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RCRA Facility Investigation Work Plan

SWMU 14

Naval Activity Puerto Rico
RCRA/HSWA Permit No. PR2170027203
Ceiba, Puerto Rico

Prepared For

Department of the Navy
Naval Facilities Engineering Command
Atlantic Division

Norfolk, Virginia

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REVISED FINAL

RCRA FACILITY INVESTIGATION WORK PLAN
FIRE TRAINING PIT AREA
SWMU 14

NAVAL ACTIVITY PUERTO RICO
RCRA/HSWA PERMIT NO. PR2170027203
CEIBA, PUERTO RICO

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DEPARTMENT OF THE NAVY
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LIST OF ACRONYMS AND ABBREVIATIONS

AFFF	aqueous film forming foam
AOC	Areas of Concern
AUF	Area Use Factor
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation Factor
Baker	Baker Environmental, Inc.
BCF	Bioconcentration Factor
bgs	below ground surface
CalEPA	California Environmental Protection Agency
CAO	Corrective Action Objectives
CDI	Chronic Daily Intake
CLEAN	Comprehensive Long-Term Environmental Action Navy Program
COPC	Chemicals of Potential Concern
CSF	Cancer Slope Factor
CTO	Contract Task Order
DRO	Diesel Range Organics
EPC	Exposure Point Concentration
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
GIS	Geographic Information System
GRO	Gasoline Range Organics
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IDW	Investigation Derived Waste
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
Kd	Adsorption Coefficient
Koc	Organic Carbon Partition Coefficient
LOAELs	Lowest Observed Adverse Effects Levels
LNAPL	light, non-aqueous phase liquid
MATC	Maximum Acceptable Toxicant Concentrations
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MCL	Maximum Contaminant Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NACIP	Navy Assessment and Control of Installation Pollutants

NAPR	Naval Activity Puerto Rico
NAVFAC	Naval Facilities Engineering Command Atlantic Division
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAELs	No Observed Adverse Effects Levels
o/w	oil/water
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PID	Photoionization Detector
PPRTVs	Provisional Peer Reviewed Toxicity Values
Purple K	potassium bicarbonate
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RAGs	Risk Assessment Guidance for Superfund
RBC	Risk Based Concentrations
RCRA	Resource Conservation and Recovery Act
RfCs	Reference Concentrations
RfDs	Reference Doses
RFI	RCRA Facility Investigation
SCCRBS	Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening
SMDPs	Scientific/Management Decision Points
SVOC	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TCL	Target Compound List
TPH	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This document presents the activities required for the performance of a Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) at SWMU 14 Fire Training Pit Area, Naval Activity Puerto Rico, Ceiba, Puerto Rico (Figure 1-1). This document was prepared by Baker Environmental, Inc. (Baker), for the Naval Facilities Engineering Command Atlantic Division (NAVFAC). This work plan is being developed under Contract Task Order (CTO) 099 under the LANTDIV Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62470-95-D-6007.

1.1 Site History

The history of the fire training pit site, SWMU 14 is described in the following paragraphs. The site consists of 3 different fire training pits and is described as the original pit, temporary pit, and current pit. SWMU 14, the Fire Training Pit Area located at Naval Activity Puerto Rico (NAPR), Ceiba, Puerto Rico was operated by the Air Operations Department from the early 1960s through 1983.

The original fire training pit was an unlined pit approximately 40 feet in diameter that was used from the early 1960s through the beginning of 1983 (see Figure 1-2). The Initial Assessment Study conducted in 1984 estimated that approximately 120,000 gallons of waste solvents, fuels, and oils were placed in the pit and set on fire for fire fighting training during the 20 years of operation (NEESA, 1984). Also burned were wood, trash, plastic, fuel filter elements, oily rags, and other debris. The fires were extinguished using aqueous film forming foam (AFFF) and potassium bicarbonate (Purple K). Past aerial photographs show drainage from this pit to the ditch along the runway shoulder (see Figure 1-2). The ditch runs from the southern portion of SWMU 14 southwestward along the taxi-way of the airfield.

The original pit was taken out of operation at the beginning of 1983 for the construction of a new fire training pit at the same location. When the new/current pit was built, all of the visibly oil-stained, contaminated soil was excavated in the immediate vicinity of the old pit; there are no records of ultimate disposal for this contaminated material. A soil sample was taken of the soil and no PCBs were detected (NEESA, 1984). No other specific information is available concerning the depth and aerial extent of soil contamination identified and excavated in 1983.

A temporary fire training pit was constructed to the north of the original pit location and was in operation during the construction of the current fire training pit in 1983 (see Figure 1-3). This temporary pit was an unlined gravel pit with an approximate diameter of 2,000 feet and was used approximately six times. Approximately 3,000 gallons of waste fuel, oil, and solvents were burned in this area. Only small amounts of fuel were allowed to soak into the ground (NEESA, 1984).

A new/current fire training pit was constructed in 1983 over top of the location of the original fire training pit. This consisted of the construction of a concrete lined pit and oil water separator to serve the pit. The pit is approximately 40 feet in diameter and consists of a concrete apron approximately 10 feet wide that encircles the concrete lined pit. Fluids from the fire training operation are contained in the pit and go through the oil/water (o/w) separator before entering the Forestall Waste Water Treatment system. It should be noted that the drainage swale identified in the description of the original pit was graded over during the construction of the new pit and is no longer present at this site.

SWMU 14 consists of the area encompassed by the current fire training pit, the temporary training pit, and the historical location of the drainage swale associated with the original pit as described above. Figures 1-2 and 1-3 show the locations of the original, temporary, and current pits associated

with SWMU 14, along with SWMU 12 which is the o/w separator associated with the fire training pit. The RCRA Section 7003 Administrative Order states that the corrective action for SWMU 12 is complete without controls.

Previous assessments conducted at SWMU 14 include: the Navy's 1984 Initial Assessment Study, the 1995 Final RCRA Facility Investigation Management Plans (Baker, 1995), the 1996 RCRA Facility Investigation (RFI) (Baker, 1996), the Draft Interim Decision Document for SWMU 14 (Baker, 2000a), comment letters between the USEPA and the Navy, and issues discussed during the conference call on October 10, 2000.

In July 2000, both EPA Region II and the Navy agreed on an interim decision document that outlined that no additional site characterization would be performed until fire training activities ceased at this site since no human health risks were identified (Baker, 200b). On March 31, 2004, the fire training activities were suspended and therefore this RFI Work Plan is being developed to support a final investigation with an anticipated resolution of a decision of final site disposition.

1.2 Objectives

This work plan is developed to support the efforts in conducting the RFI field investigation at SWMU 14. The objective is to determine if any contaminants are present from past operation of the fire training pit to the extent practical from the completion of the field activities. A human health and ecological risk assessment will be conducted utilizing the analytical results from this investigation to assess risks to human health and the environment.

The investigation areas at SWMU 14 are shown on Figure 1-3. The objectives and specific elements of the field effort to be performed include:

Original /Current Pit Location

- Surface soil sampling at three locations outside the concrete fire training pit perimeter, one of the locations will correspond to the location of the former drainage swale at the southern edge of the fire training pit area.
- Subsurface soil sampling collected at two depths from three locations outside the concrete fire training pit perimeter corresponding with the surface soil sampling locations and three boring locations inside the perimeter of the fire training pit
- The installation of three temporary wells inside three of the six soil borings; locations dependent on the findings from the subsurface soil sampling effort
- Groundwater sampling at the three temporary wells

Temporary Pit Location

- Surface Soil sampling at one location located in the center of the temporary pit
- Subsurface soil sampling collected at two depths from one location located in the center of the temporary pit
- Installation of one temporary well in the center of the temporary pit
- Groundwater sampling at the temporary well location

The subsurface soil locations inside the originals/current fire training pit perimeter were selected to provide analytical information relating to soils of the original fire training pit area located below the existing concrete pad. The soil sample locations outside the concrete pad were selected to further

delineate any potential contamination related to the fire training pit activities. All sampling locations were selected in areas not previously sampled; therefore expanding the characterization of the area. Additionally, one sample located in the southernmost portion of the SWMU was selected to represent the soils that would have been considered the drainage ditch area when the ditch was evident prior to the construction of the current pit in 1983.

1.3 Organization of the Work Plan

This work plan is organized into nine 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 of the site, including the history of SWMU 14, and a summary of previous investigations. Section 3.0 provides a description of the scope of investigations that will be utilized during the upcoming fieldwork. The proposed scope of investigations include soil sampling and analysis program, temporary monitor well installation program, groundwater sampling and analysis program, 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 and Section 6.0 provide the framework for the Human Health and Ecological Risk Assessments, respectively. Section 7.0 discusses the proposed project schedule that will be followed for this data collection investigation. The site management structure that will be utilized during this investigation, including project team responsibilities and field reporting requirements, is presented in Section 8.0, while Section 9.0 presents the report references.

2.0 CURRENT CONDITIONS

The following section is a discussion of the current conditions that exist at the fire training pit areas at SWMU 14.

2.1 Current Site Conditions

The current fire training pit is a concrete structure, constructed below grade, with a concrete apron. The pit prevents seepage of contaminants to the subsurface soils beneath the fire training area. A drainage system encircling the apron intercepts any overtopping, which is directed to an oil/water separator. The temporary pit utilized in 1983 is covered with grass and is maintained via grass cutting operations.

2.2 Site Usage

The current fire training pit was utilized for training purposes until March 31, 2004 when operations ceased. The training consisted of Navy personnel simulating an aircraft crash by igniting pieces of aircraft with two to three (55 gallon) containers of JP-5 fuel per training session. The facility underwent repair work to prepare for the usage of Tech-flame which could have been used to ignite the fires. Personnel were required to use water (only) to extinguish the training fires developed at this pit. On average, fire training activities lasted from three to four hours and were conducted two to four times a month.

2.3 Previous Investigations

Various investigations have been conducted at SWMU 14 over the years including an Initial Assessment Study, Phase I RFI, Human Health Risk Assessment Report (HHRA), and a Draft Interim Decision Document. These items and other miscellaneous items are discussed below.

The Navy conducted an Initial Assessment Study in 1984 to identify and assess sites posing a potential threat to human health or to the environment due to contamination from past hazardous waste operations. The IAS reviewed historical records, aerial photographs, surface and aerial surveys, and personnel interviews. The IAS concluded that because the contaminated soils associated with the original fire pit were removed during construction of the new pit and no PCBs were detected, and because the temporary pit was used so little, the IAS team concluded that there is no threat to human health or the environment from this site. No further action under the Navy Assessment and Control of Installation Pollutants (NACIP) Program was warranted.

The 1994 RCRA/HSWA Permit issued to Naval Station Roosevelt Roads requested that a Phase I RFI be conducted to encompass subsurface soils down to the water table. Groundwater investigations will be contingent on the subsurface soil sampling results.

Project Plans were developed and approved by the EPA to conduct the Phase I RFI for SWMU 14. The Final RCRA Facility Investigation document dated 9/14/1995 contains the entire set of project plans including a Project Management Plan, Data Collection Quality Assurance Plan, and the Health and Safety Plan (Baker, 1995). These project plans are referenced and still relevant for the performance of the work described in this work plan. This Health and Safety Plan addresses all potential exposures at SWMU 14 and reflects the current site conditions at the facility. The only changes at this site since the original RFI work was conducted in March of 1996 is that the facility is closed and no longer in use for fire training. This document also complies with applicable Occupational Safety and Health Administration requirements.

The Phase I RFI field investigation was conducted in March 1996. This field investigation included the performance of a limited soil gas survey along the perimeter of the original/current fire training pit and surface soil sampling from those areas identified from the soil gas survey exhibiting the highest

photoionization detector (PID) readings. Figure 2-1 provides the locations of the sampling conducted during the 1996 RFI investigation. Tables 2-1 and 2-2 provide the soil gas survey and surface soil sampling results from this investigation. Appendix B is provided to present the complete summary of the analytical results from this investigation. As part of the 1996 RFI, a total of five surface soil samples (14SS04 through 14SS08), as shown on Figure 2-1, were collected at the soil gas sampling locations which exhibited the highest PID readings which ranged from 21.1 parts per million (ppm) to 79.2 ppm. Fourteen semivolatile organic compounds (SVOCs), twelve being Polynuclear Aromatic Hydrocarbons (PAHs), one congener of polychlorinated biphenyl (PCB) (Aroclor-1260), and total petroleum hydrocarbons (TPH) diesel and gasoline range organics (DRO and GRO) were detected in surface soil samples. The RFI Report on the findings of this investigation was submitted to the EPA on 7/1/1996 (Baker, 1996). On January 28, 2000 the Navy informed the EPA of an omission in the data set contained in the aforementioned RFI report. Due to this omission a Human Health Risk Assessment Report was developed utilizing the complete data set from the 1996 RFI investigation at SWMU 14. The results of the Human Health Risk Assessment (HHRA) did not indicate an unacceptable cancer risk for any of the exposure scenarios or pathways. This report was submitted to the EPA for review and comment on February 4, 2000 (Baker, 2000).

The EPA provided comments on the Draft HHRA Report for SWMU 14 on July 5, 2000 finding that the human health risk assessment (HHRA) evaluation for exposure to surface soils is generally adequate and identified deficiencies in site characterization. The EPA requested that a supplemental site characterization work plan be submitted to adequately characterize all media.

The Navy responded to the EPA comments dated July 5, 2000 in a letter dated August 22, 2000. These responses were followed up by the submission of a Draft Interim Decision Document (Baker, 2000c) that was submitted to the EPA on November 22, 2000. The purpose of this document was to provide information to support the Navy's recommendation to postpone final site disposition until the site was no longer utilized for training activities. This interim decision document generation was agreed to by both the EPA Region II and the Navy during a conference call on July 5, 2000.

The EPA approved the Interim Decision Document on May 4, 2001 based on the recommendations given in Section 4.0 of the document, that "once fire training operations cease [at this unit], additional site characterization of the site will be conducted". Fire Training operations ceased on March 31, 2004 at which time the Navy procured funding for the development of this RFI Work Plan for SWMU 14.

2.4 Human Health Risk Assessment

This Baseline Human Health Risk Assessment (HHRA) was designed to support the Interim Decision Document for SWMU 14. It was conducted in accordance with United States Environmental Protection Agency (USEPA) Regulations and was consistent with the applicable risk assessment guidance documents. The objective of this HHRA was to assess the human health risks associated with exposures to surface soil contamination identified in the RCRA Facility Investigation Report for Phase I Investigations at Operable Units 1, 6, and 7 (Baker, 1996) for the Naval Facilities Engineering Command Atlantic Division (NAVFAC).

The following presents a summary of the human health risk assessment. The Interim Decision Document SWMU14 – Fire Training Pit Area dated November 22, 2000 houses the risk assessment in its entirety and should be consulted for a more detailed analysis.

A hazard identification process summarized the analytical data for existing surface soil data and identified Chemicals of Potential Concern (COPC). Once COPCs were identified, reference doses and slope factors for each were presented and methods for assessing cancer and noncancer dose-response relationships were discussed.

An exposure assessment identified potentially exposed populations, exposure pathways, and exposure parameters used for estimating site-specific risk, and a risk characterization estimated risks for each scenario, and provided a qualitative uncertainty analysis. The risk characterization provided quantitative calculations for potentially carcinogenic COPCs estimate inferentially (versus probabilistically) the potential increased cancer risk (ICR) for an individual in a specified population. This unit of risk refers to a potential cancer risk that is above the background cancer risk in unexposed individuals. For example, an ICR of 1×10^{-6} indicates that an exposed individual has an increased probability of one in one million of developing cancer subsequent to exposure, over the course of his lifetime.

