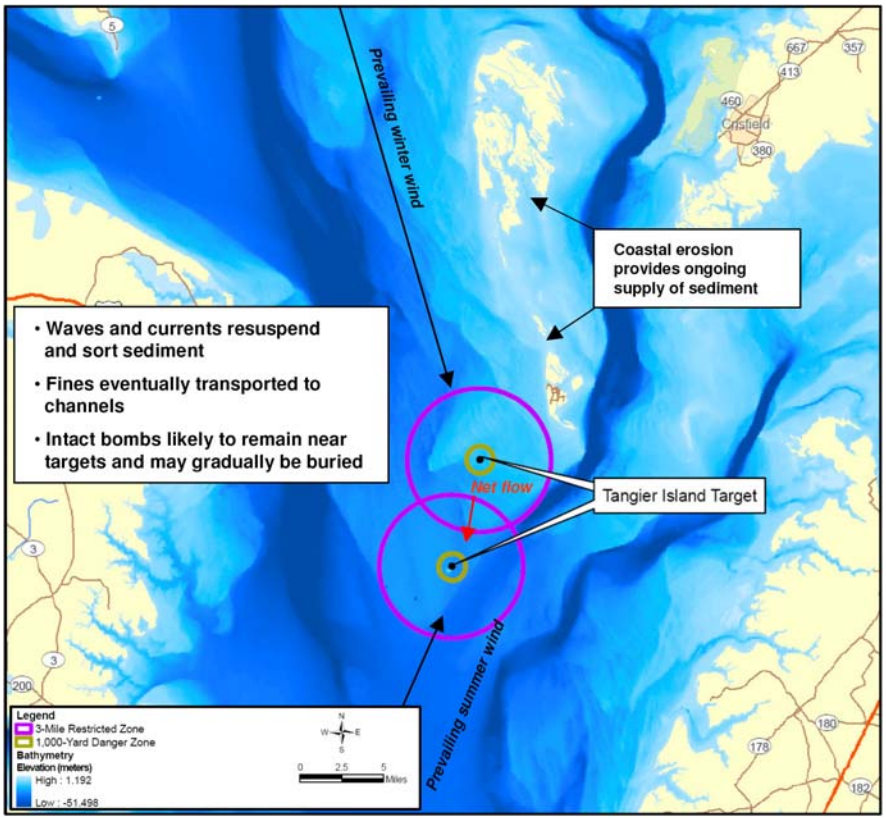

FIGURE 2
Sediment Transport Conceptual Site Model for Tangier Island Target

3.0 Tier 1 Evaluation

The potential for erosion and resuspension of sediments and MEC due to tidal circulation and wind-generated waves was evaluated. Erosion and resuspension were characterized using the methods outlined in Section 3 of the User's Guide. Tier 1 results are presented below.

Sediments are eroded when the bottom shear stress produced by waves and currents (T_b) exceeds the critical shear stress of the sediment bed (T_{ce}). For the purposes of this evaluation, the effects of currents and waves are considered separately. Table 2 summarizes the parameters used for estimating the erosion potential at the Tangier Island Target site due to tidal currents. The mean ebb and flood current velocities for Tangier Light were used to represent typical hydrodynamic conditions. The mean particle diameter is based on sediment grab samples collected in the vicinity of the Tangier Island Target site, and is a fine sand. Based on these parameters, the bottom shear stress, d* (dimensionless particle diameter), and critical shear stress were calculated using the methods outlined in Section 3.4.1 of the User's Guide. Results of these calculations show that the bottom shear stress under typical hydrodynamic conditions exceeds the critical shear stress. This indicates that erosion of bed sediments due to tidal currents under typical hydrodynamic conditions is possible, although the targets themselves (i.e., the scuttled ships) may act as flow obstructions and reduce current speeds.

An intact 25-lb bomb has the same weight as a 20-cm diameter spherical cobble (assuming a cobble density of 2.65 g/cm^3). Using a Hjulstrom diagram, which shows the relationship between the speed of a current and the size of particles that can be moved by it, a current of approximately 0.5 m/sec would be required to move an intact bomb. Although maximum spring tide currents are approximately 1 knot (0.51 cm/sec) at Tangier Light, the duration of this condition would be relatively short-lived. In addition, as noted above the current speeds in the immediate vicinity of the targets is mostly likely reduced due to flow obstructions.

TABLE 2
Parameters for Estimating Erosion Potential

	Tidal Currents	
Parameter	**Mean ebb**	**Mean flood**
Current velocity (knots)*	0.7	0.5
Current velocity (m/s)	0.36	0.26
Median particle diameter (µm)	186	186
Bottom Shear Stress (dynes/cm^2), T_b	4.0	2.0
d* (dimensionless particle diameter)	4.2	4.2
Critical Shear Stress (dynes/cm^2), T_{ce}	1.6	1.6

* Tangier Point Light, http://tidesandcurrents.noaa.gov/currents08/tab2ac5.html#44

Based on the characteristics of the Tangier Target site, wave-forced resuspension of sediment could be significant under storm conditions. Wave height is controlled by the wind speed, wind duration, and fetch (the distance over the water that the wind blows in a single direction). In the vicinity of the Tangier Island Target site, waves are fetch limited when winds are from the east. Waves will be well developed when sustained winds are from the north or south, with maximum fetches of approximately 100 km and 80 km, respectively. Smaller waves will form with sustained winds from the west, with a fetch of about 16 km.

The wave heights associated with storm events at the Tangier Island Target site were estimated based on assumptions regarding wind speed, fetch, and water depth using methods outlined in the USACE Shore Protection Manual (CERC, 1984). Wave heights for the following scenarios were estimated: gale force winds from the north and south, and hurricane force winds from the north. Table 3 summarizes the estimated wave height for each scenario.

The wave height and period for gale force winds are in reasonable agreement with those measured at Wolf Trap Light, which is deeper (approximately 6.8 m water depth). Blake et al. (2007) estimated a bottom shear stress of 65 dynes/cm^2 for waves with a height of 1.2 m and period of 5 seconds acting on a fine sand bottom, a scenario that is similar to gale force storm conditions near the Tangier Island Target site. This estimated bottom shear stress is well above the critical shear stress of about 1.6 dynes/cm^2 (Table 2), indicating that sediment resuspension is likely to occur under all of the storm conditions evaluated. After

wave-induced resuspension, sandy sediments tend to settle rapidly to the bottom, while finer-grained particles will be transported by currents. Although waves are expected to produce periodic sediment erosion, the area is still a net depositional environment over the long-term due to the ongoing supply of sediment from coastal erosion (Hobbs et al., 1992).

TABLE 3
Predicted Wave Height and Period for Gale and Hurricane Force Winds

Case	Wind Speed (m/s)	Wind Direction	Fetch (km)	Water Depth (m)	Wave Height (m)	Wave Period (s)
1	17	NW	100	3.6	1.1	4.8
2	33	NW	100	3.6	1.6	6.0
3	17	S	80	3.6	1.1	4.7

3.3 Sediment Management Questions

This section addresses the sediment transport questions that are likely to influence management decisions for the Tangier Island Target site.

1. **Will sediment transport lead to the redistribution of MEC within the danger zone, or movement of MEC outside of this area?**

   The Tangier Island Target site is in a sandy, shallow water environment that is exposed to wind and wave action. Although the sandy sediments may be resuspended during storm events and fine-grained particles (i.e., silts and clays) are likely to be transported away from the site, the intact 25-lb bombs are likely to remain in place near the targets due to their large size and weight.

2. **Will natural processes lead to the burial and isolation of MEC by newly deposited sediment?**

   The relatively shallow sandy area to the west of Tangier Island has been identified as a net depositional environment based on bathymetric differences measured over the past 100 years (Hobbs et al., 1992). The net deposition rate was estimated to be approximately 0.55 cm/yr. Therefore, the intact 25-lb bombs are likely to be gradually buried if they remain in place. In addition, the sandy sediments surrounding the bombs may be eroded during storm events, facilitating the burial process.

4. Conclusions and Recommendations

The Tier 1 sediment transport evaluation for the Tangier Island Target site indicates that sediment transport may occur in the vicinity of the targets, but the intact 25-lb bombs are unlikely to be mobilized. However, the hydrodynamic environment in the Chesapeake Bay is highly complex and variable, and the Tier 1 evaluation should be considered an initial, simplified assessment of site conditions. The geophysical survey planned as part of the SI should confirm the location and distribution of the MEC. If a more detailed and site-specific evaluation of sediment and MEC transport is warranted, then a Tier 2 study including site-specific current and wave measurements and numerical modeling could be performed.

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Appendix C
Geophysical Investigation Report

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

GPR
MAGNETICS
ELECTROMAGNETICS
SEISMICS
RESISTIVITY
UTILITY LOCATION
UXO DETECTION
BOREHOLE CAMERA
STAFF SUPPORT

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GEOPHYSICAL INVESTIGATION REPORT

Phase I Site Inspection of the Other-than-Operational Water Ranges Tangier Island, Virginia

Naval Air Station Oceana
Virginia Beach, Virginia

Contract Task Order WE03

Under the
NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Dates of Investigation:
September 13th – September 27th, 2010

FINAL SUBMITTAL
December 6th, 2010

PREPARED FOR

CH2MHILL

Virginia Beach, Virginia

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  - Processed ASCII XYZ files
  - Summary result worksheets
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  - Bathymetric
  - VSP Calculated Anomaly Density
  - Anomaly Distribution
- Preprocessed Data
  - Preprocessed data XYZ files
  - Raw data delivery reports
  - Static and Pressure tests processed XYZ, Geosoft Maps and PDF plots
- Processed Data
  - Final processed XYZ files by grid block
  - Final data delivery reports
  - Static and Pressure test processed XYZ, Geosoft map, and PDF plots
  - PDF and Geosoft map color coded gridding of instrument response data
  - Target lists in XYZ and Excel formats
  - Geosoft grid files
- Raw Data
  - All native files created by collection software
  - All converted XYZ files
- Report –Report in Microsoft Word and PDF formats
  - VSP files

ACRONYMS AND ABBREVIATIONS

3Dg	3D Geophysics.com
ASCII	American Standard Code for Information Interchange
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
cm	Centimeter
CTO	Contract Task Order
DGM	Digital Geophysical Mapping
DMM	Discarded Military Munitions
DQOs	Data Quality Objectives
EM	Electromagnetic
ft	Feet
FTP	File Transfer Protocol
GIS	Geographic Information System
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
IVS	Instrument Verification Strip
m	Meter
MC	Munitions Constituents
MEC	Munitions and Explosives of Concern
MEC-QAPP	Munitions and Explosives of Concern Quality Assurance Project Plan
MRSIMS	Munitions Response Site Information Management System
µs	Microsecond
mV	Millivolts
N	North
NAD83	North American Datum of 1983
NAEVA	NAEVA Geophysics, Inc
NAS	Naval Air Station
Navy	United States Navy
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
OPUS	Online Positioning User Service
OSHA	Occupational Safety and Health Administration
OtO	Other-than-Operational
PA	Preliminary Assessment
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance / Quality Control
QC	Quality Control
RI	Remedial Investigation
RTK	Real Time Kinematic
SI	Site Inspection
SOPs	Standard Operating Procedures
SSHO	Site Safety and Health Officer

SSHP	Site Safety and Health Plan
UHF	Ultra High Frequency
UTM	Universal Transverse Mercator
UUTA	Underwater UXO Towed Array
UXO	Unexploded Ordnance
VSP	Visual Sample Plan
WGS84	World Geodetic System 1984

1.0 INTRODUCTION

NAEVA Geophysics, Inc. (NAEVA) was contracted by CH2M HILL to conduct Digital Geophysical Mapping (DGM) in support of a Site Inspection (SI) of the Tangier Island Target Site which is identified as an Other-than-Operational (OtO) range associated with the Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. NAEVA employed 3D Geophysics (3Dg), out of Chaska, Minnesota, as a subcontractor to support this effort. Field operations were conducted from September 13th through September 27th, 2010.

1.1 BACKGROUND AND OBJECTIVES

The Department of the Navy issued Contract Task Order (CTO) WE-03 to CH2M HILL under contract N62470-08-D-1000 to conduct an SI to evaluate the potential presence of munitions and explosives of concern (MEC) at three separate locations within the Tangier Island Target Site (CH2M HILL, 2010a). These areas are off-installation, former targets used by the United States Navy (Navy) for air-to-ground training exercises in the Chesapeake Bay. The three areas include the Primary Target, Navy Targets (1 and 2), and the San Marcos Target (CH2M HILL, 2010b). Based on information gathered during the Preliminary Assessment (PA), the range was used from approximately 1970 until 1996 for aerial bombardment and rocketry training which may have resulted in the presence of MEC, which includes unexploded ordnance (UXO), discarded military munitions (DMM) and potentially munitions constituents (MC). Possible munitions used at the site included practice bombs, air-to-surface rockets, and associated spotting and witness charges (CH2M HILL, 2010a).

The SI is the second component of the overall site evaluation, following the PA. It is not intended as a full-scale Remedial Investigation (RI) to determine nature and extent of contamination, rather its purpose is to augment the data collected in the PA to identify whether further response action or investigation is required (CH2M HILL, 2010a). The objective of the SI is to evaluate the potential presence of MEC in the former underwater target areas by identifying geophysical anomalies representing metallic items on the seafloor or shallowly buried within the sediments.

1.2 SCOPE OF WORK

Geophysical operations included the following tasks:

- preparation of Activity Hazard Analysis (AHAs), Standard Operation Procedures (SOPs), and Accident Prevention Plan (APP) including a Site Safety and Health Plan (SSHP);

- review and comment on the Munitions and Explosives of Concern Quality Assurance Project Plan (MEC-QAPP);
- mobilization of all personnel and equipment;
- DGM of transects within the designated areas of each of the three areas; data processing and anomaly selection, and preparation of data deliverables.

All DGM activities followed well defined Quality Control (QC) procedures in order to establish confidence in the accuracy of the geophysical data. Data were collected along proposed transects and safety was not compromised by the large amount of underwater obstructions (sunken ships and associated debris).

All data were processed, interpreted and uploaded to the CH2M HILL File Transfer Protocol (FTP) site on schedule and in the formats specified in the work plan.

1.3 SITE LOCATION AND DESCRIPTION

Tangier Island Target Site consisted of multiple targets; Primary Target, Navy Targets 1 & 2, and San Marcos Target, and is located west and south of Tangier Island in the Chesapeake Bay, approximately 65 miles north of Norfolk, Virginia **(Figure 1)**. The areas investigated around each of these targets consisted of approximately 650 acres, 904 acres and 650 acres, respectively. The locations of the targets, according to National Oceanic and Atmospheric Administration (NOAA) chart 12225, are provided in **Table 1.** All GPS points and map data are presented in the North American Datum of 1983 (NAD83) Universal Transverse Mercator (UTM), Zone 18 North (N), meters (m). The site was used for aerial bombardment and rocketry training from the 1970s until approximately 1996. Possible munitions used at the site include practice bombs, air-to-surface rockets, and associated spotting and witness charges (CH2M HILL, 2010b).

The Primary Target is located approximately 2,800 yards west-southwest of Tangier Island in the Chesapeake Bay. The depth of water in the vicinity of this target area is reportedly 10 to 15 feet (ft). Target remnants are visible at the water surface that may pose a navigation hazard to boaters. Debris fields were observed with the side scan sonar at and around the center of the target.

Navy Targets 1 and 2 are located east of the Primary Target and west of Tangier Island. The depth of water at this site is reportedly 10 to 15 ft. There are target remnants visible above the water surface that pose a navigation hazard to boaters. Debris fields were observed with the side scan sonar primarily at and around the center of Navy Target 1.

The San Marcos Target is located approximately 5.5 miles south of the Primary Target. The depth of water at this site is reportedly 24 to 29 ft. Range usage of this target is unknown. The target location listed in **Table 1** is consistent with the location of the San Marcos Wreck (formerly Battleship Texas). Munitions used in the vicinity of the San Marcos wreck are unknown (CH2M HILL, 2010b). The NOAA charts also state that the Target had been swept to a depth of 20 ft and no objects were observed above or near the surface of the water. Debris fields were observed with the on-board side scan sonar at and around the center of the target.

Target Name	**Easting** (NAD83 UTM Zone 18N, meters)	**Northing** (NAD83 UTM Zone 18N, meters)
Primary Target	406385.747	4183972.502
Navy Target 1	409334.709	4185234.092
Navy Target 2	409770.788	4184589.409
San Marcos Target	405038.046	4175264.662

Table 1: Tangier Island Target Site Areas

2.0 EQUIPMENT

The equipment used for the investigation at Tangier Island Target Site included the Geonics EM61-Flex3 electromagnetic metal detector, Underwater UXO Towed Array (UUTA), Trimble 5700 Real Time Kinematic (RTK) Global Positioning System (GPS), and a Trimble AgGPS FmX navigation system.

2.1 GEONICS EM61-FLEX3

The EM61-Flex3 is a high-resolution time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. The EM61-Flex3 system is based on the standard Geonics EM61-MK2 metal detector. The EM61-Flex3 consists of four air-cored receiver coils, a grand air-cored transmitter coil, a digital data recorder, batteries and processing electronics (Geonics, 2009). The 1.0 x 0.2 meter receiver coils are arranged side by side and are enclosed by the transmitter coil (**Figure 2**). The EM61-Flex3 acquires up to 16 readings per second for each time gate. The EM61-Flex3 transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the spatially separated receiver coils measures these eddy currents. The EM61-Flex3 offers the ability to measure the eddy currents at two operator selected time gates (196 microsecond [µs] and 446µs). Secondary voltages induced in both coils are measured in millivolts (mV). Data are collected using the MLFXmarine acquisition program (Geomar Software, Inc.) and temporarily stored in a Panasonic ToughBook laptop computer.

2.2 UUTA

The Electromagnetic (EM) system was deployed using a UUTA developed by 3Dg. The UUTA includes an EM coil support platform (whale tail) and a rigid down-rigging system **(Figure 3)**. The downrigger is equipped with a control surface (hydrofoil or 'elevator'), which allows the system operator to control the height of the coil above the sea bottom during data acquisition. Several sensors are integrated with the UUTA to provide position control of the Flex3 coil platform. A pressure transducer on the platform accurately measures the depth of the receiver coils. An inclinometer measures the exact angle of the downrigger and is used to determine horizontal offset of the coil platform from the boat. A bow-mounted side-scan sonar and bottom finder are used to map the sea bottom depth and image potential bottom obstructions during the survey.

