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Final
Work Plan
and
Sampling and Analysis Plan
Soil, Groundwater, Surface Water, and Sediment Background Investigation
U.S. Naval Ammunition Support Detachment
Vieques Island, Puerto Rico

Prepared for

Department of the Navy
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Naval Facilities Engineering Command

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SECTION 1

Introduction

This Work Plan describes the work that will be completed for the background investigation of soils, groundwater, surface water, and sediment at the Naval Ammunition Support Detachment (NASD), Vieques, Puerto Rico. This Work Plan is prepared under the Naval Facilities Engineering Command (NAVFACENGCOM) LANTDIV Navy Contract N62470-95-D-6007, Navy Comprehensive Long-Term Environmental Action Navy (CLEAN), District III, Contract Task Order 0189. The technical approach is based on Naval Facilities Engineering Command *"Procedural Guidance for Statistically Analyzing Environmental Background Data"* and has been developed by the NASD Partnering Team to supplement site investigation data obtained for Installation Restoration (IR) sites. The purpose of this Work Plan is to outline the procedures that will be used to establish background conditions for application to site sampling data to identify release-related site constituents of concern and human health and ecological risks.

The general background and physical setting of NASD is described in Sections 2 and 3 of the Draft Master Project Plans, prepared by CH2M HILL in May 2000. A regional location map of NASD is provided as Figure 1-1, and a facility map is provided as Figure 1-2. Previous investigations at NASD have revealed that elevated levels of metals have been detected in the soils, groundwater, surface water, and sediment at several IR site locations. However, the investigations have not differentiated the degree to which these constituents were attributed to either site conditions or background conditions associated with naturally occurring constituents. The background sampling data will be used to establish the range in background concentrations of metals at NASD.

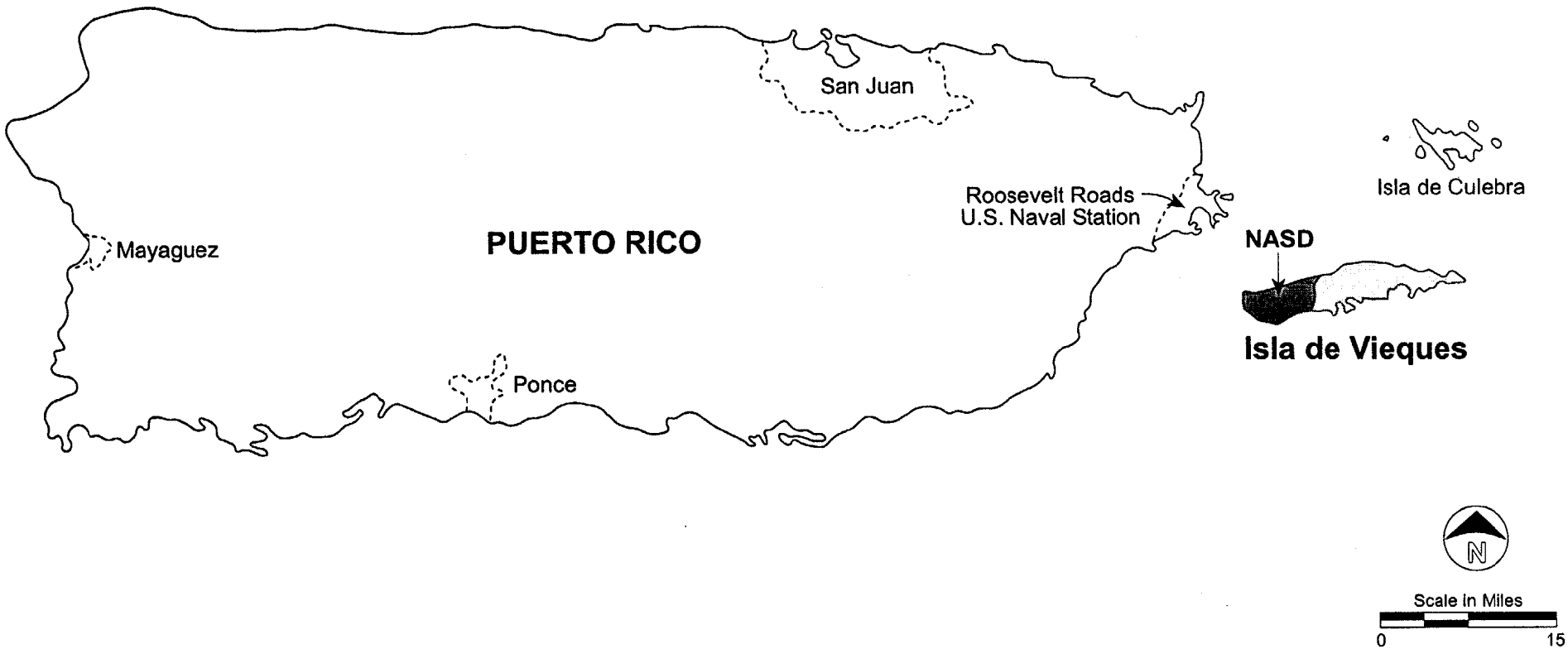

FIGURE 1-1
Site Location Map

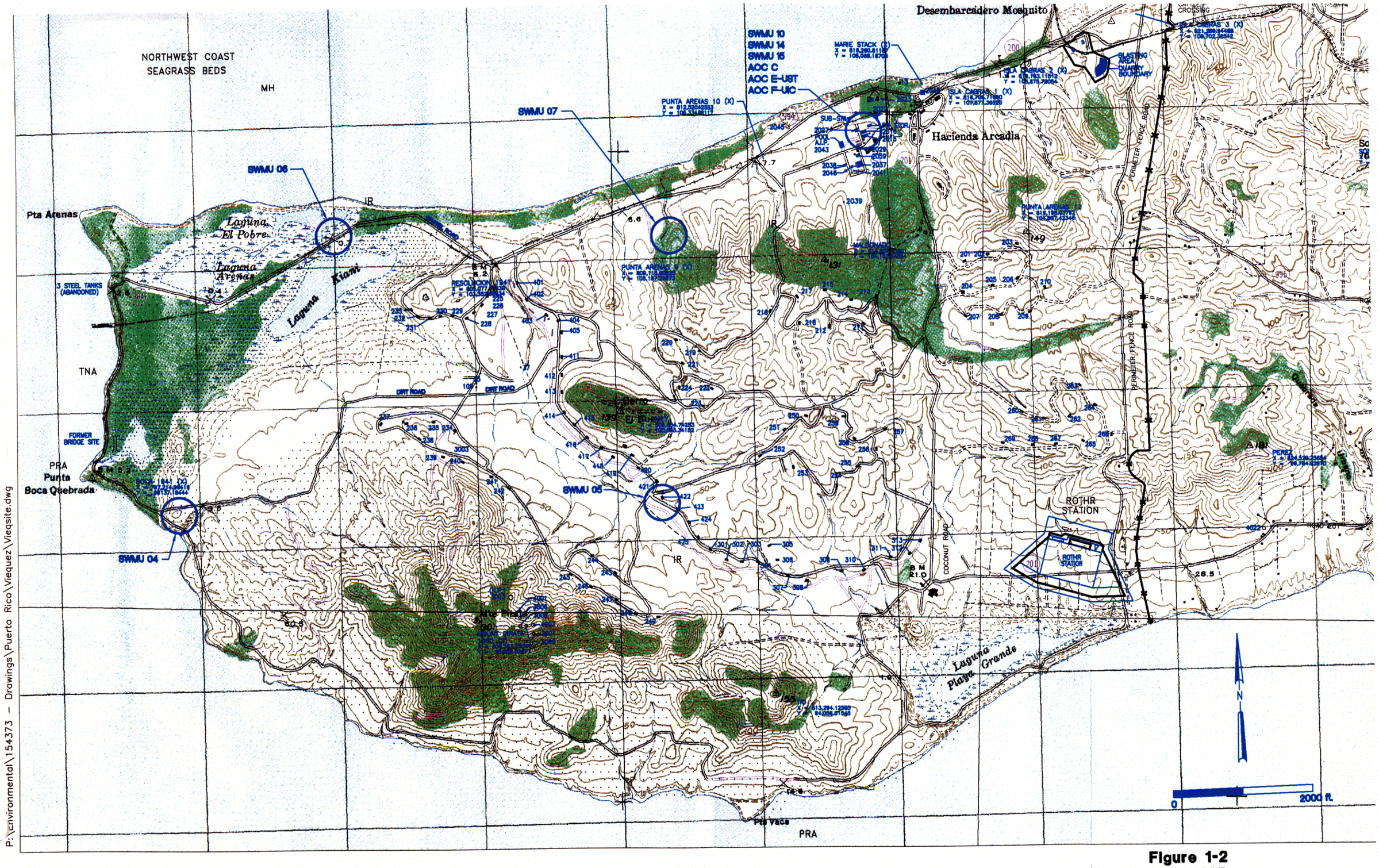

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Figure 1-2
SITE LOCATION MAP
Naval Ammunition Support Detachment, Vieques Island