For this HHRA, COPCs were identified by comparing the chemicals in surface soil samples to Residential USEPA Region III Risk Based Concentrations (RBCs) (current in 2000). RBCs were derived using conservative USEPA promulgated default values and the most recent toxicological criteria available. RBCs for potentially carcinogenic and noncarcinogenic chemicals were individually derived based on a target incremental lifetime cancer risk (ICR) of 1×10^{-6} and a target hazard quotient (HQ) of 1.0, respectively. For potential carcinogens, the toxicity criteria applicable to the derivation of the RBCs were chronic oral cancer slope factors; for noncarcinogens they were oral reference doses.

The following chemicals exceeded the residential RBCs values, and were therefore retained as COPCs for further analysis: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene and indeno(1,2,3-c,d)pyrene.

The results of the HHRA did not indicate an unacceptable cancer risk for any of the exposure scenarios or pathways. Current land use scenarios that were evaluated include commercial/utility worker, and trespasser. Future land use scenarios evaluated include commercial/utility worker, trespasser, military residential (adult and child), and construction worker. Each scenario evaluated the risk associated with ingestion of contaminants in surface soil, inhalation of particulates from surface soil, and dermal contact with surface soil. Based on the results of this HHRA it was not likely that the COPCs detected in surface soils at SWMU 14 would pose a significant health risk to current or future receptors.

2.5 Overall Previous Study Conclusions and Recommendations

Engineering controls were in place to prevent subsurface and groundwater exposure to activities conducted at the fire training pit. The engineering controls include a concrete pad with a concrete apron, and an oil and water separator which were maintained throughout the utilization of the fire training pit. SWMU 14 would not be utilized for any other function except for fire training activities. Once fire training operations cease, additional site characterization of the site would be conducted. If it was determined that an unacceptable risk was present, the area would be remediated as appropriate. Therefore, it was recommended that additional site characterization and a final decision of whether or not corrective action would be necessary once the usage of the area was terminated. This work plan supports the conclusion of the Interim Decision Document by conducting the additional site characterization.

3.0 SCOPE OF INVESTIGATION

The additional investigation at SWMU 14 – Fire Training Pit Area will consist of the following:

Original/Current Pit Location

- Analysis of surface soil from three sample locations from outside the concrete fire training pit perimeter. These locations will correlate to the three soil borings from the outside of the fire training pit.
- Analysis of subsurface soil from six soil borings, including three from outside the concrete fire training pit perimeter and three from inside the perimeter of the fire training pit.
- Installation of three temporary wells inside three of the six soil borings.
- Groundwater sampling of the three temporary wells

Temporary Pit Location

One additional sampling location will be located at the temporary pit location and will consist of the following:

- Analysis of one surface soil sample collected from the center of the temporary pit
- Analysis of subsurface soil samples collected from two depths at the center of the temporary pit
- Installation of one temporary well located in the center of the temporary pit
- Groundwater sampling of the temporary well

A sample matrix for this investigation is provided as Table 3-1. The various investigation elements are described in detail in the subsections that follow.

3.1 Soil Sampling and Analysis Program

Two of the components used to further characterize SWMU 14 are surface soil sampling and subsurface soil sampling. Three surface soil samples will be collected from outside the original/current concrete fire training pit perimeter and one from the center of the temporary pit. The sample locations at SWMU 14 will be evenly dispersed around the pit as shown on Figure 3-1 as 14SB01, 14SB02, and 14SB03. One of the three borings is set at the location of the former drainage ditch as sown on the 1977 aerial photograph. To assist in identifying this location in the field a GPS unit will be loaded with the sample map to ensure that the boring is located in the former drainage ditch.

Six soil borings will be advanced at the original/current pit at SWMU 14. Three of the soil borings will be located outside the fire training pit perimeter (14SB01, 14SB02, and 14SB03) in the same location as the surface soil samples and three will be located inside the pit perimeter (14SB04, 14SB05, and 14SB06). One soil boring will be advanced in the center of the temporary pit (14SB07). The subsurface soil samples will be collected using a Geoprobe 66DT rig capable of direct push and augering. Care will be taken to achieve maximum recovery so that a good stratigraphic profile can be developed. A boring log will be maintained indicating, among other things, color, lithology, and water occurrence. Soil samples will initially be screened at 6-inch intervals with a photoioization detector (PID) to develop a semi-quantitative contaminant profile.

At all seven soil boring locations, samples will be collected from ground surface to the water table using 5-foot long Marco Core Sampler, with two samples per boring being submitted for analysis.

The two samples per boring will be collected from the depth of any suspected contamination and directly above the water table. All surface and subsurface soil samples will be submitted to the laboratory for analyses including Appendix IX volatile organic compounds (VOCs), SVOCs, low level PAHs, PCBs, Appendix IX metals and TPH DRO and GRO. Dioxins/Furans analyses will be performed on three samples located inside the fire training pit ring. Thee samples will be collected from two shallow subsurface soil locations and one deep subsurface soil sample from directly above the groundwater table at the discretion of the field geologist.

This work plan is dynamic in that the boring locations are subject to change based on findings as the work progresses (i.e., PID readings and visual observations). Additional borings may be added to the scope of work at the discretion of the project team (Project Manager, Site Manager and NAVFAC). The decision will be based on field observations such as visual contamination and PID readings.

The soil sample designations will be as follows. One of the soil borings will be designated 14SB01. Extensions to the sample identification will reflect the depth at which the sample was obtained. For the purposes of this work plan, two-foot discretized depths will be used. Sample identification extensions will follow the pattern shown below.

14SB01-00—0 to 6 inches bgs (surface soil)
14SB01-01—1 to 3 feet bgs
14SB01-02—3 to 5 feet bgs
14SB01-03—5 to 7 feet bgs
14SB01-04—7 to 9 feet bgs, etc.

The actual sample depth will be determined in the field.

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. The specific laboratory and third party validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date.

3.2 Monitor Well Installation Program

Two temporary wells will be installed in three of the six soil borings from the original/current pit location to characterize the groundwater potentially affected by activities at the Fire Training Pit. The location of these wells will be determined based on the findings from the subsurface soil sampling effort. A third temporary well will be installed in the boring located within the temporary pit location used in 1983.

All monitor wells will be advanced using the 66DT Geoprobe rig capable of direct push and augering. All completed wells will be 1 inch in diameter. Each well boring will be sampled and logged as described in Section 3.1.

Each temporary well will consist of a 1- inch diameter, schedule 40 polyvinyl chloride (PVC), riser with a five-foot screen. Each temporary well will be sealed with plastic sheeting at the surface to prevent inflow of surface water or accidental introduction of foreign material into the hole. A

groundwater sample will be obtained from each temporary well after allowing the groundwater to enter the screen overnight. The temporary wells will not be developed.

3.3 Groundwater Sampling and Analysis Program

The groundwater sampling will be used to aid in characterization of the groundwater potentially effected by activities associated with the operation of the Fire Training Pit Area. All groundwater samples will be submitted to the laboratory for analyses including Appendix IX VOCs, SVOCs, low level PAHs, PCBs, Appendix IX metals and TPH DRO and GRO. Table 3-2 identifies the appropriate analytical method for each individual constituent to be reported by the laboratory.

The groundwater will be sampled using a low flow sampling technique. Appendix A includes a detailed description of low flow sampling technique. Field parameters of pH, temperature, turbidity, conductivity, and oxidation-reduction potential will be obtained with appropriate instrumentation during sampling.

Samples will be packed in ice and shipped next day air to the "fixed base" laboratory in a manner described in Section 3.1. 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. The specific laboratory and validator will be determined at a later date.

3.4 Quality Assurance/Quality Control Samples

QA/QC requirements for the investigation are as follows and are identified in the sample matrix presented in Table 3-1.

3.4.1 Trip Blanks

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

3.4.2 Equipment Rinsates

Equipment rinsate samples are collected from analyte-free water rinse of decontaminated equipment. Equipment rinsate blanks will be collected and submitted to an analytical laboratory for analysis. The results from the blanks will be used to determine if the sampling equipment was free of contamination. The rinsates are analyzed for the same parameters as the related samples.

It is anticipated that a total of three equipment rinsates will be collected. These samples will be associated with the subsurface soil and groundwater sampling equipment. One of the samples will be obtained from a stainless steel spoon, while another will be collected using the acetate liner. The remaining sample will be collected using the polyethylene and silicon tubing used during the collection of groundwater.

3.4.3 Field Blanks

Field blanks consist of the source water used in equipment decontamination procedures. At a minimum, one field blank for each event and 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., potable water, store-bought distilled water, and laboratory-grade de-ionized water) will be utilized for this investigation as shown in Table 3-1.

3.4.4 Field Duplicates

Field duplicate samples of the subsurface soil and groundwater will be collected during the same time the corresponding environmental sample is collected. One duplicate sample will be collected for every 10 soil and groundwater samples collected. A minimum of one duplicate sample will be collected of soil and groundwater during this investigation.

3.4.5 Matrix Spike/Matrix Spike Duplicates

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. One MS/MSD will be collected during the soil and groundwater sampling.

3.5 Other Investigation Considerations

3.5.1 Utility Clearance

Fifteen days prior to the initiation of the proposed fieldwork, a digging permit request will be submitted by Baker to the Facility Management Transportation and Utility Division (FMTUD) of the Public Works Department at NAPR. Although utilities are not identified on the GIS utility layer, all proposed soil borings and well locations will be cleared by the base utility department.

3.5.2 Investigation Derived Wastes (IDW)

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

One IDW sample will be collected from all drums containing decontamination and purge water and from the solid waste collected as a result from installing borings. The samples will be analyzed for parameters as shown in Table 3-1, as well as by methods presented in Table 3-2. Upon completion of the field program, the drums will be moved and stored per the direction of PWD personnel. 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.

3.5.3 Decontamination

The drill rig, including all applicable soil sampling equipment (i.e. macro core samples, shoes, etc.), will be decontaminated between each sampling location in accordance with the EPA approved RCRA

Facility Investigation Work Plans (Baker, 1995). The remaining contaminant free sampling equipment and materials utilized during this investigation will be disposable.

3.5.4 Surveying

All soil sampling locations will be 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. A transit and rod will be utilized to obtain top of PVC elevations of the temporary wells for generating groundwater contours used for reporting purposes.

3.5.5 Health and Safety Procedures

The Health and safety procedures found in the base RFI work plan (Baker, 1995), will be employed during this investigation.

3.5.6 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 base RFI work plan (Baker, 1995).

A chain-of-custody form will be completed for each container 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 report shall include at a minimum:

Introduction
Facility Investigation
Nature and Extent of Contamination
Risk Assessments
Conclusions and Recommendations

The RFI report sections are discussed in the following subsection.

4.1 Introduction

The introduction will consist of a discussion of the historical background of the investigations conducted at SWMU 14. The introduction will also provide a regulatory framework for NAPR and SWMU 14, as well as a discussion of current conditions.

4.2 Facility Investigation

The investigation methodologies employed to fulfill the RFI work plan objectives for SWMU 14 will be discussed. The sample locations, sample collection and handling procedures, QA/AC 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 Nature and Extent of Contamination

The nature and extent of contamination section will present analytical results and interpretation of the data. Data will be presented on tables and figures with textual explanation. Results of QA/QC procedures will also be presented.

4.4 Risk Assessments

Human Health and Ecological Risk Assessments will be performed based in the information collected during the RFI investigation. The risk assessment methodologies will be presented in Section 5.0 for human health and in Section 6.0 for ecological.

4.5 Conclusions and Recommendations

Information from the nature and extent of contamination will be synthesized into conclusions regarding site conditions. Recommendations will be made from these conclusions as to whether further investigation is needed or SWMU 14 can proceed toward closeout.

All the documentation generated during the reporting task will be posted to the NAPR web site under the document library. Additionally, all data obtained during the field effort will be incorporated into the web based GIS system currently residing on the NAPR project team web site.

5.0 HUMAN HEALTH RISK ASSESSMENT

A Human Health Risk Assessment (HHRA) will be conducted at SWMU 14. It will identify existing or potential risks that may be posed to human health and will serve to support the evaluation of the threats posed by a site with respect to current and future potential exposure scenarios. By identifying potential risk, the risk assessment will provide valuable input to the development and evaluation of remedial alternatives during the RFI.

The following sections present a general approach for conducting the HHRA.

5.1 Human Health Risk Assessment Approach

A HHRA will be conducted in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1990a). The primary guidance document for all HHRAs will be the Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A) Interim Final (USEPA, 1989). Other guidance documents will include:

- RAGS: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), USEPA 1991a.
- RAGS: Volume I - Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives), USEPA 1991b.
- RAGS: Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), USEPA 2001a.
- RAGS: Volume I - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment. Interim. Final.), USEPA 2004.
- Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites, USEPA 2002.
- Exposure Factors Handbook, USEPA 1997a.
- Guidance for Data Usability in Risk Assessment, USEPA 1990b.
- EPA Region III Risk-Based Concentration Table, USEPA 2005a.

The technical components of the HHRA are contaminant identification, exposure assessment, toxicity assessment, and risk characterization. The objectives of the risk assessment process can be accomplished by:

- Characterizing the toxicity and levels of contaminants in relevant media (e.g., soil, and groundwater).
- Characterizing the environmental fate and transport mechanisms within specific environmental media.
- Identifying potential current and future human receptors.

- Identifying potential exposure routes and the extent of the actual or expected exposure.
- Defining the extent of the expected impact or threat.
- Identifying the levels of uncertainty associated with the above items.

The HHRA will utilize all available data to date that has been properly validated in accordance with USEPA guidelines plus data that is collected and validated from additional sampling during the RFI. It should be noted that the HHRA will follow the reporting format as set forth in RAGS Part D (USEPA, 2001a).

5.2 Human Health Evaluation Process

5.2.1 Site Location and Characterization

A background section will be presented at the beginning of the risk assessment to provide an overview of site characteristics. This section will provide a site location, a general site description, and the site-specific chemicals as discussed in past reports. The physical characteristics of the site and the geographical areas of concern will be discussed. This site description will help to characterize the exposure setting.

5.2.2 Data Summary

Because decisions regarding data use may influence the resultant risk assessment, careful consideration must be given to the treatment of those data. In selecting data to include in the risk assessment, the objective is to characterize, as accurately as possible, the distribution and concentration of chemicals in each AOC.

Data summary tables will be developed for each medium sampled (e.g., soil, groundwater). Each data summary table will indicate the frequency of detection, observed range of concentrations, average background concentrations (inorganics), the mean concentration, and 95 percent upper confidence limit (UCL) value based on the data distribution (i.e., parametric or nonparametric) for each compound/analyte detected in each medium.

Naturally occurring inorganic data from the sites included in the RFI will be compared to NAPR background data prior to the COPC selection process in the HHRA. Those COPCs that are detected below two times the background concentration will be included in the risk assessment if they exceed risk based concentrations. Their contribution to site risks will be discussed in the risk characterization and uncertainty sections of the report. Finally, statistical methodologies for background comparison will be chosen after receipt and evaluation of the validated SWMU-specific data.

Arithmetic means, standard deviations, and 95 percent UCLs based on distribution type (i.e., parametric or nonparametric) will be calculated for use in the HHRA. In the statistical calculations, a concentration qualified as "U" (nondetect) will be incorporated as half the detection limit value given for that compound/analyte.

5.2.3 Identifying Chemicals of Potential Concern

The primary criteria to be used in selecting the Contaminants of Potential Concern (COPCs) from the constituents detected during the sampling and analytical phase of the investigation are the USEPA

Region III Risk Based Concentration (RBC) values. The criteria chosen to establish the COPC are derived from the USEPA's RAGS (USEPA, 1989) and the USEPA Region III Technical Guidance Manual *Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening (SCCRBS),* (USEPA, 1993a), which is referred to as the Region III SCCRBS guidance.

