FINAL FULL RCRA FACILITY INVESTIGATION WORK PLAN SWMU 71 – QUARRY DISPOSAL SITE

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

Prepared for:

Department of the Navy
NAVFAC SOUTHEAST
North Charleston, South Carolina

Prepared by:

Baker

Michael Baker Jr., Inc.
Moon Township, PA

Contract No. N62470-10-D-3000
DO JM01

October 21, 2010

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

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Prepared by:

MICHAEL BAKER JR., INC.
Moon Township, Pennsylvania

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

Signature: ______________________

Name: **Mark E. Davidson**

Title: **BRAC Env. Coordinator**

Date: **October 21, 2010**

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LIST OF ACRONYMS AND ABBREVIATIONS

APA	Aerial Photographic Analysis
Baker	Michael Baker Jr., Inc.
bgs	below ground surface
BRAC	Base Realignment and Closure
CCC	Continuous Criteria Concentrations
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERFA	Community Environmental Response Facilitation Act
CMS	Corrective Measures Study
CSF	Cancer Slope Factor
DO	Delivery Order
DoN	Department of the Navy
DRO	Diesel Range Organics
EA	Environmental Assessment
EC_{50}	Median Effective Concentration
ECP	Environmental Condition of Property
Eco-SSL	Ecological Soil Screening Level
ERA	Ecological Risk Assessment
ESL	Ecological Screening Level
FCVs	Final Chronic Values
FID	Flame Ionization Detector
GIS	Geographic Information System
GPS	Global Positioning System
GRO	Gasoline Range Organics
HHRA	Human Health Risk Assessment
HSA	Hollow-Stem Auger
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
IDW	Investigation Derived Waste
IUR	Inhalation Unit Risk
kg	Kilograms
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
LOEC	Lowest Observed Effect Concentration
LOEL	Lowest Observable Effect Level
LC_{50}	Median Lethal Concentration
MATC	Maximum Acceptable Toxicant Concentration
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
MHSPE	Ministry of Housing, Spatial Planning and Environment

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAPR	Naval Activity Puerto Rico
NAVFAC	Naval Facilities Engineering Command
NAWQC	National Ambient Water Quality Criteria
NFESC	Naval Facilities Engineering Service Center
NOEC	No Observed Effect Concentration
NOEL	No Observed Effect Level
NOAA	National Oceanic and Atmospheric Administration
NSRR	Naval Station Roosevelt Roads
NTR	Navy Technical Representative
NTU	Nephelometric Turbidity Units
OP	Organo-Phosphorus
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PID	Photoionization Detector
PMO	Program Management Office
ppt	parts per thousand
PREQB	Puerto Rico Environmental Quality Board
PVC	Polyvinyl Chloride
PWD	Public Works Department
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk Based Concentrations
RCI	Reactivity, Corrosivity and Ignitability
RCRA	Resource Conservation and Recovery Act
RfC	Inhalation Reference Concentrations
RfD	Reference Dose
RFI	Full RCRA Facility Investigation
SCV	Secondary Chronic Values
SE	Southeast
SL	Screening Levels
SQUIRT	Screening Quick Reference Tables
SWMU	Solid Waste Management Unit
SVOC	Semivolatile Organic Compounds
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
ULM	Upper Limit of the Mean
UNEP	United Nations Environmental Program
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

LIST OF ACRONYMS AND ABBREVIATIONS
(continued)

µg/L	microgram per liter
USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compounds
WQS	Water Quality Standard

1.0 INTRODUCTION

This document presents the activities required for the performance of a Full Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 71 – Quarry Disposal Site located at Naval Activity Puerto Rico (NAPR), Ceiba, Puerto Rico, formerly known as Naval Station Roosevelt Roads (NSRR). This work plan has been prepared by Michael Baker Jr., Inc. (Baker), for the Navy Base Realignment and Closure (BRAC) Program Management Office (PMO) Southeast (SE) office under contract with the Naval Facilities Engineering Command (NAVFAC), SE Atlantic Multi-Media Environmental Compliance Engineering Support,(Contract Number N62470-10-D-3000, Delivery Order [DO] JM01). This work plan was developed in accordance with the RCRA § 7003 Administrative Order on Consent (United States Environmental Protection Agency [USEPA] Docket No. 02-2007-7301). The work will be implemented in accordance with the Final RFI Management Plans (Baker, 1995), with updates to appropriate sampling and analytical methods as indicated in this Work Plan.

1.1 <u>NAPR Description and History</u>

NAPR occupies over 8,800 acres on the northern side of the east coast of Puerto Rico, along Vieques Passage with Vieques Island lying to the east about 10 miles off the harbor entrance (see Figure 1-1). NAPR also occupies the immediately adjacent islands of Piñeros and Cabeza de Perro, as presented on Figure 1-2. The northern entrance to NAPR is about 35 miles east along the coast road (Route 3) from San Juan. The property consists of 3,938 acres of upland (developable) property and 4,955 acres of environmentally sensitive areas including wetlands, mangrove, and wildlife habitat. The closest large town is Fajardo (population approximately 41,000), which is about 5 miles north of NAPR off Route 3. Ceiba (population approximately 18,000) adjoins the west boundary of NAPR (see Figure 1-1).

The facility was commissioned in 1943 as a Naval Operations Base, and finally re-designated a Naval Station in 1957. NSRR operated as a Naval Station from 1957 until March 31, 2004. NSRR was one of the largest naval facilities in the world with more than 100 miles of paved roads, approximately 1,300 buildings, a large scale airfield (Ofstie Field), a deep water port and over 30 tenant commands. NSRR played a major role in providing communication support to the Atlantic and Caribbean areas and also served as a major training site for fleet exercises.

Section 8132 of fiscal year 2004 Defense Appropriations Act, signed into law on September 30, 2003, directed that NSRR be disestablished within 6 months, and that the real estate disposal/transfer be carried out in accordance with procedures contained in the BRAC Act of 1990. This legislation required that the base closure be conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Community Environmental Response Facilitation Act (CERFA). NSRR has undergone operational closure as of March 31, 2004 and has been designated as Naval Activity Puerto Rico. The mission of NAPR is to protect the physical assets remaining, comply with environmental regulations, and sustain the value of the property until final disposal of the property. NAPR will continue until the real estate disposal/transfer is completed.

The USEPA issued a RCRA 7003 Administrative Order on Consent 'Consent Order' (USEPA Docket No. RCRA-02-2007-7301) to NAPR. The Order sets out the Navy's corrective action obligations under RCRA and replaces the 1994 RCRA permit for NAPR. Following a public comment period, the Consent Order became effective on January 29, 2007.

1.2 Site Location and Description

SWMU 71 – Quarry Disposal Site covers an area of approximately 23 acres located along Langley Drive, as shown on Figure 1-3. This SWMU encompasses the area of a former quarry operation and is the current location of the Commissary Building (Building 2394) and the adjacent parking lot (as shown on Figure 1-4).

The Aerial Photo Analysis (APA) presented in the Phase I Environmental Condition of Property (ECP) Report (Naval Facilities Engineering Command, Atlantic Division [LANTDIV], 2004) identified this area as Photo Identified Site 24, due to the observation of numerous drums in open storage areas on the south side of the former quarry/rock crusher site from 1976 to 1983, and at least 25 drums located near the rock crusher (within the 1977 polygon feature in the northeastern portion of the site), with staining on the ground adjacent to them. The Phase I ECP records review identified the area as a former quarry site, but there were no records pertaining to drum storage or disposal. Remnants of the quarry area were observed during the physical site inspection, but no signs of disposal, stains, or stressed vegetation were noted. Interviews confirmed both storage and disposal of drums containing a tar-like substance in the area, which were uncovered during construction of the Commissary Building around 1995.

The presence of some stored material (possibly drums) within the intersection of the 1976 and 1977 polygon features is shown on Figure 1-3. This figure also shows the polygons of suspected areas of site activity from the 1977 and 1985 aerial photographs reviewed during the APA. The 1985 polygon feature was described as "a fill area or disposal area with disturbed ground and possible rubble or debris". There were no signs of a disposal area observed during the Phase II ECP investigation conducted in 2004, nor were there any stains or stressed vegetation observed, as was the case during the Phase I ECP physical site inspection.

The RCRA 7003 Administrative Order on Consent (USEPA Docket No. RCRA-02-2007-7301) identified SWMU 71 (formerly referred to as ECP 17) as having documented releases of solid and/or hazardous waste and hazardous constituents. The Administrative Order required the preparation and submittal to the USEPA for their approval, of an acceptable work plan to complete the equivalent to a Phase I RFI investigation. The Phase I RFI Work Plan was prepared to conduct the field investigation necessary to determine whether or not releases of solid and/or hazardous wastes or hazardous constituents are present due to past operations at SWMU 71. The Phase I RFI Work Plan (Baker, 2008) included a surface and subsurface soil sampling program to further characterize and delineate volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides and metals detected during the ECP Phase II Investigation. A groundwater sampling program was also implemented to further delineate SVOCs and metals that were detected during the Phase II ECP sampling. The Phase I RFI Work Plan (Baker, 2008) was approved by USEPA on May 13, 2008. The field work for the Phase I RFI was conducted from May 31, 2008 to June 10, 2008. The Phase I RFI report was approved by the USEPA on August 11, 2009. Refer to Section 2.2.2 for a discussion of the Phase I RFI results.

1.3 Objectives

The purpose of this work plan is to further delineate the environmental impact to media found during the Phase I RFI conducted at SWMU 71 (Baker, 2009).

The objectives of this Full RFI are as follows:

- Delineate polynuclear aromatic hydrocarbons (PAHs) and metals in the surface and subsurface soil and metals in groundwater found during the Phase I RFI. Specifically, metals (surface and subsurface soil) and low-level PAHs (surface soil) around Phase I RFI sample locations 71SB01, 71SB02, and 71SB03 in the upper portion of the SWMU that was the former quarry disposal area. Additionally, to delineate metals (subsurface soil), low-level PAHs (subsurface soil) and dissolved metals (groundwater) in the lower portion of the site around Phase I RFI sample locations 71SB04, 71SB05, 71SB06, 71SB08 and 71SB11 adjacent to the commissary building and parking lot.

- Define the likely source area(s) of contamination.

1.4 Organization of the Work Plan

This work plan is organized into seven sections. Section 1.0 of this document includes the site history and objectives of this Full RFI. Section 2.0 provides a description of the current conditions and usage of the site, a summary of the previous investigations, including the Phase II ECP investigation performed in 2004 and the Phase I RFI performed in May/June 2008, and preliminary conceptual models for ecological and human receptors. Section 3.0 provides a description of the scope of investigations for the Full RFI fieldwork including a soil sampling and analysis program, a monitoring well installation program and 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 discusses the proposed project schedule for the Full RFI process for SWMU 71. The site management structure that will be used during this investigation, including project team responsibilities and field reporting requirements, is presented in Section 6.0, while Section 7.0 presents the report references.

2.0 CURRENT CONDITIONS AND BASIS FOR A FULL RFI

The following sections provide a discussion of the current conditions that exist at SWMU 71 along with a summary of the results of the Phase II ECP (NAVFAC Atlantic, 2005) and the Phase I RFI (Baker, 2009). In addition, the terrestrial and aquatic habitats and associated biota at and contiguous to SWMU 71 are described and preliminary conceptual models for human and ecological receptors are provided. The findings and recommendations of the Phase II ECP and Phase I RFI, comments from the USEPA and the Puerto Rico Environmental Quality Board (PREQB) on the RFI report, and the preliminary conceptual models form the basis for the Full RFI.

2.1 Current Site Conditions

SWMU 71 covers an area of approximately 23 acres (as shown on Figure 1-3) and includes the Commissary Building and adjacent parking lot (constructed in approximately 1995) in the developed, southern portion of the site (See Photo A-1, Appendix A). The northern portion of the site including the 1977 and 1985 polygon areas remain as undeveloped areas. The developed southern portion of the site and the undeveloped northern portion of the site, although separated by a steep, vegetated hillside (see Photos A-2 and A-3 in Appendix A), remain relatively flat. The northeastern portion of the site was observed as having a large amount of rock debris on the surface, this area had to be cleared to provide access to the sample locations (see Photo A-4, Appendix A). This is consistent with the 1976 aerial photograph (Figure 1-3) depicting disturbance in this area.

As shown on Figure 1-4, the Quarry Disposal Site (north of Langley Drive) does not contain natural resources such as streams, rivers, or wetland areas. However, a dry swale was located in the northern portion of the site between the 1977 and 1985 polygon features. This feature is assumed to be associated with past quarry operations given the large amounts of rock debris throughout. Water was not present in the swale during the time of the investigation, nor were there signs of prolonged soil saturation to conclude the presence of hydric soils. Also, there were no hydrophytes (i.e., plants adapted to grow in water) observed in the swale. The dominant herbaceous and small woody vegetative types that were observed are similar to those in the adjacent upland areas in and around SWMU 71. The majority of surface water runoff for the site flows southwest towards a storm water ditch and culvert system (adjacent to and underneath Langley Drive) and eventually to the E2SS3 wetland resource on the southern side of Langley Drive. Since the completion of the Phase I RFI Work Plan, the SWMU boundary has been revised slightly to include areas south of Langley Drive. The revised SWMU boundary does not necessarily represent the limits of contamination, but rather a larger buffer zone around the SWMU for purposes of future property transfer.

2.1.1 Terrestrial and Aquatic Habitats

The upland habitat bounded by NAPR is classified as subtropical dry forest (Ewel and Witmore, 1973). Similar to other forested areas of Puerto Rico, this region was previously clear-cut in the early part of the century, primarily for pastureland (Geo-Marine, Inc., 1998). After acquisition by the Navy, a secondary growth of thick scrub, dominated by lead tree (*Leucaena* spp.), Christmas tree (*Randia aculeata*), sweet acacia (*Acacia farnesiana*), and Australian corkwood (*Sesbania grandiflora*) grew in the previously grazed sections (Geo-Marine, Inc., 1998). Secondary growth communities (upland coastal forest communities and coastal scrub forest communities) exist today throughout the station's undeveloped upland.

The upland vegetative community within undisturbed areas of SWMU 71 and surrounding areas is classified as a coastal scrub forest community. Specific vegetation occurring within the coastal scrub forest community has not been documented during previous investigations. However, based on observations recorded at other SWMUs containing similar upland habitat (i.e., SWMUs 1 and 2), herbaceous and shrub species, including *Panicum maximum* (guinea grass), lead tree (*Leucaena leucocephala*), almácigo (*Bursera simaruba*), Christmas tree (*Randia aculeate*are, are likely present. Dominant vegetation within the coastal scrub forest community will be documented during the Full RFI field investigation.

Cobana negra (*Stahlia monosperma*), a federally threatened tree species, is known to occur between the boundary of black mangrove communities and coastal upland forest communities. This species is also known to occur in coastal forests of southeastern Puerto Rico (Little and Wadsworth, 1964). A single individual was encountered at NAPR during recent surveys conducted by Geo-Marine, Inc. (NAVFAC, 2006). This individual is located within a coastal scrub forest community near the Capehart housing area, west of American Circle (approximately 1.5 miles from SWMU 71). No other plant species listed under the provisions of the Endangered Species Act of 1973 are known to occur or have the potential to occur at NAPR (Geo-Marine, Inc., 2000 and NAVFAC, 2006).

The aquatic habitats (open water marine and wetland habitat) occurring in the vicinity of SWMU 71 are depicted on Figure 2-2. The wetland units depicted on Figure 2-2, identified by the Cowardin Wetland Classification System (Cowardin et al., 1979; see Figure 2-3), were delineated by Geo-Marine, Inc. in December 1999 from 1993 color infrared and 1998 true color aerial photography. Twenty percent of the wetlands delineated by aerial photography were field checked by Geo-Marine, Inc. to verify the accuracy of the delineations. Field verification was based on the 1987 Corps of Engineers wetland delineation manual (United States Army Corps of Engineers [USACE], 1987). As evidenced by Figure 2-2, there is an extensive estuarine wetland system (E2SS3) that crosses the southeastern boundary of SWMU 71. In addition, E2SS3 experiences surface water runoff from the SWMU through a ditch and culvert system that crosses its southwestern boundary. The nearest surface water body is the Ensenada Honda (approximately 800 feet southeast of SWMU 71), which is hydrologically connected to this estuarine wetland system. Seagrass beds are prevalent throughout much of the Ensenada Honda. Seagrass meadows within the Ensenada Honda are dominated by a nearly continuous cover of turtle grass with a high abundance of calcareous green algae (*Avranvilla* spp., *Ventricaria ventricosa*, *Caulerpa* spp., *Valonia* spp., and *Udotea* spp.) (Reid et al., 2001). As evidenced by Figure 2-1, seagrass meadows are present in the portion of the embayment nearest SWMU 71.

2.1.2 Biota

A description of the biota occurring within Puerto Rico and the landmass encompassed by NAPR (including the surrounding marine environment) is provided in the sections that follow. Although the specific terrestrial biota occurring at SWMU 71 have not been recorded during previous investigations, generalizations are provided based on available habitat. Specific biota occurring at SWMU 71 will be documented during the Full RFI field investigation.

2.1.2.1 Mammals

A total of 22 terrestrial mammal species are known historically from Puerto Rico; however, all mammals except bats (13 species) have been extirpated (Mac et al., 1998). The specific bat species known to occur in Puerto Rico are listed below. None of the bats found in Puerto Rico are exclusive to the island, nor are they listed under provisions of the Endangered Species Act of 1973.

- Fruit-eating bats: Jamaican fruit bat (*Artibeus jamaicensis*), Antillean fruit bat (*Brachyphylla cavernarum*), and red fig-eating bat (*Stenoderma rufum*)

- Nectivorous bats: brown flower bat (*Erophylla sezekoni bombifrons*) and greater Antillean long-tounged bat (*Monophyllus redmani*)

- Insectivorous bats: Antillean ghost-faced bat (*Mormoops blainvillii*), Parnell's mustached bat (*Pteronotus parnellii*), sooty mustached bat (*Pteronotus quadridens*), big brown bat (*Eptesicus fuscus*), red bat (*Lasiurus borealis*), velvety free-tailed bat (*Molossus molossus*), and Brazilian free-tailed bat (*Tadarida brasiliensis*)

- Piscivorous bats: Mexican bulldog bat (*Noctilio leporinus*)

Of the endangered/threatened marine mammals that may occur in Puerto Rico, only the West Indian manatee is known to occur in the coastal waters surrounding NAPR (Department of Navy [DoN], 2007). Manatee populations in Puerto Rico's coastal waters have been documented during three aerial surveys conducted from 1978 to 1979, 1984 to 1985, and in 1993 (United Nations Environmental Program [UNEP], 1995), a radio tracking study of manatee distribution and abundance (Reid and Kruer, 1998), and a year-long study of manatee distribution and abundance (Woods et al., 1984). Historical manatee sightings at NAPR are summarized on Figure 2-4. The figure (reproduced from DoN, 2007) includes information from most of the studies identified above. As evidenced by Figure 2-4, manatees have been sited quite often within the Ensenada Honda, 800 feet southeast of SWMU 71. However, this area is distant enough from the SWMU to eliminate the potential of a transport pathway.

Several terrestrial mammals have been introduced into Puerto Rico, including the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), and small Indian mongoose (*Herpestes javanicus*). These nonindigenous mammals are nuisance species that have been implicated in the decline of native bird and reptile populations (Mac et al., 1998 and United States Fish and Wildlife Service [USFWS], 1996a).

2.1.2.2 Birds

A total of 239 bird species are native to Puerto Rico (Raffaele, 1989). This total includes breeding permanent residents and non-breeding migrants. In addition, many nonindigenous bird species have been introduced into Puerto Rico, including the shiny cowbird (*Molothrus bonariensis*) and several parrot species, such as the budgerigar (*Melopsittacus undulates*), orange-fronted parrot (*Aratinga canicularis*), and monk parrot (*Myiopsitta monaqchus*). Of the 239 species native to Puerto Rico, 12 are endemic to the island (Raffaele, 1989).

Numerous native and migratory bird species have been reported at NAPR (Geo-Marine, Inc., 1998). A list compiled from literature-based information pre-dating 1990 (see Table 2-1) includes the great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), little blue heron (*Florida caerulea*), black-crowned night heron (*Nycticorax nycticorax*), belted kingfisher (*Ceryle alcyon*), spotted sandpiper (*Actitis macularia*), greater yellowlegs (*Tringa melanoleauca*), black-bellied plover (*Squatarola squatarola*), clapper rail (*Rallus longirostris*), Royal tern (*Thalasseus maximus*), sandwich tern (*Thalasseus sandvicensis*), least tern (*Stema albifrons*), yellow warbler (*Dendroica petechia*), palm warbler (*Dendroica palmarum*), prairie warbler (*Dendroica discolar*), magnolia warbler (*Dendroica magnolia*), mourning dove (*Zenaida macroura*), red-legged thrush (*Mimocichla plumbea*), common nighthawk (*Chordeiles minor*), and red-tailed hawk (*Buteo jamaicensis*). Endemic species reported from NAPR include the Puerto Rican lizard cuckoo (*Saurothera vieilloti*), Puerto Rican flycatcher (*Myiarchus antillarum*), Puerto Rican woodpecker (*Malanerpes portoricensis*), Puerto Rican emerald (*Chlorostilbon maugaeus*), and yellow-shouldered blackbird (*Agelaius xanthomus*).

The yellow-shouldered blackbird is a federally endangered species. One of the principal reasons for the status of this species is attributed to parasitism by the nonindigenous shiny cowbird, which lays its eggs in blackbird nests and sometimes punctures the host's eggs (USFWS, 1983). Other factors contributing to the status of this species include nest predation by the introduced black rat, Norway rat, and mongoose, as well as habitat modification and destruction (USFWS 1996a). The entire land area of NAPR was declared critical habitat for the yellow-shouldered blackbird in 1976; however, a 1980 agreement with the USFWS exempted certain areas from this categorization (Geo-Marine, Inc., 1998). SWMU 71 is located within the critical habitat designation for the yellow-shouldered blackbird. A study conducted by the Naval Facilities Engineering Service Center (NFESC, 1996) reported that the mangrove forests surrounding NAPR should be considered the most important nesting habitat for the yellow-shouldered blackbird and SWMU 71 extends directly into a mangrove region, as evidenced by Figure 2-1. Based on the arboreal feeding behavior of the yellow-shouldered blackbird, potential feeding habitat (shrub layers) within the nearby coastal scrub forest community could also attract the bird to this SWMU (Geo-Marine, Inc., 2000).

Other federally listed bird species that occur or have the potential to occur at NAPR are the Caribbean brown pelican (*Pelecanus occidentalis occidentalis*), roseate tern (*Sterna dougallii dougallii*), and piping plover (*Charadrius melodus*) (Geo-Marine, Inc., 1998). The piping plover is a rare, non-breeding winter visitor in Puerto Rico (Raffaele, 1989). This species breeds only in North America in three geographic regions (Atlantic Coast population [threatened], Great Lakes population [endangered], and Northern Great Plains population [threatened]; USFWS, 1996b). No piping plover observations were reported at NAPR during the 1990s or during sea turtle nesting surveys conducted in 2002 and 2004 (Geo-Marine, Inc., 2005). No historic evidence is available to indicate whether the roseate tern (threatened in Puerto Rico) has ever nested at NAPR and no roseate tern observations have been noted in or over coastal waters adjacent to NAPR (DoN, 2007). The nearest active roseate tern colony likely occurs on the eastern end of Vieques (more than 20 miles east of NAPR) (DoN, 2007). The Caribbean brown pelican (endangered in Puerto Rico) appears to be a seasonal resident at NAPR and in the surrounding coastal waters (Geo-Marine, Inc., 2005). Small numbers, primarily juveniles, have been seen day-roosting, feeding, and resting irregularly in onshore and near-shore habitats at NAPR; however, no brown pelican nesting colonies have been found at NAPR or on the small cays nearby (Geo-Marine, Inc., 2005). Based on the habitat preferences and observations recorded at NAPR, only the brown pelican has the potential to use the open water habitat downgradient from SWMU 71 (i.e., Ensenada Honda) as a food source. It is important to note that the USFWS recently published a proposed rule to remove the brown pelican from the federal list of endangered and threatened wildlife throughout its range, including Puerto Rico (see Federal Register: Volume 73, Number 34, Pages 9408 dated February 20, 2008). This proposed rule indicates that special consideration of the brown pelican at NAPR is not warranted.

2.1.2.3 <u>Reptiles and Amphibians</u>

A total of 23 amphibians and 47 reptiles are known from Puerto Rico and the adjacent waters (Mac et al., 1998). Fifteen of the amphibians and 29 of the reptiles are endemic, while four amphibian species and three reptilian species have been introduced (Mac et al., 1998). Puerto Rico's native amphibian species include 16 species of tiny frogs commonly called coquis. On the coastal lowlands, almost all coqui species are arboreal. The only amphibians listed under provisions of the Endangered Species Act of 1973 are the Puerto Rican crested toad (*Peltophryne lemur*) and the golden coqui (*Eleutherodactylus jasperi*). Both species are listed as threatened (USFWS, 2010). Distribution of the golden coqui is restricted to areas of dense bromeliad growth. All specimens to date have been collected from a small semicircular area of a 6-mile radius south of Cayey (approximately 30 miles southwest of NAPR), generally at elevations above 700 meters (USFWS, 1984). The Puerto Rican crested toad occurs at low elevations (below 200 meters) where there is exposed limestone or porous, well drained soil offering an abundance of fissures and cavities (USFWS, 1987). A single large population is known to exist from the southwest coast in Guánica Commonwealth Forest, while a small population is believed to survive on the north coast near Quebradillas, Arecibo, Barceloneta, Vega Baja, and Bayamón (USFWS, 1987). It also has been collected on the southeastern coastal plain near Coamo (USFWS, 1987). Given the habitat preferences and locations of known occurrences, these two species are not expected to occur at NAPR.

Puerto Rico's native reptilian species include 31 lizards, 8 snakes, 1 freshwater turtle, and 5 sea turtles (Mac et al., 1998). Of the five sea turtles, only the green sea turtle, hawksbill sea turtle (*Eretmochelys imbricata*), and loggerhead sea turtle (*Dermochelys coriacea*) nest within Puerto Rico. These three sea turtles, as well as the leatherback sea turtle (*Caretta caretta*) are listed under the provisions of the Endangered Species Act of 1973 (hawksbill sea turtle and leatherback sea turtle are listed as endangered, while the green sea turtle [Caribbean population] and loggerhead sea turtle are listed as threatened) (USFWS, 2010). Aerial surveys of turtles were performed from March 1984 through March 1995 along the Puerto Rican Coast. This information was summarized by Geo-Marine, Inc. (2005) in the Draft NAPR Disposal Environmental Assessment (EA). Figures 2-5 and 2-6 (reproduced from Geo-Marine, Inc., 2005) present cumulative sea turtle sightings and potential turtle nesting sites at NAPR. Significant turtle observations were made near the mouth of the Ensenada Honda, the northern shore of Pineros Island, Pelican Bay, and the Medio Mundo Passage, with the frequency of turtle observations listed as green > hawksbill > loggerhead > leatherback. No sea turtle sightings have been recorded within the region of the Ensenada Honda nearest SWMU 71.

The Puerto Rican boa (*Epicrates inornatus*) is a federally endangered species throughout its entire range (critical habitat has not been designated for this species [USFWS, 1986]). Four Puerto Rican boa sightings were reported at NAPR prior to 1999 and an additional four occurrences were reported between 2001 and 2003 (Geo-Marine, Inc., 2005). However, no boas were observed during 211 man-hours of surveys conducted within potential boa habitat in 2004 (Tolson, 2004). The Puerto Rican boa uses a variety of habitats but is most commonly found in Karst forest habitat (forested limestone hills). Based on the absence of preferred habitat, there is low probability of occurrence of this species at SWMU 71.

