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CH2MHILL

October 10, 2001

Rick Urbanski
Commanding Officer
Naval Ordnance Safety and Security Activity
23 Strauss Ave.
Indian Head, MD 20640

Dear Mr. Urbanski:

On behalf of LANTDIV attached please find the responses to NOSSA's comments on the Draft Ordnance and Explosives (OE) Site Specific Work Plan for SWMU 4 at the Former U.S. Naval Ammunition Support Detachment, Vieques Island, Puerto Rico.

If the responses are satisfactory, please respond as such in writing and we will distribute the Final Site Specific OE Work Plan .

If you have any questions or comments, please feel free to call me at (813) 874-6522 ext. 4307 or Chris Penny at (757) 322-4815.

Sincerely,

Marty Clasen
Project Manager

Christopher Penny/LANTDIV
Madeline Rivera/NSRR
BenRedmond/CH2M HILL
George Overby/CH2M HILL
Felix Lopez/DOI
John Tomik/CH2M HILL

RESPONSES TO NOSSA'S COMMENTS ON DRAFT ORDNANCE AND EXPLOSIVES (EO) SITE SPECIFIC WORK PLAN for SWMU 4 – Former NASD, VIEQUES, PUERTO RICO

COMMENT:

1. General Comment: The Site Specific Work Plan needs to have more detailed information on site topography, vegetation patterns, brush clearing methods, and geophysical detection methods.

RESPONSE:
The requested information has been added to the appropriate sections. A more detailed description of the site topography and vegetation patterns has been added to Section 1.1. Detailed brush clearing methods have been added to Section 2.2.4 and a detailed description of the geophysical detection methods has been added to Section 5. Revised sections are included in Attachment A.

COMMENT:

2. Pg. 1-6, second line: "the area was swept"... "by a team from" NSRR, not NASD.

RESPONSE:
The text has been revised to incorporate the requested change and the revised section is included in Attachment A.

COMMENT:

3. Pg. 1-7, Section 1.2.3, second paragraph: Add a footnote at the bottom of the page to reference the Phase I PA/SI Report.

RESPONSE:
The Phase I PA/SI Report is already referenced properly in the paragraph as (CH2M HILL, October 2000). A footnote is not required.

COMMENT:

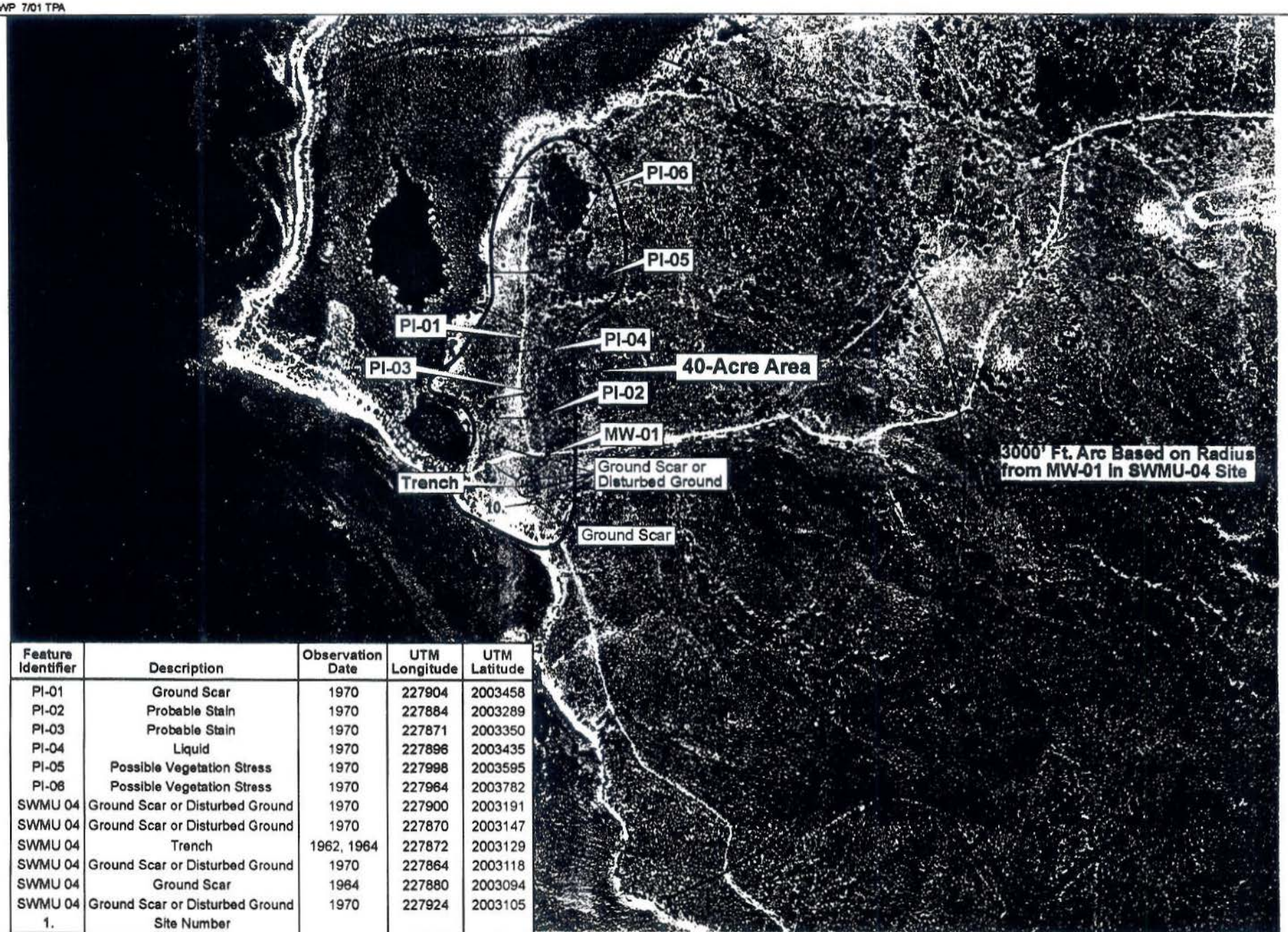
4. Figure 1-3: The 10 areas of investigation are not distinguished on the photograph.

RESPONSE:

Figure 1-3 has been revised to clearly show the 10 areas of investigation. Twelve anomalies are shown on the photograph, but the 3 anomalies (including 2 ground scars and a trench in between) have been combined into one site, making a total of 10 sites. The revised figure is included in Attachment A.

COMMENT:

5. Page 2-5, Section 2.1.2, fourth paragraph: Add a sentence referring to what will happen if the UXO found is not safe to move.



Feature Identifier	Description	Observation Date	UTM Longitude	UTM Latitude
PI-01	Ground Scar	1970	227904	2003458
PI-02	Probable Stain	1970	227884	2003289
PI-03	Probable Stain	1970	227871	2003350
PI-04	Liquid	1970	227896	2003435
PI-05	Possible Vegetation Stress	1970	227998	2003595
PI-06	Possible Vegetation Stress	1970	227964	2003782
SWMU 04	Ground Scar or Disturbed Ground	1970	227900	2003191
SWMU 04	Ground Scar or Disturbed Ground	1970	227870	2003147
SWMU 04	Trench	1962, 1964	227872	2003129
SWMU 04	Ground Scar or Disturbed Ground	1970	227864	2003118
SWMU 04	Ground Scar	1964	227880	2003094
SWMU 04	Ground Scar or Disturbed Ground	1970	227924	2003105
1.	Site Number			

Aerial Photograph Date: 1967

N

Scale in Feet

0 1500 3000

Figure 1-3
Photo-Identified Ground Scar Locations
Former NASD, Vieques Island, Puerto Rico

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RESPONSE:

If the UXO found is not safe to move, it will be blown in place. If an unknown UXO item is found, the NSRR EOD team will be called for an emergency response. The NSRR EOD team will determine the course of action for an unknown item. The revised paragraph is included in Attachment A.

COMMENT:

6. Page 2-5, Section 2.1.2, fourth paragraph: Change USA EOD to USA Environmental UXO (USA EOD could be misconstrued as US Army and subcontractors are designated UXO, not EOD). Make this change throughout the document.

RESPONSE:

USA EOD has been changed to USA Environmental throughout the document.

COMMENT:

7. Figure 2-3: Add a block under Magnetometry Survey showing "Data Reviewed by Geophysicist". Under Blow In Place block, use correct radius distances from OP 5. Change Construct Containing Structure block to "Based on MPM, Sand Bags Placed Around Item".

RESPONSE:

Figure 2-3 has been revised to include the above changes and is included in Attachment A.

COMMENT:

8. Figure 2-4: Under the block labeled Determine Exclusion Zone – Secure Area, use correct radius distances from OP 5.

RESPONSE:

Figure 2-4 has been revised to include the exclusion zone radii from OP 5. The revised figure is included in Attachment A.

COMMENT:

9. Page 2-8, Section 2.2, first paragraph: Correct the definition of OESO. OESO stands for Ordnance Environmental Support Office.

RESPONSE:

OESO has been changed to Ordnance Environmental Support Office. The revised section is included in Attachment A.

COMMENT:

10. Page 2-8, Table 2-1: Change the Site Approach section to indicate that approximately 10% of the demarcated 200 acre area will have 100% geophysical coverage. Delete the reference to statistical sampling in the Sampling Methodology section.

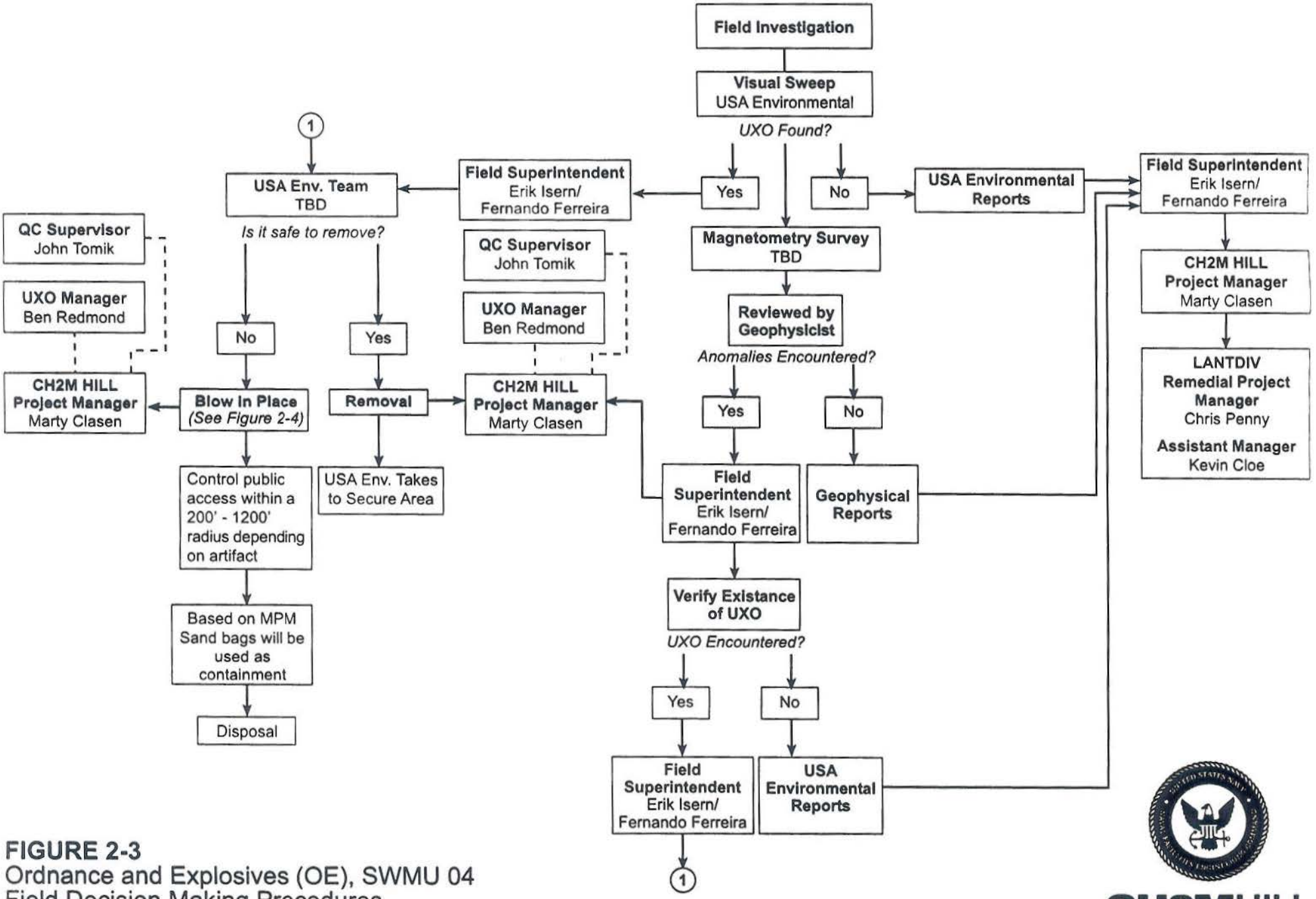

FIGURE 2-3
Ordnance and Explosives (OE), SWMU 04
Field Decision Making Procedures