RBCs are derived using conservative USEPA-promulgated default values and the most recent toxicological criteria available. RBCs for potentially carcinogenic and noncarcinogenic chemicals are individually derived based on a target incremental lifetime cancer risk (ILCR) of 1×10^{-06} and a target hazard quotient (HQ) of 1.0, respectively. For potential carcinogens, the toxicity criteria applicable to the derivation of RBCs are chronic oral cancer slope factors; for noncarcinogens, they are oral reference doses. Region III updates its table twice a year to reflect changes in toxicity criteria as reported by the Integrated Risk Information System (IRIS) and other USEPA-approved sources (e.g., NCEA). The RBCs used in this baseline HHRA will be derived from the most recent version of RBC values issued by the USEPA Region III. In accordance with Region III SCCRBS guidance (USEPA, 1993a), all non-carcinogenic RBCs will be divided by 10 to account for potential additive effects. This adjustment corresponds to assuming an HQ of 0.1, rather than 1.0.

If the maximum detected concentration of a constituent in a soil or groundwater sample exceeds the corresponding RBC value, that compound will be retained as a COPC for further evaluation in the risk screening. If the maximum detected concentration is less than the RBC value, the compound will be eliminated from further consideration. However, in accordance with the Region III SCCRBS guidance, chemicals may be re-included as COPCs if certain conditions exist that warrant chemical re-inclusion such as the potential for bioaccumulation or level of toxicity. Criteria such as historical information, prevalence, mobility, persistence, and toxicity will be considered for possible re-inclusion of a compound/analyte that was excluded as a COPC based on comparison to RBCs. Comparison to blank data will take place during the independent third party validation.

All of the available sample data will undergo review upon initiation of the HHRA. Common laboratory contaminants, such as acetone, methylene chloride, phthalate esters, toluene and methyl ethyl ketone, will be addressed only if concentrations are 10 times greater than the corresponding blanks. In addition, chemicals that are not common laboratory contaminants will be evaluated if they are greater than five times the laboratory blank. All validated analytical data will be reviewed to ensure that site-related compound/analyte concentrations that exceed PRG values are not eliminated based on the "10 times" and "5 times" rule discussed above. Site-related compound/analyte concentrations that exceed PRG values will be re-included as COPCs should they be eliminated based on comparison to blank data. The number of chemicals analyzed in the risk assessment will be a subset of the total number of chemicals detected at the site based on the elimination criteria discussed previously.

Tables will be prepared that list chemical concentrations for all media. Data will be further grouped according to organic and inorganic species within each table.

5.2.4 Exposure Assessment

The objectives of the exposure assessment will be to characterize the exposure setting, identify exposure pathways, and quantify the exposure. When characterizing the exposure setting, the potentially exposed populations will be described. The exposure pathway will identify the source, or medium, for the released chemical (e.g., groundwater), the point of potential human contact with the contaminated medium, and the exposure route(s) (e.g., ingestion). The magnitude, frequency, and duration for each exposure pathway identified will be quantified during this process.

The identification of potential exposure pathways at the site will include the activities described in the subsections that follow.

Analysis of the Probable Fate and Transport of Site- Specific Chemicals

To determine the environmental fate and transport of the chemicals of concern at the site, the physical/chemical and environmental fate properties of the chemicals will be reviewed. Some of these properties include volatility, photolysis, hydrolysis, oxidation, reduction, biodegradation, accumulation, persistence, and migration potential. This information will assist in predicting potential current and future exposures. It will help in determining those media that are currently receiving site-related chemicals or may receive site-related chemicals in the future.

The evaluation of fate and transport may be necessary where the potential for change in future chemical characteristics is likely and for those media where site-specific data on the chemical distribution is lacking. There will be a stand-alone section in the RFI Report that will address fate and transport of site-related chemicals.

Identification of Potentially Exposed Human Populations

Human populations that may currently be exposed to chemicals at NAPR include on-site workers and/or trespassers. Potential on-site trespassers include individuals who may access the site unofficially. Potential on-site workers include base personnel or adult workers who may responsible for site maintenance. The on-site worker exposure scenario will be structured to reflect USEPA's default industrial/commercial exposure scenario in which workers are assumed to be at each site eight hours per work day for twenty-five years.

It is likely that the land use at NAPR will remain the same in the future. However, in the event that land at NAPR is developed for residential use in the future, future potential human receptors are considered for evaluation. Potential exposure to COPCs at NAPR could occur in the future if utilities or buildings in the area are constructed. A future construction worker will, therefore, be evaluated for exposure to soil and/or groundwater (if contact with the water-bearing zone is possible) during excavation activities. An on-site worker is also considered as a potential future receptor.

It should be noted that the list of potential receptors and pathways to be evaluated will be refined after receipt of validated data and also during discussions with regulators prior to performing the HHRA.

Identification of Potential Exposure Scenarios Under Current and Future Land Uses

The following exposure scenarios are not final. Exposure scenarios will be finalized after the data collected in the field has been analyzed and evaluated. Generally, current and future exposure pathways will be considered preliminarily as follows:

- Soil
  - Ingestion (current adult and adolescent trespassers, current/future on-site workers, future residents, future construction workers)
  - Dermal contact (current adult and adolescent trespassers, current/future on-site workers, future residents, future construction workers)
  - Inhalation of fugitive dust (current adult and adolescent trespassers, current/future on-site workers, future residents, future construction workers)

- Groundwater
  Ingestion (future residents)
  Dermal contact (future residents, future construction worker)
  Inhalation of volatiles while showering (future residents)

Exposure Point Concentrations

After the potential exposure points and potential receptors have been defined, exposure point concentrations must be calculated. The chemical concentrations at these contact points are critical in determining intake and consequently, risk to the receptor. The data from site investigations will be used to estimate exposure point concentrations.

The exposure point concentration is an estimate of the arithmetic average concentration for a compound/analyte within an exposure unit. USEPA recommends using the average concentration to represent "a reasonable estimate of the concentration likely to be contacted over time" (USEPA, 1989). This concentration, commonly termed the exposure point concentration (EPC), is a conservative estimate of the average chemical concentration in an environmental medium at hazardous waste sites. Ideally, the EPC should be the true average concentration within the exposure unit. However, because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent UCL of the arithmetic mean should be used as the concentration term. The EPC is determined for each individual exposure unit within a site. An exposure unit is the area throughout which a receptor moves and encounters an environmental medium for the duration of the exposure. Unless there is site-specific evidence to the contrary, an individual receptor is assumed to be equally exposed to media within all portions of the exposure unit over the time frame of the risk assessment (USEPA, 2002).

USEPA's most recent guidance, Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (USEPA, 2002), provides tools to calculate upper confidence limits to be used as EPCs in risk assessments. The USEPA 2002 guidance recommends the use of the software package, ProUCL (USEPA, 2001b), to calculate upper confidence limits for use in risk assessments. The most recent version of ProUCL is Version 3.0.

The ProUCL software has been developed by USEPA to compute an appropriate 95% UCL of the unknown population mean. All upper confidence limit computation methods contained in the USEPA guidance documents are available in ProUCL, Version 3.0. ProUCL also can compute a 95% UCL of the mean based upon the gamma distribution, which is better suited to model positively skewed environmental data sets (USEPA, 2001b). ProUCL tests for normality, lognormality, and a gamma distribution of the data set, and computes a conservative and stable 95% UCL of the unknown population mean (assuming the data set consists of points from a single population) (USEPA, 2001b). Several parametric and distribution-free non-parametric methods are included in ProUCL. The upper confidence limit computation methods in ProUCL cover a wide range of skewed data distributions arising from the various environmental applications.

Exposure doses will be estimated for each exposure scenario from chemical concentrations at the point of contact by applying conservative default exposure assumptions promulgated by the USEPA for standard exposure scenarios that account for contact frequency, contact duration, body weight, and other route-specific factors such as breathing rate (e.g., inhalation). Whenever possible, USEPA recommended exposure factors in conjunction with USEPA standard default exposure factors will be used. However, if necessary, defensible exposure parameters based on professional judgment will be developed. These factors will then be incorporated into exposure algorithms that convert the environmental concentrations into exposure doses. Intakes will be reported in milligrams of chemical taken in by the receptor (i.e., ingested, inhaled, etc.) per kilogram body weight per day (mg/kg-day).

Intakes for potentially exposed populations will be calculated separately for the appropriate exposure routes and chemicals.

5.2.5 Toxicity Assessment

Toxicity values (i.e., numerical values derived from dose-response toxicity data for individual compounds) will be used in conjunction with the intake determinations to characterize risk. As per USEPA guidance, the hierarchy (USEPA, 2003) for choosing these toxicity values is:

Tier 1 - Integrated Risk Information System (USEPA, 2005b)
Tier 2 - USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) (database of values developed on a chemical-specific basis when requested by USEPA's Superfund program)
Tier 3 – Other Toxicity Values (includes additional USEPA and non-USEPA sources of toxicity information)

IRIS is the generally preferred source of human health toxicity values. IRIS generally contains RfDs, Reference Concentrations (RfCs), CSFs, drinking water unit risk values, and inhalation unit risk values that have gone through a peer review and USEPA consensus review process. IRIS normally represents the official Agency scientific position regarding the toxicity of the chemicals based on the data available at the time of the review.

The second tier is USEPA's PPRTVs. Generally, PPRTVs are derived for one of two reasons. First, the Superfund Health Risk Technical Support Center (STSC) reviews the toxicity values in the Health Effects Assessment Summary Table (HEAST) (USEPA, 1997b), which is now a Tier 3 source. As the reviews are completed, those toxicity values will be removed from HEAST, and any new toxicity value developed in such a review becomes a PPRTV and placed in the PPRTV database. Second, Regional Superfund Offices may request a PPRTV for contaminants lacking a relevant IRIS value. The STSC uses the same methodologies for both situations.

The third tier includes other sources of information. These sources should provide toxicity information based on similar methods and procedures as those used for Tiers 1 and 2, contain values which are peer reviewed, are available to the public, and are transparent about the methods and processes used to develop the values. Tier 3 sources include, but are not limited to, the following:

The California Environmental Protection Agency (Cal EPA) toxicity values
The Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels
HEAST toxicity values.

For some chemicals, the principal references previously mentioned do not contain the required information to present toxicity values. However, such chemicals should not be excluded as COPCs because of this, and their potential health effects should be considered in the HHRA. When a chemical has no chronic toxicity values, the value of a chemical that is related both chemically and toxicologically is used. The implications of the presence of chemicals without toxicity values and their absence from the quantitative risk assessment should be discussed in the uncertainty section.

5.2.6 Risk Characterization

The risk characterization will combine the results of the hazard assessment, exposure assessment and toxicity assessment to produce a quantitative estimate of current and future potential human health risk. For each compound, the human health risks expected due to chronic exposure will be estimated. Separate calculations will be performed for carcinogenic and noncarcinogenic effects.

The Incremental Lifetime Cancer Risk (ILCR) will be derived using the following linear equation:

$$ILCR = \sum_{i=1}^{n} CDI_i \bullet CSF_i$$

where CSF_i is the cancer slope factor (CSF) $(mg/kg/day)^{-1}$ for compound i, and CDI_i is the chronic daily intake (CDI) (mg/kg/day) for compound i.

The CSF is an upper 95th percentile confidence limit of the probability of a carcinogenic response based on experimental animal data. The linear ILCR equation is only valid at low risk levels (i.e., below ILCRs of 0.01). When estimated risks are greater than 0.01, the following nonlinear equation will be used:

$$ILCR = \sum_{i=1}^{n} [(1 - \exp(CDI_1 \bullet CSF_1)]$$

ILCR values will be compared to USEPA's target risk range of 1×10^{-06} to 1×10^{-04}, which is considered to be generally acceptable at most sites.

Quantitative risk calculations for noncarcinogenic compounds assume that a toxicological threshold concentration exists, below which, no adverse health effects will occur. Therefore, the potential for noncarcinogenic effects will be derived by comparing CDIs with USEPA promulgated reference doses (RfDs). Noncarcinogenic human health effects will be estimated by deriving the Hazard Index (HI), which is defined as the sum of each individual constituent Hazard Quotient (HQ). HQs will be determined using the following algorithm:

$$HQ_i = CDI_i / RfD_i$$

The HI will be derived using the following equation:

$$HI = \sum_{i=1}^{n} HQ$$

HQ_i is the hazard quotient for chemical i, and RfD_i is the reference dose (mg/kg/day) of compound i. The HI is an indicator of potential adverse health effects and is not an absolute indicator of the severity of the effect. The HI serves only to identify whether health effects will or will not occur subsequent to exposure.

HI values greater than one, or unity, indicate the potential for adverse effects to occur. HI values less than one indicate that adverse effects are unlikely. This procedure assumes that the risks from exposure to multiple chemicals are additive, an assumption that is probably valid for compounds that have the same target organ or cause the same toxic effect. In some cases when the HI exceeds unity it may be appropriate to segregate effects (as expressed by the HI) by target organ since those effects would not be additive. Where information is available about the antagonism or synergism of chemical mixtures, it will be appropriately discussed in the uncertainty analysis.

5.2.7 Uncertainty Analysis

There is uncertainty associated with any risk assessment. The exposure modeling can produce very divergent results unless standardized assumptions are used and the possible variations in others are clearly understood. Similarly, toxicological assumptions, such as extrapolating from chronic animal studies to human populations, also introduce a great deal of uncertainty into the risk assessment. Uncertainty in a risk assessment may arise from many sources including:

Environmental sampling and analysis.

Misidentification or failure to be all-inclusive in chemical identification.

Use of standardized input parameters or professional judgment in the exposure assessment.

Lack of available toxicological indices and uncertainty in deriving RfDs and CSFs.

Assumptions of additivity in the risk characterization.

The variation of any factor used in the calculation of the exposure concentration will have an impact on the total carcinogenic and noncarcinogenic risk. The uncertainty analysis will qualitatively discuss non-site and site-specific factors that may produce uncertainty in the risk assessment. These factors may include key modeling assumptions, exposure factors, assumptions inherent in the development of toxicological end points, and spatio-temporal variance in sampling.

6.0 ECOLOGICAL RISK ASSESSMENT (STEPS 1 THROUGH 3A)

This section presents the technical approach (described in general terms) for conducting an ecological risk assessment (ERA) at SWMU 14 located at NAPR, Ceiba, Puerto Rico.

The ERA process at SWMU14 will be conducted in accordance with the Chief of Naval Operations (CNO) document entitled Navy Policy for Conducting Ecological Risk Assessments (CNO 1999). The Navy ERA process (see Figure 6-1) consists of eight steps organized into three tiers and represents a clarification and interpretation of the eight-step ERA process outlined in the USEPA ERA guidance for the Superfund program (USEPA 1997c). Tier 1 of the Navy ERA process represents the screening-level ERA:

- Screening-level problem formulation and ecological effects evaluation (Step 1).
- Screening-level exposure estimate and risk calculation (Step 2).

Under Navy policy, if the results of Step 1 and Step 2 (Tier 1 screening-level ERA) indicate that, based on a set of conservative exposure assumptions, there are chemicals present in environmental media that may present a risk to receptor species/communities, the ERA process proceeds to the baseline ERA. According to Superfund guidance (USEPA 1997c), Step 3 represents the problem formulation phase of the baseline ERA. Under Navy policy, the baseline ERA is defined as Tier 2, and the first activity under Tier 2 is Step 3a. Step 3a precedes the baseline risk assessment problem formulation (Step 3b). In Step 3a, the conservative exposure assumptions applied in Tier 1 are refined and risk estimates are recalculated using the same conceptual site model. The evaluation of risks in Step 3a may also include consideration of background data, chemical bioavailability, and the frequency of detection. If the re-evaluation of the conservative exposure assumptions does not support an acceptable risk determination, the site continues in the baseline ERA process (Step 3b baseline risk assessment problem formulation). The focus of this section will be on Steps 1 and 2 (screening-level ERA) and Step 3a (refinement of the screening-level ERA exposure assumptions), although later steps of the ERA process are also briefly discussed (should the results of Step 3a warrant continuing the ERA process at a particular site).

