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FINAL PHASE I RCRA FACILITY INVESTIGATION WORK PLAN SWMU 70 – DISPOSAL AREA NORTHWEST OF LANDFILL

For NAVAL ACTIVITY PUERTO RICO
EPA I.D. No. PR2170027203
CEIBA, PUERTO RICO

Prepared for:

Department of the Navy
NAVFAC SOUTHEAST
North Charleston, South Carolina

Prepared by:

Baker

Michael Baker Jr., Inc.
Moon Township, PA

Contract No. N62470-07-D-0502
DO 0002

December 20, 2007

IQC for A/E Services for Multi-Media Environmental Compliance Engineering Support

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Prepared by:

MICHAEL BAKER JR., INC.
Moon Township, Pennsylvania

I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gather and present the information contained therein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowingly and willfully submitting a materially false statement.

Signature Jeffrey G Meyers ______________________

Name:__Jeffrey G Meyers_________

Title:___BRAC Env. Coordinator_

Date: December 20, 2007________

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LIST OF ACRONYMS AND ABBREVIATIONS

APA	Aerial Photo Analysis
Baker	Michael Baker Jr., Inc.
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERFA	Community Environmental Response Facilitation Act
CRQL	Contract Required Quantitation Limit
DO	Delivery Order
DRO	Diesel Range Organics
Eco-SSL	Ecological Soil Screening Level
ECP	Environmental Condition of Property
ERA	Ecological Risk Assessment
FID	flame ionization detector
FMTUD	Facility Management Transportation and Utility Division
GIS	Geographic Information System
GPS	Global Positioning System
GRO	Gasoline Range Organics
HM	Hazardous Materials
HSA	Hollow-Stem Auger
ID	Internal Diameter
IDW	Investigation Derived Waste
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAPR	Naval Activity Puerto Rico
NAVFAC	Naval Facilities Engineering Command
NFESC	Naval Facilities Engineering Service Center
NSRR	Naval Station Roosevelt Roads
OP	Organophosphorus (pesticides)
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PI	Photo Identified
PID	Photoionization Detector

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

PMO	Program Management Office
POL	Petroleum, oils, and lubricant
PRG	Preliminary Remediation Goal
PR LRA	Puerto Rico Local Reuse Authority
PVC	polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SE	Southeast
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TPH	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit of the mean
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This document describes the activities required for the implementation of a Phase I Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 70 – Disposal Area Northwest of Landfill located at Naval Activity Puerto Rico (NAPR) formerly Naval Station Roosevelt Roads (NSRR), located in Ceiba, Puerto Rico.

This document has been prepared by Michael Baker Jr., Inc. (Baker), for the Navy Base Realignment Closure (BRAC) Program Management Office (PMO) Southeast (SE) office under contract with the Naval Facilities Engineering Command (NAVFAC), SE (Contract No. N62470-07-D-0502, Delivery Order [DO] 0002).

1.1 NAPR Description and History

NAPR occupies over 8,800 acres on the northern side of the east coast of Puerto Rico (see Figure 1-1), along Vieques Passage with Vieques Island lying to the east about 10 miles off the harbor entrance. NAPR also occupies the immediately adjacent islands of Piñeros and Cabeza de Perro, as presented on Figure 1-2. The northern entrance to NAPR is about 35 miles east along the coast road (Route 3) from San Juan. The property consists of 3,938 acres of upland (developable) property and 4,955 acres of environmentally sensitive areas including wetlands, mangrove, and wildlife habitat. The closest large town is Fajardo (population approximately 37,000), which is about 5 miles north of NAPR off Route 3. Ceiba (population approximately 17,000) adjoins the west boundary of NAPR (see Figure 1-1).

The facility was commissioned in 1943 as a Naval Operations Base, and finally re-designated a Naval Station in 1957. NSRR operated as a Naval Station from 1957 until March 31, 2004. NSRR has undergone operational closure as of March 31, 2004 and has been designated as Naval Activity Puerto Rico. NAPR will continue until the real estate disposal/transfer is completed. The mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until final disposal of the property.

In anticipation of operational closure of NSRR the Naval Facilities Engineering Command, Atlantic Division (LANTDIV) prepared Phase I/Phase II Environmental Condition of Property (ECP) Reports to document the environmental condition of NSRR. Section 8132 of fiscal year 2004 Defense Appropriations Act, signed into law on September 30, 2003, directed that NSRR be disestablished within 6 months, and that the real estate disposal/transfer be carried out in accordance with procedures contained in the BRAC Act of 1990. This legislation requires that the base closure be conducted in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), as amended by the Community Environmental Response Facilitation Act (CERFA).

The Draft Phase I Environmental Condition of Property Report dated March 31, 2004 (LANTDIV, 2004) identified new sites at NAPR based on the results of a review of records, an analysis of historic aerial photographs, physical site inspections, and interviews with persons familiar with past and current operations and activities. The new ECP sites had not been previously identified or investigated under existing environmental program areas. A Phase II ECP field investigation was conducted in April 2004 to conduct environmental sampling to determine if a release/disposal actually occurred at any of the Phase I ECP sites recommended for further evaluation in the Phase I ECP and, if so, whether any potential risk to human health was present. The Final Phase II Environmental Condition of Property Report recommended additional sampling (to be undertaken as part of the RCRA Program) at several sites to permit a more detailed assessment (NAVFAC Atlantic, 2005).

The United States Environmental Protection Agency (USEPA) issued a RCRA 7003 Administrative Order on Consent (USEPA Docket No. RCRA-02-2007-7301), which identifies SWMU 70 (formerly referred to as ECP 16) having documented releases of solid and/or hazardous waste and hazardous constituents and requires the submittal to the USEPA for their approval, an acceptable work plan to complete the equivalent to a Phase I RFI investigation. Following a public comment period the Consent Order became effective on January 29, 2007. This document meets the requirements for a Phase I RFI Work Plan.

1.2 Site Location and History

This site is located adjacent to Ensenada Honda, southeast of Building 394, and northwest of the closed base landfill (SWMU 3) (see Figure 1-2) and covers a large area of flat lying land consisting of open areas and areas covered by secondary growth vegetation as shown on Figure 1-3. The Aerial Photography Analysis (APA) identified this area as photo identified (PI) Site 22, due to the observation of a large suspect disposal area with disturbed ground, debris, a cleared or graded area, and stressed vegetation from 1976-1980s. Figure 1-4 presents the conditions of the site in 1976 along with the polygon features from 1976, 1977, 1985, and 1995 identified during the APA. These polygons identify the suspect areas from the respective aerial photographs. In addition, containers or drums had been discarded in a vegetated area north of the main disposal area. The records review did not identify any activities in this area. The physical site inspection observed numerous piles of construction debris (metal, concrete, polyvinyl chloride [PVC] piping), but no drums or evidence of stains or stressed vegetation. Interviews confirmed the area as a construction and/or solid waste disposal site, including potential disposal of petroleum, oils, and lubricant (POL) or hazardous materials (HM) containers.

During the Phase II ECP investigation, numerous piles of construction debris (metal, concrete, and PVC piping) were observed in different portions of the site, as was the case during the physical site inspection. Appendix A provides photographs that were obtained during the investigation to show site features/conditions. Photograph A-1 presents an example of the construction debris observed. The Final Phase I/II ECP report also notes that there were no drums or evidence of stains or stressed vegetation. A majority of this site is covered in thick secondary growth vegetation, as shown on Photograph A-2. In addition, the central and southern portions of the site are classified as wetlands consisting of either estuarine-intertidal-scrub/shrub (broad-leaved evergreen) (E2SS3), or estuarine-intertidal-unconsolidated shore mud, organic, dead matter (E2US3/4/5). Photograph A-3 presents a wetland area in the vicinity of soil boring location 16E-05 as described in Section 2.2 of this report.

During the ECP investigation, soil, groundwater, sediment and surface water samples were collected. Figure 1-3 shows the sample locations from the ECP investigation.

1.3 Objectives

The purpose of this work plan is to describe the activities necessary to obtain data for further characterization of impacts to the environment due to past operations at SWMU 70. A Phase I RFI is required as outlined in the NAPR RCRA 7003 Administrative Order on Consent issued by the USEPA Region II. Therefore, this RCRA Order provides for the development of a work plan, field investigation, and reporting on the findings of the investigation with recommendations of follow-up actions necessary to ensure protection of human health and the environment.

The investigation area at SWMU 70 is shown on Figure 1-3. The objectives of the investigation to be performed at SWMU 70 are outlined below.

An investigation consisting of the collection of soil, groundwater, and sediment samples will be performed at SWMU 70 to further characterize impacts to the environment. A surface and subsurface soil sampling program is to be implemented to further characterize and delineate volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals detected during the Phase II ECP investigation. The groundwater sampling program is to further characterize SVOCs and metals detected during the Phase II ECP investigation. Finally, sediment samples will be collected to further characterize metals detected during the Phase II ECP investigation and determine if past releases from the disposal area have migrated to Ensenada Honda.

1.4 Organization of the Work Plan

This work plan is organized into seven sections. Section 1.0 of this document includes the site history and objectives of this RFI. Section 2.0 provides a description of the current conditions and usage of the site, as well as a summary of previous investigations. Section 3.0 provides a description of the scope of investigations for the upcoming field work. The proposed scope of investigations include soil sampling and analysis program, permanent monitoring well installation program, groundwater sampling and analysis program, sediment sampling and analysis program, and quality assurance/quality control (QA/QC) samples, as well as other investigation considerations. The reporting activities that will be conducted following the completion of the field investigation are described in Section 4.0. Section 5.0 discusses the proposed project schedule that will be followed for this Phase I RFI investigation. The site management structure that will be utilized during this investigation, including project team responsibilities and field reporting requirements, is presented in Section 6.0, while Section 7.0 presents the report references.

2.0 CURRENT CONDITIONS AND SITE BACKGROUND

The following sections provide a discussion of the current conditions that exist at SWMU 70 along with previous ECP investigations.

2.1 Current Site Conditions/Usage

The former disposal area is currently not utilized; the operational closure of Naval Station Roosevelt Roads occurred on March 31, 2004. The area is located in near-shore flat lands and consists of flat lying land with open areas and areas covered by secondary growth vegetation. During a physical site inspection and the Phase II ECP investigation (NAVFAC, 2005), numerous piles of construction debris (metal, concrete, and PVC piping) were observed in different portions of the site. General solid waste debris (i.e., metal, rope, etc.) was present, and the central portion of the site appeared to have excavation type of debris (i.e., concrete, rocks, etc.). However, there were no drums or evidence of stains or stressed vegetation. A majority of this site is covered in thick secondary growth vegetation. In addition, the central and southern portions of the site are classified as wetlands consisting of either estuarine-intertidal-scrub/shrub (broad-leaved evergreen) (E2SS3), or estuarine-intertidal-unconsolidated shore mud, organic, dead matter (E2US3/4/5).

2.2 Previous Investigations

The Phase I/II ECP investigation included the sampling and analysis of surface soil at six locations, subsurface soil at two locations, groundwater at three locations, and surface water with co-located sediment from two locations along the shoreline of the surface water body, Ensenada Honda. Analytical data from the Phase I/II ECP are presented in Appendix B, including comparisons to human health and ecological screening criteria used at that time. The tables also include comparison to the then applicable facility background levels for metals.

The area indicated as a disposal area located northwest of the current landfill was investigated during the ECP investigation, as shown on Figure 1-3. Surface soil samples were collected from six soil boring locations (16E-01 through 16E-06) from a depth of 0 to 1 foot below ground surface (bgs). Subsurface soil samples were only collected from soil boring 16E-01 and 16E-02. No subsurface samples were collected from soil boring locations 16E-03, 16E-04, 16E-05, and 16E-06 because the groundwater at these four locations was encountered at depths ranging from 0.3 foot bgs to 1.2 feet bgs. The subsurface soil that was obtained from 16E-01 and 16E-02 were collected to a depth of 15 feet bgs and 5 feet bgs, respectively. Groundwater at both locations was encountered at 5 feet bgs. The soil samples were obtained from 3 to 5 feet bgs and analyzed for Appendix IX VOCs, SVOCs, pesticides/ polychlorinated biphenyls (PCBs), organo-phosphorus- (OP-) pesticides, chlorinated herbicides, and metals.

A temporary monitor well was installed at soil boring location 16E-01, and groundwater samples were collected. Due to the shallow depth of groundwater at soil boring locations 16E-05 and 16E-06, the groundwater samples were collected by digging a sump in the area of the soil boring and utilizing the direct dip method immediately upon the sump filling with water. All groundwater samples were analyzed for Appendix IX VOCs, SVOCs, pesticides/ PCBs, OP-pesticides, chlorinated herbicides, and metals.

Two surface water and sediment sample locations were collected from the shoreline of this site along Ensenada Honda. Both surface water and sediment samples were analyzed for Appendix IX VOCs, SVOCs, pesticides/ PCBs, OP-pesticides, chlorinated herbicides, and metals.