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SECTION 2

Sampling Rationale and Sampling Locations

This section presents the rationale and sampling locations for the background investigation at NASD. The information collected for this background investigation will be used to supplement information collected in risk assessments and to assess if additional site investigations, institutional controls, or remediation is required. In an effort to more accurately identify site related contamination and assess potential risks of exposure to site contaminants, it is essential to identify the concentrations of naturally occurring constituents (inorganic elements or chemicals that represent underlying geochemical conditions that have not been influenced by human activity) in site media. Background samples, collected and analyzed in the same manner as other site samples, provide baseline measurements to distinguish site releases and to determine the degree of environmental risk present at a site.

The specific goal of the sampling effort at NASD Vieques is to establish background concentrations of metals in surface and subsurface soil, groundwater, surface water, and sediment. The background analyses will be statistically evaluated to determine the range in concentrations of naturally metals and to statistically compare the data to site contaminants. When background analyses indicate that site-specific and naturally occurring background chemical concentrations are not statistically different, it is concluded that their presence in site media is not representative of a contaminate release from the site and is not considered a constituent of concern. The data collected in this effort will be used to supplement data collected during previous investigations and used in future risk management evaluations at NASD Vieques.

To ensure that background and IR site soils are of similar soil composition, the Soil Conservation Service *Soil Survey of Humacao Area of Eastern Puerto Rico,* was reviewed to identify site soil characteristics. Based on these reviews, three general categories of soil types were identified:

1. Swamp and marsh deposits
2. Alluvial deposits
3. Plutonic rock made up largely of granidiorite and quartz diorite

Figure 2-1 shows the extent of each soil type in relation to the IR sites.

A review of IR site locations show that only one IR site (SWMU 06) is located in areas representative of swamp and marsh deposits. SWMU 06 is also the only IR site with surface water and sediment present at or near the site. This site is expected to go through the full Remedial Investigation/Feasibility Study (RI/FS) process, therefore, a complete background study for this area including all media is necessary. For the other two soil types, 13 sites are located in areas classified as alluvial deposits, and three IR sites are

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SYMBOL LEGEND

- Existing Water Supply Well to be Sampled as part of the Background Investigation
- Background Well to be Installed
- Upgradient IR Well to be Installed and Used as part of the Background Investigation
- Soil Sample
- Existing Surface Water and Sediment Sample
- Surface Water and Sediment Sample
- Plutonic Rock Samples

SOIL LEGEND

Quaternary

Qa - Alluvial Deposits, Sand, Silt, Clay, Gravel Flood Plain, Terrace Deposits, and Piedmont Fan Deposits

Qb - Beach and Dune Desposits, Largely Clacite, Quartz and Volcanic Rocks, and Fragment Sand with Local Magnetite

Qs - Swamp and Marsh Deposits, Organic Muck, Sandy or Silty, and Peat

Tertiary

TI - Marine Sedimentary Rocks, Undivided

Cretaceous

KTd- Plutonic Rocks, Largely Grandiorite,and Quartz Diorite, Locally Deeply Weathered

Fault Line

Scale in Feet
0 1000 2000

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FIGURE 2-1
Proposed Background Sampling Locations
NASD, Vieques Island

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located in areas classified as plutonic rock. Soil and groundwater are the only media of concern at the IR sites located in these two soil types.

The statistical analysis to be used to evaluate the background data assumes that the sampling is randomized. Randomization means that any location carries an equal probability of being sampled and that sample locations are randomly assigned. It is an insurance policy against potential bias in results to unknown processes. While an essential component to a sampling strategy, complete randomization is not necessarily the most efficient way to assign sample locations. A useful constraint to randomization in environmental situations where spatial coverage is of interest is to systematically sample from a randomized point. This means that all points in the area to be characterized carry equal probability of being sampled. Examples include gridding an area with randomized start-point and grid orientation. Application of this strategy in an area which is linear would consist of equispaced samples collected along a transect, with the first sample collected at a random start point.

Access to most of the island is limited due to the dense vegetation. Therefore, soil sampling locations were selected from a random location along a roadway and were equally spaced along the roadway. The samples will be collected away from the road in the vegetation, and away from mowed and maintained areas. The selection of groundwater sample locations was based on the locations of existing wells, and the need to fill data gaps. The locations of new wells were randomly selected, but were checked to ensure that none would be installed near or downgradient of an IR site. Sampling locations will be verified in the field for access considerations, as well as to verify that the selected areas have not been impacted by Navy operations. Samples will not be collected from areas of known contamination, and will not be collected from areas identified as IR sites.

2.1 Soil Sampling Locations

To establish background soil quality, non-impacted areas that represent the underlying geologic and hydrogeologic conditions were identified for background sampling locations.

To characterize the background soils indicative of the natural conditions, background samples will be collected from the three soil types described above. For these soil types, 8 locations are selected in swamp and marsh deposits; 8 locations are selected for alluvial deposits, and 10 locations are selected for plutonic rock areas. In addition, five samples will be collected from outcropping plutonic rocks since most of the deposits are largely made up of weathering of the plutonic rocks. Surface soil samples (0 to 6 inches below land surface [bls]) will be collected at all proposed background soil sample locations. Co-located subsurface vadose-zone soil samples (4 to 5 feet bls) will be collected at 50 percent of the proposed background soil sample locations. These samples will be analyzed for TAL metals using EPA Method SOW IML03 or latest version. The locations of the soil samples for naturally occurring background constituents are shown on Figure 2-1.

2.2 Groundwater Sampling Locations

Background data for metals in groundwater will be collected from four newly installed background wells, one newly installed upgradient IR well, and three existing water supply

wells. Construction details of existing water supply wells were reviewed to validate their use for sampling as part of the background study. The existing water supply wells are screened in the plutonic rock at similar intervals to IR monitoring wells at SWMU 04, SWMU 05 and SWMU 07. These wells will be re-developed prior to implementing the sampling plan. The wells to be installed as part of this background investigation will be installed in the alluvial deposits in which most of the IR sites are located, and in the swamp and marsh deposits in which SWMU 06 is located. The upgradient IR well will be installed near the boundary of the plutonic rock and alluvial deposits. The groundwater sampling locations for the background investigation are shown in Figure 2-1.

2.3 Surface Water/Sediment Sampling Locations

The only site with standing water other than that resulting from a recent rain event is SWMU 06. At SWMU 06, two background surface water/sediment samples were collected away as part of the IR investigation. These two samples were collected away from SWMU 06, and are not believed to be impacted from site activities. These data, as well as data obtained from the collection of two additional background surface water/sediment samples will be used for the background investigation. One new surface water/sediment sampling area will be located on the southwest corner of Laguna Kiani and the other will be located on the southwest side of Laguna Arenas. The surface water/sediment sampling locations for the background investigation are shown in Figure 2-1.

SECTION 3

Technical Approach and Investigation Procedures

This section details the technical approach developed to perform the sampling activities for the background investigation. The selection of background sampling locations was based on a review of aerial photographs, and site reconnaissance observations.

The tasks to be implemented for the background investigation include: project planning and existing data review, field investigation, sample analysis and validation, statistical data evaluation, and preparation of a Background Investigation Report. Procedures to be implemented will be addressed in site specific project plans. To simplify the process of developing site specific project plans, a Master Work Plan (WP), Master Field Sampling Plan (FSP), Master Quality Assurance Project Plan (QAPP), Master Investigation-Derived Waste Plan (IDWP), and Master Health and Safety Plan (HASP) have been prepared for IR program activities to be performed at NASD Vieques. The Master Project Plans provide the details for sampling and analysis protocols to be followed and general types of activities to be accomplished for implementation of field activities at NASD Vieques. Preparation of site specific plans is simplified through reference to the Master Plan documents.