The UUTA uses two RTK receivers to accurately measure the exact position and heading of the boat. The rigid downrigger is designed to keep the sensor platform in line with the keel of the boat and the two RTK GPS receivers. In this way, accurate geolocation of the platform can be achieved. The MLFXMarine (Geomar Software, Inc.) acquisition program captures the GPS, pressure transducer, inclinometer, and sonar bottom depth data and then calculates the position of the sensor platform **(Figure 4)**. The sonar transducer is mounted on the bow of the boat and provides the system operator immediate warning of changes in seafloor contour and other obstructions. Bow imaging of the seafloor topography allows the system operator time to adjust and maintain the optimum sensor height above bottom. The system operator adjusts the sensor height by using a control wheel to change the angle of attack of the elevator **(Figure 5)**. When boat speed and elevator angle remain constant the depth of the sensor platform does not change. The UUTA was deployed using a 22-ft jet boat **(Figures 6 & 7)**. When fully loaded with crew and equipment, the boat drafts less than two ft in the water.

2.3 TRIMBLE 5700 RTK GPS

A Trimble 5700 RTK GPS base station and rovers were used for the real-time acquisition of positional data during geophysical data collection. The GPS base station was used in conjunction with the two rovers which were mounted as described in the previous section. Real-time corrections were broadcast to the roving GPS units via a radio link using a Trimble HBP450 Ultra High Frequency (UHF) radio modem. This system provides positional corrections at a rate of one Hz, with an accuracy of three centimeter (cm) horizontal and five cm vertical when a minimum of five satellites are available. GPS base station locations were obtained by setting up the base unit and recording a minimum of four hours of static readings. These readings were then uploaded to

the Online Positioning User Service (OPUS) and a solution (corrected position) was returned. **Table 2** lists the base station location that was used.

ID	X NAD83 UTM Zone 18N, meters	Y NAD83 UTM Zone 18N, meters	Elevation Ellipsoid Height (m)	Comments
Sunset_Inn	412160.026	4186330.008	-36.649	Base at Sunset Inn

Table 2: GPS Base Station Locations

A Yagi-Uda Antenna **(Figure 7)** was necessary for radio communication coverage of the areas being investigated because of their large size. The Yagi is a directional antenna that transmits the radio energy along a preferential direction rather than the typical radio antenna that transmits the signal in 360 degrees. The energy is transmitted along a defined azimuth and thus increases the range of transmission along that path.

The GPS positions were streamed into a Panasonic Toughbook computer once per second using a National Marine Electronics Association (NMEA) GGA/GSA message and were recorded simultaneously with the EM61-Flex3 data in the MLFXMarine acquisition program. A GPS QC check was performed at the beginning of each day to ensure accuracy.

2.4 TRIMBLE AGGPS FMX DISPLAY

Navigation was facilitated by the Trimble AgGPS FmX **(Figure 8)** integrated navigation system and the bow-mounted RTK GPS. The FmX display allows the creation of virtual grids based on operator-defined lines, circles, or ovals ("AB lines"). The AB lines are set by placing two points in the field or by importing a Geographic Information System (GIS) ".shp" file. Once a line has been established, the FmX processor can calculate a virtual transect design using operator supplied line spacing. Circular transects are defined by a center (point) and line spacing. The FmX display also provides a light bar display to assist the boat operator in guiding the UUTA along the virtual survey lines. The FmX provides a swath coverage display that shows the boat operator the current survey line and previous lines on which data have already been collected.

3.0 METHODOLOGY

3.1 DGM SURVEY ACTIVITIES

Data were collected using an evenly spaced transect pattern. All transects were spaced 100 ft apart for the first 500 yards from the center of the potential target location, then the spacing was increased to 250 ft out to a total distance of 1000 yards from the center of the potential target. For all targets, the initial 500 yards from the center of the target were collected first starting on

the furthest transect out. After the 500 yards were collected and it was decided to continue collecting the outer transect, data was collected from the inside out.

A variety of transect designs (lines versus circles) were discussed with CH2M HILL prior to the start of the survey, to facilitate increased productivity. For areas with single targets, such as Primary and San Marcos targets, a concentric circle transect design was used. However since Navy 1 and 2 target investigation areas overlapped, concentric ovals were employed.

Prior to the start of the project, CH2M HILL requested that the interior lines (first 500 yards from the target location) be collected first and the data turned over within 24 hours so that an assessment could be made to determine if the remaining data (500 to 1000 yards) would be beneficial for the SI. All data were preliminarily turned over to CH2M HILL within the requested time frame so that this determination could be made.

All geophysical data were collected as described in Section 2.0.

3.2 DATA PROCESSING AND INTERPRETATION

3.2.1 Data Storage and Initial Editing

Data were temporarily stored in a Panasonic Toughbook laptop computer using Geomar MLFXmarine software and then downloaded into another laptop computer for further on-site processing using Geomar MultiFXmarine and Geosoft Oasis Montaj software version 7.2.

Daily logs and field notes were input digitally into a Trimble GeoXT device supplied by CH2M HILL using the Munitions Response Site Information Management System (MRSIMS) series of forms. Initial data processing was performed by the field team, which included reviewing the data for integrity and completeness, and creating positioned XYZ files for each data file and QC test for use in further processing. Raw geodetic (Latitude-Longitude World Geodetic System 1984 [WGS84]) coordinates were converted to projected UTM Zone 18 North NAD83 coordinates for the XYZ files.

3.2.2 Preprocessing

Converted raw data files were imported into Geosoft's Oasis Montaj to perform the following:

- Review and finalize all QC tests (Instrument Verification Strip [IVS], static, pressure) prior to processing of the DGM data for that day
- Evaluate GPS accuracy and positioning
- Evaluate data density and coil height
- Apply auto leveling and instrument drift corrections
- Apply default lag correction

- Generate preliminary contour map(s) from gridded data

3.2.3 Final Processing

After completion of preprocessing, the data were further evaluated and processed to generate final processed data files. Final processing steps included:

- Evaluation and refinement of auto leveling and instrument drift corrections in the late channel
- Evaluation and refinement of lag correction in the late channel
- Additional digital filtering and enhancement, as necessary, in the late channel
- Targeting of data, as described in Section 3.2.4
- Generation of formatted American Standard Code for Information Interchange (ASCII) files containing processed data by grid block
- Generation of final maps for each grid block showing contoured gridded data, target locations, and culture

3.2.4 Analysis and Target Selection

The UX-Detect module within Oasis Montaj identifies peak amplitude responses associated with, but not limited to, MEC items. Initial target selections were made based on the minimum curvature gridded data. Data profiles corresponding to the anomalies selected by Geosoft were then analyzed by trained geophysicists, with the targets evaluated as to their validity and position, as single-source anomalies that may generate multiple target designations depending on shape and orientation. Targets found to be invalid or incorrectly located were removed or adjusted. Additionally, anomalies that were not selected by the UX-Detect module, yet deemed to represent a potential MEC target, were manually selected. All targets were selected from final processed data from the late channel of the EM61-Flex3, roughly equivalent to Channel 3 of the bottom coil of the EM61-MK2.

Final processed XYZ (ASCII) files and geophysical maps were created for each dataset. Individual target lists were created for each transect. For all target lists, targets were sorted from highest response amplitude to lowest. All anomalies occurring at or above the targeting threshold of 10 mV in the late channel were identified using a unique ID number. Additionally, any well formed (multiple point) anomaly at or above 5 mV in the late channel was also selected as a target.

Each target list provides a Target ID, Grid ID, Easting (x) and Northing (y) UTM coordinate location for each target, anomaly type, and the recorded peak response in the late channel in

millivolts. All raw and processed data have been submitted to CH2M HILL's project geophysicist and can be found on the enclosed DVD.

3.2.5 Visual Sample Plan (VSP)

A software program called Visual Sample Plan (VSP) that was developed by the Pacific Northwest National Laboratory to design and analyze transect surveys with applications toward UXO cleanup was used to create anomaly density maps. The Geostatistical Mapping module was used that allows a continuous estimate of anomaly density across the entire study site to be generated using the surveyed transect data that only covered a relatively small portion of the site. The required inputs are the actual transect path, selected anomalies along those transect paths and a search window diameter. Transect paths and anomaly locations were imported directly into the software.

Different search window sizes were used for the areas; 275 meter window for the Primary Target, 125 meter window for the Navy Targets 1 and 2, and a 100 meter window for the San Marcos Target. The anomaly density at each search window location was used as input to the geostatistical mapping procedure to estimate the continuous anomaly density over the entire site. The results were put through a variogram model, which describes how the variability of a set changes spatially, and kriged, which minimizes variance. The kriged estimates were exported from VSP as an ASCII file and converted from a raster file into shapefiles in ArcCatalog. These shapefiles were then imported into a Geosoft database, the data was gridded and maps produced. All VSP associated files can be found on the enclosed DVD.

4.0 RESULTS

4.1 SUMMARY OF WORK PERFORMED

The DGM of the three target locations at the off shore Tangier Island Target Site located in the Chesapeake Bay took place from September 13th through September 27th. The inner 500 yard radius investigation area of the Primary Target was collected first. Then the crew moved over to collect the inner 500 yard radius investigation area of the Navy Targets 1 and 2 to allow for the data to be processed and turned over to CH2M HILL for determination to collect the outer transects. Then inner 500 yards of the San Marcos Target was then collected. It was determined that at all three targets, the outer transects would be collected. The conditions of the sea state determined which target the crew surveyed on a given day. The Primary and Navy Targets were completed on September 23rd. The decision was made to try and wait for weather conditions to improve, so that the outer transects of the San Marcos Target could be surveyed; however, on September 27th, after waiting for three days, the decision was made by the Navy, CH2M HILL,

and NAEVA/3Dg to demobilize without collecting the remaining transects at the San Marcos Target. Zero work days were lost due to equipment issues. Four work days were lost due to weather (the sea state was too high to allow for collection of data). Average daily production rate counting only days of operation was 18.8 miles. The average daily production rate including down days (weather) was 11.3 miles. The production rate, not including weather days, was higher than the original estimated production rate of 12 miles per day.

A total of 112.6 linear miles of transect data were collected and 4148 anomalies targeted at all three target locations. At the Primary Target, 39.7 linear miles of data were collected yielding 1184 anomalies. This mileage is slightly less than originally scoped (41 miles) due to the safety hazard of collecting the inner-most transects adjacent and overtop of the sunken ship. There were 53 linear miles of data collected and 2687 anomalies targeted at the Navy Targets 1 and 2. This mileage is also slightly less than originally scoped (56 miles) due to the safety hazard of collecting the inner-most transects adjacent and overtop of the sunken ships. At the San Marcos Target site, there were a total of 19.9 linear miles of data collected with 277 anomalies targeted. This mileage was significantly less than originally scoped (41 miles) due to poor weather conditions and, based on the diminishing number of anomalies outside of the 500 yard radius, it was determined that sufficient amount of data had been collected.

All selected anomalies were compared to the side scan sonar data collected prior to the collection of the DGM data. The selected features from the side scan data were imported into the DGM guidance equipment (FmX display) to assist in avoidance of any underwater structures that might have posed a navigational hazard for the boat as well as a hazard to the equipment hanging below the boat just off of the sea floor.

4.2 MOBILIZATION AND SITE SETUP

Prior to mobilization an AHA, SOPs, and an APP including an SSHP were provided to CH2M HILL. All personnel mobilized to the site had current 8-hour and/or 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) training and medical monitoring examinations in accordance with OSHA 29 CFR 1910.120 and 29 CFR 1910.134. NAEVA mobilized one field person and 3Dg mobilized three personnel on September 12th to Tangier Island, Virginia. The boat was docked and equipment was stored at Parks Marina. A GPS base station was also established on September 12th. Following a half day of installation of an IVS (discussed in Section 5.1) and establishment of new procedures for the QC checks (discussed in Section 5.2), production surveying began on September 13th. Site-specific health and safety briefs were given each morning and a float plan

was filed for each day of on-the-water activities by NAEVA's Site Safety and Health Officer (SSHO). These are included on the enclosed DVD.

4.3 DGM SURVEY

Of the 112.6 miles surveyed at the three target locations of the Tangier Island Target Site, a total of 4148 targets were identified. 112.6 miles with a 2 meter wide coil (swath of 6.4 ft) corresponds to 89.6 acres of data collected, and an average of 46.3 anomalies per acre. A summary of DGM survey results for each target location is provided below.

Primary Target

A total of two survey days (across three different calendar days) were spent surveying the Primary Target. Twelve transects, 500 ft from the center of the target to 1600 ft from the center of the target, were collected on the same day as the installation and collection of the IVS. The two outer most transects were collected on the same day that a portion of the San Marcos Target was collected. The remaining eight transects, six of the outer transects, and the nearest two to the center, were collected on the last day of surveying activities.

A total of 39.7 miles were surveyed at the Primary Target site with 1184 anomalies identified **(Figure 10)**. The 39.7 miles corresponds to 31.6 acres of data collected with an average anomaly density of 37 anomalies per acre. **Figure 11** shows the selected DGM anomalies overlaid on top of the side scan sonar data and selected features. The majority of the selected side scan sonar features that were covered by the DGM transects correlate to DGM anomalies. The features that do not are most likely not metal objects. The highest concentration of anomalies is centered approximately 175 m north-northeast of the target identified on NOAA chart 12225. Based on the VSP calculations this high response area for the Primary Target was estimated to extend out to the 30 anomaly per acre contour **(Figure 12),** which approximately corresponds to the 1400 ft transect from the center of the target to the east, the 1100 ft transect to the south, the 1200 ft transect to the west and the 1600 ft transect to the north **(Figure 10)**. This high response area makes up 13 of the total 31.6 acres collected and contains 757 of the total 1184 selected anomalies, equating to an average anomaly density of 58 anomalies per acre. Analysis of the high response area shows 26% of the total anomalies at the site are located within the first 500 ft from the center of the high response area and 64% of the total anomalies at the site are located within the high response area. Based on analysis of transects outside of the delineated high response area, 86% of the anomalies are located within the first 2200 ft from the center of the high response area. Near the center of the target, multiple debris fields were observed real time with the on-board side scan sonar. Water depths at Primary Target location ranged from 11 to 20

ft, which was greater than the reported depths of 10 to 15 ft **(Figure 13)**. The system maintained an average height above seafloor of 2.6 ft.

Navy Targets 1 and 2

A total of three days were spent surveying Navy Targets 1 and 2. On the first day of surveying, 9 transects were collected from 800 ft out from the center to 1600 ft. The data collected on the first day was enough that it was decided to collect the outer transects. On the second day of surveying, the crew decided to collect the outer ovals and leave the inner ovals, which potentially presented more of a hazard, until last. Six and a half transects were collected on the last day of surveying, 700 ft out from the center to 300 ft and the 1750 ft transect. On the last line, approximately 200 ft to the north of the identified location of Navy Target 2 and adjacent to a navigation buoy, the system struck an object that was sticking roughly 15 ft proud into the water column. The object that was struck was not visible on the side scan data and is believed to have been a support cable from the navigation buoy that connected to the sea floor at an angle away from the buoy.

Of the 53 miles surveyed, 2687 anomalies were identified **(Figure 14)**. This mileage equates to 42.2 acres of data collected and an average of 64 anomalies per acre. **Figure 15** shows the selected DGM anomalies overlaid on top of the side scan sonar data and selected features. The majority of the selected side scan sonar features that were covered by the DGM transects correlate to DGM anomalies. The features that do not are most likely not metal objects. The highest concentration of anomalies is centered approximately 60 m northwest of the Navy 1 Target location identified on NOAA chart 12225. Based on the VSP calculations, the high response area for Navy Targets 1 and 2 was estimated to extend out to the 30 anomaly per acre contour **(Figure 16),** which approximately corresponds to the 600 ft transect from the center of the target (1600 ft from the center of the high response area) to the east, the 2250 ft transect to the south, the 900 ft transect to the west and the 2250 ft transect to the north **(Figure 14)**. This high response area makes up 23 of the total 53 acres collected and contains 2083 of the total 2687 selected anomalies equating to an average anomaly density of 91 per acre. Further analysis shows 78% of the total anomalies at the site are located within the high response area. Based on analysis of transects outside of the delineated high response area, 88% of the anomalies are located within the first 3600 ft south to north and within the first 1700 ft west to east from the center of the high response area. Near the center of the target, multiple debris fields were observed real time with the side scan sonar. Water depths at Navy Targets 1 and 2 ranged from 10 to 22 ft, which was greater than the reported depths of 10 to 15 ft **(Figure 17)**. The system maintained an average height above seafloor of 2.9 ft.

San Marcos Target

A total of one day was spent surveying the San Marcos Target site. All of the inner 500 yard transects were collected in one day. Several attempts were made to collect the outer transects; however, due to high seas none of the outer transects were collected.

A total of 19.9 miles of transects were surveyed at the San Marcos Target with 277 anomalies identified **(Figure 18)**. The 19.9 miles corresponds to 15.8 acres of data collected with an average anomaly density of 17 anomalies per acre. **Figure 19** shows the selected DGM anomalies overlaid on top of the side scan sonar data and selected features. The only side scan sonar target that was covered by the DGM data correlates to a selected DGM anomaly. The anomalies are spread out evenly across the site with a slight pattern running from the southeast to the northwest **(Figure 20)**. Near the center of the target, multiple debris fields were observed real time with the side scan sonar. Water depths at the San Marcos Target site ranged from 26 to 32 ft, which was greater than the reported depths of 24 to 29 ft **(Figure 21)**. The system maintained an average height above seafloor of 3.19 ft.

Noise levels across all areas were generally low. A few datasets contained slightly elevated noise levels due an increased sea state, however still less than the targeting threshold.

4.4 DATA PROCESSING AND INTERPRETATION

All data were processed as described in Section 3.2. Any anomalies suspected as originating from noise, less than the 5mV threshold, (e.g., channel readings out of phase) rather than metallic objects are noted in the target lists included on the DVD. Also included in the DVD are processing reports that summarize all processing information including: down-line data density statistics, leveling, lag, gridding parameters used in processing, and any additional notes for each dataset. Processors examined all data prior to NAEVA demobilizing from the site.

The enclosed DVD contains all raw and processed data, including processing reports, QC test results, target lists, and color contour maps for each grid block.

5.0 QUALITY CONTROL (QC)

To establish confidence in the data reliability, QC tests were conducted throughout the project. Tests were conducted prior to and after all data collection sessions. All QC tests for the EM61-Flex3 were conducted after a minimum 15 minute warm-up period for the electronics and coils.

5.1 SYSTEM VALIDATION – INSTRUMENT VERIFICATION STRIP (IVS)

Prior to beginning the main survey and everyday thereafter, a modified IVS was surveyed. The purpose of surveying the IVS was to demonstrate the proper function of all instrumentation, methods, and personnel prior to the initiation of fieldwork and to document the site-specific noise and capabilities of the EM61-Flex3 system.

One IVS was established for the Tangier Island Target Site. A 5 lb dumb bar weight **(Figure 22)** was installed by placing the weight over a 10-ft Polyvinyl Chloride (PVC) pipe that had a survey rod with GPS antenna inside so that when the pipe/survey rod was level the weight was dropped and a GPS coordinate was recorded. Prior to placing an item, the area was surveyed to verify the location was free of metal objects. However, due to the difficulty of positioning the boat back over an exact location, a few of the passes over the IVS have additional anomalies along the lines. **Appendix A** contains a spreadsheet summary of the IVS results.