Results indicated SWMU 70 has locations with detections of VOCs and SVOCs that are consistent with a former disposal area use. Only one organic compound, indeno(1,2,3-cd)pyrene, exceeded the USEPA Region III Tap Water Risk Based Concentration (RBC) in the groundwater at sample location 16E-05 . In the soil, arsenic,and vanadium exceeded their respective USEPA Region III Residential RBCs in all surface samples. Chromium exceeded its USEPA Region III Residential RBC at 16E-06. Arsenic and vanadium exceeded their USEPA Region III Industrial RBCs in surface samples at 16E-01 through 16E-05. Arsenic was found at its highest concentrations in surface soil in the area around location 16E-04 and 16E-05. Of these two, only arsenic also exceeded the background screening values used during the Phase I/II ECP for surface soil and subsurface soil at NAPR (NAVFAC Atlantic, 2005). Concentrations of arsenic in subsurface soil were higher than in surface soil, exceeding the USEPA Region III Industrial RBCs at 16E-01 and 16E-02. Vanadium exceeded the USEPA Region III Tap Water RBC in groundwater at 16E-01 and 16E-06. This is likely due to high background vanadium concentrations in the soil at NAPR. In the sediment samples, copper and tin exceeded the marine sediment screening values at 16E-SD01 and 16E-SD02. The sediment sample at 16E-SD02 also exceeded the marine sediment screening value for silver. No exceedances of criteria were noted in the surface water.

All analytical results from the ECP investigation can be found in Appendix B. No detections of pesticides/PCBs, OP-pesticides, or chlorinated herbicides were found during the Phase II ECP investigation performed at SWMU 70.

From the detections of compounds noted above, and the exceedances of criteria at this site, the Final Phase I/II ECP report (NAVFAC Atlantic, 2005) concluded that the soil, groundwater, and sediment may be slightly impacted from previous site activities. Therefore, the report recommended further investigation of the media at this SWMU.

3.0 SCOPE OF INVESTIGATION

Surface, subsurface soil, groundwater, and sediment samples will be collected from SWMU 70 as part of the Phase I RFI. Sampling locations presented in this section were identified based on the historical aerial photograph from 1976, 1977, 1985, and 1995 and ECP investigation results. Consideration was given to site topography, site features, historical operational features of the facility, and anticipated groundwater flow direction when selecting the sampling locations. The subsections that follow outline the specific sampling protocol.

The sampling and analytical program for this investigation is summarized in Table 3-1. The proposed sampling locations for SWMU 70 are shown on Figure 3-1. The various investigation elements are described in detail in the subsections that follow.

- Eight surface soil samples will be collected from eight boring locations
- A minimum of sixteen subsurface soil samples will be collected from the eight boring locations. Depending on site conditions, a minimum of two samples will be collected from different depths at each boring location. As stated in Section 2.2, groundwater was encountered from 0.3 foot to 1.2 feet bgs in the northern portion of the SWMU, and it may not be possible to collect subsurface soil samples due to shallow depth to groundwater. If very shallow groundwater is encountered during sampling, professional judgment by the field team will be used to determine if a subsurface soil sample will be collected.
- Eight groundwater samples will be collected from eight permanent monitoring wells installed at the boring locations.
- Three sediment samples will be collected from the shoreline along Ensenada Honda.
- No surface water samples will be collected from the Ensenada Honda because the previous data collected during the ECP showed no exceedances of criteria.

3.1 <u>Soil Sampling and Analysis Program</u>

Surface and subsurface soil samples will be collected from SWMU 70. The following outlines the specific sampling protocol.

Figure 3-1 identifies the location of eight soil borings that will be advanced at SWMU 70. These locations are based upon disturbed areas identified in historical aerial photographs (near/in the mangrove swamp) and the fact that groundwater is expected to flow in a south-southwestward direction toward the Ensenada Honda. Four of these locations are proposed at the northern end of the SWMU. Three of the four northern soil borings are proposed around 16E-01 where arsenic was detected at elevated levels in the subsurface soil, within the perimeters of the disturbed areas identified in historical aerial photographs. The fourth northern soil boring is proposed downgradient (southwest) of 16E-02. The fifth location is proposed within the central area of the SWMU at the northern boundary of the disturbed areas within the wetland boundary identified in historical aerial photographs. The sixth, seventh and eighth locations are proposed in the southwestern part of the SWMU based upon disturbed areas identified in historical aerial photographs (near/in the mangrove swamp) to determine potential migration of contaminants toward the Ensenada Honda.

One surface soil sample (0 to 1 foot bgs) and a minimum of two subsurface soil samples [based on flame ionization detector (FID)/ photo ionization detector (PID) screening] and one just above the water table interface will be collected from each boring location using 2-foot long split-spoon samplers (see SOP F102 in Baker , 1995). Additional samples may be selected based on field observations of potential contamination. It should be noted that some of the proposed soil boring locations are located near or in a mangrove swamp. Groundwater is very shallow in this area (generally less than 1-foot bgs), and it may not be possible to collect subsurface soil samples due to shallow depth to groundwater. If very shallow groundwater is encountered during sampling, professional judgment by the field team will be used to determine if a subsurface soil sample will be collected. A boring log will be prepared indicating blow counts, lithology, water occurrence, and miscellaneous observations. All the surface and subsurface samples will be analyzed for Appendix IX VOCs, SVOCs, PCBs, low-level polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH) gasoline range organics (GRO)/ diesel range organics (DRO), and metals as presented in Table 3-1. A boring log will be prepared indicating blow counts, lithology, water occurrence, FID/ PID readings, and miscellaneous (visual and olfactory) observations.

All soil sampling locations will be flagged in the field and will be surveyed for horizontal location utilizing a portable Global Positioning System (GPS) unit.

The surface soil samples will be obtained from a depth of 0 to 1 foot bgs with a stainless steel spoon. The subsurface soil samples will be obtained using split-spoon samplers during boring advancement for monitoring well installation (see SOP F102 in Baker, 1995).

The soil sample designations will include the SWMU location followed by extensions to reflect the depth at which the sample was obtained. For the purposes of this work plan, two-foot discrete depths will be used except for surface soil. Sample identification extensions will follow the pattern shown below.

70SB01-00 – SWMU 70 Sample
70SB01-00 – Soil Boring Sample
70SB01-00 – Soil boring location identifier
70SB01-00 - 0 to 1 foot bgs (surface soil) sampling interval

Subsurface soil samples will be designated as follows:

70SB01-01 – First subsurface sampling interval, 1 to 3 feet bgs
70SB01-02 – Second subsurface sampling interval, 3 to 5 feet bgs, etc.

Sample identification extensions will follow the pattern shown above. However, the actual sample depth will be determined in the field.

Following sample collection, each borehole not being converted into a permanent well will be backfilled with the remaining soil to the extent practicable, in order to minimize the burden of waste disposal. The surface of the borehole will then be patched with bentonite grout.

Samples will be packed in ice and shipped next day air to the “fixed base” laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the project manager for assisting in verification of receipt.

All analysis at the laboratory will be performed using current methodologies as presented in Table 3-2. All analytical work that is conducted on the mainland of the United States must be certified by a licensed Puerto Rico chemist. The specific laboratory and third party validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date. SOPs used by the analytical laboratory will be requested from the laboratory after selection.

3.2 Monitoring Well Installation Program

A total of eight permanent monitoring wells are proposed to be installed within the soil borings at SWMU 70. The locations of these monitoring wells (at 70SB01, 70SB02, 70SB03, 70SB04, 70SB05, 70SB06, 70SB07, and 70SB08) are presented on Figure 3-1. Each permanent monitoring well will be designated 70GW-, followed by the associated boring location number.

Monitoring wells will be installed using hollow-stem augers (HSAs) or air rotary techniques, depending on the underlying stratigraphy. The wells will be constructed of 2-inch inner diameter (ID), Schedule 40 PVC, with flush joint threads. Well screens will be 10-feet long and installed to straddle the water table.

- Soil sampling will be conducted in order to classify the soil during well installation. Upon completion of soil sampling, the borehole will be reamed as necessary to the desired depth using the prescribed drilling method. The well construction materials will be installed through the HSAs, casing, or in an open borehole.

- The well screen and bottom cap will be set at the bottom of the borehole. The screen will be connected to threaded, flush-joint, riser. An expandable, water tight locking cap or slip-cap with a vent hole will be placed at the top of the casing.

- The annular space around the well screen will be backfilled with a well-graded, fine to medium sand as the HSAs or casing are being withdrawn from the borehole. The sand will extend to approximately 2 feet above the top of the screened interval. The thickness of the sand above the screened interval may be reduced if the well is too shallow to allow for placement of adequate sealing material.

- An approximately 2-foot thick sodium bentonite seal (minimum of 6 inches for very shallow wells) will be placed above the sand pack. If bentonite pellets or chips are used, they will be sized appropriately given the well and borehole diameter and placed in a careful manner that will prevent bridging. The bentonite will be hydrated with potable water, as necessary.

- The annular space above the bentonite seal will be backfilled with cement/bentonite grout to prevent surface and near subsurface water from infiltrating into the screened groundwater monitoring zone. The grout will consist of five to ten percent (by dry weight) of bentonite powder and seven gallons of potable water per 94-pound bag of portland cement. For very shallow wells, the cement/bentonite grout may be omitted.

- The depth intervals of all backfilled materials will be measured with a weighted measuring tape to the nearest 0.1-foot and recorded in the field logbook.

- Wells in high traffic areas will be completed at the surface using a "flush" manhole type cover. The flush-mounted cover will be surrounded by a concrete pad and slightly elevated above the ground surface with the concrete sloping away from the cover to the existing ground surface. However, if any of the wells are relocated into areas that are heavily vegetated; these will be provided with 2 to 3 feet of "stickup" above ground surface. Steel protective casing will be placed over the riser and surrounded by a concrete pad. The pad will be a minimum of 2 feet by 2 feet (length x width) and 6 inches in thickness (with 2 inches set into the ground outside the casing), and extending 2 feet bgs inside the annular space around the well. If water table conditions prevent having a 24-inch thick bentonite seal, the concrete pad depth in the annular space around the well may be decreased. Steel bollards will be installed around the concrete pad as additional protection and painted a bright color to aid in visibility.

- All wells will have a locking cap installed on the PVC riser or protective steel casing.

In the event of shallow refusal or other reason for relocating a monitoring well location, the borehole will be abandoned by backfilling with the drill cuttings to the extent practicable, in order to minimize the burden of waste disposal. The surface of the borehole will then be patched with bentonite grout.

Each new permanent monitoring well will be developed using pumping and surging methods (see SOP F103 in Baker, 1995) after allowing suitable time for the cement/bentonite grout to cure (typically a minimum of 24 hours). The purpose of well development is to restore the permeability of the formation which may have been reduced by the drilling operations and to remove fine-grained materials that may have entered/accumulated in the well or filter pack. The two existing wells, 13GW11 and 13GW07, will also be developed prior to sampling to clean the screen and immediate annulus and allow adequate hydraulic communication with the surrounding formation. The wells will be developed until the discharged water runs relatively clear of fine-grained materials. It should be noted that the water in some wells does not clear with continued development. Typical limits placed on well development may include any one or a combination of the following:

- Clarity of water based on visual determination

- A maximum time period (typically two hours for shallow wells)

- A maximum borehole volume (typically three to five borehole volumes plus the amount of any water added during the drilling or installation process)

- Stability of pH, specific conductance, and temperature measurements (typically less than 10 percent change between three successive measurements)

- Clarity based on turbidity measurements [typically less than 20 Nephelometric Turbidity Units (NTU)]

- A record of the well development will be completed to document the development process.

It should be noted that three of the eight proposed permanent monitoring well locations are located near or in a mangrove swamp. Groundwater is very shallow in these areas (generally less than 1-foot bgs), and the ground may be too soft to install a typical permanent well. In those cases, groundwater will be obtained by inserting a five foot screen into the ground and collecting a sample immediately upon the screen filling with water. A deviation from the standard permanent monitoring well installation and development will be noted in the monitoring well installation logs for these wells.

3.3 Groundwater Sampling and Analysis Program

The groundwater sampling will be used to aid in characterization of the groundwater potentially affected by activities associated with SWMU 70. All groundwater samples will be submitted to the laboratory for analyses including the following:

Eight groundwater samples will be collected from the eight boring locations (70SB01, 70SB02, 70SB03, 70SB04, 70SB05, 70SB06, 70SB07, and 70SB08) will be analyzed for Appendix IX VOCs, SVOCs, PCBs, total and dissolved metals, low-level PAHs, and TPH GRO/DRO (refer to Table 3-1).

The groundwater will be sampled using a low-flow sampling technique. Appendix C includes a detailed description of low flow sampling technique. Field parameters of pH, temperature, turbidity, conductivity, dissolved oxygen, and oxidation-reduction potential will be obtained with appropriate instrumentation during sampling from the permanent wells, if enough volume of groundwater is present.

As previously noted, three of the eight proposed permanent monitoring well locations are located near or in a mangrove swamp. Groundwater is very shallow in these areas (generally less than 1-foot bgs), and it may not be possible to install a permanent well. In those cases, groundwater will be obtained by inserting a five foot screen into the ground and then sampling using dedicated tubing and a peristaltic pump to extract the groundwater by using the low-flow purging and sampling technique described in Appendix D to the extent possible. The shallow monitoring wells at these locations may not be suitable for development using conventional techniques; therefore, in order to reduce the turbidity of the samples, the low-flow purging and sampling technique will be used and deviations in attainment of stability of the parameters will be noted in the sampling logs..

Samples will be packed in ice and shipped next day air to the "fixed base" laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the Project Manager for assisting in verification of receipt.

All analyses at the laboratory will be performed using current methodologies as presented in Table 3-2. All analytical work that is conducted on the mainland of the United States must be certified by a licensed Puerto Rico chemist. The specific laboratory and validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date. SOPs used by the analytical laboratory will be requested from the laboratory after selection.

3.4 Sediment Sampling and Analysis Program

A total of three sediment samples will be collected from the shoreline boundary of the SWMU along Ensenada Honda. The samples will be obtained using disposable, stainless steel spoons and/or petite ponar dredge, or acetate sediment liner. The samples will be placed in a disposable aluminum pan, homogenized with a stainless steel spoon following the removal of debris (e.g., vegetation/roots), then placed in the sample container. All pertinent sampling information such as sediment description (e.g., color and texture), sample number and location, presence or absence of aquatic invertebrates, and the time of sample collection will be recorded in the field logbook.