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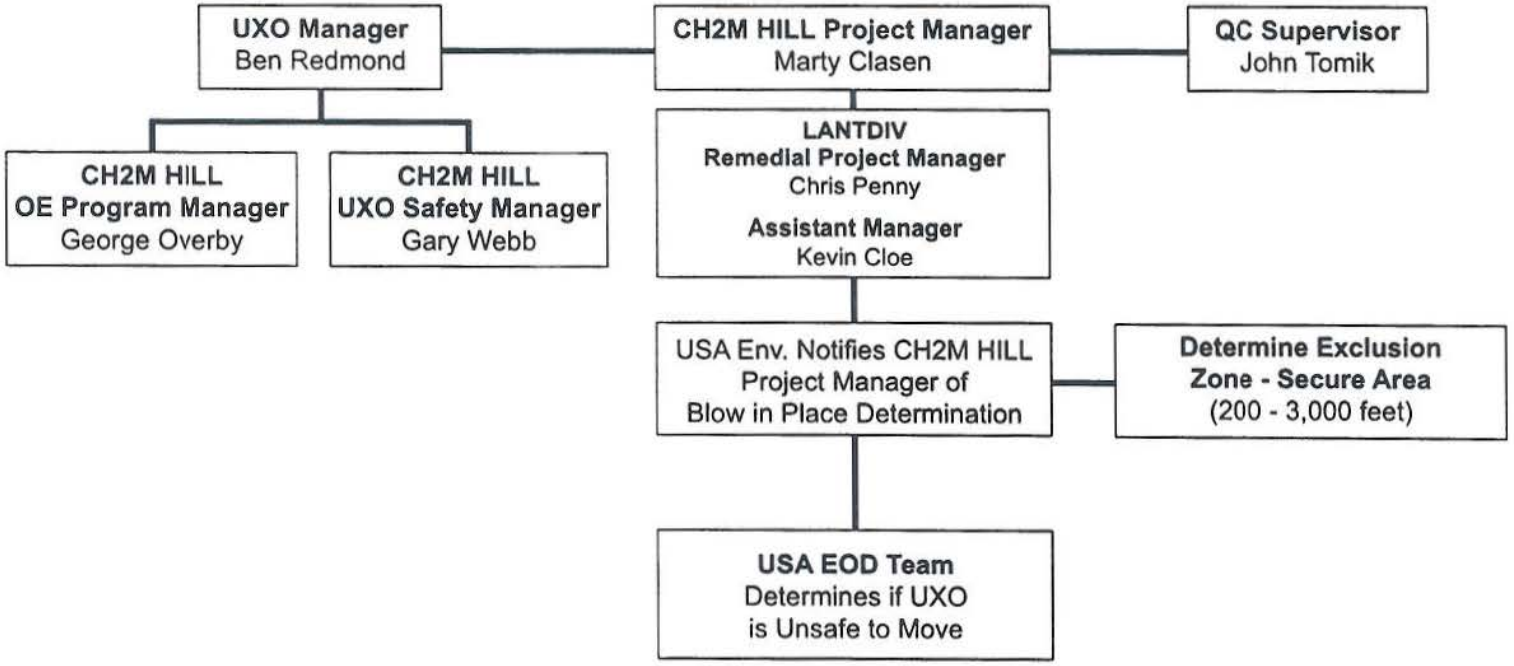

FIGURE 2-4
Ordnance and Explosives (OE)
Blow in Place Decision Tree

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RESPONSE:

The Site Approach section of Table 2-1 has been revised to indicate that approximately 10% of the site will have 100% geophysical coverage. Statistical sampling has been deleted from the Sampling Methodology section. The revised table is included in Attachment A.

COMMENT:

11. Page 2-8, Section 2.2.1, fourth bullet: Add a statement that surface clearance of UXO will be conducted before vegetation removal. Note that the investigation approach may be modified for the 10 individual sites.

RESPONSE:

The fourth bullet has been revised to show that surface clearance of UXO will occur before vegetation removal and the approach may be modified for the various sites. The revised section is included in Attachment A.

COMMENT:

12. Figure 2-5: Move office trailer to outside of fence. Show location of portable magazine and secure area for consolidated UXO storage.

RESPONSE:

Figure 2-5 has been revised. The office trailer has been moved outside of the fence and the locations of the portable magazine and UXO storage are shown. The revised figure is included in Attachment A.

COMMENT:

13. Page 2-11, Section 2.4.1, second paragraph: Add reference to NAVSEA OP 3565 Electromagnetic Radiation Hazards for Ordnance, listing the exact distance radios must be kept away from demolition operations.

RESPONSE:

The reference to NAVSEA OP 3565 has been added to section 2.4.1. The revised section is included in Attachment A.

COMMENT:

14. Page 2-12, Section 2.4.3: Check exclusion zone distances in OP 5. Revise if necessary.

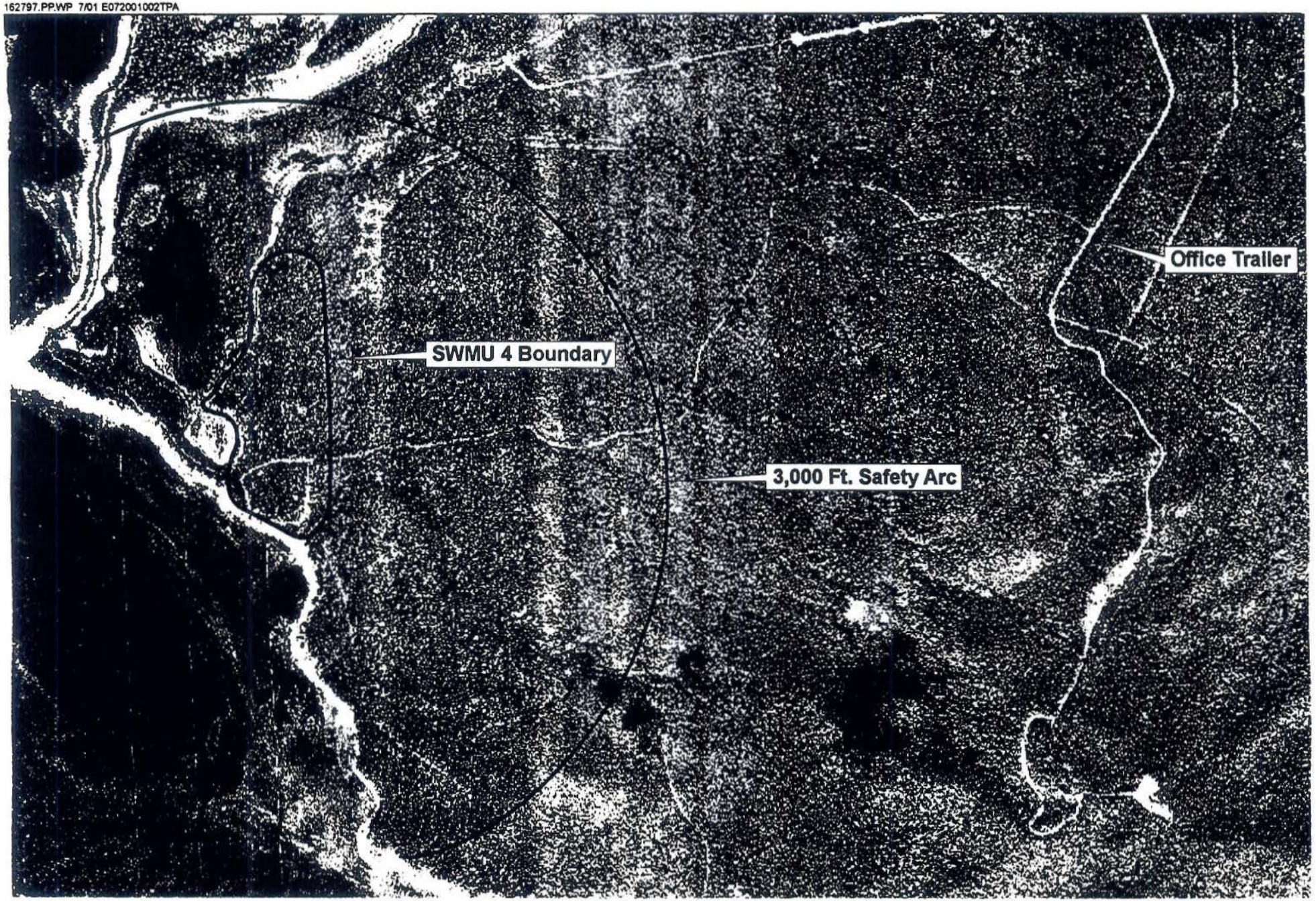
RESPONSE:

The exclusion zone distances have been verified by checking the requirements in OP 5. The revised section is included in Attachment A.

COMMENT:

15. Page 3-2, Section 3.2.1: One method of explosive storage must be chosen. Either existing magazines or portable magazines

162797.PP.WP 7/01 E072001002TPA



Aerial Photograph Date: 1994

N

Scale in Feet

0 1500 3000

Figure 2-5
Project Trailer Location
Former NASD, Vieques Island, Puerto Rico

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RESPONSE:

The method of explosives storage will be portable magazines. The potable magazines will be located at Earth Covered Magazine 229. The revised section 3.2.1 is included in Attachment A.

COMMENT:

16. Page 6-1, Section 6.1.1: Site topography section only discusses regional topography of Vieques. A detailed discussion of the topography of SWMU-4 should be added to this section.

RESPONSE:

A more detailed description of the SWMU-4 site topography has been added to section 6.1.1. The revised section is included in Attachment A.

COMMENT:

17. Page 6-15: Delete the section titled "Preventing and Treating Cold Stress" since it does not apply to Vieques.

RESPONSE:

The section titled "Preventing and Treating Cold Stress" has been deleted from Section 6..

COMMENT:

18. Page 6-15, Section 6.4.3.10: Delete this section (Compressed Gas Cylinders) since it does not apply to the work at SWMU-4.

RESPONSE:

Section 6.4.3.10 has been deleted from the document

COMMENT:

19. Page 6-21, Section 6.4.3.20 Contaminants of Concern: Many parameters exceed screening criteria. Are more stringent personal protection methods required for this project?

