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REMEDIAL INVESTIGATION REPORT SITES 9, 29 AND 34 VOLUME I TEXT NAS PENSACOLA FL
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ENSAFE

REMEDIAL INVESTIGATION REPORT
SITES 9, 29 AND 34
NAVAL AIR STATION
PENSACOLA, FLORIDA

VOLUME I - TEXT

SOUTHNAVACENGCOM
CONTRACT NUMBER:
N62467-89-D-0318
CTO-070

Prepared for:

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN)
NAVAL SUPPORT ACTIVITY
NAVAL AIR STATION
PENSACOLA, FLORIDA

Prepared by:

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5720 Summer Trees Drive, Suite 8
Memphis, Tennessee 38134
(901) 383-9115

March 29, 1996

Release of this document requires prior notification of the Commanding Officer of the Naval Air Station, Pensacola, FL

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19. Abstract
A remedial investigation was conducted for NASP Site 9 (the Navy Yard Disposal Area), Site 29 (the Soil South of Building 3640), and Site 34 (the Solvent North of Building 3557). Contamination was found in soil and groundwater apparently resulting from past releases in the Chevalier Field area. Approximately 60 parameters were detected in laboratory-analyzed samples. **[Initially, analytical data for soils were compared to risk-based, surface soil PRGs exclusively (1995 PRGs). The 1995 PRGs comparison considered conservative assumptions, fast-track remediation requirements, and Tier 1 agreements. The 1995 PRGs were used for the BRA and to justify interim soil removals on each site. Subsequent comparisons (1996 PRGs) used subsurface leaching values. This was because state/federal leachability standards were available, the extensive placement of fill over Chevalier Field during BRAC construction removed the soil pathway for risk, and Tier 1 agreement. Compared to the 1995 study, the 1996 comparison focused only on the leachability of contaminants to groundwater. Parameters above PRGs were]** heavy metals, cyanide, pesticides, polycyclic aromatic hydrocarbons (PAHs), and non-chlorinated and chlorinated aromatic volatiles. Site 9 soil conditions exceeding PRGs were characterized by metals and PAHs. The highest concentrations are in a singular location in the center of the site, and might be associated with the former dump. Non-detect to low levels of pesticides were detected at the site in soil with localized concentrations exceeding PRGs found in **[nine]** areas. These pesticides likely represent residual concentrations from surface application for pest control. PAH contamination is likely associated with a release from Site 23, an immediately adjacent UST site. Site 29 soil contained metals, PAHs, and the pesticide dieldrin. Manganese is in localized areas in surface and/or subsurface soils and is present at levels consistent with background. Non-detect to low levels of several PAHs are present in localized areas throughout the site, with benzo(a)pyrene found in subsurface soils at a single area in the site's northwest portion. The same location had PRG exceedances of the pesticide dieldrin. The dieldrin/PAHs likely represent the reworking of material as the Chevalier Field complex was built. Site 34 soils had metals and PAHs at levels exceeding PRGs. Lead and naphthalene were present in soils at a localized area adjacent to the northern end of Building 3557 (in the general area of the reported solvent release). Non-detect to low levels of pesticides are localized throughout the site. All three sites have aluminum, iron, and manganese above SMCLs/FSDWSs in groundwater. Site 29 displayed a single cyanide concentration above standards; however, no soil cyanide source was verified at the site, and no history of this constituent exists where it was found. Site 34 revealed a single localized lead concentration above standards. Site 34 also had localized naphthalene above standards in groundwater where naphthalene soil contamination was found. The soil and groundwater contamination found on these sites are considered delineated for purposes of the RI. The main areas of soil contamination on each site include: 1) the area presumed to be the former dump on Site 9; 2) the area of dieldrin and PAH contamination on Site 29; and 3) the area of lead and naphthalene contamination on Site 34. **[The contaminated areas of Sites 29 and 34 were subject to interim soil removal, along with a PAH contaminated area on the eastern portion of Site 9. Sufficient removal was documented through a confirmatory sampling program, which affirmed adequate soil removal in the targeted areas. The metals and PAH contaminated area in the west central portion of Site 9 was not removed, and will be addressed under the UST program. The 1996 PRG comparisons indicate the previously mentioned areas and several isolated locations may pose a threat to groundwater. Notably, no correlation exists between the distribution and concentrations of inorganics above PRGs in soil and inorganics above PRGs in groundwater. Therefore, based on current data, it appears that inorganic constituent leaching to groundwater poses minimal threat. Organic PRG exceedances comprise several isolated occurrences of dieldrin, slightly above PRG. Dieldrin was not detected in groundwater at any of these locations, thus indicating minimal to no threat for leaching.]** Potential impacts of contaminant migration via groundwater from these sites on Pensacola Bay and adjacent wetlands will be evaluated in investigations for NASP Sites 40 (Bayou Grande), (41 NASP wetlands), and 42 (Pensacola Bay). The human health risk from exposure to environmental media at Sites 9, 29, and 34 was assessed for hypothetical future site residents. This considered the **[extensive fill]** being added to the sites during BRAC construction, and evidence that construction will leave 68% of the area either paved/covered with buildings. Accordingly, a soil exposure scenario was considered unnecessary. As discussed in Section 10.1.7 of the BRA, the maximum groundwater concentrations reported for arsenic at Sites 9 and 29 do not exceed the ARAR, 0.05 mg/L (MCL/FPDWS). However, the risk posed by arsenic at Sites 9 and 34 (1E-4) exceeds the FDEP and USEPA point of departure (1E-6). Dieldrin (0.00013 mg/L on Site 29) is approximately equal to the FDEP ARAR (0.0001), and was not detected in confirmatory sampling. Dieldrin poses 1E-5 excess cancer risk, which exceeds the FDEP and USEPA risk point of departure. Although the calculated risk exceeds the FDEP and USEPA threshold, **[the]** absence of detected dieldrin during confirmatory sampling, **[the total absence of dieldrin in groundwater elsewhere on the sites, the absence of PAH contamination in groundwater (other than naphthalene on Site 34), and the inability to correlate soil and groundwater inorganic contamination, along with]** comparison of reported concentrations to ARARs, supports a conclusion of no further action recommendation for groundwater based on risk. Due to: 1) sporadic contaminant occurrence in soils, 2) the **[interim]** removal of soil from contaminated areas on each site, 3) extensive covering of the site area with fill, 4) the percent scheduled to be paved or built on during construction, and 5) the no further action recommendation for groundwater based on risk; assessment within the Sites 9, 29 and 34 area is unwarranted. Further, the site area does not warrant the detailed evaluation of remedial alternatives associated with a feasibility study. [Given that there are several constituents in soil above PRGs, it is recommended that the NASP master plan be modified to include restrictions on use of the surficial aquifer beneath Chevalier Field as a potable or non-potable water supply.] No further remedial action is recommended, along with a proposed plan leading to an interim record of decision for these sites.

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List of Acronyms

°C	Degrees Celsius
μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter
%D	Percent Difference
%RSD	Percent Relative Standard Deviation
ARARS	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
AT	Average Time
bls	Below land surface
BNAs	Base neutral/acid extractables
BRA	Baseline Risk Assessment
[BRAC	**Base Realignment and Closure]**
BW	Body Weight
CCB	Continuing Calibration Blank
CDI	Chronic Daily Intake
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CG	Cleanup Goal
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
COC	Chain of Custody
COPCs	Chemicals of Potential Concern
CPSSs	Chemicals Present in Site Samples
CRQL	Contract Required Quantitation Limit
CSAP	Comprehensive Sampling and Analysis Plan
CSS	Contaminant Source Survey
CSV	Chemical-Specific Value
CT	Central Tendency
C_w	Chemical Concentration in Groundwater
DCB	Decachlorobiphenyl
DI	De-ionized
DOT	Department of Transportation
E/A&H	EnSafe/Allen & Hoshall
E&E	Ecology and Environment, Inc.
ED	Exposure Duration
EF	Exposure Frequency
FB	Field Blank
FDEP	Florida Department of Environmental Protection
FDWS	Florida Drinking Water Standard
FFA	Federal Facilities Agreement
FGGC	Florida Groundwater Guidance Concentrations
FNAI	Florida Natural Areas Inventory
f_{oc}	Organic Carbon Fraction
FPDWS	Florida Primary Drinking Water Standard
FS	Feasibility Study
FSA	Full Scan Analysis

FSDWS	Florida Secondary Drinking Water Standard
ft/day	Feet per day
G&M	Geraghty & Miller, Inc.
GPS	Global Positioning System
GS	Grain Size
H_2SO_4	Sulfuric Acid
HCl	Hydrochloric Acid
HEAST	Health Effects Summary Tables
HI	Hazard Index
HNO_3	Nitric Acid
HQ	Hazard Quotient
IAS	Initial Assessment Study
ICB	Initial Calibation Blank
ICSA	Interference Check Sample Analysis
ID	Inside Diameter
IDL	Instrument Detection Limit
IDW	Investigation-derived Waste
ILCR	Incremental Lifetime Cancer Risk
IR	Ingestion Rate
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IWTP	Industrial Wastewater Treatment Plant
K	Hydraulic Conductivity
K_d	Distribution Coefficient
K_{oc}	Carbon Partitioning Coefficient
LCSA	Laboratory Control Sample Analysis
LEL	Lower Explosive Limit
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	Mean sea level
NADEP	Naval Aviation Depot
NaOH	Sodium Hydroxide
NAS	Naval Air Station
NEESA	Naval Energy and Environmental Support Activity
NPL	National Priorities List
OD	Outside Diameter
OERR	Office of Emergency and Remedial Response
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbon
PBS1	Soil Preparation Blank
PBW	Water Preparation Blank
PCBs	Polychlorinated Biphenyls
PID	Photoionization Detector
ppb	Parts per billion
PPE	Personal Protective Equipment
ppm	Parts per million
PPS	Physical parameters, soil
PPW	Physical parameters, water