Samples will be packed in ice and shipped next day air to the "fixed base" laboratory. Because of previously encountered delays associated with sample shipments from Puerto Rico to the United States, additional insurance to cover re-sampling costs should be claimed on the bill of laden. At least one member of the field team will remain on the island until verification by the laboratory of receipt of all shipments. This will minimize any potential re-sampling costs associated with mobilization. Tracking numbers for each shipment will be forwarded to the Project Manager for assisting in verification of receipt.

All sediment samples will be analyzed for Appendix IX VOCs, SVOCs, PCBs, total metals, low-level PAHs, and TPH GRO/DRO (refer to Table 3-1). All analytical work that is conducted on the mainland of the United States must be certified by a licensed Puerto Rico chemist. Again, the specific laboratory and third party validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date. SOPs used by the analytical laboratory will be requested from the laboratory after selection.

3.5 Quality Assurance/Quality Control

Field specific quality assurance/quality control (QA/QC) procedures are given below. QA/QC samples will be analyzed for parameters as shown in Tables 3-1 and 3-3 by methods presented in Table 3-2.

QA/QC samples will be obtained during these investigations. These will include the collection of equipment rinsate samples, field blanks, trip blanks, field duplicates, and matrix spike/matrix spike duplicate (MS/MSD). QA/QC requirements for the investigations are as follows and are identified in the sample matrix presented in Table 3-3.

Equipment rinsate blanks will be collected daily from reusable (non-dedicated and non-disposable) sampling equipment during the sampling event. Initially, samples from every other day should be analyzed. If analytes pertinent to the project are detected in any equipment rinsate blank, the remaining rinsate blanks will be analyzed. As an added level of QA/QC, a rinsate blank will also be collected from each batch of disposable sampling tools such as stainless steel spoons, groundwater sample tubing, acetate sediment collection liner, aluminum pie pan, etc. The results from the blanks will be used to verify that the decontamination of reusable equipment had rendered them free of cross-contaminating chemicals at levels of concern for the site; and to verify that disposable sampling tools were free of contaminants at levels of concern for the site. This comparison is made during data validation, and the equipment rinsate blank is analyzed for the same parameters as the related samples.

Field blank samples consist of the source water used in equipment decontamination procedures. At a minimum, one field blank for each source of water must be collected and analyzed for the same parameters as the related samples. It is anticipated that three different sources of water (i.e., NAPR potable water source, store-bought distilled water, and laboratory-grade de-ionized water) will be utilized for this investigation as shown in Table 3-3.

Trip blank samples will be required to accompany the samples to the laboratory because there are volatile organic and/or TPH GRO constituent samples scheduled for collection. One trip blank sample will accompany each cooler containing samples requiring the Appendix IX VOC and/or TPH GRO analysis.

Field duplicate samples of the surface soil, subsurface soil, groundwater, and sediment will be collected during the same time the corresponding environmental sample is collected. One duplicate sample will be collected for every 10 environmental samples collected per media. Groundwater sample duplicates will include a minimum of one unfiltered and one filtered sample. Analysis of duplicate and blanks associated with soil and groundwater sampling will include Appendix IX constituents.

Matrix Spike/Matrix Spike Duplicates (MS/MSDs) are laboratory derived and are collected to evaluate the matrix effect of the sample upon the analytical methodology. One MS/MSD will be collected for every 20 samples collected of a similar matrix. The sample matrices in the preceding paragraphs specified the collection and analysis of these samples.

3.6 Data Validation

All mainland laboratory data generated by the investigation will be subjected to independent, third party, validation. The USEPA Region II Data Validation Standard Operating Procedures will be followed. The specific data validator will be determined at a later date.

3.7 Other Field Activities

During the investigation, the following activities will be performed:

- Utility Clearance
- Investigation Derived Waste (IDW) Management
- Decontamination
- Surveying
- Health and Safety Procedures
- Chain of Custody

3.7.1 Utility Clearance

If this work plan is initiated while NAPR is still under operation, the following procedure must be followed to obtain utility clearance. Fifteen days prior to the initiation of the proposed fieldwork, a digging permit request will be submitted to the Facility Management Transportation and Utility Division (FMTUD) of the Public Works Department at NAPR. Utilities are identified on the Geographic Information System (GIS) utility layer, and all proposed soil borings and permanent monitoring well locations will be cleared by the base utility department.

3.7.2 Investigation Derived Wastes

The generation of IDW associated with soil sampling and monitoring well installation, including soil cuttings and decontamination fluids, will be collected and stored temporarily in 55-gallon drums. However, the soil cuttings from the subsurface soil sampling will be placed back into the boring from which they came, unless grossly visible contamination is present. As much as possible, soils last out of the hole will be returned first, thereby, approximating the original stratigraphy.

Two IDW samples will be collected during this investigation. One composite aqueous sample will be collected from all drums containing decontamination fluid (from sampling equipment and drill rig), and one composite soil sample will be collected from all drums containing drill cuttings. The samples will be analyzed for parameters as shown in Table 3-3, as well as by methods presented in Table 3-2. These samples will provide the necessary data to be able to dispose of the generated IDW at an appropriate disposal facility. Upon completion of the field program, the drums will be moved and stored at a secure location by the contractor. The soil and water IDW will be removed and disposed of from the site by an approved vendor upon receipt and review of the IDW sample analytical data.

3.7.3 Decontamination

All reusable (non-dedicated and non-disposable) soil sampling, sediment sampling, and monitoring well installation equipment (i.e. augers, bits, split-spoon samplers, petite ponar dredge, etc.), will be decontaminated between each sampling location in accordance with SOPs F501 and F502 (Baker, 1995). The drill rig will be decontaminated before arriving at the site and before leaving the site. The remaining contaminant-free sampling equipment and materials utilized during this investigation will be disposable.

3.7.4 Surveying

All soil sampling locations have been pre-determined and presented on a figure prior to entering the field. This figure will be loaded into the GPS unit for locating purposes in the field. This methodology reduces the need for a surveyor to identify the sampling locations in the field. Any of the locations that may need to be field modified will be located utilizing the GPS unit. Traditional survey equipment or survey grade GPS unit will be utilized to obtain vertical (+/- 0.01 foot) and horizontal (+/- 0.1 foot) locations and top of PVC elevations of the monitoring wells for generating groundwater contours used for reporting purposes.

3.7.5 Health and Safety Procedures

The health and safety procedures previously presented in the RFI Management Plans (Baker, 1995) will be employed during this investigation.

3.7.6 Chain-of-Custody

Chain-of-Custody procedures will be followed to ensure a documented, traceable link between measurement results and the sample/parameter that they represent. These procedures are intended to provide a legally acceptable record of sample preparation, storage, and analysis.

To track sample custody transfers before ultimate disposition, sample custody will be documented using a similar chain-of-custody form as presented in the RFI Management Plans (Baker, 1995). A chain-of-custody form will be completed for each shipment in which the samples are shipped. After the samples are properly packaged, the shipping container will be sealed and prepared for shipment to the analytical laboratory.

4.0 REPORTING

This section outlines the reporting activities that are associated with the field investigation. The reports shall include at a minimum:

- Introduction
- SWMU Investigation
- Physical Characteristics of Study Area
- Nature and Extent of Contamination
- Conclusions and Recommendations
- References

The Phase I RFI reports sections are discussed in the following subsection.

4.1 Introduction and Site Background

The introduction will consist of a discussion of site location, its current conditions and its historical background, including any investigations conducted at the SWMU. The introduction will also provide a regulatory framework for NAPR and the SWMU, as well as a discussion of current conditions.

4.2 SWMU Investigation

The investigation methodologies employed to fulfill the Phase I RFI work plan objectives for the SWMU will be discussed, including the sample locations, sample collection and handling procedures, QA/QC procedures, and analytical methods used. This section will also discuss any problems encountered including any deviations from the work plan and problem resolution.

4.3 Physical Characteristics of Study Area

The physical characteristics of the SWMU will be recorded in the field. Those observations will be photographically recorded and summarized in this section.

4.4 Nature and Extent of Contamination

The nature and extent of contamination section will present analytical results and interpretation of the data. The surface and subsurface soil analytical data will be screened against USEPA Region IX Residential and Industrial Preliminary Remediation Goals (PRGs). Analytical data for surface soil and subsurface soil collected from the 1 to 3-foot depth interval also will be compared to ecological soil screening values previously developed for use in ecological risk assessments (ERAs) at NAPR (Baker, 2006a and 2006b). The ecological soil screening values will be updated as necessary to reflect current information from the literature (i.e., ecological soil screening levels [Eco-SSLs] available at http://www.epa.gov/ecotox/ecossl/). Analytical data for subsurface soil collected from deeper depth intervals (e.g., 3 to 5-feet bgs) will not be compared to ecological soil screening values since these depths are not likely to represent a significant exposure point for ecological receptors (most heterotrophic activity and soil invertebrates occur on the surface or within the oxidized root zone [Suter II, 1995]) The groundwater analytical data will be compared to USEPA Region IX Tap Water PRGs, Federal maximum contaminant levels (MCLs), and ecological surface water screening values. The groundwater analytical data will be compared to ecological surface water screening values based on the close proximity of SWMU 70 to the Ensenada Honda (see Figure 1-2). Similarly, due to the physical characteristics (i.e., wetlands, mangrove swamp) and proximity to

Ensenada Honda, sediment analytical data will be compared to ecological sediment screening values. The sediment substrate at certain locations is expected to be typically very soft and difficult for traversing under normal conditions. However, under dry weather conditions, these conditions may be more amenable for potential human receptors to traverse. Therefore, as an added conservative measure, sediment samples will be compared to human health screening levels (USEPA Region IX Residential and Industrial PRGs. Identical to the ecological soil screening values, ecological surface water and sediment screening values used in the comparison will be those previously developed for use in ERAs at NAPR (Baker, 2006a and 2006b). Ecological surface water and sediment screening values will be updated as necessary to reflect current information from the literature.

For a given medium (surface soil, subsurface soil, groundwater, and sediment), analytical data for inorganic chemicals exceeding one or more of the screening values (human health or ecological) will be statistically compared to background analytical data in accordance with Navy guidance (Naval Facilities Engineering Service Center [NFESC], 2002, 2003, and 2004). The background analytical data used in the statistical evaluations will be those contained in the Revised Final Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2006c). The process that will be used to statistically evaluate the data is depicted in Figure 4-1. As shown by the figure, statistical evaluations will include descriptive summaries of each data set (range of detected values, range of non-detected values, maximum, mean, and 95 percent upper confidence limit [UCL] of the mean concentrations), statistical tests on the mean/median of the distributions (i.e., student's t-test, Gehan test, Satterthwaite's t-test, or Wilcoxon rank sum test), statistical tests on the right tail of the distributions (i.e., quantile test and slippage test), and proportional statistics (two-sample test of proportions). The significance level (the probability criteria for rejecting the null hypotheses that data sets were sampled from the same population) will be set at 0.05 for all statistical tests in accordance with Navy guidance (NFESC, 2002, 2003, and 2004).

The results of the screening and statistical evaluations will be presented on tables and figures with textual explanation. Results of QA/QC procedures also will be presented within the nature and extent of contamination section.

4.5 Conclusions and Recommendations

Information from the nature and extent of contamination will be synthesized into conclusions regarding the extent of the releases to the environmental media at the site. Recommendations will be made from these conclusions as to whether a full RFI is needed or if the SWMU can proceed toward a determination of Corrective Action Complete.

5.0 SCHEDULE

A schedule for the implementation of this work plan, and follow-up reports for the Phase I RFI reports for SWMU 70 is provided as Figure 5-1.

It should be noted that this schedule is dependent upon USEPA review time. Many other factors can also extend the schedule such as resampling if further re-characterization is required, weather delays in the field, funding delays by the Navy, or consensus cannot be reached on how the USEPA's comments are to be incorporated.

6.0 SITE MANAGEMENT

An organization chart presenting the proposed staffing for this project is provided on Figure 6-1. This section also outlines the responsibilities and reporting requirements of field personnel and staff.

6.1 Project Team Responsibilities

Mr.Mark Kimes, P.E., Activity Coordinator for all work in Puerto Rico, will manage the Baker Project Team. His responsibilities will be to direct the technical performance of the project staff, costs and schedule, ensuring that QA/QC procedures are followed during the course of the project. He will maintain communication with the BRAC PMO SE, Navy Technical Representative (NTR), Mr. Mark Davidson. Mr. John Mentz will administer overall QA/QC for this project.

The field activities of this project will consist of one field team managed by the Geologist, Mr. Joseph Burawa. Mr. Burawa's responsibilities include directing the field team and subcontractors. Mr. Rick Aschenbrenner, P.E. will direct the reporting effort associated with the field investigation, ensuring that all necessary staffing is utilized to assist in developing the Phase I RFI Reports for SWMU 70.

6.2 Field Reporting Requirements

The Geologist will maintain a daily summary of each day's field activities. The following information will be included in this summary:

- Contractor and subcontractor personnel on site
- Major activities of the day
- Samples collected
- Problems encountered
- Other pertinent site information

The Geologist will receive direction from the Project Manager regarding any changes in scope of the investigation.

7.0 REFERENCES

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NFESC. 2003. Guidance for Environmental Background Analysis. Volume II: Sediment. NFESC User's Guide UG-2054-ENV. April 2003

NFESC. 2002. Guidance for Environmental Background Analysis. Volume I: Soil. NFESC User's Guide UG-209-ENV. April 2002.