2.1.2.4 <u>Fish and Aquatic Invertebrates</u>

A diverse fish and invertebrate community can be found in the marine environment surrounding NAPR. This can be attributed to the varied habitats that include marine and estuarine open water habitat, mud flats, seagrass beds, and mangrove forests. The fish community is represented by stingrays, herrings, groupers, needlefish, mullets, barracudas, jacks, snappers, grunts, snooks, lizardfishes, parrotfishes, gobies, filefishes, wrasses, damselfishes, and butterflyfish (Geo-Marine, Inc., 1998). The benthic invertebrate community includes sponges, corals, anemones, sea cucumbers, sea stars, urchins, and crabs. A list of known species residing within the Ensenada Honda is not available from the literature.

2.2 <u>Previous Investigations</u>

In addition to the APA presented in the Phase I ECP Report (LANTDIV, 2004) as discussed in Section 1.2, previous investigations at SWMU 71 include the Phase II ECP (NAVFAC Atlantic, 2005), and the Phase I RFI (Baker, 2009). Results and recommendations from the Phase II ECP and the Phase I RFI investigations are summarized below.

2.2.1 Phase II ECP Investigation

The Phase II ECP investigation (NAVFAC Atlantic, 2005) included the sampling and analysis of surface and subsurface soil at one location, and subsurface soil and groundwater at a second location. Analytical data from the Phase II ECP are presented in Appendix B, including comparisons to human health and ecological screening criteria used at that time. The tables also include comparison to the applicable facility background levels for metals used at that time.

Figure 1-4 shows the SWMU layout with a 2006 aerial photograph and sample locations from the ECP. The polygons from the APA have been overlaid on this and other figures to show how these historical areas related to the present site conditions. As discussed in more detail in the following paragraphs, the result of the Phase II ECP concluded that SWMU 71 has been impacted by past operations at NAPR and recommended the site be incorporated into the RCRA Corrective Action Program to permit a more detailed assessment.

One surface soil sample was collected from soil boring location 17E-01 where the former quarry was located (see Figure 1-4 for sampling locations) using a hand auger in conjunction with a stainless steel spoon from a depth of 0.0 to 1.0 foot below ground surface (bgs). Sand and rock fragments (possibly spoils from the quarry operations) were encountered, followed by solid rock. Therefore, only one subsurface soil sample was collected using a hand auger in conjunction with a stainless steel spoon, from a depth of 1.0 to 1.3 ft bgs. The soil samples from 17E-01 were submitted for Appendix IX VOCs, SVOCs, pesticides, polychlorinated biphenyls (PCBs), organo-phosphorus (OP) pesticides, chlorinated herbicides, and metals analysis.

A second boring was advanced at 17E-02, in an area where approximately 25 drums containing a tar-like substance were uncovered during the construction of the Commissary Building. Surface soil was not obtained from soil boring location 17E-02, as was originally proposed in the ECP Work Plan, (LANTDIV, 2004) because the surface soil from this location was considered to have been disturbed by the construction activity and therefore, unrepresentative of releases to the surface at the site. Subsurface soil samples were collected from soil boring location 17E-02 from two-foot intervals (i.e., 1 to 3 feet bgs, 3 to 5 feet bgs, etc.), down to groundwater (20 feet bgs), where the boring was terminated (24 feet bgs). Fill material consisting of mainly gravel was encountered to a depth of 8 feet bgs, followed by gravel in a clay matrix. Fuel odor and staining was observed within the depth range of approximately 5 feet to 10 feet bgs. Subsurface soil samples from soil boring location 17E-02 were screened in the field using a Flame Ionization Detector (FID) and Photoionization Detector (PID). Based on the FID/PID results from 17E-02, two subsurface soil samples from sampling intervals of 1.0 to 3.0 feet bgs and 7.0 to 9.0 feet bgs were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, OP pesticides, chlorinated herbicides, and metals.

Groundwater was encountered at a depth of 20 feet bgs at soil boring location 17E-02 and a temporary monitoring well was installed for groundwater sample collection. The groundwater sample was submitted for Appendix IX VOCs, SVOCs, pesticides/PCBs, OP-pesticides, chlorinated herbicides, and dissolved metals analysis.

The following constituents exceeded their USEPA Region III Residential Risk Based Concentrations (RBC) for soil or their USEPA Region III Tap Water RBCs for groundwater as follows:

- Surface soil
  - vanadium

- Subsurface soil
  - dibenzo(a,h)anthracene
  - benzo(a)pyrene
  - arsenic
  - chromium
  - vanadium

- Groundwater
  - naphthalene
  - vanadium

It should also be noted that none of the concentrations of the metals exceeded the established background concentrations for NAPR at that time. No PCBs, OP-pesticides, or chlorinated herbicides were detected in any medium.

From the detections of PAHs and metals in both the soil and groundwater at the Quarry Disposal Site, it was concluded that is was likely that previous activities have impacted the environment at this site. Therefore, the ECP report recommended further investigation of the media at this SWMU.

2.2.2 Phase I RFI

The objective of the Phase I RFI was to determine whether contaminants are present from past disposal activities at SWMU 71, from the completion of field activities (surface and subsurface soil and groundwater sampling) as described in the USEPA approved Phase I RFI Work Plan (Baker, 2008).

A summary of the samples collected during the Phase I RFI is as follows:

- Four surface soil samples were submitted for laboratory analysis of Appendix IX VOCs, SVOCs (including low-level polynuclear aromatic hydrocarbons [PAHs]), pesticides, and metals.

- Eleven subsurface soil samples from six boring locations (71SB03, 71SB04, 71SB05, 71SB06, 71SB10, and 71SB11) were submitted for laboratory analysis of VOCs, SVOCs (including LLPAHs), pesticides, total petroleum hydrocarbons (TPH) diesel range organics (DRO)/gasoline range organics (GRO), and metals.

- Three groundwater samples from soil boring locations 71SB04, 71SB06, and 71SB08. These samples were submitted for laboratory analysis of VOCs, SVOCs (including low-level PAHs), pesticides, TPH DRO/GRO, and metals. Due to the low groundwater volume at 71SB04, only VOCs, SVOCs, and GRO were submitted for analysis. No groundwater sample was collected from 71SB05 because of low yield.

Analytical results and comparison to applicable screening criteria and Base background used at that time are presented in Appendix C.

Zinc was detected at 71SB01 in surface soil above the Base background and ecological screening values. Benzo(a)pyrene, benzo(a)anthracene, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene were detected above residential and/or industrial Screening Levels (SLs) at 71SB02 and 71SB03 in the surface soil in the northern portion of the SWMU, within the 1977 and 1985 polygon features that were previously identified as the former quarry and a fill and disposal area.

Cobalt was detected at a concentration above its residential SL and ecological and background screening values in the subsurface soil at 71SB03-01. Cobalt also exceeded both SLs and background for subsurface soil at three locations in the southern portion of the SWMU (71SB04, 71SB06, and 71SB11). Arsenic exceeded its residential and/or industrial SL and background concentration for subsurface soil at three locations (71SB04, 71SB05, and 71SB06).

Dissolved vanadium in groundwater exceeded Regional Tap Water SL background and the ecological screening value at 71SB06 and background and both the ecological and tap water screening values in sample 71GW08 and the duplicate 71GW08D.

It is evident from the analyses of samples obtained during the Phase I RFI investigation that surface soil, subsurface soil, and groundwater have been impacted from past activities that have occurred on SWMU 71. A Full RFI Investigation was recommended in order to delineate PAHs and metals in the surface and subsurface soil and metals in groundwater, define the likely source area(s), and determine the potential for unacceptable risks to human health and/or the environment. The Phase I RFI Report was approved by the USEPA on August 11, 2008.

2.3 Preliminary Conceptual Models for Human and Ecological Receptors

Preliminary conceptual models for ecological and human receptors are presented on Figures 2-7 and 2-8, respectively. The conceptual models outline potential sources of contaminants, transport pathways, exposure media, potential exposure routes, and receptor groups. Specific components of each preliminary conceptual model (i.e., source areas, transport pathways, and exposure pathways and routes) are discussed in the sections that follow.

2.3.1 Preliminary Conceptual Model for Ecological Receptors

The numerous drums represent potential source areas for the release of chemicals to surface soil. Contaminated surface soil also represents a potential source for the release of chemicals to subsurface soil and downgradient surface soil. Contaminated surface and subsurface soil represents a potential source for the release of chemicals to groundwater. Finally, the ditch and culvert system represents a potential source for the release of chemicals to an adjacent estuarine wetland system. Transport pathways associated with these source areas are identified and discussed in Section 2.3.1.1 below.

2.3.1.1 Transport Pathways

A transport pathway describes the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. As depicted on Figure 2-7, potential mechanisms for contaminant transport from potential source areas at SWMU 71 are believed to include the following:

- Overland transport of chemicals with surface soil via surface runoff to downgradient surface soil.

- Leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport with groundwater to the estuarine wetland surface water and sediment.

- Uptake by biota from surface soil and subsurface soil and trophic transfer to upper trophic level receptors.

Based on the findings of the Phase I RFI, leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport with groundwater to the estuarine wetland surface water and sediment is considered a potentially complete but insignificant transport pathway. As discussed in Section 2.2.1, groundwater was encountered 20 feet bgs at SWMU 71 during the advancement of soil borings conducted as part of the Phase I RFI investigation (Baker, 2009). With the exception of vanadium, chemicals were not detected in SWMU 71 groundwater collected during the Phase I RFI field investigation at concentrations greater than ecological screening values and upper limit of the mean (ULM) background concentrations. Vanadium was detected within the dissolved fraction of three Phase I RFI groundwater samples at concentrations greater than the ecological- and background-based screening value (23 µg/L in 71GW06, 53 µg/L in 71GW08, and 56 µg/L in 71GW08D). However, vanadium was not detected within the total recoverable fraction of groundwater, nor was this metal detected in SWMU 71 surface soil and subsurface soil at concentrations greater than ULM background concentrations (Baker, 2009). These data indicate that elevated vanadium concentrations within the dissolved fraction of groundwater are not site-related. The proposed groundwater sampling program presented in Section 3.3 will provide additional analytical data that will used to further evaluate this potential transport pathway.

2.3.1.2 Exposure Pathways and Routes

An exposure pathway links a source of contamination with one or more receptors via exposure to one or more media. Requirements for a complete exposure pathway are listed below.

- A source of contamination must be present
- Release and transport mechanisms must be available to move the contaminants from the source to an exposure point
- An exposure point must exist where ecological receptors could contact affected media
- An exposure route must exist whereby the contaminant can be taken up by ecological receptors

As depicted on Figure 2-7, potentially complete and significant exposure pathways exist at SWMU 71. An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. Exposure pathways and routes applicable to SWMU 71 are discussed in the paragraphs that follow.

The most common exposure routes are dermal contact, direct uptake, ingestion, and inhalation. Terrestrial plants may be exposed to chemicals present in surface soil directly through their root surfaces during water and nutrient uptake. Terrestrial invertebrates may be exposed to chemicals in soil through dermal adsorption and ingestion. Much of the toxicological data available for terrestrial invertebrates are based upon *in situ* studies that represent both pathways. Invertebrates also represent a link between surface soil and upper trophic level receptors through food web transfer. As such, they are often 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) 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. These exposure routes, where applicable, are depicted on Figure 2-7. Their relative importance depends in part on the chemical being evaluated. For chemicals having the potential to bioaccumulate (e.g., PCBs), the greatest exposure to wildlife is likely to be from the ingestion of prey. For chemicals having a limited potential to bioaccumulate (e.g., aluminum), the exposure of wildlife to chemicals is likely to be greatest through the direct ingestion of abiotic media, such as surface soil.

Direct ingestion of drinking water is only considered if the salinity of a potential drinking water source is less than 15 parts per thousand (ppt), the approximate toxic threshold for wildlife receptors (Humphreys, 1988). As evidenced by Figures 2-1 and 2-3, there are potential drinking water sources within or contiguous to SWMU 71. Therefore, ingestion of surface water is considered an exposure pathway for upper trophic level terrestrial receptors.

Certain potential exposure pathways and/or routes depicted on Figure 2-7 are considered insignificant relative to other pathways due to low potential for exposure and low levels of relevant contaminants.

For example, dermal exposures are not considered significant relative to ingestion exposures for upper trophic level receptors. This is supported by evidence outlined in Suter II et al. (2000) and the USEPA (2003), including the general fate properties of the majority of compounds detected in soil (e.g., low affinity for dermal uptake), the low potential exposure frequency and duration, and the protection offered by feathers, fur, and scales to avian, mammalian, and reptilian receptors. In addition, literature reviews indicate that dermal exposures to wildlife from classes of chemicals known or suspected to be of concern via dermal adsorption (e.g., VOCs, organophosphorous pesticides, and petroleum compounds) are often overestimated in laboratory studies (where feathers/fur are removed) and do not represent realistic exposure scenarios (USEPA, 2003). Furthermore, though burrowing reptiles (which would be expected to experience the most significant exposure) may inhabit the upland vegetative units at and contiguous to SWMU 71, chemicals known or suspected to be of concern via dermal adsorption are not known to be associated with historical activities at the site (e.g., organophosphorous pesticides) or were detected at a low frequency and concentration (e.g., VOCs). Moreover, USEPA (2003) calculated that the contribution of dermal exposures to the total dose received by terrestrial receptors to be 0.5 percent or less and therefore omitted the dermal pathway from consideration during ecological soil screening level (Eco-SSL) development. Incidental ingestion of surface soil during feeding and preening activities by upper trophic level receptors, as well as direct contact exposures by lower trophic level terrestrial receptors (i.e., invertebrates) are considered significant exposure routes (see Figure 2-7).

Inhalation of gaseous chemicals and chemicals adhered to particulate matter (e.g., soil) also is considered insignificant relative to ingestion pathways. As described above for dermal exposures, this approach is consistent with Suter II et al. (2000) and USEPA (1997 and 2003), which recognize the relatively small contribution the inhalation pathway contributes to exposure estimates. For example, USEPA (2003) estimates that the expected contribution to the total dose associated with the inhalation pathway is less than 0.01 percent for particulates and less than 1.0 percent for volatiles. Furthermore, inhalation of gaseous chemicals that have volatilized from surface soil is likely to be insignificant given that VOCs were generally detected at a low frequency and concentration during the Phase I RFI field investigation.

2.3.2 Preliminary Conceptual Model for Human Health Receptors

Development of a preliminary conceptual model of potential exposure is critical in evaluating exposures for the human receptors. The preliminary conceptual model considers all reasonable current and future potential exposures and media of concern under a no-action scenario. The following four elements are considered to determine whether a complete exposure pathway is present (USEPA, 1989):

- A source and potential mechanism of chemical release
- An environmental retention or transport medium
- A point of potential human contact with the contaminated medium; and
- A human exposure route (e.g., ingestion) at the contact point

SWMU 71, the former Quarry Disposal Site, encompasses 23 acres of land and is the current location of the Commissary Building (Building 2394) and an adjacent parking lot. The history of this site is presented in Section 1.2. Current site conditions are presented in Section 2.1. Analytical results from the Phase II ECP and Phase I RFI indicated that surface and subsurface soils sampled at various locations contained various metals (i.e., vanadium, arsenic, chromium, and cobalt) and PAHs (i.e., benzo(a)pyrene, benzo(a)anthracene, dibenz(a,h)anthracene, indeno(1,2,3-c,d) pyrene) which exceeded Base background concentrations, residential and/or industrial SLs. The soil samples were collected where the former quarry was located as well as in an area where drums containing a tar-like substance were uncovered during construction of the Commissary Building. Sampling results from one groundwater monitoring well during the Phase II ECP showed that groundwater sampled approximately 20 feet bgs contained concentrations of naphthalene and vanadium. However, the concentrations of vanadium detected were less than the established background concentrations at NAPR at the time of sampling. Subsequent sampling of groundwater during the Phase I RFI showed that only dissolved vanadium exceeded its respective Tap Water Regional SL.

Based on the available information on SWMU 71, potential migration, exposure pathways, and human receptors have been identified (Figure 2-8). Potential contaminant release mechanisms from affected media include storm water runoff, leaching to underlying groundwater, and advective transport in the direction of groundwater flow. Potentially affected media at SWMU 71 may include one or more of the following: surface soil, subsurface soil, and groundwater.

Based on the findings of the Phase I RFI, leaching of chemicals from surface soil and/or subsurface soil by infiltrating precipitation and transport to groundwater is considered a potentially complete, but insignificant transport pathway. With the exception of select metals (i.e., arsenic, chromium, cobalt, and vanadium) and two PAHs (i.e., benzo(a)pyrene and dibenzo(a,h) anthracene), the majority of the chemicals analyzed were not detected in subsurface soil samples collected three feet bgs to 24 feet bgs at concentrations greater than the Residential and/or Industrial Regional SLs and background concentrations. The only constituents detected in groundwater above the Tap Water Regional SL during these investigations were dissolved vanadium and naphthalene which were less than the established background concentrations at the time of the sampling. These data indicate that the vertical migration of chemicals with infiltrating precipitation is minimal and not likely reaching the water table. It is noted that if groundwater is encountered during the advancement of soil borings conducted as part of the proposed Full RFI field investigation, monitoring wells will be installed and groundwater samples will be collected (see Section 3.2).

Current exposure scenarios for SWMU 71 as presented in Figure 2-8 are as follows:

- Trespassers (adults and youth [6 to 16 years])

Future exposure scenarios for SWMU 71 as presented in Figure 2-8 are as follows:

- Industrial/commercial workers
- Construction workers
- Trespassers (adults and youth [6 to 16 years])
- Residents (adult and young children [1 to 6 years])

Future residential land use is conservatively assumed for SWMU 71, although it is not likely given expected future land use. A future residential exposure scenario is included for conservative comparison with other exposure scenarios and to estimate the worst-case exposure conditions. The preliminary conceptual model will be refined, as necessary, following data collection. This will serve as the basis for the exposure pathway evaluations in the baseline Human Health Risk Assessment (HHRA).

3.0 SCOPE OF INVESTIGATION

In choosing sample locations, consideration was given to site topography, site features, and reported operational features of the facility, as well as the analytical results of the Phase I RFI. Sampling locations may be adjusted in the field as necessary. Any deviations to this work plan will be noted in the field notebooks by the sampling team.

The sampling and analytical program for this investigation is summarized in Table 3-1. The sampling locations for SWMU 71 are shown on Figures 3-1(upper area) and 3-2 (lower area). Sampling will consist of 19 surface soil samples from 19 soil borings, fifty-five subsurface soil samples from thirty-seven soil borings and nine groundwater samples (five from new monitoring wells to be installed and four from existing wells).

3.1 Soil Sampling and Analysis Program

The rationale for the soil sampling locations and the analytical program is discussed below. At each proposed location, it is anticipated that one surface soil sample (0 to 1 ft bgs) and one or two subsurface soil samples (depending on site topography and geology) will be collected until there is refusal to bedrock, unless otherwise indicated in the discussion below.

Upper Area

- Four soil borings (71SB12 through 71SB15) will be installed in the upper northeastern portion of the site surrounding Phase I sample location 71SB01 (See Figure 3-1). The samples will be placed approximately 20 to 25 feet radially away from 71SB01. Surface soil (0 to 1 ft bgs) and shallow (1 to 3 ft bgs) subsurface soil samples will be collected from each location (for a total of four surface and four subsurface soil samples) and analyzed for Appendix IX metals to delineate zinc detected in the surface soil above Base background and ecological screening criteria. Borings should be advanced to refusal, but it is unlikely that borings will be advanced further than 3 ft bgs. During the Phase I RFI, sample 71SB01 was advanced to refusal to a depth of 2.1 ft bgs where bedrock was encountered.

- Twelve soil boring locations (71SB16 through 71SB27) will be advanced surrounding Phase I RFI sample locations 71SB02, 71SB03, and Phase II ECP sample location 17E-01 in the upper northwestern portion of the site within the 1977 and 1985 historical polygon features where the former quarry was located. Surface soil (0 to 1 ft bgs) samples collected will be analyzed for low-level PAHs to delineate PAH detections above residential and industrial screening levels (SLs) in 71SB02 and Regional SLs in 71SB03. Twelve shallow (1 to 3 ft. bgs) subsurface soil samples will be collected and analyzed for Appendix IX low-level PAHs to determine if PAHs detected in surface soils are also present in the subsurface soils and Appendix IX metals to delineate cobalt detected above Base background, industrial and residential SLs in subsurface soil. Borings should be advanced to refusal, but it is unlikely that any boring will be advanced further than 3 ft bgs. During the Phase II ECP and the Phase I RFI, when borings were advanced, refusal was encountered at depths ranging from 1.2 ft bgs to 2.5 ft bgs. However, if one or more of the soil borings are advanced beyond 3 ft bgs, attempts will be made to collect a subsurface soil sample from the 3 to 5 foot bgs depth interval.

- Three samples (71SB28 through 71SB30) will be collected around the boundary of the 1985 polygon. Surface (0 to 1 ft bgs) and shallow subsurface (1 to 3 ft bgs) soil samples will be collected from each location for a total of three surface and three shallow subsurface soil samples) and analyzed for Appendix IX low-level PAHs and metals (total) to delineate the boundaries of the polygon.

Lower Area

- One soil boring (71SB31) will be advanced south of Phase I RFI sample location 71SB11 to delineate cobalt detected in subsurface soil (7.0 to 9.0 ft bgs) above Base background, residential and industrial SLs and ecological screening criteria. Two subsurface soil samples will be collected, one from the 1 to 3 ft bgs interval and the other from 9.0 to 11.0 ft bgs (or from an alternative interval) based on the discretion of the field geologist. Subsurface soil samples will be collected and analyzed for Appendix IX metals. Surface soil samples will not be collected because the areas surrounding the Commissary Building and parking lot are assumed to be disturbed to a depth of about one foot bgs because of construction activities, thus surface soil is unrepresentative of surface soil at the SWMU that may have had a release from SWMU activities.

- Four soil borings (71SB32 through 71SB35) will be advanced surrounding Phase I RFI sample location 71SB04 and subsurface soil will be collected and analyzed for Appendix IX metals. Two subsurface soil samples will be collected per boring, one from the 1 to 3 ft bgs interval and the other from 7.0 to 9.0 ft bgs (or from an alternative interval) based on the discretion of the field geologist. Arsenic and cobalt were detected above background and residential SLs in subsurface soil (at 7-9 ft bgs) from Phase I RFI sample location 71SB04. No surface soil is proposed for sampling in this area because construction activities are likely to have rendered surface soil unrepresentative of the SWMUs potential releases to the surface.

- Four soil borings (71SB36 through 71SB39) will be advanced surrounding Phase I RFI sample location 71SB05 and subsurface soil will be collected and analyzed for Appendix IX metals and Appendix IX low-level PAHs. There were exceedances of arsenic above residential and industrial SLs, and Base background screening values from both subsurface samples (1 to 3 ft bgs and 7 to 9 ft bgs) at Phase I RFI sample location 71SB05. Benzo(a)pyrene was also detected in the two subsurface soil samples collected at 71SB05 above Regional SLs. No surface soil is proposed for sampling in this area because construction activities are likely to have rendered surface soil unrepresentative of the SWMUs potential releases to the surface. Two subsurface soil samples will be collected per boring, one from the 1 to 3 ft bgs interval and the other from the depth of suspected contamination, at the discretion of the field geologist.

- Four soil borings (71SB40 through 71SB43) will be advanced around Phase I RFI sample location to delineate 71SB06 subsurface exceedances of arsenic and cobalt (above Base background, residential, and industrial screening values). Subsurface soil samples collected from these borings will be analyzed for Appendix IX Metals. No surface soil is proposed for sampling in this area because construction activities are likely to have rendered surface soil unrepresentative of the SWMUs potential releases to the surface. Two subsurface soil samples per boring will be collected per boring, one from the 1 to 3 ft bgs interval and the other from the depth of suspected contamination (7 to 9 ft bgs), at the discretion of the field geologist.

- Five soil borings (71SB44 through 71SB48) will be advanced primarily for monitoring well installation to delineate dissolved vanadium detected in groundwater samples from Phase I RFI sample locations 71SB06 and 71SB08 above Base background, Tap Water Regional

SLs, and ecological screening criteria. Two upgradient samples are proposed (71SB44 and 71SB45) to determine the potential source of the vanadium. Samples 71SB46 through 71SB48 are proposed south of the Commissary Building. These sample locations are downgradient of Phase I RFI sample locations 71SB06 and 71SB08 which had dissolved vanadium detected above screening values. These sample locations are intended to provide confirmation that elevated concentrations of dissolved vanadium are not present in the groundwater south and southeast of Langley Drive. Ten subsurface soil samples (two subsurface soil samples from each boring, one from the 1 to 3 ft bgs interval and the other from the interval immediately above the groundwater surface) will be collected from each boring. Subsurface soil samples will be analyzed for Appendix IX metals.

Sample matrices for this investigation are provided as Table 3-1 and Table 3-2. The proposed sample locations for the Full RFI at SWMU 71 (as well as the previous sample locations of the Phase I RFI) are shown on Figures 3-1 and 3-2.

The surface and subsurface soil samples will be obtained with a 66DT Geoprobe® drill rig capable of direct push and augering. Soil samples will be collected continuously from the ground surface to Geoprobe refusal using a 4-foot long MacroCore® Sampler to advance the borings. It is expected that some soil borings will be advanced no more than 5 feet in the upper area of the SWMU where the former rock quarry is located since the Phase I RFI investigation boring logs showed refusal ranging from 1.2 ft bgs to 2.5 ft bgs. Depth to refusal for Phase I RFI soil boring 71SB10 was at 12 ft bgs, this sample was located around 25 feet north of the parking lot to the east of the swale at the SWMU. In the lower area (the area south of the parking lot and Commissary Building) it is expected that soil borings will be advanced to no more than 30 feet bgs since during the Phase I RFI, refusal was encountered ranging from 16 feet bgs to 29 feet bgs. In the Phase I RFI, the unconsolidated materials encountered consisted of primarily clay and gravel with some sand until weathered bedrock was encountered. During soil boring installation, care will be taken to achieve maximum recovery so that a good stratigraphic profile can be developed. A boring log will be maintained as specified in the Final RCRA Facility Investigation Management Plans (Baker, 1995).

At sample locations in the upper area where the quarry was located, one surface soil and one shallow subsurface soil sample (1 to 3 feet bgs) will be collected. At locations south of the parking lot and Commissary building, two subsurface soil samples will be collected per boring, one from the 1 to 3 ft bgs interval and the other from the depth of suspected contamination (based on PID measurements, olfactory and/or at the discretion of the field geologist). Surface soil samples will not be collected in the southern portion of the SWMU because the areas surrounding the Commissary Building and parking lot are assumed to be disturbed to a depth of at least one foot bgs because of construction activities. Surface and subsurface soil samples will be collected following the procedures in Final RCRA Facility Investigation Management Plans (Baker, 1995). All pertinent sampling information such as soil description (e.g., color and texture), sample number and location, presence or absence of soil discoloration, and the time of sample collection will be recorded in the field logbook.

The surface and subsurface soil samples collected from the boring locations will be analyzed for Appendix IX low-level PAHs and total metals, as shown on Table 3-1. Table 3-2 presents a summary of the QA/QC samples that will be collected as part of this investigation. All analyses at the laboratory will be performed using current methodologies as presented in Table 3-3.