PRG	Preliminary Remediation Goal
PVC	Polyvinyl Chloride
PWC	Public Works Center
QA/QC	Quality Assurance/Quality Control
R	Flagged
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-based Concentration
RC	Reference Concentration
R_f	Retardation Factor
RfD	Reference Dose
RGO	Remedial Goal Options
RI	Remedial Investigation
RMI	Reasonable Maximum Exposure
ROD	Record of Decision
[ROICC	**Resident Officer In Charge of Construction]**
RRFs	Relative Response Factors
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SF	Cancer Slope Factor
SMCL	Secondary Maximum Contaminant Levels
SMP	Site Management Plan
SOP/QAM	Standard Operating Procedures and Quality Assurance Manual
SOUTHNAVFACENGCOM	Southern Division Naval Facilities Engineering Command
SOW	State of Work
SPLP	Synthetic Precipitation Leaching Procedure
SVOCs	Semivolatile Organic Compounds
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TCX	Tetrachloro-m-xylene
TEF	Toxicity Equivalency Factor
TIC	Tentatively Identified Compound
TOC	Total Organic Carbon
TRPHs	Total Recoverable Petroleum Hydrocarbons
U	Undetected
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
VTSR	Verified Time of Sample Receipt

EXECUTIVE SUMMARY

A remedial investigation was conducted for Category V —Chevalier Field area, Site 9 (the Navy Yard Disposal Area), Site 29 (the Soil South of Building 3640), and Site 34 (the Solvent North of Building 3557). The investigation identified the presence of contamination in soil and groundwater apparently resulting from past releases in the Chevalier Field area.

Approximately 60 parameters were detected in laboratory-analyzed samples. **[The analytical data for soils were initially compared to risk-based, surface soil PRGs exclusively (1995 PRGs). The 1995 PRGs comparison considered conservative assumptions, fast-track remediation requirements, and Tier 1 agreements. The 1995 PRGs were used for the BRA and to justify interim soil removals on each site. Subsequent comparisons (1996 PRGs) used subsurface leaching values. This was because state/federal leachability standards were available, the extensive placement of fill over Chevalier Field during BRAC construction removed the soil pathway for risk, and Tier 1 agreement. Compared to the 1995 study, the 1996 comparison focused only on the leachability of contaminants to groundwater. Parameters above PRGs]** consisted of heavy metals, cyanide, pesticides, polycyclic aromatic hydrocarbons (PAHs), and non-chlorinated and chlorinated aromatic volatiles.

Site 9 soil conditions were characterized by metals and PAHs exceeding PRGs. The highest concentrations were **[at a singular location]** in the center of the site, and are associated with material potentially from the former dump. Non-detect to low levels of pesticides were detected at the site in surface soil with localized concentrations exceeding PRGs found in **[nine]** areas. These pesticides likely represent residual concentrations from surface application for pest control. It is most likely that the PAH contamination is associated with a final release from Site 23, a UST site immediately adjacent to Site 9. **[Soil from the most contaminated zones were subject to interim removal action.]**

Site 29 soil conditions were characterized by metals, PAHs, and the pesticide dieldrin in soils at levels exceeding PRGs. Manganese is present in surface and/or subsurface soils in localized

[Bold items in brackets denote changes to the first draft of document.]

areas and is present at levels consistent with background. Non-detect to low levels of several PAHs are present in localized areas throughout the site, with benzo(a)pyrene found in subsurface soils at a single area in the northwest portion of the site. The same location had **[PRG exceedances]** of the pesticide dieldrin. The dieldrin/PAHs likely represent the presence of reworked material as the Chevalier Field complex was built**[, and soils at this location were subject to interim removal action.]**

Site 34 soil conditions were characterized by metals and PAHs at levels exceeding PRGs. Lead and naphthalene were present in subsurface soils at a localized area adjacent to the northern end of Building 3557. These constituents were present in the general area of the reported solvent release**[, and soils in this area were subject to interim removal action.]** Non-detect to low levels of pesticides are localized throughout the site.

All three sites have aluminum, iron, and manganese above Federal Secondary Maximum Contaminant levels and Florida Secondary Drinking Water Standards in groundwater. Site 29 displayed a single cyanide concentration above standards; however, no soil cyanide source was verified at the site, and no history of this constituent exists where it was found. Site 34 revealed a single localized lead concentration above standards. Site 34 also displayed a localized concentration of naphthalene above standards in groundwater where there was naphthalene soil contamination.

The soil and groundwater contamination found on these sites are considered delineated for purposes of the RI. The main areas of soil contamination on each site include: 1) the area presumed to be the former dump on Site 9; 2) the area of dieldrin and PAH contamination on Site 29; and 3) the area of lead and naphthalene contamination on Site 34. **[The contaminated areas of Sites 29 and 34 were subject to interim soil removal, along with a PAH contaminated area on the eastern portion of Site 9. Sufficient removal was documented through a confirmatory sampling program, which affirmed the adequate soil removal had taken place in the targeted areas. The metals and PAH contaminated area in the west**

[Bold items in brackets denote changes to the first draft of document.]

central portion of Site 9 was not included in the soil removals, and will be addressed under the UST program during the investigation of Site 23.

The 1996 PRG comparisons indicate the previously mentioned areas and several isolated locations may pose a threat to groundwater. Notably, no correlation exists between the distribution and concentrations of inorganics above PRGs in soil and inorganics above PRGs in groundwater. Therefore, based on current data, it appears that inorganic constituent leaching to groundwater poses minimal threat. Organic PRG exceedances comprise several isolated occurrences of dieldrin only slightly above leachability PRGs. Dieldrin was not detected in groundwater at any of these locations, thus indicating minimal to no threat for leaching].

Potential ecological impacts of contaminant migration via groundwater from these sites on the adjacent areas of Pensacola Bay and wetlands will be evaluated in investigations for NAS Pensacola Sites 40 (Bayou Grande), 41 (NASP wetlands), and 42 (Pensacola Bay).

The human health risk associated with exposure to environmental media at Sites 9, 29, and 34 was assessed for hypothetical future site residents. This assessment considered that **[extensive fill]** is being added to the sites during the BRAC construction, and that 68% of the area will be either paved or covered with buildings when construction is complete. As a result of this, a soil exposure scenario was considered unnecessary. As discussed in Section 10.1.7 of the BRA, the maximum groundwater concentrations reported for arsenic at Sites 9 and 29 do not exceed the ARAR, 0.05 mg/L (MCL/FPDWS). However, the risk posed by arsenic at Sites 9 and 34 (1E-4) exceeds the FDEP and USEPA point of departure (1E-6). The only reported concentration for dieldrin (0.00013 mg/L on Site 29) is approximately equal to the FDEP ARAR (0.0001), and this compound was not detected in the confirmatory sampling effort. The single hit of dieldrin detected poses 1E-5 excess cancer risk, which exceeds the FDEP and USEPA risk point of departure. Although the calculated risk exceeds the FDEP and USEPA threshold, **[the]** absence of detected dieldrin during confirmatory sampling, **[the absence of dieldrin in**

groundwater elsewhere on the sites, the absence of PAH contamination in groundwater, (except for naphthalene on Site 34), and the inability to correlate soil and groundwater inorganic contamination, along with] comparison of reported concentrations to ARARs supports a conclusion of no further action recommendation for groundwater based on risk. Due to: 1) the sporadic occurrence of contaminants, 2) the **[interim]** removal of soil from the localized contaminated areas on each site, 3) the extensive covering of the site area with fill, 4) the percent of the area scheduled to be paved or built on during BRAC construction, and 5) the no further action recommendation for groundwater based on risk; further delineation and assessment within the Sites 9, 29, and 34 area is unwarranted. It is further recommended that the site area does not warrant the detailed evaluation of remedial alternatives associated with a feasibility study. **[Given the presence of several constituents in soil above leachability PRGs, however, it is recommended that the NASP master plan be modified to include restrictions on the use of the surficial aquifer beneath Chevalier Field as a potable or non-potable water supply.]** No further **[remedial]** action is recommended, along with a proposed plan leading to an interim record of decision for these sites.

[Bold items in brackets denote changes to the first draft of document.]

1.0 INTRODUCTION

Under the authority of the U.S. Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) program, a Remedial Investigation (RI) was recently completed at the following Category V sites at Naval Air Station Pensacola:

- Site 9 — Navy Yard Disposal Area
- Site 29 — Soil South of Building 3460
- Site 34 — Solvent North of Building 3557

These sites are listed in the Site Management Plan (SMP) of the Installation Restoration Program (IRP) for NAS Pensacola (SOUTHNAVFACENGCOM 1995). They are located on Chevalier Field, on the southeast portion of the naval installation. The investigation was undertaken by EnSafe/Allen & Hoshall (E/A&H) to meet the requirements of the federal Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) program, which administers the investigation and cleanup of hazardous waste sites. The RI report summarizes the activities, results, and conclusions of the investigation, including a BRA, and provides the basis for the feasibility study (FS) to be completed at the site. The objectives are outlined below.

Objectives of the Remedial Investigation

- To determine the source, nature, and to the degree practicable for an acceptable FS, the extent of soil and groundwater contamination and to characterize the surface soil at various points within the site.

- To make it easier to evaluate the risk to human health and the environment from onsite contaminated media. This goal is accomplished through the baseline risk assessment (BRA) process.

After the remedial investigation is complete, an FS will be conducted to determine appropriate methods of addressing site contamination, based on data generated during the RI process.