Suter II, G.W. 1995. Guide for Performing Screening Ecological Risk Assessments at DOE Facilities. Oak Ridge National Laboratory, Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-153.

TABLES

TABLE 3-1
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

		Fixed Based Analytical Lab Analysis								
Media	**Sample Depth (ft bgs)**	App IX VOCs	App IX SVOCs	App IX PCBs	Low Level PAHs	App IX Metals (Total)	App IX Metals (Dissolved)	TPH DRO	TPH GRO	**Comment**
Surface Soil Samples										
70SB01-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB02-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB03-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB04-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB05-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB06-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB07-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB08-00	0.0 - 1.0	X	X	X	X	X		X	X	
70SB08-00D	0.0 - 1.0	X	X	X	X	X		X	X	Duplicate
70SB08-00MS/MSD	0.0 - 1.0	X	X	X	X	X		X	X	Matrix Spike/Matrix Spike Duplicate
Subsurface Soil Samples[2]										
70SB01-XX[1]	TBD	X	X	X	X	X		X	X	
70SB01-XX[1]	TBD	X	X	X	X	X		X	X	
70SB02-XX[1]	TBD	X	X	X	X	X		X	X	
70SB02-XX[1]	TBD	X	X	X	X	X		X	X	
70SB03-XX[1]	TBD	X	X	X	X	X		X	X	
70SB03-XX[1]	TBD	X	X	X	X	X		X	X	
70SB04-XX[1]	TBD	X	X	X	X	X		X	X	
70SB04-XX[1]	TBD	X	X	X	X	X		X	X	
70SB05-XX[1]	TBD	X	X	X	X	X		X	X	
70SB05-XX[1]	TBD	X	X	X	X	X		X	X	
70SB05-XXD[1]	TBD	X	X	X	X	X		X	X	Duplicate
70SB06-XX[1]	TBD	X	X	X	X	X		X	X	
70SB06-XX[1]	TBD	X	X	X	X	X		X	X	
70SB07-XX[1]	TBD	X	X	X	X	X		X	X	
70SB07-XX[1]	TBD	X	X	X	X	X		X	X	
70SB08-XX[1]	TBD	X	X	X	X	X		X	X	
70SB08-XX[1]	TBD	X	X	X	X	X		X	X	
70SB08-XXD[1]	TBD	X	X	X	X	X		X	X	Duplicate
70SB08-XXMS/MSD[1]	TBD	X	X	X	X	X		X	X	Matrix Spike/Matrix Spike Duplicate

TABLE 3-1
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

		Fixed Based Analytical Lab Analysis								
Media	**Sample Depth (ft bgs)**	App IX VOCs	App IX SVOCs	App IX PCBs	Low Level PAHs	App IX Metals (Total)	App IX Metals (Dissolved)	TPH DRO	TPH GRO	**Comment**
Groundwater Samples										
70TW01	NA	X	X	X	X	X	X	X	X	
70TW02	NA	X	X	X	X	X	X	X	X	
70TW03	NA	X	X	X	X	X	X	X	X	
70TW04	NA	X	X	X	X	X	X	X	X	
70TW05	NA	X	X	X	X	X	X	X	X	
70TW06	NA	X	X	X	X	X	X	X	X	
70TW07	NA	X	X	X	X	X	X	X	X	
70TW08	NA	X	X	X	X	X	X	X	X	
70TW08D	NA	X	X	X	X	X	X	X	X	Duplicate
70TW08MS	NA	X	X	X	X	X	X	X	X	Matrix Spike
70TW08MSD	NA	X	X	X	X	X	X	X	X	Matrix Spike Duplicate
Sediment Samples										
70SD01	NA	X	X	X	X	X		X	X	
70SD02	NA	X	X	X	X	X		X	X	
70SD03	NA	X	X	X	X	X		X	X	
70SD03D	NA	X	X	X	X	X		X	X	Duplicate
70SD03MS/MSD	NA	X	X	X	X	X		X	X	Matrix Spike/Matrix Spike Duplicate

Notes:

(1) - XX is the designator for the depth interval from which the sample will be collected (i.e., 01 = 1-3 ft bgs, or 02 = 3-5 ft bgs, etc.)

(2) - Although two subsurface soil samples are proposed per boring, additional subsurface soil will be collected if areas of staining or other indicators of contamination are encountered at multiple depths. In this event, the number of QA/QC samples outlined in Section 3.5 and listed on Table 3-3 will be adjusted.

ft bgs - feet below ground surface.

NA - Not Applicable.

TBD - To be determined in the field

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Volatiles	Water (μg/L)	Low Soil (μg/kg)	Method Number
Acetone	25	50	8260B (5030B)(low level)
Acetonitrile	40	200	8260B (5030B)(low level)
Acrolein	20	100	8260B (5030B)(low level)
Acrylonitrile	20	100	8260B (5030B)(low level)
Benzene	1.0	5.0	8260B (5030B)(low level)
Bromodichloromethane	1.0	5.0	8260B (5030B)(low level)
Bromoform	1.0	5.0	8260B (5030B)(low level)
Bromomethane	1.0	10	8260B (5030B)(low level)
Carbon Disulfide	1.0	5.0	8260B (5030B)(low level)
Carbon Tetrachloride	1.0	5.0	8260B (5030B)(low level)
Chlorobenzene	1.0	5.0	8260B (5030B)(low level)
Chloroethane	1.0	10	8260B (5030B)(low level)
Chloroform	1.0	5.0	8260B (5030B)(low level)
Chloromethane	1.0	10	8260B (5030B)(low level)
Chloroprene	1.0	5.0	8260B (5030B)(low level)
3-Chloro-1-propene	1.0	5.0	8260B (5030B)(low level)
1,2-Dibromo-3-chloropropane	1.0	10	8260B (5030B)(low level)
Dibromochloromethane	1.0	5.0	8260B (5030B)(low level)
1,2-Dibromoethane	1.0	5.0	8260B (5030B)(low level)
Dibromomethane	1.0	5.0	8260B (5030B)(low level)
trans-1,4-Dichloro-2-butene	2.0	10	8260B (5030B)(low level)
Dichlorodifluoromethane	1.0	5.0	8260B (5030B)(low level)
1,1-Dichloroethane	1.0	5.0	8260B (5030B)(low level)
1,2-Dichloroethane	1.0	5.0	8260B (5030B)(low level)
trans-1,2-dichloroethene	1.0	5.0	8260B (5030B)(low level)
1,1-Dichloroethene	1.0	5.0	8260B (5030B)(low level)
Methylene Chloride	5.0	5.0	8260B (5030B)(low level)
1,2-Dichloropropane	1.0	5.0	8260B (5030B)(low level)
cis-1,3-Dichloropropene	1.0	5.0	8260B (5030B)(low level)
trans-1,3-Dichloropropene	1.0	5.0	8260B (5030B)(low level)
Ethyl benzene	1.0	5.0	8260B (5030B)(low level)
Ethyl methacrylate	1.0	5.0	8260B (5030B)(low level)
2-Hexanone	10	25	8260B (5030B)(low level)
Iodomethane	5.0	5.0	8260B (5030B)(low level)
Isobutanol	40	200	8260B (5030B)(low level)
Methacrylonitrile	20	100	8260B (5030B)(low level)
2-Butanone	10	25	8260B (5030B)(low level)
Methyl methacrylate	1.0	5.0	8260B (5030B)(low level)
4-Methyl-2-pentanone	10	25	8260B (5030B)(low level)

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Volatiles (Cont.)	Quantitation Limits* Water (μg/L)	Low Soil (μg/kg)	Method Number
Pentachloroethane	5.0	25	8260B (5030B)(low level)
Propionitrile	20	100	8260B (5030B)(low level)
Stryene	1.0	5.0	8260B (5030B)(low level)
1,1,1,2-Tetrachloroethane	1.0	5.0	8260B (5030B)(low level)
1,1,2,2-Tetrachloroethane	1.0	5.0	8260B (5030B)(low level)
Tetrachloroethene	1.0	5.0	8260B (5030B)(low level)
Toluene	1.0	5.0	8260B (5030B)(low level)
1,1,1-Trichloroethane	1.0	5.0	8260B (5030B)(low level)
1,1,2-Trichloroethane	1.0	5.0	8260B (5030B)(low level)
Trichloroethene	1.0	5.0	8260B (5030B)(low level)
Trichlorofluoromethane	1.0	5.0	8260B (5030B)(low level)
1,2,3-Trichloropropane	1.0	5.0	8260B (5030B)(low level)
Vinyl Acetate	2.0	10	8260B (5030B)(low level)
Vinyl Chloride	1.0	10	8260B (5030B)(low level)
Xylene	2.0	10	8260B (5030B)(low level)

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Semivolatiles	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Acenaphthene	10	330	8270C
Acenaphthylene	10	330	8270C
Acetophenone	10	330	8270C
2-Acetylaminofluorene	10	330	8270C
4-Aminobiphenyl	20	330	8270C
Aniline	20	660	8270C
Anthracene	10	330	8270C
Aramite	10	330	8270C
Benzo(a)anthracene	10	330	8270C
Benzo(b)fluoranthene	10	330	8270C
Benzo(k)fluoranthene	10	330	8270C
Benzo(g,h,i)perylene	10	330	8270C
Benzo(a)pyrene	10	330	8270C
Benzyl alcohol	10	330	8270C
Bis(2-chloroethoxyl)methane	10	330	8270C
Bis(2-chloroethyl)ether	10	330	8270C
Bis(2-ethylhexyl)phthalate	10	330	8270C
4-Bromophenyl phenyl ether	10	330	8270C
Butylbenzylphthalate	10	330	8270C
4-Chloroaniline	20	660	8270C
4-Chloro-3-methylphenol	10	330	8270C
2-Chloronaphthalene	10	330	8270C
2-Chlorophenol	10	330	8270C
4-Chlorophenyl phenyl ether	10	330	8270C
Chrysene	10	330	8270C
3&4 Methylphenol	10	330	8270C
2-Methylphenol	10	330	8270C
Diallate	10	330	8270C
Dibenzofuran	10	330	8270C
Di-n-butyl phthalate	10	330	8270C
Dibenzo(a,h)anthracene	10	330	8270C
o-Dichlorobenzene	10	330	8270C
m-Dichlorobenzene	10	330	8270C
p-Dichlorobenzene	10	330	8270C
3,3'-Dichlorobenzidine	20	660	8270C
2,4-Dichlorophenol	10	330	8270C
2,6-Dichlorophenol	10	330	8270C
Diethylphthalate	10	330	8270C
p-(Dimethylamino)azobenzene	10	330	8270C
7,12-Dimethyl benz(a)anthracene	10	330	8270C
3,3-Dimethyl benzidine	20	1,700	8270C
2,4-Dimethylphenol	10	330	8270C
alpha, alpha-Dimethylphenethylamine	2,000	67,000	8270C
Dimethyl phthalate	10	330	8270C

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

	Quantitation Limits*		
Semivolatiles (Cont.)	Water (µg/L)	Low Soil (µg/kg)	Method Number
m-Dinitrobenzene	10	330	8270C
4,6-Dinitro-2-methylphenol	50	1,700	8270C
2,4-Dinitrophenol	50	1,700	8270C
2,4-Dinitrotoluene	10	330	8270C
2,6-Dinitrotoluene	10	330	8270C
Di-n-octylphthalate	10	330	8270C
1,4-Dioxane	10	330	8270C
Dinoseb	10	330	8270C
Ethylmethanesulfonate	10	330	8270C
Fluoranthene	10	330	8270C
Fluorene	10	330	8270C
Hexachlorobenzene	10	330	8270C
Hexachlorobutadiene	10	330	8270C
Hexachlorocyclopentadiene	10	330	8270C
Hexachloroethane	10	330	8270C
Hexachlorophene	5,000	170,000	8270C
Hexachloropropene	10	330	8270C
Indeno(1,2,3-cd)pyrene	10	330	8270C
Isophorone	10	330	8270C
Isosafrole	10	330	8270C
Methapyrilene	2,000	67,000	8270C
3-Methylcholanthrene	10	330	8270C
Methyl methanesulfonate	10	330	8270C
2-Methylnaphthalene	10	330	8270C
Naphthalene	10	330	8270C
1,4-Naphthoquinone	10	330	8270C
1-Naphthylamine	10	330	8270C
2-Naphthylamine	10	330	8270C
2-Nitroaniline	50	1,700	8270C
3-Nitroaniline	50	1,700	8270C
4-Nitroaniline	50	1,700	8270C
Nitrobenzene	10	330	8270C
2-Nitrophenol	10	330	8270C
4-Nitrophenol	50	1,700	8270C
4-Nitroquinoline-1-oxide	20	3,300	8270C
n-Nitrosodi-n-butylamine	10	330	8270C
n-Nitrosodiethylamine	10	330	8270C
n-Nitrosodimethylamine	10	330	8270C
n-Nitrosodiphenylamine	10	330	8270C
n-Nitrosodi-n-propylamine	10	330	8270C
n-Nitrosomethylethylamine	10	330	8270C
n-Nitrosomorpholine	10	330	8270C
n-Nitrosopiperidine	10	330	8270C
n-Nitrosopyrrolidine	10	330	8270C