Soil borings will be labeled consecutively (beginning with 71SB12 and ending with 71SB48) in a manner consistent with previous sample designations at NAPR. Extensions to the sample identification will reflect the depth at which the sample was obtained. For the purposes of this work plan, two-foot discrete depths will be used. Sample identification extensions will follow the pattern shown below.

71SB17-00 - SMWU 71
71SB17-00 - Soil Boring
71SB17-00 - Soil boring location identifier
71SB17-00 –Depth designator - 0 to one foot bgs (surface soil) sampling interval

Subsurface soil samples will be designated as follows:

71SB17-01 - First subsurface sampling interval, 1 to 3 feet bgs
71SB17-02 - Second subsurface sampling interval, 3 to 5 feet, bgs and so on.

However, 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. Tracking numbers for each shipment will be forwarded to the data manager for assisting in verification of receipt of samples by the laboratory.

All analysis at the laboratory will be performed using current methods as presented in Table 3-3. All analytical work conducted on the mainland of the United States of America must be certified by a Puerto Rico licensed chemist. The specific laboratory and third party validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date. The validation services to be provided will include 100 percent validation of the data in accordance with the most recent USEPA guidelines.

3.2 Monitoring Well Installation

A monitoring well will be installed and a groundwater sample will be collected from the five soil boring locations (71SB44 through 71SB48) presented on Figure 3-2.

Monitoring wells will be installed in soil borings advanced with the 66DT Geoprobe rig and will consist of a 4-1/4 inch diameter, Schedule 40 polyvinyl chloride (PVC), riser with a 10-foot screen. The well construction materials will be installed through the hollow-stem augers (HSAs), casing, or in an open borehole. For the monitoring wells, the well screen and bottom cap will be set at the bottom of the borehole. The screen will be connected to threaded, flush-joint, riser. An expandable, water tight locking cap or slip-cap with a vent hole will be placed at the top of the casing. The annular space around the well screen will be backfilled with a well-graded, fine to medium sand as the HSAs or casing are being withdrawn from the borehole. The sand will extend to approximately two feet above the top of the screened interval. The thickness of the sand above the screened interval may be reduced if the well is too shallow to allow for placement of adequate sealing material. An approximate two foot thick bentonite seal (minimum of 6 inches for very shallow wells) will be placed above the sand pack. If bentonite pellets or chips are used, they will be sized appropriately given the well and borehole diameter and placed in a careful manner that will prevent bridging. The bentonite will be hydrated with potable water, as necessary. The annular space above the bentonite seal will be backfilled with cement/bentonite grout to prevent surface and near subsurface water from infiltrating into the screened groundwater monitoring zone. The grout will consist of five to ten percent (by dry weight) of bentonite powder and seven gallons of potable water per 94-pound bag of Portland cement. The depth intervals of all backfilled materials will be measured with a weighted measuring tape to the nearest 0.1-foot and recorded in the field logbook.

Wells will be provided with 2 to 3 feet of "stickup" above ground surface. Steel protective casing will be placed over the riser and surrounded by a concrete pad. The pad will be a minimum of 2 feet by 2 feet (length x width) and 6 inches in thickness (with 2 inches set into the ground outside the casing), and extending 2 feet bgs inside the annular space around the well. If water table conditions prevent having a 24-inch thick bentonite seal, the concrete pad depth in the annular space around the well may be decreased. Wells 71SB45 and 71SB46 will be completed with a “flush" manhole type cover (all wells installed in the Phase I RFI had a flush mount cover because they were located in high traffic areas). All stickup wells will be equipped with a locking cap installed on the protective steel casing.

Each monitoring well will be developed using overpumping or pumping and surging methods after allowing suitable time for the cement/bentonite grout to cure (typically a minimum of 24 hours). The purpose of well development is to restore the permeability of the formation which may have been reduced by the drilling operations and to remove fine-grained materials that may have entered/accumulated in the well or filter pack. The wells will be developed until the discharged water runs relatively clear of fine-grained materials. It should be noted that the water in some wells does not clear with continued development. Typical limits placed on well development may include any one or a combination of the following:

- Clarity of water based on visual determination

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

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

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

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

A record of the well development will be completed to document the development process. Monitoring well installation and well development procedures will be conducted following the procedures in <u>Final RCRA Facility Investigation Management Plans</u> (Baker, 1995).

3.3 Groundwater Sampling and Analysis

Nine groundwater samples will be collected from the five monitoring wells installed during this investigation and from the four existing wells installed during the Phase I RFI (71SB04, 71SB05, 71SB06, and 71SB08) and submitted to the laboratory for analysis of Appendix IX metals (total and dissolved), as shown on Table 3-1.

The groundwater will be sampled using a bladder pump and a low-flow sampling technique, if the well exhibits sufficient yield, with the pump intake set at the lowest practicable point in the well. Appendix D includes a detailed description of the USEPA Region II low flow sampling technique. Field parameters of pH, temperature, turbidity, conductivity, dissolved oxygen, and oxidation-reduction potential will be obtained with appropriate instrumentation during sampling if enough volume of groundwater is present. During the Phase I RFI the well installed at boring 71SB05 was dry, and 71SB04 had low yield. If there is low yield again at these wells, procedures for sampling low yield wells will be followed which is included as part of the low flow sampling technique in

Appendix D. It should be noted that a bladder pump is appropriate for both shallow wells, as well as those installed up to 30 feet. The groundwater samples will be placed into appropriate laboratory supplied containers.

The groundwater sample designations will be from the soil boring locations proposed, as shown on Figure 3-1 and Table 3-1. Sample identification extensions will follow the pattern below.

71GW01 - SMWU 71 Sample
71GW01 - GW = Groundwater Sample
71GW01 - Monitoring well location identifier (corresponding to the associated soil boring)

Samples will be packed in ice and shipped next day air to the analytical laboratory. Tracking numbers for each shipment will be forwarded to the data manager for assisting in verification of receipt of samples by the laboratory.

All analysis at the laboratory will be performed using current methods as presented in Table 3-3. All analytical work conducted on the mainland of the United States of America must be certified by a Puerto Rico licensed chemist. The specific laboratory and third party validator, as well as a certified licensed chemist from Puerto Rico, will be determined at a later date. The validation services to be provided will include 100 percent validation of the data in accordance with the most recent USEPA guidelines.

3.4 Quality Assurance/Quality Control Samples

QA/QC requirements for this investigation will consist of trip blanks, equipment rinsates, field blanks, field duplicates, and matrix spike/matrix spike duplicates (MS/MSDs). These samples are listed on Tables 3-1 and 3-2. The Data Quality Assurance Project Plan presented in the Final RCRA Facility Investigation Management Plans (Baker, 1995) will be used as guidance for the sampling and analysis plan.

3.4.1 Trip Blanks

Trip blank samples are required to accompany the samples submitted to the laboratory for VOC analysis. Since VOCs are not included as part of this investigation, trip blank samples are not required to be collected.

3.4.2 Equipment Rinsates

Equipment rinsate samples are collected from analyte-free water rinse of decontaminated equipment. Equipment rinsate blanks will be collected on a daily basis and submitted to the laboratory for analysis. The total number of equipment rinsate samples to be collected will be dependent on the length of the field investigation. The results from the blanks will be used to determine if the sampling equipment was free of contamination. The equipment rinsate samples are analyzed for the same parameters as the related samples. These samples will be associated with the surface and subsurface soil and groundwater sampling equipment. The samples will be obtained from macro core liners for collection of surface and subsurface soil, and from the teflon-lined polyethylene tubing and bladder pump used during the collection of groundwater. These samples will be analyzed as presented in Table 3-2.

3.4.3 Field Blanks

Field blank samples consist of the source water used in equipment decontamination procedures. At a minimum, one field blank for each source of water must be collected and analyzed for the same parameters as the related samples. It is anticipated that two different sources of water (i.e., store-bought distilled water, and laboratory-grade deionized water) will be utilized for this investigation as shown in Table 3-2.

3.4.4 Field Duplicates

Field duplicate samples of the surface soil, subsurface soil, and groundwater will be collected during the same time the corresponding environmental sample is collected. One duplicate sample will be collected at a frequency of 10 percent of environmental samples collected per media as shown on Table 3-1.

3.4.5 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 as shown on Table 3-1.

3.5 Other Investigation Considerations

During the investigation, the following activities will be performed:

- Clearing and Grubbing
- Utility Clearance
- Groundwater Elevation Measurement
- Slug Tests
- Investigation Derived Waste (IDW) Management
- Decontamination
- Surveying
- Health and Safety Procedures
- Chain of Custody
- Vegetation and Biota Documentation

Each of these activities is discussed in the following sections.

3.5.1 Clearing and Grubbing

It may be necessary for site clearing to be performed so the Geoprobe 66DT rig can gain access to delineate the suspected contamination. One day of site clearing will be performed by the direct push subcontractor or other subcontractor if required.

3.5.2 Utility Clearance

The party conducting the implementation of this work plan will be responsible for clearing all proposed soil boring and well locations.

3.5.3 Groundwater Elevation Measurements

Depth to groundwater measurement will be collected from each of the newly installed monitoring wells shortly after installation and prior to and after well development and sampling activities. All groundwater level measurements will be recorded in the field log books. Prior to sampling, a synoptic set of static water levels will be recorded in order to obtain data to more accurately interpret the groundwater flow direction at SWMU 71.

3.5.4 Slug Tests

Slug tests will be performed at the five newly installed monitoring wells following completion of well installation, development and groundwater sampling. The purpose of the slug tests is to estimate the hydraulic conductivity of the saturated zone in the immediate vicinity of the monitoring well by measuring the aquifer response to a change in static conditions induced by introduction or removal of a slug of known volume from the well. A 1.5-inch diameter slug (approximately 1.5-inches in diameter by 3 foot long) will be used. Each test will be initiated by measuring the static water level in the well. A pressure transducer attached to a computerized data logger will then be installed in the well and the water levels will be allowed to re-equilibrate. The slug will be introduced into the well and the change in the water level over time will be measured for the falling head portion of the slug test. Measurements will continue until water levels stabilize at which point the slug will be removed from the well and the change in water level will again be measured until the water levels stabilizes for the rising head portion of the test.

3.5.5 Investigation Derived Waste Management

Two IDW samples will be collected during this investigation. One composite aqueous sample will be collected from all drums containing decontamination fluid (from sampling equipment and drill rig), and one composite soil sample will be collected from all drums containing drill cuttings. It should be noted that whenever possible, the soil cuttings from the subsurface soil sampling will be placed back into the boring from which they came, unless contamination is indicated as determined by the field manager based on PID measurements and visual/olfactory signs of contamination. If contamination is indicated, the soil cuttings associated with that soil boring will be stored temporarily in a 55-gallon drum.

A composite soil sample will be compiled from individual discrete (grab) samples of equal volume collected from each of the 55-gallon drums of containerized IDW soil. Each individual discrete soil sample will be placed into a decontaminated stainless-steel bowl (or other appropriate container) and thoroughly homogenized prior to filling the appropriate laboratory provided sample containers. The soil samples will be analyzed for toxicity characteristic leaching procedure (TCLP) metals, and reactivity, corrosivity, and ignitability (RCI) as shown in Table 3-2, using methods presented in Table 3-3.

The IDW composite water samples will be collected similar to the soil composite sample with the exception that the individual discrete (grab) samples of equal volume collected from each of the 55-gallon drums of containerized IDW water will be placed directly into the appropriate laboratory provided sample containers. The water samples will be analyzed for Appendix IX metals and RCI as shown in Table 3-2, using methods presented in Table 3-3.

These samples will provide the necessary data to be able to dispose of the generated IDW at an appropriate disposal facility. Upon completion of the field program, the drums will be moved and stored per the direction of Public Works Department (PWD) personnel. The soil and water IDW will be removed and disposed from the site by an approved vendor upon receipt and review of the IDW sample analytical data.

3.5.6 Decontamination

All reusable (non-dedicated and non-disposable) soil sampling and monitoring well installation equipment (i.e. augers, bits, split-spoon samplers, etc.), will be decontaminated between each sampling location in accordance with the Final RCRA Facility Investigation Management Plans (Baker, 1995). The drill rigs will be decontaminated before arriving at the site and before leaving the site. The remaining contaminant-free sampling equipment and materials utilized during this investigation will be disposable.

3.5.7 Surveying

All sampling locations are pre-determined and presented on a figure prior to entering the field. This figure will be loaded into a field-grade global positioning system (GPS) unit for locating purposes in the field. After sample locations are determined in the field and flagged, a surveyor (subcontractor) will obtain and record the locations of each sample. Traditional survey equipment or survey grade GPS unit will be utilized to obtain vertical (+/- 0.01 foot) and horizontal (+/- 0.1 foot) locations and top of PVC elevations of the monitoring well(s).

3.5.8 Health and Safety Procedures

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

3.5.9 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.

A chain-of-custody form will be completed and accompany the samples for each shipment of samples in accordance with RFI Management Plans (Baker, 1995). After the samples are properly packaged, the shipping container will be sealed and prepared for shipment to the analytical laboratory.

3.5.10 Vegetation and Biota Documentation

Dominant vegetation and terrestrial biota, if any, observed in the upland vegetative community at SWMU 71 during the field activities will be documented in the field logbook and/or in a photographic log.

4.0 REPORTING

This section outlines the reporting activities that are associated with the field investigation. The Full RFI report will include the following:

- Introduction
- Background
- Physical Characteristics of Study Area
- Full RFI Activities
- Physical Results
- Analytical Results
- Conclusions and Recommendations
- References

The Full RFI report sections that will address these requirements are discussed in the following subsections.

4.1 Introduction

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

4.2 Background

This section provides the history and description of NAPR and SWMU 71. This section also includes a summary of the results of previous investigations conducted at SWMU 71.

4.3 Physical Characteristics of Study Area

This section will provide the environmental setting, including the regional and site-specific geology and hydrogeology. Regional and local climatic conditions that may be relevant to the environmental impacts of the contaminated media at the site will also be discussed, as relevant.

4.4 Full RFI Activities

This section will describe the field activities conducted to fulfill the Full RFI Work Plan objectives for the SWMU. This will include a description of the sample locations, sample collection and handling procedures, QA/QC procedures, and analytical methods used. This section will also discuss any problems encountered including any deviations from the Work Plan and problem resolution.

4.5 Physical Results

This section will present the current site conditions at SWMU 71 at the time of the Full RFI Investigation. The site geology and hydrogeology, as ascertained from the soil boring program and other information will also be discussed.

4.6 Analytical Results

This section will present analytical results of the environmental media and interpretation of the data, to characterize the contaminants present in the soil and groundwater.

4.6.1 Media-Specific Ecological Screening Values

The sections that follow describe the various criteria and toxicological benchmarks that will be used as ecological-based media-specific screening values for chemicals in soil (surface and subsurface soil) and groundwater. The media-specific screening values, listed in Tables 4-1 (soil) and 4-2 (groundwater) represent conservative exposure thresholds above which adverse ecological effects may occur.

4.6.1.1 Soil Screening Values

The literature-based toxicological benchmarks selected as screening values for chemicals in surface soil (0.0 to 1.0-foot depth interval) and subsurface soil (1.0 to 3.0-foot depth interval) are summarized in Table 4-1. USEPA ecological soil screening levels (Eco-SSLs) (documentation available at http://www.epa.gov/ecotox/ecossl/) were preferentially used as soil screening values.

Eco-SSLs have been developed for eight receptor groups: plants, soil invertebrates, avian herbivores, avian ground insectivores, avian carnivores, mammalian herbivores, mammalian ground insectivores, and mammalian carnivores. For a given chemical, the lowest Eco-SSL value for plants, soil invertebrates, avian herbivores, avian ground insectivores, avian carnivores, mammalian herbivores was selected as the soil screening value. Eco-SSLs for mammalian ground insectivores were not considered for soil screening value development because there are no mammalian ground insectivores in Puerto Rico (mammalian insectivores are limited to aerial insectivores [i.e., bats]). As discussed in Guidelines for Developing Ecological Soil Screening Levels (USEPA, 2005), aerial and arboreal insectivorous birds and mammals were excluded from Eco-SSL development because they are considered inappropriate (i.e., they do not have a clear or indirect exposure pathway link to soil [indirect exposure pathways involve ingestion of prey that have direct contact with soil]). Eco-SSLs for mammalian carnivores also were not considered for soil screening value development because there are no carnivorous mammals on Puerto Rico. With the exception of bats, the terrestrial mammals represented by potentially complete exposure pathways are limited to nonindigenous, nuisance species (i.e., Norway rat, black rat, and mongoose) that have been implicated in the decline of native reptilian and bird populations (Mac et al., 1998 and USFWS, 1996a). Eco-SSLs for mammalian herbivores are considered appropriate for soil screening value development based on the presence of fruit-eating and nectivorous bats in Puerto Rico.

For those chemicals lacking plant, soil invertebrate, avian herbivore, avian ground insectivore, avian carnivore, or mammalian herbivore Eco-SSLs, the literature-based toxicological benchmarks listed below were used as soil screening values.

- Toxicological thresholds for earthworms and microorganisms (Efroymson et al., 1997a)
- Toxicological thresholds for plants (Efroymson et al., 1997b)

Identical to the Eco-SSLs, when more than one screening value was available for a given chemical from Efroymson et al. (1997a and 1997b), the lowest value was selected as the soil screening value. For those chemicals lacking plant, soil invertebrate, avian herbivore, avian ground insectivore, avian carnivore, or mammalian herbivore Eco-SSL and a toxicological threshold from Efroymson et al.

(1997a and 1997b), the following literature-based values, listed in their order of decreasing preference, were used as soil screening values:

- Toxicity reference values for plants and invertebrates listed in USEPA (1999)
- Soil standards developed by the Ministry of Housing, Spatial Planning and Environment (MHSPE, 2000)
- Canadian soil quality guidelines (agricultural land use) developed by the Canadian Council of Ministers of the Environment (CCME, 2007)

Soil screening values based on MHSPE soil standards represent an average of the target and intervention soil standards. Values are based on a default organic carbon content of 2.0 percent, which represents the minimum adjustment range (2.0 to 30.0 percent). Soil screening values developed by CCME soil quality guidelines were given the lowest preference since many are background-based interim guidelines that do not represent effect-based concentrations.

4.6.1.2 Groundwater Screening Values

Puerto Rico Water Quality Standards (WQS) for Class SB coastal and estuarine waters listed in the Puerto Rico Water Quality Standards Regulation amended March 31, 2010 (PREQB, 2010) were preferentially used as groundwater screening values. For those chemicals lacking a Puerto Rico WQS, groundwater screening values were identified from the following information listed in their order of decreasing preference:

- Chronic saltwater National Ambient Water Quality Criteria (NAWQC) (USEPA, 2009a)
- Final Chronic Values (FCVs) for saltwater contained in ECO Update Volume 3, Number 2 (USEPA, 1996)
- USEPA Region 4 chronic screening values for saltwater contained in Ecological Risk Assessment (ERA) Bulletins – Supplement to Risk Assessment Guidance for Superfund (RAGS) (USEPA 2001)
- Minimum chronic toxicity test endpoints (No Observed Effect Concentration [NOEC], No Observed Effect Level [NOEL], and Maximum Acceptable Toxicant Concentration [MATC] values) for marine species reported in the ECOTOX Database System (USEPA, 2007a)
- Chronic Lowest Observable Effect Levels (LOELs) for saltwater contained in National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQUIRTs) (Buchman, 2008) with a safety factor of 10 (Wentsel et al., 1996).

The order of preference was selected based on their level of protection. For example, FCVs would be expected to offer a greater degree of protection than a single species NOEC, MATC, or LOEL since their derivation considers a larger toxicological database. In the absence of the above-mentioned FCVs, USEPA Region 4 chronic screening values, chronic test endpoints, and chronic LOELs, screening values were derived from the acute literature values listed below:

- Acute LOELs for saltwater contained in NOAA SQUIRTs (Buchman, 2008)

- Acute toxicity test endpoints (NOEC, NOEL, LOEL, Lowest Observed Effect Concentration [LOEC], median lethal concentration [LC_{50}], and median effective concentration [EC_{50}] values) for marine species contained in the ECOTOX Database System (USEPA, 2007a)

- LC_{50} values for marine species contained in Superfund Chemical Matrix (USEPA, 2004)

Chronic-based screening values were extrapolated from acute NOEC, NOEL, LOEC, LOEL, LC_{50}, and EC_{50} values as follows:

- An uncertainty factor of 30 was used to convert an acute NOEC or NOEL a chronic-based screening value (Wentsel et al., 1996)

- An uncertainty factor of 50 was used to convert an Acute LOEC or LOEL to a chronic-based screening value (Wentsel et al., 1996)

- An uncertainty factor of 100 was used to convert an EC_{50} or LC_{50} to a chronic-based screening value (Wentsel et al., 1996)

When acute toxicity data were used to extrapolate a chronic screening value, NOECs/NOELs were given preference over LOECs/LOELs, LOECs/LOELs were given preference over LC_{50} and EC_{50} values, and EC_{50} values were given preference over LC_{50} values. When more than one value was available from the literature for a given test endpoint (e.g., NOEC), the minimum value was conservatively used to extrapolate a chronic screening value.

The screening values listed in Table 4-2 for arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc are PREQB WQSs for Class SB coastal and estuarine waters and/or USEPA saltwater NAWQC (i.e., continuous criteria concentrations [CCCs]). Although PREQB WQSs for all metals are expressed only as total recoverable concentrations, USEPA saltwater CCC values for many metals, including arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc, can be expressed as total recoverable or dissolved concentrations (USEPA, 2009a). Because the SWMU 71 groundwater samples will be analyzed for total recoverable and dissolved metals, the total recoverable PREQB WQSs and USEPA CCC values listed in Table 4-2 for these nine metals were converted to dissolved screening values by multiplying the total recoverable values by the following conversion factors (USEPA, 2009a):

- Arsenic: 1.000
- Cadmium: 0.994
- Chromium: 0.993
- Copper: 0.830
- Lead: 0.951
- Mercury: 0.850
- Nickel: 0.990
- Selenium: 0.998
- Zinc: 0.946

Antimony, barium, beryllium, cobalt, silver, thallium, tin, and vanadium lack screening values expressed as dissolved concentrations. For these eight metals, total recoverable screening values will be conservatively used to screen the dissolved analytical data.

For those chemicals lacking saltwater toxicological thresholds and literature values, surface water screening values were identified or developed from the literature-based freshwater values listed below in their order of decreasing preference.

- PREQB WQSs for Class SD surface waters (PREQB, 2010)
- Chronic freshwater NAWQC (USEPA, 2009a)
- FCVs for freshwater contained in ECO Update Volume 3, Number 2 (USEPA, 1996)
- USEPA Region 4 chronic screening values for freshwater contained in Ecological Risk Assessment Bulletins – Supplement to RAGs (USEPA 2001) and USEPA Region 5 ecological screening levels (ESLs) (http://www.epa.gov/reg5rcra/ca/ESL.pdf) (USEPA, 2003)
- Minimum chronic toxicity test endpoints (NOEC, NOEL, and MATC values) for freshwater species reported in the ECOTOX Database System (USEPA, 2007a)
- Great Lakes basin Tier II Secondary Chronic Values (SCVs) listed in the Great Lakes Initiative Toxicity Data Clearinghouse (http://www.epa.gov/gliclearinghouse/) (USEPA, 2007b)
- Chronic LOELs for freshwater contained in NOAA SQUIRTs (Buchman, 2008) with a safety factor of 10 (Wentsel et al., 1996).

Identical to saltwater-based values, the order of preference was selected based on their level of protection. It is noted that USEPA Region 4 and Region 5 screening values were given equal preference. When a value was available from both sources, the minimum value was selected as the surface water screening value. In the absence of the above-mentioned freshwater FCVs, freshwater USEPA Region 4 and Region 5 screening values, freshwater chronic test endpoints, and freshwater chronic LOELs, screening values were derived from the acute literature values listed below:

- Acute LOELs for freshwater contained in NOAA SQUIRTs (Buchman, 2008)
- Acute toxicity test endpoints (NOEC, NOEL, LOEL, LOEC, LC_{50}, EC_{50} values) for freshwater species contained in the ECOTOX Database System (USEPA, 2007a)
- LC_{50} values for freshwater species contained in Superfund Chemical Matrix (USEPA, 2004)

Chronic-based screening values were extrapolated from acute NOEC, NOEL, LOEC, LOEL, LC_{50}, and EC_{50} values using the safety factors from Wentsel et al. (1996) identified above.

In some cases, acute and/or chronic saltwater LOELs for chemical classes (e.g., PAHs) were available from the literature (Buchman, 2008). A saltwater LOEL based on a chemical class was used as the groundwater screening value only if that chemical lacked freshwater and saltwater literature-based benchmarks and/or toxicity test endpoints.

4.6.2 Human Health Screening Values

Applicable human health criteria for soils include USEPA Regional Industrial SLs and USEPA Regional Residential SLs (USEPA, 2010), and the upper limit of means background levels (inorganics only) (Baker, 2010). The USEPA Regional Industrial and Residential SLs selected as screening values for chemicals in surface soil (0 to 1-foot depth interval) and subsurface soil (1 to 10-foot depth interval) are summarized in Table 4-3. Applicable human health criteria for groundwater are USEPA Regional Tap Water SLs, Federal Drinking Water Maximum Contaminant Levels (MCLs) (USEPA, 2009b), and any inorganic background levels present in the groundwater at NAPR (Baker, 2010). The USEPA Regional Tap Water SLs and Federal MCLs selected as screening values for chemicals in groundwater are summarized in Table 4-3.

4.6.2.1 Regional Screening Levels

The Regional SLs were developed by the USEPA to support the risk assessment screening process, while improving consistency across USEPA Regions and incorporating updated guidance in a timely manner. The Regional SL Table was developed with the Department of Energy's Oak Ridge National Laboratory under an Interagency Agreement as an update of the individual screening tables that had previously been maintained by Regions 3, 4, and 9. As recommended by the USEPA, these Regional SLs are to replace all other screening values.

The Regional SL Table contains risk-based screening levels derived from standardized equations (representing ingestion, dermal contact, and inhalation exposure pathways), calculated using the latest toxicity values, default exposure assumptions and physical and chemical properties. The SLs contained in the Regional SL Table are generic; they are calculated without site-specific information. Regional SLs should be viewed as Agency guidelines, not legally enforceable standards. The SLs for potentially carcinogenic chemicals are based on a target Incremental Lifetime Cancer Risk (ILCR) of $1x10^{-06}$. The SLs for noncarcinogens are based on a target hazard quotient (HQ) of 1.0. However, in order to account for cumulative risk from multiple chemicals in a medium, the noncarcinogenic SLs will be divided by a factor of ten, yielding a target HQ of 0.1. For potential carcinogens, the toxicity criteria applicable to the derivation of SL values are oral Cancer Slope Factors (CSFs) and inhalation unit risk (IUR) factors; for noncarcinogens, they are chronic oral reference doses (RfDs) and inhalation reference concentrations (RfCs). These toxicity criteria are subject to change as more updated information and results from the most recent toxicological/epidemiological studies become available. The Regional SL Table is updated periodically to reflect such changes. It should be noted that the most recent Regional SL Table update available at this time is from May 2010 (USEPA, 2010). However, the most current version available at the time the Full RFI is completed will be used for screening purposes.

4.6.2.2 Federal Drinking Water MCLs and Puerto Rico WQS

Federal Drinking Water MCLs are enforceable standards for public water supplies promulgated under the Safe Drinking Water Act and are designed for the protection of human health. MCL Goals are calculated based on laboratory or epidemiological studies and apply to drinking water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with a lifetime exposure (70-year lifetime) of an average adult (70 kilograms [kg]) consuming 2 liters of water per day. MCLs consider both the MCL Goal and the technical feasibility of removing the contaminant from the public water supply. Accordingly, MCLs are established as close to the MCL Goal as technically feasible (USEPA, 2009b).