RESPONSE:

The screening levels are very conservative. The screening numbers are risk-based and assume long-term exposure. The exposure risk to onsite chemicals of concern is very low and the personal protection equipment presented in the Health and Safety Plan is appropriate. Section 6.4.3.20 has been revised to provide more detail about the screening criteria. The revised section is included in Attachment A.

Attachment A – Text Revisions

COMMENT:

1. General Comment: The Site Specific Work Plan needs to have more detailed information on site topography, vegetation patterns, brush clearing methods, and geophysical detection methods.

Revised Section 1.1

The former OB/OD area at SWMU-4 is described as 200 yards wide by 0.5 miles long, or 36.4 acres (approximately 40 acres). The OB/OD area extended along the western shore of Vieques south of Punta Boca Quebrada. Previous investigations in June of 2000 indicated that UXO projectiles most likely "kicked out" from OB/OD operations, extended approximately 2,000 feet east of the center point of the 40 acre site. A buffer zone of 1,000 feet was added to this distance and an arc with a radius of 3,000 feet was inscribed to define an area to be fenced off. The 3,000 foot arc comprises an area of approximately 400 acres. The 2,000 foot arc comprises an area of approximately 200 acres. The SWMU-4 site (area with known UXO items from OB/OD operations) encompasses approximately 200 acres. The entire demarcated area including a 1,000 foot buffer zone is approximately 400 acres. Figures 1-1 and 1-2 present the location of the Former NASD and the location of SWMU 4 in relation to the Former NASD, respectively.

Land surface elevations in the SWMU-4 area range from sea level to approximately 150 feet above mean sea level. The southern portion of the site borders the flanks of Mt. Pirata and has the highest elevation (150 feet). The northern part of the site extends into a salt water lagoon near Punta Boca Quebrada and has the lowest elevations (mean sea level). The main OB/OD 40 acre area is relatively flat, except where a quebrada (drainage area that is dry except during storm events) cuts through the southern end of the site. The 40 acre area ranges in elevation from sea level to approximately 50 feet above sea level.

The majority of SWMU 4 has a dense shrub canopy of thorny shrubs and a sacttered herbaceous stratum. The total vegetative cover was approximately 75-95 percent. Dominant shrubs identified on the site included Acacia farnenciana, Prosopis glandulosa, Pithlcellobium dulce, and Zanthoxylum brevipes. Another co-dominant shrub was Leucaena leucocephala. The herbaceous stratum was dominated by Bothriochloa ischaemum, Commelina erecta, C. diffusa, and Lasiacis divaricata. No endangered or threatened plant species were observed during the field survey.

Revised Section 2.2.4

The method of vegetation removal on SWMU 4 will be mechanical removal using Timberline equipment and the Standard Manual Vegetation Clearance as indicated in Section 2.2.8 of the OE Master Work Plan. Any restrictions on vegetation removal activities will be reviewed by the DoI as the local environmental authority.

Because SWMU-4 is heavily vegetated, some degree of manual vegetation clearing is anticipated to be required prior to conducting geophysical surveys or anomaly excavation operations. Site clearing operations will be completed prior to start up of activities to avoid time delays in conducting UXO geophysical survey efforts.

Team Composition. The basic vegetation removal team consists of an UXO Technician III and a UXO Technician II. The basic UXO team can be augmented with up to five non-UXO-qualified laborers for hand cutting vegetation. The laborers will use hand tools that are appropriate to the

vegetation being cut, such as chain saws, heavy-duty power weed whackers, and machetes to cut the vegetation.

Initial Sweep. As the first step, the UXO technicians will carefully inspect all areas of the grid ahead of the laborers with the aid of Schonstedt GA-52CX magnetometers (or equivalent). The UXO Technicians will mark any UXO or other hazards by encircling the hazard with flagging tape. The laborers will be instructed to avoid working in designated areas. If UXO is discovered on the surface, mechanical equipment will not be used unless the area can first be effectively swept of all surface UXO.

Vegetation Disposal. The cut vegetation will be mulched in place using the Timberline equipment. A typical method of vegetation disposal is chipping the vegetation into mulch, which is then spread over the cleared area to serve as seeding of native plants, ground cover, and soil nutrient. If a significant amount of poison oak is present, chipping will not be performed.

Grass and Brush Clearance. Grass or brush clearance will be accomplished with gas-powered string trimmers with saw blade attachments, or where appropriate, a tractor equipped with a bush hog mower. The brush will be cut to a height of no greater than 6 inches above ground surface to eliminate interference with UXO detection or survey activities.

Tree Trimming or Removal. Trees will be trimmed or removed on a case-by-case basis and only as required to accomplish the project tasks in the scope of work (SOW). If removal is required, the tree will be cut using chain saws. The tree will be sectioned, if necessary, to remove it from the immediate area, so it does not interfere with OE/UXO detection or survey activities. Qualified CH2M HILL ecologists will conduct a site reconnaissance of the proposed work area prior to tree trimming or removal activities to identify and flag any biota that may be a Federally protected species. CH2M HILL will use responsible judgement to avoid cutting trees larger than 3 inches in diameter unless absolutely necessary, and to avoid removal of hardwoods if possible. Trees will be felled into an area that has already been surface swept for UXO.

Safety Hazards. Appropriate Personal Protection Equipment (PPE) will be worn according to Section 6, Site Safety and Health Plan. Certain vegetation, such as small-diameter trees and solid stalk plants, will be cut parallel to the ground and as close to the ground as possible to avoid impaling hazards in the event that someone fell on the remaining stalk.

The vegetation that is removed will be either mulched in place or placed in a staging area or clearing where it will be mulched or chipped. When the survey is completed, the mulch will be spread, via mechanical means, over the entire cleared area as a ground cover. Special considerations will be taken to protect the habitats of the nesting turtles and the Cobana Negra tree as specified in Section 10, Environmental Protection Plan, of the OE Draft Final Master Work Plan.

Revised Section 5

5.1 Geophysical Investigation Methods

5.1.1 Equipment

The geophysical survey will be a critical component of the assessment at SWMU-4 since the site presents unique challenges due to differences in target type, target depth, physical setting, and background.

5.1.1.1 Geophysical Sensors

Two types of geophysical sensor technologies will be used for locating OE at SWMU-4 and fall into two categories: electromagnetic instruments and magnetometers. Commonly accepted technologies and instruments in these two classes are discussed in Table 5-1. These instruments and their applications are discussed below.

Time Domain Electromagnetics. *Time-domain electromagnetic metal detectors, such as the Geonics EM-61 device, are designed to detect shallow ferrous and non-ferrous metallic objects with very good spatial resolution and with minimal interference from adjacent metallic features. An EM transmitter generates a pulsed primary magnetic field in the earth, which induces eddy currents in nearby metallic objects. The eddy current decay produces a secondary magnetic field measured by the receiver coil of the EM-61. By taking the measurement at a relatively long time after the start of the decay, the current induced in the ground*

TABLE 5-1
Geophysical Detection Technologies and Instruments

Technology Type	Example Instruments	Data Collection Mode
Electromagnetic Instruments:		
Time-Domain Electromagnetic (TDEM)	Geonics Model EM-61 Geonics Model EM-61 Hand-held (HH) Geonics Model EM-63	Digital
Magnetometers:		
Total Field Cesium Vapor Magnetometer (TFM)	Geometrics Model G-858	Digital
Flux Gate Gradiometer (FGM)	Schonstedt Model GA-52/CX	Analog audio
Vector Gradiometer (VGM)	SENSYS MX Compact	Digital

has fully dissipated and only the current in the metal is still producing a secondary field. The responses are recorded and displayed by an integrated data logger.

The system consists of two air-cored, 1-m square coils. Secondary voltages induced in both coils are measured in mV. The coils are stacked 40 cm apart, with the source/receiver coil ("B" – bottom coil) located below a second receiver coil ("T" – top coil). The EM-61 records a voltage output from both coils (Channel B and Channel T data), as well as a differential (Channel D) that is the calculated voltage difference between the two coils. The bottom coil data is generally most useful for detecting ordnance-size buried metallic objects. Three modes of operation are available: (1) trailer mode, in which the coils are carried on a wheeled cart; (2) harness mode, in which the operator carries the coils on a shoulder harness; and (3) array mode, whereby two coil systems are ganged into an array for high-productivity coverage. The electronics, battery, and an integrated data logger are carried in a small operator backpack.

Spatial positioning of the EM-61 data can be achieved in four separate ways: via GPS, ultrasonics, tick-wheel, or fiducial marks. GPS is the primary navigation choice, and is used when the EM-61 is deployed in the trailer mode or array mode. Once-per-second GPS coordinates are logged that capture

the location of the GPS antenna co-located at the center of the EM-61 coil. When GPS is not practicable, an internal survey tick-wheel can be used for both trailer and array mode. In this case, the distances along profile lines are recorded as the sensor(s) are moved forward. Tick-wheels are appropriate as a backup to GPS or when GPS technology is adversely affected by local vegetation/topographic conditions. Navigation via fiducial time marks can be utilized when the EM-61 is deployed in a harness mode while the EM-61 data are recorded at fixed time intervals. In wooded conditions where GPS, tick wheels, and fiducial methods are not practicable, ultrasonic techniques provided via the USRADS technology are utilized, as discussed below.

The EM-61HH, similar to the EM-61, is a time domain electromagnetic metal detector that uses a single transmitter coil and a single receiver coil. The coils are 18.5 cm in diameter and are located approximately 6 inches above the ground surface, when mounted on the wheel assembly. The EM-61HH can be operated with or without the wheel. Without wheels, the detector is used in a sweeping mode in front of the operator where the detector collects readings at automatic time rates. With the wheel assembly, the operators push the detector in a more controlled in-line operation and position the data via a tick-wheel. In the wheel mode, the data collection rate can be adjusted to collect readings at every 0.1 m or 0.2 m. The EM-61HH records two-time integrated voltage responses, one at an early time and one at a late time during the decay of the secondary magnetic field. The late time data is advantageous for eliminating responses from very small metallic objects, because their signal will decay in time beyond detection. In general, because of the coil size and design of the instrument, the EM-61HH's near-surface sensitivity to small shallow objects is greater than that of the EM-61, and for larger items at depth it is less. The EM-61HH requires closer survey line spacing than the EM-61 to achieve similar coverage. The line spacing for the Em-61HH should be between 1 to 2 ft, depending on the size of the suspected targets. The line spacing would be the only operational change with regard to the grid layout. The functions of the EM61-HH for data collection and data output are identical to the EM-61.

Total Field Magnetometry. *Total field magnetic surveys utilize Geometrics Inc. G-858G magnetometers for survey data acquisition and a G-856AX magnetometer for base station measurements. The G-858G, which is an optically pumped cesium vapor instrument, measures the intensity of the earth's magnetic field in nanoTeslas (nT). During operation of the magnetometer, a direct current is used to generate a polarized monochromatic light. Absorption of the light occurs within the naturally precessing cesium atoms found in the instrument's two vapor cells. When absorption is complete, the precessing atoms become a transfer mechanism between light and a transverse radio-frequency (RF) field at a specific frequency of light known as the Larmor frequency. The light intensity is used to monitor the precession and adjusts the RF frequency allowing for the determination of the magnetic field intensity.*

The earth's magnetic field, believed to originate in currents in the earth's liquid outer core, varies in intensity from approximately 25,000 nT near the equator (where it is parallel to the earth's surface) to approximately 70,000 nT near the poles (where it is perpendicular to the earth's surface). In the United States, the intensity of the earth's magnetic field varies from approximately 48,000 to 60,000 nT, and has an associated inclination ranging from approximately 58 to 77 degrees.