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Semivolatiles (Cont.)	Quantitation Limits*		Method Number
	Water (μg/L)	Low Soil (μg/kg)	
5-Nitro-o-toluidine	10	330	8270C
bis-(2-chloroisopropyl)ether	10	330	8270C
Pentachlorobenzene	10	330	8270C
Pentachloronitrobenzene	10	330	8270C
Pentachlorophenol	50	1,700	8270C
Phenacetin	10	330	8270C
Phenanthrene	10	330	8270C
Phenol	10	330	8270C
1,4-Phenylenediamine	2,000	1,700	8270C
2-Picolin	10	330	8270C
Pronamide	10	330	8270C
Pyrene	10	330	8270C
Pyridine	50	330	8270C
Safrole	10	330	8270C
1,2,4,5-Tetrachlorobenzene	10	330	8270C
2,3,4,6-Tetrachlorophenol	10	330	8270C
o-Toluidine	20	330	8270C
1,2,4-Trichlorobenzene	10	330	8270C
2,4,5-Trichlorophenol	10	330	8270C
2,4,6-Trichlorophenol	10	330	8270C
1,3,5-Trinitrobenzene	10	330	8270C
Low Level PAHs	**Quantitation Limits***		**Method Number**
	Water (μg/L)	**Low Soil (μg/kg)**	
Acenaphthene	0.2	6.7	8270C
Acenaphthylene	0.2	6.7	8270C
Anthracene	0.2	6.7	8270C
Benzo(a)anthracene	0.2	6.7	8270C
Benzo(b)fluoranthene	0.2	6.7	8270C
Benzo(k)fluoranthene	0.2	6.7	8270C
Benzo(g,h,i)perylene	0.2	6.7	8270C
Benzo(a)pyrene	0.2	6.7	8270C
Chrysene	0.2	6.7	8270C
Dibenzo(a,h)anthracene	0.2	6.7	8270C
Fluoranthene	0.2	6.7	8270C
Fluorene	0.2	6.7	8270C
Indeno(1,2,3-cd)pyrene	0.2	6.7	8270C
1-Methylnaphthalene	0.2	6.7	8270C
2-Methylnaphthalene	0.2	6.7	8270C
Naphthalene	0.2	6.7	8270C
Phenanthrene	0.2	6.7	8270C
Pyrene	0.2	6.7	8270C

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

PCBs	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
Aroclor-1016	1.0	33	8082
Aroclor-1221	2.0	67	8082
Aroclor-1232	1.0	33	8082
Aroclor-1242	1.0	33	8082
Aroclor-1248	1.0	33	8082
Aroclor-1254	1.0	33	8082
Aroclor-1260	1.0	33	8082
Total Petroleum Hydrocarbons	**Quantitation Limits***		**Method Number**
	Water (µg/L)	**Low Soil (µg/kg)**	
TPH DRO	100	3300	8015B
TPH GRO	50	250	8015B

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.
µg/L - micrograms per liter.
µg/kg - micrograms per kilogram.

TABLE 3-2
METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Inorganics	Method Number	Water (µg/L)	Low Soil (mg/kg)	Method Description
Antimony	6010B	20	2.0	Inductively Coupled Plasma
Arsenic	6010BB	10	1.0	Inductively Coupled Plasma
Barium	6010B	10	1.0	Inductively Coupled Plasma
Beryllium	6010B	4.0	0.4	Inductively Coupled Plasma
Cadmium	6010B	5.0	0.5	Inductively Coupled Plasma
Chromium	6010B	10	1.0	Inductively Coupled Plasma
Cobalt	6010B	10	1.0	Inductively Coupled Plasma
Copper	6010B	20	2.0	Inductively Coupled Plasma
Lead	6010B	5.0	0.5	Inductively Coupled Plasma
Mercury	7470A/7471A	0.2	0.02	Cold Vapor AA
Nickel	6010B	40	4.0	Inductively Coupled Plasma
Selenium	6010B	10	1.0	Inductively Coupled Plasma
Silver	6010B	10	1.0	Inductively Coupled Plasma
Thallium	6010B	10	1.0	Inductively Coupled Plasma
Tin	6010B	10	5.0	Inductively Coupled Plasma
Vanadium	6010B	10	1.0	Inductively Coupled Plasma
Zinc	6010B	20	2.0	Inductively Coupled Plasma

RCRA Metals	Method Number	Quantitation Limits*		Method Description
		Soil (mg/kg)	Water (µg/L)	
Arsenic	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Barium	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Cadmium	6010B(3050B/3010A)	0.50	5	Inductively Coupled Plasma
Chromium	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Lead	6010B(3050B/3010A)	0.50	5.0	Inductively Coupled Plasma
Mercury	7470A/7471A	0.020	0.20	Cold Vapor AA
Selenium	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma
Silver	6010B(3050B/3010A)	1.0	10	Inductively Coupled Plasma

Notes:
* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.
µg/L - micrograms per liter.
mg/kg - milligrams per kilogram.

TABLE 3-3
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
QA/QC SAMPLES AND IDW SAMPLES
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

	Aqueous Samples Analysis Requested									Solid Samples Analysis Requested		
Media	App IX VOCs	App IX SVOCs	App IX PCBs	Low Level PAHs	App IX Metals (Total)	TPH DRO	TPH GRO	Benzene	RCRA Metals	Benzene	RCRA Metals	**Comment**
Trip Blank Samples												
2007TB01	X[1]						X[1]					
2007TB02	X[1]						X[1]					
2007TB03	X[1]						X[1]					
2007TB04	X[1]						X[1]					
Equipment Rinsate Samples												
2007ER01	X	X	X	X	X	X	X					Stainless Steel Spoon
2007ER02	X	X	X	X	X	X	X					Split Spoon Sampler or Macro Core Liner
2007ER03	X	X	X	X	X	X	X					Polyethylene and Silicon Tubing
2007ER04	X	X	X	X	X	X	X					Petite Ponar Dredge, Acetate Sediment Liner, Stainless Steel Spoon, or Aluminum Pie Pan
Field Blank Samples												
2007FB01	X	X	X	X	X	X	X					Lab Grade Deionized Water
2007FB02	X	X	X	X	X	X	X					Store Bought Distilled Warer
2007FB03	X	X	X	X	X	X	X					NAPR Potable Water
IDW Samples												
2007IDW01								X	X			Aqueous
2007IDW02										X	X	Solid

Note:

[1] - The analysis required for this sample will be dependent on which samples are being accompanied in the cooler.

FIGURES

K:_SOUTHNAVFAC\111626 DO2\Task 5 – RFI Work Plans\SWMU 70 RFI\CAD\ 111626_70_01

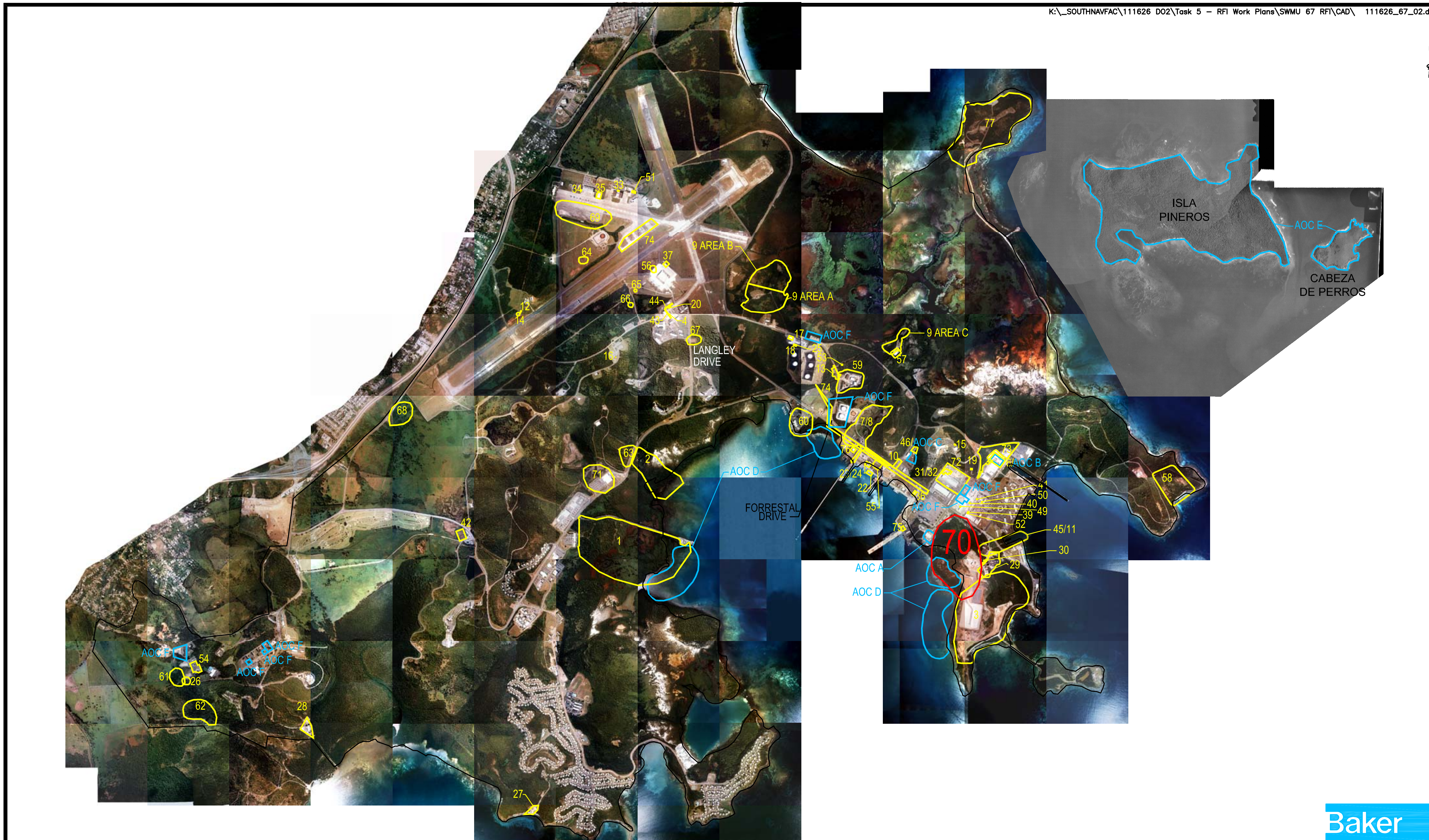
4 0 2 4 8

1 inch = 4 miles

FIGURE 1–1
REGIONAL LOCATION MAP
SWMU 70–DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN

SOURCE: METRODATA, INC., 1999.

NAVAL ACTIVITY PUERTO RICO



LEGEND

– SWMUs

– AREA TO WHICH THIS INVESTIGATION PERTAINS

AOC D – AOCs

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

3000 0 1500 3000

1 inch = 3000 ft.

FIGURE 1–2
SWMU/AOC LOCATION MAP
SWMU 70–DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN

NAVAL ACTIVITY PUERTO RICO

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

Baker

LEGEND

- 1976 POLYGON FEATURE
- 1977 POLYGON FEATURE
- 1985 POLYGON FEATURE
- 1995 POLYGON FEATURE
- ESTUARINE WETLAND BOUNDARY
- E2SS3 ESTUARINE WETLAND IDENTIFICATION
- SURFACE SOIL SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE SOIL AND GROUNDWATER SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE SOIL, SUBSURFACE SOIL, AND GROUNDWATER SAMPLE LOCATION (PHASE II ECP 2004)
- SWMU BOUNDARY

FIGURE 1-3
SITE LAYOUT AND ECP LOCATION MAP
SWMU 70-DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

SOURCE: GEO-MARINE, INC., HISTORIC 1976.

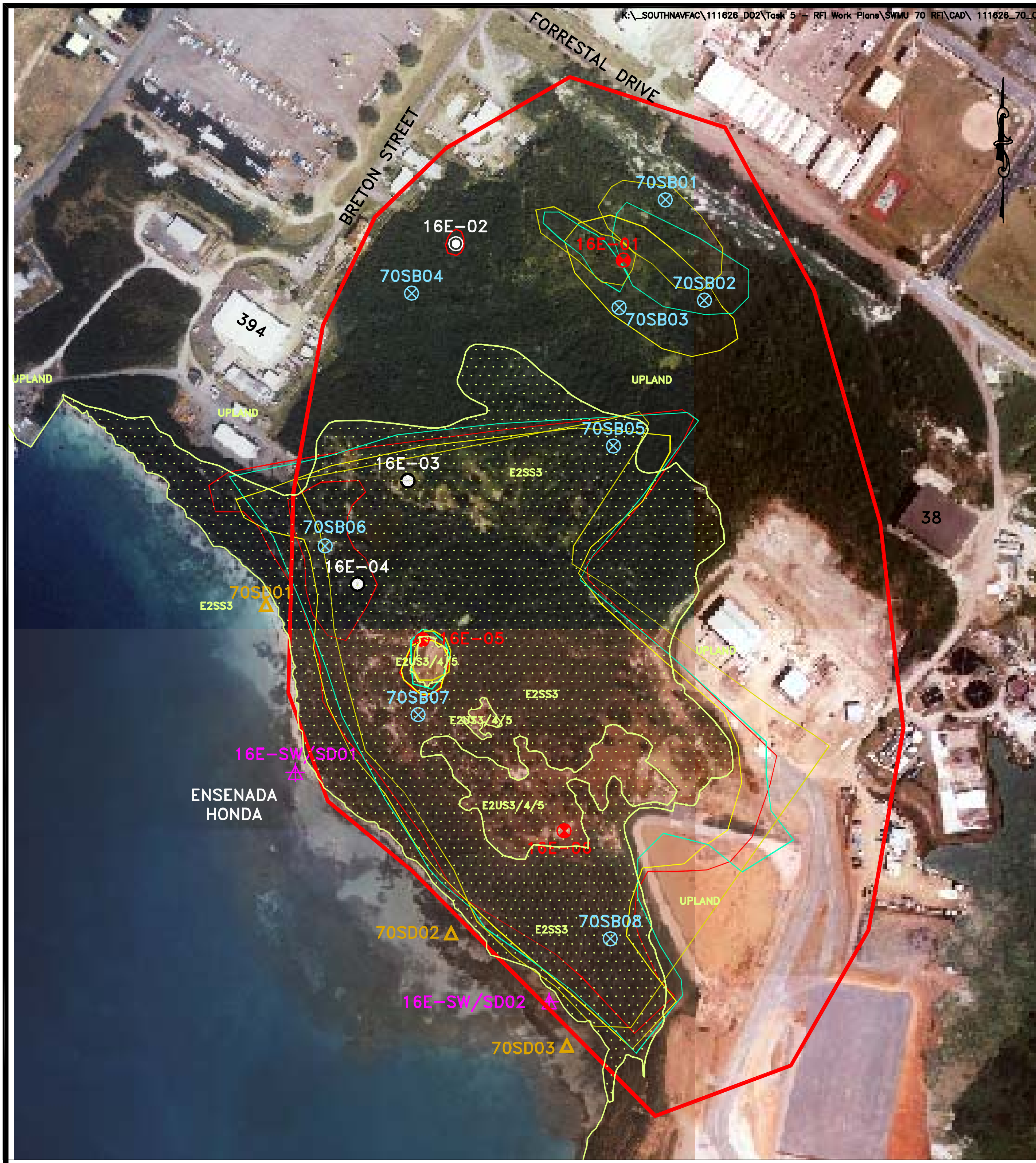
Baker

LEGEND

- 1976 POLYGON FEATURE
- 1977 POLYGON FEATURE
- 1985 POLYGON FEATURE
- 1995 POLYGON FEATURE
- ESTUARINE WETLAND BOUNDARY
- E2SS3 - ESTUARINE WETLAND IDENTIFICATION
- SWMU BOUNDARY