3.1 Existing Data Review

As part of the preparation of this plan, a United States Geological Survey (USGS) report which documents a 1997 groundwater study of existing water supply wells on NASD Vieques was reviewed. Because the laboratory reporting limits were higher than the reporting limits currently being used for the IR investigations, the data collected by the USGS are not usable. Therefore, 3 existing water supply wells will be resampled as part of the background study.

A site visit will be conducted to evaluate the current condition and integrity of the wells before sampling. Well inspections will include verification of intact protective casings and well locks, and measurements of total well depths. Boring and well constructions have been reviewed as part of this Work Plan development. All background wells are screened in the water table aquifer and are appropriate for use in establishing background water quality of the surficial aquifer.

3.2 Field Investigation

This task involves efforts related to fieldwork support, the field investigation, and surveying.

3.2.1 Field Work Support

Fieldwork support includes subcontractor procurement, mobilization, and utility clearance, as described in the following subsections.

3.2.1.1 Subcontractor Procurement

As part of the initial field mobilization to NASD, CH2M HILL will procure surveying, drilling of soil borings, monitoring well installations, analytical laboratory, and data validation services for work at the Base. The subcontracted analytical laboratory will meet NFESC Level D quality control.

3.2.1.2 Mobilization/Demobilization

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

Demobilization activities include time for IDW sampling and general site restoration prior to the return transport of field equipment and crew. IDW generated during field activities will be containerized in 55-gallon drums. Equipment decontamination fluids will be containerized in 55-gallon drums for storage. The 55-gallon drums will be properly labeled and stored at a location designated by LANTDIV and NASD prior to disposal.

All IDW generated will be analyzed to determine if it is hazardous or non-hazardous. The IDW will be disposed of in the appropriate manner dictated by the results of the analysis. It is anticipated that the IDW generated will be non-hazardous waste.

3.2.1.3 Utility Clearance

Utility clearances will be performed prior to the start of any subsurface investigation activities at the site. CH2M HILL will coordinate subsurface utility clearances with Public Works Center (PWC) at the Base. CH2M HILL will be responsible for insuring that all appropriate contacts have been made with Base personnel and that clearances have been given for proposed subsurface sampling locations, including marking of utilities near the areas of proposed subsurface sampling locations, prior to the initiation of field operations.

3.2.2 Field Sampling Activities

A description of the field activities to be conducted for the background study is addressed in this section. The background investigation consists of the collection and analysis of:

- Eight groundwater samples from three existing water supply wells, one newly installed IR well, and four newly installed background wells.
- Thirty six soil samples, including 24 surface soil and 12 subsurface soil samples
- Five soil samples from the plutonic rock
- Two surface water and sediment samples from co-located sample locations

The number of samples to be collected for establishing background conditions and methods of analysis are presented in Table 3-1. Quality Assurance/Quality Control (QA/QC) samples are also identified in the table, and are discussed in greater detail in subsequent sections.

Details regarding the required containers, preservatives, and holding times for groundwater and soil samples are presented in Section 2 of the Master Field Sampling Plan.

A summary of sample containers, preservatives, and holding times to be used for the background investigation are presented in Table 3-2.

TABLE 3-1
Background Investigation Samples
NASD, Vieques, Puerto Rico

Parameter	Method	No. of Samples	Equipment Rinseate Blanks	Field Blanks	Field Duplicates	Matrix Spike/ Duplicate	Total Number of Samples
Groundwater Samples							
TAL Metals and Cyanide (Total)	CLP ILM04	8	4	1	1	1	15
TAL Metals (Dissolved)	CLP ILM04	8	4	1	1	1	15
Soil Samples							
TAL Metals	CLP ILM04	42	5	1	4	2	54
Surface Water							
TAL Metals	CLP ILM04	2	1	--	--	--	3
Sediment			--	--	--	--	--
TAL Metals	CLP ILM04	2	1	--	--	--	3

Notes:
NA = Not Applicable
CLP = Contract Laboratory Program (most recent version)
TCL = Target Compound List
TAL = Target Analyte List
TOC= Total Organic Carbon; for surface soil only; useful for risk assessment and natural attenuation
Assumptions regarding rate of sample collection:
1. Five days are required to collect groundwater samples
2. Four days are required to collect soil samples
3. One day is required to collect surface water and sediment samples

Trip blanks – one per cooler containing VOC samples
Equipment Rinseate blanks – one per matrix per day; blank for filtered samples is a filtration blank
Field Blanks – since sampling is conducted base-wide no field blank will be collected
Field Duplicates – one per every ten samples per matrix/medium
Matrix Spike/Matrix Spike Duplicates – One per 20 samples per matrix (not required for low-concentration analyses by CLP OLC02)

TABLE 3-2
Required Containers, Preservatives, and Holding Times for Soil and Groundwater Background Investigation Samples
NASD, Vieques, Puerto Rico

Parameter	Method	No. of Sample Containers	Sample Containers	Preservative	Holding Time	Volume of Sample Collected
Groundwater/Surface Water Samples						
TAL Metals (Total)	CLP ILM04	1 (filtered) 1 (unfiltered)	1 Liter polyethylene bottle	HNO to pH < 2 Cool to 4°C	6 months	Fill to shoulder
Soil/Sediment Samples						
TAL Metals	CLP ILM04	1	8 oz. Plastic or glass bottle	Cool to 4°C	6 months	Fill completely

3.2.2.1 Soil Sampling Procedures

The background investigation involves the collection of co-located surface and subsurface soil samples. Surface soil samples will be collected using a stainless-steel trowel and stainless steel mixing bowl. Surface soils will be collected from the surface to a depth of 6 inches below ground surface (bgs). A stainless steel hand auger will be employed for collecting the subsurface soil samples. Subsurface samples will be collected from a depth of 4 to 5 feet bls. The applicable Standard Operating Procedures (SOPs) for the collection of soil samples are located in the Master Work Plan (MWP).

3.2.2.2 Groundwater Sampling Techniques

Groundwater samples will be collected using low flow purging and sampling techniques. It is anticipated that a submersible Redi-Flow pump or peristaltic pump will be used for groundwater sampling, depending on the depth to groundwater. The applicable SOPs for the collection of groundwater samples are located in the MWP.

3.2.2.3 Surface Water and Sediment Sampling Techniques

Surface water and sediment samples will be collected from the same location. Surface water samples will be collected first to minimize turbidity of the sample. The SOPs for the collection of surface water and sediment samples are located in the MWP.

3.2.3 Sampling Equipment Decontamination

All non-disposable sampling equipment will be decontaminated immediately after each use. The applicable SOPs for the decontamination of personnel and equipment are presented in Volume 2 of the Master Project Plans and are included with the FSP checklist.

3.2.4 Surveying

Sampling locations of each background soil sample will be horizontally located using a global positioning system (GPS) following field activities. All survey data will be tied in to the Base coordinate system.

3.2.5 Sample Designation

Sampling locations and sampled media collected during the background investigation will be assigned unique designations to allow the sampling information and analytical data to be entered into a Geographic Information System (GIS) Data Management system to be developed for NASD. The following sections describe the sample designation specifications.

3.2.5.1 Specifications for Field Location Data

Field station data consists of information assigned to a physical location in the field where a sample is collected. For example, a soil boring that has been installed will require a name that will uniquely identify it with respect to other soil boring locations, or other types of sampling locations. The station name provides for a key in the database to which any samples collected from that location can be linked to form a relational database.

A listing of the location identification numbers will be maintained by the field team leader, who will be responsible for enforcing the use of the standardized numbering system during all field activities. Each station will be designated by an alphanumeric code that will identify the station location by facility, site type, site number, location type, and sequential location number. The scheme that will be used to identify field station data is documented in Section 3 of the Master Field Sampling Plan and summarized in Table 3-3.

TABLE 3-3
Field Station Scheme

First Segment	Second Segment	
Facility, Station Type, Site Number	**Station Type**	**Station Number, Qualifier**
AAANNN	**AA**	**NNNA**
Facility:	Station Type:	
ND = NASD	SB = Subsurface Soil Sample Location	
Station Type:	SD = Sediment Sample Location	
S = Site	SS = Surface Soil Sample Location	
O = Operable Unit	SW = Surface Water Sample Location	
U = UST	GW = Groundwater Sample Location	
A = AOC	Station Number:	
BG = Background	Sequential Station Number	
Site Number:	Qualifier:	
04 AOC B	S = Shallow	
05 AOC H	D = Deep	
06 AOC I	K = Background	
07 AOC J		
10 AOC K		
14 AOC L		
15 AOC R		

Notes:
"A" = alphabetic
"N" = numeric

3.2.5.2 Specifications for Analytical Data

Analytical data will be generated through sampling of various media at NASD. Each analytical sample collected will be assigned a unique sample identifier. The scheme used as a guide for labeling analytical samples in the field is documented below. The format that will be used for electronic deliverables from the analytical laboratory and the data validator is documented below.