Anomalies in the earth's magnetic field are caused by remnant or induced magnetism. Remnant magnetism is caused by naturally occurring magnetic materials. Induced magnetic anomalies result from the induction of a secondary magnetic field in a ferromagnetic material (such as UXO, pipelines, drums, tanks, or well casings) by the earth's magnetic field. The shape and amplitude of an induced magnetic anomaly over a ferromagnetic object depend on the geometry, size, depth, and magnetic susceptibility of the object, and on the magnitude and inclination of the earth's magnetic field in the

study area. Induced magnetic anomalies over buried objects such as drums, pipes, tanks, and buried metallic debris and UXO generally exhibit an asymmetrical, south high/north low signature (maximum amplitude on the south side and minimum on the north).

The earth's magnetic field undergoes low-frequency diurnal variations associated with the earth's rotation, generally referred to as magnetic drift. These variations have their source mainly in the ionosphere and their magnitude is large enough to introduce artificial trends in field data. A base station G-856 magnetometer is generally used to monitor and record this drift so that it can be removed from the field data during processing.

During operation of the G-856 magnetometer, direct current is applied to a coil that is wrapped around a sensor bottle filled with a hydrogen-rich fluid. The current temporarily polarizes the protons in the fluid. When the current is turned off, the protons precess about the earth's magnetic field at a frequency proportional to the total magnetic field intensity. Measurement of the precession frequency, as a voltage induced in another coil, permits the calculation of the intensity of the earth's magnetic field.

G858G magnetometers can be deployed in a variety of configuration form factors. The magnetic survey design used to conduct the geophysical investigation varies according to site-specific objectives and target sizes. Magnetometers can be deployed as sensor pairs or in multiple-sensor arrayed configuration. They can be deployed in a backpack mode where an operator carries a single G858 unit, or in a cart mode where up to 8 magnetometers can collect data simultaneously. The most appropriate deployment configuration will be determined on a site-by-site basis, as the objectives of a magnetic survey and expected results are discussed in a Site-Specific Work Plan. However, the following issues and concerns routinely will be evaluated:

- *Review existing site surface and subsurface information.*
- *Evaluate the potential influence of cultural features (e.g., utilities, fences, structures, power lines, etc.).*
- *Define most appropriate sensor configuration form-factor (backpack or cart-based).*
- *Define most appropriate sensor navigation method.*
- *Define any health and safety hazards.*

Spatial positioning of the total field magnetometer data can be achieved in three separate ways: via GPS, ultrasonics, or fiducial marks. GPS is the primary navigation choice, and is used when magnetometers are deployed in either the backpack or cart-modes. Once-per-second GPS coordinates are logged that capture the location of the GPS antenna located at the center of the magnetometer array. When GPS is not practicable, a fiducial navigation method is utilized. In this case, the distances along profile lines are determined through capture of time marks as the sensors are moved across known markers. Fiducial methods are appropriate as a backup to GPS or when GPS technology is adversely affected by local vegetation/topographic conditions. In wooded conditions where GPS and fiducial methods are not practicable, ultrasonic techniques provided via the USRADS technology are utilized.

During the survey, the operator will not carry any metal objects (e.g., steel-toe boots, belt, rings, and watches), and his/her speed will not exceed 1.5 meters per second (m/s) (approximately 5.0 ft per second (ft/s). The fiducial marker switch will be used at approximate 9-foot intervals to maintain

down-line survey control. At the end of each day, data will be downloaded into a PC, backed up on floppy and zip disks, and then supplied to the geophysicist for processing.

Schonstedt Gradiometer. *The Schonstedt GA-52 fluxgate gradiometer is a handheld analog magnetometer which detects ferrous objects and ferromagnetic minerals. The Schonstedt GA-72 fluxgate gradiometer is the same instrument as the GA-52, but with a meter display added. Both instruments provide an audible signal representing the magnitude and direction of the local magnetic field. The operator sweeps the instrument back and forth along the ground. Whenever a change (anomaly) in the magnetic field is encountered, the operator notes the change in pitch, and plants a pin flag. This type of UXO detection has therefore been referred to as Mag and Flag. The anomalous signal is the magnetometer response to a secondary magnetic field produced by buried munitions or other ferrous* metal.

Fluxgate magnetometers are sensitive to small, near-surface metallic items, which may include "hot" rocks containing magnetic mineralization. These devices have limited capability to detect targets at depth and produce no digital readings that can be archived as part of the administrative record. As such, Mag and Flag operations based on the GA-52 are not considered a primary option for geophysical mapping.

SENSYS Vector Gradiometer. *The SENSYS MX Compact gradiometer system is used when conditions require high resolution mapping of small targets to depths of 4 ft or less, or when surveying is to be performed in the vicinity of metal structures such as fences, buried utility lines, or metal buildings. Additionally, gradiometer systems are effective when a large degree of debris and/or ferromagnetic soil is present.*

MX Compact contains MAGNEX 120 gradiometers that consists of two magnet-inductors positioned coaxial at distance inside the probe. Both inductors are connected in differential bridge, suppressing the influence of the homogeneous earth field. Magnetic anomalies coming within detection range generate a gradiometric bias, which is transformed into an audible signal a meter reading, and a variable voltage. The intensity and field direction of the magnetic anomaly is shown as a plus/minus indication on the galvanometer and recorded on the data logger via an analog-to-digital converter.

As with total field sensors, vector gradiometers can be deployed in a variety of configuration form factors. The magnetic survey design used to conduct the geophysical investigation varies according to site-specific objectives and target sizes. Gradiometers can be deployed as sensor pairs or in multiple-sensor arrayed configuration. They can be deployed in a backpack mode where an operator carries a single MX Compact gradiometer, or in a cart mode where between three and 24 gradiometers can collect data simultaneously. In the cart mode, the sensors can be deployed as a push-cart or towed from a vehicle. The most appropriate deployment configuration will be determined on a site-by-site basis, as the objectives of a magnetic survey and expected results are discussed in a Site-Specific Work Plan. However, the following issues and concerns will be routinely evaluated:

- *Review existing site surface and subsurface information.*
- *Evaluate the potential influence of cultural features (e.g., utilities, fences, structures, power lines, etc.).*
- *Define most appropriate sensor configuration form-factor (backpack, pushcart-based, or tow-vehicle).*
- *Define most appropriate sensor navigation method.*

- *Define any health and safety hazards.*

Spatial positioning of the gradiometer data can be achieved via GPS. Once-per-second GPS coordinates are integrated within the data logging system that capture the location of the GPS antenna located at the center of the gradiometer array. When GPS is not practicable, a fiducial navigation method is utilized. In this case, the distances along profile lines are determined through capture of time marks as the sensors are moved across known markers. Fiducial methods are appropriate as a backup to GPS or when GPS technology is adversely affected by local vegetation/topographic conditions. In wooded conditions where GPS and fiducial methods are not practicable, ultrasonic techniques provided via the USRADS technology are utilized.

During the survey, the operator will not carry any metal objects (e.g., steel-toe boots, belt, rings, or watches), and his/her speed will not exceed 1.5 m/s (approximately 5.0 ft/s). The fiducial marker switch will be used at approximate 9-ft intervals to maintain down-line survey control. At the end of each day, data will be downloaded into a PC, backed up on floppy and zip disks, and then supplied to the geophysicist for processing.

5.1.1.2 Geophysical Navigation Methods

A suite of navigation options is required to effectively collect sensor position data within the wide variety of vegetation and topographic conditions where digital geophysical mapping may be required. Additionally, the range in number, type, and depth of potential UXO at those sites requires navigation accuracy of 20 cm. To respond effectively to the diverse set of navigation needs, four types of navigation technologies are utilized.

- *GPS*
- *Acoustic/ultrasonic methods*
- *Fiducial methods*
- *Tick wheels*

Global Positioning Systems. *Advanced differential GPS technologies provide the sensor locations at half-foot, real-time accuracy. Blackhawk Geometrics will utilize the dual frequency, dual code, Trimble RTK differential GPS for field-mapping applications when satellite visibility conditions are adequate. Additionally, the subcontractor will deploy the single frequency, dual code, Trimble Pathfinder XRS equipped with multi-path rejection technology. This technology is favorable in lightly wooded and congested areas where GPS signals are affected by multi-path reflection. GPS technologies offer full integration with geophysical sensors, real-time differential solutions based on either satellite-provided or base-station-provided differential corrections, and the "multi-path rejection" capability that enables GPS positioning in tree-covered sites or near buildings.*

Several site-specific issues must be resolved before GPS can be used reliably onsite. These include definition of the site-specific coordinate system on all navigation equipment, establishment of a differential GPS base station, establishment of methods to utilize real-time differential corrections over large sites, and complete testing of site-specific considerations.

In addition to mapping geophysical data, CH2M HILL uses GPS for many different UXO-mapping related tasks, including:

- *Feature identification: GPS is used to augment geophysical data and improve effectiveness of geophysical mapping through capture of visual observations made during a site walk-over. During this process, GPS plays a key role in position-stamping debris piles, unidentified fences, soil changes, vegetation, burn areas, craters, etc.*

- *Grid corner locations: GPS is used to mark survey grid corners.*
- *Target relocation: GPS equipped with targets loaded from the project GIS will be used for target relocation.*

When GPS is determined to be appropriate for sensor navigation, the availability of sufficient satellite coverage will be determined prior to deployment to the site. Two factors dictate sufficiency of satellite coverage: the view of the sky from the survey site, and the number and height of GPS satellites above the survey site. Access to a clear view of the sky is affected by tree coverage, proximity to buildings, and topographic features such as cliffs and steep hills. The orbits of the GPS satellites can be readily viewed through use of GPS planning software such as Trimble SATVIZ. By reviewing the satellite availability on a daily basis, optimal survey periods can be defined, and periods of poor satellite visibility can be coordinated with rest times, preventive maintenance, data downloading, and travel.

GPS is used for geophysical mapping by deploying a rover receiver in conjunction with the geophysical sensors. Concurrently, a second receiver is established as a static base-station over a known survey point. While the rover unit logs data with the sensors, the base-station unit logs data for post-processing.

To achieve the required 20 cm accuracy, differential corrections must be applied to the GPS data. These corrections compensate for slight timing errors in the GPS data associated with atmospheric affects on the GPS signals. Three sources of real-time differential correction are available, including broadcasts from the Coast Guard (where available, typically near the costs and major waterways); satellite-based subscription services (such as OMNISTAR); and onsite base-stations.

Acoustic/Ultrasonic Methods. *Acoustic/ultrasonic navigation methods represent an accurate alternative for precision sensor location under conditions where GPS is not applicable. In particular, acoustic/ultrasonic methods are used for geophysical mapping under tree canopies where continuous line-of-sight to the GPS satellites is obscured. Blackhawk Geometrics will employ USRADS, manufactured by CHEMRAD. USRADS is an active spread-spectrum system that utilizes pre-placed transponder beacons to survey in wooded areas. The USRADS technology is fully integrated with magnetometer, gradiometer, and electromagnetic sensors and generates data in state plane coordinate systems. The sensor package can be deployed as a backpack, cart-based, or vehicle-towed configuration, and can be used in data collection or target relocation modes. Data can be collected via USRADS for grid, transect, and full converge modes.*

Fiducial Methods/Tick Wheels. *Fiducial methods and tick wheels represent less accurate navigation methods that can be used in cases where primary navigation methods (GPS and/or ultrasonic technologies) prove impractical. CH2M HILL will only deploy these technologies if the primary methods are not useable. Fiducial methods use a time-marking procedure to determine the spatial location of the collected data. Using this approach, a series of survey lanes are established over a grid. Flags are placed at the beginning and end of each lane and an operator walks down the lane while the data logger collects sensor readings at a prescribed sampling rate (10 times per second, for example). As the operator walks past the starting and ending points in the survey lane, he or she hits a button on the data logger that places a fiducial time mark in the data stream. By assuming the operator walked in a straight line at a constant velocity, the location of each data point can be estimated. Under good conditions, accuracy levels of 10 cm can be achieved.*

Tick wheels employ a methodology similar to that of as fiducial markers to determine the location of collected sensor readings. Tick wheels are integrated with a data logger and mechanically programmed to initiate a data recording sequence after a pre-set forward distance is traversed. For

example, the EM61 can be programmed to collect data every 1 ft of forward distance. As with fiducial methods, accuracy levels of 10 cm can be achieved if good conditions exist at a site and if the operational assumption of a straight-line path is not violated.