FIGURE 1-4
1976 AERIAL PHOTOGRAPH
SWMU 70-DISPOSAL AREA
NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN

NAVAL ACTIVITY PUERTO RICO



350 0 175 350

1 inch = 350 ft.

SOURCE: GEO-MARINE, INC., SEPTEMBER 6, 2000.

Baker

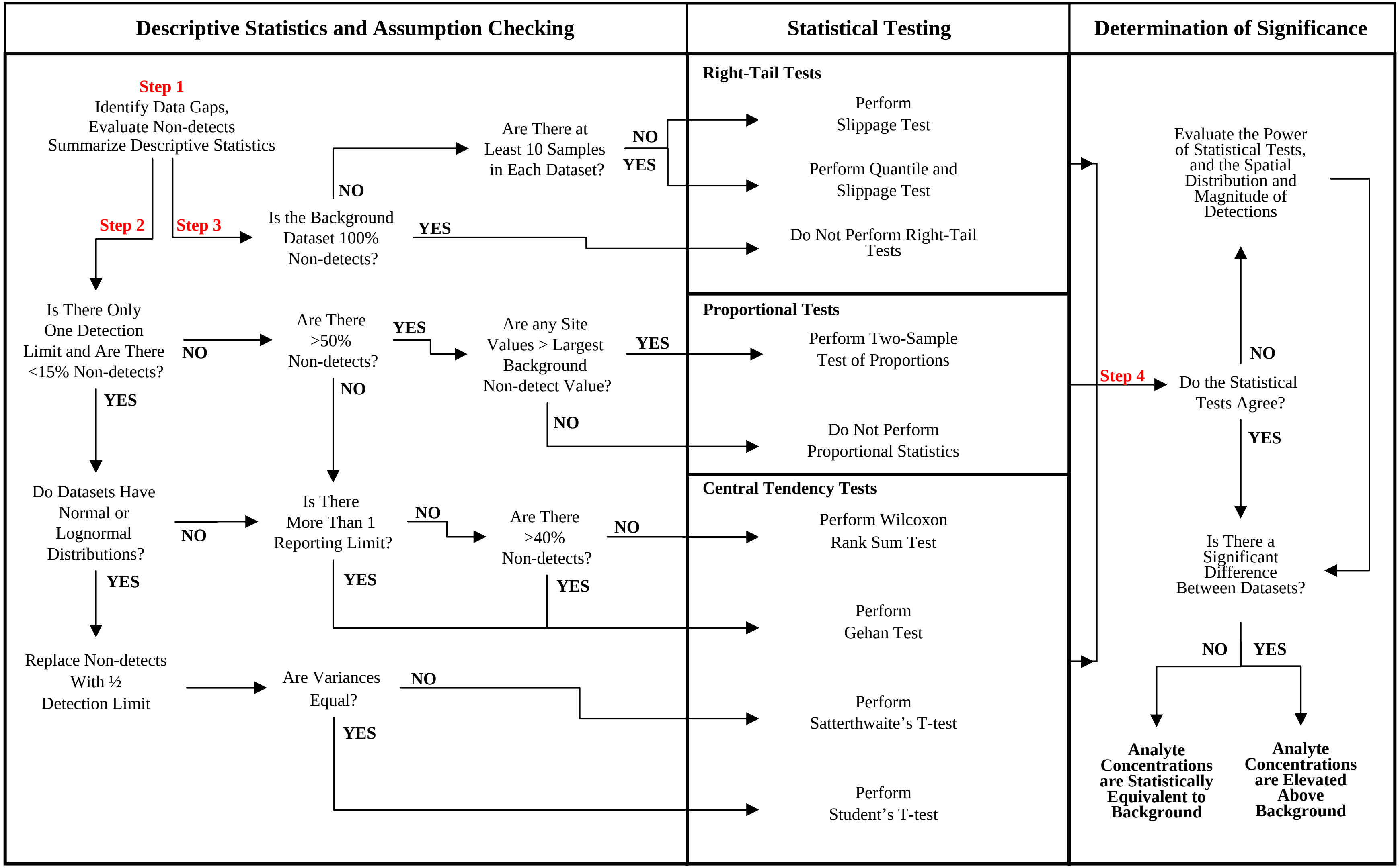
LEGEND

- 1976 POLYGON FEATURE
- 1977 POLYGON FEATURE
- 1985 POLYGON FEATURE
- 1995 POLYGON FEATURE
- ESTUARINE WETLAND BOUNDARY
- ESTUARINE WETLAND IDENTIFICATION
- SURFACE SOIL SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE SOIL AND GROUNDWATER SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE SOIL, SUBSURFACE SOIL, AND GROUNDWATER SAMPLE LOCATION (PHASE II ECP 2004)
- PROPOSED SURFACE, SUBSURFACE AND GROUNDWATER SAMPLING LOCATIONS
- PROPOSED SEDIMENT SAMPLE LOCATIONS
- SWMU BOUNDARY

FIGURE 3-1
PROPOSED SAMPLE LOCATION MAP
SWMU 70-DISPOSAL AREA
NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN

NAVAL ACTIVITY PUERTO RICO

FIGURE 4-1
STATISTICAL ANALYSIS PROCESS
SWMU 70 –DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

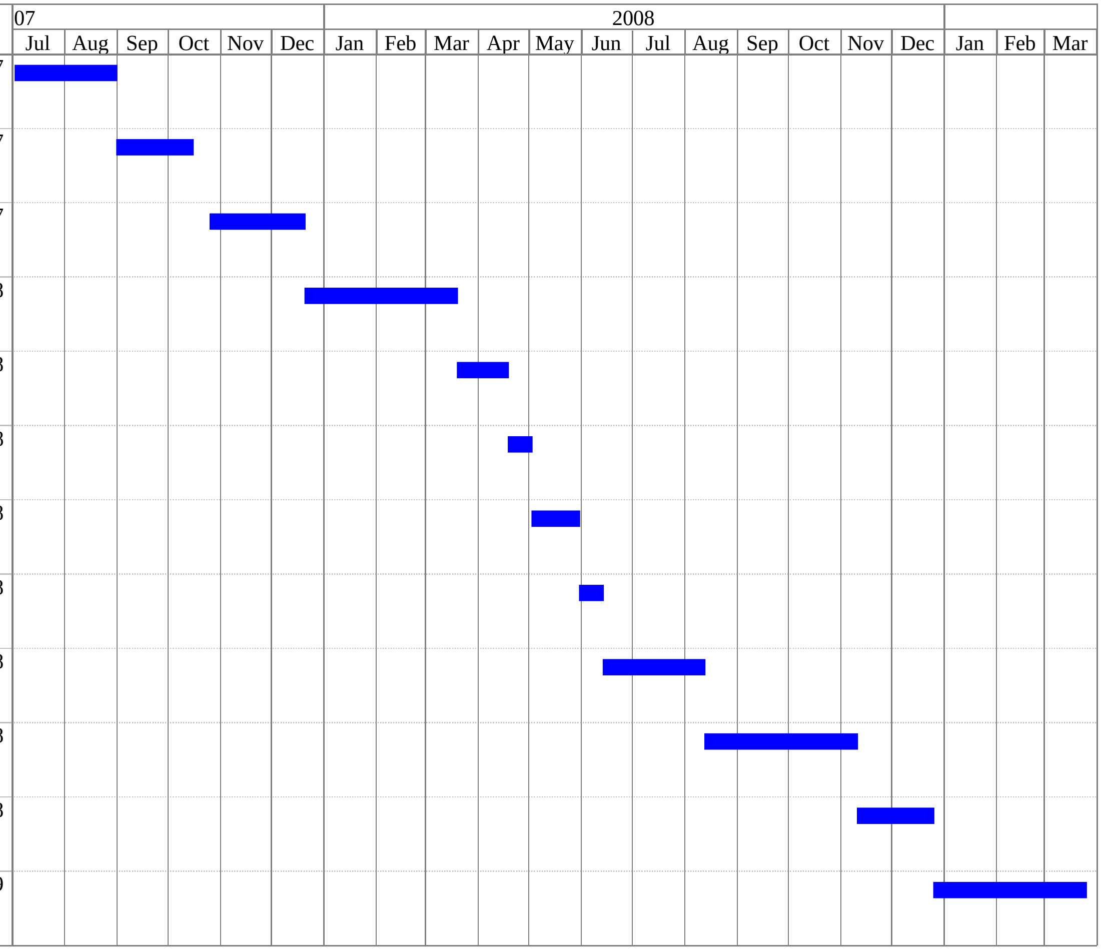


T-tests performed on log-transformed data if datasets have lognormal distributions.

Revised: December 20, 2007

FIGURE 5-1
PROPOSED PROJECT SCHEDULE
SWMU 70- DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE I RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

ID	Task Name	Duration	Start	Finish
1	Draft RFI Work Plan to the EPA	60 edays	7/2/07	8/31/07
2	EPA Review	48 edays	8/31/07	10/18/07
3	Final RFI Work Plan to the EPA	56 edays	10/25/07	12/20/07
4	EPA Review & Approval	90 edays	12/21/07	3/20/08
5	Initiate Field Work	30 edays	3/20/08	4/19/08
6	Field Investigation	14 edays	4/19/08	5/3/08
7	Laboratory Analysis	28 edays	5/3/08	5/31/08
8	Data Validation	14 edays	5/31/08	6/14/08
9	Draft Phase I RFI Report for SWMU 70 to EPA	60 edays	6/14/08	8/13/08
10	EPA Review	90 edays	8/13/08	11/11/08
11	Final Phase I RFI Report for SWMU 70 to EPA	45 edays	11/11/08	12/26/08
12	EPA Review & Approval	90 edays	12/26/08	3/26/09