3.2.5.3 Sample Identification Scheme

A standardized numbering system will be used to identify all samples collected during water, soil, and sediment sampling activities. The numbering system will provide a tracking procedure to ensure accurate data retrieval of all samples taken. A listing of the sample identification numbers will be maintained by the field team leader, who will be responsible for enforcing the use of the standardized numbering system during all sampling activities. Sample identification for all samples collected during the investigations will use the following format.

Each sample will be designated by an alphanumeric code that will identify the facility, site, matrix sampled, and contain a sequential sample number. QA/QC samples will have a unique sample designation. The general guide for sample identification is documented in Table 3-4. If one qualifier is pertinent to the sample ID but another is not, only the Table 3-3 applicable qualifiers will be used. A non-utilized character space does not have to be maintained.

3.2.5.4 Electronic Deliverable File Format

An offsite laboratory will analyze the supplemental background investigation samples and tabulate the results in an electronic format specified by CH2M HILL. The data validator will add data validation qualifiers to the table of analytical results. In addition to hard copy data package deliverable, CH2M HILL will receive an electronic file from the data validator in a table format that will facilitate downloading into a database. The format that will be used for electronic deliverables is tabulated in Table 3-5.

3.2.6 Surveying

Sampling locations at each background sample locations will be horizontally located using a GPS following field activities. All survey data will be expressed as NAD 83 coordinates for x and y directions and in terms of NGVD for the z direction.

3.3 Sample Analysis and Validation

This task involves efforts related to the sample management and data validation. CH2M HILL will be responsible for tracking sample analysis and obtaining results from the laboratory. The analytical data generated during the AOCs investigation field program will be validated by an independent data validation subcontractor according to EPA's *Functional Guidelines for Data Validation* (EPA, 1994).

TABLE 3-4
Sample Designation Scheme

First Segment	Second Segment		Third Segment
Facility, Station, and Site Number	**Sample Type**	**Sample Location + Sample Qualifier**	**Additional Qualifiers (sample depth, sampling round, etc.)**
AAANN	**AA**	**NNNA or NNAA**	**ANN or NNNN**
Facility: ND = NASD Station Type: S = Site W = SWMU O = Operable Unit U = UST A = AOC BK = Background Site Number: 04 AOC B 05 AOC H 06 AOC I 07 AOC J 10 AOC K 14 AOC L 15 AOC R	Sample Type: DS = Direct Push – Soil DW = Direct Push – Water SD = Sediment SS = Surface Soil TB = Trip Blank EB = Equipment Blank FB = Field Blank FD = Field Duplicate Sample Location: 1. Station Samples (NNA) **NN**A - refers to sequential station number NN**A** - letter qualifier for Deep, Shallow, or Composite, sample (if applicable). 2. QC Samples (NNN) **N**NN - numbered sequentially for each type of blank (i.e., 1, 2, etc.) collected for that day's sampling N**NN** - refers to month of sampling event Sample Qualifiers: F = filtered sample P = duplicate sample K = background sample		Additional Qualifiers: 1. Monitoring Well Groundwater Sample (refers to sampling round for that well): R01 - Round 1 R02 - Round 2 R03 - Round 3 2. Direct Push Subsurface Sample (refers to depth of sample): Enter depth of top of sample interval 3. QC Samples NNNN - refers to day and year of sampling event

Notes:
"A" = alphabetic
"N" = numeric

TABLE 3-5
Analytical Data Electronic Deliverable

Analytical data must be delivered in a format compatible with Microsoft Access 2.0 or 7.0

Field Name	Field Type	Description
Sample_ID	A20	The CH2M HILL sample ID (taken from the Chain of Custody).
Sample_Analysis	A5	The analysis performed on the sample. We classify our samples into six main groups: VOA, SVOA, INORG, PEST, WCHEM, and FMETAL (for filtered samples).
Date_Analyzed	D	The date the sample was analyzed.
Date_Received	D	The date the sample was received in the lab.
Date_Collected	D	The date the sample was collected.
Lab_Sample_ID	A15	The lab sample ID.
Dilution_Factor	N	The dilution factor used, if applicable.
SDG_Number	A6	The SDG number.
CAS_Number	A6-A2-A1	CAS Number of the compound being analyzed (Note that the CAS number must consist of three number segments of defined length, separated by dashes).
Chem_Name	A50	The compound being analyzed.
Ana_Value	N	The analytical result.
Std_Qual	A5	The lab qualifiers, if any (e.g., U, UJ, B).
DV_Qual	A5	The data validation qualifier (e.g., J, R).
Units	A10	The unit of the result (e.g., MG/L).
Detect_Limit	N	The detection limit for the compound.
Method	A15	Analytical method used to analyze the sample fraction.

3.3.1 Sample Analysis

All analyses of soil, sediment, and groundwater will be conducted at a contracted laboratory that fulfills all requirements of the U.S. Navy's QA/QC Program Manual and EPA's CLP and SW 846 (for methods not covered by CLP). The laboratory must follow the scope of work prepared by the project team. A signed certificate of analysis will be provided with each laboratory data package, along with a certificate of compliance certifying that all work was performed in accordance with the CLP SOW. All analyses will be performed following the highest level of Navy guidance. Analyses will include the proper ratio of field QC samples recommended by NFESC guidance for the data quality objectives (DQOs).

This task includes checking the data from the laboratory and converting it into an electronic format that can be readily incorporated into the GIS Data Management system for NASD.

3.3.1.1 Field Quality Control Procedures

Quality control duplicate samples and blanks are used to provide a measure of the internal consistency of the samples and to provide an estimate of the components of variance and the bias in the analytical process. The QAPP provides details with regard to the number and frequency of field QC samples to be collected during the investigation.

3.3.1.2 Blanks

Blanks provide a measure of cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. ASTM Type II water will be used for blanks. Four types of blanks can be generated during sampling activities: trip blanks, field blanks, equipment rinseate blanks, and temperature blanks.

VOCs are not anticipated to be collected as part of this background sampling event. However, if VOCs are collected, one trip blank will be included in each cooler used for the daily shipment of VOC samples. If more than one cooler is being sent on a given day, all of the VOC samples should be placed in one cooler, if possible, to minimize the number of trip blanks needed. The trip blanks will be prepared before each sampling event, shipped or transported to the field with the sampling bottles, and returned unopened for analysis. Trip blanks will indicate if there is contamination during shipment to the field, from storage in the field, or from shipment from the field to the analytical laboratory.

One field blank will be collected per sampling event. If sampling events extend beyond one week (five working days) or for windy and dusty field conditions, the number of field blanks should be increased. Field blanks are used to determine the chemical quality of water used for such procedures as decontamination and blank collection.

One equipment blank per sample medium will be obtained for each day of sampling. Equipment blanks will give an indication of the efficiency of decontamination procedures.

EPA has recently requested that a temperature blank be included in each cooler containing samples for CLP analyses so that the laboratory can record the temperature without disturbing the samples. The temperature blank will be labeled, but will not be given a sample number nor will it be listed as a sample on the COC form.

3.3.1.3 Duplicates

Field duplicate samples will be collected at a frequency of 1 field duplicate per 10 field samples per matrix. The locations from which the duplicates are taken will be selected randomly. Each duplicate sample will be split evenly into two sample containers and submitted for analysis as two independent samples.

3.3.1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD samples will be collected at a frequency of 1 MS/MSB for every 20 field samples collected. Analytical results of these samples indicate the impact of the matrix (water, soil, sediment) on extracting the analyte for analysis. MS/MSD samples give an indication of the laboratory's analytical accuracy and precision within the sample matrix. Data validators will use these results to evaluate the accuracy of the analytical data.

3.3.2 Data Validation

Analytical results will be validated by CH2M HILL subcontractors approved by the Navy. Data validators will use EPA Region II guidance (Functional Guidelines).