5.1.1.3 Geophysical Survey Modes

A wide variety of survey modes can be utilized to collect geophysical data for the detection, location, and characterization of UXO. These modes include:

- *Full surveys*
- *Grid surveys*
- *Transects*
- *Meandering paths*

The most appropriate survey mode is dictated by several factors, including topography, vegetation, and the number, type and distribution of UXO. Additionally, the most effective survey mode is dependent on the objectives of the survey. For example, if a site is being remediated, then it may be appropriate to conduct a full survey, whereas if a site evaluation is being performed, random grids, transects, or meandering paths may prove more effective.

Full Coverage Surveys. *Full coverage is used when an entire site requires UXO detection, location, and characterization. Under this methodology, the site is evaluated prior to deployment to determine the most effective strategy of data collection. The site data for the Former NASD will be employed to review site conditions including: site topography, vegetation, proximity to structures (pipelines, fences, etc,.), and other site conditions that may affect access or sensor performance. Full coverage can be achieved through deployment of the sensor system in a variety of techniques, including subdivision of the site into a grid mosaic or collection of parallel survey lines. All data traverses are brought into the GIS for verification of full coverage.*

Grid Based Surveys. *Grids are used to survey discrete rectilinear parcels either as part of clearance or evaluation activities. Typically square, grids are usually 100 ft on edge (10,000 sq ft or approximately 0.23 acres) or 200 ft on edge (40,000 sq ft or 0.92 acres). If logistically practical, grids are aligned in a north-south/east-west orientation to simplify the processing of the collected data.*

Transect Surveys. *Transect surveys are utilized to evaluate the extent of contamination in a large area through systematic surveying along linear paths. For example, to estimate the extent of contamination associated with a known impact area, transect survey lines can be collected radially outward from the known contamination area. Subsequent analysis can define the approximate limits of the contamination. Similarly, transects can be utilized in a rectilinear pattern to search large areas. These "pattern searches" can be employed to locate large features such as OB/OD sites and landfills, or to statistically evaluate the UXO contamination within a large site. Transect offset patterns and swath widths are dictated by the site-specific objectives of the survey.*

Meandering Path Investigations. *Meandering path surveys are effective for the statistically evaluation of UXO contamination. Under this approach, semi-random traverses are executed within pre-defined bounds of an investigation site. The operator deploys sensors in a random walk to collect statistically random data from a site. An advantage of the meandering path approach relative to grids or transect surveys is the flexibility afforded to the operator to make minor real-time adjustments in the path to avoid problematic survey areas (trees, bushes, ravines, etc.). As such, this method allows statistical sampling without significant brush cutting. Meandering paths are inherently random and not pre-planned. However, the general area for the survey is defined in the GIS prior to deployment.*

Mag and Flag Survey Procedures. *Mag and Flag surveys will be performed only when digital geophysical mapping is determined to be impractical or ineffective. The use of Mag and Flag procedures will be determined on a site-by-site basis, and will not be used as the primary methodology for UXO detection.*

Mag and Flag surveys will be performed using Schonstedt magnetometers (see Section 5.4.1.1) according to the following procedures:

1. *The UXO Technician III will oversee the division of the survey area into 10-foot-wide search lanes, which will allow UXO technicians to perform 5-foot wide sweeps in two passes. Wooden stakes will be driven into opposing ends of the survey area boundary every 5 ft. Surveyor's line will then be strung between opposing stakes to form the easily definable search lanes.*

2. *Under the supervision of the UXO Technician III, operators will systematically and thoroughly survey assigned search lanes using the highest sensitivity setting of the instrument. The operator will slowly move forward along the search lane, sweeping the instrument from side to side, and making sure the entire width of the search lane is swept. As anomalous areas are encountered, the magnetometer will generate a change in aural tone that is indicative of a metallic object. The operator will further refine the position of anomalous areas by observing the peak aural tones as the magnetometer is moved over the anomalous locations.*

3. *The operator will place a pin flag in the ground where the aural tone is the highest along intersecting perpendicular sweeps.*

4. *The operator will continue in this fashion until the search lane is completed.*

5. *After all lanes are surveyed, the geographical coordinates will be determined and recorded for each pin flag. The procedures discussed above should be performed using two types of instrumentation:*

- *Five-instrument array using Schonstedt 52CX fluxgate magnetometers, passive (single instrument deployment in the meandering path surveys)*

- *White's Spectrum XLT metal detector, active*

The detectors will be interfaced to Precision Differential Global Positioning System (PDGPS) or USRADS. These instrumentation packages were selected based on the ordnance, soil type, terrain, and vegetation of the survey site.

5.1.2 Airborne Geophysical Survey

This section defines the approach and methodology of conducting airborne geophysical surveys for the purpose of detecting and mapping OE materials. The airborne magnetometer system was developed by CEHNC and Oak Ridge National Laboratory (ORNL). It has been deployed at sites such as Edwards Air Force Base (AFB) in California, Badlands Bombing Range in South Dakota, and Shumaker Naval Ammunition Depot in Arkansas.

5.1.2.1 Calibration Site

The contractor will construct a small calibration site within or adjacent to the prescribed survey area. The calibration site is utilized to develop and determine "signatures" of ordnance and ordnance-related items that form the objectives of the airborne survey. The data and information obtained from

the calibration site is utilized during the processing, analysis, and interpretation of the airborne data to aid in quality control of the data as well as in the determination of the targets of interest.

The calibration site will contain a small complement of engineering items (e.g. pipe, rebar, etc.), ordnance items and artifacts, and scrap that is expected to be encountered within the survey area. The size and extent of the calibration site is generally dependent upon the number and types of ordnance-related items expected as well as the local geology, vegetation, and topography. Prior to emplacing items at the site, the contractor will conduct a "pre-seed" walkover survey using a Geometrics G-858 vertical gradiometer. Once items are emplaced, the contractor will then conduct "post-seed" walkover and flyover surveys. The post-seed data will be used for signature and filter development that will be employed in the determination of targets from the airborne survey.

All items placed within the calibration site will be completely documented, including physical dimensions, weight, placement depth, orientation, attitude, and any other reference data deemed appropriate to support calibration activities. Upon completion of the survey, the contractor will remove all items from the calibration site and return the site to its pre-survey condition.

5.1.2.2 Survey Methods and Objectives

The contractor will perform an airborne geophysical survey to acquire, process, and analyze geophysical data for individual OE items as well as suspected clusters, groupings, and high-density areas of OE items and artifacts within the site. The data acquired during this survey will be used by the Navy for a variety of characterization, screening-level, and removal activities associated with determination of the extent of potential UXO-related contamination. Additional specifics associated with the survey include:

- *Utilization of the airborne system to acquire total field magnetometer data*
- *Utilization of Scintrex CS-2 magnetometers in the airborne system to acquire data at the project sites*
- *Acquisition of diurnal magnetic data using a Geometrics G-895 or GEM GSM-19 base station magnetometer*
- *Acquisition and utilization of real-time GPS data to position-stamp all airborne-collected geophysical data with a minimum accuracy of +/- 3 ft*
- *Execution of the survey to achieve full coverage of the sites, such that survey data will contain no significant gaps in coverage caused by non-parallel flight lines or data dropouts*
- *Examination of data onsite to provide QC maps showing data coverage and data quality prior to site demobilization*
- *Conducting the survey in a completely safe manner and in accordance with all FAA regulations and requirements*

5.1.2.3 Airborne Magnetometer System

The airborne magnetometer system will be mounted on a Bell 206 Long Ranger helicopter or other suitable airborne platform and will be flown at altitudes ranging from approximately 3 to 20 ft above ground level (consistent with safety considerations) in pre-programmed traverses over the entire survey area. Survey speeds will range from 40 to 60 miles per hour (mph). Flight lines will be spaced approximately 30 ft apart with data recorded at a rate of 1200 hertz (Hz). Base station magnetic

readings will also be recorded in order to monitor diurnal magnetic activity. This diurnal magnetic activity will be removed from the data as part of the data processing, as are a variety of additional corrections and filters. Airborne magnetic data will only be acquired during the daytime between the hours of 0600 and 1800, depending onsite access and weather conditions.

The geophysical survey system will be configured in an eight-sensor magnetic array and will be mounted directly on the helicopter. High-sensitivity cesium vapor magnetometers (Scintrex CS-2) will be installed at approximately 1.75-m intervals within the 6-m booms, three sensors on either side and two forward. Signal processing and recording will be provided by a state-of-the-art operating console and acquisition system located inside the helicopter.

The airborne magnetometer system will utilize a real-time differential GPS for navigation and data positioning with an accuracy of +/- 3 ft. A laser altimeter will be used to monitor terrain/water clearance in-flight. The laser altimeter will be accurate to 4 inches over the normal operational range.

5.1.2.4 Airborne Magnetometer Survey Products and Results

The airborne magnetometer survey will be used by the contractor to generate a variety of data sets. The geophysical data will be post-processed, analyzed, and interpreted by the contractor to produce precision mapping products and, where appropriate, "dig sheets" containing anomalies representing targets and items located by the airborne system. These anomalies will be categorized and prioritized based on analytic signal amplitude and total field strength with an induced dipole response. Survey results will be provided to CEHNC within 30 days of survey completion. These results are intended to be used for reacquisition and sampling of anomalies identified and located by the airborne systems.

A comprehensive report will be generated. This report will contain a copy of all post-processed airborne geophysical data, tabular listings of all identified anomalies complete with differentially corrected GPS coordinates and respective signal strengths, and, as appropriate, results and documentation of any associated intrusive investigations.

5.1.3 Geophysical Team Members and Qualifications

At a minimum, the geophysical team will consists of a Senior Survey Technician, who will be responsible for the data collection and processing, and one Survey Technician. The data will be processed and evaluated on location by the Senior Survey Technician. Qualifications for Geophysical contractors should be based on experience and the ability to perform the functions in CEHNC DID OE 005-05, CEHNC DID OE 005-07, and the CH2M HILL Work Plan.

5.1.4 Production Rates

Geophysical mapping production rates are highly variable and depend on several factors, including topography, vegetation, site access, proximity of survey area, and weather conditions. Additionally, the selection of the sensor suite (sensor type and array configuration), defined by the expected type, number and distribution of expected UXO and local soil conditions, affects productivity. For example, in open areas with little vegetation, magnetometer systems deployed as ganged arrays can out-perform TDEM sensors in terms of area covered per day.

Another factor that impacts productivity is the mode of survey selected. Full coverage surveys are the most efficient as they require the least set-up time, whereas small grids are less efficient. Specific production rates will be determined on a site-specific basis.

5.1.5 Data Resolution and Data Density

UXO are detected, located, and characterized through the collection and analysis of data containing a geophysical signature of the buried target. The signature must have enough signal strength to allow for clear and unambiguous detection, and must have sufficient signal fidelity to allow for the recognition of the anomaly as potential UXO. As such, the resolution of the target is based on the following factors: (1) the type, number, and expected distribution of potential UXO; (2) existence of possible debris, and/or metal structures that may complicate or obscure the geophysical anomaly; (3) the type of sensor deployed; and (4) the height of the sensor off the ground.