1.1 Project Organization

The RI was executed in three parts. First, all available previous investigation reports in the administrative record were reviewed to develop a comprehensive understanding of the site history and background to develop the Sampling and Analysis Plan (SAP)(E/A&H 1994a, 1994b, 1994c). Next, a contaminant source survey (CSS) was performed to gain additional information concerning the history of Sites 9, 29, and 34, and past and present activities which may have contributed to contamination at these sites. Finally, a field investigation was performed where soil borings were advanced and monitoring wells were installed to collect soil and groundwater samples for chemical and physical analyses. **[In addition to a field investigation being performed, interim soil removals were performed at all three sites in order to accommodate Base Realignment And Closure (BRAC) construction schedules for Chevalier Field.]**

1.2 Purpose of Report

This RI report summarizes the activities, results, and conclusions of the overall investigation, and provides the basis for a feasibility study to be completed and, ultimately, a Record of Decision (ROD) for the site. The report also documents the data collection and analytical methods used during the investigation.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Area Description

Sites 9, 29, and 34 of Category V, are located near the southwest portion of Chevalier Field as shown on Figure 2-1, Site Location Map and Figure 2-2, Site Distribution Map. This industrial area is used by the Naval Aviation Depot (NADEP) to rebuild, repair, and paint aircraft. Helicopter airframe work is conducted in two large hangars (Buildings 3460 and 3557) near the area of investigation. Immediately west of Building 3460 the site is a large, flat, grassy field and an asphalt parking lot. The site area also includes portions of the extensive concrete parking apron surrounding Buildings 3460 and 3557.

Site 9

The Navy Yard Disposal Area, used for trash and refuse disposal from 1917 until the early 1930s, includes the large grassy area and parking lot west of Building 3460, along with portions of Murray Road, Industrial Road, the places where Murray and Moffett Roads intersect Ellyson Avenue, and a portion of the concrete apron next to Building 3460. The land surface at Site 9 is approximately 5 feet above mean sea level. The terrain is relatively flat. Building 3615, the only structure on Site 9, is a picnic shelter in the northeast portion of the site. An aboveground steam pipeline originates near this shelter and crosses the eastern portion of the site, northeast to southwest, where it re-enters the ground. The northeast portion of the site includes the parking lot, while the northwest and southern portions of the site are mostly unpaved areas with sandy soil and mowed grass. The southeast corner of the site includes a portion of the concrete apron that surrounds Building 3460. The west and southwest portions of the site encompass those areas near Industrial, Murray, and Moffett Roads, and Ellyson Avenue (E&E 1992a).

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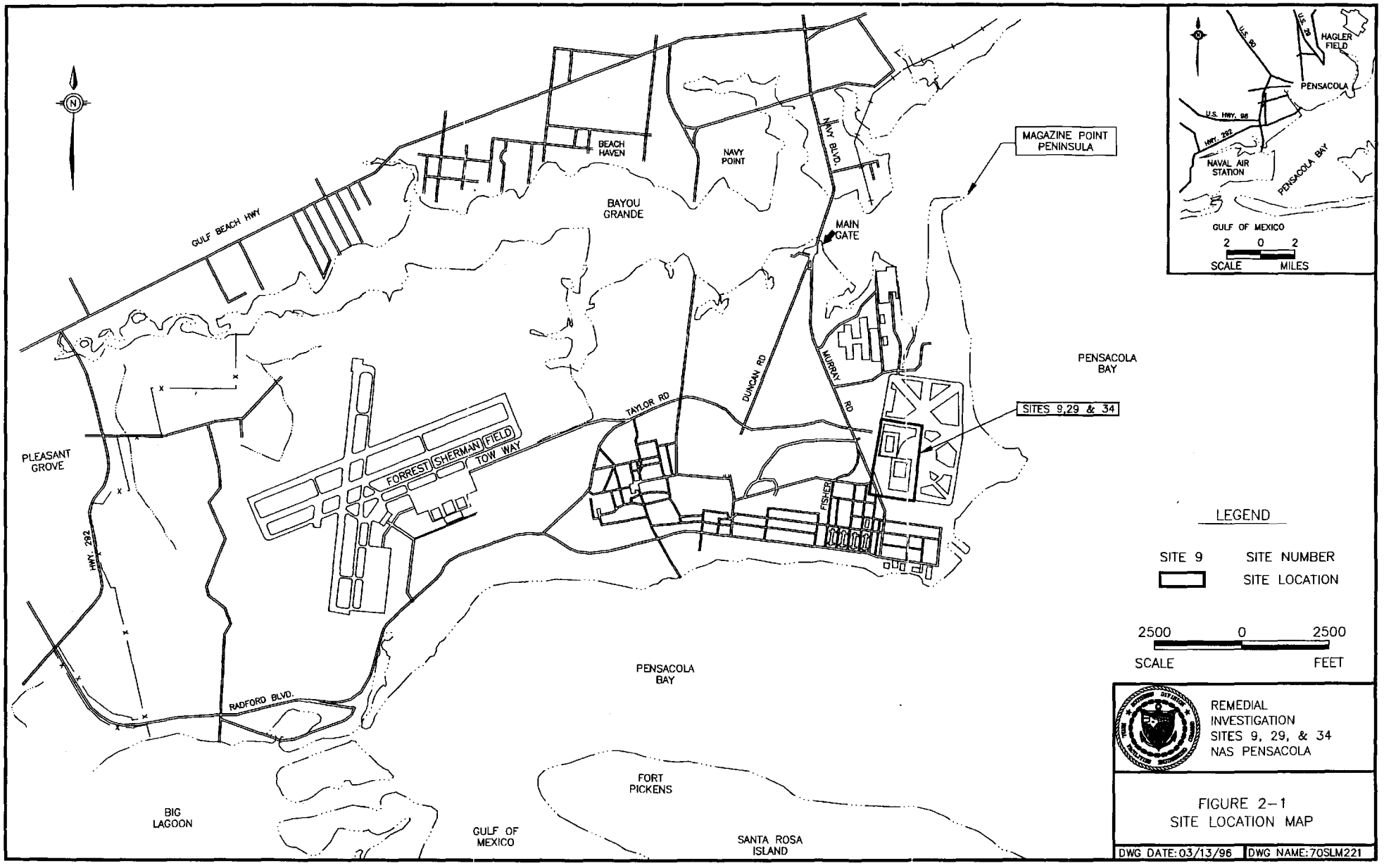
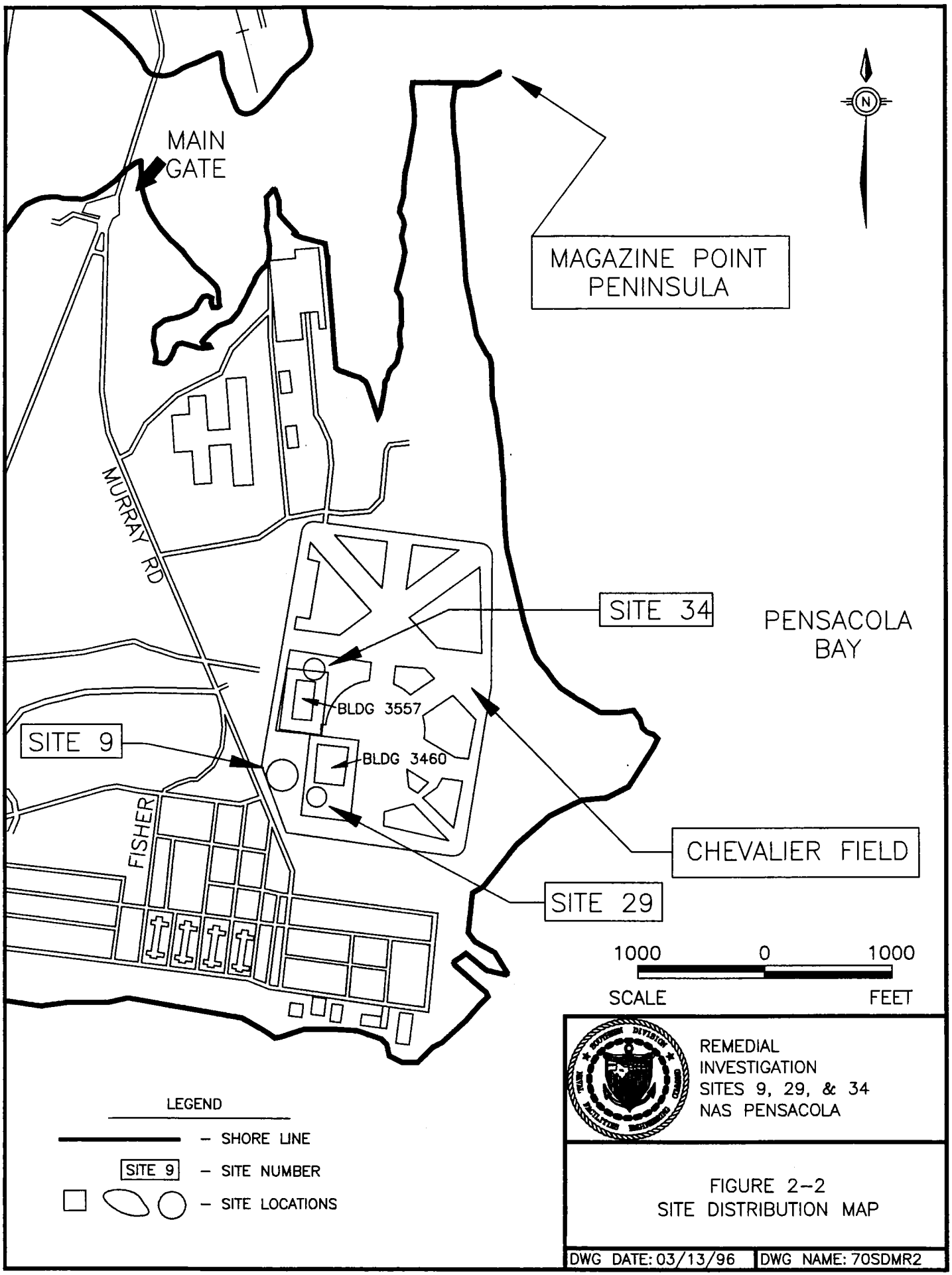