The hardcopy data packages will be reviewed by the subcontractor chemists using the process outlined in EPA's *Functional Guidelines for Evaluating Data* (EPA, 1994). Areas of review included (when applicable to the method) holding time compliance, calibration verification, blank results, matrix spike precision and accuracy, method accuracy as demonstrated by laboratory confirmation samples (LCSs), field duplicate results, surrogate recoveries, internal standard performance, and interference checks. A data review worksheet will be completed for each of these data packages and any non-conformance will be documented. This data review and validation process is independent of the laboratory's checks and focuses on the usability of the data to support the project data interpretation and decision-making processes.

Data that are not within the acceptance limits will be appended with a qualifying flag, which consists of a single or double-letter abbreviation that reflects a problem with the data. The following flags will be used in the evaluation:

U - Undetected. Analyte was analyzed for but not detected above the method detection limit.

UJ - Detection limit estimated. Analyte was analyzed for, and qualified as not detected. The result is estimated.

J - Estimated. The analyte was present, but the reported value may not be accurate or precise.

R - Rejected. The data are unusable. (NOTE: Analyte/compound may or may not be present.)

Numerical sample results that are greater than the method detection limit (MDL) but less than the laboratory reporting limit (RL) are qualified with a "J" for estimated as required by EPA's *Functional Guidelines* (EPA, 1994).

3.4 Data Quality Evaluation

Analytical data will be collected during this investigation in the form of laboratory analytical results and the database will be populated with data validation qualifier results.

The data quality evaluation (DQE) is the quantitative and qualitative evaluation of overall trends in the project-specific database. The objective of the DQE process is to understand the effects of the overall analytical process on data usability to support project-specific DQOs. The DQE includes an analysis of the effect of the specific sample matrix on the overall analytical process.

The DQE deliverable is a DQE TM that can be used by the project team to readily understand project-specific data usability. Topics to be addressed in the DQE TM include the following:

- *Potential blank contamination*—the effect on the usability of data for compounds detected in both the field or laboratory blank samples and the corresponding field samples
- *Laboratory performance*—evaluation of the recovery for blank spike samples such as the LCS, calibration criteria, etc.
- *Potential matrix interferences*—evaluation of the accuracy and precision for surrogates, spiked field samples, and duplicate field sample results
- *Assessment of PARCCs*—comparison of DV findings with PARCCs (precision, accuracy, representativeness, comparability, and completeness)

This task also includes the evaluation of validated laboratory data and field-generated data. The data evaluation will include incorporation of historical data from the previous investigations, tabulation of the data, and generation of figures and/or tables associated with data (e.g., sampling location maps).

3.5 Statistical Analysis

Various statistical evaluations can be conducted on the validated data for selection of a representative data set. The rationale for the statistical evaluation is that a single sample result may not represent true background conditions. However, a set of data with an adequate number of samples could provide a range of background concentrations for the various constituents that are representative of a typical background distribution.

A representative background data set, when developed, may have multiple and varied uses at a site. A site representative data set can be considered similar to a background data set when the following criteria are similar for each data set:

- Number of samples
- Frequency of detects
- Range of detected concentrations (as presented by boxplots)
- Calculated mean concentrations
- Calculated upper confidence limit (UCL) 95 percent concentrations

When comparing individual data points to evaluate the nature and extent of contamination above background levels , an upper-bound (maximum) detected value in the background is useful in the evaluation. The upperbound maximum is also useful to compare a site maximum detailed concentration with a background value to evaluate whether the site has been affected by operation. Therefore, a simple statistic of estimating the mean of detected values and multiplying it by 2 may be selected as the method of choice for future comparisons with single points or maximum site concentrations. Two times the mean value is estimated after a final data set is selected. A data set is considered final after data validation and after outliers within the data set are identified and eliminated. The removal of outliers ensures a conservative estimation of background representative values by removing the extreme high and low values from the data set. Removal of outliers because of potential artifacts is expected at sites where no effects have occurred.

An outlier can be defined as "an observation that does not conform to the pattern established by other observations." An outlier can arise from incorrect analysis because of

instrument breakdowns, calibration problems, and power failures. They also can be a result of inherent spatial or temporal variability in a chemical's distribution. Statistical tests for outliers are a part of the data validation process wherein data are screened and examined in various ways before being placed in a data set and used for estimating population parameters or for making decisions.

After an outlier is identified, a decision to exclude the outlier will be made, and then a mean and variance will be estimated from the censored data. Because a statistical test may not be used as a sole basis for discarding a data point, a second graphical method may be used for visual identification of the outliers. This avoids the chance of incorrectly declaring a suspect data point to be an outlier. The mathematical method is chosen to calculate site final background values because of the its accuracy and ease of use.

Non-detect concentrations will not be used in this calculation. However, the mean estimates calculated using the non-detect concentrations will be included in an appendix for comparison. In addition, for future comparisons of site data sets and the background data set, a UCL 95 percent concentration will be estimated.

Whenever a site contaminant concentration is near the estimated background (two times the mean) value, the concentration distribution range should be considered for decision making. These evaluations may include comparisons of data distributions by different statistical methods such as boxplots, UCL 95 percent comparisons, and analysis of variance (ANOVA). Evaluation of the sample quantitation limits or detection limits also provides information about the data distribution. These additional comparisons may be used for future analysis when a 2X mean value is only slightly exceeded for a specific site.

3.6 Investigation Reports

A Draft Background Study Report will be prepared for submittal to LANTDIV, NSRR, and PREQB. Based on the evaluation of the results presented in the Draft Report, a Final Report will be prepared.

SECTION 4

Project Management and Staffing

The CH2M HILL Task Manager designated for the oversight of this project is Mr. Marty Clasen. Mr. Clasen will be supported by Mr. John Tomik, who serves as Activity Manager for Vieques Island. Mr. Clasen will be responsible for such activities as technical support and oversight, budget and schedule review and tracking, preparation and review of invoices, personnel resources planning and allocation, and coordination with LANTDIV, NSRR, and subcontractors.

The AOC investigation field program (soil and groundwater sampling) will be performed by qualified CH2M HILL staff members. CH2M HILL will notify LANTDIV and NSRR which CH2M HILL personnel will mobilize to the site prior to initiating field activities.

The Navy Technical Representative (NTR) is Mr. Chris Penny. Mr. Penny is the LANTDIV representative and provides technical direction on the project and coordinates funding and overall interaction with other agencies and interested parties. Mr. Penny can be contacted at the address and phone number listed below.

Ms. Madeline Rivera Ruiz is the Installation Restoration Program Coordinator for U.S. Naval Station, Roosevelt Roads. Ms. Ruiz is responsible for the coordination of all Naval environmental activities at Roosevelt Roads and Vieques Island. Ms. Ruiz can be contacted at the address and phone number listed below.

Mr. Chris Penny
Remedial Project Manager
Installation Restoration Section
Environmental Programs Branch
Environmental Division
Atlantic Division (LANTDIV) Code 1822
Naval Facilities Engineering Command
1510 Gilbert Street
Norfolk, VA 23511-2699
(757) 322-4815

Ms. Madeline Rivera Ruiz
U.S. Naval Station Roosevelt Roads
Environmental Engineering Division
Public Works Department, Bldg. 31
Ceiba, Puerto Rico 00735
(787) 865-5337

SECTION 5

Contractual Services

This section documents the anticipated subcontract services required for the completion of tasks documented in this work plan. The background investigations will require subcontract services from the following:

- Hollow Stem Auger and Air Rotary Drilling
- Analytical Laboratory
- Data Validation
- Surveying

SECTION 6

Project Schedule

This section documents the project schedule and the due dates of deliverables. Table 6-1 shows a breakdown on primary deliverables and assumed intervals for governmental review. Longer periods of review will result in an extended schedule.