Three adjustments to the data collection systems can be made to assure that sufficient data resolution is achieved. First, the sensors can be deployed as ganged multi-sensor arrays with the offset of the sensors adjusted establish sensor spacing. Second, the line-spacing can be adjusted to establish inter-sensor offsets. Third, the data collection rate can be adjusted to increase (or decrease) collection of data in the forward-moving direction. Data collection rates are varied by adjusting the number samples collected per second (for GPS, ultrasonic, and fiducial methods) or by adjusting the spatial data-collection interval of the tick-wheel. The specific data resolution and data density requirements will be established on a site-specific basis.

5.2 Location Surveying, Mapping and Navigation

Section 7, Location Surveys and Mapping Plan, discusses the methods, equipment, and accuracy required for location surveys and mapping. Location/navigation control will occur using the survey control points, internal instrument recorders (survey wheels, timers, etc.), fiduciary control markers, and measuring tapes or measures lanes. All sensor data will be correlated with navigational data based upon a local first-order control point.

5.3 Instrument Standardization

5.3.1 Instrument Drift

Geophysical instruments facilitate detection of subsurface targets by measuring anomalous readings caused by the targets relative to a background level. These geophysical anomalies are the basis of UXO detection. If the background level of an instrument varies over time (drifts), then the capability to detect anomalous features in the data associated with buried targets is diminished. As such, all instruments require the calibration of the background instrument level.

Instrument drift will be measured by recording data over conveniently located areas known to be free of subsurface geophysical anomalies. These drift calibration areas will be defined by surveying the site with geophysical sensors to locate a parcel with no measurable anomalous geophysical features. Once established, each sensor will record data over the site in north-south and east-west transects at least twice per day, once before any field data are collected and once after all data are completed. These data will be downloaded and reviewed by the Project Geophysicist on a daily basis to determine whether DC adjustments are required in any of the collected field data.

5.3.2 Diurnal Corrections

The earth's magnetic field can be affected by electrical storms, solar flares, and magnetic storms, as well as local sources of ferrous materials (e.g. fences, structures, vehicles, etc.) or electrical noise (cell phones, radios, etc,). Diurnal or daily changes in the earth's magnetic field also occur and must be

compensated for. This is accomplished by logging total field magnetometer data at an established base station while field surveying is occurring. The diurnal base station will be a Geometrics G856 proton precession total field magnetometer, and will be established over a site determined to be clear of subsurface anomalies.

Data from the diurnal base station are downloaded daily and utilized during the data processing step to adjust the survey data for fluctuation in the earth's magnetic field.

5.3.3 Standardization Procedures

Just as the effects of sensor drift require quantification to allow for effective geophysical mapping, sensor standardization is also required to ensure collection of accurate and repeatable UXO target signature data. The objective of standardization procedures is to determine whether each deployed sensor is adequately operating within the sensor performance specification. To ensure that each data collection activity results in repeatable data, the following steps will be executed:

- *Instrument serial numbers will be recorded in field logs.*
- *Personnel will be checked for metallic objects prior to survey commencement.*
- *Wiring will be secured to the transport structure to minimize noise directly from the instrument.*
- *Azimuth measurements will be made to determine any dependence of the measured signal on azimuth and corrections will be applied to measurements obtained along different azimuths, as necessary.*
- *Navigation instrumentation will be calibrated over a known monument and recalibrated over a known point daily.*
- *Instrument calibrations will be performed, recorded, and logged each morning and evening over a known source to insure that instrument functionality is maintained within the required specifications of repeatability.*
- *Individual measurements will be compared to the locally obtained statistical baseline information to determine the normal operating range and deviations that constitute failure.*
- *System timing delays will be determined from the calibration data and corrected to insure accurate positioning.*
- *Tick wheel operation and/or fiducial marks will be used as a primary or back up method of positioning when GPS or acoustic methods cannot be applied or fail in the field.*
- *Instrument transport structures will be maintained level to ensure consistent positioning and data.*
- *During grid operations, the first and last lines will be repeated in opposite directions to ensure instrument and data quality.*
- *GPS features will be recorded for each individual grid and meander path to serve as a backup record independent of the field log and field maps.*
- *Field geophysicists and instrument operators will continuously check instrument readouts and audio alerts to ensure proper operation.*

Standardization procedures are modified on a site-specific basis to maximize efficiency and to adjust to logistical and schedule requirements.

5.3.4 Abbreviated Standardization Checks

Standardization for geophysical mapping is ensured through adherence to standard procedures and full documentation. The following are logs used to maximize sanitation, repeatability, and control of mapping activities:

- *Crew Deployment Log: This log defines the location of each geophysical survey crew on a daily basis. The log tracks crewmembers, equipment, and the expected area to be surveyed. Attached to this daily log are maps of the areas to be surveyed containing the coordinates of benchmarks in the areas as well as the coordinates of each quadrant corner.*
- *Field Log: This log is filled out by each crew chief and details all activities of the survey. This is a daily log and contains observations about crew performance, sensor performance, site conditions, soil conditions, and weather changes.*
- *Instrument Calibration Log: This log documents the daily calibration of each field instrument. Daily calibration procedures are executed for each geophysical and navigational instrument. The sensor system is brought to a calibration area before each survey day starts and the background magnetic field and the magnetic field signal from a reference target are measured and recorded.*
- *Data Control Log: Kept in the office trailer, this log tracks all data flowing in from the field and out to the office. Data include all geophysical field data, calibration data (via Calibration Logs), all field notes from field logs, and all GPS quadrant coordinate data. This log tracks the GIS system electronically, with hard copy prints made daily.*
- *Data Processing Log: All magnetometer data from the field are run through a standard data-processing procedure. This procedure is the same for all data and is tracked with the data processing log. This log documents all coordinate transformations, visual data-quality checks, statistical data-quality checks, survey-coverage statistics, interpolation parameters, etc.*

5.3.5 Instrument Response to a Known Standard

Geophysical instruments used for mapping activities, anomaly reacquisition, hole clearance, and QC will be field tested daily to ensure that they are operating properly. The Project Geophysicist, in consultation with the LANTDIV, will establish standard calibration lines over known inert OE items buried in a test grid. If the standard indication cannot be attained, the instrument will be re-calibrated, repaired, or replaced.

- *The function of each geophysical instrument will be checked according to the manufacturer's specifications upon daily checkout by the survey teams.*
- *Each digital geophysical instrument will measure and record two standard calibration test lines over known inert OE items each morning prior to use. Peak anomaly readings over the OE items within 10 percent of the known values will be considered to indicate that the instrument is functioning correctly.*
- *Each digital geophysical instrument will measure and record two standard calibration test lines over known inert OE items at the end of each day and at any other time at the discretion of the instrument operator or the Project Geophysicist, to assess instrument functionality and drift.*

- *Analog geophysical devices will be tested at the beginning and ending of every work day over the standard calibrations. If an audible response is not achieved over each known buried OE item, the instrument will be re-calibrated, repaired, or replaced as necessary.*

5.4 Data Processing: Correction and Analysis

UXO geophysical data analysis begins after execution of standard data processing steps where field data are verified, cataloged, reviewed, and converted into interpolated grid files in state plane coordinates.

Geosoft's Oasis Montage UX Detect software and onsite Surfer (a software packaged by Golden Software) or another suitable software approved by NOSSA, will be used to analyze and interpret the collected geophysical survey data. This software facilitates interpretation of digital magnetic and electromagnetic data sets. Output from this analysis will be used to identify any anomalous areas that require further investigation. The final geophysical data set will then be provided to LANTDIV for independent interpretation/evaluation.

Analysis of geophysical data includes the following procedures, each of which is documented in the data processing log:

- *Initial data review*
- *Specialized filtering*
- *Target detection*
- *Target analysis*
- *Analysis review*

5.4.1 Initial Data Review

One-dimensional data (from transects and meandering paths) and two-dimensional data (from grids and contagious surveys) will be reviewed for accuracy, completeness, and data fidelity. Grid data will be loaded in the project GIS for comparison with cultural features that exist within the GIS. Additionally, the initial review in the GIS allows the operator to examine the data with respect to the visual features observed onsite and captured via GPS. The operator will examine the quality of the data and define additional filtering or re-processing of the data that may be necessary. The operator will validate that the data are complete and the data falls within the prescribed grids bounds.

Additionally, one-dimensional line data will be re-reviewed in Geosoft's Oasis Montage UX Detect software, which has a profile display mode. All observations related to data review will be fully documented in the data processing log.

5.4.2 Specialized Filtering

Geophysical data sets may require additional processing to extract the maximum amount of information about subsurface targets. This filtering process is an important component of the analysis because it allows low amplitude signatures to be accentuated and low-relief targets to be detected. Filters are applied to minimize noise and reduce effects of geologic trends and adverse soil conditions. The resulting filtered grids will be analyzed in the Geosoft Oasis Montage/UX-Detect software system by a trained operator to identify more subtle targets possibly missed in the standard approach.

5.4.3 Target Detection

Targets are detected in a two-step process: (1) initial automated detection, and (2) operator-aided detection by a qualified geophysicist.

The first step is automated target detection based on threshold analyses. Geosoft's UX-Detect is used for simple threshold detection and is augmented by in-house methods utilizing a region-growing algorithm for more sophisticated auto detection and feature extraction. Parameters controlling the selection of targets include proximity of adjacent targets, signal power density, collocation of targets on other channels of data, areas size, and distribution of anomaly amplitudes.

The second step is manual detection of targets based on systematic visual search of raw and filtered data, on single or multiple channels. This is accomplished within the Oasis Montage/UX-Detect software system. At this stage, automatic target detections are modified, deleted and/or added to by the operator. The automated and operator target detection steps result in a target list and a set of target parameters, including X, Y, area, semi-major length, semi-minor axis length, proximity to other targets, and signal strength statistics.

5.4.4 Target Analysis

Detected anomalies will be analyzed to estimate target parameters including Easting, Northing, depth, and mass. Two different analysis methods, based on analytical models and empirical models, will be used to characterize the targets and are employed depending on the type of data collected. GeoSoft Oasis Montage/UX-Detect software is used with total field magnetometer for mass and depth characterization based on a two-dimensional Euler deconvolution algorithm that calculates the apparent depths and weights of selected magnetic targets. The apparent depth to the magnetic source is derived from Euler's homogeneity equation, which relates the magnetic field and its gradient components to the location of the source of an anomaly, with the degree of homogeneity expressed as a "structural index." Additionally, a magnetic dipole model is employed to estimate target depth and *magnetic moment through an iterative least-square model-matching algorithm. Magnetic moment is related to ferrous mass through an empirical relationship. For electromagnetic data, empirical relationships based on the signal strength and spatial extent on both channels of the EM-61 sensor are used to estimate target mass and depth.*

In addition to these methods of target analysis, the operator uses a signature database to review the algorithm-based results. In this process, each target is reviewed relative to target signatures of known items buried at known depths and orientations. Additionally, as excavation groundtruth data is acquired during UXO removal, the information is fed back to the Project Geophysicist and incorporated within the project site UXO target signature database. Through this process, knowledge base project site signatures increase, and the effectiveness of data analysis improves.

5.5.5 Analysis Review

Review of data analysis is comprised of five steps. First, a review is performed of all entries in the data processing log that track both the chain of custody of the data and all numerical procedures that have been applied to the data. Second, 10 percent of all data is reprocessed and reanalyzed to ensure replication of the results. Third, all target detection data is reviewed by a second qualified geophysicist. Fourth, all target detection and geophysical data are reviewed within the project GIS to ensure that no cultural features are masking potential new targets, and that no detected targets are actually cultural features. Fifth, the results of all excavation activities are fed back to the Project Geophysicist for confirmation of excavation. Under this process, all groundtruth data is checked to

make sure that the item removed during excavation is of the size, type, and orientation consistent with the recorded data.

5.6 Quantitative Interpretation and Dig Sheet Development

The target analysis process culminates in the creation of dig sheets, which contain target location, depth, and weight estimates. The dig sheets will also contain listings of the peak raw amplitudes recorded on sensors and the distance from the peak amplitude to the 50 percent amplitude level. These amplitude values are used to verify that the correct target is excavated.