Puerto Rico WQS for Class SG (groundwater intended for use as a source of drinking water supply and agricultural uses including irrigation) listed in the Puerto Rico Water Quality Standards

Regulation amended March 31, 2010 (PREQB, 2010) are also included as groundwater screening values. The more stringent of the Federal MCL or PR WQS is used as the screening value.

4.6.3 Background Screening Values

For a given medium (i.e., surface soil, subsurface soil, and groundwater), analytical data for inorganic chemicals exceeding one or more of the screening values (human health or ecological) will be compared to NAPR background screening values (i.e., ULM background concentrations), as presented in Table 4-4. The ULM background concentrations used in the evaluations are those derived from the inorganic data sets contained in the Revised Final II Summary Report for Environmental Background Concentrations of Inorganic Compounds (Baker, 2010). The ULM background concentrations, as well as the ecological and human health screening values, will be compared to the Full RFI analytical data to determine if the proposed sampling effort delineated the extent of soil contamination detected during the Phase I RFI.

4.7 Conclusions and Recommendations

Information from the physical and analytical results (nature and extent of contamination) will be synthesized into conclusions regarding site conditions. Recommendations will be made from these conclusions as to whether a Corrective Measures Study (CMS) is needed or the SWMU can proceed toward corrective action complete. If the conclusions from the Full RFI indicate exceedances of human health and/or ecological screening values and background screening values, then the Full RFI Report will recommend moving the SWMU to a CMS with the preparation of a Draft CMS Work Plan. A HHRA and ERA will be conducted as part of the CMS and the CMS Work Plan will present the specific methodology that will be employed for conducting these assessments.

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 Geographic Information System (GIS) system currently residing on the NAPR project team web site. The data that is loaded onto the NAPR website is validated, and validation qualifiers are included on the website. Before the data files are uploaded to the website, the hard copy of the validation reports are checked against the validated electronic data files. Baker will also provide updates of current activities associated with this project in the RCRA Quarterly Progress Report for NAPR.

4.8 References

Source material used in the development of the Full RFI Report will be documented in the References section of the report.

5.0 SCHEDULE

A schedule for the implementation of this Work Plan, and follow-up reports for the Full RFI for SWMU 71, is provided as Figure 5-1. It should be noted that this schedule is dependent upon EPA review time. Many other factors can also extend the schedule such as 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 EPA's comments are to be incorporated.

6.0 SITE MANAGEMENT

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

6.1 Project Team Responsibilities

Mr. Mark Kimes, P.E, Activity 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 Navy BRAC Project Management Office (SE), Navy Technical Representative (NTR), Mr. Mark Davidson. Mr. John Mentz will administer overall QA/QC for this project.

The field activities of this project will consist of one field team managed by the Site Manager (to be determined). The Site Manager's responsibilities include directing the field team and subcontractors. Mr. Rick Aschenbrenner, P.G. will direct the reporting effort associated with the field investigation, ensuring that all necessary staffing is utilized to assist in developing the Full RFI Report for SWMU 71 – Quarry Disposal Site.

6.2 Field Reporting Requirements

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

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TABLES

TABLE 2-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT NAVAL ACTIVITY PUERTO RICO
SWMU 71 – QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name (1)		
Pied-billed grebe	Red-billed tropicbird	Brown pelican (2)
Brown booby	Magnificent frigatebird	Great blue heron
Louisiana heron	Snowy egret	Great egret
Striated heron	Little blue heron	Cattle egret
Least bittern	Yellow-crowned night heron	Black-crowned night heron
White-cheeked pintail	Blue-winged teal	American widgeon
Red-tailed hawk	Osprey	Merlin
Clapper rail	American coot	Caribbean coot
Common gallinule	Piping plover (3)(4)	Semipalmated plover
Black-bellied plover	Wilson's plover	Killdeer
Ruddy turnstone	Black-necked stilt	Whimbrel
Spotted sandpiper	Semipalmated sandpiper	Short-billed dowitcher
Greater yellowlegs	Lesser yellowlegs	Willet
Stilt sandpiper	Pectoral sandpiper	Laughing gull
Royal tern	Sandwich tern	Bridled tern
Least tern	Brown noddy	White-winged dove
Zenaida dove	White-crowned pigeon	Mourning dove
Red-necked pigeon	Common ground dove	Bridled quail dove
Ruddy quail dove	Caribbean parakeet	Smooth-billed ani
Yellow-billed cuckoo	Mangrove cockoo	Short-eared owl
Chuck-will's-widow	Common nighthawk	Antillean crested hummingbird
Green-throated carib	Antillean mango	Belted kingfisher

TABLE 2-1
LIST OF BIRDS REPORTED FROM OR HAVING THE POTENTIAL TO OCCUR AT NAVAL ACTIVITY PUERTO RICO
SWMU 71 – QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Common Name [1]		
Gray kingbird	Loggerhead kingbird	Stolid flycatcher
Caribbean elaenia	Purple martin	Cave swallow
Barn swallow	Northern mockingbird	Pearly-eyed thrasher
Red-legged thrush	Black-whiskered vireo	American redstart
Parula warbler	Prairie warbler	Yellow warbler
Magnolia warbler	Cape May warbler	Black-throated blue warbler
Adelaide's warbler	Palm warbler	Black and white warbler
Ovenbird	Northern water thrush	Bananaquit
Striped-headed tanager	Shiny cowbird	Black-cowled oriole
Greater Antillean grackle	Yellow-shouldered blackbird [2]	Hooded mannikin
Yellow-faced grassquit	Black-faced grassquit	Least sandpiper
Western sandpiper	Puerto Rican woodpecker	Rock dove
Puerto Rican emerald	Puerto Rican flycatcher	Pin-tailed whydah
Spice finch	Ruddy duck	Peregrine falcon
Marbled godwit	Puerto Rican lizard cuckoo	Prothonotary warbler
Green-winged teal	Orange-cheeked waxbill	Roseate tern [3][4]
Least grebe	West Indian whistling duck	Puerto Rican screech owl
Puerto Rican tody	Green heron	

Notes:

(1) List of birds taken from Geo-Marine, Inc. (1998).
(2) Federally-designated endangered species.
(3) Federally-designated threatened species.
(4) Species has the potential to occur at Naval Activity Puerto Rico.

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM - ENVIRONMENTAL SAMPLES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

		Fixed Based Lab Analysis			
Media	**Sample Depth (ft bgs)**	App IX Low-Level PAHs	App IX Metals (Total)	App IX Metals (Dissolved)	**Comment**
Surface Soil Samples					
71SB12-00	0.0 - 1.0		X		
71SB12-00D	0.0 - 1.0		X		Duplicate
71SB13-00	0.0 - 1.0		X		
71SB14-00	0.0 - 1.0		X		
71SB15-00	0.0 - 1.0		X		
71SB16-00	0.0 - 1.0	X			
71SB16-00D	0.0 - 1.0	X			Duplicate
71SB16-00MS/MSD	0.0 - 1.0	X			Matrix Spike/Matrix Spike Duplicate
71SB17-00	0.0 - 1.0	X			
71SB18-00	0.0 - 1.0	X			
71SB19-00	0.0 - 1.0	X			
71SB20-00	0.0 - 1.0	X			
71SB21-00	0.0 - 1.0	X			
71SB22-00	0.0 - 1.0	X			
71SB23-00	0.0 - 1.0	X			
71SB24-00	0.0 - 1.0	X			
71SB25-00	0.0 - 1.0	X			
71SB26-00	0.0 - 1.0	X			
71SB27-00	0.0 - 1.0	X			
71SB28-00	0.0 - 1.0	X			
71SB29-00	0.0 - 1.0	X			
71SB30-00	0.0 - 1.0	X			
Subsurface Soil Samples(2)					
71SB12-XX(1)	1.0-3.0		X		
71SB13-XX(1)	1.0-3.0		X		
71SB14-XX(1)	1.0-3.0		X		
71SB15-XX(1)	1.0-3.0		X		
71SB16-XX(1)	1.0-3.0	X	X		
71SB17-XX(1)	1.0-3.0	X	X		
71SB17-XXD(1)	1.0-3.0	X	X		Duplicate
71SB17-XXMS/MSD(1)	1.0-3.0	X	X		Matrix Spike/Matrix Spike Duplicate
71SB18-XX(1)	1.0-3.0	X	X		
71SB19-XX(1)	1.0-3.0	X	X		

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM - ENVIRONMENTAL SAMPLES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

		Fixed Based Lab Analysis			
Media	**Sample Depth (ft bgs)**	App IX Low-Level PAHs	App IX Metals (Total)	App IX Metals (Dissolved)	**Comment**
Subsurface Soil Samples[2]					
71SB20-XX[1]	1.0-3.0	X	X		
71SB21-XX[1]	1.0-3.0	X	X		
71SB22-XX[1]	1.0-3.0	X	X		
71SB23-XX[1]	1.0-3.0	X	X		
71SB24-XX[1]	1.0-3.0	X	X		
71SB25-XX[1]	1.0-3.0	X	X		
71SB26-XX[1]	1.0-3.0	X	X		
71SB27-XX[1]	1.0-3.0	X	X		
71SB27-XXD[1]	1.0-3.0	X	X		Duplicate
71SB28-XX[1]	1.0-3.0	X	X		
71SB29-XX[1]	1.0-3.0	X	X		
71SB30-XX[1]	1.0-3.0	X	X		
71SB31-XX[1](3)	TBD		X		
71SB31-XX[1](3)	TBD		X		
71SB32-XX[1](3)	TBD		X		
71SB32-XX[1](3)	TBD		X		
71SB33-XX[1](3)	TBD		X		
71SB33-XX[1](3)	TBD		X		
71SB34-XX[1](3)	TBD		X		
71SB34-XX[1](3)	TBD		X		
71SB35-XX[1](3)	TBD		X		
71SB35-XXD[1](3)	TBD		X		Duplicate
71SB35-XXMS/MSD[1](3)	TBD		X		Matrix Spike/Matrix Spike Duplicate
71SB35-XX[1](3)	TBD		X		
71SB36-XX[1](3)	TBD	X	X		
71SB36-XX[1](3)	TBD	X	X		
71SB37-XX[1](3)	TBD	X	X		
71SB37-XX[1](3)	TBD	X	X		
71SB38-XX[1](3)	TBD	X	X		
71SB38-XX[1](3)	TBD	X	X		

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM - ENVIRONMENTAL SAMPLES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

		Fixed Based Lab Analysis			
Media	**Sample Depth (ft bgs)**	App IX Low-Level PAHs	App IX Metals (Total)	App IX Metals (Dissolved)	**Comment**
Subsurface Soil Samples(2)					
71SB39-XX(1)(3)	TBD	X	X		
71SB39-XX(1)(3)	TBD	X	X		
71SB39-XXD(1)(3)	TBD	X	X		Duplicate
71SB39-XXMS/MSD(1)(3)	TBD	X	X		Matrix Spike/Matrix Spike Duplicate
71SB40-XX(1)(3)	TBD		X		
71SB40-XX(1)(3)	TBD		X		
71SB41-XX(1)(3)	TBD		X		
71SB41-XX(1)(3)	TBD		X		
71SB42-XX(1)(3)	TBD		X		
71SB42-XX(1)(3)	TBD		X		
71SB43-XX(1)(3)	TBD		X		
71SB43-XX(1)(3)	TBD		X		
71SB44-XX(1)(3)	TBD		X		
71SB44-XX(1)(3)	TBD		X		
71SB44-XXD(1)(3)	TBD		X		Duplicate
71SB45-XX(1)(3)	TBD		X		
71SB45-XX(1)(3)	TBD		X		
71SB46-XX(1)(3)	TBD		X		
71SB46-XX(1)(3)	TBD		X		
71SB46-XXD(1)(3)	TBD		X		Duplicate
71SB46-XXMS/MSD(1)(3)	TBD		X		Matrix Spike/Matrix Spike Duplicate
71SB47-XX(1)(3)	TBD		X		
71SB47-XX(1)(3)	TBD		X		
71SB48-XX(1)(3)	TBD		X		
71SB48-XX(1)(3)	TBD		X		
Groundwater Samples					
71GW04(4)	NA		X	X	
71GW05(5)	NA		X	X	
71GW06	NA		X	X	
71GW08	NA		X	X	

TABLE 3-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM - ENVIRONMENTAL SAMPLES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

Media	Sample Depth (ft bgs)	Fixed Based Lab Analysis: App IX Low-Level PAHs	App IX Metals (Total)	App IX Metals (Dissolved)	Comment
Groundwater Samples					
71GW44	NA		X	X	
71GW44D	NA		X	X	Duplicate
71GW44MS	NA		X	X	Matrix Spike
71GW44MSD	NA		X	X	Matrix Spike Duplicate
71GW45	NA		X	X	
71GW46	NA		X	X	
71GW47	NA		X	X	
71GW48	NA		X	X	

Notes:

(1) XX - This indicates the designation for the depth interval from which the sample will be collected (i.e., 01 = 1-3ft bgs, 02 = 3-5 ft bgs, etc.). This will be established in the field.

(2) It is expected that one suburface soil sample will be collected from the 1-3 ft. bgs interval based on the depth to below 3 ft bgs in previous sample events. If a boring is able to be advanced further than 3 ft bgs, an additional subsurface soil sample will be collected and QA/QC outlined in Section 3.3 and listed on this table will be adjusted.

(3) Although two subsurface soil samples are proposed per boring, additional subsurface soil will be collected if areas of staining or other indicators of contamination are encountered at multiple depths. In this event, the number of QA/QC samples outlined in Section 3.3 and listed on this table will be adjusted.

(4) Groundwater sample will be additionally analyzed for pesticides and TPH DRO if there is sufficient volume of water to allow for sample collection.

(5) Groundwater sample will be additionally analyzed for VOCs, Low-Level PAHs, pesticides, and TPH DRO and GRO if there is sufficient volume of water to allow for sample collection.

ft bgs - feet below ground surface.
App IX - Appendix IX
NA - Not Applicable.
PAHs - Polynuclear Aromatic Hydrocarbons
TBD - To be determined in the field

VOCs - Volatile Organic Compounds
TPH - Total Petroleum Hydrocarbons
DRO - Diesel Range Organics
GRO - Gasoline Range Organics

TABLE 3-2

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM - QA/QC SAMPLES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

		Fixed Base Lab Analysis				
Sample Media	**Media**	App IX Low-level PAHs	Appendix IX Metals	Reactivity, Corrosivity and Ignitability	TCLP Metals	**Comment**
Equipment Rinsates	71ER01	X	X			Macro Core Acetate Liner
	71ER02	X	X			Macro Core Acetate Liner
	71ER03	X	X			Macro Core Acetate Liner
	71ER04	X	X			Macro Core Acetate Liner
	71ER05	X	X			Macro Core Acetate Liner
	71ER06		X			Groundwater sampling equipment
	71ER07		X			Groundwater sampling equipment
	71ER08		X			Teflon-lined polyethylene tubing
	71ER09	X	X			Macro Core Acetate Liner
	71ER10	X	X			Macro Core Acetate Liner
Field Blanks	71FB01	X	X			Store Bought Distilled Water
	71FB02	X	X			Lab Grade Deionized Water
IDW	71IDW01	X	X	X	X	Solid
	71IDW02	X	X	X		Aqueous

Notes:
App IX - Appendix IX
PAHs - Polynuclear Aromatic Hydrocarbons
TCLP - Toxicity Characteristic Leaching Procedure
IDW - Investigation Derived Waste

TABLE 3-3

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CRQLs
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Low Level Quantitation Limits*		Preparation Methods			
Appendix IX - LL SVOCs	**Water (µg/L)**	**Low Soil (µg/kg)**	**Water**	**Soil**	**Method Number**	**Method Description**
Acenaphthene	0.2	6.7	3520C	3550B	8270D	Gas Chromotography/Mass Spectrometry (GC/MS)
Acenaphthylene	0.2	6.7	3520C	3550B	8270D	GC/MS
Anthracene	0.2	6.7	3520C	3550B	8270D	GC/MS
Benzo(a)anthracene	0.2	6.7	3520C	3550B	8270D	GC/MS
Benzo(b)fluoranthene	0.2	6.7	3520C	3550B	8270D	GC/MS
Benzo(k)fluoranthene	0.2	6.7	3520C	3550B	8270D	GC/MS
Benzo(g,h,i)perylene	0.2	6.7	3520C	3550B	8270D	GC/MS
Benzo(a)pyrene	0.2	6.7	3520C	3550B	8270D	GC/MS
Chrysene	0.2	6.7	3520C	3550B	8270D	GC/MS
Dibenzo(a,h)anthracene	0.2	6.7	3520C	3550B	8270D	GC/MS
Fluoranthene	0.2	6.7	3520C	3550B	8270D	GC/MS
Fluorene	0.2	6.7	3520C	3550B	8270D	GC/MS
Indeno(1,2,3-cd)pyrene	0.2	6.7	3520C	3550B	8270D	GC/MS
1-Methylnaphthalene	0.2	6.7	3520C	3550B	8270D	GC/MS
2-Methylnaphthalene	0.2	6.7	3520C	3550B	8270D	GC/MS
Naphthalene	0.2	6.7	3520C	3550B	8270D	GC/MS
Phenanthrene	0.2	6.7	3520C	3550B	8270D	GC/MS
Pyrene	0.2	6.7	3520C	3550B	8270D	GC/MS
	Quantitation Limits*		**Preparation Methods**			
Reactivity, Corrosivity, Ignitibility	**Water (mg/L)**	**Soil (mg/kg)**	**Water**	**Soil**	**Method Number**	**Method Description**
Cyanide	1	1	9012A	9012A	9014	Titrimetric
Flashpoint/Ignitability	NA	NA	NA	NA	1010A/1030	Pensky-Martens Closed Cup Tester
pH	NA	NA	NA	NA	9040C/9045D	Electrometric
Sulfide	1	10	NA	9030B	9034	Titrimetric

Notes:

* Quantitation limits listed for soil 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. GC - Gas Chromotography
mg/kg - milligrams per kilogram. MS - Mass Spectrometry

TABLE 3-3

METHOD PERFORMANCE LIMITS
APPENDIX IX COMPOUND LIST AND CRQLs
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Inorganics	Method Number	Quantitation Limits* Water (μg/L)	Low Soil (mg/kg)	Preparation Methods Water	Soil	Method Description
Antimony	6020A	20	2.0	3005A	3050B	Inductively Coupled Plasma - Mass Spectrometry - (ICP/MS)
Arsenic	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Barium	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Beryllium	6020A	4.0	0.4	3005A	3050B	6020A ICP/MS
Cadmium	6020A	5.0	0.5	3005A	3050B	6020A ICP/MS
Chromium	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Cobalt	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Copper	6020A	20	2.0	3005A	3050B	6020A ICP/MS
Lead	6020A	5.0	0.5	3005A	3050B	6020A ICP/MS
Mercury	7470A/7471B	0.2	0.02	7470A	7471A	7470A/7471B (Cold Vapor AA)
Nickel	6020A	40	4.0	3005A	3050B	6020A ICP/MS
Selenium	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Silver	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Thallium	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Tin	6020A	10	5.0	3005A	3050B	6020A ICP/MS
Vanadium	6020A	10	1.0	3005A	3050B	6020A ICP/MS
Zinc	6020A	20	2.0	3005A	3050B	6020A ICP/MS
TCLP Metals	**Method Number**	**Quantitation Limits* Soil (μg/L)**	**Water (μg/L)**	**Preparation Methods Water**	**Soil**	**Method Description**
Arsenic	6010C (3050B/3010A)	1.0	10	NA	1311/3010A	Inductively Coupled Plasma
Barium	6010C (3050B/3010A)	1.0	10	NA	1311/3010A	Inductively Coupled Plasma
Cadmium	6010C (3050B/3010A)	0.50	5	NA	1311/3010A	Inductively Coupled Plasma
Chromium	6010C (3050B/3010A)	1.0	10	NA	1311/3010A	Inductively Coupled Plasma
Lead	6010C (3050B/3010A)	0.50	5.0	NA	1311/3010A	Inductively Coupled Plasma
Mercury	7471B/7470A	0.020	0.20	NA	1311/7470A	Cold Vapor AA
Selenium	6010C (3050B/3010A)	1.0	10	NA	1311/3010A	Inductively Coupled Plasma
Silver	6010C (3050B/3010A)	1.0	10	NA	1311/3010A	Inductively Coupled Plasma

Notes:

* Quantitation limits listed for soil 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.

mg/kg - milligrams per kilogram.

NA - Not Applicable

ICP/MS - Inductively Coupled Plasma/Mass Spectrometry

TCLP - Toxicity Characteristic Leaching Procedure

TABLE 4-1
ECOLOGICAL SOIL SCREENING VALUES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Surface Soil Screening Value	Reference	Comment
PAHs (ug/kg):			
Low molecular weight PAHs [(1)]	29,000	USEPA 2007a	Ecological soil screening level for soil invertebrates
High molecular weight PAHs [(2)]	18,000	USEPA 2007a	Ecological soil screening level for soil invertebrates
Metals (mg/kg):			
Antimony	10.0	USEPA 2005a	Ecological soil screening level for mammalian herbivores
Arsenic	18.0	USEPA 2005b	Ecological soil screening level for plants
Barium	330	USEPA 2005c	Ecological soil screening level for soil invertebrates
Beryllium	21.0	USEPA 2005d	Ecological soil screening level for mammalian herbivores
Cadmium	0.77	USEPA 2005e	Ecological soil screening level for avian ground insectivores
Chromium	26.0	USEPA 2008	Ecological soil screening level for avian ground insectivores
Cobalt	13.0	USEPA 2005f	Ecological soil screening level for plants
Copper	28.0	USEPA 2007b	Ecological soil screening level for avian ground insectivores
Lead	11.0	USEPA 2005g	Ecological soil screening level for avian ground insectivores
Mercury	0.10	Efroymson et al. 1997a	Toxicological threshold for earthworms
Nickel	38.0	USEPA 2007c	Ecological soil screening level for plants
Selenium	0.52	USEPA 2007d	Ecological soil screening level for plants
Silver	4.2	USEPA 2006	Ecological soil screening level for avian ground insectivores
Thallium	1.00	Efroymson et al. 1997b	Toxicological threshold for plants
Tin	50.0	Efroymson et al. 1997b	Toxicological threshold for plants
Vanadium	7.8	USEPA 2005h	Ecological soil screening level for avian ground insectivores
Zinc	4.6	USEPA 2007e	Ecological soil screening level for avian ground insectivores

Notes:

USEPA = United States Environmental Protection Agency
PAH = Polynuclear Aromatic Hydrocarbon
ug/kg = microgram per kilogram
mg/kg = milligram per kilogram

[(1)] Low molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds include: 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene.

[(2)] High molecular weight PAHs are defined by the USEPA (2007a) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds include: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene.

TABLE 4-1
ECOLOGICAL SOIL SCREENING VALUES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Table References:

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revisions. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revisions. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-85/R3

United States Environmental Protection Agency (USEPA). 2008. Ecological Soil Screening Levels for Chromium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-66.

USEPA. 2007a. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs) (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-78.

USEPA. 2007b. Ecological Soil Screening Levels for Copper (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-68.

USEPA 2007c. Ecological Soil Screening Levels for Nickel (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-76.

USEPA. 2007d. Ecological Soil Screening Levels for Selenium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-72.

USEPA. 2007e. Ecological Soil Screening Levels for Zinc (Interim Final). Office of Solid Waste and Emergecny Response, Washington, D.C. OSWER Directive 9285.7-73.

USEPA. 2006. Ecological Soil Screening Levels for Silver (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWEER Directive 9285.7-77.

USEPA. 2005a. Ecological Soil Screening Levels for Antimony (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61.

USEPA. 2005b. Ecological Soil Screening Levels for Arsenic (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-62.

USEPA. 2005c. Ecological Soil Screening Levels for Barium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-63.

USEPA. 2005d. Ecological Soil Screening Levels for Beryllium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-64.

USEPA. 2005e. Ecological Soil Screening Levels for Cadmium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-65.

USEPA. 2005f. Ecological Soil Screening Levels for Cobalt (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-67

USEPA. 2005g. Ecological Soil Screening Levels for Lead (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-70.

USEPA. 2005h. Ecological Soil Screening Levels for Vanadium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-75.

TABLE 4-2
ECOLOGICAL GROUNDWATER SCREENING VALUES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Surface Water Screening Value (1)	Reference	Comment (2)
Metals - Toal Recoverable Fraction (ug/L):			
Antimony	500	Buchman 2008	Proposed CCC
Arsenic	36.0	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Total recoverable Critria Continuous Concentration
Barium	16,667	USEPA 2007	Minimum acute value (96-hr NOEC for *Cyprinodon variegatus* [sheepshead minnow]) with a safety factor of 30
Beryllium	310	USEPA 2007	Minimum acute value (96-hr LC_{50} for *Fundulus heteroclitus* [mummichog]) with a safety factor of 100
Cadmium	8.85	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Total recoverable Critria Continuous Concentration
Chromium	50.4	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Criteria Continuous Concentration for hexavalent chromium
Cobalt	45.0	USEPA 2007	Minimum acute value (96-hr LC_{50} for *Nitocra spinipes* [Harpacticoid copepod]) with a safety factor of 100
Copper	3.73	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Total recoverable Critria Continuous Concentration
Lead	8.52	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Total recoverable Critria Continuous Concentration
Mercury	1.11	USEPA 2009	Total recoverable Criteria Continuous Concentration
Nickel	8.28	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Total recoverable Critria Continuous Concentration
Selenium	71.1	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Total recoverable Critria Continuous Concentration
Silver	2.24	PREQB 2010	Total recoverable Puerto Rico Water Quality Standard
Thallium	21.3	USEPA 2001	USEPA Region 4 chronic screening value
Tin	180 (3)	USEPA 2003	USEPA Region 5 ecological screening level
Vanadium	12.0 (3)	USEPA 2003	USEPA Region 5 ecological screening level
Zinc	85.6	PREQB 2010/USEPA 2009	Total recoverable Puerto Rico Water Quality Standard/Total recoverable Critria Continuous Concentration
Metals - Dissolved Fraction (ug/L):			
Antimony	500 (4)	Buchman 2008	Proposed Criteria Continuous Concentration
Arsenic	36.0	USEPA 2009	Dissolved Criteria Continuous Concentration for trivalent arsenic
Barium	16,667 (4)	USEPA 2007	Minimum acute value (96-hr NOEC for *Cyprinodon variegatus* [sheepshead minnow]) with a safety factor of 30
Beryllium	310 (4)	USEPA 2007	Minimum acute value (96-hr LC_{50} for *Fundulus heteroclitus* [mummichog]) with a safety factor of 100
Cadmium	8.8	USEPA 2009	Dissolved Criteria Continuous Concentration
Chromium	50.0	USEPA 2009	Dissolved Criteria Continuous Concentration for hexavalent chromium
Cobalt	45.0 (4)	USEPA 2007	Minimum acute value (96-hr LC_{50} for *Nitocra spinipes* [Harpacticoid copepod]) with a safety factor of 100
Copper	3.1	USEPA 2009	Dissolved Criteria Continuous Concentration
Lead	8.1	USEPA 2009	Dissolved Criteria Continuous Concentration
Mercury	0.94	USEPA 2009	Dissolved Criteria Continuous Concentration

TABLE 4-2
ECOLOGICAL GROUNDWATER SCREENING VALUES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Surface Water Screening Value (1)	Reference	Comment (2)
Metals - Dissolved Fraction (ug/L) continued:			
Nickel	8.2	USEPA 2009	Dissolved Criteria Continuous Concentration
Selenium	71.0	USEPA 2009	Dissolved Criteria Continuous Concentration
Silver	2.24 (4)	PREQB 2010	Total recoverable Puerto Rico Water Quality Standard
Thallium	21.3 (4)	USEPA 2001	USEPA Region 4 chronic screening value
Tin	180 (3)(4)	USEPA 2003	USEPA Region 5 ecological screening level
Vanadium	12.0 (3)(4)	USEPA 2003	USEPA Region 5 ecological screening level
Zinc	81.0	USEPA 2009	Dissolved Criteria Continuous Concentration

Notes:
NA = Not Available
USEPA = United States Environmental Protection Agency
µg/L = microgram per liter
(1) The values shown are marine/estuarine screening values unless otherwise noted.
(2) The safety factors applied to acute endpoints (i.e., LC_{50}, EC_{50}, NOEC, and LOEL values) and chronic endpoints (i.e., LOELs) are those recommended by Wentsel et al. (1996).
(3) The chemical lacks a marine/estuarine surface water screening value/literature-based toxicity value. The value shown is a freshwater screening value/toxicity value.
(4) The chemical lacks a screening value expressed as a dissolved concentration. The value shown is expressed as a total recoverable concentration.