Due to the potential complexity of ERAs, they are often conducted using a tiered approach and are punctuated with Scientific/Management Decision Points (SMDPs). SMDPs represent points in the ERA process where agreements on conclusions, actions, or methodologies are needed so that the ERA process can continue (or terminate) in a technically defensible manner. These decision points generally occur following the completion of a step in the ERA process. The results of the ERA process at the decision point are used to determine how the ERA process should proceed, for example, to the next step in the process or directly to a later step. The process continues until a final decision has been reached for a site (e.g., remedial action if risks are identified or no further action if risks are acceptable). The process can also be iterative if data needs are identified at any step; the needed data are collected and the process starts again at the point appropriate to the type of data collected.

6.1 Screening-Level Problem Formulation

The screening-level problem formulation is the first phase of the ERA process and establishes the goals, scope, and focus of the screening-level ERA. The products of the screening-level problem formulation are (1) the preliminary conceptual model and (2) the assessment and measurement endpoints. The purpose of the preliminary conceptual model is to describe how ecological receptors

may be exposed to chemicals originating from the site. Major components of the screening-level problem formulation include:

- **Environmental Setting** – A general description of the site history and site features, with emphasis on the habitats and ecological receptors known or likely to be present on or near the site. This description is typically based on existing information and mapping.

- **Existing Analytical Data** – A summary of existing analytical chemistry data for ecologically relevant media at the site.

- **Contaminant Fate and Transport Mechanisms** – A characterization of known or potential contaminant sources and the likely transport mechanisms (if any) to ecological habitats based on the fate properties of the source-related chemicals. The mechanisms of toxicity for these chemicals are also considered.

- **Exposure Routes and Pathways** – An evaluation of potential exposure routes and a determination of the existence of any potentially complete exposure pathways.

- **Conceptual Model** – The screening-level problem formulation culminates in the development of a preliminary conceptual model, which describes how chemicals associated with the site may come into contact with ecological receptors.

- **Endpoint Selection** – Assessment and measurement endpoints to be evaluated in the screening-level ERA are selected for potentially complete exposure pathways identified in the conceptual model.

These major components of the screening-level problem formulation are described in more detail in the following sections. This phase of the ERA process is intended to answer two main questions: (1) do complete exposure pathways exist at the site? and (2) are sufficient data available to conduct the screening level ERA?

6.1.1 Environmental Setting

As described above, the description of the environmental setting focuses on the SWMU history (how the SWMU was used in the past and how it is currently being used), physical site features, habitats and biota, and the existing analytical chemistry data for ecologically relevant media. The environmental setting will be described both for NAPR as a whole and for the specific SWMU under consideration.

6.1.1.1 Site Description and Physical Features

Information on the site history provides an indication of the types of chemicals expected on the site and the media in which they are likely to be present. The physical features of the site, which include geological (e.g., soils), hydrogeological (e.g., surface water and groundwater flow patterns), and climatologic (e.g., precipitation) parameters, are important in determining how chemicals from source areas could be transported to ecological habitats. Sources of this information may include site-specific documents, facility personnel, available mapping, soil survey documents, weather records, and site visits.

6.1.1.2 Habitat Types and Ecological Receptors

Descriptions of the habitat types and ecological receptors known or likely to be present on the site are an important part of describing the environmental setting. This can encompass aquatic habitats (e.g., creeks and ponds) and receptors (e.g., fish), wetland habitats (e.g., marshes) and receptors (e.g., amphibians), and/or terrestrial habitats (e.g., forests) and receptors (e.g., wildlife and vegetation). Sources of this information may include facility-specific documents (e.g., natural resource management plans), available mapping, the literature, and site visits.

6.1.2 Existing Analytical Data

The existing analytical data for ecologically relevant media will be compiled and evaluated. The evaluation will consider such factors as sample size, sample location, analytical parameters, and reporting limits to determine if the available data are adequate to conduct the screening-level ERA.

6.1.3 Contaminant Fate and Transport Mechanisms

In the absence of measured values of chemicals within biotic media, the transport and partitioning of constituents into particular environmental compartments, and their ultimate fate in those compartments, can be predicted from key physical-chemical characteristics. The physical-chemical characteristics that are most relevant for exposure modeling in this assessment include water solubility, adsorption to solids, octanol-water partitioning, and degradability. These characteristics are defined below.

The water solubility of a compound influences it's partitioning to aqueous media. Highly water-soluble constituents, such as most volatile organic compounds (VOCs), have a tendency to remain dissolved in the water column rather than partitioning to sediment (Howard 1991). Compounds with high water solubility also generally exhibit a lower tendency to bioconcentrate in aquatic organisms and a greater likelihood of biodegradation, at least over the short term (Howard 1991).

Adsorption is a measure of a compound's affinity for binding to solids, such as soil or sediment particles. Adsorption is expressed in terms of partitioning, either adsorption coefficient (K_d); (a unitless expression of the equilibrium concentration in the solid phase versus the water phase) or as organic carbon partition coefficient (K_{oc}) (K_d normalized to the organic carbon content of the solid phase; again unitless) (Howard 1991). For a given organic chemical, the higher the K_{oc} or K_d, the greater the tendency for that chemical to adhere strongly to soil or sediment particles. K_{oc} values can be measured directly or can be estimated from either water solubility or the octanol-water partition coefficient using one of several available regression equations (Howard 1991).

Octanol-water partitioning indicates whether a compound is hydrophilic or hydrophobic. The octanol-water partition coefficient (K_{ow}) expresses the relative partitioning of a compound between octanol (lipids) and water. A high affinity for lipids equates to a high K_{ow} and vice versa. As discussed above, K_{ow} has been shown to correlate well with Bioconcentration Factors (BCFs) in aquatic organisms, adsorption to soil or sediment particles, and the potential to bioaccumulate in the food chain (Howard 1991). Typically expressed as log K_{ow}, a value of three (3.0) or less generally indicates that the chemical will not bioconcentrate to a significant degree (Maki and Duthie 1978). A log K_{ow} of three equates to an aquatic species BCF of about 100, using the following equation from Lyman et al. (1990):

$$\log BCF = (0.76)(\log K_{ow}) - 0.23 \qquad \text{(Equation 6-1)}$$

Degradability is an important factor in determining whether there will be significant loss of mass or change in the form of a chemical over time in the environment. The half-life of a compound is typically used to describe losses from either degradation (biological or abiotic) or from transfer from one compartment to another (e.g., volatilization from soil to air). The half-life is the time required for one-half of the mass of a compound to undergo the loss or degradation process.

6.1.4 Exposure Routes and Pathways

An exposure pathway links a source of contamination with one or more receptors through exposure to one or more ecologically relevant media. Exposure, and thus potential risk, can only occur if complete exposure pathways exist.

An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. The most common exposure routes are dermal contact, direct uptake, ingestion, and inhalation. Terrestrial vegetation may be exposed to chemicals present in surface soils through their root surfaces during water and nutrient uptake. Unrooted, floating aquatic plants, rooted submerged aquatic plants, and algae may be exposed to chemicals directly from the water of (for rooted plants) from sediments. Terrestrial and aquatic invertebrates may be exposed to chemicals in surface soil, sediment, or surface water through dermal adsorption and ingestion. Much of the toxicological data available for terrestrial and aquatic invertebrates are based on *in situ* studies that represent both pathways. Therefore, both pathways are typically considered together. Invertebrates also present a link between soil/sediment chemicals and invertebrate consumers through food web transfer. As such, they are typically included as prey items for upper trophic level dietary exposures.

Birds and mammals may be exposed to chemicals through: (1) the inhalation of gaseous chemicals or chemicals adhered to particulate matter; (2) the incidental ingestion of contaminated abiotic media (e.g., soil or sediment) during feeding or cleaning activities; (3) the ingestion of contaminated water; (4) the ingestion of contaminated plant and/or animal tissues for chemicals that have entered food webs; and/or (5) dermal contact with contaminated abiotic media. Their relative importance depends in part on the chemical being evaluated. For chemicals having the potential to bioaccumulate (e.g., polychlorinated biphenyls [PCBs]), the greatest exposure to wildlife is likely to be from the ingestion of prey. For chemicals having a limited potential to bioaccumulate (i.e., aluminum), the exposure of wildlife to chemicals is likely to be greatest through the direct ingestion of abiotic media, such as surface soil or sediment.

6.1.5 Conceptual Model

The conceptual model is designed to diagrammatically relate potentially exposed receptor populations with potential contaminant source areas based on the physical nature of the SWMU and potential exposure pathways. Important components of the preliminary conceptual model are the identification of potential sources of contaminants, transport pathways, exposure media, potential exposure routes, and potential receptor groups. Actual or potential exposures of ecological receptors associated with a SWMU will be determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has four components: (1) a source of chemicals that can be released to the environment; (2) a release and transport mechanism to move the chemicals from the source to an exposure point; (3) an exposure point where ecological receptors could contact the affected media; and (4) an exposure route whereby chemicals can be taken up by ecological receptors.

The main objective of the conceptual model in Step 1 of the ERA process is to identify any complete exposure pathways present at a site. The site-specific ERAs will provide conceptual models that relate directly to the SWMUs under consideration.

6.1.6 Endpoints and Risk Hypotheses

The conclusion of the screening-level problem formulation includes the selection of ecological endpoints, which are based on the preliminary conceptual model. Endpoints in the screening level ERA define ecological attributes that are to be protected (assessment endpoints) and a measurable characteristic of those attributes (measurement endpoints) that can be used to gauge the degree of impact that has or may occur (USEPA 1992; 1997c, and 1998). Assessment endpoints are an explicit expression of the environmental component or value that is to be protected. They are most often relate to attributes of biological populations or communities, and are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by chemicals attributable to the site (USEPA 1997b). Assessment endpoints contain an entity (e.g., red-tailed hawk) and an attribute of that entity (e.g., survival rate). Individual assessment endpoints usually encompass a group of species or populations (the receptor) with some common characteristic, such as specific exposure route or contaminant sensitivity, with the receptor then used to represent the assessment endpoint in the risk evaluation. A measurement endpoint is a measurable ecological characteristic that is related to the component or value chosen as the assessment endpoint.

The considerations for selecting assessment and measurement endpoints are summarized in USEPA (1992 and 1997c) and discussed in detail in Suter (1989, 1990, and 1993). Assessment and measurement endpoints may involve ecological components from any level of biological organization, from individual organisms to the ecosystem (USEPA 1992). Effects on individuals are important for some receptors, such as rare and endangered species, but population- and community-level effects are typically more relevant to ecosystems. Population- and community-level effects are usually difficult to evaluate directly without long-term and extensive study. However, measurement endpoint evaluations at the individual level, such as an evaluation of the effects of chemical exposure on reproduction, can be used to predict effects on an assessment endpoint at the population- or community-level. In addition, use of criteria values designed to protect the vast majority (e.g., 95 percent) of the components of a community (e.g., Ambient Water Quality Criteria for the Protection of Aquatic Life) can be useful in evaluating potential community- and/or population-level effects.

The most appropriate generic assessment endpoint for ERAs will be the maintenance of receptor populations. Therefore, the specific objective of the ERA will be to determine if exposure to site-related chemicals present in surface water, groundwater (if appropriate), sediment, and/or surface soil are likely to result in declines in ecological receptor populations. Declines in populations could result in a shift in community structure and possible elimination of resident species.

Measurement endpoints are used in ERAs because it is often difficult or impossible to directly assess whether the environmental value that is to be protected (the assessment endpoint) is being impacted. For example, an assessment endpoint may involve a decline in a particular population or a shift in the structure of a community. While these things might be quantifiable, the necessary studies would generally be time-consuming and difficult to interpret. However, measurement endpoints indicative of observed adverse effects on individuals are relatively easy to measure in toxicity studies and can be related to the assessment endpoint. For example, contaminant concentrations that lead to decreased reproductive success or increased mortality of individuals in toxicity tests could, if found in the environment, result in shifts in population structure, potentially altering the community composition associated with a site.

Risk hypotheses are testable hypotheses about the relationship among the assessment endpoints and their predicted responses when exposed to chemicals. Although USEPA (1997c) prescribes that risk hypotheses be developed in Step 3 (baseline risk assessment problem formulation), it is generally useful to develop preliminary risk hypotheses as part of the screening-level problem formulation.

6.1.6.1 Selection of Receptors

Because of the complexity of natural systems, it is generally not possible to directly assess the potential impacts to all ecological receptors present within an area. Therefore, receptor species (e.g., red-tailed hawk) or species groups (e.g., terrestrial invertebrates) are often selected as surrogates to evaluate potential risks to larger components of the ecological community (guilds; e.g., insectivorous birds) represented in the assessment endpoints (e.g., survival and reproduction of insectivorous birds). Selection criteria typically include those species that:

- Are known to occur, or are likely to occur, at the site.
- Have a particular ecological, economic, or aesthetic value.
- Are representative of taxonomic groups, life history traits, and/or trophic levels in the habitats present at the site for which complete exposure pathways are likely to exist.
- Can, because of toxicological sensitivity or potential exposure magnitude, be expected to represent potentially sensitive populations at the site.
- Have sufficient ecotoxicological information available on which to base an evaluation.

Upper trophic level receptor species will be chosen for dietary exposure modeling based on the criteria listed above, the general guidelines presented in USEPA (1991c, the environmental setting, (e.g., habitats), and the assessment endpoints selected at the SWMU.

Lower trophic level receptor species (e.g., terrestrial and aquatic invertebrates and plants) are generally evaluated in screening-level ERAs based on those taxonomic groupings for which screening values have been developed. These groupings and screening values are used in most ecological risk assessments. As such, specific species of lower trophic level biota will not be chosen as receptor species because of the limited information available for specific species and because these biota are dealt with on a community level via a comparison to media-specific screening values.

6.1.7 Screening-Level Problem Formulation Decision Point

As discussed in Section 5.1, the screening-level problem formulation is intended to answer two main questions: (1) do complete exposure pathways exist at the SWMU? and (2) are sufficient data available to conduct the screening level ERA? Complete exposure pathways from a source area are likely to exist if all of the following are present:

- Habitat that supports ecological receptor populations (note that ecological habitat may be absent due to chemical contamination or habitat alteration).
- Contaminant transport pathways to ecologically relevant media. Although a site may contain no or marginal ecological habitat, it will be assessed if site-related chemicals have the potential to migrate to areas containing more extensive or more viable habitat. A site of this nature may contribute to overall contamination in the watershed in which it exists.

- Complete exposure routes.

If no complete exposure pathways exist at a site, the ERA process will terminate at the screening-level problem formulation with a conclusion of negligible risk. If one or more complete exposure pathways are known or likely to exist, the ERA process will continue to the screening-level ecological effects evaluation, screening-level exposure estimation, and screening-level risk calculation but will only evaluates those pathways that have been determined to be complete.

6.2 Screening-Level Ecological Effects Evaluation

The purpose of the screening-level ecological effects evaluation is the establishment of chemical exposure levels (screening values) that represent conservative thresholds for adverse ecological effects. One set of screening values is typically developed for each of the selected assessment endpoints. The completed screening-level ERA will contain tables listing the screening values selected, by medium, for SWMU 14.

Two types of screening values (media-specific screening values and ingestion-based screening values) will be developed. Media-specific screening values will be developed for ecologically relevant media at the SWMU (e.g., surface soil). Ingestion-based screening values for dietary exposures will be derived for each receptor species and chemical evaluated for food web exposures. Toxicological information from the literature for wildlife species most closely related to the receptor species will be used if available. This information will be supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) when necessary.

Chronic No Observed Adverse Effect Levels (NOAELs) based on growth or reproduction will be preferentially used as ingestion-based screening values for upper trophic level receptors. NOAELs represent the highest dose of a chemical at which an effect being measured in a toxicity test does not occur. If several chronic toxicity studies are available from the literature for a given chemical, the most appropriate study will be selected for each receptor species based on study design, study methodology, study duration, study endpoint and test species. When chronic NOAEL values are unavailable, estimates will be derived or extrapolated from chronic Lowest Observed Adverse Effect Levels (LOAELs) or acute values (LD_{50}). LOAELs represent the lowest dose of a chemical at which an effect being measured in a toxicity test occurs, while an LD_{50} represents the dose of a chemical at which half of the organisms being tested die. An uncertainty factor of 10 will be used to convert a reported LOAEL to a NOAEL, while an uncertainty factor of 100 will be used to convert the acute LD_{50} to a chronic NOAEL (i.e., the LD_{50} will be multiplied by 0.01 to obtain the chronic NOAEL).