Data Quality Objectives (DQOs) evaluated in the IVS and associated QC tests included positioning repeatability, system data repeatability, and dynamic detection repeatability. As defined in the QAPP, positional error at known monuments did not exceed 10.2 cm (4 inches) and the response to a standardized item did not vary more than ± 20%. Summary of all QC results can be found in **Appendix B.** Other DQOs evaluated in production data included: downline data density having sufficient data collected such that at least 98% of possible sensor readings captured within 25 cm or lesser spacing between points and no readings will fall outside of 61 cm, and 97% of the data will be collected within 5 ft of the bottom and of the allowable 3% outside no segment length will exceed 10 m. All DQOs were met. The horizontal positioning had to be accurate enough to allow reacquisition and selected targets lie within 3 meter of IVS seed item. All peak responses in the late channel over the seeded objects were within specifications.

5.2 QC TEST DESCRIPTIONS AND ACCEPTANCE CRITERIA

In addition to the IVS, the following QC procedures were performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis. Sample graphical displays of the QC data and summary of the results are included in **Appendix B**.

GPS Check Point: At the beginning of the day after setting up the base station and before collecting any data, the UUTA bow and stern GPS antennas were tested. On the first day, the boat was secured to two pilings at the dock and multiple measurements were taken. These were averaged together to obtain "known" points for the bow and stern. All subsequent measurements were compared to these initial readings. The locations were stored in a Panasonic Toughbook

laptop and documented in a daily DGM form on the PDA. Positional discrepancies within 10 cm were considered acceptable.

Static Background and Static Spike: Since the boat was docked in the water and could not be pulled out onto the land, the static tests were performed in the water. The system was deployed as it would be for data collection, however the "whale tail" was kept at the surface and data was collected for a 3-minute period. A static test is the primary measurement of instrument functionality and consists of one minute without a spike, one minute with a spike (two large clamps were clipped onto the "whale tail"), and then one minute without a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist and to check for consistent response. The acceptance criterion was that the spike response after background correction be within ± 20% of the previous day's measured response. Static tests were plotted on a scale of ± 4 mV so that any abnormally high data spikes could be observed. The static background and static spike tests were conducted at the beginning and end of the day.

Pressure Test: Prior to data collection the accuracy of the pressure sensor (i.e. EM sensor platform depth) was tested. Two data points were recorded during the test to verify the functionality of the pressure sensor. The test was conducted on land prior to deployment of the system in the water. The acceptance criterion was that the pressure sensor's depth results were within 6 inches of the known depth.

Repeat Data: As a result of the difficulty to accurately repeat a line of data in the water, the IVS data were used to verify repeatability of the data. Because of the difficulty of flying the system along the exact same line and height twice in the dynamic marine environment, and because instrument response is very sensitive to the distance of a metallic object from the coil, this test was evaluated qualitatively.

5.3 QC TEST RESULTS

QC data were evaluated using Geosoft's Quality Assurance/Quality Control (QA/QC) software. Static and Pressure test profiles were plotted on a scale of ± 4 mV from the mean. The following provides a summary of the QC results:

1. **GPS Check Point:** All recorded points were well within tolerance. The average variance from the reported location was 2.2 cm.
2. **Static Background / Spike Test:** All static and spike tests were within acceptance criteria.
3. **Pressure Test:** All pressure test measurements were within acceptance criteria.

4. **Repeat Data:** Repeat lines generally showed acceptable repeatability. Discrepancies in the response on repeat lines were a result of line path or coil height deviation.

6.0 CONCLUSIONS

All tasks involved in the DGM survey of the three target locations at the Tangier Island Target Site were completed as scoped. Supporting QC data and all other DQOs, as outlined in the MEC-QAPP, were within specifications. The survey covered approximately 112.6 linear miles across the three target locations, which consisted of water depths ranging from 10 to 32 ft. Although there was some downtime due to weather, the crew was able to meet the estimated production levels and complete the project on schedule.

Primary Target: The data collected during this investigation shows that the identified target location from NOAA chart 12225 for the Primary Target is relatively accurate and the majority of the geophysical anomalies are confined to an area 1400 ft from the center of the target to the east, 1100 ft to the south, 1200 ft to the west and the 1600 ft to the north as shown on **Figure 10**. Based on analysis of the density maps, 26% of the total anomalies at the site are located within the first 500 ft from the center of the high response area, 64% of the total anomalies at the site are located within the high response area (stated above) and 86% of the total anomalies are located within the first 2200 ft from the center of the high response area.

Navy Targets 1 and 2: The results from this investigation indicate the presence of a target at the location identified as Navy Target 1 on NOAA chart 12225as shown on **Figure 14**. The high response area is trending south-southeast to north-northwest with a bulbous center. The location of Navy Target 2 is just inside the area delineated as high response and does not appear to be a target. Based on analysis of the density maps, 78% of the total anomalies at the site are located within the high response area and 88% of the total anomalies are located within the first 3600 ft south to north and within the first 1700 ft west to east from the center of the high response area.

San Marcos Target: Even though there is significant evidence supporting the existence of a ship at this target location, the results from this investigation do not indicate significant use of San Marcos as a target. The anomalies are spread out evenly across the site with a slight pattern running from the southeast to the northwest.

7.0 REFERENCES

CH2M HILL, 2010a, Munitions and Explosive of Concern Uniform Federal Policy – Quality Assurance Project Plan for Tangier Island Target Phase I Site Inspection Munitions Response Program, July 2010

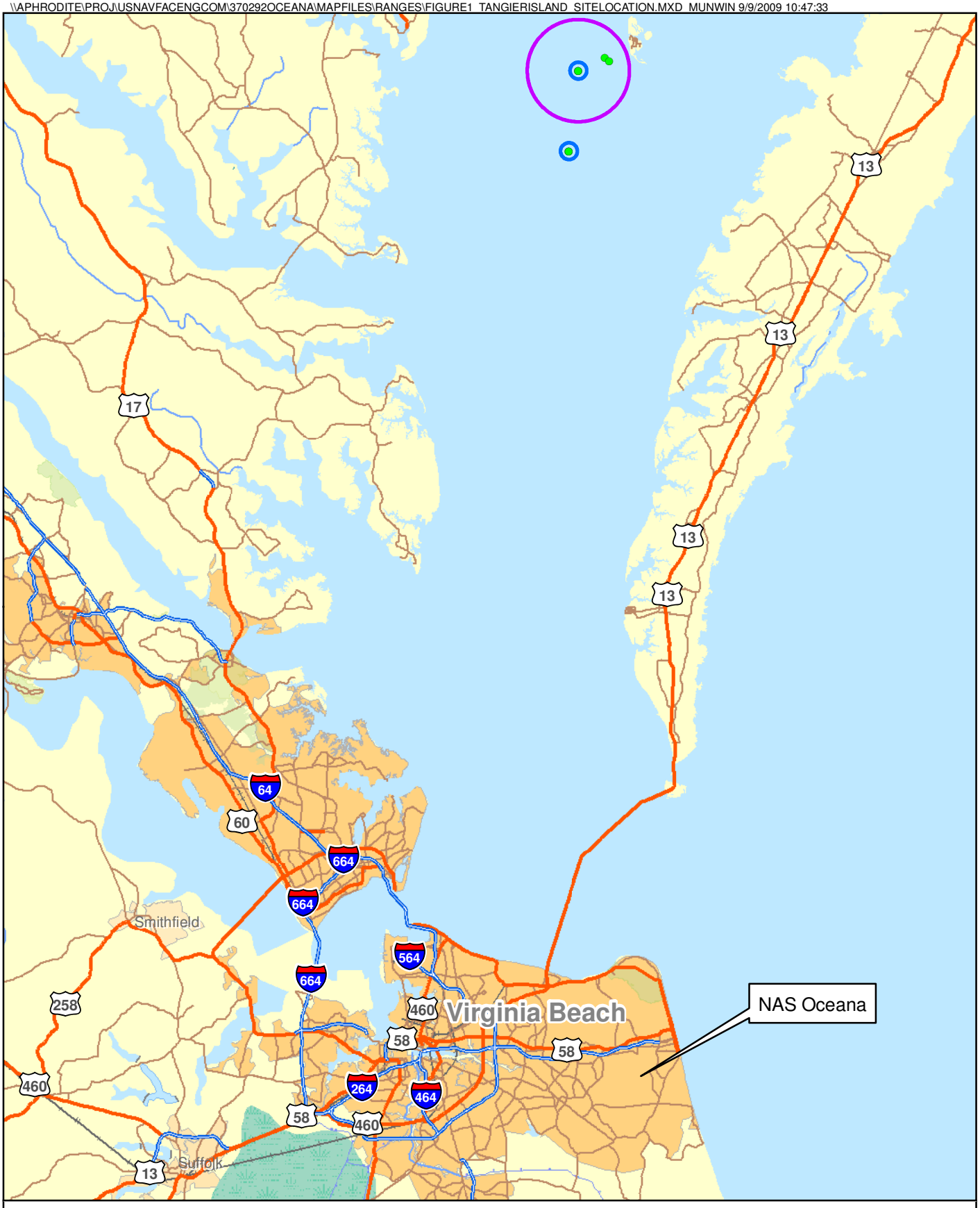
CH2M HILL, 2010b, Statement of Work/Technical Specifications Digital Geophysical Mapping Site Inspection Other-than-Operational Ranges Naval Air Station, Oceana Virginia Beach, VA, Rev 0, March 4 2010

Geonics, 2009, EM61-FLEX 3 High Sensitivity Wide Swath Metal Detector, Operating Notes, Mississauga, Ontario, August 2009

National Oceanic and Atmospheric Administration. Chart 12225 - Chesapeake Bay Wolf Trap to Smith Point [Navigational Chart]. Current Edition: 59, Print Date: 12/1/2009. Available from: http://www.charts.noaa.gov/OnLineViewer/12225.shtml

FIGURES

\\APHRODITE\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\RANGES\FIGURE1_TANGIERISLAND_SITELOCATION.MXD MUNWIN 9/9/2009 10:47:33



Legend

- NAS Oceana
- 3-Nautical Mile Restricted Area
- 1,000-Yard Prohibited Area
- Target Location

N
W E
S

0 4.5 9
Miles

Figure 1
Tangier Island Site Location
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

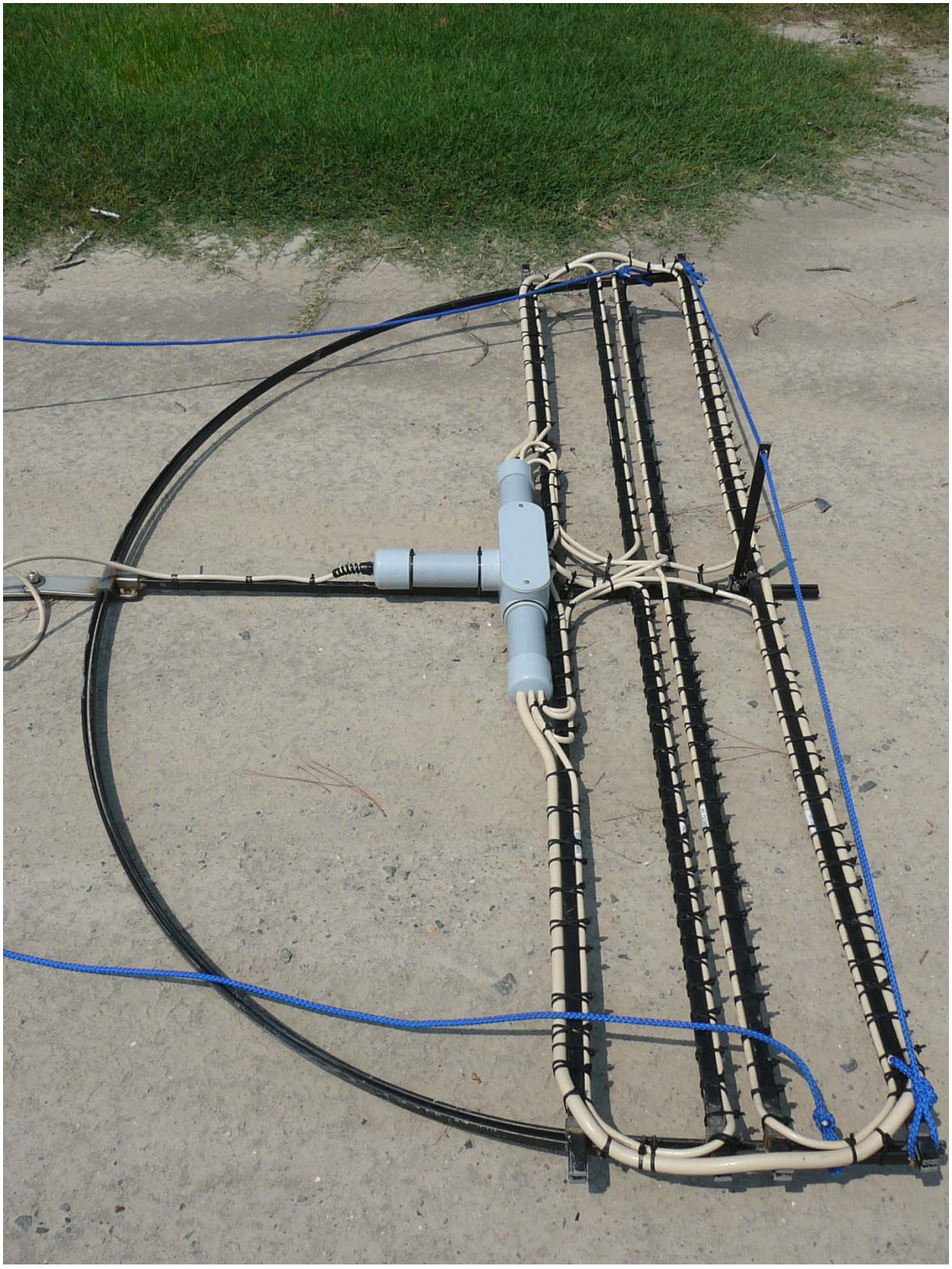


Figure 2: Geonics EM61-Flex3

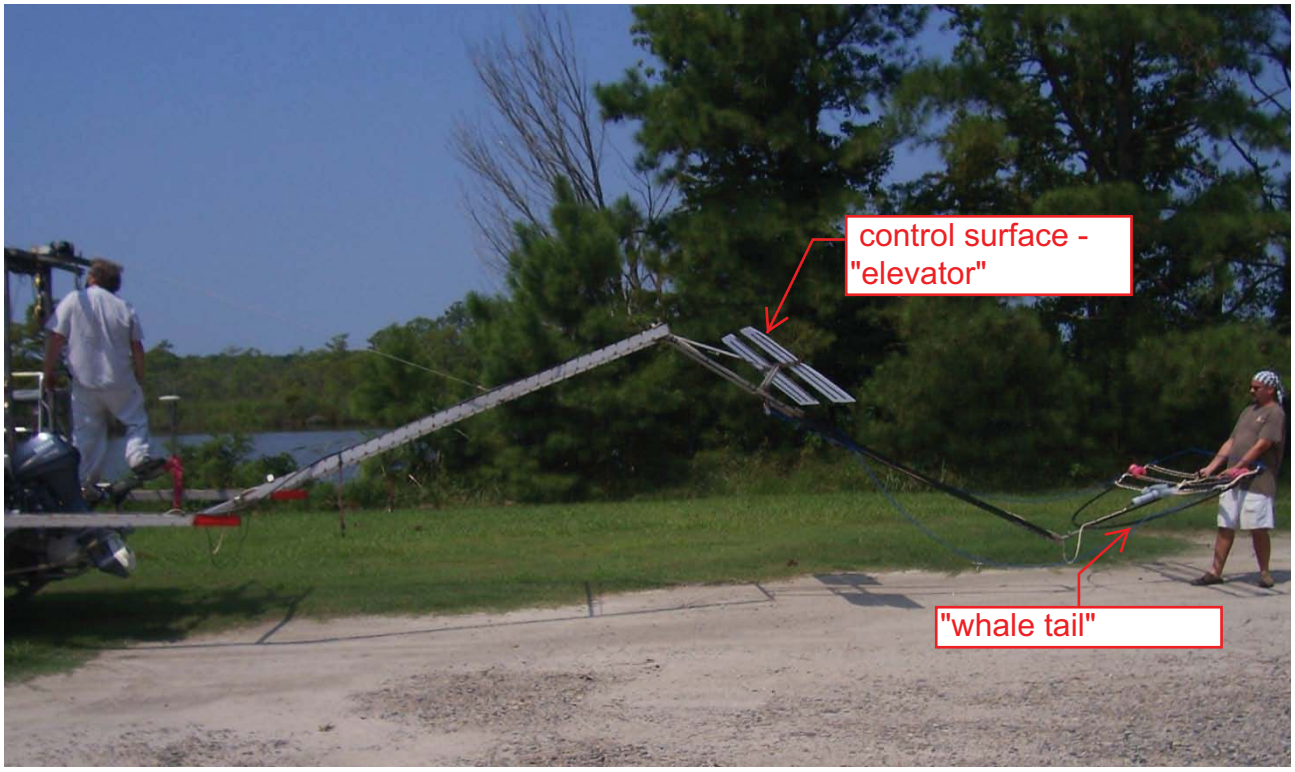


Figure 3: Underwater UXO Towed Array (UUTA)