Table References:

Buchman, M.F. 2008. NOAA Screening Quick Reference Tables. NOAA OR&R Report 08-1. National Oceanic and Atmospheric Administration, Office of Response

Puerto Rico Environmental Quality Board (PREQB). 2010. Puerto Rico Water Quality Standards Regulation. March 31, 2010.

Wentsel, R.S., T.W. Pa Point, M. Simini, R.T. Checkai, and D. Ludwig. 1996. Tri-Service Procedural Guidelines for Ecological Risk Assessments. Edgewood Research Aberdeen Proving Ground, MD. ADA297968.

USEPA. 2009. National Recommended Water Quality Criteria. Office of Water and Office of Science and Technology, Washington, D.C. http://www.epa.gov/waterscience/criteria/wqctable/.

TABLE 4-2
ECOLOGICAL GROUNDWATER SCREENING VALUES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Table References (continued) :

USEPA. 2007. ECOTOX User Guide: Ecotoxicology Database System. Version 4.0. http:/www.epa.gov/ecotox/. Accessed May 14, 2003, July 2, 2008, January 8, 2009, April 1, 2009, and August 28, 2009.

USEPA. 2003. USEPA Region 5 Ecological Screening Levels Table. http://www.epa.gov/reg5rcra/ca/ESL.pdf.

USEPA. 2001. Region 4 Ecological Risk Assessment Bulletins - Supplement to RQGS. Waste Management Division, Atlanta, GA. http://www.epa.gov/region04/waste/ots/ecolbul.htm.

TABLE 4-3

HUMAN HEALTH SCREENING VALUES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Regional Screening Levels Residential Soil (1)	(units)	Regional Screening Levels Industrial Soil (1)	(units)	Regional Screening Levels Tap Water (1)	(units)	USEPA MCLs/ PR WQS (2)	(units)
PAHs								
Acenaphthene	340,000 (3)	ug/kg	3,300,000 (3)	ug/kg	220 (3)	ug/L	NE	
Acenaphthylene	340,000 (3)(4)	ug/kg	3,300,000 (3)(4)	ug/kg	220 (3)(4)	ug/L	NE	
Anthracene	1,700,000 (3)	ug/kg	17,000,000 (3)	ug/kg	1,100 (3)	ug/L	NE	
Benzo(a)anthracene	150	ug/kg	2,100	ug/kg	0.029	ug/L	NE	
Benzo(b)fluoranthene	150	ug/kg	2,100	ug/kg	0.029	ug/L	NE	
Benzo(k)fluoranthene	1,500	ug/kg	21,000	ug/kg	0.29	ug/L	NE	
Benzo(g,h,i)perylene	170,000 (3)(5)	ug/kg	1,700,000 (3)(5)	ug/kg	110 (3)(5)	ug/L	NE	
Benzo(a)pyrene	15	ug/kg	210	ug/kg	0.0029	ug/L	0.2	ug/L
Chrysene	15,000	ug/kg	210,000	ug/kg	3	ug/L	NE	
Dibenzo(a,h)anthracene	15	ug/kg	210	ug/kg	0.0029	ug/L	NE	
Fluoranthene	230,000 (3)	ug/kg	2,200,000 (3)	ug/kg	150 (3)	ug/L	NE	
Fluorene	230,000 (3)	ug/kg	2,200,000 (3)	ug/kg	150 (3)	ug/L	NE	
Indeno(1,2,3-cd)pyrene	150	ug/kg	2,100	ug/kg	0.029	ug/L	NE	
1-Methylnaphthalene	22,000	ug/kg	99,000	ug/kg	2	ug/L	NE	
2-Methylnaphthalene	31,000 (3)	ug/kg	410,000 (3)	ug/kg	15 (3)	ug/L	NE	
Naphthalene	3,600	ug/kg	18,000	ug/kg	0.14	ug/L	NE	
Phenanthrene	170,000 (3)(5)	ug/kg	1,700,000 (3)(5)	ug/kg	110 (3)(5)	ug/L	NE	
Pyrene	170,000 (3)	ug/kg	1,700,000 (3)	ug/kg	110 (3)	ug/L	NE	
Metals								
Antimony	3 (3)	mg/kg	41 (3)	mg/kg	2 (2)	ug/L	5.6 (9)	ug/L
Arsenic	0.39	mg/kg	2	mg/kg	0.045	ug/L	10	ug/L
Barium	1,500 (3)	mg/kg	19,000 (3)	mg/kg	730 (2)	ug/L	2,000	ug/L
Beryllium	16 (3)	mg/kg	200 (3)	mg/kg	7 (2)	ug/L	4	ug/L
Cadmium	7 (3)	mg/kg	80 (3)	mg/kg	2 (2)	ug/L	5	ug/L
Chromium	12,000 (2)(6)	mg/kg	150,000 (3)(6)	mg/kg	5,500 (2)(6)	ug/L	100	ug/L
Cobalt	2 (3)	mg/kg	30 (3)	mg/kg	1 (3)	ug/L	NE	
Copper	310 (3)	mg/kg	4,100 (3)	mg/kg	150 (3)	ug/L	1,300	ug/L

TABLE 4-3

HUMAN HEALTH SCREENING VALUES
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Chemical	Regional Screening Levels Residential Soil (1)	(units)	Regional Screening Levels Industrial Soil (1)	(units)	Regional Screening Levels Tap Water (1)	(units)	USEPA MCLs/ PR WQS (2)	(units)
Metals (continued)								
Lead	400 (7)	mg/kg	800 (7)	mg/kg	15 (8)	ug/L	15	ug/L
Mercury	1 (3)	mg/kg	3 (3)	mg/kg	0.057 (3)	ug/L	0.05 (9)	ug/L
Nickel	150 (3)	mg/kg	2,000 (3)	mg/kg	73 (3)	ug/L	610 (9)	ug/L
Selenium	39 (3)	mg/kg	510 (3)	mg/kg	18 (3)	ug/L	50	ug/L
Silver	39 (3)	mg/kg	510 (3)	mg/kg	18 (3)	ug/L	NE	
Thallium	NE		NE		2 (8)	ug/L	0.24 (9)	ug/L
Tin	4,700 (3)	mg/kg	61,000 (3)	mg/kg	2,200 (3)	ug/L	NE	
Vanadium	0.55 (3)	mg/kg	7 (3)	mg/kg	0.26 (3)	ug/L	NE	
Zinc	2,300 (3)	mg/kg	31,000 (3)	mg/kg	1,100 (3)	ug/L	NE	

Notes:

ug/L - microgram per liter
ug/kg - microgram per kilogram
mg/kg - milligram per kilogram
USEPA - United States Environmental Protection Agency
PAH - Polynuclear Aromatic Hydrocarbon
MCL - Maximum Contaminant Level
PR - Puerto Rico
WQS - Water Quality Standards
NE - Not established

(1) USEPA Regional Screening Levels (May 2010)
(2) The more stringent of the USEPA MCL or PR WQS is listed.
(3) Noncarcinogenic Regional Screening Levels based on a target hazard quotient of 0.1 for conservative screening purposes.
(4) Value for acenaphthene used as a surrogate.
(5) Value for pyrene used as a surrogate.
(6) Value for chromium III used as a surrogate.
(7) USEPA Action Level for lead in soil.
(8) Value for MCL used as surrogate.
(9) Value designated by PREQB WQS for protection of water body for reasons of human health.

TABLE 4-4
NAPR BACKGROUND SCREENING VALUES
SWMU 71-QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

	Surface Soil (mg/kg)	Subsurface Clay (mg/kg)	Groundwater Metals (Total) ug/L	Groundwater Metals (Dissolved) ug/L
Metals	**Upper Limit of Means (x+2s)**	**Upper Limit of Means (x+2s)**	**Upper Limit of Means (x+2s)**	**Upper Limit of Means (x+2s)**
Antimony	3.17	--	12.24	11.19
Arsenic	2.65	1.59	18.89	14.03
Barium	199	220	686	260
Beryllium	0.59	0.596	2.21	5.400
Cadmium	1.02	0.54	16.62	36.42
Chromium	49.8	114.5	162.41	6.5
Cobalt	46.2	26.9	633.21	580.5
Copper	168	246	324	29
Lead	22	6.3	26.25	1.3
Mercury	0.109	0.108	0.15	0.157
Nickel	20.7	24.7	95.74	84.1
Selenium	1.48	5.94	29.88	23.92
Silver	--	--	18.31	3.67
Thallium	--	0.92	--	--
Tin	3.76	4	9.35	--
Vanadium	259	434	484.66	20.96
Zinc	115	88	547.53	360.64

Notes:
(--) - Could not be calculated (insufficient number of detections)

Reference: Baker, 2008, *Revised Final II Summary Report for Environmental Background Concentrations of* Inorganic Compounds, Naval Station Roosevelt Roads, Ceiba, Puerto Rico. February 29, 2008.

FIGURES

K:_SOUTHNAVFAC\119197 JM01\SWMU 71\Work Plan\Full RFI\CADD\111626_71RFI_01.DGN

4 0 2 4 8

1 inch = 4 miles

Baker

FIGURE 1-1
REGIONAL LOCATION MAP
SWMU 71-QUARRY DISPOSAL SITE
FULL RFI WORK PLAN

SOURCE: METRODATA, INC., 1999.

NAVAL ACTIVITY PUERTO RICO

LEGEND

SWMUs

71 – AREA TO WHICH THIS INVESTIGATION PERTAINS

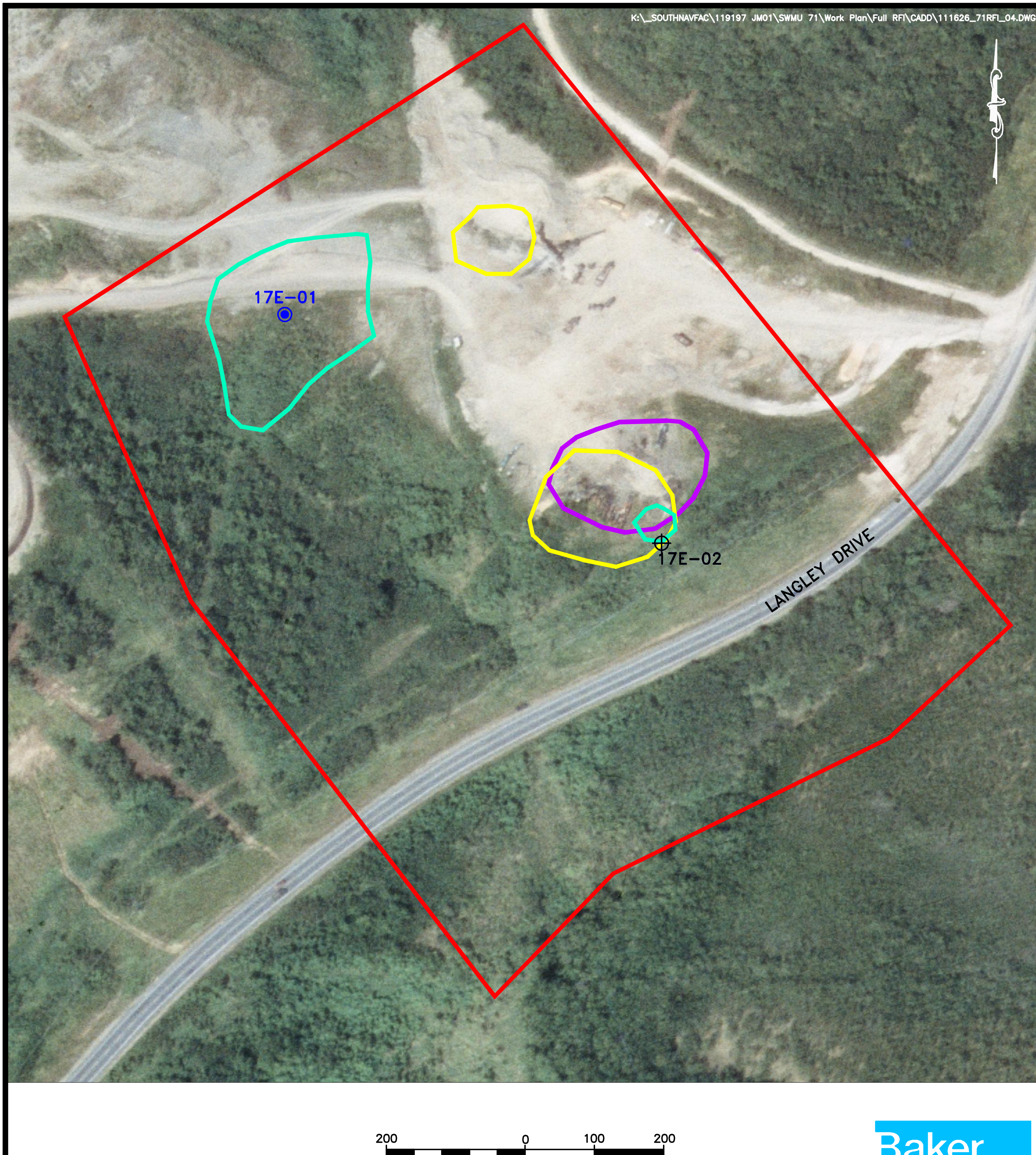
AOC D – AOCs

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

3000 0 1500 3000
1 inch = 3000 ft.

FIGURE 1-2
SWMU/AOC LOCATION MAP
SWMU 71-QUARRY DISPOSAL SITE
FULL RFI WORK PLAN

NAVAL ACTIVITY PUERTO RICO



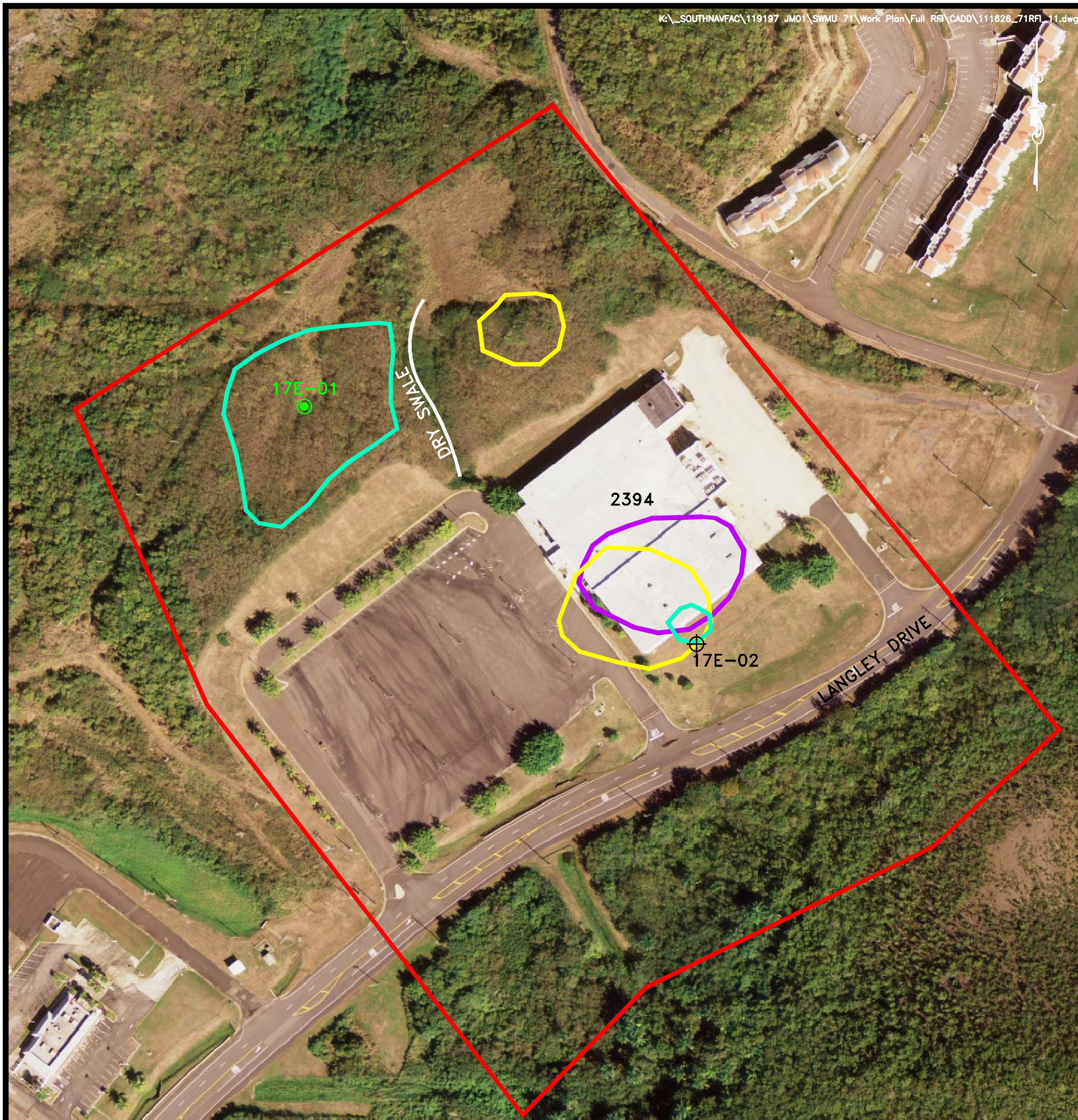
Baker

LEGEND

- 1976 APA POLYGON FEATURE
- 1977 APA POLYGON FEATURE
- 1985 APA POLYGON FEATURE
- SUBSURFACE SOIL AND GROUNDWATER SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE SOIL AND SUBSURFACE SOIL SAMPLE LOCATION (PHASE II ECP 2004)
- SWMU BOUNDARY

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

FIGURE 1-3
SITE LAYOUT AND ECP SAMPLE LOCATION MAP-
1976 AERIAL PHOTOGRAPH
SWMU 71-QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO



200 0 100 200

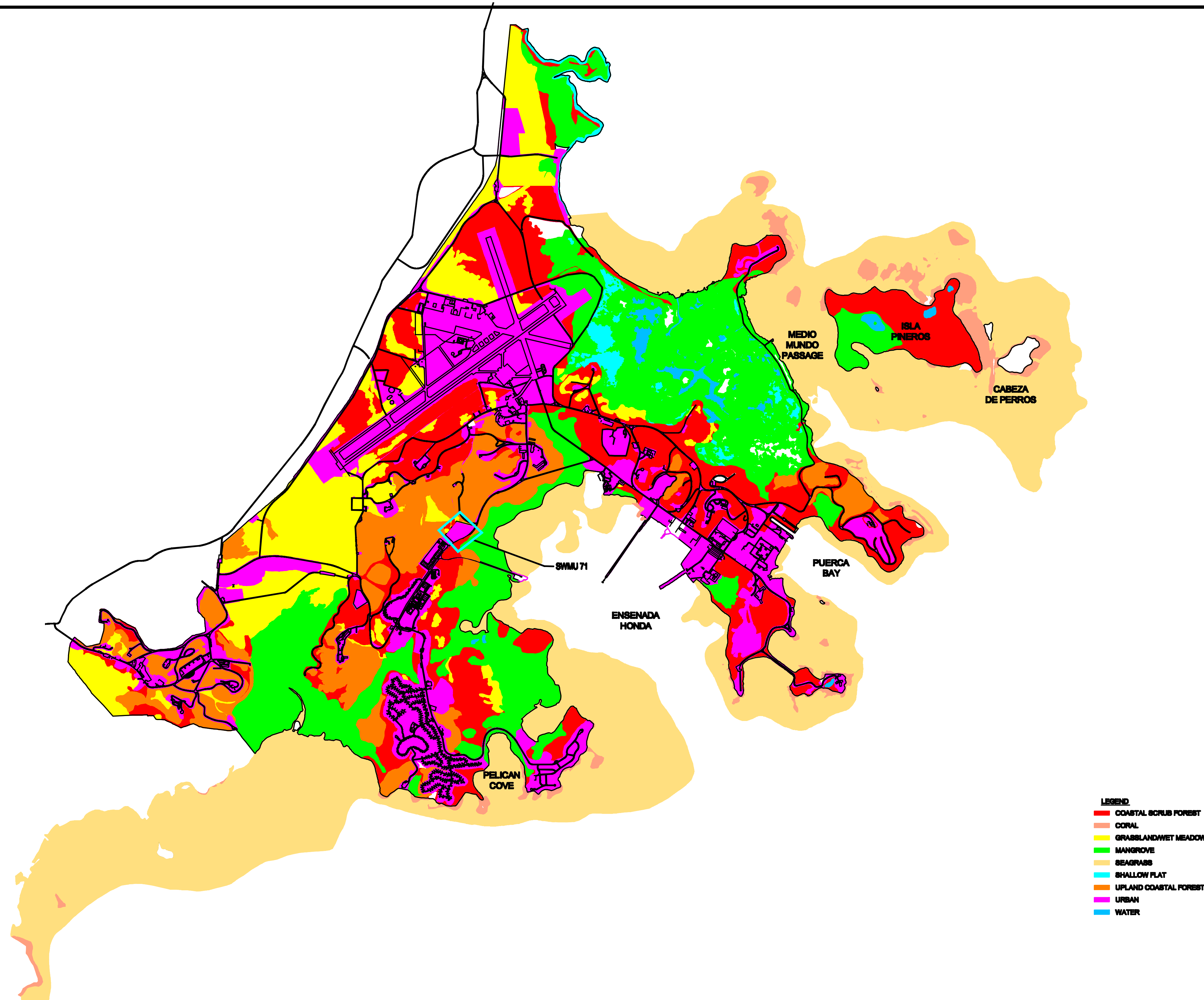
1 inch = 200 ft.

LEGEND

- 1976 APA POLYGON FEATURE
- 1977 APA POLYGON FEATURE
- 1985 APA POLYGON FEATURE
- SUBSURFACE SOIL AND GROUNDWATER SAMPLE LOCATION (PHASE II ECP 2004)
- SURFACE SOIL AND SUBSURFACE SOIL SAMPLE LOCATION (PHASE II ECP 2004)
- SWMU BOUNDARY

SOURCE: USGS, NOV. 2006.

FIGURE 1-4
SITE LAYOUT AND ECP SAMPLE LOCATION MAP-
2006 AERIAL PHOTOGRAPH
SWMU 71-QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO



SOURCE: GEO-MARINE, INC.

REVISIONS			NORTH
	DRAWN	/RRR	
	REVIEWED	MEK	
	S.O.#	119197	
	CADD#	119197_71_07.DWG	

SWMU 71-QUARRY DISPOSAL SITE
NAVAL ACTIVITY PUERTO RICO

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker

TERRESTRIAL AND AQUATIC HABITAT OCCURRING
AT NAVAL ACTIVITY PUERTO RICO
FULL RFI WORK PLAN

SCALE 1" = 2000'

DATE AUGUST 2010

FIGURE
2-1

- APPROXIMATE SWMU 71 BOUNDARY

E2SS3 – E2SS3 WETLAND BOUNDARIES (SEE FIGURE 2–3 FOR CLASSIFICATIONS)

FIGURE 2–2
WETLAND LOCATION MAP
SWMU 71–QUARRY DISPOSAL SITE
FULL RFI REPORT

NAVAL ACTIVITY PUERTO RICO

CONTOUR SOURCE: LANTDIV, FEB. 1992/1997

M - MARINE

SUBSYSTEM	CLASS	Subclass
1 - SUBTIDAL	RB - Rock Bottom	1 Bedrock 2 Rubble
	UB - Unconsolidated Bottom	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
	AB - Aquatic Bed	1 Algal 3 Rooted Vasc 5 Unknown
	RF - Reef	1 Coral 3 Worm
	OW - Open Water (unknown bottom)	
2 - INTERTIDAL	AB - Aquatic Bed	1 Algal 3 Rooted Vasc 5 Unknown
	RF - Reef	1 Coral 3 Worm
	RS - Rocky Shore	1 Bedrock 2 Rubble
	US - Unconsolidated Shore	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic

E - ESTUARINE

SUBSYSTEM	CLASS	Subclass
1 - SUBTIDAL	RB - Rock Bottom	1 Bedrock 2 Rubble
	UB - Unconsolidated Bottom	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
	AB - Aquatic Bed	1 Algal 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*
	RF - Reef	2 Mollusk 3 Worm
	OW - Open Water *(unknown bottom)*	
2 - INTERTIDAL	AB - Aquatic Bed	1 Algal 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*
	RF - Reef	2 Mollusk 3 Worm
	SB - Streambed	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
	RS - Rocky Shore	1 Bedrock 2 Rubble
	US - Unconsolidated Shore	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Dead
	EM - Emergent	1 Persistent 2 Nonpersistent
	SS - Scrub-Shrub	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*
	FO - Forested	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*

R - RIVERINE

SUBSYSTEM	CLASS	Subclass
1 - TIDAL	RB - Rock	1 Bedrock 2 Rubble
2 - LOWER PERENNIAL	UB - Unconsolidated Bottom	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
	SB - Streambed	1 Bedrock 2 Rubble 3 Cobble - Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated
3 - UPPER PERENNIAL	AB - Aquatic Bed	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*
	RS - Rocky Shore	1 Bedrock 2 Rubble
4 INTERMITTENT	US - Unconsolidated Shore	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
	OW - Open Water *(unknown bottom)*	
5 - UNKNOWN PERENNIAL	**EM - Emergent	2 Nonpersistent

L - LACUSTRINE

SUBSYSTEM	CLASS	Subclass
1 - LIMNETIC	RB - Rock Bottom	1 Bedrock 2 Rubble
	UB - Unconsolidated Bottom	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
	AB - Aquatic Bed	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*
	OW - Open Water *(unknown bottom)*	
2 - LITTORAL	RB - Rock Bottom	1 Bedrock 2 Rubble
	RS - Rocky Shore	1 Bedrock 2 Rubble
	UB - Unconsolidated Bottom	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
	AB - Aquatic Bed	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*
	US - Unconsolidated Shore	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated
	EM - Emergent	2 Nonpersistent
	OW - Open Water *(unknown bottom)*	

P - PALUSTRINE

CLASS	Subclass
RB - Rock Bottom	1 Bedrock 2 Rubble
UB - Unconsolidated Bottom	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic
AB - Aquatic Bed	1 Algal 2 Aquatic Moss 3 Rooted Vasc 4 Floating Vasc 5 *Unknown Submerg.* 6 *Unknown Surface*
US - Unconsolidated Shore	1 Cobble - Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated
ML - Moss-Lichen	1 Moss 2 Lichen
EM - Emergent	1 Persistent 2 Nonpersistent
SS - Scrub-Shrub	1 Broad-leaved Decid. 2 Needle-leaved Decid. 3 Broad-leaved Everg. 4 Needle-leaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*
FO - Forested	1 Broad-leaved Decid. 2 Needle-eaved Decid. 3 Broad-leaved Everg. 4 Needle-eaved Everg. 5 Dead 6 *Deciduous* 7 *Evergreen*
OW - Open Water *(unknown bottom)*	

MODIFIERS

WATER REGIME

	Non-Tidal		Tidal
A Temp. Flooded	H Permanently Flooded	K Artificially Flooded	*S Temporary-Tidal
B Saturated	J Intermittently Flooded	L Subtidal	*R Seasonal-Tidal
C Seasonally Flooded	K Artificially Flooded	M Irregularly Flooded	*T Semipermanent- Tidal
D Seasonally Flooded/ Well Drained	W Intermittently Flooded/ Temporary	N Regularly Flooded	*V Permanent-Tidal
E Seasonally Flooded/ Saturated	Y Saturated/Semipermanent/ Seasonal	P Irregularly Flooded	U Unknown
F Semipermanently Flooded	Z Intermittently Exposed Permanent		
G Intermittently Exposed	U Unknown		

* These water regimes are only used in tidally influenced, freshwater systems.