GULF BEACH HWY
BEACH HAVEN
NAVY POINT
BAYOU GRANDE
NAVY BLVD.
MAGAZINE POINT PENINSULA
MAIN GATE
PENSACOLA BAY
SITES 9,29 & 34
DUNCAN RD
MURRAY RD
TAYLOR RD
FISHER
FORREST SHERMAN FIELD
TOW WAY
PLEASANT GROVE
HWY 292
RADFORD BLVD.
PENSACOLA BAY
FORT PICKENS
BIG LAGOON
GULF OF MEXICO
SANTA ROSA ISLAND
U.S. 90
U.S. 29
HAGLER FIELD
PENSACOLA
U.S. HWY. 98
HWY. 292
NAVAL AIR STATION
PENSACOLA BAY
GULF OF MEXICO
2 0 2
SCALE MILES
LEGEND
SITE 9 SITE NUMBER
SITE LOCATION
2500 0 2500
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 2-1
SITE LOCATION MAP
DWG DATE: 03/13/96
DWG NAME: 70SLM221


MAIN GATE
MAGAZINE POINT PENINSULA
MURRAY RD
SITE 34
PENSACOLA BAY
BLDG 3557
BLDG 3460
SITE 9
FISHER
CHEVALIER FIELD
SITE 29
1000 0 1000
SCALE FEET
LEGEND
– SHORE LINE
SITE 9 – SITE NUMBER
– SITE LOCATIONS
REMEDIAL INVESTIGATION SITES 9, 29, & 34 NAS PENSACOLA
FIGURE 2-2
SITE DISTRIBUTION MAP
DWG DATE: 03/13/96
DWG NAME: 70SDMR2

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Site 29

Most of the site (the Soil South of Building 3460) includes the concrete aircraft parking apron on the southern side of the Building 3460. A small portion of the site's western side includes a part of the flat grassy field described for Site 9. Activities surrounding the site include those described for Building 3460. To the east is Building 3588, an airframe painting facility. To the south are Building 607, which is used for general maintenance and repair of helicopters and Building 630, which is currently not in use. Until recently, a fenced outside storage area north of Building 630 was used to store helicopter rotor blades and fuel tanks. Immediately north of this former storage area is an automobile parking area used by NADEP employees. The site also encompasses a portion of the industrial wastewater treatment plant (IWTP) sewer line which services:

- The Chevalier Field NADEP buildings described.
- Other NADEP buildings in the southeast portion of Chevalier Field.
- NADEP buildings near the waterfront (Building 604/former Building 71 area).

The portion of the sewer line crossing Site 29 runs southeast to northwest across the site, continuing to the northwest across Site 9. This gravity-fed line segment is constructed of 15-inch vitreous clay pipe and buried 7.2 to 7.8 feet below land surface (bls), approximately 3 to 4 feet below the top of the saturated zone. An 8-inch, vitreous clay line running southwest from Building 3460, connects into the main line approximately 60 feet from the building's southwest corner. Land surface elevation at the site is approximately 7 to 8 feet above mean sea level (E&E 1992a).

Site 34

The site (the Solvent North of Building 3557), which lies beneath the concrete apron immediately north of Building 3557, includes a small tank farm at the edge of the concrete apron approximately 150 feet north of the building. This tank farm consists of 6 large and 2 smaller cylindrical storage tanks, arranged aboveground on concrete foundations. The larger tanks have an approximate 20,000 gallon capacity. The contents of the six larger tanks have been identified as: T-101 (epoxy stripper MIL-R-81924), T-105 (detergent MIL-C-43616), T-106 (Stoddard solvent PD680-Type II), and T-107 (unknown). A paved trench from the tank farm to Building 3557 pipes materials from the tanks to activities inside the building. Land surface elevation at the site is approximately four feet above mean sea level (E&E 1992a). Figure 2-2 shows where sites are located relative to one another.

2.2 Site Histories and Previous Investigations

2.2.1 General History

Site 9: This site, which was used for the disposal of trash and refuse between 1917 and the early 1930s, is shown on several old maps as the Navy Yard Dump or the Warrington Village Dump (NEESA 1983). Part of Site 9 was excavated in the late 1960s, during trenching for an industrial wastewater treatment plant sewer. Although glass, scrap metal, and debris were unearthed, no unusual odor was reported (E&E 1992a).

Site 29: According to an initial assessment study, workers excavating within the site in 1981 received minor skin burns from contact with a black liquid in the soil. The workers were reportedly burned while repairing a 16-inch water main south of Building 3460. A black liquid was floating on water in a trench that had been excavated to repair the water main. When the water was pumped out, a residue coated the sides of the trench and pipe, and an odor similar to paint remover was noticed by workers. Because the incident occurred at a location

approximately 100 feet from the section of the IWTP sewer line crossing the site, it was suspected that industrial waste from the line might have leaked into the surrounding soil (E&E 1992b). It was not known what chemical caused the burns (NEESA 1983). During the CSS no physical evidence was identified on the concrete apron at Site 29 that suggested repairs were made to the wastewater sewer line. Also, the NAS Pensacola Public Works Center (PWC) has no utility maps depicting repairs conducted during this time period. A second leak in the wastewater sewer line was repaired during September 1986. This leak was under the grassy portion of the site immediately west of Building 3460 beneath the aboveground steamline system. The leak occurred along a portion of the industrial waste sewer line about 7.2 feet bls and approximately 3 to 4 feet below the top of the saturated zone. Information concerning the amount of leakage was sketchy (NAS Pensacola PWC 1994).

Site 34: In May 1984, a leak in a pipeline at the north end of Building 3557 reportedly resulted in the loss of approximately 45,000 gallons of a solvent detergent used to clean aircraft (G&M 1986). The solution contained 1.7 percent chlorinated aromatic hydrocarbon solvent, resulting in a calculative total of 750 gallons of solvent released. Local sediment, soil, and/or groundwater may have been impacted from the solvent detergent release. Constituents may have penetrated beneath the apron via the expansion joints which separate individual concrete sections. Escaped solvent detergent might have run off via the unpaved drainage swale that leads from the tank farm to the west. This pathway discharges via culverts beneath Industrial Road into the paved drainage ditch west of Chevalier Field (NAS Pensacola Wetland 6). It is presumed that contaminants were carried offsite via this route (E&E 1992a).

2.2.2 Chronology of Events and Previous Investigations

Note: This section summarizes previous work with a connection to Sites 9, 29, and 34.

1983 — Initial Assessment Study

The Initial Assessment Study (IAS) report conducted by the Naval Energy and Environmental Support Activity (NEESA) identified sites posing a potential threat to human health or the environment due to contamination from past hazardous materials operations. Historical records, aerial photographs, field inspections, and personnel interviews were used to identify 29 potentially contaminated sites at NAS Pensacola. Sites 9 and 29 were among those identified for evaluation by this study. According to the IAS report, Site 9 was used only to dispose of domestic trash and refuse, and not for hazardous waste. Also according to the report, there is no danger to human health or the environment from Site 9, and no further study at the site was recommended. Because several workers received minor skin burns from contact with an unknown chemical during excavation, Site 29 was concluded to constitute a potential threat to human health. Further study was recommended for Site 29 (NEESA 1983).

1984 — Verification Study

The 1984 Verification Study performed by Geraghty and Miller (G&M) examined Sites 9, 23 (a petroleum site immediately west of Site 9 where two reported releases occurred from an underground supply line), 29, and 34 by installing four monitoring wells along the southwest perimeter of Chevalier Field (GM-7, GM-29, GM-30, and GM-6). Piezometric information from these wells indicated that groundwater moved toward the paved ditch west of Chevalier Field. Groundwater samples from these wells and surface water collected from the ditch downstream from the site were analyzed for VOCs. No VOCs were present in groundwater samples from these wells at concentrations at or above method detection limits, though low concentrations of VOCs were found in the surface water samples. The study suggested that contaminants were very localized or had been purged from the shallow aquifer. No further inquiry was recommended for Sites 9 and 29. Since the Site 34 spill was very

recent, the study recommended additional monitoring wells and surface water sampling for Site 34 (G&M 1984).

1986 — Characterization Study

Site 34 was further studied by G&M in the 1986 Characterization Study. As a part of this study, three additional shallow monitoring wells and 1 deep well (GM-53, GM-56, GM-57, GM-61) were installed within the site. Groundwater samples were analyzed for VOCs, along with 3 surface water samples from downstream locations in the paved ditch. VOCs were detected in the sample from GM-53 (2 ppm benzene, 4 ppm toluene) and in all 3 surface water samples (2 to 42 ppm total VOCs). However, the types of VOCs identified in the groundwater and surface water were different, suggesting that the source of VOCs in the surface waters is not related to Site 34. The study suggested that the site does not appear to pose a threat to human health; no further action was recommended (G&M 1986).