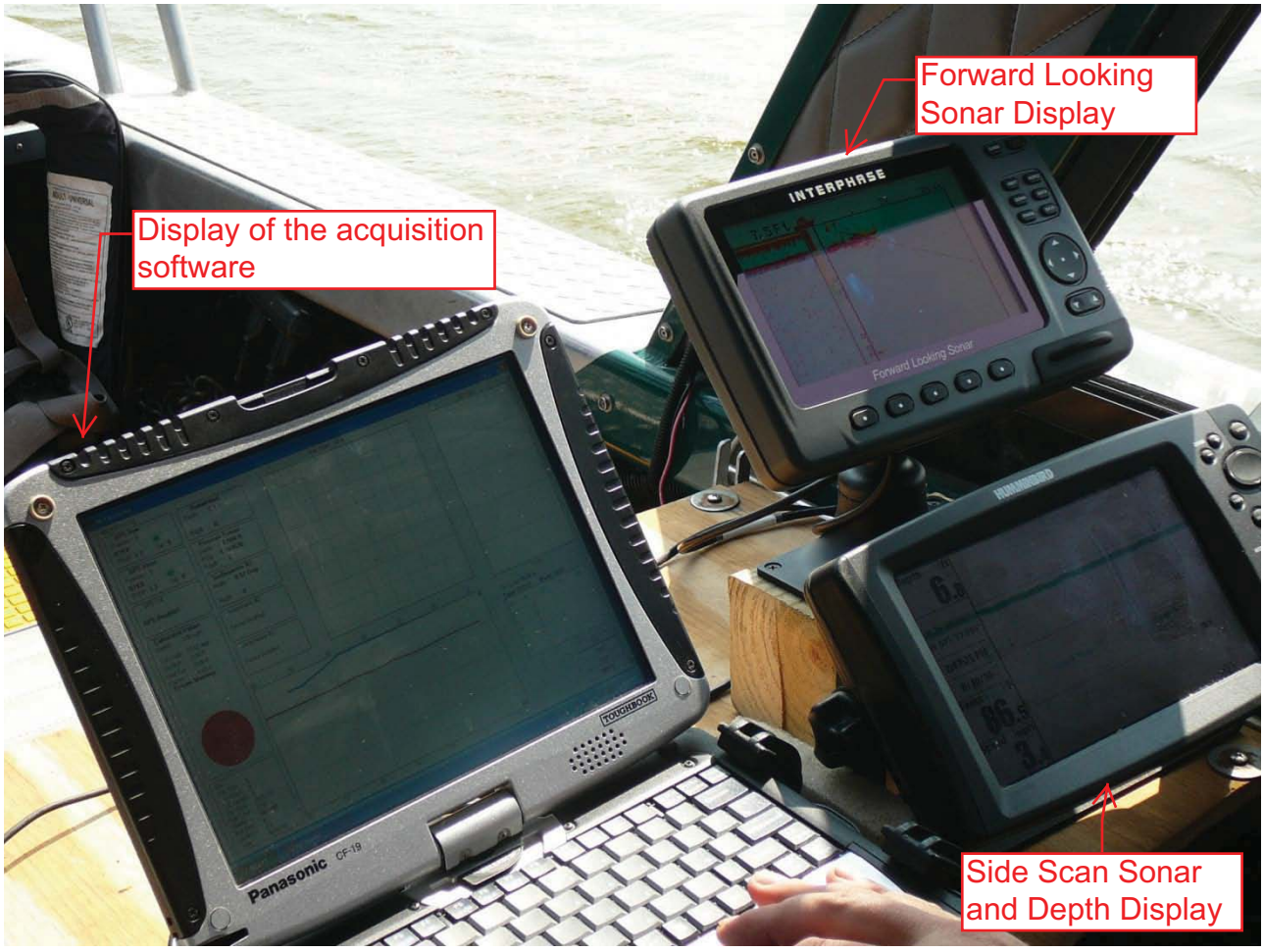


Figure 4: UUTA Control "Captain" Area

Figure 5: UUTA Elevator Control

Figure 6: Marine Tow Vehicle - 22 foot Jet Boat

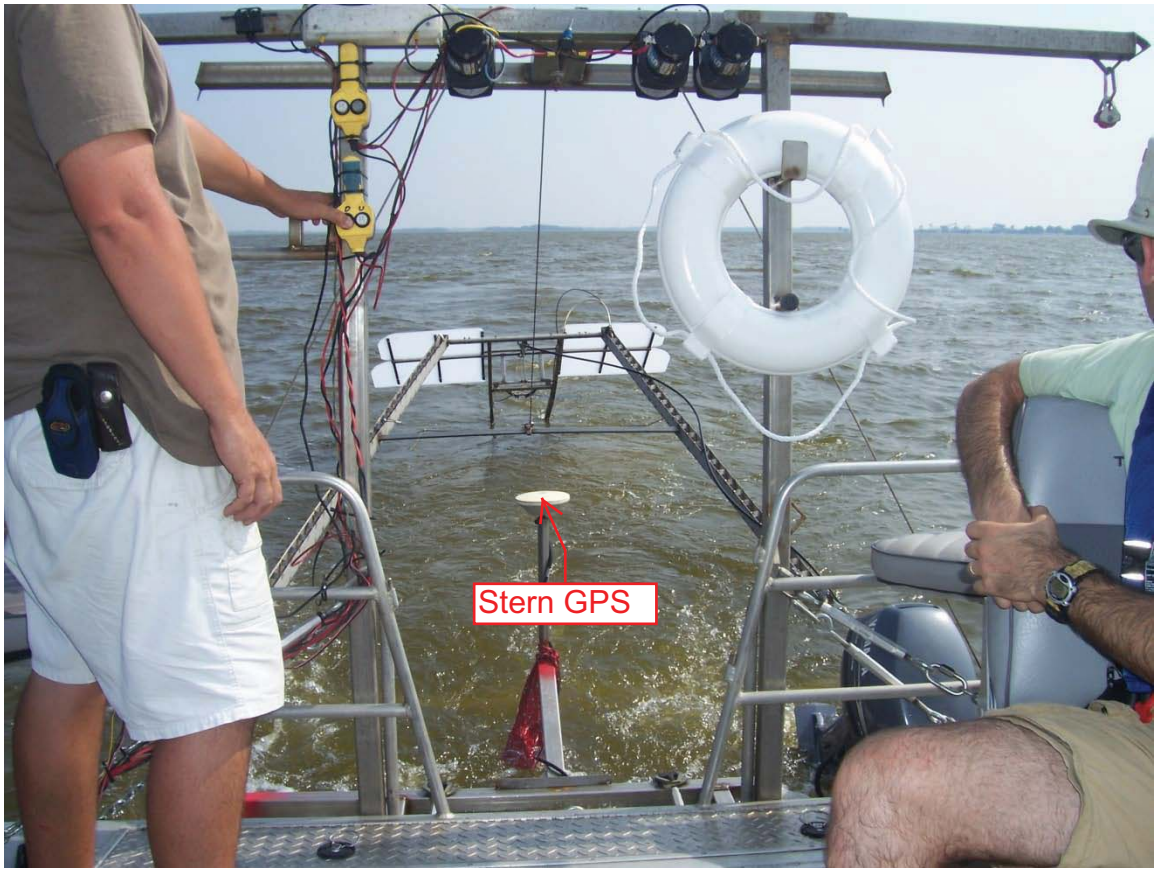


Figure 7: System being deployed

Figure 8: Yagi-Udi Directional Antenna

Figure 9: Trimble AgGPS FmX Display

405500 406000 406500 407000 407500

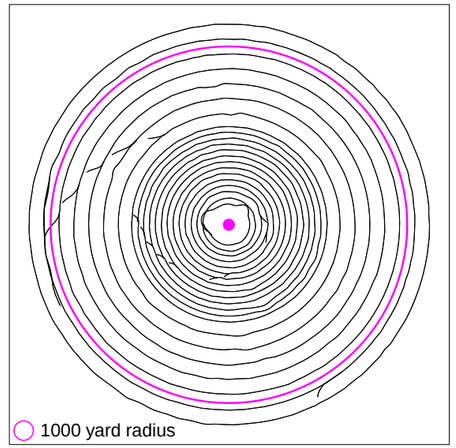
4185000 4184500 4184000 4183500 4183000

Tangier
Primary

150 148 146 144 142 140 138 136 134 132 130 128 126 124 122 120 118 116 114 112 110 108 106 104 102 100 98 96 94 92 90 88 86 84 82 80 78 76 74 72 70 68 66 64 62 60 58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0

mV

Late Channel



Legend

- Site Target
- Selected Target
  (See individual Block Target Pick List For Response, Location and ID Number)
- Bouy — Culture, if noted
- High Density Response Area
  (Based on VSP Calculation of Areas greater than 30 Anomalies/Acre)

100 0 100 200 300 400 500 600

(meters)

NAD83 / UTM zone 18N

Figure 10

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

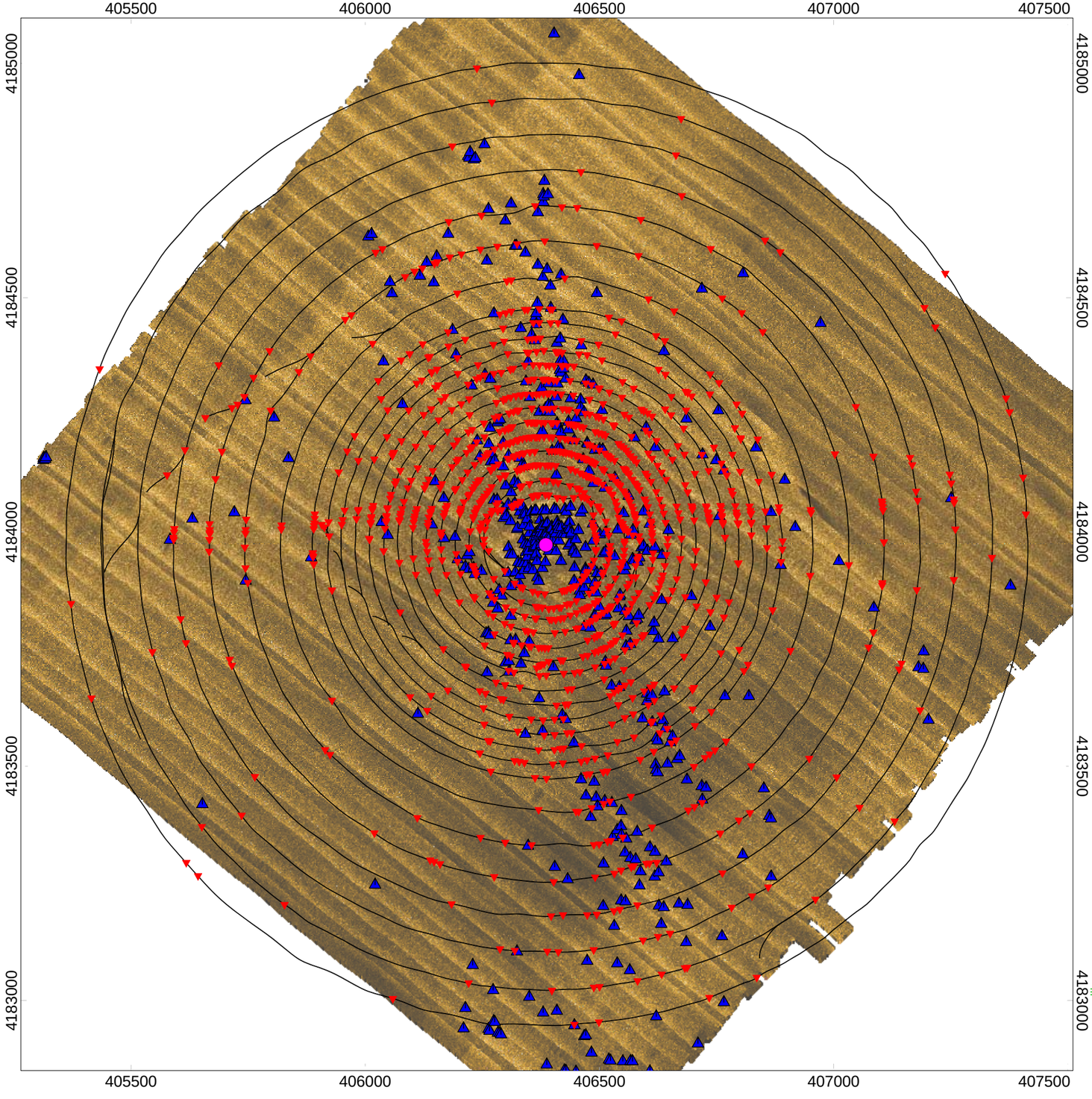
3Dgeophysics.com

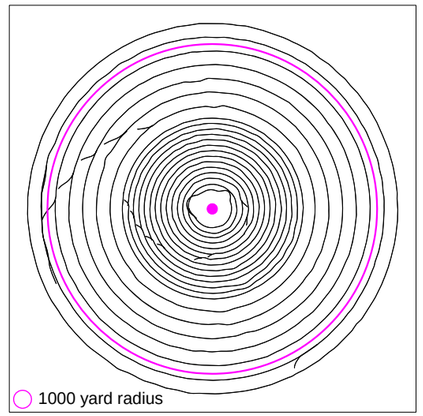
Client: CH2M HILL

EM61-FLEX 3
Anomaly Distribution Mosaic
Tangier Primary Target Site
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/13/2010 - 09/23/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard





Legend

- Site Target
- Selected DGM Target
  (See individual Block Target Pick List For Response, Location and ID Number)
- Side Scan Sonar Target
  (Side Scan Targets Selected by Sonographics, Inc.)
- DGM Transect/Line Path

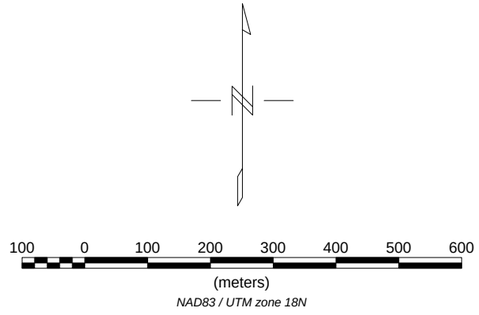


Figure 11

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

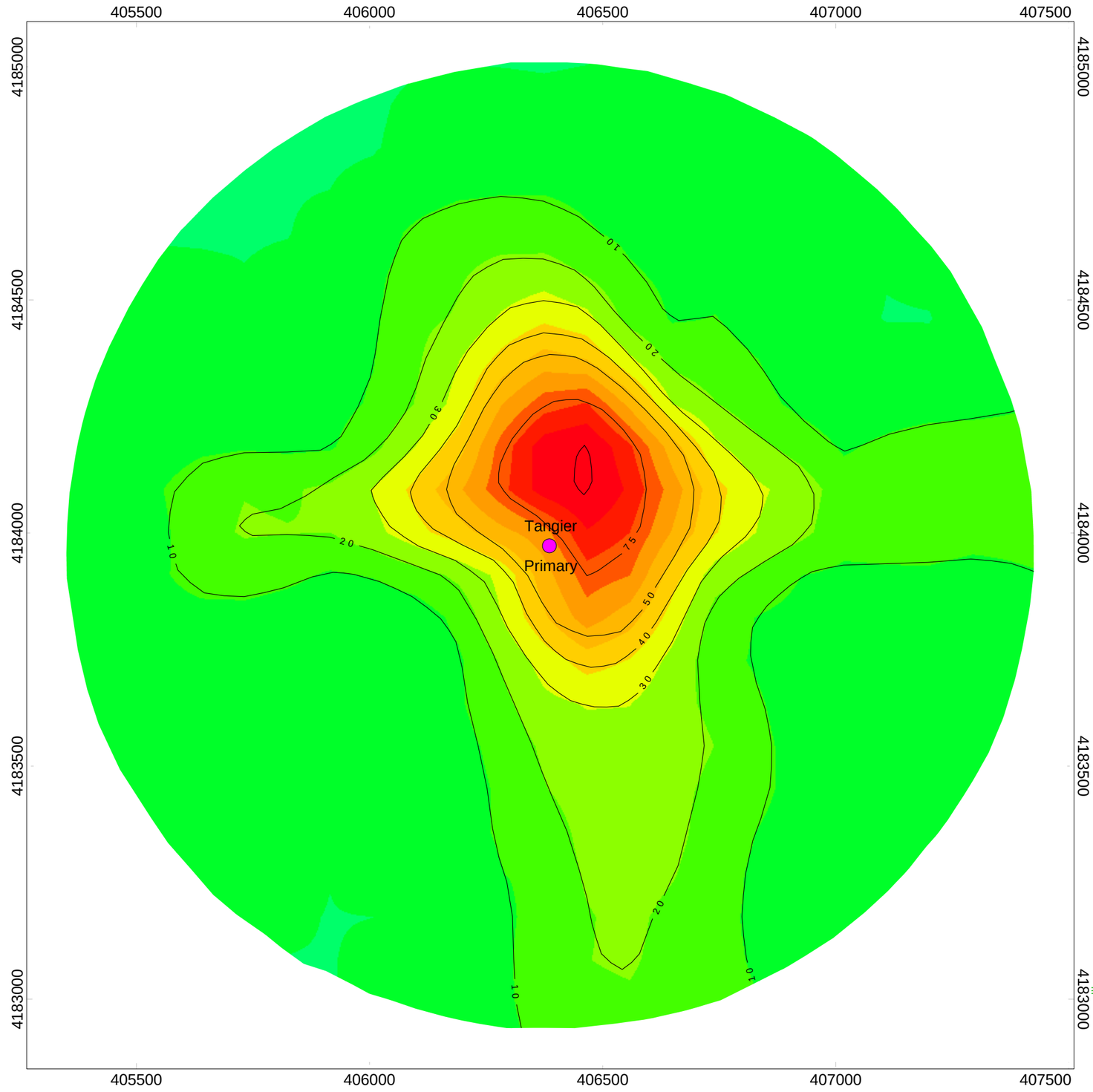
3Dgeophysics.com

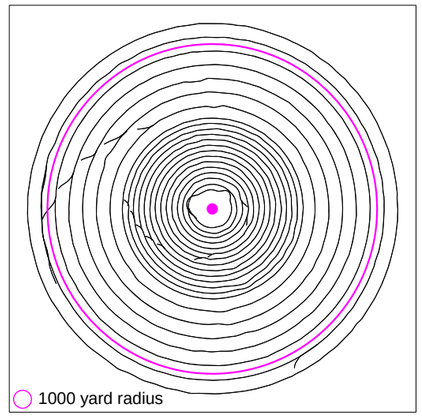
Client: CH2M HILL

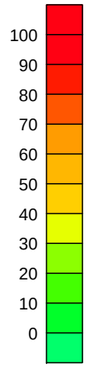
EM61-Flex 3
Side Scan Sonar with Selected DGM Targets
Tangier Primary Target Site
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/13/2010 - 09/23/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard

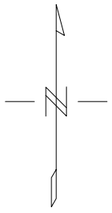


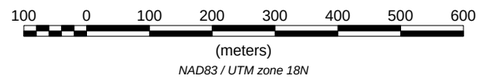




Legend

- Site Target





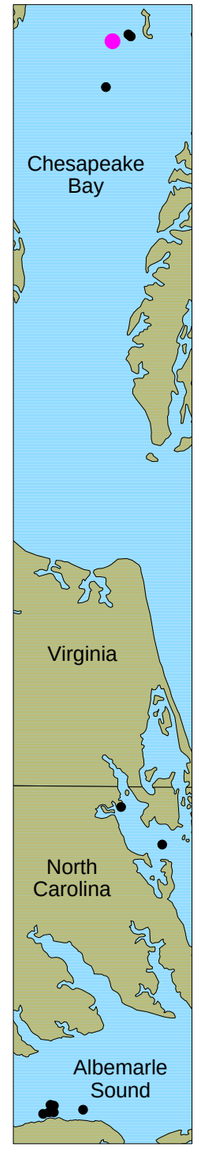


Figure 12

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

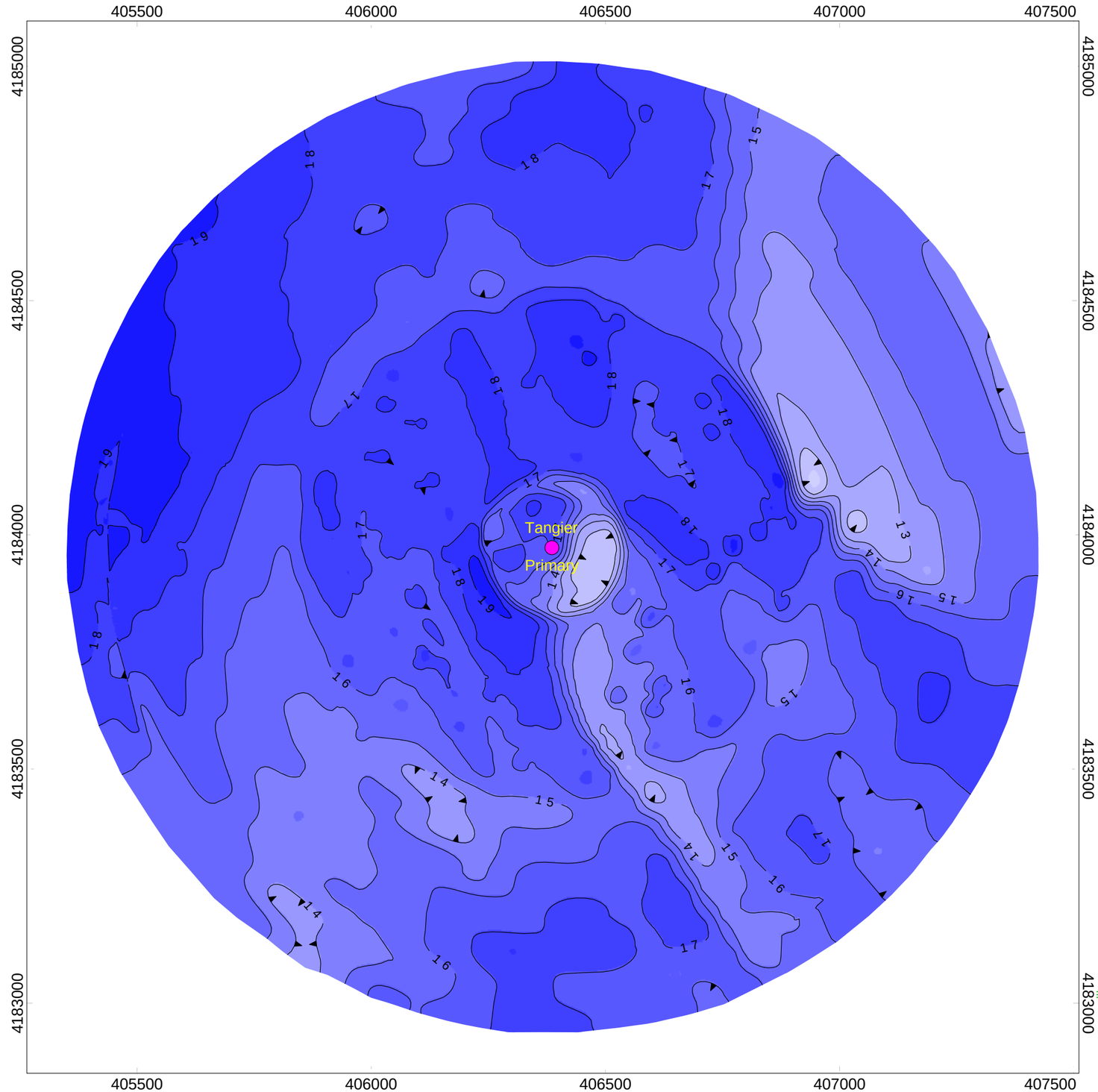
3Dgeophysics.com

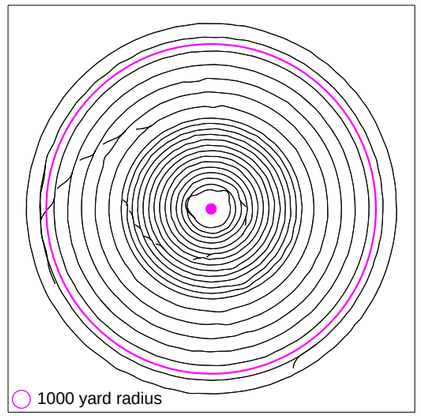
Client: CH2M HILL

EM61-Flex 3
VSP Calculated Anomaly Density
Tangier Primary Target Site
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/13/2010 - 09/23/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard

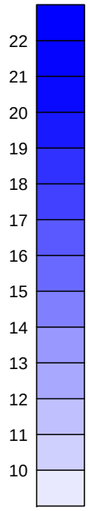




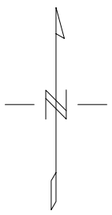
Legend

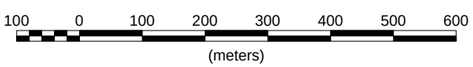
Site Target

NOTE: Depths are interpolated between the transect lines.



Depth
Feet





(meters)

NAD83 / UTM zone 18N

Figure 13

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

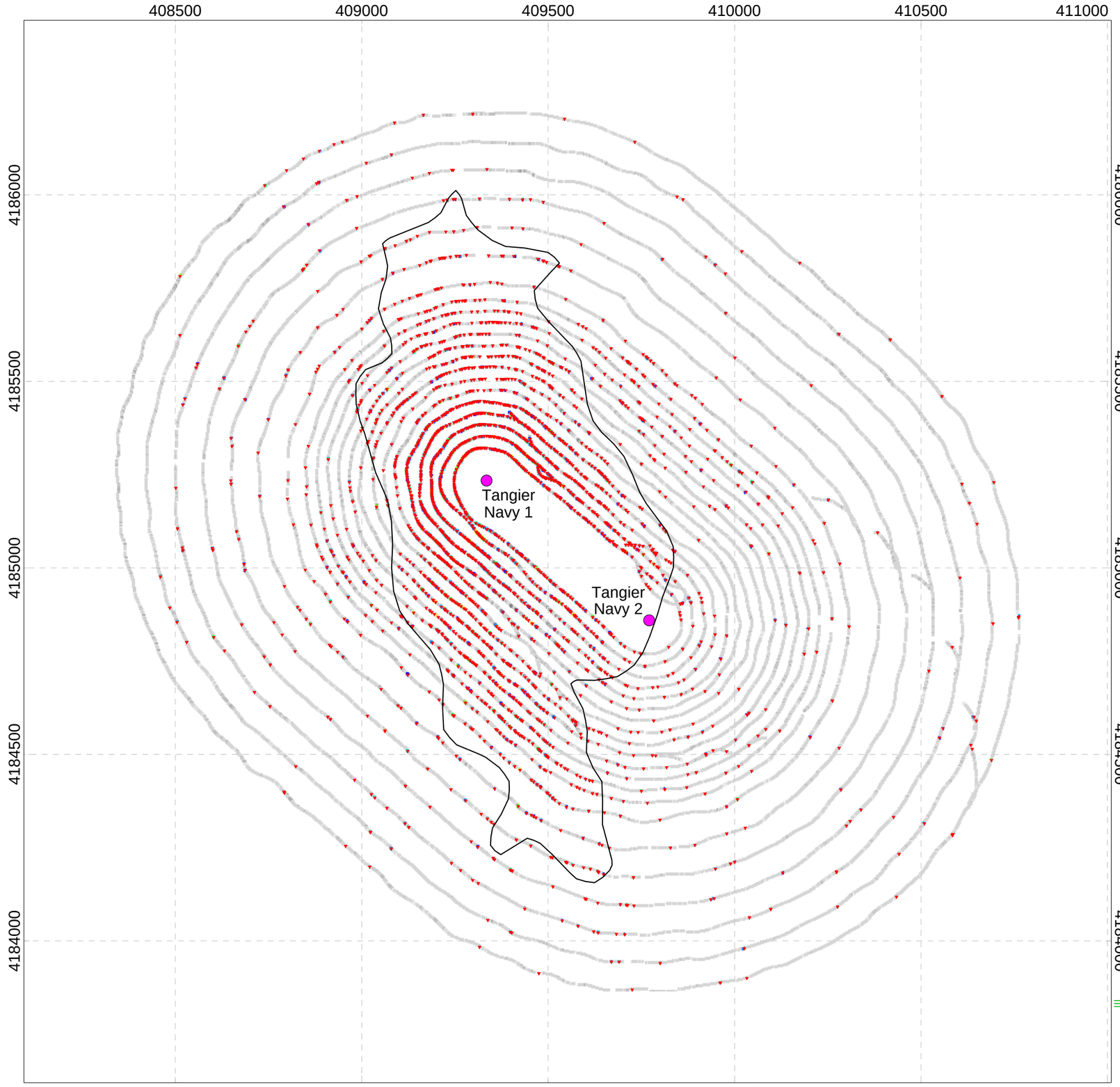
3Dgeophysics.com

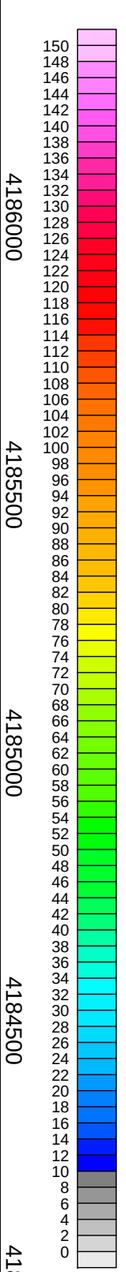
Client: CH2M HILL

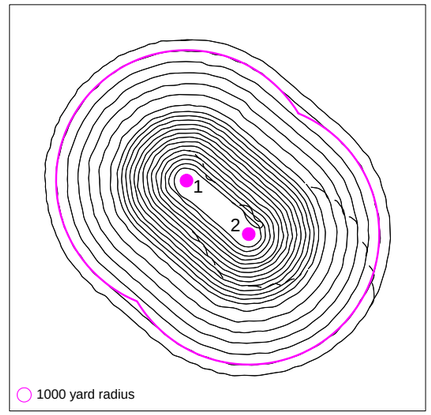
Humminbird 997c SI Combo
Bathymetric Mosaic
Tangier Primary Target Site
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/13/2010 - 09/23/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard

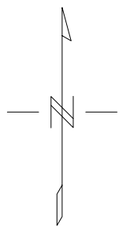


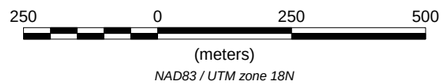




Legend

- Site Target
- Selected Target (See individual Block Target Pick List For Response, Location and ID Number)
- Culture, if noted — Bouy
- High Density Response Area (Based on VSP Calculation of Areas greater than 30 Anomalies/Acre)





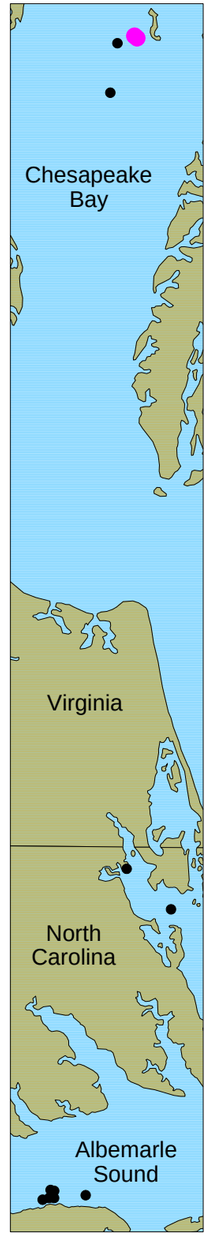


Figure 14

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

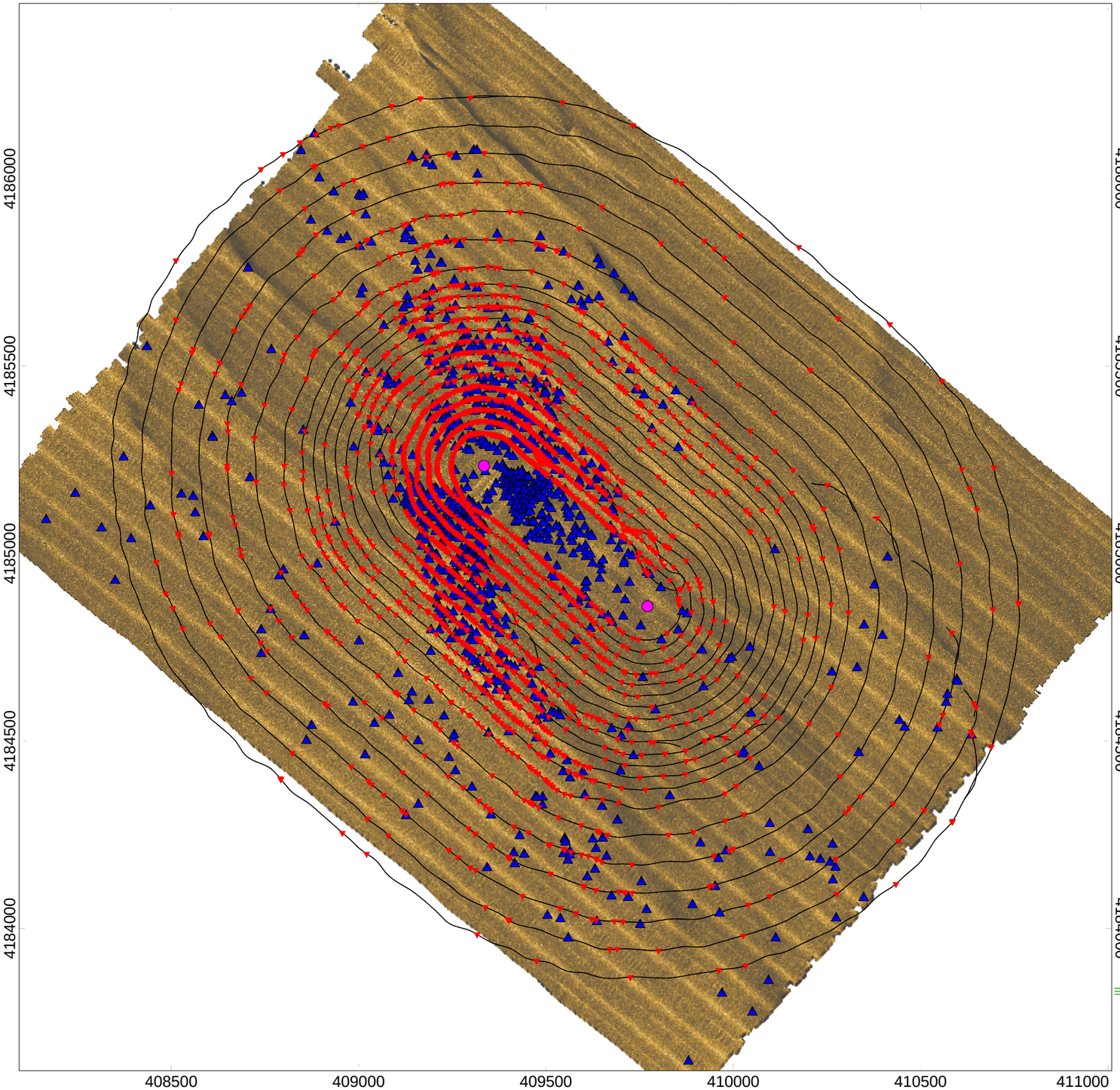
3Dgeophysics.com

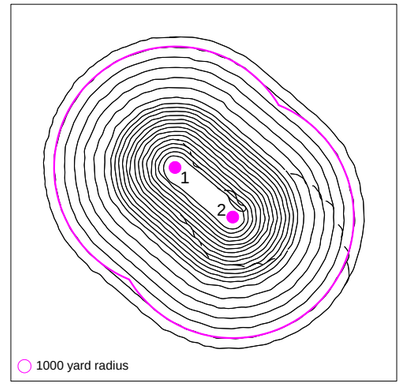
Client: CH2M HILL

EM61-FLEX 3
Anomaly Distribution Mosaic
Tangier Navy 1 and Navy 2 Target Sites
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/15/2010 - 09/19/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard





Legend

- Site Target
- Selected DGM Target
  (See individual Block Target Pick List For Response, Location and ID Number)
- Side Scan Sonar Target
  (Side Scan Targets Selected by Sonographics, Inc.)
- DGM Transect/Line Path

250 0 250 500

(meters)

NAD83 / UTM zone 18N

Figure 15

NAEVA GEOPHYSICS INC.
Subsurface Geophysical Surveys

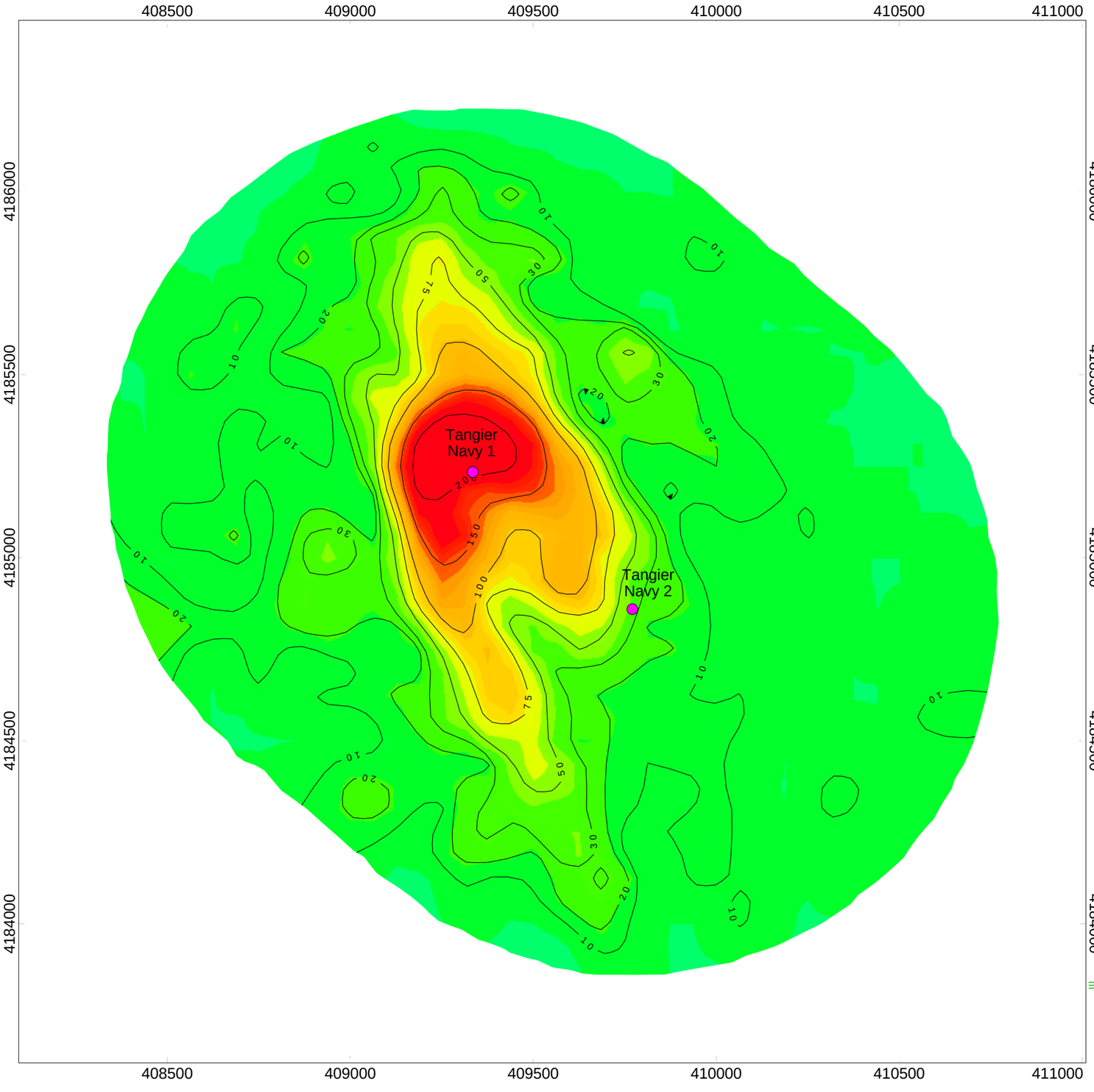
3Dgeophysics.com

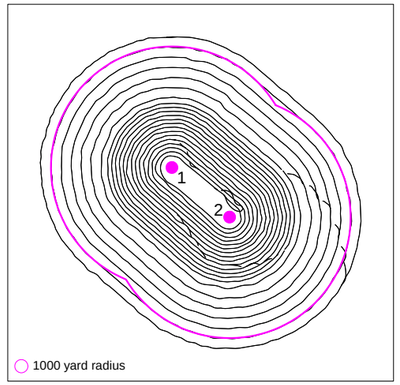
Client: CH2M HILL

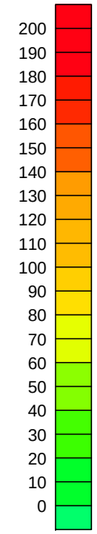
EM61-Flex 3
Side Scan Sonar with Selected DGM Targets
Tangier Navy 1 and Navy 2 Target Sites
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/15/2010 - 09/19/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard







Legend

Site Target

250 0 250 500

(meters)

NAD83 / UTM zone 18N

Figure 16

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

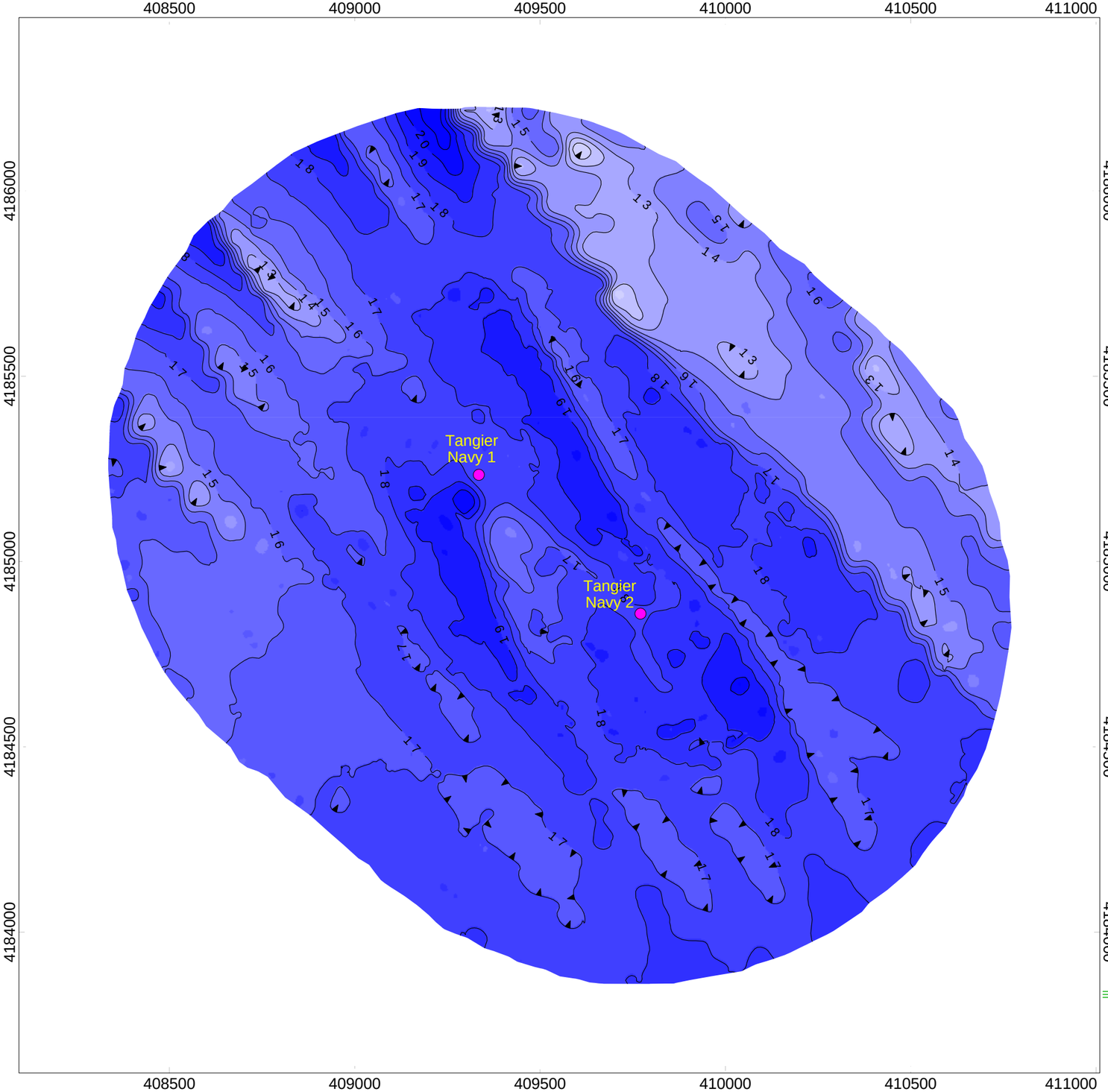
3Dgeophysics.com

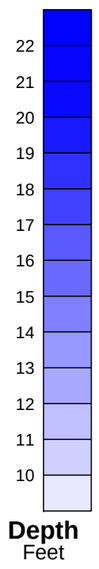
Client: CH2M HILL

EM61-Flex 3
VSP Calculated Anomaly Density
Tangier Navy 1 and Navy 2 Target Sites
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

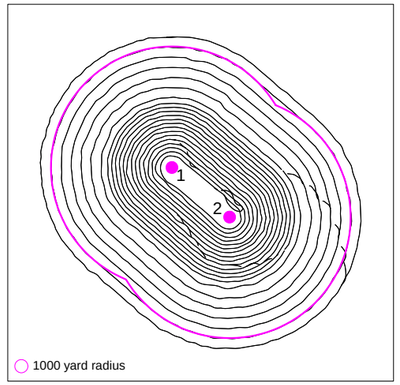
Date of Survey: 09/15/2010 - 09/19/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard





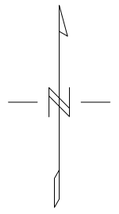
Depth
Feet

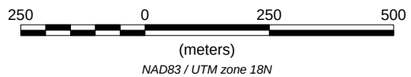


Legend

Site Target

NOTE: Depths are interpolated between the transect lines.





NAD83 / UTM zone 18N

Figure 17

NAEVA GEOPHYSICS INC.
Subsurface Geophysical Surveys

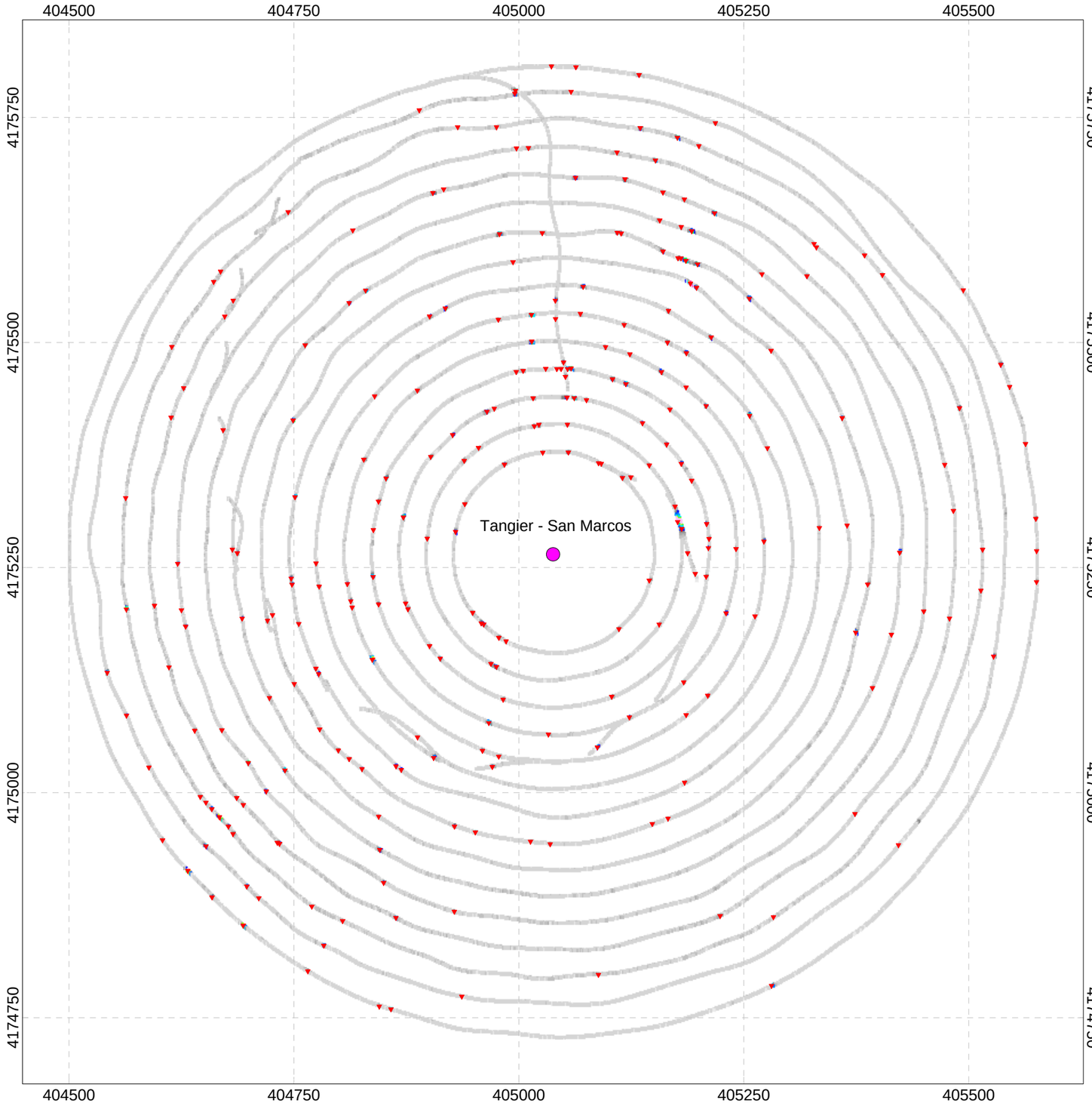
3Dgeophysics.com

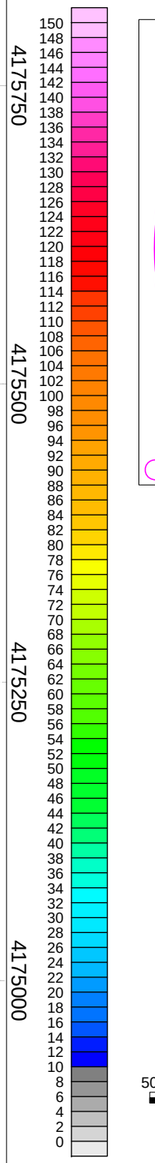
Client: CH2M HILL

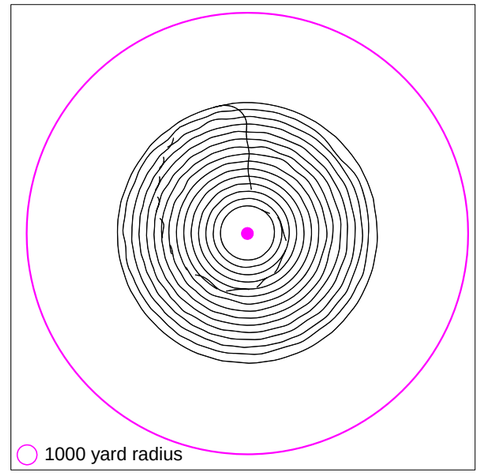
Humminbird 997c SI Combo
Bathymetric Mosaic
Tangier Navy 1 and Navy 2 Target Sites
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/15/2010 - 09/19/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard







Legend

- Site Target
- Selected Target (See individual Block Target Pick List For Response, Location and ID Number)
- Culture, if noted
- Bouy

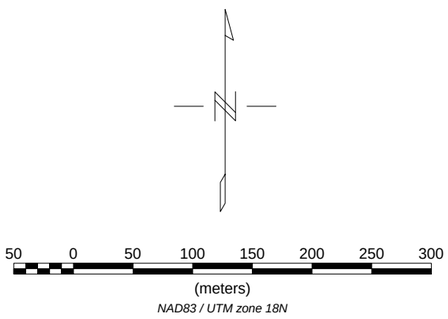


Figure 18

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

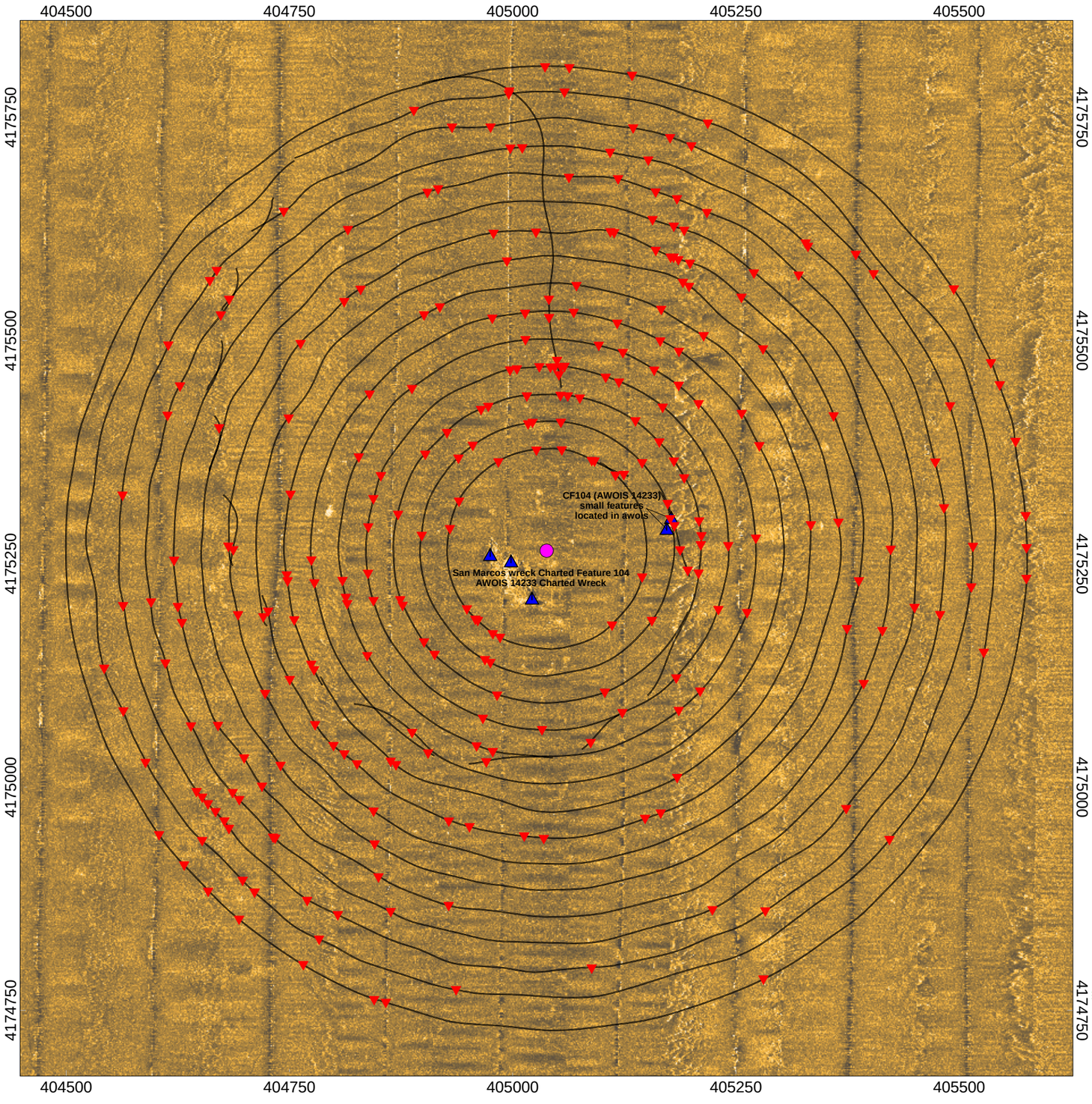
3Dgeophysics.com

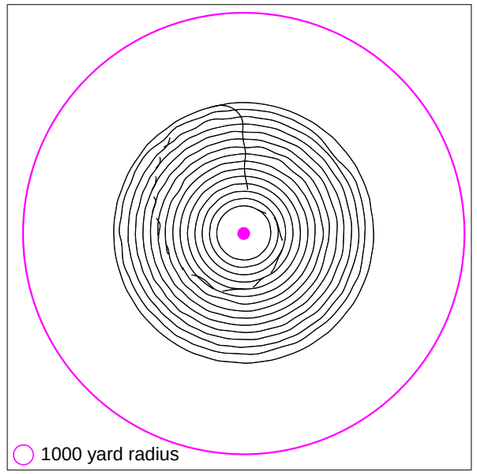
Client: CH2M HILL

EM61-FLEX 3
Anomaly Distribution Mosaic
Tangier San Marcos Target Site
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/21/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard





Legend

- Site Target
- Selected DGM Target
  (See individual Block Target Pick List For Response, Location and ID Number)
- Side Scan Sonar Target
  (Side Scan Targets Selected by Dave Evans & Associates)
- DGM Transect/Line Path