WATER CHEMISTRY

Coastal Halinity	Inland Salinity	pH (fresh water)
1 Hyperhaline	7 Hypersaline	a Acid
2 Euhaline	8 Eusaline	t circumneutral
3 Mixohaline	9 Mixosaline	i Alkaline
4 Polyhaline	0 Fresh	
5 Mesohaline		
6 Oligohaline		
0 Fresh		

SOIL

g Organic
n Mineral

SPECIAL

b Beaver
d partially drained/ditched
f Farmed
h Diked/Impounded
r Artificial Substrate
s Spoil
x Excavated

SOURCE: UNITED STATES, FISH AND WILDLIFE SERVICE. CLASSIFICATION OF WETLANDS AND DEEPWATER HABITATS OF THE UNITED STATES, 1985

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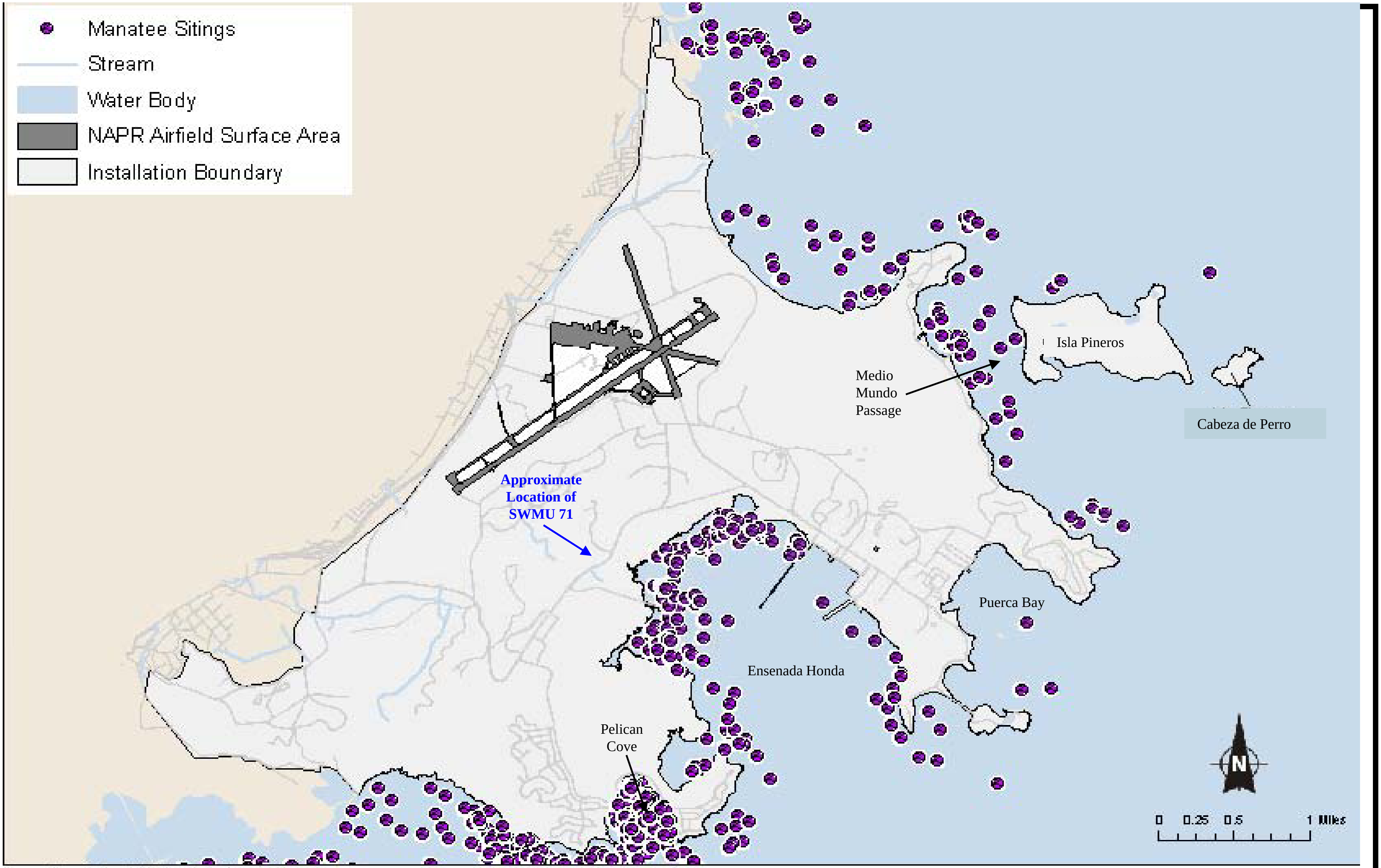
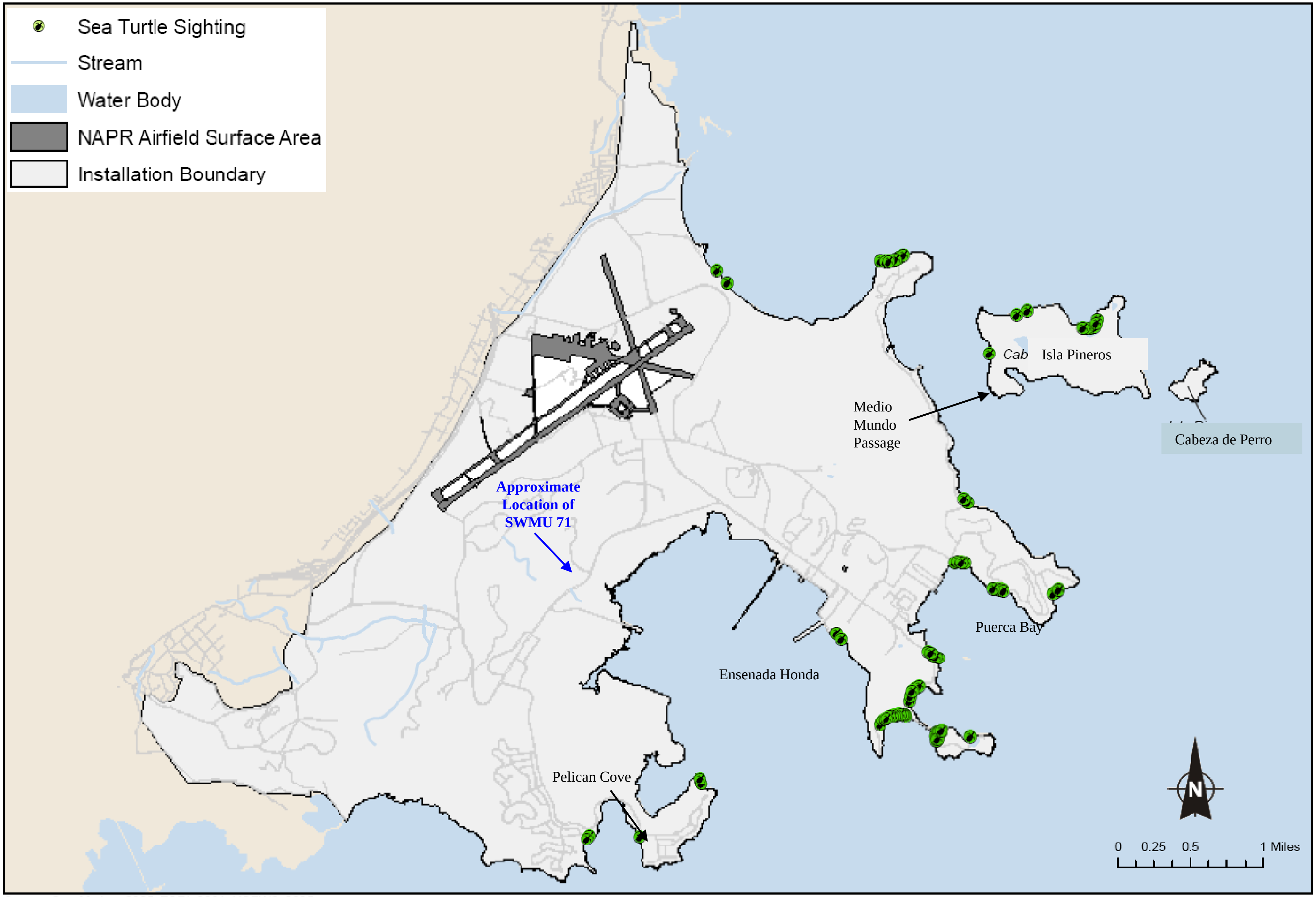
FIGURE 2-3
THE COWARDIN WETLAND CLASSIFICATION SYSTEM
SWMU 71-QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO



Source: Geo-Marine, 2005; ESRI, 2004; USFWS, 2005;

Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007.

FIGURE 2-4
HISTORICAL MANATEE SIGHTINGS IN EASTERN PUERTO RICO
SWMU 71 – QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

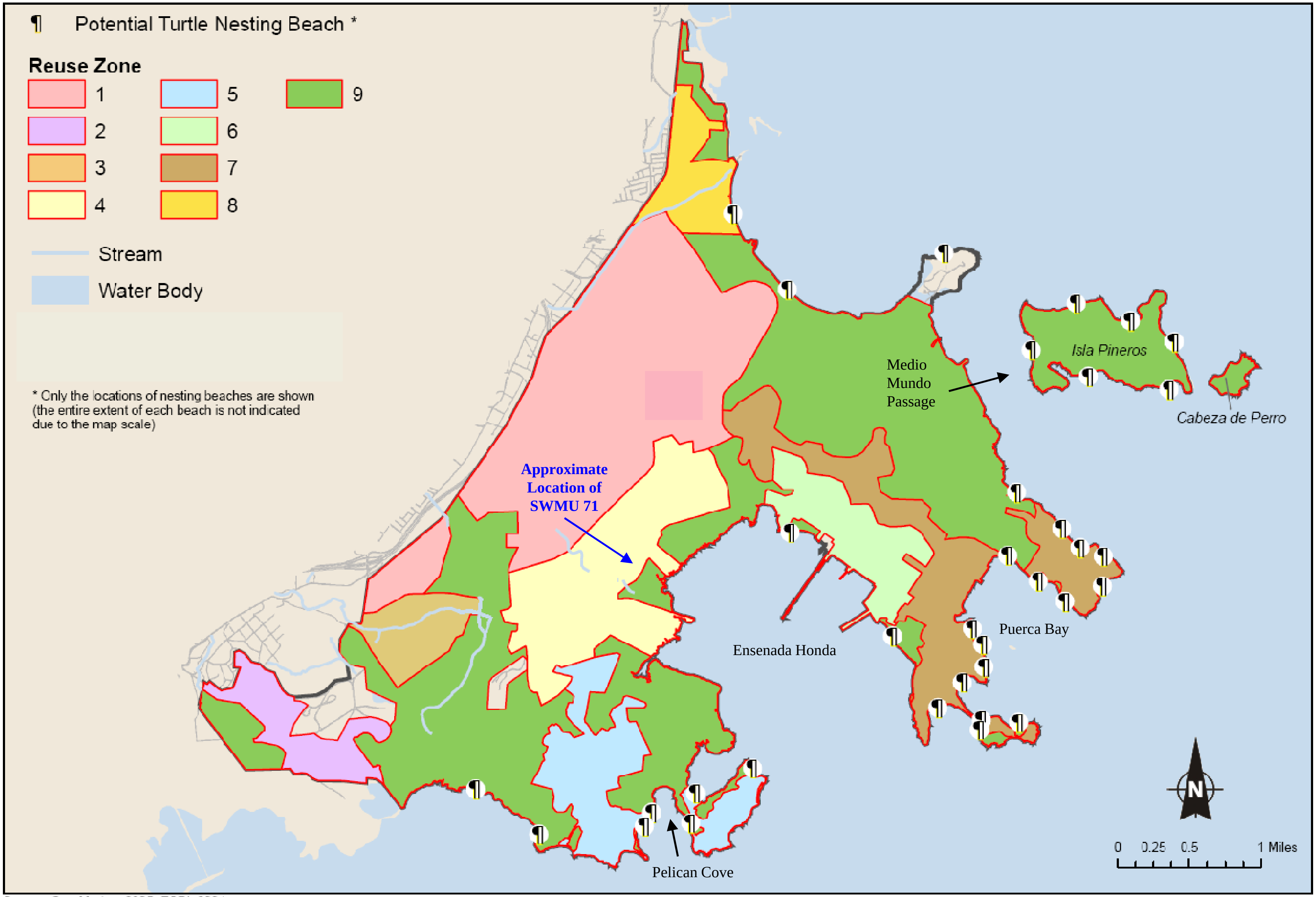


Source: Geo-Marine, 2005; ESRI, 2004; USFWS, 2005;

Cumulative sea turtle sightings from March 1984 through March 1995 obtained from weekly aerial surveys of the Former Naval station Roosevelt Roads.

Figure from: Department of the Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007.

FIGURE 2-5
SEA TURTLE SIGHTINGS AT NAVAL ACTIVITY PUERTO RICO
SWMU 71 – QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO



Source: Geo-Marine, 2005; ESRI, 2004;

Figure from: Department of Navy (DoN). 2007. *Environmental Assessment for the Disposal of Naval Activity Puerto Rico (formerly Naval Station Roosevelt Roads).* April 2007

FIGURE 2-6
POTENTIAL TURTLE NESTING SITES
SWMU 71 – QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO

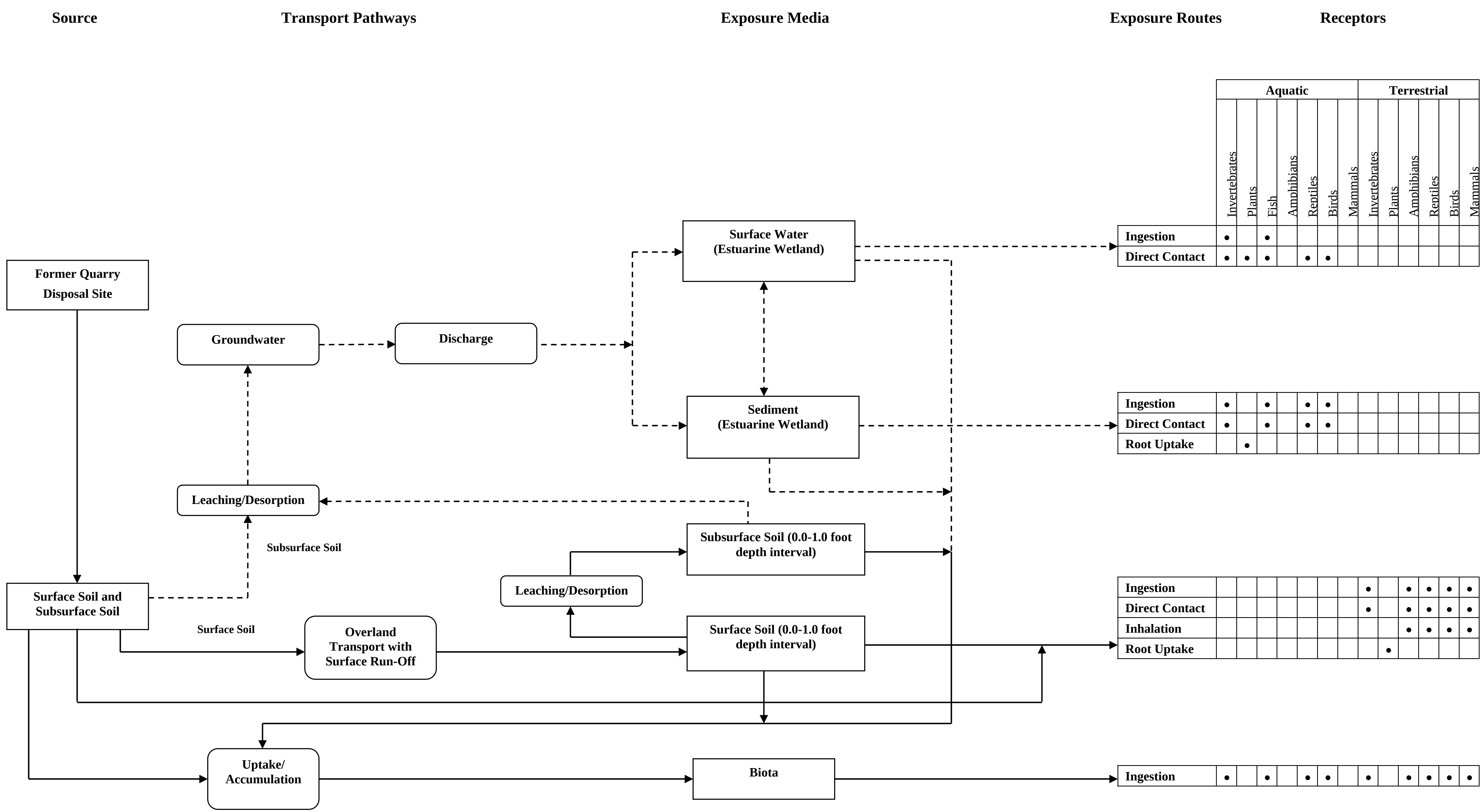


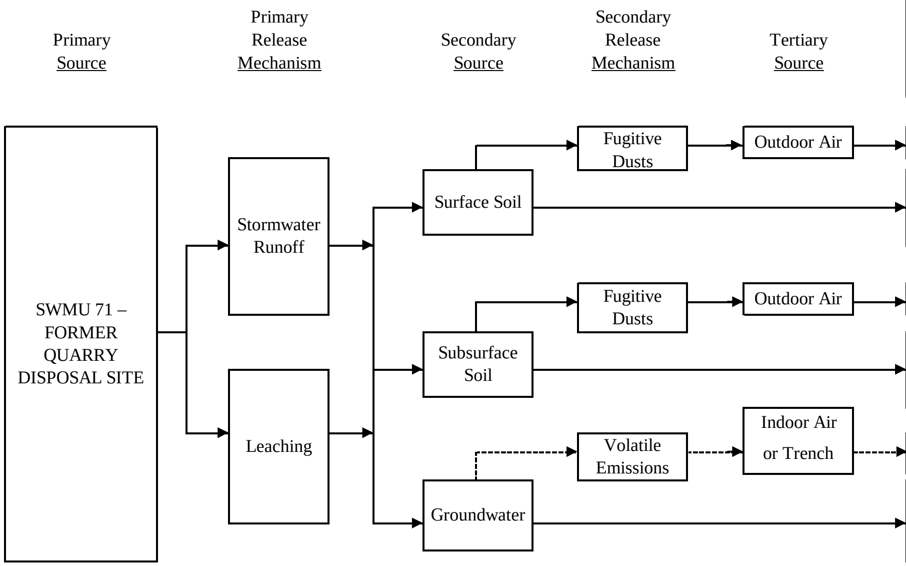
FIGURE 2-7
PRELIMINARY CONCEPTUAL MODEL FOR ECOLOGICAL RECEPTORS
SWMU 71 –QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

→ Potentially complete and significant pathway
⇢ Potentially complete and insignificant pathway

• - Receptor/represented by a potentially complete exposure pathway
x - Receptor/represented by a potentially complete and insignificant exposure pathway

K:_SOUTHNAVFAC\111626 DO2\Task 15 - CMS Inv 56 61 69\69 CMS Report\Draft\ERA\Figures

FIGURE 2-8
PRELIMINARY CONCEPTUAL MODEL FOR HUMAN RECEPTORS
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

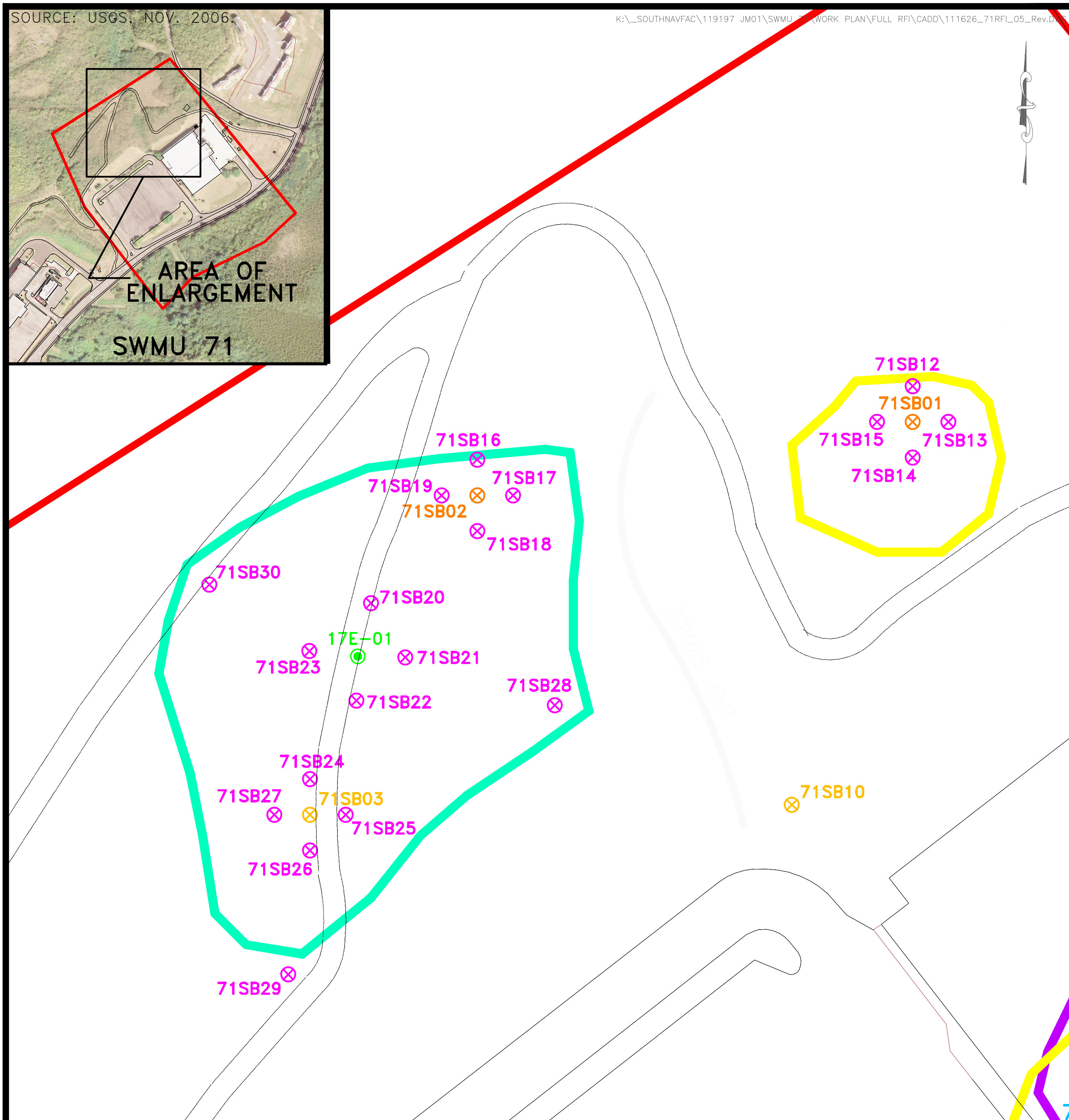


Exposure Route	Current and Future Adult Trespassers	Current and Future Youth Trespassers	Future Adult Industrial / Commercial Workers	Future Adult Residents	Future Young Child Residents	Future Adult Construction Workers
Inhalation	CF	CF	F	F	F	F
Ingestion	CF	CF	F	F	F	F
Dermal Contact	CF	CF	F	F	F	F
Inhalation			F	F	F	F
Ingestion			F	F	F	F
Dermal Contact			F	F	F	F
Inhalation			F	F	F	F
Ingestion				F	F	F
Dermal Contact				F	F	F

Potential Human Receptors

Legend

F	Future Exposure Pathway
CF	Current and Future Exposure Pathway
→ (solid arrow)	Potentially Complete Exposure Pathway
-·-→ (dashed arrow)	Potentially Complete and Insignificant Exposure Pathway



80 0 40 80

1 inch = 80 ft.