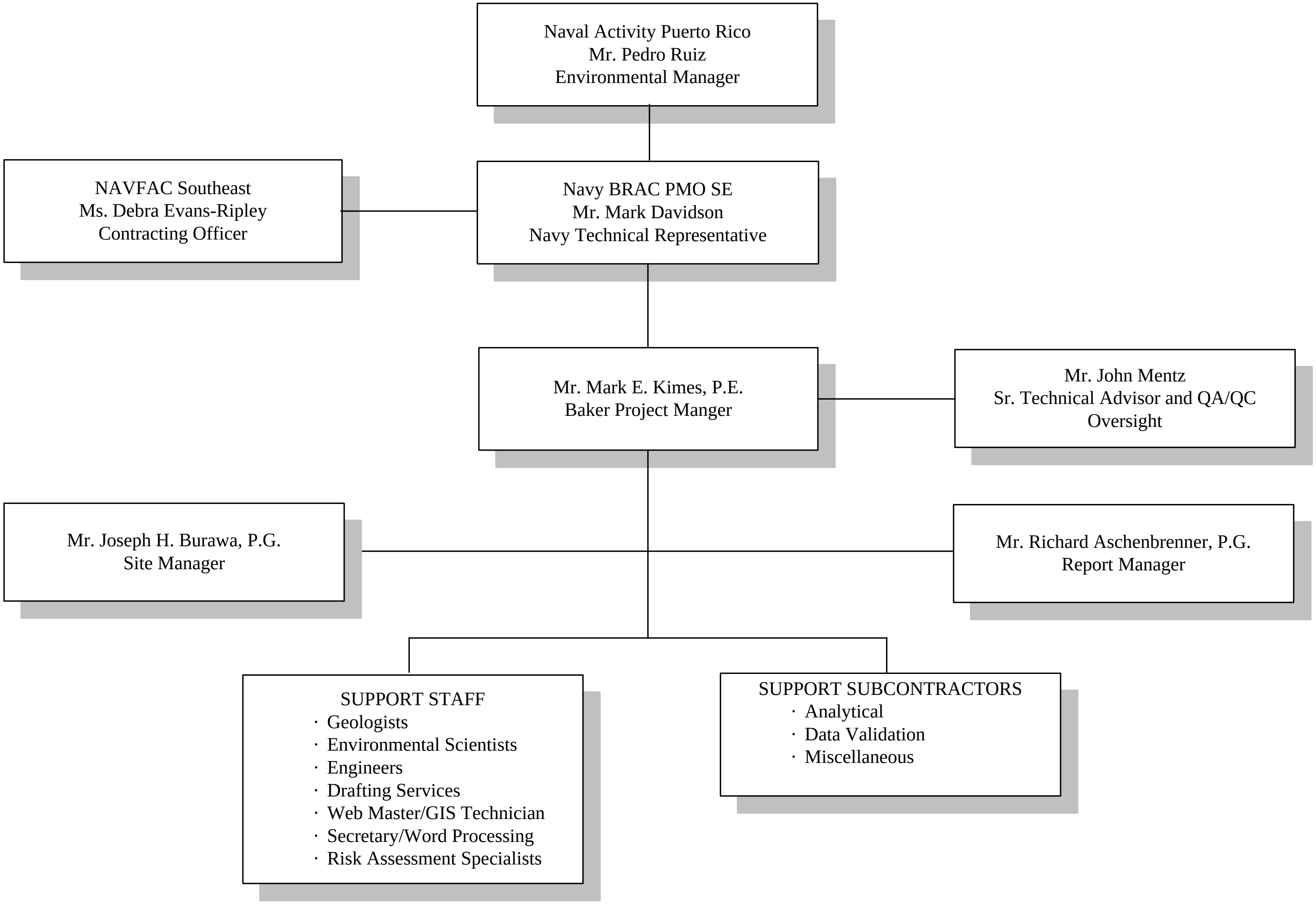


Project:Phase I RFI Work Plan
Date: 12/19/07

Task

Revised: December 20, 2007

FIGURE 6-1
PROJECT ORGANIZATION
PHASE I RFI WORK PLAN – SWMU 70
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



APPENDIX A
Photographs of SWMU 70 –
Disposal Area Northwest of Landfill

SWMU 70 – Disposal Area Northwest of Landfill

Photograph A-1: Typical Construction Debris

Photograph A-2: Typical Thick Secondary Growth Vegetation

SWMU 70 – Disposal Area Northwest of Landfill
(Continued)

Photograph A-3: Wetland Area in the Vicinity of 16E-05

APPENDIX B
Summary of Analytical Results from Phase II ECP Study

TABLE B-1

SUMMARY OF ORGANIC DETECTIONS IN SURFACE SOIL
SWMU 70- DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (ug/kg)	**EPA Region III Residential RBCs** (ug/kg)	16E-01 16E-SS01 05/13/04 0.00 - 1.00	16E-01 16E-SS01D 05/13/04 0.00 - 1.00	16E-02 16E-SS02 05/13/04 0.00 - 1.00	16E-03 16E-SS03 05/13/04 0.00 - 0.30	16E-04 16E-SS04 05/13/04 0.00 - 1.00	16E-05 16E-SS05 05/13/04 0.00 - 1.00	16E-06 16E-SS06 05/13/04 0.00 - 1.00
Volatile Organic Compounds (ug/kg)									
Chlorobenzene	2,000,000	160,000	6.1 U	2.4 J	6.3 U	2.2 J	5.4 U	2.2 J	5.2 U
Tetrachloroethene	5,300	1,200	2.4 J	5.5 J	2.1 J	2.3 J	5.4 U	2.3 J	5.2 U
Semivolatile Organic Compounds (ug/kg)									
Benzo(g,h,i)perylene	NE	NE	440 U	450 U	420 U	480 U	390 U	42 J	390 U
Indeno(1,2,3-cd)pyrene	3,900	870	440 U	450 U	420 U	480 U	390 U	46 J	390 U
Pesticides/PCBs (ug/kg)									
Not Detected									
OP-Pesticides (ug/kg)									
Not Detected									
Chlorinated Herbicides (ug/kg)									
Not Detected									

Notes:
J - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
NE - Not Established.
ft bgs - feet below ground surface.
ug/kg - micrograms per kilogram.

TABLE B-1

SUMMARY OF ORGANIC DETECTIONS IN SURFACE SOIL
SWMU 70- DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (ug/kg)	**EPA Region III Residential RBCs** (ug/kg)	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Location of Maximum Detection
Volatile Organic Compounds (ug/kg)							
Chlorobenzene	2,000,000	160,000	0/7		0/7		16E-SS01D
Tetrachloroethene	5,300	1,200	0/7		0/7		16E-SS01D
Semivolatile Organic Compounds (ug/kg)							
Benzo(g,h,i)perylene	NE	NE	NE		NE		16E-SS05
Indeno(1,2,3-cd)pyrene	3,900	870	0/7		0/7		16E-SS05
Pesticides/PCBs (ug/kg)							
Not Detected							
OP-Pesticides (ug/kg)							
Not Detected							
Chlorinated Herbicides (ug/kg)							
Not Detected							

Notes:
J - The reported result is an estimated concentration that is less than the PC
U - The compound was analyzed for, but was not detected at or above the M
NE - Not Established.
ft bgs - feet below ground surface.
ug/kg - micrograms per kilogram.

TABLE B-2

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (ug/kg)	**EPA Region III Residential RBCs** (ug/kg)	2x Average Detected Background (mg/kg)	16E-01 16E-SS01 05/13/04 0.00 - 1.00	16E-01 16E-SS01D 05/13/04 0.00 - 1.00	16E-02 16E-SS02 05/13/04 0.00 - 1.00	16E-03 16E-SS03 05/13/04 0.00 - 0.30	16E-04 16E-SS04 05/13/04 0.00 - 1.00	16E-05 16E-SS05 05/13/04 0.00 - 1.00	16E-06 16E-SS06 05/13/04 0.00 - 1.00
Appendix IX Inorganics (mg/kg)										
Arsenic	1.9	0.43	2.4	**1.9**	**2.2**	**2**	**2.9**	**3.7**	**3.2**	**1.9**
Barium	7,200	550	181	11	16	120	11	7.8	12	16
Beryllium	200	16	0.45	0.51 U	0.051 B	0.43 B	0.06 B	0.047 B	0.057 B	0.085 B
Cadmium	100	7.8	0.27	0.64 U	0.63 U	0.26 B	0.64 U	0.57 U	0.64 U	0.19 B
Chromium	310	23	59.3	5.8	5.8	19	7.2	4.3	7.8	**47**
Cobalt	2,000	160	44.0	1.4	1.4	27	2.5	0.76 B	2.4	13
Copper	4,100	310	234	11	14	150	11	3	8.4	43
Lead	400(1)	400(1)	125	2.8	2.3	7.9	1.9	0.77	1.4	3.3
Mercury	31(2)	2.3(2)	0.11	0.0079 B	0.0096 B	0.02 B	0.018 B	0.0086 B	0.0063 B	0.012 B
Nickel	2,000	160	16.6	2.3 B	2.6 B	14	2.7 B	1.4 B	3.3 B	19
Sulfide	NE	NE	28.48	34 U	34 U	32 U	36 U	29 U	37 U	30 B
Tin	61,000	4,700	2.43	2 B	2.6 B	2.7 B	3.3 B	2.9 B	2.1 B	2.9 B
Vanadium	100	7.8	355	**14** N*	**18** N*	**96** N*	**20** N*	6 N*	**23** N*	**74** N*
Zinc	31,000	2,300	125	7	9.2	130	11	3.4	7	34

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
N - The matrix spike recovery is not within control limtis.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
* - Duplicate analysis is not within control limits.
(1) - 1996 Soil Screening Guidance.
(2) - Value based on the RBC for Mercuric Chloride.
NE - Not Established.
ft bgs - feet below ground surface.
ug/kg - micrograms per kilogram.
mg/kg - milligrams per kilogram.

Shading indicates exceedance of EPA Region III Industrial BCs
Bold indicates exceedance of EPA Region III Residential RBCs
Underline indicates exceedance of 2 x Average Detected Background

TABLE B-2

Revised: December 20, 2007

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (ug/kg)	**EPA Region III Residential RBCs** (ug/kg)	2x Average Detected Background (mg/kg)	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Number Exceeding 2x Average Detected Background	Range Exceeding 2x Average Detected Background	Location of Maximum Detection
Appendix IX Inorganics (mg/kg)										
Arsenic	1.9	0.43	2.4	5/7	2 - 3.7	7/7	1.9 - 3.7	3/7	2.9 - 3.7	16E-SS04
Barium	7,200	550	181	0/7		0/7		0/7		16E-SS02
Beryllium	200	16	0.45	0/7		0/7		0/7		16E-SS02
Cadmium	100	7.8	0.27	0/7		0/7		0/7		16E-SS02
Chromium	310	23	59.3	0/7		1/7	47	0/7		16E-SS06
Cobalt	2,000	160	44.0	0/7		0/7		0/7		16E-SS02
Copper	4,100	310	234	0/7		0/7		0/7		16E-SS02
Lead	400[(1)]	400[(1)]	125	0/7		0/7		0/7		16E-SS02
Mercury	31[(2)]	2.3[(2)]	0.11	0/7		0/7		0/7		16E-SS02
Nickel	2,000	160	16.6	0/7		0/7		1/7	19	16E-SS06
Sulfide	NE	NE	28.48	NE		NE		1/7	30B	16E-SS06
Tin	61,000	4,700	2.43	0/7		0/7		5/7	2.6B - 3.3B	16E-SS03
Vanadium	100	7.8	355	0/7		6/7	14N* - 96N*	0/7		16E-SS02
Zinc	31,000	2,300	125	0/7		0/7		1/7	130	16E-SS02

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
N - The matrix spike recovery is not within control limtis.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
* - Duplicate analysis is not within control limits.
(1) - 1996 Soil Screening Guidance.
(2) - Value based on the RBC for Mercuric Chloride.
NE - Not Established.
ft bgs - feet below ground surface.
ug/kg - micrograms per kilogram.
mg/kg - milligrams per kilogram.

TABLE B-3

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (ug/kg)	**EPA Region III Residential RBCs** (ug/kg)	16E-01 16E-SB01-02 05/13/04 3.00 - 5.00	16E-02 16E-SB02-02 05/13/04 3.00 - 5.00	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Location of Maximum Detection
Volatile Organic Compounds (ug/kg)									
Acetone	92,000,000	7,000,000	17 J	47 U	0/2		0/2		16E-SB01-02
Semivolatile Organic Compounds (ug/kg)									
Not Detected									
Pesticides/PCBs (ug/kg)									
Not Detected									
OP-Pesticides (ug/kg)									
Not Detected									
Chlorinated Herbicides (ug/kg)									
Not Detected									

Notes:
J - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
ft bgs - feet below ground surface.
ug/kg - micrograms per kilogram.

TABLE B-4

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (mg/kg)	**EPA Region III Residential RBCs** (mg/kg)	2x Average Detected Background (mg/kg)	16E-01 16E-SB01-02 05/13/04 3.00 - 5.00	16E-02 16E-SB02-02 05/13/04 3.00 - 5.00	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Number Exceeding 2x Average Detected Background	Range Exceeding 2x Average Detected Background	Location of Maximum Detection
Appendix IX Inorganics (mg/kg)												
Arsenic	1.9	0.43	2.05	**6.1**	**6.4**	2/2	6.1 - 6.4	2/2	6.1 - 6.4	2/2	6.1 - 6.4	16E-SB02-02
Barium	7,200	550	222	10	13	0/2		0/2		0/2		16E-SB02-02
Beryllium	200	16	0.74	0.072 B	0.43 U	0/2		0/2		0/2		16E-SB01-02
Chromium	310	23	133	13	2.9	0/2		0/2		0/2		16E-SB01-02
Cobalt	2,000	160	30.0	1 B	1.1 U	0/2		0/2		0/2		16E-SB01-02
Copper	4,100	310	193	9.6	1.4 B	0/2		0/2		0/2		16E-SB01-02
Lead	400[(1)]	400[(1)]	8.68	0.95	0.54 U	0/2		0/2		0/2		16E-SB01-02
Nickel	2,000	160	31.9	4.5 B	0.88 B	0/2		0/2		0/2		16E-SB01-02
Tin	61,000	4,700	2.96	3.3 B	2.7 B	0/2		0/2		1/2	3.3B	16E-SB01-02
Vanadium	100	7.8	462	**17** N*	3 N*	0/2		1/2	17N*	0/2		16E-SB01-02
Zinc	31,000	2,300	88.6	8	1.4 B	0/2		0/2		0/2		16E-SB01-02

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
N - The matrix spike recovery is not within control limtis.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
* - Duplicate analysis is not within control limits.
(1) - 1996 Soil Screening Guidance.
ft bgs - feet below ground surface.
mg/kg - milligrams per kilogram.

Shading indicates exceedance of EPA Region III Industrial BCs
Bold indicates exceedance of EPA Region III Residential RBCs
Underline indicates exceedance of 2 x Average Detected Background

TABLE B-5

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	Federal MCLs (ug/L)	**EPA Region III Tap Water RBCs** (ug/L)	PR Water Quality Standards (ug/L)	16E-01 16E-GW01 05/15/04	16E-01 16E-GW01D 05/15/04	16E-05 16E-GW05 05/12/04	16E-06 16E-GW06 05/12/04
Volatile Organic Compounds (ug/L)							
Acetone	NE	550	NE	6 J	25 U	25 U	25 U
2-Butanone	NE	700	NE	1.3 J	1.3 J	10 U	10 U
Semivolatile Organic Compounds (ug/L)							
Benzo(g,h,i)perylene	NE	NE	NE	10 U	10 U	1 J	10 U
Indeno(1,2,3-cd)pyrene	NE	0.092	NE	10 U	10 U	**0.85** J	10 U
Pesticides/PCBs (ug/L)							
Not Detected							
OP-Pesticides (ug/L)							
Not Detected							
Chlorinated Herbicides (ug/L)							
Not Detected							

Notes:

J - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.