1991 — Contamination Assessment/Remedial Activities Investigation

As a part of the Navy's IRP, E&E performed Phase I contamination assessments for 22 IRP sites at NAS Pensacola to identify principal areas and primary contaminants of concern at each site and to recommend any subsequent investigations. Fieldwork included site reconnaissance, surface emission surveys, particulate air screening, utilities surveys, collection of soil and groundwater samples, and hydrologic assessments. Sites 9, 29, and 34 were included in these investigations. It should be noted that the lab analyses were conducted as *screening analyses, and were intended only* to focus additional investigations - these screening analyses were somewhat deficient in 1) the lack of reproducibility and 2) the use of a single column-type GC analysis (no confirmation samples run). It should also be noted that groundwater samples were analyzed unfiltered and were characterized by very high turbidities, the latter being a factor

commonly associated with erroneously high metal results. Findings were presented in Interim Data Reports for each site:

- **Site 9**. The Site 9 Phase I investigation identified soil and groundwater contaminated primarily with TRPHs and PAHs. Low amounts of radiation were also identified at the site. The report referred to the repeated disturbance of soil on the site from grading, backfilling, and construction activities, and how these activities have most likely affected the redistribution of contaminants on the site. Low concentrations of metals such as lead and arsenic were widespread. The distribution of these metals in the unsaturated zone was attributed to localized sources of contamination and redistribution of soil on the site. Concentrations of TRPHs were identified in soil along the site's perimeter and near where the industrial waste sewer line crosses the site. PAHs were present at twice the detection limit at one location. Groundwater contamination primarily consisted of metals, in the form of lead. The scattered distribution of elevated lead in the saturated zone was attributed to localized contaminant sources, the extensive redistribution of soil from construction and earth moving, and/or leakage from the industrial waste sewer line. E&E concluded that further investigation was required at and near Site 9 (E&E 1992c).

- **Site 29**. The Site 29 Phase I investigation indicated the presence of metals, TRPHs, PAHs, and VOCs. TRPHs appeared to be limited to soil in the northern area of the site and along the section of the industrial waste sewer line passing through the site. The northern concentration of TRPHs indicated a potential local source of contaminants. PAHs present in a single sample from the eastern part of the site also suggested a local contaminant source. Higher concentrations of metals were in groundwater samples collected along the sewer line than in samples from other locations on the site. However, arsenic was found at concentrations above Florida Primary Drinking Water

Standards (FPDWS) in a groundwater sample from the southern edge of the site. Methylene chloride from an unknown source was present in a groundwater sample from the western part of the site. E&E concluded that further investigation was required at and near Site 29 (E&E 1992d).

- **Site 34.** During the Site 34 Phase I investigation, soil and groundwater analyses identified the presence of metals, TRPHs, PAHs and phenols. E&E concluded that the contaminants were not related to the solvent detergent leak and that additional contaminant sources might be impacting Site 34. Low concentrations of chromium, lead, zinc, and cadmium were detected from land surface to the water table in soil samples collected south of the onsite drainage swale. Limited TRPH contamination was found in the soil near the pipeline conduit between the tank farm and Building 3557, and along the portion of the industrial waste sewer line passing under the site. Low concentrations of PAHs were also present in soil at two areas along the sewer line. Groundwater samples exhibited slightly elevated concentrations of metals, with chromium, iron, and manganese exceeding Florida primary and secondary drinking water standards. Elevated concentrations of metals were also identified in groundwater along the industrial sewer line at Site 34. Low concentrations of VOCs, BNAs, PAHs, and phenols were also detected from groundwater samples at Site 34. A 25-foot deep concrete lined sump pit under the northern half of Building 3557 receives wash water from six aircraft cleaning bays in the building. E&E estimated that 50,000 to 70,000 gallons of infiltrated groundwater a day are pumped to the industrial waste sewer, along with collected aircraft washdown from the building. This continuous pumping operation was assumed to dewater portions of Site 34 and influence groundwater flow direction at the site. It was thought that the sump pumping might have removed detergent or solvent-contaminated groundwater from the shallow aquifer and directed it to the industrial waste sewer north

of the building. E&E concluded that further investigation was required at and near Site 34 (E&E 1992e).

1992 — Data Summary/Preliminary Scoping Report for Ecological Assessment Work Plans
This E&E report documented data for the scoping of work plans for NAS Pensacola Operable Units 15, 16, and 17 (Bayou Grande, the NAS Pensacola wetlands, and Pensacola Bay). The report was also intended to outline the need for risk assessment studies at these sites. Sites 9, 29, and 34 were noted to be among 11 contributing sources that potentially discharge into the yacht basin of Bayou Grande via groundwater migration and surface runoff. The report suggested that an ecological risk assessment was warranted for the yacht basin due to the high risk quotients associated with contaminants in the sediments and surface waters and the multiple contributing sources (E&E 1992f).

[1995 — Interim Removal Actions
In order to accommodate the BRAC construction agenda scheduled to begin on Chevalier Field in early 1995, several soil interim removal actions were performed on Sites 9, 29, and 34 commensurate with NADEP demolition and new construction work. The interim soil removals performed on Sites 9, 29, and 34 are described in the Soil Removal Summary Report (E/A&H 1996). This report discusses the removal actions, the confirmatory samples/results collected by E/A&H, sampling techniques, disposal of removed soil, and subsequent backfilling of excavated areas.]

3.0 ENVIRONMENTAL SETTING

3.1 Physiography

NAS Pensacola is in the Gulf Coast lowlands on a peninsula bounded by Pensacola Bay to the south and east and Bayou Grande to the north. The main topographic feature is a bluff paralleling the southern and eastern shorelines of the peninsula. Landward of the bluff is a gently rolling upland with elevations up to 40 feet above mean sea level (msl) (USGS 1970a and 1970b). In the eastern part of the base, a low and nearly level marine terrace lies east of the bluff with elevations of approximately five feet or less above msl. Chevalier Field and Magazine Point are on this marine terrace.

Sandy soils typify the NAS Pensacola area. Consequently, most rainfall infiltrates directly into the subsurface, resulting in few natural streams. Streams on base generally are man-made and channelized. Numerous natural wetlands occur in low-lying areas.

3.2 Stratigraphy and Hydrogeology

Stratigraphy beneath the Florida Panhandle generally consists of Quaternary marine terrace and fluvial deposits, underlain by a thick sequence of interlayered fine-grained clastic deposits and carbonate strata of Tertiary age (Southeastern Geological Survey [SEGS] 1986). Three main regional hydrogeologic units have been described within this stratigraphic column (in descending order): the Surficial/Sand-and-Gravel Aquifer, the Intermediate System, and the Floridan Aquifer System. Figure 3-1 provides a generalized cross-section of these hydrogeologic units in northwest Florida.

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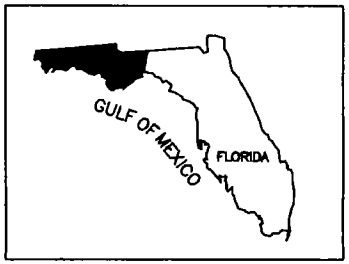

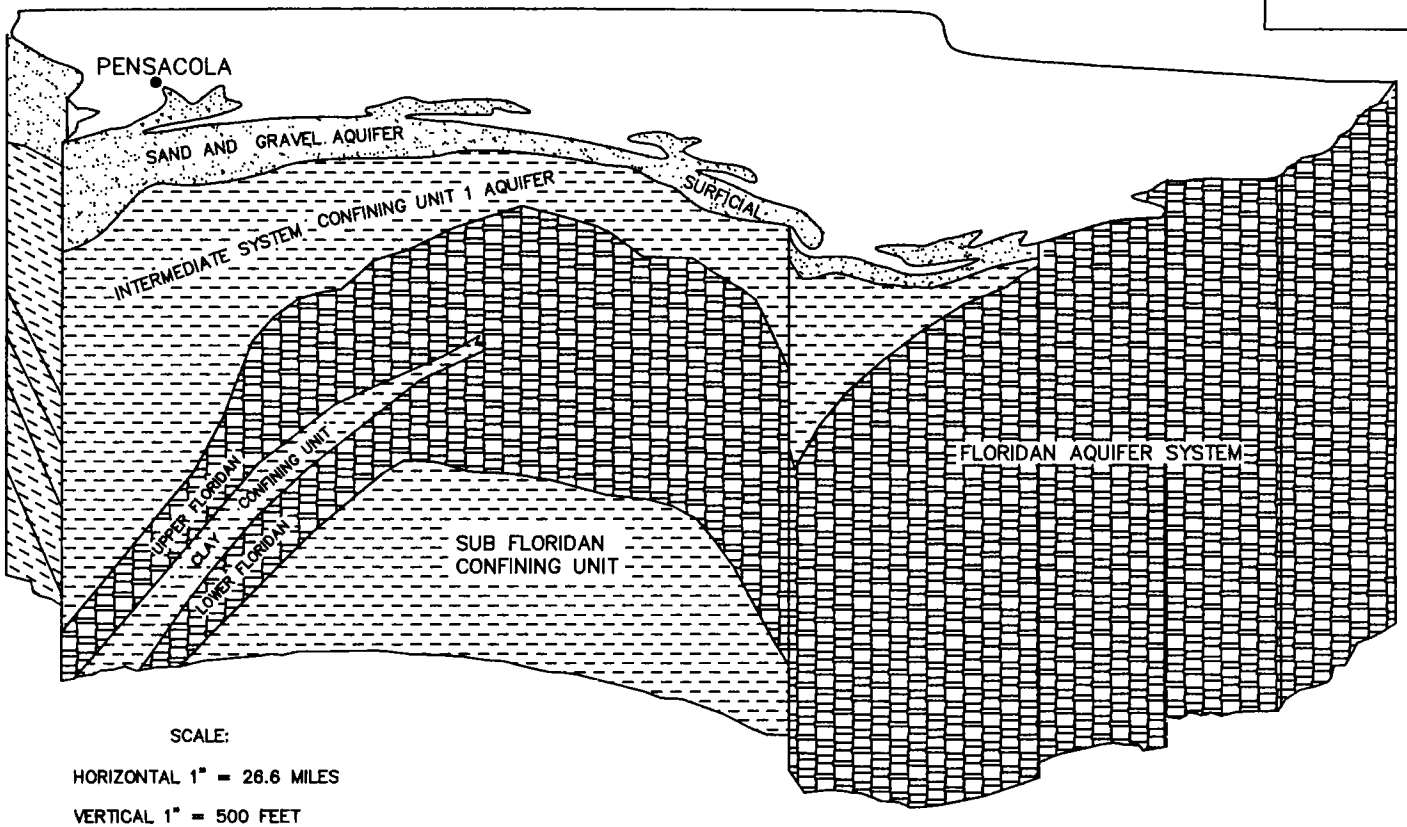

SCALE:

HORIZONTAL 1" = 26.6 MILES

VERTICAL 1" = 500 FEET

VERTICAL EXAGGERATION = 281

SOURCE: E&E 1992c.