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

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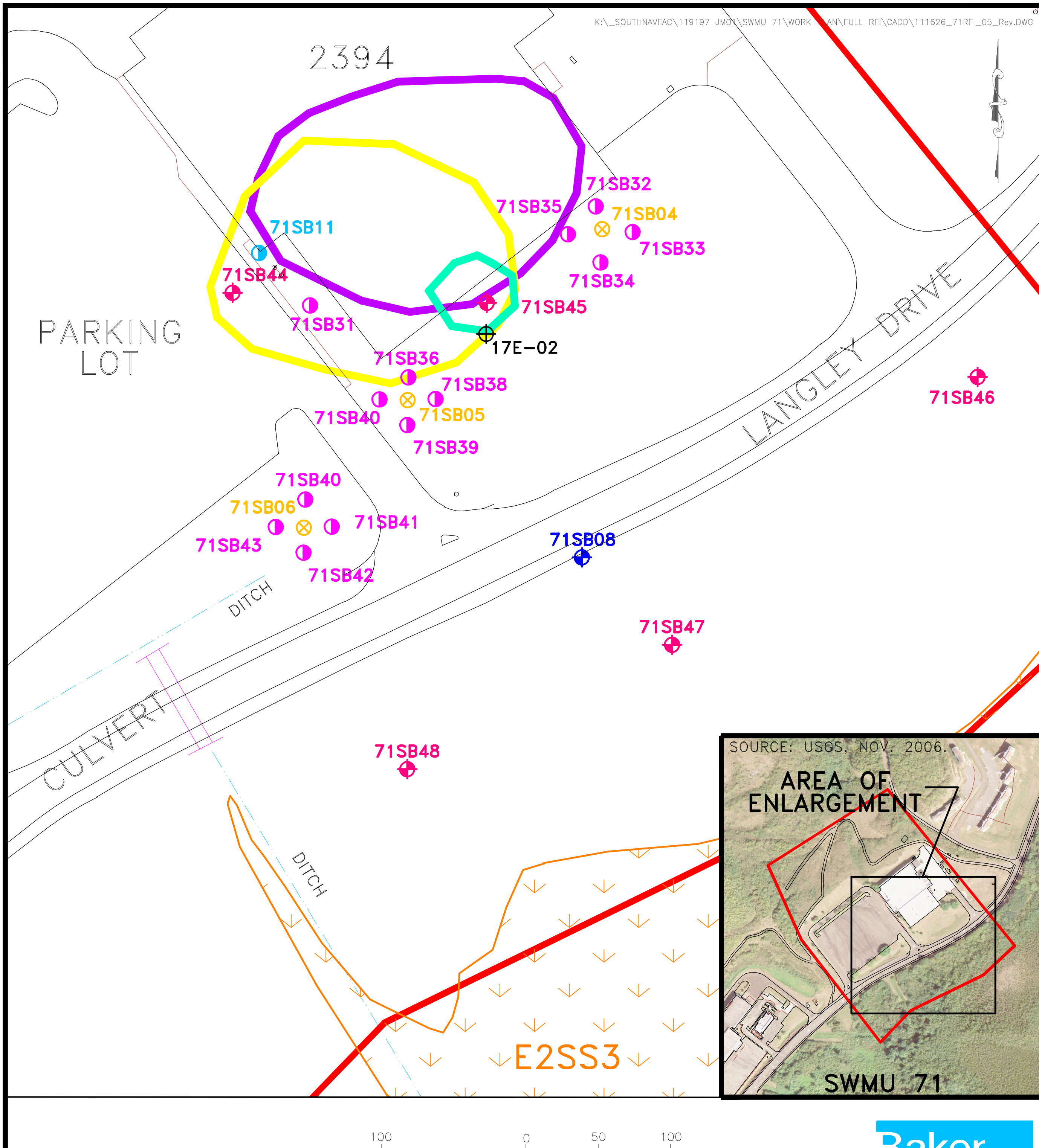
- – SWMU BOUNDARY
- – 1985 APA POLYGON FEATURE
- – 1977 APA POLYGON FEATURE
- – PROPOSED FULL RFI SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION
- – PROPOSED FULL RFI SUBSURFACE SOIL SAMPLE LOCATION
- – PHASE I RFI SURFACE SOIL SAMPLE LOCATION (JUNE 2008)
- – PHASE I RFI SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION (JUNE 2008)
- – EXISTING SURFACE SOIL AND SUBSURFACE SOIL SAMPLE LOCATION (PHASE II ECP 2004)

FIGURE 3-1
PROPOSED FULL RFI SAMPLE LOCATION MAP (UPPER AREA)
SWMU 71-QUARRY DISPOSAL SITE
FULL RFI REPORT

NAVAL ACTIVITY PUERTO RICO



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

Baker

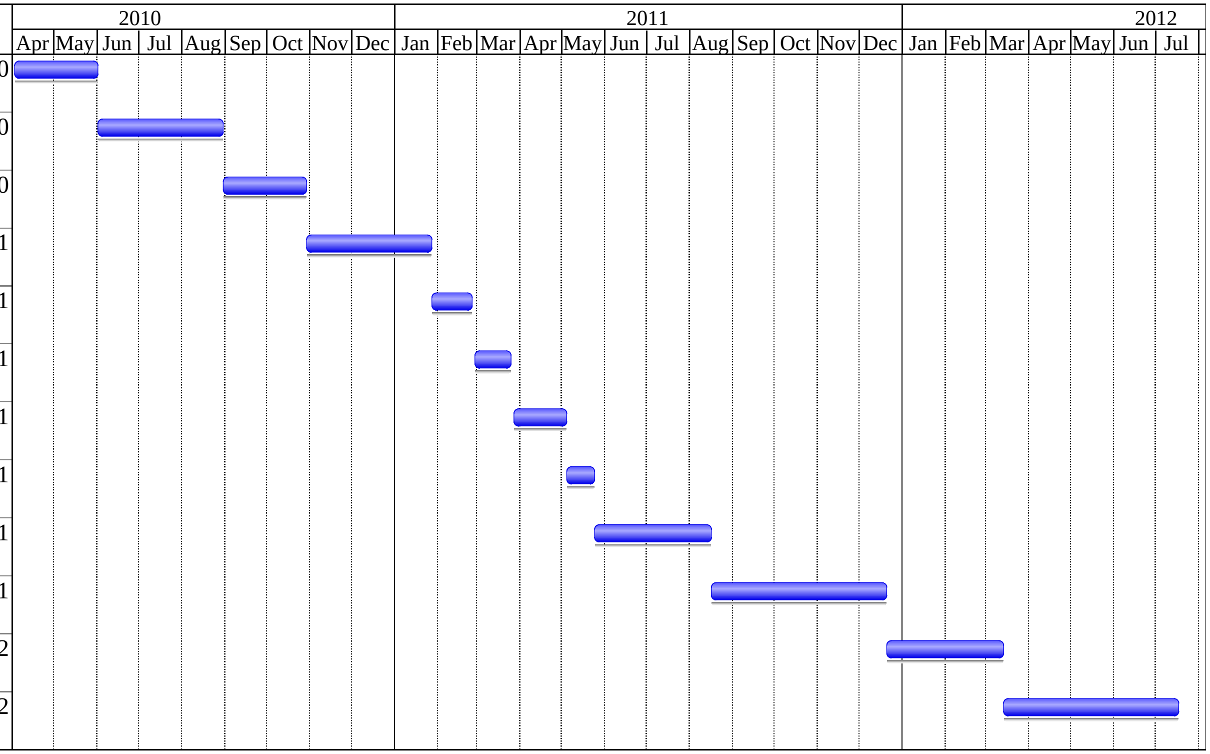
- 1985 APA POLYGON FEATURE
- 1976 APA POLYGON FEATURE
- 1977 APA POLYGON FEATURE
- COWARDIN WETLAND BOUNDARY
- E2SS3 – COWARDIN WETLAND CLASSIFICATION
- PROPOSED FULL RFI SUBSURFACE SOIL SAMPLE LOCATION
- PROPOSED FULL RFI SUBSURFACE SOIL AND GROUNDWATER SAMPLE LOCATION
- PHASE I RFI SUBSURFACE SOIL SAMPLING LOCATION (JUNE 2008)
- PHASE I RFI GROUNDWATER SAMPLING LOCATION (JUNE 2008)
- PHASE I RFI SUBSURFACE SOIL AND GROUNDWATER SAMPLING LOCATION (JUNE 2008)
- PHASE II ECP SUBSURFACE SOIL AND GROUNDWATER SAMPLE LOCATION (2004)

FIGURE 3-2
PROPOSED FULL RFI SAMPLE LOCATION MAP (LOWER AREA)
SWMU 71–QUARRY DISPOSAL SITE
FULL RFI REPORT

NAVAL ACTIVITY PUERTO RICO

FIGURE 5-1
PROPOSED PROJECT SCHEDULE
SWMU 71 - QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

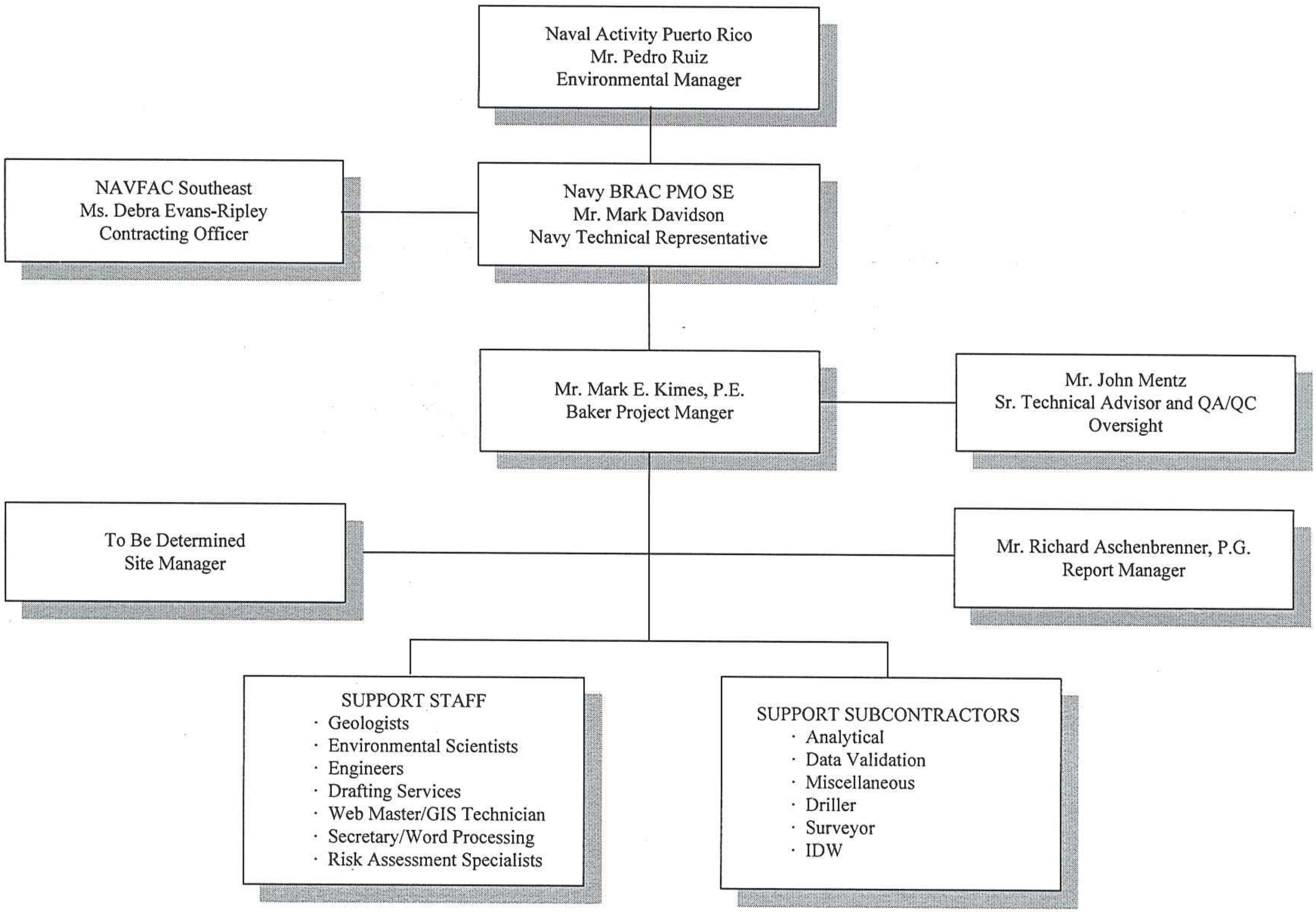
Task Name	Duration	Start	Finish
Draft Full RFI Work Plan to the EPA	60 edays	4/3/10	6/2/10
EPA Review	90 edays	6/2/10	8/31/10
Final Full RFI Work Plan to the EPA	60 edays	8/31/10	10/30/10
EPA Review & Approval	90 edays	10/30/10	1/28/11
Sub Procurement and Field Work Planning	21 days	1/28/11	2/25/11
Field Investigation	20 days	2/28/11	3/25/11
Laboratory Analysis	28 days	3/28/11	5/4/11
Data Validation	14 days	5/5/11	5/24/11
Draft Full RFI Report for SWMU 71 to EPA	60 days	5/25/11	8/16/11
EPA Review	90 days	8/17/11	12/20/11
Final Full RFI Report for SWMU 71 to EPA	60 days	12/21/11	3/13/12
EPA Review & Approval	90 days	3/14/12	7/17/12



Project: Full RFI Work Plan
Date: 5/11/10

Task

FIGURE 6-1
PROJECT ORGANIZATION
SWMU 71 – QUARRY DISPOSAL SITE
FULL RFI WORK PLAN
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO



APPENDIX A
SITE PHOTOGRAPHS

Photo A-1. Site overview photo taken on the western boundary of SWMU 71
View looking northeast across the site.

Photo A-2. Steep vegetated hillside looking northeast behind the Commissary Building.

Photo A-3. Steep vegetated hillside looking southwest behind the Commissary Building.

Photo A-4. Post site clearing provided for drill rig access, view looking west.

APPENDIX B
SUMMARY OF POSITIVE DETECTS - PHASE II ECP

APPENDIX B

SUMMARY OF INORGANIC DETECTIONS IN SURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE II ECP STUDY
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (mg/kg)	**EPA Region III Residential RBCs** (mg/kg)	2x Average Detected Background (mg/kg)	17E-01 17E-SS01 05/06/04 0.00 - 1.00	17E-01 17E-SS01D 05/06/04 0.00 - 1.00	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Number Exceeding 2x Average Detected Background	Range Exceeding 2x Average Detected Background	Location of Maximum Detection
Appendix IX Inorganics (mg/kg)												
Barium	7,200	550	181	60	47	0/2		0/2		0/2		17E-SS01
Beryllium	200	16	0.45	0.18 B	0.15 B	0/2		0/2		0/2		17E-SS01
Chromium	310	23	59.3	16	15	0/2		0/2		0/2		17E-SS01
Cobalt	2,000	160	44.0	21	21	0/2		0/2		0/2		17E-SS01, 17E-SS01D
Copper	4,100	310	234.2	120	95	0/2		0/2		0/2		17E-SS01
Lead	400[1]	400[1]	15.25	5.3	3.8	0/2		0/2		0/2		17E-SS01
Mercury	31[2]	2.3[2]	0.11	0.03 S	0.022	0/2		0/2		0/2		17E-SS01
Nickel	2,000	160	16.55	15	<u>17</u>	0/2		0/2		1/2	17	17E-SS01D
Silver	510	39	0.37	<u>1.1</u> B	<u>0.55</u> B	0/2		0/2		2/2	0.55B - 1.1B	17E-SS01
Tin	61,000	4,700	2.43	<u>3.4</u> B	<u>3.3</u> B	0/2		0/2		2/2	3.3B - 3.4B	17E-SS01
Vanadium	100	7.8	354.5	**140**	**120**	2/2	120 - 140	2/2	120 - 140	0/2		17E-SS01
Zinc	31,000	2,300	125.2	62	68	0/2		0/2		0/2		17E-SS01D

Notes:

B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
S - The result was determined by Method of Standard Addition.
(1) - 1996 Soil Screening Guidance.
(2) - Value based on the RBC for Mercuric Chloride.
ft bgs - feet below ground surface.
mg/kg - milligrams per kilogram.
Shading indicates exceedance of EPA Region III Industrial RBCs
Bold indicates exceedance of EPA Region III Residential RBCs
<u>Underline</u> indicates exceedance of 2 x Average Detected Background

APPENDIX B

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE II ECP STUDY
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (ug/kg)	**EPA Region III Residential RBCs** (ug/kg)	17E-01 17E-SB01-01 05/06/04 1.00 - 1.3	17E-02 17E-SB02-01 05/06/04 1.00 - 3.00	17E-02 17E-SB02-04 05/06/04 7.00 - 9.00	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Location of Maximum Detection
Volatile Organic Compounds (ug/kg)										
Acetone	92,000,000	7,000,000	53 U	50 U	27 J	0/3		0/3		17E-SB02-04
Benzene	52,000	12,000	5.3 U	5 U	8.6	0/3		0/3		17E-SB02-04
Carbon tetrachloride	22,000	4,900	3.7 J	5 U	4.4	0/3		0/3		17E-SB02-04
Ethylbenzene	10,000,000	780,000	5.3 U	5 U	150	0/3		0/3		17E-SB02-04
Xylene	20,000,000	1,600,000	11 U	10 U	24	0/3		0/3		17E-SB02-04
Semivolatile Organic Compounds (ug/kg)										
Acenaphthene	6,100,000	470,000	170 J	370 U	8,000 U	0/3		0/3		17E-SB01-01
Anthracene	31,000,000	2,300,000	230 J	370 U	8,000 U	0/3		0/3		17E-SB01-01
Benzo(a)anthracene	3,900	870	530	370 U	8,000 U	0/3		0/3		17E-SB01-01
Benzo(b)fluoranthene	3,900	870	310 J	38 J	8,000 U	0/3		0/3		17E-SB01-01
Benzo(k)fluoranthene	39,000	8,700	410	24 J	8,000 U	0/3		0/3		17E-SB01-01
Benzo(g,h,i)perylene	NE	NE	240 J	62 J	8,000 U	NE		NE		17E-SB01-01
Benzo(a)pyrene	390	87	**370**	370 U	8,000 U	0/3		1/3	370	17E-SB01-01
Chrysene	390,000	87,000	530	36 J	8,000 U	0/3		0/3		17E-SB01-01
Dibenzofuran	200,000	16,000	78 J	370 U	8,000 U	0/3		0/3		17E-SB01-01
Dibenzo(a,h)anthracene	390	87	**110** J	37 J	8,000 U	0/3		1/3	110J	17E-SB01-01
Fluoranthene	4,100,000	310,000	1,100	370 U	8,000 U	0/3		0/3		17E-SB01-01
Fluorene	4,100,000	310,000	120 J	370 U	8,000 U	0/3		0/3		17E-SB01-01
Indeno(1,2,3-cd)pyrene	3,900	870	240 J	53 J	8,000 U	0/3		0/3		17E-SB01-01
2-Methylnaphthalene	410,000	31,000	63 J	370 U	2,500 J	0/3		0/3		17E-SB02-04
Phenanthrene	NE	NE	830	370 U	8,000 U	NE		NE		17E-SB01-01
Pyrene	3,100,000	230,000	920	19 J	8,000 U	0/3		0/3		17E-SB01-01

APPENDIX B

SUMMARY OF ORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE II ECP STUDY
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (ug/kg)	**EPA Region III Residential RBCs** (ug/kg)	17E-01 17E-SB01-01 05/06/04 1.00 - 1.3	17E-02 17E-SB02-01 05/06/04 1.00 - 3.00	17E-02 17E-SB02-04 05/06/04 7.00 - 9.00	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Location of Maximum Detection
Pesticides/PCBs (ug/kg)										
4,4'-DDE	8,400	1,900	3.7 U	0.81 J	4 U	0/3		0/3		17E-SB02-01
4,4'-DDT	8,400	1,900	3.7 U	0.53 J	4 U	0/3		0/3		17E-SB02-01
OP-Pesticides (ug/kg)										
Not Detected										
Chlorinated Herbicides (ug/kg)										
Not Detected										

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

APPENDIX B

SUMMARY OF INORGANIC DETECTIONS IN SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE II ECP STUDY
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date Sample Depth (ft bgs)	EPA Region III Industrial RBCs (mg/kg)	**EPA Region III Residential RBCs** (mg/kg)	2x Average Detected Background (mg/kg)	17E-01 17E-SB01-01 05/06/04 1.00 - 1.3	17E-02 17E-SB02-01 05/06/04 1.00 - 3.00	17E-02 17E-SB02-04 05/06/04 7.00 - 9.00	Number Exceeding EPA Region III Industrial RBCs	Range Exceeding EPA Region III Industrial RBCs	**Number Exceeding EPA Region III Residential RBCs**	**Range Exceeding EPA Region III Residential RBCs**	Number Exceeding 2x Average Detected Background	Range Exceeding 2x Average Detected Background	Location of Maximum Detection
Appendix IX Inorganics (mg/kg)													
Arsenic	1.9	0.43	2.05	1.1 U	**0.9** B	1.1 U	0/3		1/3	0.9B	0/3		17E-SB02-01
Barium	7,200	550	222	57	72	81	0/3		0/3		0/3		17E-SB02-04
Beryllium	200	16	0.74	0.18 B	0.2 B	0.26 B	0/3		0/3		0/3		17E-SB02-04
Chromium	310	23	133	16	19	**57**	0/3		1/3	57	0/3		17E-SB02-04
Cobalt	2,000	160	30.0	20	18	22	0/3		0/3		0/3		17E-SB02-04
Copper	4,100	310	193	100	76	100	0/3		0/3		0/3		17E-SB01-01, 17E-SB02-04
Lead	400(1)	400(1)	8.68	4.5	2.7	3.6	0/3		0/3		0/3		17E-SB01-01
Mercury	31(2)	2.3(2)	0.093	0.01 B	0.0085 B	0.016 B	0/3		0/3		0/3		17E-SB02-04
Nickel	2,000	160	31.9	13	14	27	0/3		0/3		0/3		17E-SB02-04
Silver	510	39	0.46	0.32 B	1.1 U	1.1 U	0/3		0/3		0/3		17E-SB01-01
Tin	61,000	4,700	2.96	2.6 B	2.7 B	2.7 B	0/3		0/3		0/3		17E-SB02-01, 17E-SB02-04
Vanadium	100	7.8	462	**130**	**100**	**150**	2/3	130 - 150	3/3	100 - 150	0/3		17E-SB02-04
Zinc	31,000	2,300	88.6	60	39	42	0/3		0/3		0/3		17E-SB01-01

Notes:
U - The compound was analyzed for, but was not detected at or above the MDL/PQL.
B - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
(1) - 1996 Soil Screening Guidance.
(2) - Value based on the RBC for Mercuric Chloride.
ft bgs - feet below ground surface.
mg/kg - milligrams per kilogram.
Shading indicates exceedance of EPA Region III Industrial RBCs
Bold indicates exceedance of EPA Region III Residential RBCs

APPENDIX B

SUMMARY OF ORGANIC DETECTIONS IN GROUNDWATER
SWMU 71 - QUARRY DISPOSAL SITE
PHASE II ECP STUDY
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	Federal MCLs (ug/L)	**EPA Region III Tap Water RBCs** (ug/L)	PR Water Quality Standards (ug/L)	17E-02 17E-GW02 05/09/04	Number Exceeding Federal MCLs	Range Exceeding Federal MCLs	**Number Exceeding EPA Region III Tap Water RBCs**	**Range Exceeding EPA Region III Tap Water RBCs**	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	Location Maximum Detection
Volatile Organic Compounds (ug/L)											
Acetone	NE	550	NE	6.8 J	NE		0/1		NE		17E-GW01
2-Butanone	NE	700	NE	1.9 J	NE		0/1		NE		17E-GW01
Ethylbenzene	700	130	700	3	0/1		0/1		0/1		17E-GW01
Semivolatile Organic Compounds (ug/L)											
Cresol, m & p	NE	NE	NE	1.8 J	NE		NE		NE		17E-GW01
Naphthalene	NE	0.65	NE	**1.3** J	NE		1/1	1.3J	NE		17E-GW01
Pesticides/PCBs (ug/L)											
Not Detected											
OP-Pesticides (ug/L)											
Not Detected											
Chlorinated Herbicides (ug/L)											
Not Detected											

Notes:

J - The reported result is an estimated concentration that is less than the PQL, but greater than or equal to the MDL.
ug/L - micrograms per liter.
NE - Not Established.
Bold indicates exceedance of EPA Region III Tap Water RBCs

APPENDIX B

SUMMARY OF INORGANIC DETECTIONS IN GROUNDWATER
SWMU 71 - QUARRY DISPOSAL SITE
PHASE II ECP STUDY
NAVAL ACTIVITY PUERTO RICO

Site ID Sample ID Sample Date	Federal MCLs (mg/L)	**EPA Region III Tap Water RBCs** (mg/L)	PR Water Quality Standards (mg/L)	17E-02 17E-GW02 05/09/04	Number Exceeding Federal MCLs	Range Exceeding Federal MCLs	**Number Exceeding EPA Region III Tap Water RBCs**	**Range Exceeding EPA Region III Tap Water RBCs**	Number Exceeding PR Water Quality Standards	Range Exceeding PR Water Quality Standards	Location Maximum Detection
Appendix IX Inorganics (mg/L)											
Barium	2	0.26	NE	0.1	0/1		0/1		NE		17E-GW01
Chromium	0.1	0.011	NE	0.0013 B	0/1		0/1		NE		17E-GW01
Cobalt	NE	0.073	NE	0.0039 B	NE		0/1		NE		17E-GW01
Copper	1.3(1)	0.15	1.3	0.0041 B	0/1		0/1		0/1		17E-GW01
Mercury	0.002	0.0011(2)	0.002	0.00049 B	0/1		0/1		0/1		17E-GW01
Nickel	NE	0.073	NE	0.0033 B	NE		0/1		NE		17E-GW01
Vanadium	NE	0.0037	NE	**0.012**	NE		1/1	0.012	NE		17E-GW01

Notes:

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

(1) - EPA action level.

(2) - Value based on the Tap Water RBC for Mercuric Chloride.

NE - Not Established.

mg/L - milligrams per liter.

Bold indicates exceedance of EPA Region III Tap Water RBCs

APPENDIX C
SUMMARY OF PHASE I RFI ANALYTICAL RESULTS

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - SURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID / Sample ID / Date / Depth Range	**Regional Screening Levels Residential**	*Regional Screening Levels Industrial*	Selected Ecological Surface Soil Screening Values	NAPR Basewide Background [1]	71SB01 / 71SB01-00 / 6/2/2008 / 0.0-1.0	71SB02 / 71SB02-00 / 6/2/2008 / 0.0-1.0	71SB03 / 71SB03-00 / 6/2/2008 / 0.0-1.0	71SB03 / 71SB03-00D / 6/2/2008 / 0.0-1.0	71SB10 / 71SB10-00 / 6/1/2008 / 0.0-1.0
Volatile Organic Compounds (ug/L)									
Acetone	6,100,000 [2]	61,000,000 [2]	NE	NE	130 J	160 J	150 J	230 J	400 J
Iodomethane	NE	NE	NE	NE	1.2 U	0.91 U	1.4 J	1.5 J	2.5 J
Semivolatile Organic Compounds (ug/kg)									
2-Methylnaphthalene	31,000 [2]	410,000 [2]	NE	NE	97 U	9.1	1.9 U	1.9 U	1.9 U
3-Methylcholanthrene	NE	NE	NE	NE	350 U	24 J	7 U	6.8 U	6.8 U
Acenaphthene	340,000 [2]	3,300,000 [2]	NE	NE	33 U	120	3.8 J	1.1 J	0.63 U
Anthracene	1,700,000 [2]	17,000,000 [2]	NE	NE	97 U	350	11	3.4 J	1.9 U
Benzo[a]anthracene	150	2,100	NE	NE	97 U	**1,600**	58	34	1.9 U
Benzo[a]pyrene	15	210	NE	NE	38 U	***1,600***	**51**	**59**	0.73 U
Benzo[g,h,i]perylene	170,000 [2]	1,700,000 [2]	NE	NE	97 UJ	580 J	33 J	25 J	1.9 U
Benzo[k]fluoranthene	1,500	21,000	NE	NE	57 U	1,500	83	55	1.1 U
Bis(2-ethylhexyl) phthalate	35,000	120,000	NE	NE	270 U	200	25 U	26 U	13 U
Butyl benzyl phthalate	260,000	910,000	NE	NE	410 U	85	8.2 U	8 U	8 U
Chrysene	15,000	210,000	6,010 [10]	NE	35 U	1300	50	30	0.68 U
Dibenz(a,h)anthracene	15	210	NE	NE	34 U	***280***	11	10	0.66 U
Dibenzofuran	NE	NE	NE	NE	240 U	47	4.8 U	4.7 U	4.7 U
Fluoranthene	230,000 [2]	2,200,000 [2]	NE	NE	97 U	1800	100 J	42 J	1.9 U
Fluorene	230,000 [2]	2,200,000 [2]	NE	NE	44 U	81	3 J	0.97 J	0.86 U
Indeno[1,2,3-cd]pyrene	150	2,100	NE	NE	69 U	**450**	15	9.8	1.3 U
Methapyrilene	NE	NE	NE	NE	530 UJ	210 J	11 U	10 U	10 UJ
Naphthalene	3,900	20,000	NE	NE	34 UJ	7.2 J	1.1 J	0.96 J	0.67 UJ
Phenanthrene	NE	NE	NE	NE	97 U	1,300	50 J	16 J	1.9 U
Pyrene	170,000 [2]	1,700,000 [2]	NE	NE	97 U	2,200	97	67	1.9 U

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - SURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID Sample ID Date Depth Range	**Regional Screening Levels Residential**	*Regional Screening Levels Industrial*	Selected Ecological Surface Soil Screening Values	NAPR Basewide Background [(1)]	71SB01 71SB01-00 6/2/2008 0.0-1.0	71SB02 71SB02-00 6/2/2008 0.0-1.0	71SB03 71SB03-00 6/2/2008 0.0-1.0	71SB03 71SB03-00D 6/2/2008 0.0-1.0	71SB10 71SB10-00 6/1/2008 0.0-1.0
PAHs (ug/kg)									
Low molecular weight PAHs	NE	NE	29,000 [(11)]	NE	596	3669	173	68.2	11.7
High molecular weight PAHs	NE	NE	18,000 [(12)]	NE	567	9511	399	291	11.0
Pesticides (ug/kg)									
None Detected									
Metals (mg/kg)									
Antimony	3.1 [(2)]	41 [(2)]	78 [(8)]	3.17	2.5 J	0.97 J	0.19 UJ	0.17 UJ	0.078 UJ
Arsenic	0.39	1.6	18 [(4)]	2.65	***2.5***	**1.6**	**1.4**	**1.3**	**1.1**
Barium	1,500 [(2)]	19,000 [(2)]	330 [(5)]	199	110	88	86	81	150
Beryllium	16 [(2)]	200 [(2)]	40 [(5)]	0.59	0.27	0.18	0.22	0.21	0.29
Cadmium	7 [(2)]	81 [(2)]	32 [(4)]	1.02	1.3	3.1	0.13	0.094 J	0.069 J
Chromium	280	1,400	57 [(7)]	49.8	23 J	21 J	22 J	23 J	16 J
Cobalt	2.3 [(2)]	30 [(2)]	13 [(4)]	46.2	**25**	**14**	**22**	**22**	**25**
Copper	310 [(2)]	4,100 [(2)]	70 [(4)]	168	130	100	86	86	120
Lead	400 [(3)]	800 [(3)]	120 [(4)]	22	71 J	61 J	5.9 J	6.7 J	2.4 J
Mercury	2.3 [(2)]	31 [(2)]	0.1 [(6)]	0.109	0.024	0.023	0.011 J	0.01 J	0.0083 J
Nickel	160 [(2)]	2,000 [(2)]	38 [(4)]	20.7	14	13	14	16	13
Selenium	39 [(2)]	510 [(2)]	0.52 [(4)]	1.48	0.13 U	0.16 J	0.36 J	0.36 J	0.43 J
Silver	39 [(2)]	510 [(2)]	560 [(8)]	NE	0.087 J	0.056 J	0.079 J	0.089 J	0.026 J
Vanadium	55 [(2)]	720 [(2)]	10 [(9)]	259	**140**	**110**	**170**	**160**	**220**
Zinc	2,300 [(2)]	31,000 [(2)]	120 [(5)]	115	410 J	110 J	65 J	63 J	52 J

Table References:

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USEPA. 2005g. Ecological Soil Screening Levels for Beryllium (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-63.