TABLE 6-1
Proposed Project Milestones

Phase II Expanded PA/SI Investigation, Contract Task Order 0031

Key Project Milestones	Date From Notice to Proceed		Days Duration
	Start	End	
Notice to Proceed	0	0	0
Submit Draft Background Investigation Work Plan	11/9/00	11/9/00	0
Navy, EPA and PREQB Review of Draft Work Plan	11/9/00	11/17/00	8
Prepare Final Work Plan	11/17/00	11/24/00	7
Submit Final Work Plan	11/24/00	12/11/00	0
Procure Subcontractors/Mobilize	11/13/00	11/24/00	15
Conduct Field Investigation	11/27/00	12/22/00	26
Laboratory Analyses	11/30/01	1/31/01	60
Data Validation/Management	1/31/01	2/29/01	30
Data Evaluation	3/1/01	3/15/01	15
Prepare Draft Reports	3/15/01	4/15/01	30
Submit Draft Reports	4/15/01	4/15/01	0
Navy, EPA and PREQB Review of Draft Reports	4/15/01	5/15/01	30
Prepare Final Reports	5/15/01	5/30/01	15
Submit Final Reports	5/30/01	5/30/01	0

APPENDIX A

Checklists

Site-Specific Investigation-Derived Waste Plan Checklist

This checklist supplements the Master IDW Plan with site-specific information. Once completed for a specific project, it provides necessary IDW information for each investigation. It is to be taken into the field with the Master IDW Plan.

Site: NASD

1. IDW Media:
   - X_____Soil cuttings
   - X_____Well development or purge water
   - X_____Decontamination residual soil and wastewater
   - X_____PPE or disposable equipment
   - _____Other _____

2. Expected Regulatory Status:
   - _____Hazardous
   - _____Solid Waste
   - X_____Unknown
   - X_____Other Waste management activities regulated by OSHA Hazwoper standard (1910.120)

3. Site Location: Decontamination fluids and PPE will be generated at all SWMUs.

4. Nature of Contaminants Expected:
   - X_____Petroleum contamination
   - X_____Polyaromatic hydrocarbon
   - X_____Pesticides
   - X_____Herbicides
   - X_____PCBs
   - X_____Metals
   - X_____Other - Contaminant concentrations from previous analytical results were very low for all of the above.

5. Volume of IDW Expected:
   - X_____Drums - Maximum of 6. One for decontamination Fluids, four for drilling cuttings and one for PPE and other disposable items.
   - _____Cubic Yards
   - _____Tons
   - _____Gallons

6. Compositing Strategy for Sample Collection: No IDW sampling planned. Will base disposal decisions on analytical results from sampling.

7. IDW Storage

   X_____As per Master IDW Plan _____Other_____

8. Waste Disposal

   X_____As per Master IDW Plan _____Other_____

Site-Specific Field Sampling Plan Checklist

This checklist supplements the Master Field Sampling Plan with site-specific information. Once completed for a specific project, it provides necessary field sampling information for each investigation. It is to be taken into the field with the Master FSP.

Site: NASD

1. Tasks to be performed:

_____Geophysical surveys
_____Soil gas surveys
X_____Surface water and sediment sampling
X_____Surface soil sampling
X_____Soil boring installation
X_____Subsurface soil sampling
X_____Monitoring well installation and development
_____Monitoring well abandonment
X_____Groundwater sampling
X_____In-situ groundwater sampling
_____Aquifer testing
X_____Hydrogeologic measurements
_____Biota sampling
_____Trenching
_____Land surveying
X_____Investigation derived waste sampling
X_____Decontamination
_____Other_____

2. Field measurements to be taken:

X_____temperature
X_____pH
_____dissolved oxygen
X_____turbidity
X_____specific conductance
X_____organic vapor monitoring
X_____geophysical parameters (list):
X_____electromagnetic induction
_____ground-penetrating radar
X_____surveying
_____magnetometry
X_____global positioning system
_____soil gas parameters (list):
_____combustible gases
X_____water-level measurements
_____pumping rate
_____other_____

3. Sampling program (nomenclature, etc.):

_____As per Master FSP X_____Other As presented in the PA/SI Investigation Workplan

4. Map of boring and sampling locations (attach to checklist): See Workplan.

5. Table of field samples to be collected: See Investigation Workplan.

6. Applicable SOPs or references to specific pages in Master FSP: The following SOPs from Volume 2 of the Master Project Plans are to be implemented.

- Shallow Soil Sampling
- Monitoring Well Installation
- Homogenization of Soil and Sediment Samples

- VOC Sampling – Water
- Field Filtering
- Chain-of-Custody
- Packaging and Shipping Procedures
- Field Rinse Blank Preparation
- Decontamination of Personnel and Equipment
- Disposal of Fluids and Solids

7. Site-specific procedures or updates to protocols established in the Master FSP:

Described in the Workplan.

Site-Specific Quality Assurance Project Plan Checklist

This checklist supplements the Master QAPP with site-specific information. Once completed for a specific project, it provides necessary quality assurance information for each investigation. It is to be taken into the field with the Master QAPP.

Site: NASD

1. List sampling tasks: groundwater and subsurface soil sampling, surface soil sampling, and monitoring well installations.

2. List data quality objectives: The objective of the SWMU Investigation is to determine the need for further action at each of the SWMUs. Previous analytical data and the analytical data generated from the Investigation will be reviewed and a recommendation for no further action or additional investigation will be made based on the data.

3. Organization:

LANTDIV Navy Technical Representative	Chris Penny / LANTDIV
PREQB Federal Facilities Project Manager	Jose Lejara / PREQB
CH2M HILL Activity Manager	John Tomik / CH2M HILL
Quality Control Senior Review	Kevin Sanders / CH2M HILL
Technical Project Manager	Marty Clasen/ CH2M HILL
Field Team Leader	Eric Isern / CH2M HILL

4. Table of samples with analyses to be performed and associated QC samples included in the SWMU Investigation Workplan.

5. Analytical Quantitation Limits:

   X_____As per Master QAPP

   _____Other

6. QA/QC Acceptance Criteria (e.g., precision, accuracy)

   X_____As per Master QAPP _____Other (attached)

7. Data reduction, validation, and reporting:

   X_____As per Master QAPP _____Other (attached)

8. Internal QC Procedures (field and laboratory):
   X_____As per Master QAPP _____Other (attached)

9. Corrective Action:
   X_____As per Master QAPP _____Other (attached)

10. Other deviations from Master QAPP - None

Site-Specific Health and Safety Plan

This checklist must be used in conjunction with the Master HASP. This checklist is intended for use by CH2M HILL employees only. All CH2M HILL employees performing tasks under this checklist must read and sign both this checklist and the Master HASP and agree to abide by their provisions (see EMPLOYEE SIGNOFF attached to the checklist.

Site: NASD

Location(s): SWMU Location Map and Individual SWMU figures are included in the Workplan.

This document shall be maintained on site with the Master Health and Safety Plan. It will include as attachments from the Work Plan a site map and the site characterization and objectives for this site.

The procedures described in the Master Health and Safety Plan will be followed unless otherwise specified in this Site-Specific Health and Safety Plan.

1. HAZWOPER-Regulated Tasks

_____Test pit and excavation
X_____Soil boring installation
X_____Geoprobe boring
X_____Geophysical surveys
X_____Hand augering
X_____Subsurface soil sampling
X_____Surface soil sampling
_____Soil gas surveys
X_____Sediment sampling
X_____Monitoring well/drive point installation
_____Monitoring well abandonment
X_____Groundwater sampling
_____Aquifer testing
X_____Hydrologic measurements
X_____Surface water sampling
_____Biota sampling
X_____Investigation-derived waste (drum) sampling and disposal
_____Observation of loading of material for offsite disposal
_____Oversight of remediation and construction
_____Other_____

2. Hazards of Concern: (Check as many as are applicable. Refer to Section 3 of Master H&S Plan for control measures):

X_____Heat stress	_____Confined space entry
_____Cold stress	_____Trenches, excavations
_____Buried utilities, drums, tanks	_____Protruding objects
	X_____Vehicle traffic
_____Inadequate illumination	_____Ladders, scaffolds
X_____Drilling	_____Fire
_____Heavy equipment	_____Working on water
_____Working near water	_____Snakes or insects
_____Flying debris	X_____Poison ivy, oak, sumac
_____Gas cylinders	X_____Ticks
X_____Noise	_____Radiological
X_____Slip, trip, or fall hazards	_____Other_____
X_____Back injury	_____

3. Contaminants of Concern (List if known. Refer to Table 3.8 of the Master HASP contaminant-specific information

_____PCBs_____	_____Metals_____	_____VOCs_____
_____PNAs_____	_____SVOCs_____	

4. Personnel (List CH2M HILL field team members :

Field team leader(s)	Erik Isern
Site safety coordinator(s)	Erik Isern
Field team members	Karen Karvazy, Emiliano Cabale, Hector Hernandez, Joshua Hayes, Allyie chang, Mike Weatherby

5. Contractors/Subcontractors

X_____Procedures as per Master HASP

X_____Other

Name: To be added _____ _____

Contact: To be added _____ _____

Telephone: To be added _____ _____

6. Level of personal protective equipment (PPE) required: D
Refer to Table 5.1 of Master HASP, CH2M HILL SOPs HS-07 and HS-08, and Respiratory Protection, Section 2 of the Site Safety Notebook.