REMEDIAL
INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 3-1
GENERALIZED GEOLOGIC CROSS-SECTION OF
HYDROGEOLOGIC UNITS IN
NORTHWEST FLORIDA

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Surficial/Sand-and-Gravel Aquifer

The Surficial Aquifer, comprised primarily of unconsolidated siliciclastic sediments is approximately 300 feet thick at NAS Pensacola. These sediments belong to undifferentiated Pleistocene-Holocene terrace deposits, the Pliocene Citronelle formation, and underlying Miocene coarse clastics (Wilkins et al. 1985). West of the Choctawhatchee River in northwest Florida, the Surficial Aquifer is referred to as the Sand-and-Gravel Aquifer, and is a major source of drinking water (SEGS 1986). The Florida Department of Environmental Protection (FDEP) classification of the surficial aquifer is G-1 with a USEPA classification of IIA. Because the Sand-and-Gravel Aquifer is the uppermost unit contiguous with land surface and receives recharge through direct infiltration, it is susceptible to contamination from surface activities. In the vicinity of NAS Pensacola, the unit has been subdivided into three distinct zones based on hydrogeologic differences (in descending order): *the surficial zone, the low permeability zone*, and *the main producing zone* (Wilkins et al. 1985). This investigation focuses on the upper (shallow depth) and basal (intermediate depth) portions of the surficial zone. A generalized cross-section of the Sand-and-Gravel Aquifer produced by Geraghty & Miller (G&M 1984), as shown in Figure 3-2, illustrates the stratigraphic relationship of these zones.

Surficial Zone

The surficial zone is contiguous with land surface and contains groundwater under water table or perched conditions. At NAS Pensacola, the surficial zone is approximately 40 to 60 feet thick and is generally composed of a poorly graded quartz sand (G&M 1984, 1986). Beneath the western side of the base, a substantial stratum of sand with abundant organic matter occurs within the zone and pinches out to the east. Depth to groundwater ranges from 0 to 20 feet depending on ground surface elevation. Aquifer tests have yielded high hydraulic conductivities, on the order of 10^{+1} to 10^{+2} feet/day (E&E 1990). The lower contact with the low permeability zone is transitional,

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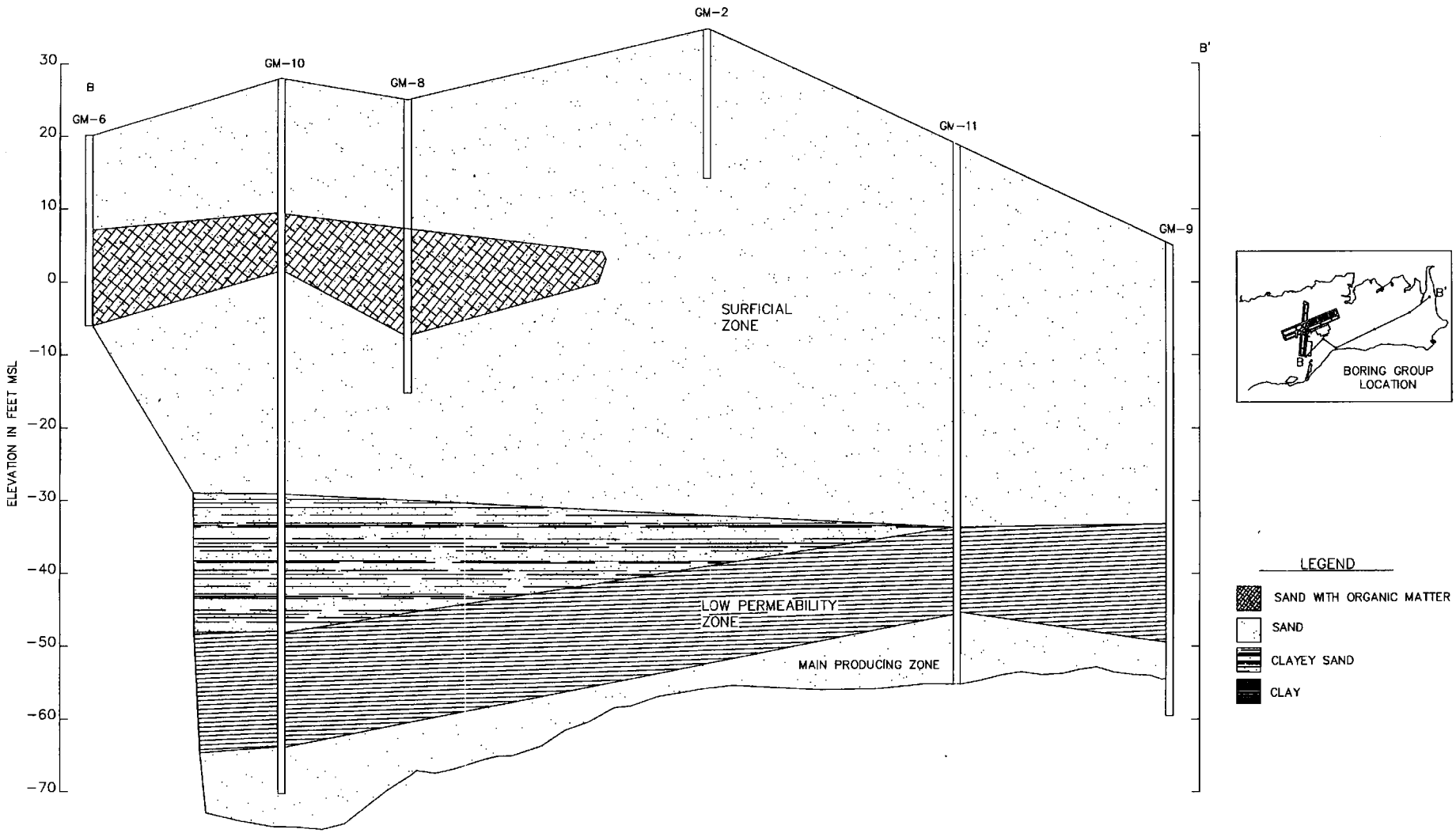

SOURCE: GERAGHTY & MILLER, 1986

REMEDIAL INVESTIGATION
REPORT
NAS PENSACOLA SITES
9, 29 & 34

FIGURE 3-2
GEOLOGICAL CROSS-SECTION
OF THE SURFICIAL AQUIFER
AT NAS PENSACOLA

DATE: 03/13/96 | DWG NAME: 70SITCS1

resulting in a fining downward sequence in the lower portion of the surficial zone proper. Generally, the low permeability zone is thicker to the west, and thins to the east. This increased clay content in the transition from surficial to the low permeability zone is responsible for lower hydraulic conductivities that have been measured in the base of the surficial zone.

Shallow groundwater flow in the surficial zone is generally influenced by topography, usually flowing toward and discharging to the nearest surface water body.

Low Permeability Zone

The low permeability zone underlies the surficial zone and is characterized by clay and silt-sized sediments. At NAS Pensacola, this zone is composed of gray to blue, gray sandy and silty marine clay with some shell fragments and clayey sands, with total thickness ranging from 8 to 40 feet (G&M 1984, 1986). The upper contact is transitional with the overlying surficial zone; however, the top of the low permeability zone is marked by the first occurrence of a stiff blue-gray clay. Studies at NAS Pensacola indicate the low permeability zone is continuous beneath the air station. Hydraulic conductivities of the low permeability zone are much lower than the overlying surficial zone, ranging between the orders of 10^{-4} feet/day for clays and 10+0 feet/day for clayey sands (G&M 1986). Hence, the low permeability zone acts as a confining or semiconfining layer to inhibit groundwater flow between the overlying surficial and underlying main producing zone.

Main Producing Zone

The main producing zone underlies the low permeability zone and comprises the bottom portion of the Sand-and-Gravel Aquifer. Regionally, depth to the top of the zone ranges from 60 to 120 feet. The zone is composed of sand and gravel with thin beds of silt and clay, and is estimated to be approximately 300 feet thick at NAS Pensacola. Of the three zones in the

Sand-and-Gravel Aquifer, this one is generally the most permeable and is the principal source of water supply for the Pensacola area (Wilkins et al. 1985). Groundwater in this zone generally is confined, and in southern Escambia County it recharges primarily north of southern Escambia County and is supplemented by leakage in the northern parts of the county where it is present at the surface. Regional groundwater flows generally east toward Pensacola Bay and south toward the Gulf of Mexico. Three supply wells at NAS Pensacola produce water from this zone; however, they are used only as an emergency supplement to the base water supply, to supply irrigation to the base golf course, and fire protection due to the water's high iron content (G&M 1984, 1986). For potable water, NAS Pensacola depends on an offsite water source provided from main producing zone wells at Corry Field, approximately three miles to the north.

Intermediate System

The Intermediate System, a regionally and vertically extensive, laterally persistent hydrologic unit, underlies the Surficial/Sand-and-Gravel Aquifer. The system is comprised of fine-grained clastic units of Miocene age (Pensacola Clay, Alum Bluff Group) that lie beneath coarse clastics of the overlying Sand-and-Gravel Aquifer. In the vicinity of NAS Pensacola, depth to the top of the unit is approximately 300 feet, with a thickness of approximately 1,100 feet (Wilkins et al. 1985, SEGS 1986). The system is regionally characterized by poor to non-water-bearing conditions. Permeabilities are much lower than those of the overlying Sand-and-Gravel Aquifer and the underlying Floridan Aquifer System, and consequently the system functions as a confining unit for the underlying Floridan Aquifer System (SEGS 1986).