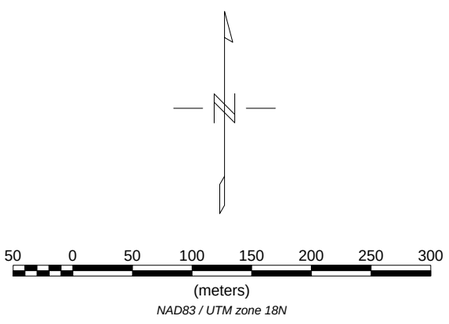


Figure 19

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

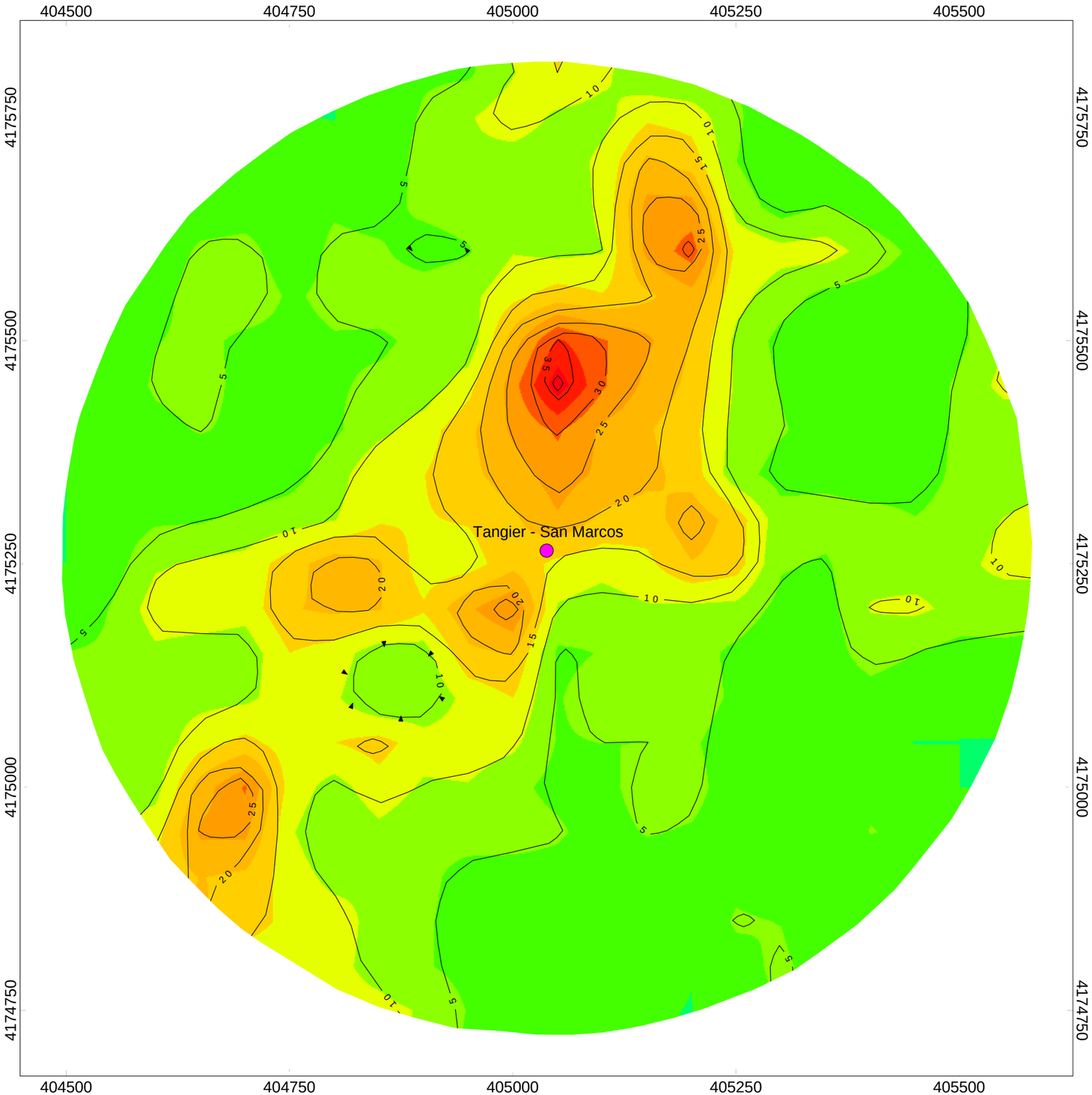
3Dgeophysics.com

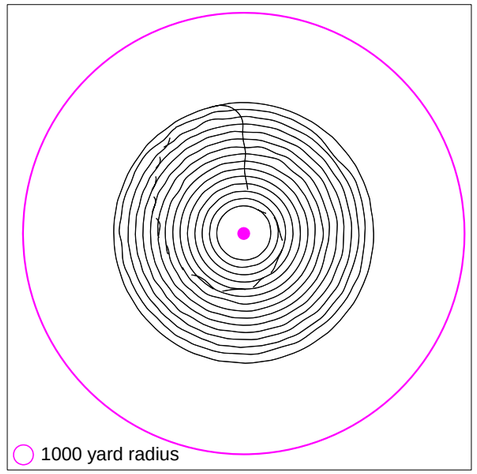
Client: CH2M HILL

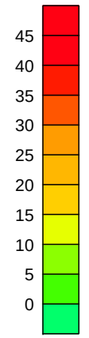
EM61-Flex 3
Side Scan Sonar with Selected DGM Targets
Tangier San Marcos Target Site
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/21/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard

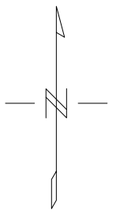






Legend

Site Target



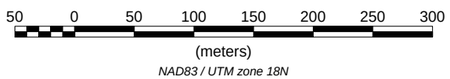
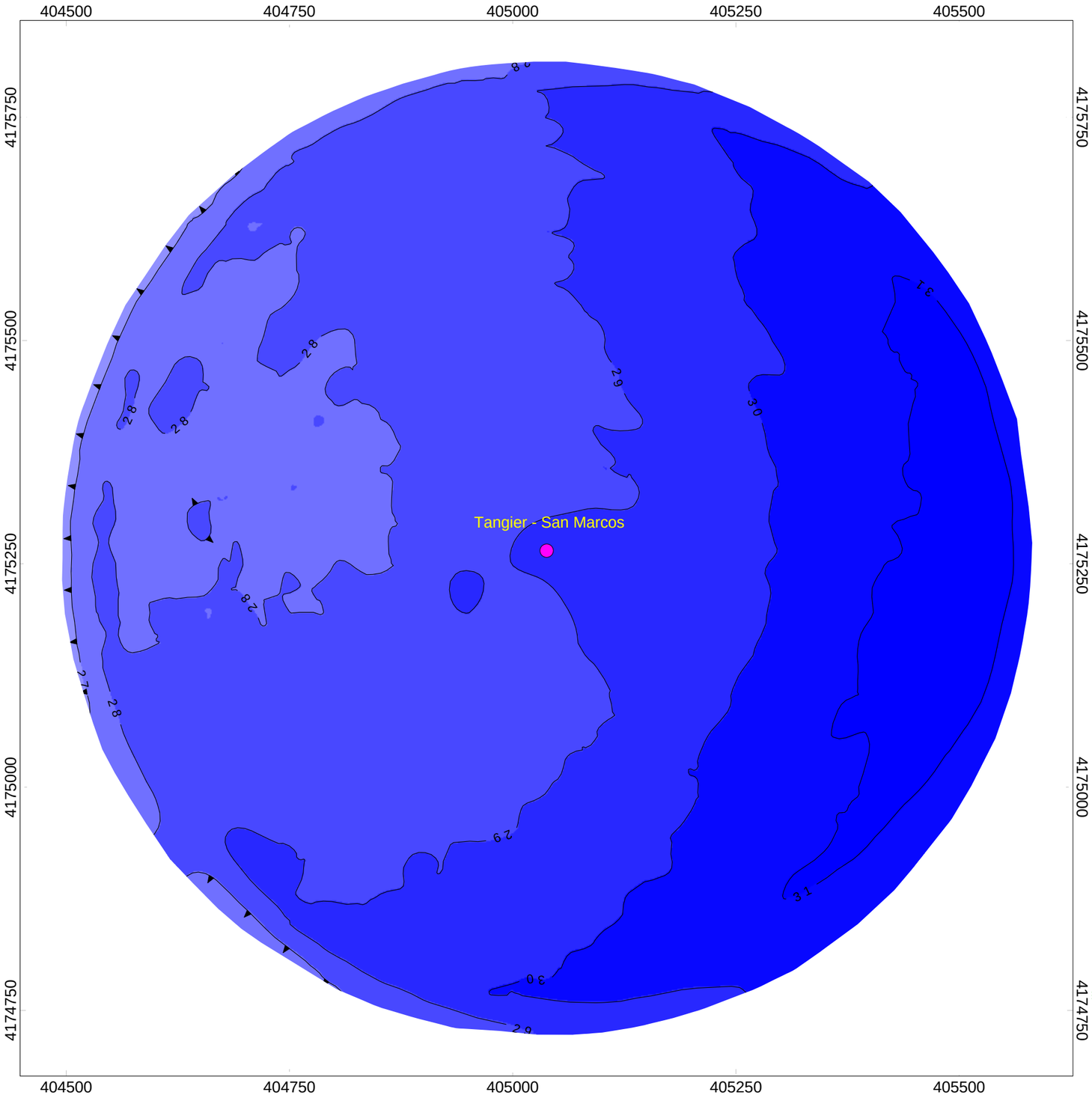


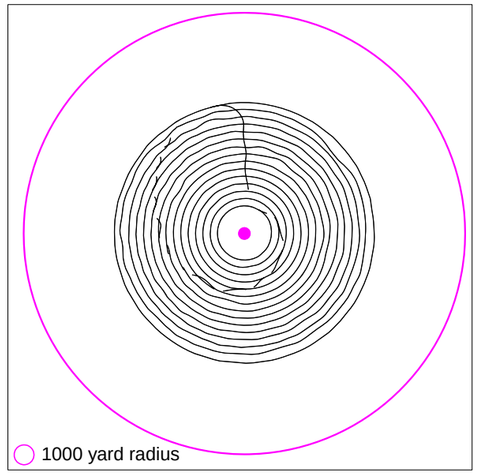
Figure 20

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

3Dgeophysics.com

Client: CH2M HILL
EM61-Flex 3 VSP Calculated Anomaly Density Tangier San Marcos Target Site Other-Than-Operational Ranges - NAS Oceana Virginia Beach, Virginia
Date of Survey: 09/21/2010 Date of Map Creation: 09/27/2010
Map Approver: J. Guillard

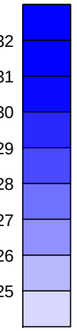




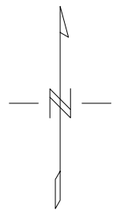
Legend

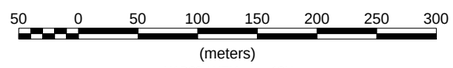
Site Target

NOTE: Depths are interpolated between the transect lines.



Depth
Feet





NAD83 / UTM zone 18N

Figure 21

NAEVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

3Dgeophysics.com

Client: CH2M HILL

Humminbird 997c SI Combo
Bathymetric Mosaic
Tangier San Marcos Target Site
Other-Than-Operational Ranges - NAS Oceana
Virginia Beach, Virginia

Date of Survey: 09/21/2010
Date of Map Creation: 09/27/2010

Map Approver: J. Guillard

Figure 22: Example of IVS object

APPENDIX A

Summary of IVS Results

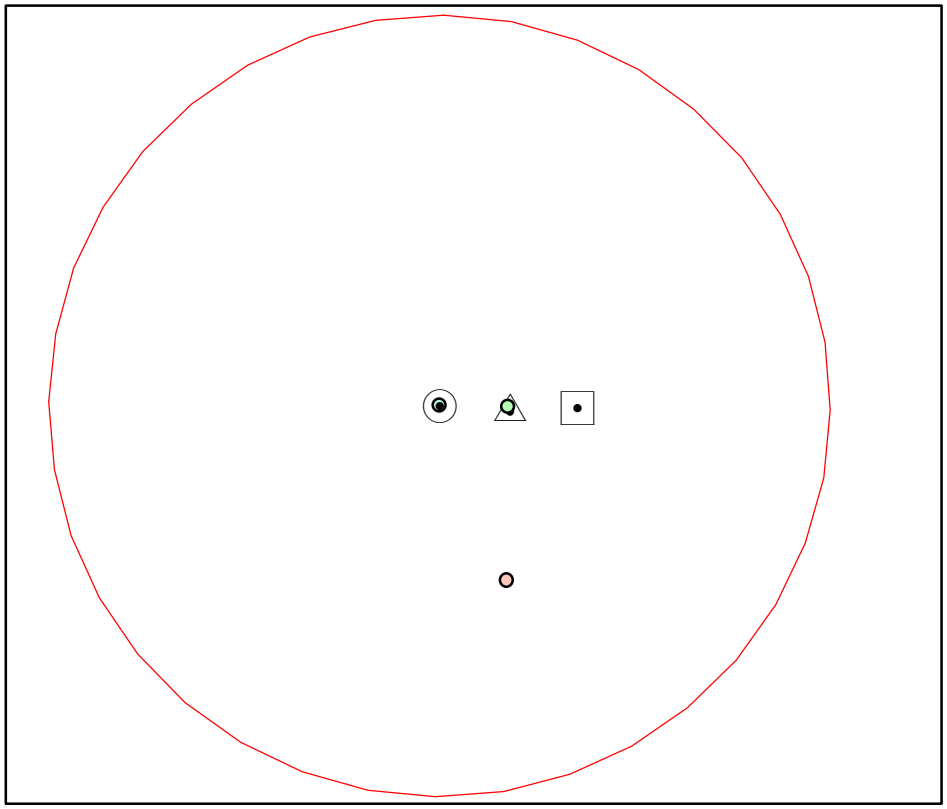
Date / File Name	X_UTM	Y_UTM	Coil_Height (ft)	ChL_mV	Offset from idealized seed location	Pass/Fail Based on 3m radius	Latency (sec)	Comments
0913IVS - Pass 5	412314.40	4185368.20	2.05	47.20	0.58	Pass	0.50	Pass 1 was not over item but did pick it up. Pass 2 ,3 &4 not over item
0915IVS - Pass 2	412314.80	4185368.00	2.2	127.90	0.23	Pass	0.50	
0918IVS - Pass 2	412314.60	4185368.20	1.84	161.60	0.38	Pass	0.50	Pass 1 not over item
0919IVS - Pass 1	412314.80	4185368.80	1.68	109.60	0.68	Pass	0.50	
0921IVS - Pass 2	412315.00	4185368.60	1.92	60.00	0.46	Pass	0.50	Pass 1 not over item
0923IVS - Pass 3	412315.20	4185368.20	1.6	62.50	0.23	Pass	0.50	Passes 1, 2, 5 not over item. Pass 4 farther from item. Used pass 3 only.

APPENDIX B

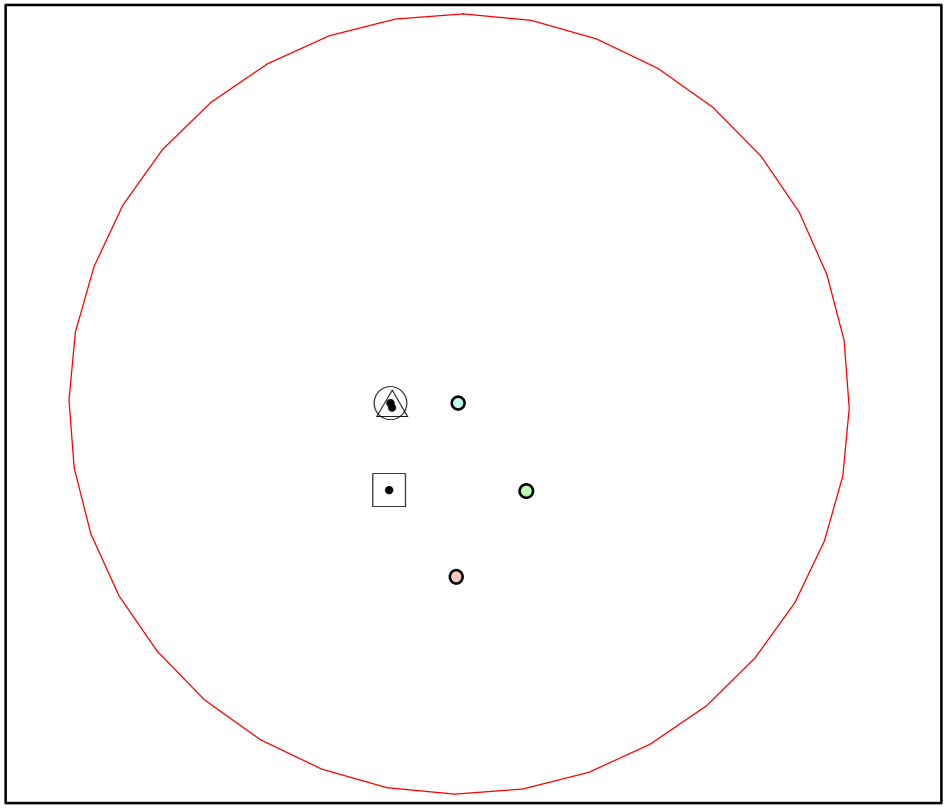
Summary of GPS QC Check Results

ID	GPS Location	X UTM	Y UTM	Offset Distance	Average	Comments
gps_091310	bow	412497.2074	4187406.2798		0.019	1st point at location, used as control
gps_091510		412497.2074	4187406.2798	0.000		
gps_091810		412497.2247	4187406.2574	0.028		
gps_091910		412497.2250	4187406.2796	0.018		
gps_092110		412497.2426	4187406.2794	0.035		
gps_092310		412497.2250	4187406.2796	0.018		
gps_091310	stern	412501.4852	4187412.9366		0.024	1st point at location, used as control
gps_091510		412501.4674	4187412.9146	0.028		
gps_091810		412501.4848	4187412.8922	0.044		
gps_091910		412501.4679	4187412.9590	0.028		
gps_092110		412501.4674	4187412.9146	0.028		
gps_092310		412501.5026	4187412.9142	0.028		

Bow GPS



Stern GPS



0 2.5 5 10

Centimeters

Legend

- gps_091310
- gps_091510
- gps_091810
- gps_091910
- gps_092110
- gps_092310
- 10cm Max Offset

N

NAEVA GEOPHYSICS INC.