Not all chemicals analyzed in ecologically relevant media will be evaluated for food web exposures. The organic chemicals evaluated for food web exposures will be limited to those chemicals with the potential to bioaccumulate to a significant extent. Bioaccumulative organic chemicals are defined in this work plan as those with a maximum reported log octanol-water partition coefficient (log K_{ow}) greater than or equal to 3.0. Rational for using a log K_{ow} of 3.0 to identify an organic chemical with the potential to bioaccumulate will be included in the completed screening-level ERAs. For conservatism, all inorganic chemicals will be evaluated for food web exposures. The exception is cyanide, which will be excluded from the evaluation of food web exposures because it is readily metabolized and does not bioaccumulate (Eisler 1991).

6.3 Screening-Level Exposure Estimation

This portion of the screening-level ERA involves the identification of the data to be used to represent concentrations of chemicals to which ecological receptors may be exposed to in various media and the derivation of exposure point concentrations (EPCs) from those data (typically the maximum detected concentration). Exposure assumptions, exposure models, and model input parameters are also presented and discussed.

6.3.1 Selection Criteria for Analytical Data

Available analytical data for ecologically relevant media will be selected for use in the screening level ERA based on a set of selection criteria that will include:

- Data must be validated by a qualified data validator using acceptable data validation methods. Rejected (R) values will not be used in the ERA. Unqualified data and data qualified as J will be treated as detected. Data qualified as U or UJ will be treated as non-detected.

- Maximum reporting limits will be conservatively used to estimate exposure for non-detected chemicals.

- In some instances, duplicate samples have been collected in the field. The maximum concentration of each chemical in the original or duplicate sample will be used as a conservative estimate of chemical concentrations at a particular sampling point.

- For surface soil, analytical data for samples collected from the surface to a maximum depth of one foot below ground surface (bgs) will be used since this depth range is the most active biological zone (Suter II 1995).

- For groundwater, total (unfiltered) metal concentrations will be used for comparison to surface water screening values.

Background chemical concentrations may be gathered from facility-wide, site-specific, or region-wide data and presented in the screening level ERA for comparative purposes. These data will not be quantitatively considered until Step 3a (if the ERA progresses to this step).

6.3.2 Exposure Point Concentrations – Abiotic Media

Maximum detected concentrations in abiotic media (e.g., surface soil) will be used to conservatively estimate potential chemical exposures for the ecological receptors selected to represent the assessment endpoints. For conservatism, the maximum detection limit for chemicals that were analyzed for but not detected will also be compared to medium-specific screening values and (where applicable) used for food web exposure modeling. This will be done to ensure that detection limits were similar to, or less than, chemical concentrations at which potential adverse effects to ecological receptors may occur. For samples with duplicate analyses, the higher of the two concentrations will be used in the screening (when both values were detects or both values were non-detects). In cases where one result is a detection and the other a non-detect, the detected value will be used in the assessment.

6.3.3 Exposure Point Concentrations – Prey Items

Exposures for upper trophic level receptor species via the food web will be determined by estimating the chemical-specific concentrations in each dietary component using uptake and food web models. Ingestion of abiotic media, if appropriate, will also be included when calculating the total level of exposure. As indicated previously, maximum measured concentrations in abiotic media will be used in all calculations to provide a conservative assessment.

Estimates for food web exposures will be based on bioaccumulation factors developed from the literature. The uptake of chemicals from the abiotic media into these food items will be based on conservative (e.g., maximum or 90th percentile) BCFs or bioaccumulation factors (BAFs). Default factors of 1.0 (dry weight to dry weight) will be used only where data are unavailable for a chemical in the literature. The completed screening-level ERAs for SWMU 14 will contain tables listing the BAFs/BCFs selected for each prey item. The methodology and models used to derive these estimates will also be included within the completed screening-level ERAs.

6.3.3.1 Dietary Intakes

Dietary intakes for each upper trophic level receptor species selected to represent the assessment endpoints will be calculated using the following formula (modified from USEPA [1993b]):

$$DI_x = \frac{[[\sum_i [(FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]][AUF]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg body weight/day)
FIR	=	Food ingestion rate (kg/day, dry weight)
FC_{xi}	=	Concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (dry weight basis)
SC_x	=	Concentration of chemical x in soil/sediment (mg/kg, dry weight)
PDS	=	Proportion of diet composed of soil/sediment (dry weight basis)
WIR	=	Water ingestion rate (L/day)
WC_x	=	Concentration of chemical x in water (mg/L)
BW	=	Body weight (kg, wet weight)
AUF	=	Area Use Factor (unitless)

As discussed in USEPA (1997c), exposure parameter values used in this food web model will be selected to provide for a conservative evaluation in the screening-level ERA. Examples of these conservative assumptions include:

- All of the dietary items consumed by the receptor are obtained from the site (i.e., an Area Use Factor [AUF] of 1 will be assumed) at the point of maximum concentrations.
- Chemicals are assumed to be 100 percent bioavailable.
- Maximum ingestion rates will be used (calculated maximum ingestion rates are based on the maximum body weight).
- Minimum body weights will be used.

6.4 Screening-Level Risk Calculation

The screening-level risk calculation is the final step in a screening-level ERA. In this step, the maximum exposure concentrations (abiotic media) or exposure doses (upper trophic level receptor species) are compared with the corresponding screening values to derive screening risk estimates. The outcome of this step is a list of preliminary Ecological Chemicals of Potential Concern (COPCs) for each medium-pathway-receptor combination evaluated or a conclusion of negligible risk.

6.4.1 Selection of Preliminary Ecological Chemicals of Potential Concern

Preliminary ecological COPCs will be selected using the hazard quotient (HQ) method. HQs are calculated by dividing the maximum chemical concentration in the medium being evaluated by the corresponding medium-specific screening value or, in the case of upper trophic level receptors, by dividing the exposure dose by the corresponding ingestion-based screening value. Chemicals with HQs greater than or equal to 1.0 will be considered preliminary ecological COPCs in the screening level ERA.

The following conservative methodology will be used to identify preliminary ecological COPCs for abiotic media:

- The maximum detected concentration in each ecologically relevant media will be used to calculate media-specific HQs. For a given medium, chemicals with HQs greater than or equal to 1.0 based on maximum detected concentrations will be identified as preliminary ecological COPCs for that medium.

- For chemicals not detected in any samples of a particular medium, the maximum reporting limit will be used to calculate media-specific HQs. For a given medium, non-detected chemicals with HQs greater than or equal to 1.0 based on maximum reporting limits will b e identified as preliminary ecological COPCs for that medium.

- Chemicals (detected and non-detected) without screening values for a given medium will be identified as preliminary ecological COPCs for that medium.

To select preliminary ecological COPCs by evaluating food web exposures, maximum chemical concentrations in ecologically relevant abiotic media will be used to estimate dietary doses for each receptor. All inorganics (excluding cyanide) and all organic chemicals with a log K_{ow} greater than or equal to 3.0 will be evaluated for food web exposures. HQs will be calculated with NOAELs, LOAELs, and Maximum Acceptable Toxicant Concentrations (MATCs) (the geometric mean of the NOAEL and LOAEL). Calculations with NOAELs provide the most conservative risk estimate, while calculations with LOAELs provide the least conservative risk estimate. Calculations with MATCs provide realistic risk estimates since the MATC represents an estimation of the threshold concentration (i.e., the concentration above which a toxic effect on the test endpoint is produced). For the screening-level ERA, chemicals (detected and non-detected) with NOAEL-based HQs greater than or equal to 1.0 will be identified as preliminary ecological COPCs. Identical to the media-specific screening, chemicals without ingestion-based screening values will also be retained as ecological COPCs for upper trophic level receptors.

HQs exceeding one indicate the potential for risk since the chemical concentration or dose (exposure) exceeds the screening value (effect). However, screening values and exposure estimates are derived using intentionally conservative assumptions such that HQs greater than or equal to one do not necessarily indicate that risks are present or impacts are occurring. Rather, it identifies chemical-

pathway-receptor combinations requiring further evaluation. Following the same reasoning, HQs that are less than one indicate that risks are very unlikely, enabling a conclusion of no unacceptable risk to be reached with high confidence.

6.5 Uncertainties

Once the screening-level ERA is complete, the results will be evaluated to identify the type and magnitude of uncertainty associated with the risk conclusions. Reliance on results from a risk assessment can be misleading without a consideration of uncertainties, limitations, and assumptions inherent in the process. Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information.

6.6 Screening-Level ERA Decision Point

The results of the ERA will be used to evaluate the status of SWMU 14 in terms of potential ecological risk. Possible decision points following completion of the screening-level ERA are:

- **No further action is warranted**. This decision is appropriate if the screening-level ERA indicates that sufficient data are available on which to base a conclusion of no unacceptable risk (HQ values for each media-pathway-receptor combination is less than one).

- **Further evaluation is warranted**. This decision is appropriate if the screening-level ERA indicates that there is the potential for unacceptable risk for one or more media-pathway-receptor combinations. In this instance, the ERA process will proceed to Step 3a wherein the risk estimates are refined based on more realistic and site-specific assumptions and data.

- **Further data are required**. This decision is appropriate if the screening-level ERA indicates that there are insufficient data on which to base a risk estimate. This decision may also be appropriate if the potential for unacceptable risks is identified following the screening-level ERA and additional data are needed to refine these estimates in Step 3a.

- **Take remedial action**. This decision may be appropriate for sites in which the potential for unacceptable risks was identified following the screening-level ERA but these potential risks could be best addressed through remedial action (e.g., presumptive remedy, soil removal) rather than additional study.

6.7 Baseline Ecological Risk Assessment

If the results of the screening ERA suggest that further ecological risk evaluation or data collection is warranted for SWMU 14, the ERA process will proceed to the baseline ERA which is a more detailed phase of the ERA process (Steps 3 through 7). Under this contract task order, only Steps 1 through 3a will be completed, although all steps will be discussed below to further the understanding of the ERA process.

This section documents the technical approach to the baseline ERA (Steps 3 through 7 of the ERA process). The first step of the baseline ERA (Step 3) is the baseline problem formulation. The baseline problem formulation refines the risk estimates from the screening ERA using more realistic exposure assumptions (Step 3a), and if unacceptable risks are still possible, refines the conceptual model and endpoints (Step 3b) in order to determine the direction of subsequent steps of the ERA process.

6.7.1 General Methodology for the Baseline ERA

The basic purpose of the baseline ERA is to refine the risk estimates from the screening ERA. Potential risk estimates will be refined using a focused conceptual model based on more realistic and site-specific exposure assumptions, additional site-specific data, and/or detailed literature review. The focused conceptual model would include refined assessment endpoints, measurement endpoints, and risk questions or hypotheses. Following the completion of Step 3, a decision point will be reached with two potential outcomes. If the refined risk estimates are acceptable for each assessment endpoint, the investigation can proceed to risk characterization (Step 7) to document this conclusion. If the uncertainties associated with the refined risk estimates are unacceptable and/or the risk estimates indicate potential risks, site-specific studies might be required and the ERA process will continue (Steps 4 through 6).

Step 7 consists of the documentation and synthesis of the information and data identified in Steps 1 through 3 (no additional study) or 1 through 6 (additional study). In this step, risk is evaluated and characterized using both quantitative and qualitative methods. Conclusions are made on whether or not there is a reasonable potential for unacceptable ecological risk at the site, and if there is a potential for ecological risk, the magnitude of that risk. The results of the completed baseline risk assessment (Step 7) are used to make any necessary risk management decisions (Step 8).

6.7.1.1 Step 3a

The first activity (Step 3a) of the baseline ERA is to refine the conservative exposure assumptions employed in the screening ERA and recalculate the risk estimates. This reevaluation may include considerations of background, sample detection frequency, bioavailability, and realistic exposure scenarios (CNO, 1999). Realistic exposure scenarios might include the use of average rather than maximum: (1) exposure point concentrations, (2) species ingestion rates, and (3) exposure frequency or duration. A review of the literature will be used to refine the conservative exposure assumptions (such as species body weight) used in the screening ERA. In the screening ERA, minimum species body weights are used and these are often not region-specific. Average species body weights for the state, region, and/or subspecies will be used, if available.

Step 3a will also include a re-screening against medium-specific screening values. As appropriate to a baseline analysis, alternate screening values may be developed, where appropriate, to account for bioavailability issues (such as the use of dissolved metals, rather than total metals, in surface water). These alternative screening values will be obtained from the scientific literature, available federal and state regulatory guidance, and other appropriate sources. These screening values will be adjusted, where appropriate, based on modifying factors such as hardness or total organic carbon. The rationale for these alternate screening values will be provided.

Following the completion of Steps 3a and (if warranted) 3b, a decision point will be reached with two potential outcomes. If Steps 3a and 3b indicate that there are no unacceptable risks, the ERA process would skip directly to Step 7 to document this conclusion. If unacceptable risks are still possible following Step 3, or if the level of uncertainty in the risk estimates is unacceptable, additional studies (Steps 4 through 6) could be undertaken to further refine the risk estimates. Completion of Step 7 ends the baseline (Tier 2) assessment.

6.7.2 Results of the Baseline ERA Process

Possible decision points based on the results of the baseline ERA are evaluated in Step 8 of the process and involve risk management decisions. Possible decisions include:

- **No further action is warranted.** This decision is appropriate if the baseline ERA indicates that there is no reasonable potential for unacceptable ecological risk within acceptable uncertainty.

- **Evaluate the need for remedial action.** This decision is appropriate if the baseline ERA indicates that there is a reasonable likelihood for unacceptable ecological risks within acceptable uncertainty. Whether or not remedial actions are taken will depend upon a number of risk management factors such as the results of any human health risk assessments and the potential impact of the remedial action itself on the habitats and biota present on the site. This analysis would occur as part of Step 8 (Tier 3).

6.8 Ecological Corrective Action Objectives

Corrective Action Objectives (CAOs) will be established for chemicals retained as ecological COPCs in Step 3a of the Navy ERA process. CAOs for abiotic media (e.g., surface soil) will be developed by multiplying media-specific screening values by 0.99:

$$CAO_x = (SV_x)(0.99)$$

where CAO_x is the Corrective Action Objective for chemical x and SV_x is the media-specific screening value for chemical x. CAOs for food web exposures will be developed by modifying the dietary intake equation. Using surface soil as an example, the CAOs for food web exposures will be calculated as follows:

$$CAO_x = \frac{(0.99)(SV_{xj})(BW_j)}{[[\sum_i (FIR_j)(BAF_{ix} or BCF_{ix})(PDF_{ij})] + [(FIR_j)(PDS_j)]][AUF]}$$

CAO_x	=	Corrective Action Objective for chemical x (mg/kg, dry weight)
SV_{ij}	=	Ingestion-based screening value for chemical i applied to receptor j (mg chemical/kg body weight/day)
BWj	=	Body weight for receptor j (kg, wet weight)
FIR	=	Food ingestion rate for receptor j (kg/day, dry-weight)
BAF_{ix}	=	Surface soil-Biota BAF for chemical x and food item i dry weight basis)
BCF_{ix}	=	Surface soil-Biota BCF for chemical x and food item i (dry weight basis)
PDF_{ij}	=	Proportion of diet composed of food item i for receptor j (dry weight basis)

PDS_j	=	Proportion of diet composed of surface soil for receptor j (dry weight basis)
AUF_j	=	Area Use Factor for receptor j (unitless)

If a chemical is retained as an ecological COPC for abiotic media and food web exposures (e.g.,) retained as a surface soil COPC and an upper trophic level terrestrial receptor COPC in Step 3a of the ERA process), the minimum CAO will be selected as the final CAO.