Floridan Aquifer System

The Floridan Aquifer System underlies the Intermediate System at an approximate depth of 1,400 feet in the NAS Pensacola area. The unit is composed predominantly of limestone, but is separated into upper and lower units by a significant clay layer called the Bucatunna Clay (see

Figure 3-1). Groundwater within the Floridan System is highly mineralized in the area of NAS Pensacola and is not used for water supply (Wagner et al. 1984). However, groundwater from the Upper Floridan Aquifer is used for water supply as close as approximately 25 miles east of NAS Pensacola.

3.3 Ecological Setting

3.3.1 Regional Ecological Setting

According to Wolfe et al., 1988, the Florida Panhandle has a wide variety of surface waters and physiographic regions, leading to an ecological diversity found in few other areas of the United States. Watersheds of the panhandle support a diverse array of habitats and vegetative communities. Bottom land hardwoods predominate in river floodplains and pines, mixed with a variety of other shrubs, prevail in upland areas. Wetlands are prevalent along the coastal fringe and river floodplains. Barrier islands support dune vegetation communities and salt marshes. Bays supporting seagrass meadows and oyster reefs are present in intertidal and subtidal areas.

Seven major rivers in the region discharge into seven bar-built estuaries formed at the mouths of the rivers. The Florida Panhandle is a crossroads where animals and plants from the Gulf Coastal Plain reach their eastward distributional limits, and where many northern species reach their southern limits. Many peninsular Florida species are also distributed there. Due to the wet temperate climate of the region, the panhandle area may support the highest diversity of species of any other similar-size territory in the U.S.

The high annual rainfall and low, gently sloping terrain creates numerous wetlands in the region. Bogs, swamps, marshes, wet prairies, and wet flatwoods provide a diversity of wetland types

supporting a wide variety of flora and fauna. Terrestrial vegetation includes open pine woods and hardwood forests; most are second-growth forests of pines and encroaching hardwoods.

The Florida Panhandle's estuaries and nearshore marine habitats are some of the greatest natural and economic assets of the region. Important commercial organisms (such as oysters and fish) abound in these areas and contribute to the economy of the region. Coastal saltmarsh habitats provide critical nursery, feeding, and refuge for these important commercial species. Seagrass beds within estuaries also are vital to the seafood industry.

3.3.2 Ecological Setting at NAS Pensacola

NAS Pensacola, which occupies approximately 5,800 acres, is bounded by Bayou Grande to the north and Pensacola Bay to the east and south. To the west, the installation transitions to less developed swampy lowlands. NAS Pensacola's eastern portion is largely developed, with military and industrial facilities and historical/cultural sites. Most of the installation's activities are located on the eastern side of the base. The less developed west side of the base has approximately 3,500 acres of natural or semi-natural beach areas, forests, and wetlands.

NAS Pensacola is the setting for numerous, aquatic and terrestrial habitats, from coastal strand and estuarine environments along the bay and bayou to inland pine flatwoods communities. Wetland environments include a broad spectrum of both estuarine and palustrine wetlands, as well as various disturbed habitats, many in states of recovery as they undergo reforestation or return to their natural condition.

Vegetation Communities

NAS Pensacola natural vegetation communities fall into several broad categories: (1) coastal dune scrub communities, (2) pine flatwoods communities, (3) hardwood/pine communities,

(4) sand pine scrub communities, (5) bay swamps, (6) freshwater marshes, and (7) estuarine coastal marshes (USFWS 1987). Coastal dune scrub communities are associated with shorelines subject to high energy waves. The vegetation consists of salt-tolerant plants able to establish themselves in shifting sands. Pine flatwood communities in coastal lowlands are characterized by trees that can tolerate various soil moisture conditions. Tree species in flatwoods communities are short, with a wide variety of small shrubs and herbaceous plants in the understory. Hardwood/pine communities are a highly diverse mixture of hardwood trees and pines. Sand pine scrub communities on well drained sandy soils contain sand pines, oaks, and various shrubs. Bay swamps are wetlands with titi and cypress swamps known to contain permanent standing water and high accumulations of organic peat. Freshwater marshes occur as grass/sedge/rush/herb communities in areas with high soil saturation or standing water. Estuarine coastal marshes, including salt marshes, occur along low energy shorelines and in tidal bayous (USFWS 1987).

Wildlife

NAS Pensacola habitats provide potential ranges for a wide variety of animal life such as deer, squirrel, opossum, raccoon, fox, beaver, and bobcat. The station's beaches serve as resting, feeding, and nesting areas for various shorebirds. Ospreys have been observed nesting along undeveloped shoreline areas of the Big Lagoon, southeast of the Forrest Sherman Airfield. Numerous small mammals, amphibians, and reptiles also inhabit the base. The coastal marsh, submerged grass bed, and shallow water habitats at NAS Pensacola help support fishery communities within the Pensacola Bay estuarine complex. Approximately 180 species of bony fishes form the basis of the Pensacola Bay fish community (USFWS 1987).

Threatened and Endangered Species

Appendix A of the Comprehensive Natural Resources Management Plan for NAS Pensacola and OLF Bronson lists the rare, threatened, and endangered species that may be found within NAS Pensacola boundaries (USFWS 1987). E/A&H investigations of different areas of NAS Pensacola have identified osprey, great blue heron (as well as other shorebirds), alligator snapping turtle, Godfrey's golden aster, Carolina lilaeopsis, white-top pitcher plant, and narrow-leaved sundew. All are considered rare or endangered for Escambia County, Florida, by the Florida Natural Areas Inventory (FNAI 1994).

3.4 Area Climate

The Pensacola area has a mild, subtropical climate, with average annual temperature ranging from 55°F in the winter to 81°F in the summer. Daily temperatures can be more extreme, ranging from less than 7°F in the winter to more than 102°F in the summer. Thunderstorms, which occur on approximately half the summer days, can cause a precipitous drop in temperature of 10 to 20 degrees in a matter of minutes (E&E 1992f).

November is the driest month of the year, with an average rainfall of 3.2 inches, based on climatological data from 1962 to 1991. Rainfall averages approximately 60 inches a year, with the highest amounts in July and August when thunderstorms occur almost daily. Thunderstorms resulting in 3 to 4 inches of rain in an hour are common. Rainfall is lowest during spring and fall (4 inches average per month). In general, spring and fall rains are less intense, last longer, and produce less surface runoff, but higher rates of infiltration and net recharge (E&E 1992f).

Winds, which prevail from the north during the winter and the south during the summer, are generally moderate in velocity, except during thunderstorms. A difference in the ocean-land temperature produces the sea-breeze effect, a daily clockwise rotation in the surface wind

direction near the coast. Hurricanes and tornadoes can substantially damage the nearshore environment. Since 1980, **[eight hurricanes have passed within 50 miles of Pensacola, the most recent being Hurricanes Erin and Opal in August and October 1995, respectively.]**

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4.0 PRELIMINARY SURVEYS

4.1 Phase I Surveys

Preliminary surveys for each site were performed during the 1991 Phase I investigations conducted by E&E. Section 2.2, Site History and Previous Investigations, summarizes the findings of these investigations. These Phase I investigations are discussed in the Interim Data Report for each site (E&E 1992cde).

4.2 Contaminant Source Survey

A CSS was conducted before each the field investigation. The survey was used to quantify information on past and present site activities or incidents that may have resulted in known or suspected releases of contamination to the environment.

The following sources were reviewed:

- Previous investigation reports and site historical information.
- NAS Pensacola PWC drawings and utility maps.
- Aerial photographs.

Additionally, NAS Pensacola personnel were interviewed.

Contaminant Source Survey Findings

A review of aerial photographs from 1951 to 1989 indicated changes in activities and surface features within the site such as repeated earth moving, backfilling, and paving. Early photos depict the eastern portion of the site as largely beneath the pavement of Chevalier Field's runways, taxiways, and parking apron. The western portion of the site was largely unpaved with a sandy soil surface. Surface drainage appears to be westward, toward the paved ditch

leading to the yacht basin (E&E 1992c). Further construction activities in the site area appear in later photos, with the installation of the industrial waste sewer line throughout the site area, and the construction of Buildings 3460, 3557, and other buildings or structures currently associated with NADEP. Extensive reconstruction of the concrete parking apron in the site areas also occurred. Commensurate with the construction of facilities on Chevalier Field, new road construction occurred in the southwest portion of the site area. Road modifications and construction included Murray, Moffett, and Industrial Roads, and Ellyson Avenue. The excavation, trenching, backfilling, and grading activities associated with the extensive construction in the site area may have had the potential for redistribution of pre-existing contaminants (E&E, 1992cde).

The industrial waste sewer line, which traverses portions of Sites 9, 29, and 34, is a potential source of contaminants for these sites. Approximately 2,700 feet of gravity-fed sewer line constructed of vitreous clay pipe branches throughout the site area. The sewer line transports wastes of various types to the industrial waste water treatment plant on Magazine Point. Most wastes enter the sewer line without any pretreatment, and may include everything that is used by NADEP facilities (strippers, solvents, waste oils, etc.). The sewer line has been subject to numerous failures, such as pipes breaking and lift stations failing, which have caused leaks and spills along the route. It was assumed that leaks from the industrial waste sewer line south of Building 3460 in 1981 caused the hazards identified at Site 29 (see Section 2.2) and any contamination associated with the site (E&E, 1992b). Results of the Phase I investigations suggested that the industrial waste sewer line may have contributed contaminants to all three sites (E&E, 1992cde).

In addition to these sources, at least one spill has been documented in relationship with the tank farm north of Building 3557 and piping leading south into the building (Site 34) (E&E 1992a).