THE LEADER IN SUBSURFACE DETECTION

Subsurface Geophysical Surveys

3Dgeophysics.com

Daily GPS Quality Control Check
Tangier Island Target Site
Other-Than-Operational Ranges - NAS Oceana
Date of Survey: 09/13/2010 - 09/23/2010
Date of Map Creation: 10/08/2010

Summary of Static Test Results

File name / Date	Coil 1 Response (ChL)	Coil 1 Percentage	Coil 2 Response (ChL)	Coil 2 Percentage	Pass/Fail Coil1	Pass/Fail Coil2	Pass/Fail ALL	Comments
0913QC1	1224.93	0%	1368.34	0%				Test done on the water with different test item (Large Clamp)
0913QC2	1160.99	5%	1334.58	2%	Pass	Pass	Pass	Test done on the water with different test item (Large Clamp)
0915QC1	1532.85	0%	1643.07	0%				Test done on the water with new placement of test item (Large Clamp)
0915QC2	1460.08	5%	1534.96	7%	Pass	Pass	Pass	Test done on the water with new placement of test item (Large Clamp)
0918QC1	1496.93	2%	1777.00	8%	Pass	Pass	Pass	Test done on the water with new placement of test item (Large Clamp)
0919QC1	1564.08	2%	1748.95	6%	Pass	Pass	Pass	Test done on the water with new placement of test item (Large Clamp)
0921QC1	1517.41	1%	1734.54	6%	Pass	Pass	Pass	Test done on the water with new placement of test item (Large Clamp)
0923QC1	1400.24	9%	1490.72	9%	Pass	Pass	Pass	Test done on the water with new placement of test item (Large Clamp)
0923QC2	1297.09	15%	1436.34	13%	Pass	Pass	Pass	Test done on the water with new placement of test item (Large Clamp)

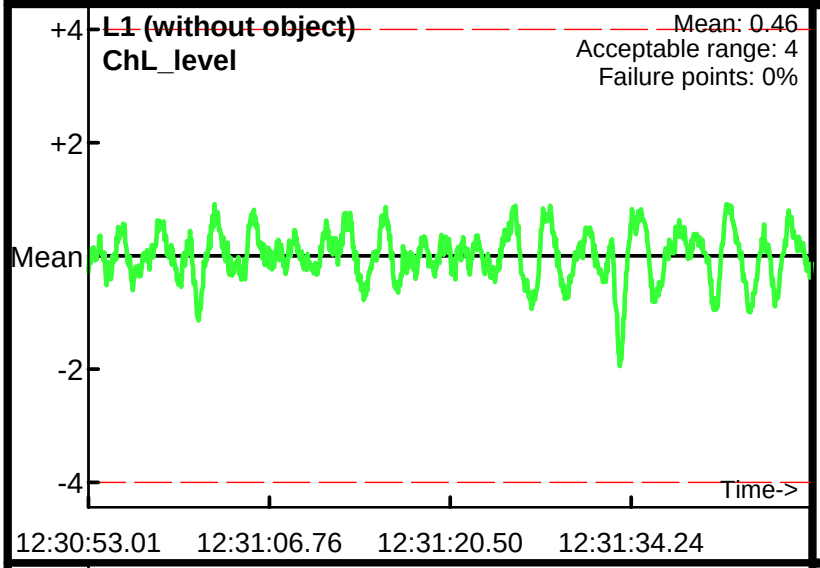
Static Calibration Test

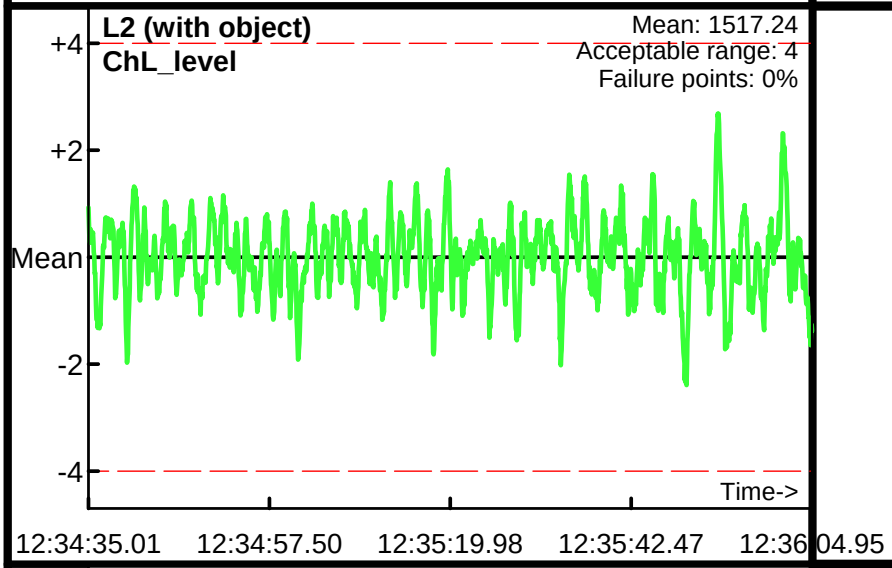
Mean Response Values
ChL_Level Without Object: -0.17
ChL_Level Signal Strength With Object: 1517.41

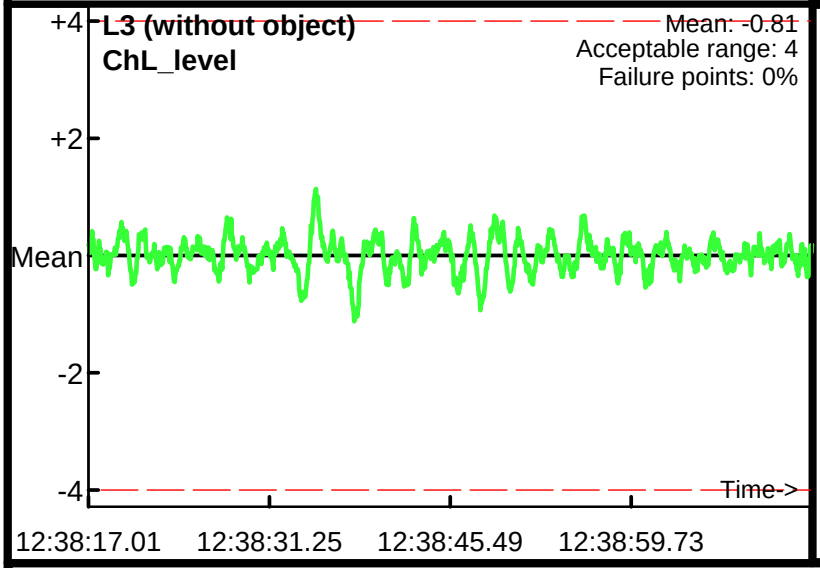
Project: NAS Oceana
Equipment: EM-61 FLEX 3
Grid/Location: Tangier Island Target Site

Outside range
Acceptable limits

QC1 Coil 1 Test
Operator: Geo1
Date: 9/21/2010







Database: \0921QC1.gdb
Line Name: L1 L2 L3

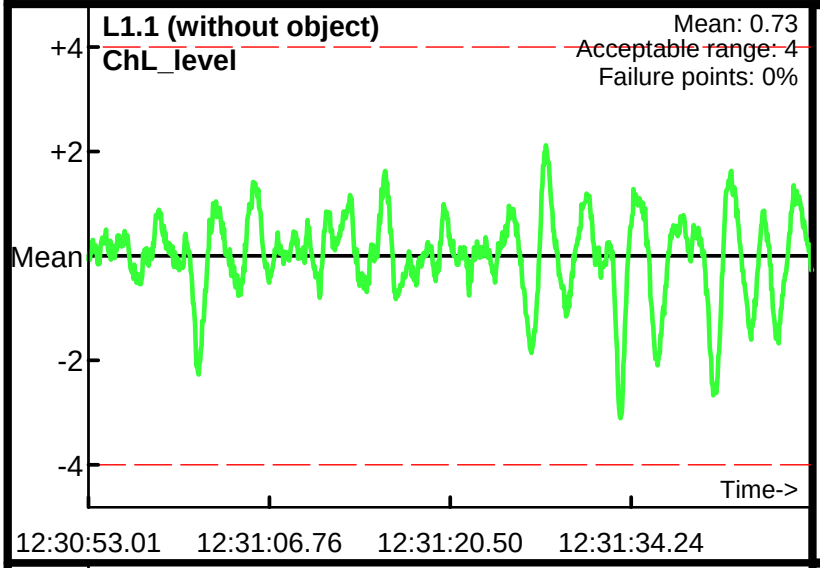
Static Calibration Test

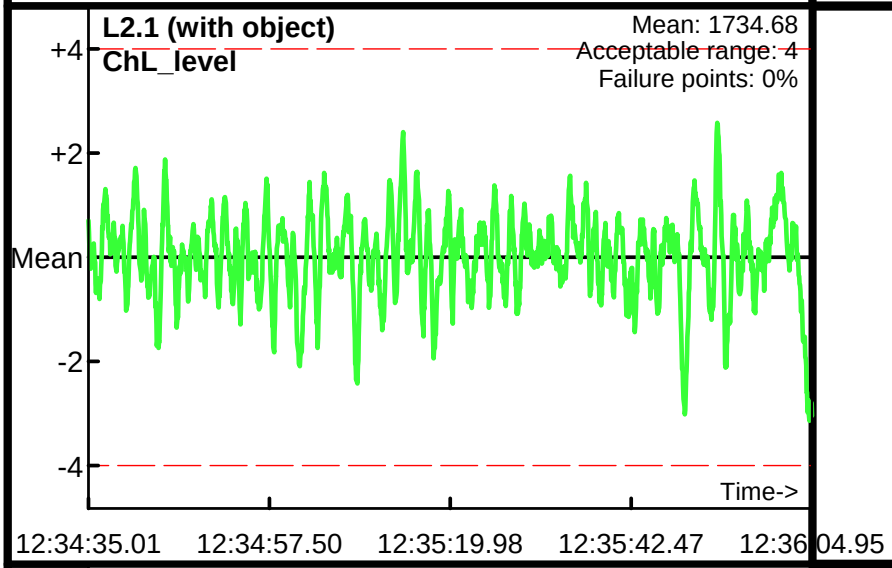
Mean Response Values
ChL_Level Without Object: 0.14
ChL_Level Signal Strength With Object: 1734.54

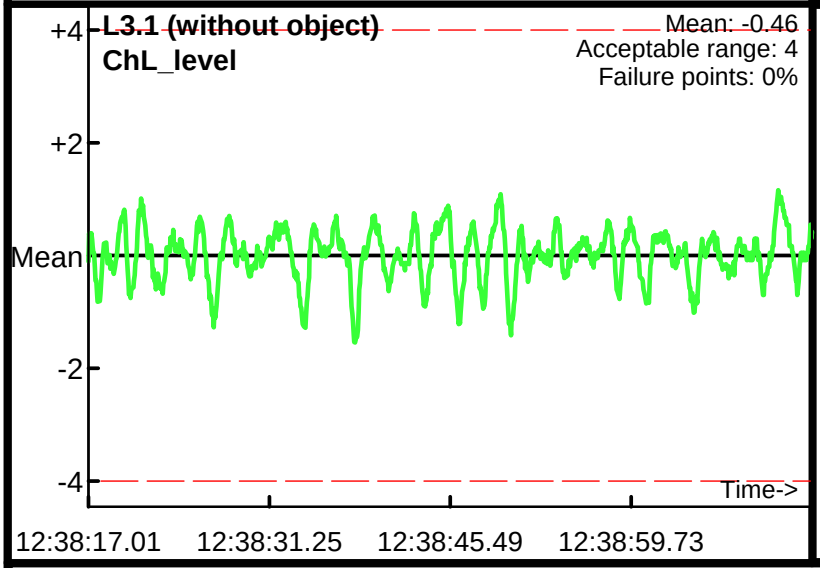
Project: NAS Oceana
Equipment: EM-61 FLEX 3
Grid/Location: Tangier Island Target Site

Outside range
Acceptable limits

QC1 Coil 2 Test
Operator: Geo1
Date: 9/21/2010







Database: .\0921QC1.gdb
Line Name: L1.1 L2.1 L3.1

Summary of Pressure Test Results

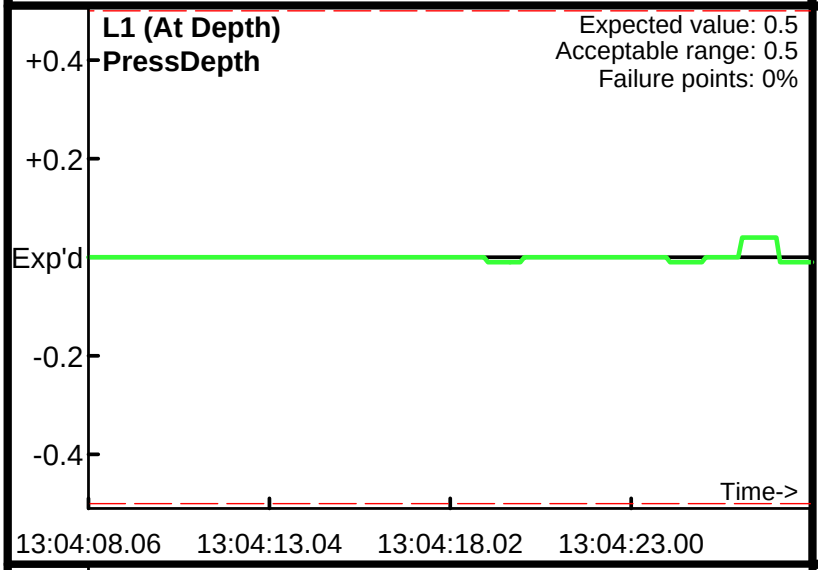
File name / Date	Coil 1 Depth 1	Coil 2 Depth 1	Coil 1 Depth 2	Coil 2 Depth 2	Coil 1 Pass/Fail	Coil 2 Pass/Fail	Comments
0913Pres	0.50	0.50	4.10	4.10	Pass	Pass	within 6in of 4.4 ft
0915Pres	0.47	0.47	4.05	4.05	Pass	Pass	within 6in of 4.4 ft
0918Pres	0.42	0.42	4.08	4.08	Pass	Pass	within 6in of 4.4 ft
0919Pres	0.45	0.45	4.08	4.08	Pass	Pass	within 6in of 4.4 ft
0921Pres	0.45	0.45	4.11	4.11	Pass	Pass	within 6in of 4.4 ft
0923Pres	0.54	0.54	4.13	4.13	Pass	Pass	within 6in of 4.4 ft

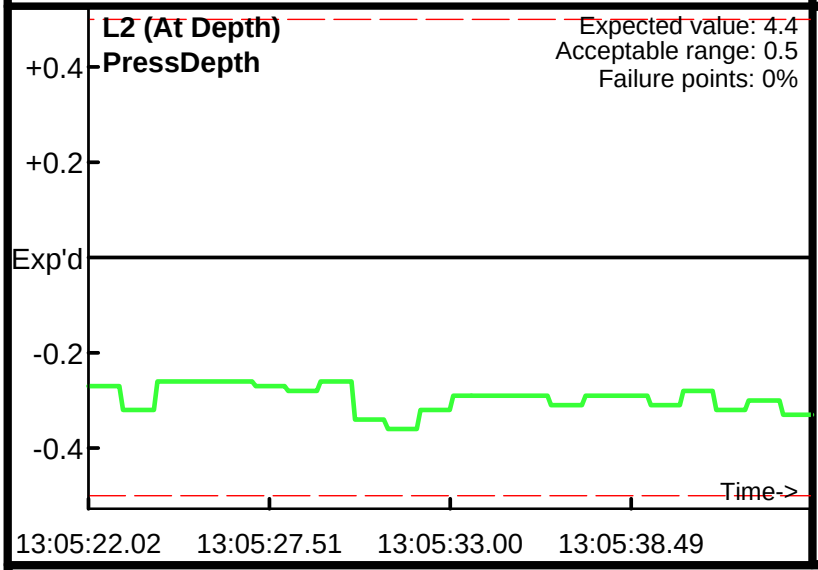
Static Calibration Test

Project: NAS Oceana
Equipment: EM-61 FLEX 3
Grid/Location: Tangier Island Target Site

Outside range
Acceptable limits

QC Coil 1 test
Operator: Geo1
Date: 9/13/2010





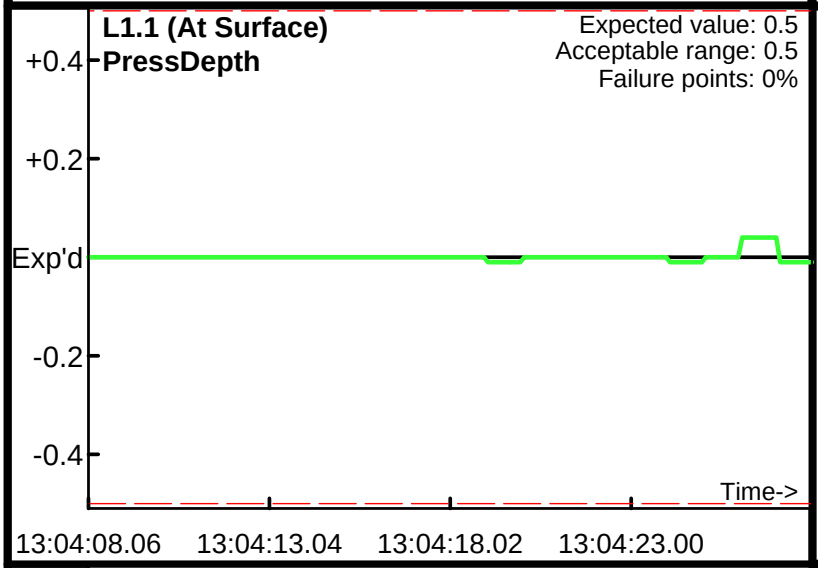
Database: \0913Pres.gdb
Line Name: L1 L1 L2

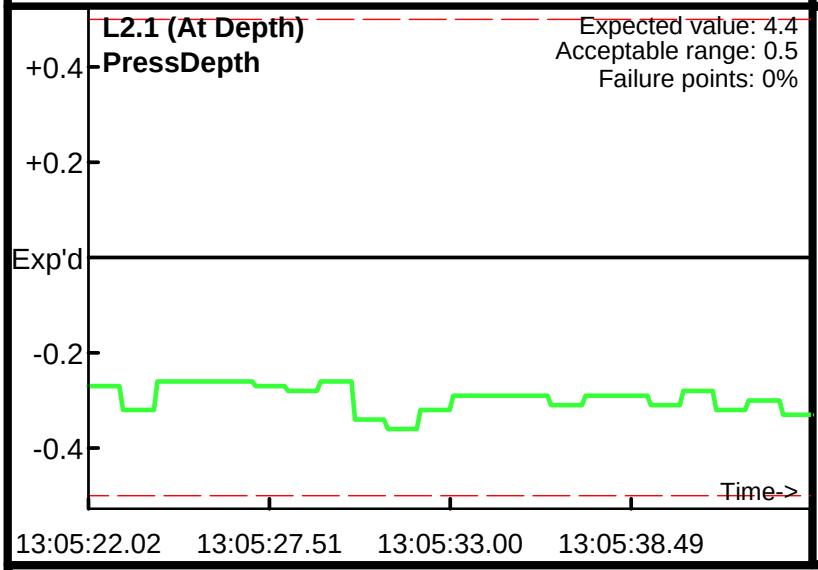
Pressure Test

Project: NAS Oceana
Equipment: EM-61 FLEX 3
Grid/Location: Tangier Island Target Site

Outside range
Acceptable limits

QC Coil 2 test
Operator: Geo1
Date: 9/13/2010





Database: \0913Pres.gdb
Line Name: L1.1 L1.1 L2.1