7. Air monitoring instruments to be used (refer to Master HSP for action levels):

X____OVM 10.6 _____FID

_____CGI _____Dust monitor

_____O_2

8. Decontamination procedures:

_____As per Section 7 of Master HASP

X_____Other As described in the SWMU Investigation Workplan.

9. List any other deviations or variations from the Master HASP: None

10. Emergency Response (Check that all names and numbers are correct on page 47 of Master HASP and attach corrected page to this checklist)

11. Map to hospital (Highlight route to hospital from site and attach to this checklist)

12. Emergency Contacts (Check that all names and numbers are correct on page 49 of Master HASP and attach corrected page to this checklist)

13. Approval. This prepared site-specific checklist must be approved by John Longo/NJO or Laura Johnson/NJO or their authorized representative

Name Title: Health and Safety Manager Date:

(Signature will be included in the Final HASP)

14. Employee Signoff. All CH2M HILL employees working at the site must sign the attached Employee Signoff for the checklist as well as for the Master HASP.

_____Site

HASP Checklist Employee Signoff

The employees listed below have been given a copy of both this health and safety plan checklist and the Master HSP, have read and understood them, and agree to abide by their provisions.

EMPLOYEE NAME	EMPLOYEE SIGNATURE AND DATE

APPENDIX B

Response to Comments

Response to Comments

Draft Workplan and Sampling and Analysis Plan for Soil, Groundwater, Surface Water and Sediment Background Investigation - Naval Ammunition Storage Detachment, Vieques Island, Puerto Rico

Response to comments prepared by Marian Olsen, Program Support Branch, EPA Region 2.

General Comment 1: *Groundwater Sampling. As discussed at the meeting, and a number of issues raised in the document, I recommend that a hydrogeologist from the Program Support Branch should review the document. There are a number of issues related to sampling techniques, location of upgradient wells, geology, etc. that need to be evaluated.*

Response: A geologist from EPA Region 2 has reviewed this Workplan and his comments are incorporated into these responses. See page number 7 of this response to comments.

General Comment 2: *Background Definition. It is important that the definition of background be included in the document. Specifically, the samples should be collected away from the on-site or other localized sources that may have contaminated the site and away from all identifiable sources of contamination relevant to those detected at the site such as roads, storm sewer catch basins or nearby factories (see RAGS Section 4.4).*

It would be helpful to provide information in the document regarding past operational practices, waste types, contaminants mobility and soil type that support that the areas being selected for background sampling locations are not impacted by the site. If this information is provided in other documents, they should be referenced.

Response: As stated in Section 2 of the Workplan, background concentrations are considered concentrations of naturally occurring constituents (inorganic elements or chemicals that represent underlying geochemical conditions that have not been influenced by human activity) in site media.

Historical aerial photographs presented in the Environmental Baseline Survey (EBS) were reviewed to identify locations which have not been impacted by human activity. In addition, the samples have been located away from roadways and drainage ditches. Each sample location will also be verified in the field to ensure that the area has not been impacted by

human activity.

General Comment 3: *Use of Background in Risk Assessment. Based on discussions with a member of the Background Workgroup, the recommendation is that Background not be used to screen out chemicals of concern but rather should be an area of discussion in the risk characterization section of the risk assessment. It is also important to include arsenic as a chemical of concern, since it is a Group A carcinogen.*

Response: Statistical analysis will be conducted on the background and site data, and risk management decisions will be made in accordance with the evaluation procedure outlined in EPA's *Statistical Test for Background Comparison at Hazardous Waste Sites,* November 1998, and EPA's *Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites,* December 1995. Arsenic will be included in these evaluations. More detail of the statistical analysis approach is presented in response to comment number 4.

General Comment 4: *Statistical Analysis. The report fails to discuss the procedures that will be used in the statistical analysis in detail. It is suggested that more details regarding this approach should be included in the document. At a minimum a 2X comparison to background should be conducted. A decision-tree of the various types of tests that will be conducted should be included either in the document or as a separate memo. This discussion should address how non-detects and outliers will be addressed and include a decision tree for the evaluation.*

Response: Various statistical evaluations can be conducted on the validated data for selection of a representative data set. The rationale for the statistical evaluation is that a single sample result may not represent true background conditions. However, a set of data with an adequate number of samples could provide a range of background concentrations for the various constituents that are representative of a typical background distribution.

A representative background data set, when developed, may have multiple and varied uses at a site. A site representative data set can be considered similar to a background data set when the following criteria are similar for each data set:

- Number of samples per data set from background and the site
- Frequency of detects
- Range of detected concentrations (as presented by boxplots)
- Calculated mean concentrations
- Calculated upper confidence limit (UCL) 95 percent concentrations

When comparing individual data points, such as when evaluating the nature and extent of contamination above background levels, or when comparing a site maximum detected concentration with a background value

to evaluate whether the site has been affected due to operations, an upper-bound (maximum) detected value in the background is useful in the evaluation. Therefore, a simple statistic of estimating the mean of detected values and multiplying it by 2 may be selected as the method of choice for future comparisons with single points or maximum site concentrations. Two times the mean value is estimated after a final data set is selected. A data set is considered final after data validation and after outliers within the data set are identified and eliminated. The removal of outliers ensures a conservative estimation of background representative values by removing the extreme high and low values from the data set. Removal of outliers because of potential artifacts is expected at sites where no effects have occurred.

An outlier can be defined as "an observation that does not conform to the pattern established by other observations." An outlier can arise from incorrect analysis because of instrument breakdowns, calibration problems, and power failures. They also can be a result of inherent spatial or temporal variability in a chemical's distribution. Statistical tests for outliers are a part of the data validation process wherein data are screened and examined in various ways before being placed in a data set and used for estimating population parameters or for making decisions.

After an outlier is identified, a decision to exclude the outlier will be made, and then a mean and variance will be estimated from the censored data. Because a statistical test may not be used as a sole basis for discarding a data point, a second graphical method may be used for visual identification of the outliers. This avoids the chance of incorrectly declaring a suspect data point to be an outlier. The mathematical method is chosen to calculate site final background values because of the its accuracy and ease of use.

Non-detect concentrations will not used in this calculation. However, the mean estimates calculated using the non-detect concentrations will be included in an appendix for comparison. In addition, for future comparisons of site data sets and the background data set, a UCL 95 percent concentration will be estimated.

Whenever a site contaminant concentration is near the estimated background (two times the mean) value, the concentration distribution range should be considered for decision making. These evaluations may include comparisons of data distributions by different statistical methods such as boxplots, UCL 95 percent comparisons, and analysis of variance (ANOVA). Evaluation of the sample quantitation limits or detection limits also provides information about the data distribution. These additional comparisons may be used for future analysis when a 2X mean value is only slightly exceeded for a specific site.

General Comment 5: *For the sediments and surface water, only 2 samples are planned. It is recommended that the document should address how this data will be analyzed considering the small number of samples available.*

Response: Two background surface water/sediment samples were collected from Kiani Lagoon during the PA/SI investigation of SWMU-06. These two samples were collected away from SWMU-06, and are not believed to be impacted from site activities. This data will be included in the background study as well as the two additional proposed samples. The four surface water and sediment background samples will exceed the number of site samples, which is currently two.

The number of samples for various media were selected according to a statistical approach that provides a sample size sufficient to evaluate the concentration distribution patterns and to estimate an upper tolerance interval. Nonparametric tolerance intervals make no assumptions about the underlying distribution of the chemical or compound. However, independent samples were assumed to be randomly drawn from an infinite population. The desired level of confidence and coverage must be specified to determine the associated number of samples. Coverage is the percent or quantile of the population distribution to be bounded by the largest concentration in the sample. Because one objective of the background data collection effort is to realistically reflect the full range of background concentrations, the selection of a sufficient number of samples is desirable to adequately interpret site-related concentrations of naturally occurring metals.