7.0 SCHEDULE

A schedule for the implementation of this work plan, and follow-up reports for the RFI report for SWMU 14, is provided as Figure 7-1. It should be noted that this schedule is dependent upon EPA 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 is delayed by the Navy, or consensus cannot be reached on how the USEPA's comments are to be incorporated.

8.0 SITE MANAGEMENT

An organization chart presenting the proposed staffing for this project is provided on Figure 8-1. This section also outlines the responsibilities and reporting requirements of field personnel and staff.

8.1 Project Team Responsibilities

Ms. Janna L. Staszak, P.E., the Activity Coordinator, will provide senior technical review and administrative support. Ms. Staszak's involvement will be to provide senior technical review of project deliverables and to monitor the project schedule and budget.

Mr. Mark Kimes, P.E, Activity Manager 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 Naval Facilities Engineering Command (NAVFAC) Atlantic Division, Navy Technical Representative (NTR), Mr. Kevin Cloe, P.E. Mr. John Mentz will administer overall QA/QC for this project.

The field portion of this project will consist of one field team managed by the Geologist, Mr. Mark Dejohn. Mr. Dejohn's responsibilities include directing the Baker field team and subcontractors. Ms. Susan Grimm will direct the reporting effort of the field investigation. Ms. Grimm will direct and ensure that all necessary staffing is utilized to assist in developing the RFI Report for SWMU 14.

8.2 Field Reporting Requirements

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

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

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

9.0 REFERENCES

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TABLES

TABLE 2-1

PHOTOIONIZATION DETECTOR MEASUREMENT RESULTS
SWMU 14 SOIL GAS SURVEY
RFI REPORT FOR PHASE I INVESTIGATIONS AT OU 1, 6, AND 7
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

LOCATION	TIME	PID READING	COMMENTS
A1, A2	1321 , 1322	0.5 , 0.5	
B1, B2	1322 , 1323	0.4 , 0.5	
C1, C2	1323 , 1323	0.4 , 0.4	
D1, D2	1323 , 1324	0.4 , 0.5	
E1, E2	1325 , 1325	0.5 , 0.4	
F1, F2	1325 , 1325	0.5 , 0.5	
G1, G2	1326 , 1326	0.5 , 0.5	
H1, H2	1326 , 1327	0.8 , 0.5	
I1, I2	1328 , 1330	3.2 , 0.5	
J1, J2	1330 , 1334	**79.2** , 2.1	Sample 14SS04-00 (Grass is dead)
K1, K2	1335 , 1336	**49.7** , 1.4	Sample 14SS05-00 (Grass is stressed)
L1, **L2**	1337 , 1337	4.8 , **21.0**	Sample 14SS06-00 (Grass is stressed)
M1, M2	1338 , 1341	**64.5** , 2.1	Sample 14SS07-00
N1, N2	1341 , 1342	1.5 , 3.1	
O1, O2	1343 , 1344	1.0 , 15.1	
P1, P2	1345 , 1346	1.8 , 1.2	
Q1, Q2	1347 , 1347	1.0 , 0.8	
R1, R2	1348 , 1349	0.8 , 0.9	
S1, S2	1350 , 1350	0.9 , 0.9	
T1, T2	1350 , 1351	0.9 , 0.8	
U1, U2	1352 , 1352	1.0 , 1.0	
V1, V2	1353 , 1353	1.0 , 0.9	
W1, **W2**	1354 , 1354	1.0 , **34.5**	Sample 14SS08-00
X1, X2	1359 , 1359	1.9 , 1.2	
Y1, Y2	1359 , 1400	1.3 , 1.2	

Notes:

All concentrations in parts per million (ppm)
Hnu Background measurement = 0.6 ppm
Bolded location/concentration submitted for chemical analysis
A1, B1, etc. samples obtained 3 feet from edge of concrete pit.
A2, B2, etc. samples obtained 10 feet from edge of concrete pit.

TABLE 2-2

DETECTED CONCENTRATIONS OF ORGANIC COMPOUNDS
SWMU 14 SURFACE SOIL
RFI REPORT FOR PHASE I INVESTIGATIONS AT OU 1, 6, AND 7
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Parameter Name	14SS04 3/22/1996	14SS05 3/22/1996	14SS06 3/22/1996	14SS07 3/22/1996	14SS08 3/22/1996
Volatile Organics (ug/kg)	No volatile organic compunds were detected.				
Semi-volatile Organics (ug/kg)					
Anthracene	400 U	410 U	390 U	110 J	360 U
Benzo(a)anthracene	400 U	45 J	300 J	3400	360 U
Benzo(a)pyrene	400 U	45 J	1800	5000	360 U
Benzo(b)fluoranthene	400 U	410 U	2800	7600	360 U
Benzo(g,h,i)perylene	66 J	91 J	1200	3600	360 U
Benzo(k)fluoranthene	400 U	410 U	640	2400	360 U
Bis(2-ethylhexyl)phthalate	400 U	410 U	97 J	390 U	360 U
Chrysene	400 U	50 J	690	3800	360 U
Dibenzo(a,h)anthracene	400 U	410 U	210 J	920	360 U
Diethylphthalate	400 U	410 U	54 J	390 U	360 U
Fluoranthene	88 J	110 J	230 J	67 J	360 U
Indeno(1,2,3-cd)pyrene	400 U	58 J	1300	3800	360 U
Phenanthrene	400 U	410 U	39 J	58 J	360 U
Pyrene	170 J	270 J	650	100 J	360 U
Total Petroleum Hydrocarbons (mg/kg)					
Diesel Range Organics	560	360	120	490	4.5 U
Gasoline Range Organics	3.7	3.8	1.8	1.8	0.032
PCBs (ug/kg)					
Aroclor-1260	28	17	12	19	6 NJ

Notes:
ug/kg - micrograms per kilogram
U - Not detected
J - Estimated value
NJ - Tentative identification estimated

TABLE 3-1

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SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
SWMU 14 - FIRE TRAINING PIT
RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Fixed Based Analytical Lab Analysis									
Media	App IX VOCs	App IX SVOCs	App IX PCBs	Low Level PAHs	App IX Metals (Total)	App IX Metals (Dissolved)	Dioxins/Furans	TPH DRO	TPH GRO	Comment
Surface Soil Samples										
14SB01-00	X	X	X	X	X			X	X	
14SB02-00	X	X	X	X	X			X	X	
14SB03-00	X	X	X	X	X			X	X	
14SB07-XX	X	X	X	X	X			X	X	
14SB0X-00D	X	X	X	X	X			X	X	Duplicate
14SB0X-00MS/MSD	X	X	X	X	X			X	X	MatrixSpike/Matrix Spike Duplicate
Subsurface Soil Samples										
14SB01-XX	X	X	X	X	X			X	X	
14SB01-XX	X	X	X	X	X			X	X	
14SB02-XX	X	X	X	X	X			X	X	
14SB02-XX	X	X	X	X	X			X	X	
14SB03-XX	X	X	X	X	X			X	X	
14SB03-XX	X	X	X	X	X			X	X	
14SB04-XX	X	X	X	X	X		X	X	X	
14SB04-XX	X	X	X	X	X			X	X	
14SB05-XX	X	X	X	X	X		X	X	X	
14SB05-XX	X	X	X	X	X			X	X	
14SB06-XX	X	X	X	X	X			X	X	
14SB06-XX	X	X	X	X	X		X	X	X	
14SB06-XXD	X	X	X	X	X		X	X	X	Duplicate
14SB07-XX	X	X	X	X	X			X	X	
14SB07-XX	X	X	X	X	X			X	X	
Groundwater Samples										
14TW0X	X	X	X	X	X	X		X	X	
14TW0X	X	X	X	X	X	X		X	X	
14TW0X	X	X	X	X	X	X		X	X	
14TW0XD	X	X	X	X	X	X		X	X	Duplicate
14TW0XMS/MSD	X	X	X	X	X	X		X	X	MatrixSpike/Matrix Spike Duplicate
QA/QC SAMPLES										
Equipment Rinsates										
14ER01	X	X	X	X	X			X	X	Stainless Steel Spoon
14ER02	X	X	X	X	X		X	X	X	Acetate Liner
14ER03	X	X	X	X	X			X	X	Groundwater Samping Tubing
Trip Blanks										
14TB01	X								X	
14TB02	X								X	
14TB03	X								X	
Field Blanks										
14FB01	X	X	X	X	X		X	X	X	Lab Grade DI Water
14FB02	X	X	X	X	X		X	X	X	Store Bought Distilled Water
14FB03	X	X	X	X	X		X	X	X	Potable Water
IDW Samples										
14IDW1	X	X	X	X	X			X	X	Solid
14IDW2	X	X	X	X	X			X	X	Liquid

Notes:

Groundwater samples will be designated a location number in the field.

Two subsurface soil samples will be collected from each boring location. The soil interval will designated in the sufix sample number.

TABLE 3-2

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METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 14 - FIRE TRAINING PIT - RFI WORK PLAN
NAPR, PR

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

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METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 14 - FIRE TRAINING PIT - RFI WORK PLAN
NAPR, PR

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

TABLE 3-2

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METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 14 - FIRE TRAINING PIT - RFI WORK PLAN
NAPR, PR

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

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METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 14 - FIRE TRAINING PIT - RFI WORK PLAN
NAPR, PR

Semivolatiles (Cont.)	Quantitation Limits*		Method Number
	Water (µg/L)	Low Soil (µg/kg)	
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

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METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 14 - FIRE TRAINING PIT - RFI WORK PLAN
NAPR, PR

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

Revised: November 11, 2005

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 14 - FIRE TRAINING PIT - RFI WORK PLAN
NAPR, PR

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
Dioxins/Furans	**Quantitation Limits***		**Method Number**
	Water (ng/L)	**Low Soil (ng/g)**	
2,3,7,8-TCDD	5.000	0.50	8280A
2,3,7,8-PCDF	12.500	1.25	8280A
2,3,7,8-PCDD	12.500	1.25	8280A
2,3,7,8-HCDF	12.500	1.25	8280A
2,3,7,8-HCDD	12.500	1.25	8280A
2,3,7,8-TCDF	5.000	0.50	8280A
Total Petroleum Hydrocarbons	**Quantitation Limits***		**Method Number**
	Water (µg/L)	**Low Soil (µg/kg)**	
TPH DRO	100	3300	5030/8015B
TPH GRO	50	250	3550/8015B

* 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.
NA - Not Applicable

TABLE 3-2

Revised: November 11, 2005

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CONTRACT
REQUIRED QUANTITATION LIMITS (CRQL)
SWMU 14 - FIRE TRAINING PIT - RFI WORK PLAN
NAPR, PR

Inorganics	Method Number	Quantitation Limits*		Method Description
		Water (µg/L)	Low Soil (mg/kg)	
Antimony	6010	20	2.0	Inductively Coupled Plasma
Arsenic	6010	10	1.0	Inductively Coupled Plasma
Barium	6010	10	1.0	Inductively Coupled Plasma
Beryllium	6010	4.0	0.4	Inductively Coupled Plasma
Cadmium	6010	5.0	0.5	Inductively Coupled Plasma
Chromium	6010	10	1.0	Inductively Coupled Plasma
Cobalt	6010	10	1.0	Inductively Coupled Plasma
Copper	6010	20	2.0	Inductively Coupled Plasma
Lead	6010	5.0	0.5	Inductively Coupled Plasma
Mercury	7470/7471	0.2	0.02	Cold Vapor AA
Nickel	6010	40	4.0	Inductively Coupled Plasma
Selenium	6010	10	2.5	Inductively Coupled Plasma
Silver	6010	10	1.0	Inductively Coupled Plasma
Thallium	6010	25	2.5	Inductively Coupled Plasma
Tin	6010	50	10.0	Inductively Coupled Plasma
Vanadium	6010	10	1.0	Inductively Coupled Plasma
Cyanide	9012	0.010	1.0	Colorimetric
Sulfide	9030	1.0	25	Titrimetric, Iodine
Zinc	6010	20	2.0	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.

FIGURES

Baker

LEGEND

– SWMUs

SWMU 14

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

1000 0 1000 1000

1 inch = 1000 ft.

FIGURE 1–1
SWMUs 12 AND 14 LOCATION MAP

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

2099204RF

150 0 75 150

1 inch = 150 ft.

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LEGEND

SWMUs

SWMU 14

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

FIGURE 1-2
1977 LOCATION MAP
SWMU 14
FIRE TRAINING PIT
RFI WORK PLAN

NAVAL ACTIVITY PUERTO RICO
PUERTO RICO

2099202RF

150 0 75 150

1 inch = 150 ft.

Baker

Michael Baker Jr., Inc.

LEGEND

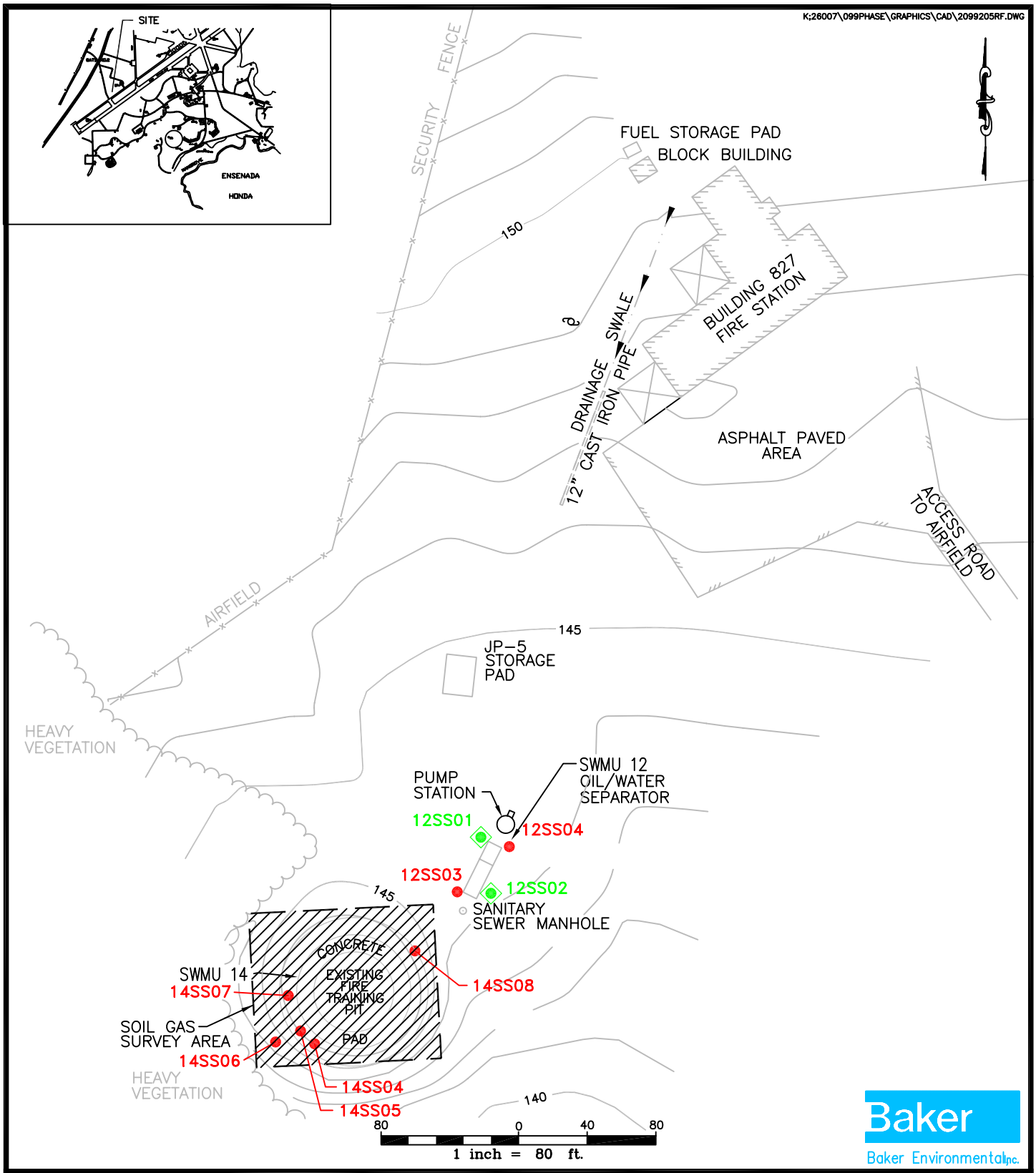
SWMUs

SWMU 14

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

FIGURE 1-3
LOCATION MAP
SWMU 14
FIRE TRAINING PIT
RFI WORK PLAN

NAVAL ACTIVITY PUERTO RICO
PUERTO RICO



LEGEND

- 145 SURFACE ELEVATION CONTOUR
- SURFACE WATER DRAINAGE DIRECTION
- SURFACE SOIL SAMPLE COLLECTED (9-95)
- SURFACE SOIL SAMPLE COLLECTED (3-22-96)
- AREA OF SOIL GAS SURVEY

SOURCE: LANTDIV, FEB. 1992.