For each grid, the geophysical subcontractor will assess each of the following factors prior to generating an anomaly list:

- *The local background conditions of the magnetic, gradiometric or electromagnetic response*
- *Data completeness and accuracy*
- *Data quality based on the survey and grid QA data*
- *The grid boundary conditions, utilities and/or other cultural features present, and unsurveyable areas (beneath roads, trees, buildings, etc.)*
- *A delineation of the extent and boundaries of metal-rich landfill areas, if any (Anomaly lists will not be generated for metal-rich landfill areas)*

The criteria for selecting and locating anomalies for the anomaly list include the following items:

- *The maximum amplitude of the response*
- *The maximum amplitude of the response with respect to local background conditions*
- *The lateral extent (plan size) of the area of response*
- *The three-dimensional shape of the response*
- *The location of the response with respect to the edge of the grid, unsurveyable areas, land features, cultural features, or utilities within or adjacent to the grid*
- *The shape and amplitude of the response with respect to the response of known targets buried in the geophysical prove-out test plot*
- *The shape and amplitude of the response with respect to relevant anomalies encountered in previous OE removal grids*
- *The apparent depth of the anomaly*
- *Potential distortions in the response due to interference from nearby cultural features*
- *Supplemental analysis of the top coil or differential data as necessary*
- *Any instrument or grid survey QC that could affect the analysis*

The Project Geophysicist will analyze the geophysical data for each OE removal grid, identify anomalies that may represent buried UXO, and prepare anomaly lists containing the following information:

- *Project site*
- *Geophysical contractor*
- *Responsible geophysicist*
- *Grid identification*
- *Grid corner locations in state plane coordinates*
- *Grid background response levels*
- *Unique anomaly identification numbers*
- *Predicted anomaly easting and northing in both local grid (relative) coordinates and in state plane coordinates*
- *Instrument peak value at each anomaly location*

The anomaly lists will be prioritized and anomalies deemed more likely to be UXO will be ranked higher than anomalies less likely to be UXO. A proposed, grid-specific "cut line" for preparation of the dig sheet will also be provided. The dig sheet will be of a subset of the anomaly list. Anomalies below the "cut line" will generally not be excavated unless warranted by field conditions. Each anomaly list submitted to LANTDIV will be accompanied by a proposed "cut line," separating the recommended dig locations from the anomalies unlikely to represent UXO. The "cut line" for each grid will be established based on the site conditions for each OE removal grid. Based on its QA review, LANTDIV may accept or adjust the "cut lines," or add additional dig locations prior to accepting a final dig list for each OE removal grid.

5.7 Anomaly Reacquisition

Before intrusive activities can be performed, the geophysical anomalies identified on the digital geophysical surveys must be reacquired. Anomaly reacquisition is a two-step process. The first step is to locate the ground position of the anomaly coordinates as specified on the dig sheet. This will be performed using differential GPS, conventional survey methods, or measuring tapes, based on local site conditions. A white non-metallic pin flag, labeled with the unique anomaly number, is placed in the ground at the indicated grid coordinates. The second step is to use the same instrument used to detect the target (total field magnetometer, vector gradiometer, or electromagnetic sensor) to identify the peak location of the anomaly, the precise location on the ground where the excavation should occur. The sensor will be moved back and forth over the general area of the anomaly coordinates until the peak value of the anomaly is located. If more than one peak is located, the peak with the highest amplitude will be selected. If no unique peak value is present (i.e., the same peak value is measured over an area) the center of the maximal area will be selected. If no peak value is located at the indicated location, the white anomaly location flag will be left in place and the Project Geophysicist will be consulted.

The peak value measured over the anomaly will then be recorded and the dig location will be marked with a colored flag labeled with the anomaly number. The specified relocation process serves three purposes: 1) it focuses the excavation over the actual anomaly peak, instead of an interpolated location between the survey measurement points; 2) it reduces measurement errors; and 3) and it provides a quality control ground check for the dig locations.

All discrepancies between the dig sheet location and the actual reacquired location, and any anomalies that could not be reacquired, will be recorded. The reacquisition location will be measured and logged. The reacquisition coordinates will be used as the official dig location for location quality control assessment.

5.8 Feedback Process

The feedback of groundtruth excavation data is one of the most important ways to ensure efficient and effective UXO geophysical mapping. Excavation data collected during each intrusive activity will be captured to document the item location, weight, shape, orientation, and depth. This data will be electronically entered into a groundtruth database and incorporated within the project GIS.

The feedback process will also populate the database developed for each target signature developed during the data processing and analysis steps. The Project Geophysicist will review the target signatures in conjunction with the integrated groundtruth data to evaluate local geologic/geophysical effects on the target signatures. This information will be described in weekly reports and be communicated to the staff processing and reviewing geophysical data.

Excavation results for each OE removal grid will be posted on the project-provided internet web site within approximately three working days of grid completion. The Project Geophysicist, or a designate, will review the excavation results with respect to the anomaly selection criteria, "cut-line" level selection, QC dig results, actual UXO encountered, and any performance criteria failures, and provide a weekly progress report with recommendations to LANTDIV.

5.9 Quality Control

Geophysical mapping QC will be defined on a site-specific basis and be dictated by the sensors, navigation methods, survey modes utilized to achieve the site-specific objectives. However, the following QC steps will be incorporated into all site-specific plans:

- *Daily pre- and post-operation instrument calibrations ensure readings within manufacturer's specifications*
- *Digital capture of data over standard calibration response objects with 10 percent variation threshold*
- *Navigation calibration via twice-daily acquisition of survey benchmark locations*
- *Target reacquisition accuracy testing via repetitive acquisition of selected anomalies*
- *Post-operation equipment checks to ensure that equipment is serviceable, with damaged or malfunctioning gear identified. Equipment maintenance program with preventive and corrective response measures.*
- *Independent review of raw and processed data via OE QC Analysts. All dig sheets reviewed by two qualified geophysicists prior to intrusive activity.*
- *Audits of field procedures with defined pass/fail criteria and defined corrective measures*
- *Defined records management and review procedures*

- *Selection of additional targets not initially selected for dig sheets. Selecting additional targets numbering 10 percent of original list verifies false alarm reduction techniques.*
- *Random sampling of completed grids. QC specialist performs hand-held mag or EM sweep identifying metal debris. Targets numbering 10 percent of detected targets selected for excavation to validate discrimination methods. Results reported to Project Manager and corrective actions identified.*
- *Confirmatory excavations. Upon LANTDIV concurrence, small sub-grids (e.g., 100 sq ft) fully excavated to prescribed depths. Spoils checked to ensure 100 percent OE removal. Results reported to Project Manager and corrective actions identified as needed.*
- *Comparative review of intrusive results. Excavation results reviewed by Project Geophysicist ensuring excavated anomalies correspond to the selected targets. The size, depth, and orientation of each target compared with digital data identifying possible mis-matches. All suspect intrusive results will be reinvestigated.*
- *Comprehensive digital documentation of site activities with in-place feedback procedures to capture lessons learned. Daily "lessons-learned" component of morning safety tailgate briefings.*

After each excavation is completed the field crew will collect a target signature over the excavation area in an "X" pattern. The crossing profiles will be at least 20 ft long and will be collected in the north-south/east-west directions. This post-excavation data will be supplied to the Project Geophysicist for review. The purpose of this data collection is to validate and verify that after the excavation is completed, no additional anomaly associated with an additional target exists at the excavation location.

The raw and processed geophysical survey data, replicate and other QC data, field notes, data processing parameters, maps, anomaly lists, and proposed "cut lines" for each OE removal grid will be provided by the geophysical subcontractor to the Project Geophysicist, or his designate, for QC review. If acceptable to the project team, the data will be considered to be in draft form and will be provided to LANTDIV for review at least 2 weeks prior to planned intrusive activities in that particular grid.

A QA review of the data and proposed dig lists will be performed by LANTDIV. Select geophysical data and target lists may also be reviewed by other designated QA parties. The Project Geophysicist or a designate will address comments received from any review, and responses will be submitted to the LANTDIV. Upon acceptance of comment responses by the LANTDIV, the geophysical data, maps, and dig list will be made available for use by the UXO teams.

QC audits, to ensure that the overall QC procedures and objectives of the project are met, will be performed at the discretion of the CH2M HILL Project Manager.

5.10 Corrective Measures

Specific corrective measures are dependent of the type of geophysical equipment used during an operation and will be developed on a site-specific basis. However, the following are the basic corrective measures CH2M HILL employs for digital geophysical mapping:

- *Replacement of sensors if they fail to meet calibration requirements*
- *Replacement of navigation equipment if daily checks of location accuracy are not met*

- *Re-survey of grids when data quality specification are not met*
- *Re-processing of all geophysical data collected during a survey day if 10 percent reprocessing procedures results in detection of additional valid targets*
- *Re-excavation of targets if Project Geophysicist determines that the excavated targets are not associated with the initial target anomaly*

5.11 Records Management

CH2M HILL will establish a geophysical records management plan upon issuance of site-specific task orders. However, the following items will be contained in each plan:

- ***Field survey records management:*** *All data files and field logs generated during the filed operation will be managed by the Project Geophysicist. Paper files will be organized in the office trailer and filed by individual day. Photocopies of all paper documents will be made and filed at an offsite location. Electronic files will be organized on an office PC dedicated to geophysical investigation management. Electronic files include, but are not limited to: magnetometer files, gradiometer files, EM61 sensor files, diurnal base station files, rover GPS files, base station GPS files, sensor calibration files, and drift correction files. File directory structures will be organized by day-of-year, with subdirectories for specific field activities (GPS data, survey data, etc.). All field data will be backed up onto CD ROM or tape on a daily basis as well as transferred to an offsite CH2M HILL location.*
- ***GIS records management:*** *All generated and developed GIS files will be managed by the GIS Specialist and stored on an onsite PC dedicated for GIS management and analysis. The data will be stored within the standard GIS sub-directory structure with "README" files in each directory containing a description of the contained files. All GIS data will be backed up onto CD ROM or tape on a daily basis as well as transferred to an offsite CH2M HILL location.*
- ***Data processing and analysis record management:*** *All data files and data processing logs generated during the processing and analysis of geophysical field data will be managed by the Project Geophysicist. Paper files will be organized in the office trailer and be filed by individual day. Photocopies of all paper documents will be made and filed at an offsite location. Electronic files will be organized on an office PC dedicated to geophysical investigation management. File directory structures will be organized by day-of-year, with subdirectories for specific field activities (GPS data, survey data, etc.). All field data will be backed up onto CD ROM or tape on a daily basis as well as transferred to an offsite CH2M HILL location.*

All data (field data, GIS data, geophysical processing, and analysis data) will be backed up as a complete system on a weekly basis onto CD. Two copies of the CD will be created with one copy stored in the office trailer and one copy sent to an offsite CH2M HILL location.

5.12 Interim Reporting

Access to interim data will be provided via a project internet web site or other project appropriate method. All digital data will be provided in formats compatible with the LANTDIV's computer systems. Interim data will include:

- *CADD base and topographic maps for all OE removal grids, with grid control points, in Intergraph .DGN or AutoCAD Release 14 .DXF format*
- *Draft and final geophysical data, as specified in Section 5.7, for all OE removal grids*
- *Grid data and QC reports for all OE removal grids in Word97 format*
- *Draft and final anomaly lists for all OE removal grids in Excel97 format*
- *Dig lists and relocation coordinates for all OE removal grids in Excel97 format*
- *Anomaly excavation reports for all OE removal grids in Excel97 format*
- *QA dig lists and excavation reports for all OE removal grids in Excel97 format*

5.13 Final Reports and Maps

All sensor data will be pre-processed for sensor offsets, diurnal magnetic variations, etc., and correlated with navigation data. The approved geophysical mapping technology will digitally capture the instrument readings into a file coincident with the state grid coordinates. This field data will be checked, corrected, and processed into ASCII files in the ADF file format. Corrections such as for navigation and instrument bias will be applied but there will be no filtering or normalization of the data. All corrections will be documented.