USEPA. 2005h. Ecological Soil Screening Levels for Antimony (Interim Final). Office of Solid Waste and Emergency Response, Washington, D.C. OSWER Directive 9285.7-61.

SUMMARY OF DETECTED LABORATORY RESULTS - SURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes/Qualifiers:

J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Undetected at the Limit of Detection.
UJ - Reported quantitation limit is qualified as estimated
ft bgs - feet below ground surface
ug/kg - micrograms per kilogram
mg/kg - miligrams per kilogram
NA - Not Analyzed
NE - Not Established
NAPR - Naval Activity Puerto Rico
USEPA - United States Environmental Protection Agency

(1) NAPR basewide background surface soil screening value (upper limit of the means concentration [mean plus two standard deviations]) (Baker, 2008)

(2) Noncarcinogenic RSLs based on a target hazard quotient of 0.1 for conservative screening purposes

(3) USEPA Action Level for lead in soils

(4) Plant-based ecological soil screening level (USEPA,, 2005a [arsenic]; USEPA, 2005b [cadmium]; USEPA, 2005c [cobalt]; USEPA, 2005d [lead]; USEPA, 2007a [copper]; USEPA, 2007b [nickel]; USEPA, 2007c [selenium])

(5) Invertebrate-based ecological soil screening level (USEPA, 2005h [antimony]; USEPA, 2005f [barium]; USEPA, 2005g [beryllium]; USEPA, 2007d [zinc])

(6) Toxicological threshold for earthworms (Efroymson et al., 1997a)

(7) Reproduction-based MATC for *Eisenia andrei* (earthworm)

(8) Ecological soil screening level (http://www.epa.gov/ecotox/ecossl/)

(9) Growth-based LOAEC for *Brassica oleracea* (broccoli) with a safety factor of 10

(10) Value for total phthalates (MHSPE 2000)

(11) Low molecular weight PAHs are defined by the USEPA (2007b) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds analyzed for in SWMU 71 soil were 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. Maximum method detection limit was used if there were no detections.

(12) High molecular weight PAHs are defined by the USEPA (2007b) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds analyzed for in SWMU 71 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene. Maximum method detection limits were used for non-detected PAHs.

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID Sample ID Date Depth Range	**Regional Screening Levels Residential**	*Regional Screening Levels Industrial*	Selected Ecological Surface Soil Screening Values	NAPR Basewide Background (1)	71SB03 71SB03-01 6/2/2008 1.0-3.0	71SB04 71SB04-04 5/30/2008 7.0-9.0	71SB04 71SB04-08 5/30/2008 15.0-17.0	71SB05 71SB05-01 5/29/2008 1.0-3.0	71SB05 71SB05-04 5/29/2008 7.0-9.0	71SB06 71SB06-04 5/30/2008 7.0-9.0
Volatile Organic Compounds (ug/kg)										
4-Methyl-2-pentanone (MIBK)	530,000 (2)	5,200,000 (2)	NE	NE	3.2 UJ	3.5 UJ	4.1 UJ	5.9 UJ	3.4 UJ	3.5 UJ
Acetone	6,100,000 (2)	61,000,000 (2)	NE	NE	28 UJ	130 J	6.3 UJ	100 J	110 J	16 UJ
Benzene	1,100	5,600	101	NE	1.3 J	0.96 U	1.1 U	1.6 U	0.93 U	0.97 U
Bromomethane	790 (2)	3,500 (2)	NE	NE	1.8 U	1.9 U	2.3 U	3.2 U	1.9 U	2 U
Iodomethane	NE	NE	NE	NE	1.1 U	1.2 UJ	1.4 UJ	2 U	1.2 U	1.2 UJ
Semivolatile Organic Compounds (ug/kg)										
1,1'-Biphenyl	390,000 (2)	5,100,000 (2)	NE	NE	7.7 U	9.4 U	8.6 U	11 U	8.6 U	9 U
2-Methylnaphthalene	31,000 (2)	410,000 (2)	NE	NE	1.8 U	2.2 U	2 U	2.5 U	2 U	2.1 U
Acenaphthene	340,000 (2)	3,300,000 (2)	NE	NE	0.59 U	0.72 U	0.66 U	10	2.1 J	0.69 U
Anthracene	1,700,000 (2)	17,000,000 (2)	NE	NE	1.8 U	2.2 U	2 U	37	4.2 J	2.1 U
Benzo[a]anthracene	150	2,100	NE	NE	1.8 U	2.2 U	2 U	150	24	2.1 U
Benzo[a]pyrene	15	210	NE	NE	0.69 U	0.84 U	0.77 U	***240*** J	**38**	0.8 U
Benzo[b]fluoranthene	150	2,100	NE	NE	0.79 UJ	0.97 UJ	0.88 UJ	1.1 UJ	49 J	0.92 UJ
Benzo[g,h,i]perylene	170,000 (2)	1,700,000 (2)	NE	NE	1.8 UJ	2.2 U	2 UJ	110 J	20	2.1 U
Benzo[k]fluoranthene	1,500	21,000	NE	NE	1 U	1.3 U	1.2 U	230 J	1.2 U	1.2 U
Bis(2-ethylhexyl) phthalate	35,000	120,000	6,010 (10)	NE	16 U	17 U	36 U	21 U	170	9.4 U
Chrysene	15,000	210,000	NE	NE	0.63 U	0.78 U	0.71 U	150	25	0.74 U
Dibenzofuran	NE	NE	NE	NE	4.4 U	5.3 U	4.9 U	6.2 U	4.9 U	5.1 U
Di-n-octyl phthalate	NE	NE	6,010	NE	3.4 U	4.2 U	3.8 U	4.9 U	240	4 U
Fluoranthene	230,000 (2)	2,200,000 (2)	NE	NE	1.8 U	2.2 U	2 U	280	38	2.1 U
Fluorene	230,000 (2)	2,200,000 (2)	NE	NE	0.8 U	0.98 U	0.89 U	7.3 J	1.3 J	0.93 U
Indeno[1,2,3-cd]pyrene	150	2,100	NE	NE	1.2 U	1.5 U	1.4 U	41 J	7.8 J	1.5 U
Naphthalene	3,900	20,000	NE	NE	0.9 J	0.76 UJ	0.7 UJ	1 J	0.7 UJ	0.73 UJ
Phenanthrene	NE	NE	NE	NE	1.8 U	2.2 U	2 U	140	18	2.1 U
Phenol	1,800,000 (2)	18,000,000 (2)	30,000 (6)	NE	5 U	6.1 U	5.6 J	7.1 U	5.6 U	5.8 U
Pyrene	170,000 (2)	1,700,000 (2)	NE	NE	1.8 U	2.2 U	2 U	310	51	2.1 U

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID Sample ID Date Depth Range	**Regional Screening Levels Residential**	*Regional Screening Levels Industrial*	Selected Ecological Surface Soil Screening Values	NAPR Basewide Background [(1)]	71SB03 71SB03-01 6/2/2008 1.0-3.0	71SB04 71SB04-04 5/30/2008 7.0-9.0	71SB04 71SB04-08 5/30/2008 15.0-17.0	71SB05 71SB05-01 5/29/2008 1.0-3.0	71SB05 71SB05-04 5/29/2008 7.0-9.0	71SB06 71SB06-04 5/30/2008 7.0-9.0
PAHs (ug/kg)										
Low molecular weight PAHs	NE	NE	29,000 (12)	NE	11.3	13.5	12.3	480	68.3	12.9
High molecular weight PAHs	NE	NE	18,000 (13)	NE	10.3	12.7	11.6	1233	217	12.2
Pesticides (ug/kg)										
None Detected										
Metals (mg/kg)										
Antimony	31 (2)	410 (2)	78 (5)	NE	0.07 UJ	0.086 UJ	0.09 UJ	0.86 J	0.17 UJ	0.12 UJ
Arsenic	0.39	1.6	18 (4)	1.59	**1.4**	**<u>1.6</u>**	0.74	***<u>1.7</u>***	***<u>1.8</u>***	***<u>1.7</u>***
Barium	1,500 (2)	19,000 (2)	330 (5)	220	46	140	97	87	77	150
Beryllium	16 (2)	200 (2)	40 (5)	0.596	0.14	0.42	0.22	0.37	0.22	0.46
Cadmium	7 (2)	81 (2)	32 (4)	0.54	0.065 J	0.15	0.054 J	0.13 J	0.086 J	0.16
Chromium	280	1,400	57 (10)	114.5	21 J	48 J	27 J	38 J	21 J	48 J
Cobalt	2.3 (2)	30 (2)	13 (4)	26.9	***<u>35</u>***	***<u>46</u>***	<u>37</u>	**26**	**21**	***<u>74</u>***
Copper	310 (2)	4,100 (2)	70 (4)	246	110	84	130	100	83	95
Lead	400 (3)	800 (3)	120 (4)	6.3	3.5 J	4.6 J	1.1 J	<u>6.7</u> J	3.5 J	<u>11</u> J
Mercury	2.3 (2)	31 (2)	0.1 (6)	0.108	0.0041 U	0.038	0.0043 U	0.014 J	0.0092 J	0.0048 U
Nickel	160 (2)	2,000 (2)	38 (4)	24.7	16	19	<u>27</u>	23	16	<u>35</u>
Selenium	39 (2)	510 (2)	0.52 (4)	5.94	0.2 J	1.3	0.13 U	0.67 J	0.25 J	0.49 J
Silver	39 (2)	510 (2)	560 (8)	NE	0.038 J	0.051 J	0.027 J	0.038 J	0.07 J	0.018 U
Vanadium	55 (2)	720 (2)	10 (11)	434	**120**	**220**	150	**220**	**160**	**270**
Zinc	2,300 (2)	31,000 (2)	120 (5)	88	63 J	<u>98</u> J	51 J	57 J	59 J	79 J
TPH DRO and GRO (mg/kg)										
Diesel Range Organics	NE	NE	NE	NE	NA	1.7 J	1.1 J	11	15	1.3 J
Gasoline Range Organics	NE	NE	NE	NE	NA	0.073 U	0.11 U	0.2 J	NA	0.1 U
Total TPH	100	NE	NE	NE	NA	1.7 J	1.1 J	11.2	15	1.3 J

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID Sample ID Date Depth Range	**Regional Screening Levels Residential**	*Regional Screening Levels Industrial*	Selected Ecological Surface Soil Screening Values	NAPR Basewide Background [1]	71SB06 71SB06-09D 5/30/2008 17.0-19.0	71SB06 71SB06-09 5/30/2008 17.0-19.0	71SB10 71SB10-03 6/1/2008 5.0-7.0	71SB10 71SB10-06 6/1/2008 11.0-13.0	71SB11 71SB11-04 5/29/2008 7.0-9.0	71SB11 71SB11-07 5/29/2008 13.0-15.0
Volatile Organic Compounds (ug/kg)										
4-Methyl-2-pentanone (MIBK)	530,000 [2]	5,200,000 [2]	NE	NE	3.1 UJ	3.5 UJ	3.7 UJ	110 J	3.3 UJ	3.3 UJ
Acetone	6,100,000 [2]	61,000,000 [2]	NE	NE	4.7 UJ	5.4 UJ	39 UJ	210 J	240 J	47 UJ
Benzene	1,100	5,600	101	NE	0.85 U	0.94 U	1 U	0.99 U	0.9 U	0.89 U
Bromomethane	790 [2]	3,500 [2]	NE	NE	1.7 U	1.9 U	2 U	2 U	1.9 J	1.8 U
Iodomethane	NE	NE	NE	NE	1.1 UJ	1.2 UJ	1.3 U	1.9 J	5.5 J	4.6 J
Semivolatile Organic Compounds (ug/kg)										
1,1'-Biphenyl	390,000 [2]	5,100,000 [2]	NE	NE	8.3 U	8.4 U	7.9 U	100	8.7 U	8.8 U
2-Methylnaphthalene	31,000 [2]	410,000 [2]	NE	NE	1.9 U	1.9 U	1.8 U	50	2 U	2 U
Acenaphthene	340,000 [2]	3,300,000 [2]	NE	NE	0.64 U	0.65 U	0.61 U	0.65 U	0.67 U	0.68 U
Anthracene	1,700,000 [2]	17,000,000 [2]	NE	NE	1.9 U	1.9 U	1.8 U	1.9 U	2 U	2 U
Benzo[a]anthracene	150	2,100	NE	NE	1.9 U	1.9 U	1.8 U	5.3 J	2 U	2 U
Benzo[a]pyrene	15	210	NE	NE	0.74 U	0.75 U	0.7 U	0.75 U	0.78 U	0.79 U
Benzo[b]fluoranthene	150	2,100	NE	NE	0.85 U	0.86 U	0.81 UJ	0.87 UJ	0.89 UJ	0.91 UJ
Benzo[g,h,i]perylene	170,000 [2]	1,700,000 [2]	NE	NE	1.9 UJ	1.9 UJ	1.8 U	1.9 U	2 U	2 U
Benzo[k]fluoranthene	1,500	21,000	NE	NE	1.1 U	1.1 U	1.1 U	1.1 U	1.2 U	1.2 U
Bis(2-ethylhexyl) phthalate	35,000	120,000	6,010 [10]	NE	11 U	12 U	10 U	21 U	7.7 U	7.4 U
Chrysene	15,000	210,000	NE	NE	0.68 U	0.69 U	0.65 U	0.7 U	0.72 U	0.73 U
Dibenzofuran	NE	NE	NE	NE	4.7 U	4.8 U	4.5 U	73	4.9 U	5 U
Di-n-octyl phthalate	NE	NE	6,010	NE	3.7 U	3.8 U	3.5 U	3.8 U	3.9 U	3.9 U
Fluoranthene	230,000 [2]	2,200,000 [2]	NE	NE	1.9 U	1.9 U	1.8 U	1.9 U	2 U	2 U
Fluorene	230,000 [2]	2,200,000 [2]	NE	NE	0.86 U	0.88 U	0.82 U	0.88 U	0.91 U	0.92 U
Indeno[1,2,3-cd]pyrene	150	2,100	NE	NE	1.3 U	1.4 U	1.3 U	1.4 U	1.4 U	1.4 U
Naphthalene	3,900	20,000	NE	NE	0.67 UJ	0.68 UJ	0.64 UJ	0.68 UJ	0.71 UJ	0.72 UJ
Phenanthrene	NE	NE	NE	NE	1.9 U	1.9 U	1.8 U	86	2 U	2 U
Phenol	1,800,000 [2]	18,000,000 [2]	30,000 [6]	NE	5.4 U	5.5 U	5.1 U	7.8 J	5.6 U	5.7 U
Pyrene	170,000 [2]	1,700,000 [2]	NE	NE	1.9 U	1.9 U	1.8 U	4.7 J	2 U	2 U

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID / Sample ID / Date / Depth Range	**Regional Screening Levels Residential**	*Regional Screening Levels Industrial*	Selected Ecological Surface Soil Screening Values	NAPR Basewide Background (1)	71SB06 / 71SB06-09D / 5/30/2008 / 17.0-19.0	71SB06 / 71SB06-09 / 5/30/2008 / 17.0-19.0	71SB10 / 71SB10-03 / 6/1/2008 / 5.0-7.0	71SB10 / 71SB10-06 / 6/1/2008 / 11.0-13.0	71SB11 / 71SB11-04 / 5/29/2008 / 7.0-9.0	71SB11 / 71SB11-07 / 5/29/2008 / 13.0-15.0
PAHs (ug/kg)										
Low molecular weight PAHs	NE	NE	29,000 (12)	NE	11.7	11.7	11.1	143.9	12.3	12.3
High molecular weight PAHs	NE	NE	18,000 (13)	NE	11.0	11.2	10.6	17.4	11.7	11.7
Pesticides (ug/kg)										
None Detected										
Metals (mg/kg)										
Antimony	31 (2)	410 (2)	78 (5)	NE	0.12 UJ	0.089 UJ	0.076 UJ	0.093 UJ	0.082 UJ	0.12 UJ
Arsenic	0.39	1.6	18 (4)	1.59	1.6	1.5	**1**	0.96	**1.4**	1.6
Barium	1,500 (2)	19,000 (2)	330 (5)	220	220	160	140	110	110	98
Beryllium	16 (2)	200 (2)	40 (5)	0.596	0.29	0.33	0.18	0.26	0.45	0.53
Cadmium	7 (2)	81 (2)	32 (4)	0.54	0.036 J	0.039 J	0.041 J	0.034 U	0.12	0.037 J
Chromium	280	1,400	57 (10)	114.5	13 J	15 J	54 J	36 J	51 J	50 J
Cobalt	2.3 (2)	30 (2)	13 (4)	26.9	32	42	**20**	34	***47***	34
Copper	310 (2)	4,100 (2)	70 (4)	246	180	280	150	120	59	77
Lead	400 (3)	800 (3)	120 (4)	6.3	1.2 J	1.4 J	1.5 J	13 J	7.9 J	6.5 J
Mercury	2.3 (2)	31 (2)	0.1 (6)	0.108	0.0037 U	0.0042 U	0.0036 U	0.0041 U	0.039	0.0044 U
Nickel	160 (2)	2,000 (2)	38 (4)	24.7	12	11	41	16	25	27
Selenium	39 (2)	510 (2)	0.52 (4)	5.94	0.12 U	0.18 J	0.12 J	0.13 J	1.2	0.31 J
Silver	39 (2)	510 (2)	560 (8)	NE	0.025 J	0.024 J	0.026 J	0.018 J	0.03 J	0.019 J
Vanadium	55 (2)	720 (2)	10 (11)	434	240	270	**190**	250	**220**	330
Zinc	2,300 (2)	31,000 (2)	120 (5)	88	50 J	79 J	55 J	61 J	61 J	57 J
TPH DRO and GRO (mg/kg)										
Diesel Range Organics	NE	NE	NE	NE	1.7 J	1.9 J	NA	NA	5	2 J
Gasoline Range Organics	NE	NE	NE	NE	0.068 U	0.083 U	NA	NA	NA	NA
Total TPH	100	NE	NE	NE	1.7 J	1.9 J	NA	NA	5	2 J

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes/Qualifiers:

J - Estimated: The analyte was positively identified; the quantitation is an estimation
U - Undetected at the Limit of Detection.
ft bgs - feet below ground surface
mg/kg - miligrams per kilogram
NE - Not Established
NAPR - Naval Activity Puerto Rico
USEPA - United States Environmental Protection Agency

Note that analytical results greater than three feet bgs are not compared to Ecological Soil Screening Values due to the lack of a complete exposure pathway for ecological receptors.

(1) NAPR basewide background soil screening value (upper limit of the means concentration [mean plus two standard deviations]) for Subsurface Soil Background Clay Table 3-4 (Baker, 2008)

(2) Noncarcinogenic RSLs based on a target hazard quotient of 0.1 for conservative screening purposes

(3) USEPA Action Level for lead in soils

(4) Plant-based ecological soil screening level (USEPA,, 2005a [arsenic]; USEPA, 2005b [cadmium]; USEPA, 2005c [cobalt]; USEPA, 2005d [lead]; USEPA, 2007a [copper]; USEPA, 2007b [nickel]; USEPA, 2007c [selenium])

(5) Invertebrate-based ecological soil screening level (USEPA, 2005h [antimony]; USEPA, 2005f [barium]; USEPA, 2005g [beryllium]; USEPA, 2000d [zinc])

(6) Toxicological threshold for earthworms (Efroymson et al., 1997a)

(7) Toxicogical threshold for plants (Efroymson et al., 1997b)

(8) Ecological soil screening level (http://www.epa.gov/ecotox/ecossl/)

(9) Ministry of Housing,Spatial Analysis and Environment (MHSPE), 2000, Circular on Target Values for Soil Remediation. Directirate-General for Environmental Protection, Department of Soil Protection, The Hague, Netherlands. February 4, 2000.

(10) Reproduction-based MATC for *Eisenia andrei* (earthworm)

(11) Growth-based LOAEC for *Brassica oleracea* (broccoli) with a safety factor of 10

(12) Low molecular weight PAHs are defined by the USEPA (2007b) as PAH compounds composed of fewer than four rings. The low molecular weight PAH compounds analyzed for in SWMU 71 soil were 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, and phenanthrene. Maximum method detection limit was used if there were no detections.

(13) High molecular weight PAHs are defined by the USEPA (2007b) as PAH compounds composed of four or more rings. The high molecular weight PAH compounds analyzed for in SWMU 71 soil were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene. Maximum method detection limits were used for non-detected PAHs.

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SUMMARY OF DETECTED LABORATORY RESULTS - SUBSURFACE SOIL
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

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SUMMARY OF DETECTED LABORATORY RESULTS - GROUNDWATER
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Site ID Sample ID Date	**Regional Tap Water Screening Levels**	*USEPA MCLs*	Ecological Groundwater Screening Values	NAPR Basewide Background [(1)]	71SB04 71GW04 6/10/2008	71SB06 71GW06 6/3/2008	71SB08 71GW08 6/3/2008	71SB08 71GW08D 6/3/2008
Volatile Organic Compounds (ug/L)								
Carbon disulfide	100 [(2)]	NE	15 [(6)]	NE	0.82 J	0.48 U	0.17 U	0.17 U
Semivolatile Organic Compounds (ug/L)								
Bis(2-ethylhexyl) phthalate	4.8	6.0	360 [(5)]	NE	1.2	0.34 UJ	0.34 U	0.34 U
Pesticides (ug/L)								
None Detected								
Total Metals (ug/L)								
Barium	730 [(2)]	2,000	16,667 [(3)]	686	NA	94	26	23
Cadmium	1.8 [(2)]	5.0	8.85 [(7)]	16.62	NA	0.12 U	0.12 U	0.16 J
Cobalt	1.1 [(2)]	NE	45 [(4)]	633.21	NA	**8.1** J	**1.6**	**1.4** J
Nickel	73 [(2)]	NE	8.28 [(7)]	95.74	NA	3.2	2.3 J	1.6 J
Selenium	18 [(2)]	50	71.1 [(7)]	29.88	NA	1.4 J	3.1	2.9 J
Vanadium	26 [(2)]	NE	12 [(6)]	484.66	NA	18 J	**57**	**53**
Zinc	1,100 [(2)]	NE	85.6 [(7)]	547.53	NA	6.5 U	8.6 J	9 J
Dissolved Metals (ug/L)								
Barium	730 [(2)]	2,000	16,667 [(3)]	260	NA	60	24	25
Cobalt	1.1 [(2)]	NE	45 [(4)]	580.5	NA	**4.9**	**1.4** J	**2** J
Nickel	73 [(2)]	NE	8.28 [(7)]	84.1	NA	3.5	1.5	2 J
Selenium	18 [(2)]	50	71.1 [(7)]	23.92	NA	2.1 J	3.6	3.6 J
Vanadium	26 [(2)]	NE	12 [(6)]	20.96	NA	23 J	**53**	**56**
Zinc	1,100 [(2)]	NE	85.6 [(7)]	360.64	NA	6.5 U	6.5 U	6.8 J
TPH DRO and GRO (mg/L)								
Diesel Range Organics [C10-C28]	12.5 [(8)]	NE	NE	NE	NA	0.21	0.1	0.079 J

APPENDIX C

SUMMARY OF DETECTED LABORATORY RESULTS - GROUNDWATER
SWMU 71 - QUARRY DISPOSAL SITE
PHASE I RFI REPORT
NAVAL ACTIVITY PUERTO RICO, CEIBA, PUERTO RICO

Notes:

U - Not detected
J - Analyte present - Reported value is estimated
NA - Not Analyzed
NE - Not Established
mg/l - micrograms per liter
ug/l - micrograms per liter
NAPR - Naval Activity Puerto Rico
USEPA - United States Environmental Protection Agency

(1) NAPR basewide background groundwater screening value (upper limit of the means concentration [mean plus two standard deviations]) (Baker, 2008)
(2) Noncarcinogenic RSLs based on a target hazard quotient of 0.1 for conservative screening purposes
(3) Minimum acute value (96-hour NOEC for *Cyprinodon variegatus* [sheepshead minnow] with a safety factor of 30)
(4) Minimum acute value (96-hour LC_{50} for *Nitocra spinipes* [Harpacticoid copepod] with a safety factor of 100)
(5) Proposed recoverable Criteria Continuous Concentration
(6) USEPA Region 5 ecological screening level
(7) Total recoverable criteria continuous concentration
(8) Screening level for TPH is 25% of PREQB soil and groundwater criteria, as proposed in the approved work plan dated 12/6/07

APPENDIX D
USEPA REGION II GROUND WATER 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 three 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 "daily" 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 ("daily decon") and after each well is sampled ("between-well decon"). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using "daily 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 ("daily 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 ("between-well decon," see #18 below).

17. **Daily Decon**

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

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

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

D) Disassemble pump.

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

F) Rinse pump parts with potable water.

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

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

I) Rinse impeller assembly with potable water.

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

K) Rinse impeller assembly with distilled/deionized water.

18. **Between-Well Decon**

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

minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

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

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

VIII. FIELD LOG BOOK

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

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

IX. REFERENCES

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