FIGURE 2-1
SAMPLING LOCATIONS
OU#1 - SWMU 12-FIRE TRAINING PIT OIL/WATER SEPARATOR AND SWMU 14 - FIRE TRAINING PIT AREA

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

2099203RF

150 0 75 150

1 inch = 150 ft.

Baker

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LEGEND

- ◉ – PROPOSED SOIL SAMPLE LOCATION
- ◇ – SURFACE SOIL SAMPLE COLLECTED (9–95)
- ● – SURFACE SOIL SAMPLE COLLECTED (3–22–96)

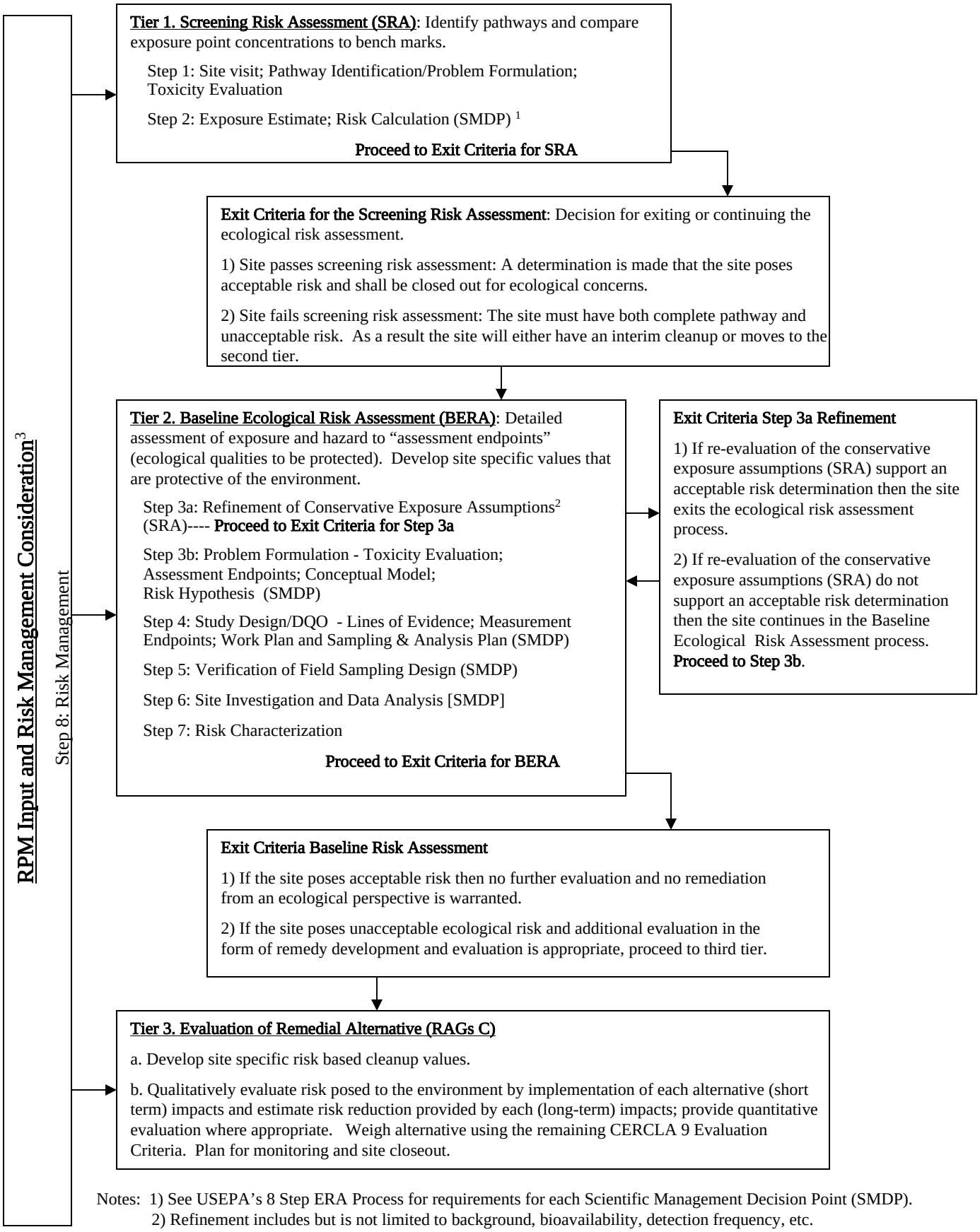
NOTES:

- BOTH SURFACE SOIL AND SUBSURFACE SOIL WILL BE COLLECTED FROM 14SB01 THROUGH 14SB03.
- THREE TEMPORARY WELLS WILL BE INSTALLED IN THREE OF THE BORING LOCATIONS TO BE DETERMINED IN THE FIELD.

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

FIGURE 3–1
PROPOSED SOIL AND GROUNDWATER SAMPLING LOCATIONS
SWMU 14
FIRE TRAINING PIT
NAVAL ACTIVITY PUERTO RICO
PUERTO RICO

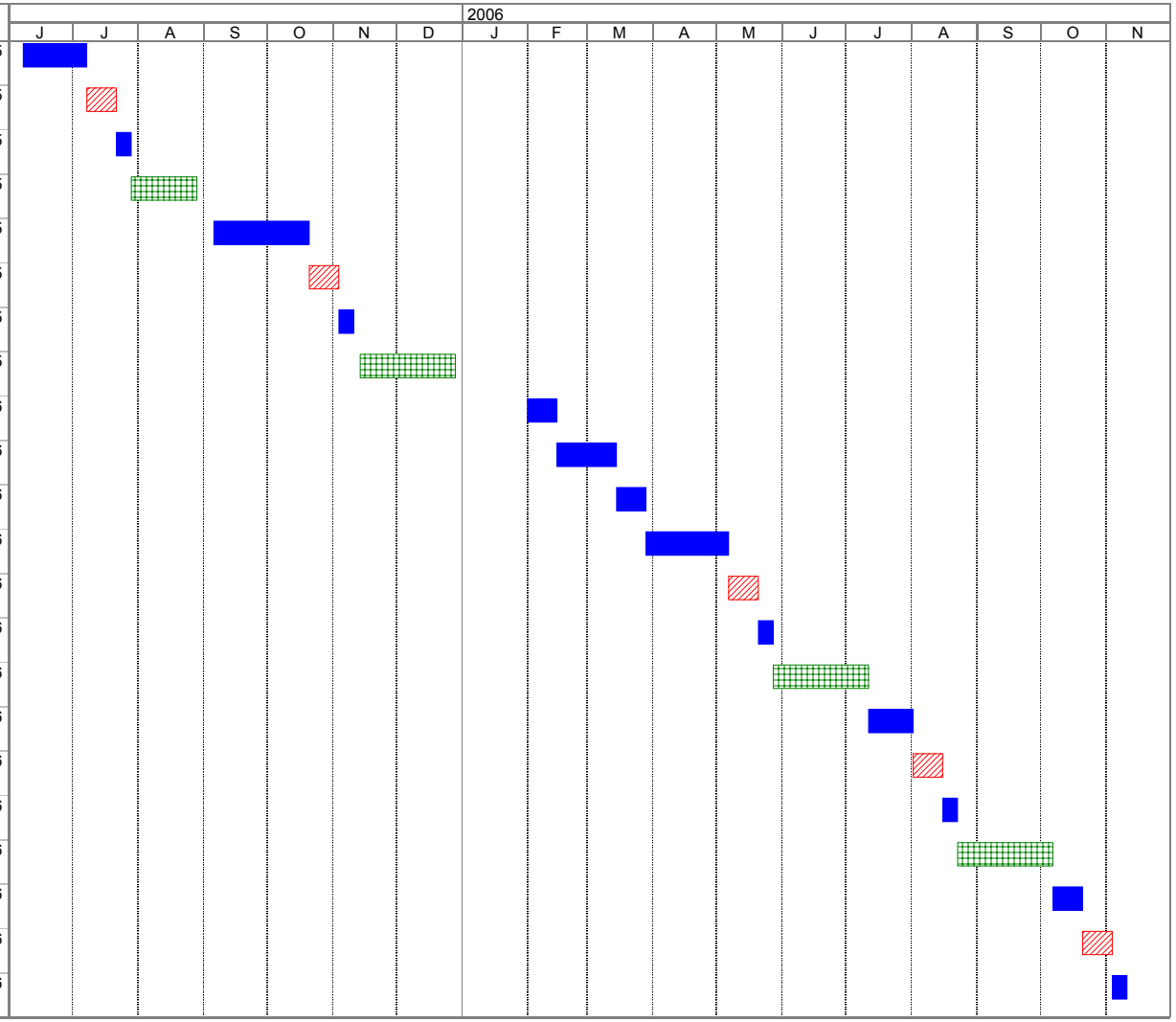
Figure 6-1: Navy Ecological Risk Assessment Tiered Approach



Notes: 1) See USEPA's 8 Step ERA Process for requirements for each Scientific Management Decision Point (SMDP).
2) Refinement includes but is not limited to background, bioavailability, detection frequency, etc.
3) Risk Management is incorporated throughout the tiered approach.

Figure 7-1
Proposed Project Schedule
RFI SWMU 14-Fire Training Pit Area Work Plan
Naval Activity Puerto Rico, Ceiba, Puerto Rico

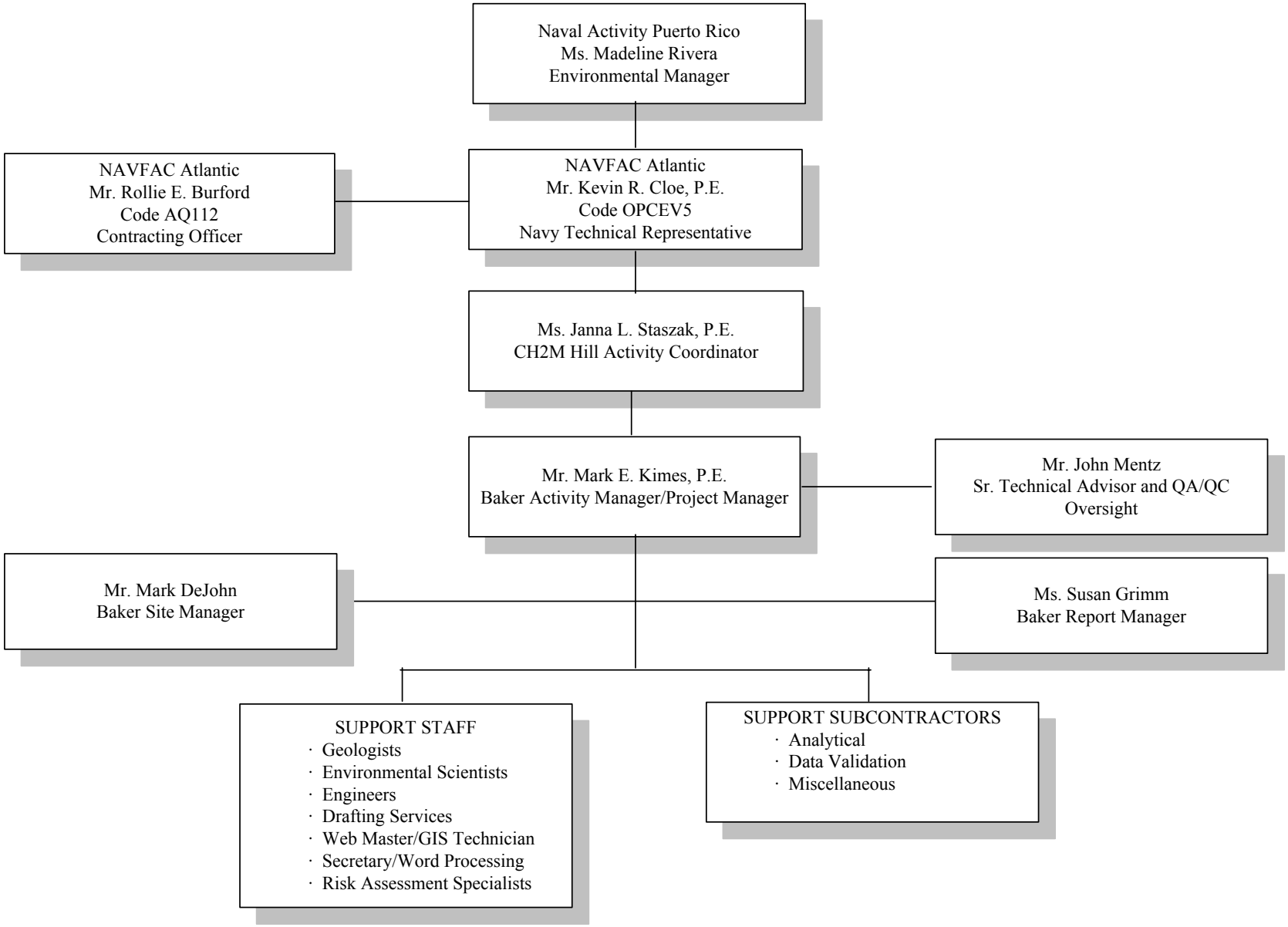
ID	Task Name	Duration	Start	Finish
1	Draft RFI Work Plan for SWMU 14	30 edays	6/8/05	7/8/05
2	Navy Review	14 edays	7/8/05	7/22/05
3	Draft RFI Work Plan for SWMU 14 to EPA	7 edays	7/22/05	7/29/05
4	EPA Review	31 edays	7/29/05	8/29/05
5	Final RFI Work Plan for SWMU 14	45 edays	9/6/05	10/21/05
6	Navy Review	14 edays	10/21/05	11/4/05
7	Final RFI Work Plan for SWMU 14 to EPA	7 edays	11/4/05	11/11/05
8	EPA Review & Approval	45 edays	11/14/05	12/29/05
9	Field Investigation	14 edays	2/1/06	2/15/06
10	Laboratory Analysis	28 edays	2/15/06	3/15/06
11	Data Validation	14 edays	3/15/06	3/29/06
12	Draft RFI Report for SWMU 14	39 edays	3/29/06	5/7/06
13	Navy Review	14 edays	5/7/06	5/21/06
14	Draft RFI Report for SWMU 14 to EPA	7 edays	5/21/06	5/28/06
15	EPA Review	45 edays	5/28/06	7/12/06
16	Draft Final RFI Report for SWMU 14	21 edays	7/12/06	8/2/06
17	Navy Review	14 edays	8/2/06	8/16/06
18	Draft Final RFI Report for SWMU 14 to EPA	7 edays	8/16/06	8/23/06
19	EPA Review	45 edays	8/23/06	10/7/06
20	Final RFI Report for SWMU 14	14 edays	10/7/06	10/21/06
21	Navy Review	14 edays	10/21/06	11/4/06
22	Final RFI Report for SWMU 14 to EPA	7 edays	11/4/06	11/11/06



Project: SWMU 14
Date: Revised 12/29/05

Baker Environmental — EPA Review — Navy Review — Milestone

FIGURE 8-1
PROJECT ORGANIZATION
SWMU 14 – FIRE TRAINING PIT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



APPENDIX A
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

Pre-Sampling Activities

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

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

U.S. EPA, 1993, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/530-R-93-001.