The data will be presented in delineated fields as x, y, and z, where x and y are state plane coordinates in east and north, and z is the instrument reading. Where there are multiple instrument values, such as with the EM instruments, the channels will be provided in separate files. Each of the three data fields will be separated by a space (not a comma). TDEM data will consist of two separate files of three columns in the same format, with the z component for the top and bottom coils in separate files (for the EM-61) or for the early and late time gates (for the EM-61HH). There will be no header or other information included in the file. No individual file may be more than 4 megabytes in size and no more than 60,000 lines long. Each grid of data will be logically and sequentially named so that the file name can be easily correlated with the grid name used by other project personnel.

A digital planimetric map of each OE removal grid, in Intergraph .DGN format or AutoCAD Release 14 .DXF format, will be made available to LANTDIV inspection prior to the collection of any new grid geophysical data. These maps will reflect the current site conditions after site preparation work (removal of fencing, dumpsters, play-sets, etc.) has been completed. These maps will be in state plane coordinates, and will coincide with the location of the geophysical survey data.

For each OE removal grid, the complete digital geophysical data set for each OE removal grid will be made available for LANTDIV inspection within approximately seven days of the completion of survey activities for that grid. All data is considered to be in draft form until LANTDIV comments are received and addressed.

The geophysical data for each OE removal grid will be accompanied by a Microsoft Word file documenting the field activities associated with the data collection, the data processing performed, and the results of the CH2M HILL QC review.

COMMENT:

2. Pg. 1-6, second line: "the area was swept"... "by a team from" NSRR, not NASD.

Revised Page 1-6

The inactive OB/OD area reportedly was swept for live munitions by an Explosive Ordnance Demolition (EOD) team from NSRR (Greenleaf/Telesca,1984).

COMMENT:

3. Pg. 1-7, Section 1.2.3, second paragraph: Add a footnote at the bottom of the page to reference the Phase I PA/SI Report.

Revised Section 1.2.3

Revision not necessary as the Phase I PA/SI Report is already referenced properly in the paragraph as CH2M HILL, October, 2000. A footnote is not required.

COMMENT:

4. Figure 1-3: The 10 areas of investigation are not distinguished on the photograph.

Revised Figure 1-3

The revised Figure 1-3 distinguishing the 10 areas of investigation is provided with this attachment.

COMMENT:

5. Page 2-5, Section 2.1.2, fourth paragraph: Add a sentence referring to what will happen if the UXO found is not safe to move.

Revised Section 2.1.2

The FS will notify the USA Environmental Senior Supervisor and he will determine if it is safe to remove the UXO to a designated secure area for disposition. If the UXO is not safe to remove, the CH2M HILL PM will be notified immediately of the situation. If the UXO found is not safe to move, it will be blown in place. If an unknown UXO item is found, the NSRR EOD team will be called for an emergency response. The NSRR EOD team will determine the course of action for an unknown UXO item. If the EOD Team determines that removal of the UXO is safe, the FS will notify the PM of the decision by the EOD Team.

COMMENT:

6. Page 2-5, Section 2.1.2, fourth paragraph: Change USA EOD to USA Environmental UXO (USA EOD could be misconstrued as US Army and subcontractors are designated UXO, not EOD). Make this change throughout the document.

Revised Section 2.1.2

The revised section 2.1.2 is provided above with comment number 5.

COMMENT:

7. Figure 2-3: Add a block under Magnetometry Survey showing "Data Reviewed by Geophysicist". Under Blow In Place block, use correct radius distances from OP 5.

Change Construct Containing Structure block to "Based on MPM, Sand Bags Placed Around Item".

Revised Figure 2-3

The revised Figure 2-3 is provided with this attachment

COMMENT:

8. Figure 2-4: Under the block labeled Determine Exclusion Zone – Secure Area, use correct radius distances from OP 5.

Revised Figure 2-4

The revised figure 2-4 is provided with this attachment

COMMENT:

9. Page 2-8, Section 2.2, first paragraph: Correct the definition of OESO. OESO stands for Ordnance Environmental Support Office.

Revised Section 2.2, first paragraph

The Site Approach working group consisted of representatives from LANTDIV, NOSSA, Ordnance Environmental Support Office (OESO), and CH2M HILL OE staff.

COMMENT:

10. Page 2-8, Table 2-1: Change the Site Approach section to indicate that approximately 10% of the demarcated 200 acre area will have 100% geophysical coverage. Delete the reference to statistical sampling in the Sampling Methodology section.

Revised Table 2-1

TABLE 2-1
Project Sites and Associated Sampling Approaches

Site	Estimated Acreage	Site Approach	Sampling Methodology
SWMU 4*	30	Remedial Investigation of 10 percent of the 200 acre site (approximately 30 acres), survey grids, vegetation removal, surface OE clearance, digital geophysical mapping survey, UXO intrusive investigation to 1 ft bgs.	100 percent digital geophysical mapping survey of select sites

Notes:
bgs below ground surface
RI Remedial Investigation
**Inactive open OB/OD, the primary release mechanism is either residual OE remaining onsite, kick-outs from explosions, poor housekeeping, mishandling or misplacement of items in the area.*
The investigation approach for these sites is a digital geophysical mapping survey extending for a 100-ft radius from the center of the suspect sites.

COMMENT:

11. Page 2-8, Section 2.2.1, fourth bullet: Add a statement that surface clearance of UXO will be conducted before vegetation removal. Note that the investigation approach may be modified for the 10 individual sites.

Revised Section 2.2.1, fourth bullet

- *Conduct surface clearance of site before vegetation removal for each PI site. The vegetation removal method may vary from site to site*

COMMENT:

12. Figure 2-5: Move office trailer to outside of fence. Show location of portable magazine and secure area for consolidated UXO storage.

Revised Figure 2-5

Revised Figure 2-5 is provided with this attachment

COMMENT:

13. Page 2-11, Section 2.4.1, second paragraph: Add reference to NAVSEA OP 3565 Electromagnetic Radiation Hazards for Ordnance, listing the exact distance radios must be kept away from demolition operations.

Revised Section 2.4.1, second paragraph

Radios will be available for communication with the site office and other personnel. Radios shall not be used within 100 ft of located OE/UXO or demolition operations as per NAVSEA OP 3565, Electromagnetic Radiation Hazards for Ordnance.

COMMENT:

14. Page 2-12, Section 2.4.3: Check exclusion zone distances in OP 5. Revise if necessary.

Revised Section 2.4.3

A restricted/exclusion zone (EZ) shall be established around the area where intrusive activities are conducted, in accordance with Section 6 of this plan. Initially, a 300-feet EZ will be established at each location where intrusive activities are being conducted. If OE/UXO is located during excavation, the EZ will be adjusted to 1,250-ft for non-fragmenting explosive materials, 2,500 ft for fragmenting explosive materials, or 4,000-ft for bombs and projectiles of caliber 5-inch and greater. While UXO operations are in progress, only those personnel necessary for the operation will be allowed within the EZ. If nonessential personnel enter the area, all UXO operations will cease.

COMMENT:

15. Page 3-2, Section 3.2.1: One method of explosive storage must be chosen. Either existing magazines or portable magazines

Revised Section 3.2.1

Explosives will be stored in a custom manufactured portable explosives storage Type 2 magazine as described in Section 55.206 of ATF P 5400.7, Alcohol, Tobacco, and Firearms Explosives Law and Regulations. This portable unit is constructed with a separate compartment for initiators (blasting caps) and explosives. Explosives items will be stored in accordance with its Hazard Division (HD)

and the storage compatibility group criteria listed in Chapter 3 of DoD 6055.9-STD. Quantity-Distance (Q-D) information is presented in Section 4, Explosives Siting Plan.

The portable explosives storage magazine will be placed on the concrete pad adjacent to the existing earth covered magazine (ECM) 229 near SWMU-4. The entrance to ECM 229 will be completed with fencing and a gate with lock. The maximum Net Explosives Weight (NEW) to be stored in each magazine is 50 pounds. This explosives storage area will meet the requirements of:

- *ATF P 5400.7 - Alcohol, Tobacco, and Firearms Explosives Laws and Regulations*
- *DoD 6055.9-STD - DoD Ammunition and Explosives Safety Standards*
- *DA Pam 385-64 - Ammunition and Explosives Safety Standards*
- *NAVSEA OP 5 Volume 1, Ammunition and Explosives Ashore*

Requirements for the explosives storage area include security locks and fencing, placarding, and lightning protection systems. Requirements for quantity-distance are specified in Section 4, Explosives Siting Plan.

COMMENT:

16. Page 6-1, Section 6.1.1: Site topography section only discusses regional topography of Vieques. A detailed discussion of the topography of SWMU-4 should be added to this section.

Revised Section 6.1.1

Land surface elevations in the SWMU-4 area range from sea level to approximately 150 feet above mean sea level. The southern portion of the site borders the flanks of Mt. Pirata and has the highest elevation (150 feet). The northern part of the site extends into a salt water lagoon near Punta Boca Quebrada and has the lowest elevations (mean sea level). The main OB/OD 40 acre area is relatively flat, except where a quebrada (drainage area that is dry except during storm events) cuts through the southern end of the site. The 40 acre area ranges in elevation from sea level to approximately 50 feet above sea level.

The majority of SWMU 4 has a dense shrub canopy of thorny shrubs and a sacttered herbaceous stratum. The total vegetative cover was approximately 75-95 percent. Dominant shrubs identified on the site included Acacia farnenciana, Prosopis glandulosa, Pithlcellobium dulce, and Zanthoxylum brevipes. Another co-dominant shrub was Leucaena leucocephala. The herbaceous stratum was dominated by Bothriochloa ischaemum, Commelina erecta, C. diffusa, and Lasiacis divaricata. No endangered or threatened plant species were observed during the field survey.

COMMENT:

17. Page 6-15: Delete the section titled "Preventing and Treating Cold Stress" since it does not apply to Vieques.

Revised Page 6-15

Section titled "Preventing and Treating Cold Stress" has been removed from Section 6.

COMMENT:

18. Page 6-15, Section 6.4.3.10: Delete this section (Compressed Gas Cylinders) since it does not apply to the work at SWMU-4.

Revised Section 6.4.3.10

This subsection has been deleted from Section 6.

COMMENT:

18. Page 6-21, Section 6.4.3.20 Contaminants of Concern: Many parameters exceed screening criteria. Are more stringent personal protection methods required for this project?

Revised Section 6.4.3.19

SWMU 4 – OB/OD Site. *Previous investigations included the collection of soil and groundwater samples for VOCs, SVOCs, PCBs, and metals analysis. Parameters exceeding conservative long-term exposure risk based screening criteria in surface soils included aluminum, arsenic, iron, lead, thallium, vanadium, 2,4-dinitrotoluene, 2,4,6-trinitrotoluene, and hexahydro-1,3,5-trinitro-1,3,5,7-tetrazocine. In subsurface soils, the metals arsenic and barium exceeded screening criteria. Parameters exceeding screening criteria in groundwater included aluminum, barium, cadmium, chromium, iron, manganese, nickel, selenium, vanadium, and zinc. In addition, various small UXO and spent munitions were discovered at the site. The metals detected at the site were detected at concentrations indicative of background concentrations for the island.*

Table 6-3 shows potential exposure routes.

TABLE 6-3
Potential Routes of Exposure

Dermal*: Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 6.6.*	***Inhalation****: Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in Sections 6.6 and 6.7, respectively.*	***Other****: Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).*