U - The compound was analyzed for, but was not detected at or above the MDL/PQL.

ug/L - micrograms per liter.

NE - Not Established.

Bold indicates exceedance of EPA Region III Tap Water RBCs

TABLE B-5

Revised: December 20, 2007

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	Federal MCLs (ug/L)	**EPA Region III Tap Water RBCs** (ug/L)	PR Water Quality Standards (ug/L)	Number Exceeding Federal MCLs	Range Exceeding Federal MCLs	**Number Exceeding EPA Region III Tap Water RBCs**	**Range Exceeding EPA Region III Tap Water RBCs**	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	Location of Maximum Detection
Volatile Organic Compounds (ug/L)										
Acetone	NE	550	NE	NE		0/4		NE		16E-GW01
2-Butanone	NE	700	NE	NE		0/4		NE		16E-GW01, 16E-GW01D
Semivolatile Organic Compounds (ug/L)										
Benzo(g,h,i)perylene	NE	NE	NE	NE		NE		NE		16E-GW05
Indeno(1,2,3-cd)pyrene	NE	0.092	NE	NE		1/4	0.85J	NE		16E-GW05
Pesticides/PCBs (ug/L)										
Not Detected										
OP-Pesticides (ug/L)										
Not Detected										
Chlorinated Herbicides (ug/L)										
Not Detected										

Notes:

J - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
ug/L - micrograms per liter.
NE - Not Established.

TABLE B-6

SUMMARY OF INORGANIC DETECTIONS IN GROUNDWATER
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	Federal MCLs (mg/L)	**EPA Region III Tap Water RBCs** (mg/L)	PR Water Quality Standards (mg/L)	16E-01 16E-GW01 05/15/04	16E-01 16E-GW01D 05/15/04	16E-05 16E-GW05 05/12/04	16E-06 16E-GW06 05/12/04
Appendix IX (Dissolved) Inorganics (mg/L)							
Barium	2	0.26	NE	0.062	0.062	0.031	0.055
Chromium	0.1	0.011	NE	0.0018 B	0.0015 B	0.01 U	0.0017 B
Cobalt	NE	0.073	NE	0.01 U	0.01 U	0.0021 B	0.01 U
Nickel	NE	0.073	NE	0.04 U	0.04 U	0.0041 B	0.0042 B
Vanadium	NE	0.0037	NE	**0.015** B	**0.019** B	0.05 U	**0.013**
Total Cyanide and Sulfide (mg/L)							
Not Detected							

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.

U - The compound was analyzed for, but was not detected at or above the MDL/PQL.

NE - Not Established.

mg/L - milligrams per liter.

Bold indicates exceedance of EPA Region III Tap Water RBCs

TABLE B-6

SUMMARY OF INORGANIC DETECTIONS IN GROUNDWATER
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	Federal MCLs (mg/L)	**EPA Region III Tap Water RBCs** (mg/L)	PR Water Quality Standards (mg/L)	Number Exceeding Federal MCLs	Range Exceeding Federal MCLs	**Number Exceeding EPA Region III Tap Water RBCs**	**Range Exceeding EPA Region III Tap Water RBCs**	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	Location Maximum Detection
Appendix IX (Dissolved) Inorganics (mg/L)										
Barium	2	0.26	NE	0/4		0/4		NE		16E-GW01, 16E-GW01D
Chromium	0.1	0.011	NE	0/4		0/4		NE		16E-GW01
Cobalt	NE	0.073	NE	NE		0/4		NE		16E-GW05
Nickel	NE	0.073	NE	NE		0/4		NE		16E-GW06
Vanadium	NE	0.0037	NE	NE		3/4	0.013 - 0.019B	NE		16E-GW01D
Total Cyanide and Sulfide (mg/L)										
Not Detected										

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
NE - Not Established.
mg/L - milligrams per liter.

TABLE B-7

SUMMARY OF INORGANIC DETECTIONS IN SEDIMENT
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	Marine Sediment Screening Values (mg/kg)	16E-SW/SD01 16E-SD01 05/14/04 0.00 - 0.50	16E-SW/SD02 16E-SD02 05/14/04 0.00 - 0.50	Number Exceeding Marine Sediment Screening Values	Range Exceeding Marine Sediment Screening Values	Location of Maximum Detection
Appendix IX Inorganics (mg/kg)						
Arsenic	7.24	3.1	3 B	0/2		16E-SD01
Barium	48.0	8.3	11	0/2		16E-SD02
Chromium	52.3	13	23	0/2		16E-SD02
Cobalt	10.0	3.3	6.4	0/2		16E-SD02
Copper	18.7	21	41	2/2	21 - 41	16E-SD02
Lead	30.2	2	4.8	0/2		16E-SD02
Mercury	0.13	0.018 B	0.036 B	0/2		16E-SD02
Nickel	15.9	5 B	9 B	0/2		16E-SD02
Silver	0.73	1.9 U	0.86 B	1/2	0.86B	16E-SD02
Tin	3.40	3.5 B	6.1 B	2/2	3.5B - 6.1B	16E-SD02
Vanadium	57.0	21 N*	36 N*	0/2		16E-SD02
Zinc	124	24	35	0/2		16E-SD02
Sulfide	NA	160	680	NA		16E-SD02

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
N - The matrix spike recovery is not within control limtis.
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
* - Duplicate analysis is not within control limits.
NA - Not Available.
Shading indicates exceedance of Marine Sediment Screening Value
ft bgs - feet below ground surface.
mg/kg - milligrams per kilogram.

TABLE B-8

SUMMARY OF ORGANIC DETECTIONS IN SURFACE WATER
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	PR Water Quality Standards (ug/L)	**Surface Water Screening Values** (ug/L)	16E-SW/SD01 16E-SW01 05/14/04	16E-SW/SD02 16E-SW02 05/14/04	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	**Number Exceeding Surface Water Screening Values**	**Range Exceeding Surface Water Screening Values**	Location Maximum Detection
Volatile Organic Compounds (ug/L)									
Bromoform	NE	640	1 U	1	NE		0/2		16E-SW02
Semivolatile Organic Compounds (ug/L)									
Not Detected									
Pesticides/PCBs (ug/L)									
Not Detected									
OP-Pesticides (ug/L)									
Not Detected									
Chlorinated Herbicides (ug/L)									
Not Detected									

Notes:
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
ug/L - micrograms per liter.
NE - Not Established.

TABLE B-9

SUMMARY OF INORGANIC DETECTIONS IN SURFACEWATER
SWMU 70 - DISPOSAL AREA NORTHWEST OF LANDFILL
PHASE II ECP REPORT
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	PR Water Quality Standards (mg/L)	**Surface Water Screening Values** (mg/L)	16E-SW/SD01 16E-SW01 05/14/04	16E-SW/SD02 16E-SW02 05/14/04	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	**Number Exceeding Surface Water Screening Values**	**Range Exceeding Surface Water Screening Values**	Location Maximum Detection
Appendix IX (Total) Inorganics (mg/L)									
Barium	NE	50	0.0068 B	0.026	NE		0/2		16E-SW02
Chromium	0.011	0.0504	0.01 U	0.0015 B	0/2		0/2		16E-SW02
Vanadium	NE	0.120[(1)]	0.1 U	0.018	NE		0/2		16E-SW02
Zinc	0.081	0.086	0.025	0.012 B	0/2		0/2		16E-SW01

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.

U - The compound was analyzed for, but was not detected at or above the MDL/PQL.

(1) - This chemical lacks a marine/estuarine surface water screening value. The value shown is a freshwater screening value.

NE - Not Established.

mg/L - milligrams per liter.

APPENDIX C
USEPA Region II – Groundwater Sampling Procedure
Low Stress (Low Flow) Purging and Sampling

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUND WATER SAMPLING PROCEDURE
LOW STRESS (Low Flow) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II standard method for collecting low stress (low flow) ground water samples from monitoring wells. Low stress Purging and Sampling results in collection of ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of ten feet unless multiple intervals are sampled. The procedure is appropriate for collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with all EPA programs.

This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The purpose of the low stress purging and sampling procedure is to collect ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing an additional filtered sample from the same well. Second, this procedure minimizes aeration of the ground water during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of ground water purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of one or more key indicator parameters to stabilize; c) cascading of water and/or formation of air bubbles in the tubing; and d) cross-contamination between wells.

Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump=s intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided to the extent possible in all cases. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameters fails to stabilize after 4 hours, one of four options should be considered: a) continue purging in an attempt to achieve stabilization; b) discontinue purging, do not collect samples, and document attempts to reach stabilization in the log book; c) discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or d) Secure the well, purge and collect samples the next day (preferred). The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4 or 3/8 inch ID) to ensure that the tubing remains filled with ground water during sampling.

Cross-Contamination

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough Adaily@ decontamination procedures between sampling of each well in addition to the start of each sampling day (see Section VII, below).

Equipment Failure

Adequate equipment should be on-hand so that equipment failures do not adversely impact sampling activities.

IV. PLANNING DOCUMENTATION AND EQUIPMENT

< Approved site-specific Field Sampling Plan/Quality Assurance Project Plan (QAPP). This plan must specify the type of pump and other equipment to be used. The QAPP must also specify the depth to which the pump intake should be lowered in each well. Generally, the target depth will correspond to the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump

intake. In all cases, the target depth must be approved by the EPA hydrogeologist or EPA project scientist.

< Well construction data, location map, field data from last sampling event.

< Polyethylene sheeting.

< Flame Ionization Detector (FID) and Photo Ionization Detector (PID).

< Adjustable rate, positive displacement ground water sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may only be used for inorganic sample collection.

< Interface probe or equivalent device for determining the presence or absence of NAPL.

< Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.

< Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

< Flow measurement supplies (e.g., graduated cylinder and stop watch or in-line flow meter).

< Power source (generator, nitrogen tank, etc.).

< Monitoring instruments for indicator parameters. Eh and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Specific conductance, pH, and temperature may be monitored either in-line or using separate probes. A nephalometer is used to measure turbidity.

< Decontamination supplies (see Section VII, below).

< Logbook (see Section VIII, below).

< Sample bottles.

< Sample preservation supplies (as required by the analytical methods).

< Sample tags or labels, chain of custody.

V. SAMPLING PROCEDURES

<u>Pre-Sampling Activities</u>

1. Start at the well known or believed to have the least contaminated ground water and proceed systematically to the well with the most contaminated ground water. Check the well, the lock, and the locking cap for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID and FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the opened well with a PID and an FID instrument and record the reading in the field log book.
6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Note that the reference point should be surveyed for correction of ground water elevations to the mean geodesic datum (MSL).

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled prior to purging. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book. If LNAPLs and/or DNAPLs are detected, install the pump at this time, as described in step 9, below. Allow the well to sit for several days between the measurement or sampling of any DNAPLs and the low-stress purging and sampling of the ground water.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that well in the EPA-approved QAPP or a depth otherwise approved by the EPA hydrogeologist or EPA project scientist. The pump intake must be kept at least two (2) feet above the bottom of the well to prevent disturbance and resuspension of any sediment or NAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO)

approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

±0.1 for pH
±3% for specific conductance (conductivity)
±10 mv for redox potential
±10% for DO and turbidity

Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

13. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

    Ground water samples to be analyzed for volatile organic compounds (VOCs) require pH adjustment. The appropriate EPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Ground water purged from the well prior to sampling can be used for this purpose.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance should be consulted in preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples should be collected during the sampling event:

< Field duplicates
< Trip blanks for VOCs only
< Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, ground water samples should be collected systematically from wells with the lowest level of contamination through to wells with highest level of contamination. The equipment blank should be collected after sampling from the most contaminated well.

VII. DECONTAMINATION

Non-disposable sampling equipment, including the pump and support cable and electrical wires which contact the sample, must be decontaminated thoroughly each day before use (Adaily decon@) and after each well is sampled (Abetween-well decon@). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using Adaily decon@ procedures (see #17, below) prior to their initial use. For centrifugal pumps, it is strongly recommended that non-disposable sampling equipment, including the pump and support cable and electrical wires in contact with the sample, be decontaminated thoroughly each day before use (Adaily decon@).

EPA=s field experience indicates that the life of centrifugal pumps may be extended by removing entrained grit. This also permits inspection and replacement of the cooling water in centrifugal pumps. All non-dedicated sampling equipment (pumps, tubing, etc.)

must be decontaminated after each well is sampled (Abetween-well decon,@ see #18 below).

17. **Daily Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Disassemble pump.

E) Wash pump parts: Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water.

G) Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Rinse impeller assembly with distilled/deionized water.

18. **Between-Well Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

< Well identification number and physical condition.
< Well depth, and measurement technique.
< Static water level depth, date, time, and measurement technique.
< Presence and thickness of immiscible liquid layers and detection method.
< Collection method for immiscible liquid layers.
< Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
< Well sampling sequence and time of sample collection.
< Types of sample bottles used and sample identification numbers.
< Preservatives used.
< Parameters requested for analysis.

- < Field observations of sampling event.
- < Name of sample collector(s).
- < Weather conditions.
- < QA/QC data for field instruments.

IX. REFERENCES

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