U.S. EPA Region II, 1989, CERCLA Quality Assurance Manual.

APPENDIX B
Summary of Analytical Results, Surface Soil – Organics, SWMU 14 RFI Report for Phase I Investigations at OU 1, 6, and 7

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL - ORGANICS
SWMU 14 SURFACE SOIL
RFI REPORT FOR PHASE I INVESTIGATIONS AT OU 1, 6, AND 7
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Parameter Name	14SS04 3/22/1996	14SS05 3/22/1996	14SS06 3/22/1996	14SS07 3/22/1996	14SS08 3/22/1996
Volatile Organics (ug/kg)					
1,1,1,2-Tetrachloroethane	12 U	12 UJ	12 U	12 U	11 U
1,1,1-Trichloroethane	6 U	6 UJ	6 U	6 U	5 U
1,1,2,2-Tetrachloroethane	6 U	6 UJ	6 U	6 U	5 U
1,1,2-Trichloroethane	6 U	6 UJ	6 U	6 U	5 U
1,1-Dichloroethane	6 U	6 UJ	6 U	6 U	5 U
1,1-Dichloroethene	6 U	6 UJ	6 U	6 U	5 U
1,2,3-Trichloropropane	12 U	12 UJ	12 U	12 U	11 U
1,2-Dibromo-3-chloropropane	25 UJ	25 UJ	23 UJ	24 U	22 U
1,2-Dibromoethane	25 U	25 UJ	23 U	24 U	22 U
1,2-Dichloroethane	6 UJ	6 UJ	6 UJ	6 U	5 U
1,2-Dichloroethene	6 U	6 UJ	6 U	6 U	5 U
1,2-Dichloropropane	6 U	6 UJ	6 U	6 U	5 U
2-Chloro-1,3-butadiene	120 U	120 UJ	120 U	120 U	110 U
2-Hexanone	12 UJ	12 UJ	12 UJ	12 U	11 U
3-Chloropropene	25 U	25 UJ	23 U	24 U	22 U
Acetone	12 UJ	12 UJ	12 UJ	12 UJ	11 UJ
Acetonitrile	120 U	120 UJ	120 U	120 U	110 U
Acrolein	620 U	630 UJ	590 U	590 U	540 U
Acrylonitrile	120 U	120 UJ	120 U	120 U	110 U
Benzene	6 U	6 UJ	6 U	6 U	5 U
Bromodichloromethane	6 U	6 UJ	6 U	6 U	5 U
Bromoform	6 U	6 UJ	6 U	6 U	5 U
Bromomethane	12 U	12 UJ	12 U	12 U	11 U
Carbon disulfide	6 U	6 UJ	6 U	6 U	5 U
Carbon tetrachloride	6 U	6 UJ	6 U	6 U	5 U
Chlorobenzene	6 U	6 UJ	6 U	6 U	5 U
Chloroethane	12 U	12 UJ	12 U	12 U	11 U
Chloroform	6 U	6 UJ	6 U	6 U	5 U
Chloromethane	12 U	12 UJ	12 U	12 U	11 U
cis-1,3-Dichloropropene	6 U	6 UJ	6 U	6 U	5 U
Dibromochloromethane	6 U	6 UJ	6 U	6 U	5 U
Dichlorodifluoromethane	25 U	25 UJ	23 U	24 UJ	22 UJ
Ethyl methacrylate	25 U	25 UJ	23 U	24 U	22 U
Ethylbenzene	6 U	6 UJ	6 U	6 UJ	5 UJ
Iodomethane	12 U	12 UJ	12 U	12 U	11 U
Isobutanol	2500 R	2500 R	2300 R	2400 R	2200 R
Methacrylonitrile	25 U	25 UJ	23 U	24 U	22 U
Methyl Ethyl Ketone	12 U	12 UJ	12 U	12 U	11 U
Methyl isobutyl ketone	12 U	12 UJ	12 U	12 U	11 U
Methyl methacrylate	25 U	25 UJ	23 U	24 U	22 U
Methylene bromide	12 U	12 UJ	12 U	12 UJ	11 UJ
Methylene chloride	6 UJ	6 UJ	6 UJ	6 U	5 U
Pentachloroethane	25 U	25 UJ	23 U	24 U	22 U
Propionitrile	62 R	63 R	59 R	59 R	54 R
Styrene	6 U	6 UJ	6 U	6 U	5 U
Tetrachloroethene	6 U	6 UJ	6 U	6 U	5 U
Toluene	6 U	6 UJ	6 U	6 U	5 U
trans-1,3-Dichloropropene	6 U	6 UJ	6 U	6 U	5 U

SUMMARY OF ANALYTICAL RESULTS, SURFACE SOIL - ORGANICS
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RFI REPORT FOR PHASE I INVESTIGATIONS AT OU 1, 6, AND 7
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Parameter Name	14SS04 3/22/1996	14SS05 3/22/1996	14SS06 3/22/1996	14SS07 3/22/1996	14SS08 3/22/1996
Volatile Organics (ug/kg) (cont.)					
trans-1,4-Dichloro-2-butene	25 U	25 UJ	23 U	24 U	22 U
Trichloroethene	6 U	6 UJ	6 U	6 U	5 U
Trichlorofluoromethane	12 UJ	12 UJ	12 UJ	12 UJ	11 UJ
Vinyl acetate	12 U	12 UJ	12 U	12 U	11 U
Vinyl chloride	12 U	12 UJ	12 U	12 U	11 U
Xylenes	6 U	6 UJ	6 U	6 U	5 U
Semi-volatile Organics (ug/kg)					
1,2,4,5-Tetrachlorobenzene	400 U	410 U	390 U	390 U	360 U
1,2,4-Trichlorobenzene	400 U	410 U	390 U	390 U	360 U
1,2-Dichlorobenzene	400 U	410 U	390 U	390 U	360 U
1,2-Diphenylhydrazine	400 U	410 U	390 U	390 U	360 U
1,3,5-Trinitrobenzene	4000 U	4100 U	3900 U	3900 U	3600 U
1,3-Dichlorobenzene	400 U	410 U	390 U	390 U	360 U
1,3-Dinitrobenzene	800 U	820 U	770 U	770 U	710 U
1,4-Dichlorobenzene	400 U	410 U	390 U	390 U	360 U
1,4-Dioxane	800 R	820 R	770 R	770 R	710 R
1,4-Naphthoquinone	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
1,4-Phenylenediamine	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
1-Naphthylamine	800 U	820 U	770 U	770 U	710 U
2,2'-Oxybis(1-chloropropane)	400 U	410 U	390 U	390 U	360 U
2,3,4,6-Tetrachlorophenol	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
2,4,5-Trichlorophenol	2000 U	2100 U	1900 U	1900 U	1800 U
2,4,6-Trichlorophenol	400 U	410 U	390 U	390 U	360 U
2,4-Dichlorophenol	400 U	410 U	390 U	390 U	360 U
2,4-Dimethylphenol	400 U	410 U	390 U	390 U	360 U
2,4-Dinitrophenol	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
2,4-Dinitrotoluene	400 U	410 U	390 U	390 U	360 U
2,6-Dichlorophenol	400 U	410 U	390 U	390 U	360 U
2,6-Dinitrotoluene	400 U	410 U	390 U	390 U	360 U
2-Acetylaminofluorene	800 U	820 U	770 U	770 U	710 U
2-Chloronaphthalene	400 U	410 U	390 U	390 U	360 U
2-Chlorophenol	400 U	410 U	390 U	390 U	360 U
2-Methylnaphthalene	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
2-Methylphenol	400 U	410 U	390 U	390 U	360 U
2-Naphthylamine	1000 U	1000 U	970 U	970 U	890 U
2-Nitroaniline	2000 U	2100 U	1900 U	1900 U	1800 U
2-Nitrophenol	400 U	410 U	390 U	390 U	360 U
2-Picoline	400 R	410 R	390 R	390 R	360 R
3&4-Methylphenol	400 U	410 U	390 U	390 U	360 U
3,3'-Dichlorobenzidine	800 U	820 U	770 U	770 U	710 U
3,3'-Dimethylbenzidine	2000 U	2100 U	1900 U	1900 U	1800 U
3-Methylcholanthrene	400 U	410 U	390 U	390 U	360 U
3-Nitroaniline	2000 U	2100 U	1900 U	1900 U	1800 U
4,6-Dinitro-2-methylphenol	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
4-Aminobiphenyl	800 U	820 U	770 U	770 U	710 U
4-Bromofluorobenzene	400 U	410 U	390 U	390 U	360 U
4-Chloro-3-methylphenol	800 U	820 U	770 U	770 U	710 U

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NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Parameter Name	14SS04 3/22/1996	14SS05 3/22/1996	14SS06 3/22/1996	14SS07 3/22/1996	14SS08 3/22/1996
Semi-volatile Organics (ug/kg) (cont.)					
4-Chloroaniline	800 U	820 U	770 U	770 U	710 U
4-Chlorophenylphenylether	400 U	410 U	390 U	390 U	360 U
4-Nitroaniline	2000 U	2100 U	1900 U	1900 U	1800 U
4-Nitrophenol	2000 U	2100 U	1900 U	1900 U	1800 U
4-Nitroquinoline-1-oxide	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
5-Nitro-o-toluidine	800 U	820 U	770 U	770 U	710 U
7,12-Dimethylbenz(a)anthracene	800 U	820 U	770 U	770 U	710 U
Acenaphthene	400 U	410 U	390 U	390 U	360 U
Acenaphthylene	400 U	410 U	390 U	390 U	360 U
Acetophenone	400 U	410 U	390 U	390 U	360 U
alpha,alpha-Dimethylphenethylamine	2000 U	2100 U	1900 U	1900 U	1800 U
Aniline	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
Anthracene	400 U	410 U	390 U	110 J	360 U
Aramite, Total	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
Benzidine	4000 UJ	4100 UJ	3900 UJ	3900 UJ	3600 UJ
Benzo(a)anthracene	400 U	45 J	300 J	3400	360 U
Benzo(a)pyrene	400 U	45 J	1800	5000	360 U
Benzo(b)fluoranthene	400 U	410 U	2800	7600	360 U
Benzo(g,h,i)perylene	66 J	91 J	1200	3600	360 U
Benzo(k)fluoranthene	400 U	410 U	640	2400	360 U
Benzoic acid	2000 U	2100 U	1900 U	1900 U	1800 U
Benzyl alcohol	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
Bis(2-chloroethoxy)methane	400 U	410 U	390 U	390 U	360 U
Bis(2-chloroethyl)ether	400 U	410 U	390 U	390 U	360 U
Bis(2-ethylhexyl)phthalate	400 U	410 U	97 J	390 U	360 U
Butylbenzylphthalate	400 U	410 U	390 U	390 U	360 U
Carbazole	400 U	410 U	390 U	390 U	360 U
Chlorobenzilate	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
Chrysene	400 U	50 J	690	3800	360 U
Diallate, Total	400 U	410 U	390 U	390 U	360 U
Dibenzo(a,h)anthracene	400 U	410 U	210 J	920	360 U
Dibenzofuran	400 U	410 U	390 U	390 U	360 U
Diethylphthalate	400 U	410 U	54 J	390 U	360 U
Dimethylphthalate	400 U	410 U	390 U	390 U	360 U
Di-n-butylphthalate	400 U	410 U	390 U	390 U	360 U
Di-n-octyl phthalate	400 U	410 U	390 U	390 U	360 U
Dinoseb	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
Diphenylamine	400 U	410 U	390 U	390 U	360 U
Ethyl methanesulfonate	400 U	410 U	390 U	390 U	360 U
Fluoranthene	88 J	110 J	230 J	67 J	360 U
Fluorene	400 U	410 U	390 U	390 U	360 U
Hexachlorobenzene	400 U	410 U	390 U	390 U	360 U
Hexachlorobutadiene	400 U	410 U	390 U	390 U	360 U
Hexachlorocyclopentadiene	400 U	410 U	390 U	390 U	360 U
Hexachloroethane	400 U	410 U	390 U	390 U	360 U
Hexachlorophene	4000 R	4100 R	3900 R	3900 R	3600 R
Hexachloropropene	2000 U	2100 U	1900 U	1900 U	1800 U
Indeno(1,2,3-cd)pyrene	400 U	58 J	1300	3800	360 U

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NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Parameter Name	14SS04 3/22/1996	14SS05 3/22/1996	14SS06 3/22/1996	14SS07 3/22/1996	14SS08 3/22/1996
Semi-volatile Organics (ug/kg) (cont.)					
Isophorone	400 U	410 U	390 U	390 U	360 U
Isosafrole	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
Methapyrilene	1000 UJ	1000 UJ	970 UJ	970 UJ	890 UJ
Methyl methanesulfonate	400 U	410 U	390 U	390 U	360 U
Naphthalene	400 U	410 U	390 U	390 U	360 U
Nitrobenzene	400 U	410 U	390 U	390 U	360 U
N-Nitrosodiethylamine	400 UJ	410 U	390 U	390 U	360 U
N-Nitrosodimethylamine	400 U	410 U	390 U	390 U	360 U
N-Nitroso-di-n-butylamine	400 UJ	410 UJ	390 UJ	390 UJ	360 UJ
N-Nitroso-di-n-propylamine	400 U	410 U	390 U	390 U	360 U
N-Nitrosodiphenylamine	400 U	410 U	390 U	390 U	360 U
N-Nitrosomethylethylamine	400 U	410 UJ	390 UJ	390 UJ	360 UJ
N-Nitrosomorpholine	800 UJ	820 UJ	770 UJ	770 UJ	710 UJ
N-Nitrosopiperidine	400 U	410 U	390 U	390 U	360 U
N-Nitrosopyrrolidine	2000 UJ	2100 UJ	1900 UJ	1900 UJ	1800 UJ
o-Toluidine	400 R	410 R	390 R	390 R	360 R
p-Dimethylaminoazobenzene	800 U	820 U	770 U	770 U	710 U
Pentachlorobenzene	400 U	410 U	390 U	390 U	360 U
Pentachloronitrobenzene	400 U	410 U	390 U	390 U	360 U
Pentachlorophenol	2000 U	2100 U	1900 U	1900 U	1800 U
Phenacetin	400 U	410 U	390 U	390 U	360 U
Phenanthrene	400 U	410 U	39 J	58 J	360 U
Phenol	400 U	410 U	390 U	390 U	360 U
Pronamide	400 U	410 U	390 U	390 U	360 U
Pyrene	170 J	270 J	650	100 J	360 U
Pyridine	800 U	820 U	770 U	770 U	710 U
Safrole	400 U	410 U	390 U	390 U	360 U
Total Petroleum Hydrocarbons (mg/kg)					
Diesel Range Organics	560	360	120	490	4.5 U
Gasoline Range Organics	3.7	3.8	1.8	1.8	0.032
PCBs (ug/kg)					
Aroclor-1016	48 U	49 U	46 U	46 U	42 U
Aroclor-1221	48 U	49 U	46 U	46 U	42 U
Aroclor-1232	48 U	49 U	46 U	46 U	42 U
Aroclor-1242	48 U	49 U	46 U	46 U	42 U
Aroclor-1248	48 U	49 U	46 U	46 U	42 U
Aroclor-1254	96 U	98 U	93 U	93 U	85 U
Aroclor-1260	28	17	12	19	6 NJ

Notes:
ug/kg - micrograms per kilogram
U - Not detected
J - Estimated value
UJ - Report quantitation limit is qualified as estimated
R - Result is rejected and unusable
NJ - Tentative identification estimated