An upper tolerance bound is designed to contain at least $100p$ percent of the sampled population from a sample of size n with $100(1-a)$ percent confidence. The level of confidence reflects the probability that the maximum concentration detected from a collection of samples will bound the pre-specified quantile of the population distribution. The equation used to generate the minimum sample size is as follows:

$$n = \frac{\ln(a)}{\ln(p)}$$

where a = significance level ($0<a<1$)

p = percentile of the population to be contained by the upper bound ($0<p<1$)

n = minimum number of samples required

For example, half of the population is more than and half of the distribution is less than the 50th quantile, the population median value. The upper and lower quantiles of the distribution, the 75th and 25th quantiles, respectively, are the concentration levels at which 25 percent and 75 percent of the population are greater. A prespecified confidence level of 5 percent and prespecified 50th quantile means that the maximum concentration from the

sample of size "n" will not be less than the median (due to chance alone) more than 5 times out of 100. "N" increases as either the preselected quantile (upper tolerance limit) or preselected level of confidence increases. The effect of raising the quantile of interest dominates the increase in required sample size. For example, to be 90 percent certain that the maximum concentration from a sample exceeds the median of the population being sampled requires a sample size of four; to be 95 percent certain requires a sample size of five–a comparatively negligible increase in sample size. To be 90 percent confident that the maximum sample concentration is greater than the 95th quantile requires a sample size of 45; to be 95 percent confident requires an "n" of 59.

The following tabulates the sample sizes required to meet a range of prespecified coverage and a range of prespecified confidence levels:

Estimated Quantile	85% Confidence	90% Confidence	95% Confidence
50th (Median)	3	4	5
75th (Upper Quantile)	7	9	11
85th	12	15	19
90th	19	22	29
95th	37	45	59

Levels of confidence for each media (sediment, surface water, groundwater, and so forth) are calculated according to the project objectives and other considerations. In general, as shown by the above equation, a larger number of samples is required to support either a higher confidence interval or a greater proportion of the distribution. A larger number of samples increases the probability of sampling more "rare" events (extreme values), thereby increasing (biasing high) the overall calculated background value. There also are cost considerations in implementing higher confidence intervals: in general, it costs incrementally more per sample to obtain small increases in the confidence interval. The selection of confidence intervals for NASD is based on both the need to obtain a relatively representative data set and on the cost of obtaining such data.

Therefore, to obtain the greatest confidence for the largest population and also to remain economical, the following levels of confidence, population coverage, and sample sizes for each media were targeted for the sampling effort:

Media	Level of Confidence (%)	Estimated Quantile (%)	Number of Samples
Surface Soil	90-95	90	26
Subsurface Soil	85	85	13
Surface Water	90	50	4
Sediment	90	50	4
Groundwater	85-90	75	8

Specific Page Comments

Specific Comment 1: *Page 1.1. This section should clarify which chemicals will be evaluated for background. It appears it is metals, but the text in the second paragraph discusses several other chemicals i.e., PAHs. This section of the document should clarify that only background metals data is being collected and evaluated.*

Response The reference to pesticides and PAHs have been deleted from the text.

Specific Comment 2: *Page 2.1. The discussion of the importance of the background data should be included in the risk characterization section of the report and not be used to screen out chemicals of concern*

Response Please see response to general comment number 3.

Specific Comment 3: *Figure 2.1 The legend needs to be fixed along with the location of the samples.*

Response: The figure has been revised to include the changes proposed in the meeting.

Specific Comment 4: *Page 2-3. The discussion of the statistical analysis techniques should be augmented with a basic definition of background and the need to assure that the samples are taken from areas that are not impacted by the site.*

Response: Please see response to general comment number 2.

Specific Comment 5: *The discussion of samples near the roadway should be modified since there is a potential for contaminants from the trucks, petroleum products, etc. to impact the area near the exhaust pipe. Several studies have found this a problem for lead contamination. It is suggested that the samples need to be taken far enough away that the road conditions are not impacting the sampling.*

Response: Please see response to general comment number 2.

Specific Comment 6: *Page 2-4. The number of surface water and sediment samples proposed for the analysis is extremely small and it raises issues regarding any statistical analysis that can be conducted with this information. At a minimum, the document should explain the proposed statistical analyses that are proposed based on this small sample size.*

Response Please see response to general comment number 5.

Specific Comment 7: *Page 3-2. This section indicates that all of the waste that will be generated will be non-hazardous waste. It is suggested, in the unlikely event that it is not, a discussion of how the determination will be made that it is toxic and the next steps. It appears that this is addressed on page A-2, but this information should be brought forward into the text.*

Response All investigation derived waste (IDW) will be placed in 55-gallon drums and labeled as IDW until analytical results are received. The IDW will be disposed of as hazardous, or non-hazardous waste, depending on the results of the analysis.

Specific Comment 8: *Page 3-4. The sampling techniques for groundwater should be evaluated by a hydro.*

Response Please see response to general comment number 1.

Specific Comment 9: *Page 3-11. Will this document also be sent to EPA?*

Response: Yes, this document will be submitted to EPA for review and approval.

Specific Comment 10: *Page A-7. Isn't hand augering planned for the surface soil samples?*

Response: Yes, Page A-7 has been revised accordingly.

Response to comments prepared by Andy Crossland – Geologist/ERRD/PSB/TST, EPA Region 2.

Comment 1: *It is not clear what plutonic rock samples will be analyzed for or what data need they fill. Will they be thin sectioned to determine mineral composition? Crushed and analyzed for trace metals? Some greater justification should be given as to why these samples are necessary and the exact analyses that would be performed. Also, are these surface samples? How will they be collected?*

Response: The samples will be collected by breaking off pieces of rock out-crop with a stainless steel rock pick. The samples will be crushed by the laboratory before analysis and analyzed for metals. Soils on the site are derived from the weathering processes of the plutonic rock. The data will be not be used to correlate directly with soil samples, but may be used in the risk

management decision process.

Comment 2: *The samples of plutonic rock are sited along the southern coast. Although I have not been to the island, it seems likely that rock in this area would be amongst the most weathered, possibly with the added complication of direct contact with the sea. It may make sense to seek out an area with the least weathering for the rock samples. This would give the best picture of the original rock composition – if that is the goal. This issue should be addressed in tandem with justifying the need for the samples as noted above.*

Response 2: Plutonic rock out-crops were identified along Mount Pirata. Three sampling locations for rock samples have been relocated inland.

Comment 3: *Figure 2-1 shows a fault which runs through the western portion of the island. Does the fault have sufficient displacement such that those rocks to the southwest are of different composition than to the northeast? What is the spatial distribution of granidiorite and quartz diorite? Both of these issues could have implications for background levels of metals in the groundwater. Different plutonic bodies could result in different groundwater geochemistry and effect the background concentrations. If the rock composition varies across the fault or in some other regular manner, the 3 supply wells which are to be sampled may not be appropriate background locations for all areas of plutonic rock.*

Response: There is no difference between rock type on either side of the fault. In addition, the only site located in this formation is located on the west side of the fault.

Comment 4: *The document states that groundwater sampling will be conducted using low flow with a peristaltic or submersible pump. It should be possible to define which one. Also, has the MWP been reviewed to ensure proper sampling methods etc.?*

Response: All sampling and analysis will be conducted in accordance with the master workplan which was reviewed by EPA and PREQB. The preferred sampling method is peristaltic pump. However, when the depth to groundwater approaches 20 feet or more, use of a peristaltic pump is not possible and a submersible pump must be used.

Comment 5: *What are the anticipated depths of the wells to be installed? Will they have 10 foot screens which cross the water table? What about the well which is to be located near the boundary between bedrock and alluvial deposits? Some details are in order.*

Response: All wells will be constructed with 10 feet of screen which will straddle the water table. The anticipated depth to water in the alluvial deposits is 5 to 10 feet below land surface (bls). The anticipated depth to water in the swamp/marsh deposits is less than 5 feet bls.

Comment 6: *Locational data should be collected and reported in Puerto Rico State Plane NAD 83 coordinates.*

Response: All sampling locations will be surveyed in the x, y direction using NAD 83 coordinates, and in the z direction using NGVD.

Comment 7: *Region 2 EPA is in the process of developing a standard EDD for all data submittals in the region. When that standard is adopted, new data will need to be in that format. Until that time, please add the following fields to the EDD proposed: X and Y coordinates in Puerto Rico State Plane NAD 83, and a separate field which distinguishes whether the sample is for total or dissolved concentrations.*

Response: All data is obtained electronically and placed in a database. The information requested is part of the standard data collection procedures.