4.3 Habitat and Biota Survey

Sites 9, 29, and 34 are located in an industrial area within the confines of southwest Chevalier Field. The general area mostly encompasses the concrete aircraft parking apron in the vicinity of Buildings 3460 and 3557, along with the maintained grassy field west of Building 3460. No natural plant or animal habitats exist on site, which consists of weedy, ruderal habitat outside landscaped areas. During the work week, the area is heavily trafficked by people on foot and by vehicles. The shoreline of Pensacola Bay lies approximately 2,700 feet east of the center of the site area, and shore birds are often observed in the vicinity of Chevalier Field. These sightings are normally associated with wetlands east of Chevalier Field, and the drainage ditch west of Chevalier Field. E/A&H biologists involved with recent field work in the site area did not notice shorebird activity within the site boundaries. However, this does not mean that shorebirds do not visit the site area during periods of reduced human activities (weekends, after working hours, etc.).

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5.0 FIELD INVESTIGATION APPROACH

The U.S. Navy-, USEPA-, and FDEP-approved work plans and sampling and analysis plans (SAP) for Sites 9, 29, and 34 outline a three-phased investigation consisting of soil borings, installation of temporary and permanent monitoring wells, and collection of soil and groundwater samples for Target Analyte List/Target Compound List (TAL/TCL) analyses using Contract Laboratory Program (CLP) protocol (USEPA 1994a). This phased approach was developed and agreed to by E/A&H, USEPA, FDEP, and the Navy in mid-January 1994. These sites were given high priority due to forthcoming construction deadlines mandated by the BRAC Commission at Chevalier Field.

The first phase of the investigation was conducted to identify the presence or absence of contaminants at each site, and establish preliminary remediation goals (PRGs) for identified constituents. Further assessment activities were to be dependent on whether soil and groundwater samples exceeded the applicable PRGs. Phase II of the investigation was implemented to delineate plume/soil contaminants identified at concentrations exceeding PRGs. Based on cost/time estimates, the approving organizations agreed to use temporary monitoring wells during the initial phases, in addition to soil borings. The goal was to rapidly identify sources and types for the contaminants above PRGs for soil and groundwater.

Phase III of the investigation was to utilize strategically placed permanent monitoring wells (converted from select temporary well locations) and soil borings (if required), to confirm contamination delineation and form a basis for risk assessment (E/A&H 1994d). However, contamination assessment and delineation activities actually took place during the Phase II investigation using permanent and temporary monitoring wells installed for the earlier phases of the RI. If deemed to necessary, Phase III long-term groundwater contamination monitoring will need to be conducted using permanent monitoring wells installed after BRAC demolition

and construction are completed within the site areas. PRGs and analytical results are discussed in Section 7 of this report. Preliminary findings (Phase I) were discussed in a technical memorandum (E/A&H 1994d). This memorandum was used to develop a subsequent phase of fieldwork, which is discussed in detail in this remedial investigation report.

Analytical Parameters

In accordance with the SAPs for these sites, soil and groundwater samples were collected for Full Scan Analysis (FSA) using CLP TAL/TCL parameters during Phase I. In subsequent phases, analyses were limited to specific groups of contaminants. Selected soil and groundwater sampling locations were also chosen for Physical Parameters Soil (PPS), Grain Size (GS), and Physical Parameters Water (PPW) analyses. Soil samples were also collected for a soil leachability comparison and analyzed using Synthetic Precipitation Leaching Procedure (SPLP) analysis.

Two different laboratories were used to process CLP samples. All Phase I and initial Phase II CLP samples were processed by Pace Laboratories, Inc., Hampton, NH. CLP samples collected during the final Phase II sampling effort (December, 1994) were processed by CompuChem Laboratories, Inc., Research Triangle Park, NC. PPS/PPW and GS samples were processed by Savannah Laboratories, Inc. and Thompson, Engineering and Testing, Inc., both located in Mobile, AL.

Sample Identification

The final Comprehensive Sampling and Analysis Plan (CSAP) specifies a 10 digit identification code for soil and groundwater samples. This code identifies samples by site, sample medium, and location, with other pertinent information as required (E/A&H 1994e):

Site:

- The first three digits denote the site where the sample was collected.

Sample Matrix:

- The fourth digit identifies the sample matrix as follows:

S	=	Soil
C	=	Soil duplicate sample
G	=	Groundwater
H	=	Groundwater duplicate sample
T	=	Trip blank
E	=	Equipment rinsate blank
F	=	Field blank
K	=	Matrix spike sample
X	=	Matrix spike duplicate sample

Sampling Location:

- The fifth through eighth digits represent the sampling location.

Depth Interval:

- The ninth and tenth digits represent the depth interval or sample serial number.

An example of the final sample identification method is as follows:

009S002001 Site 9/soil boring/location 20/0-1 foot depth interval

5.1 Phase I Investigation

The Phase I investigations for Sites 9, 29, and 34 were conducted by E/A&H personnel during February, 1994, in conjunction with similar investigations for the remaining Category V sites identified in the NAS Pensacola SMP. All locations were placed in accordance with the final SAPs for these sites.

5.1.1 Phase I Soil Investigation

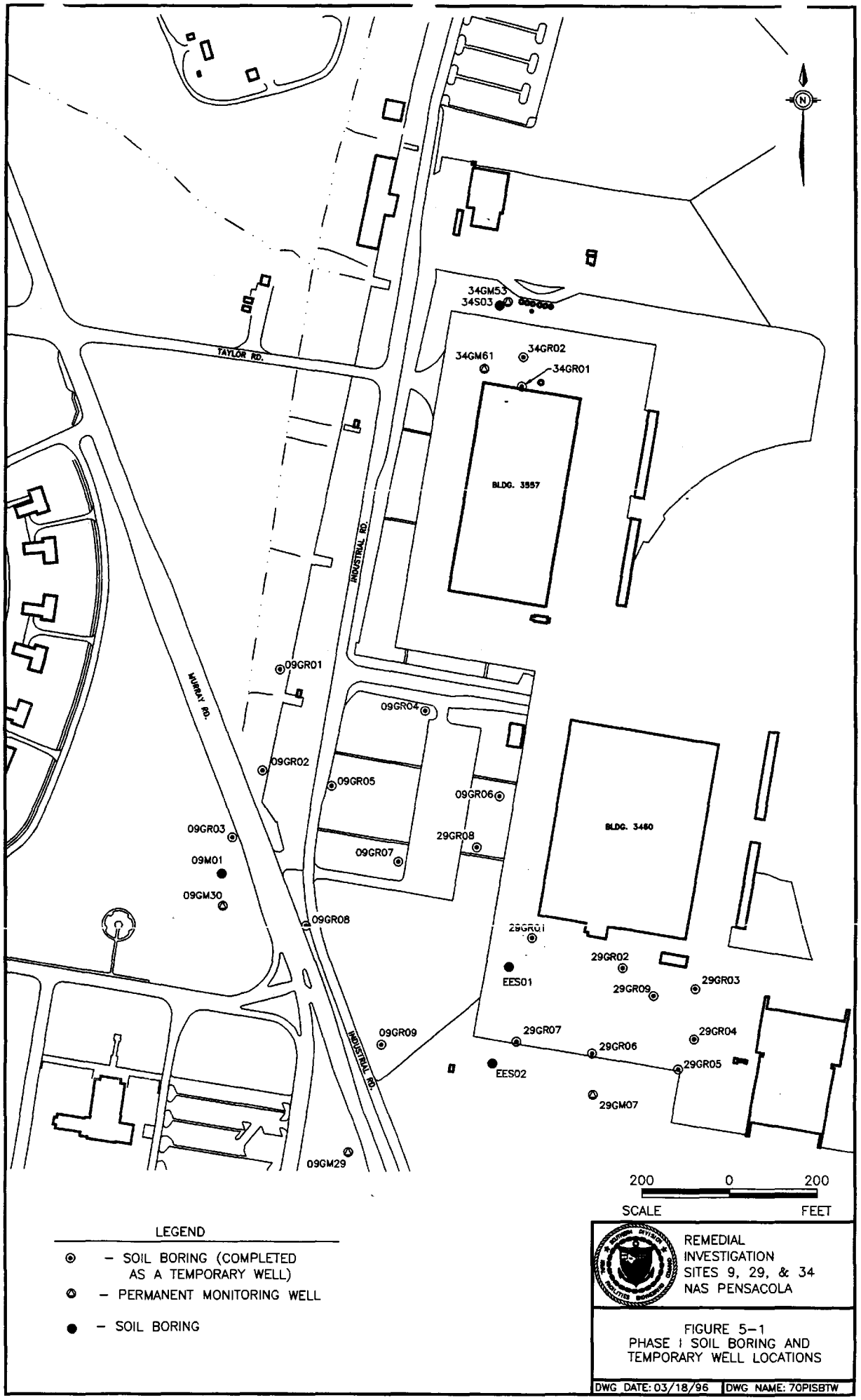
Figure 5-1 depicts the Phase I soil boring and temporary well locations across the site area. In all, 23 soil borings were advanced across the site area during Phase I:

- Site 9 — 9 soil borings
- Site 29 — 11 soil borings
- Site 34 — 3 soil borings

Twenty were converted into temporary monitoring wells. Two borings on Site 29, and one boring on Site 34 were not converted. The extra borings on Site 29 were advanced to verify findings of detectable concentrations of 1,1,1-trichloroethane (1,1,1-TCE) by another contractor. This contractor completed 50 composite soil samples (land surface to water table) across Chevalier Field during January 2, 1994, and concluded finding concentrations of 1,1,1-TCE slightly above BDL at Site 29. E/A&H added two borings to the scope of work for Site 29 in the same locations at which the constituent was detected by this contractor (E/A&H 1994d).

Phase I Soil Boring and Sampling Methodology

Twelve boring locations on Sites 29 and 34 required coring through concrete on the Chevalier Field parking apron, before drilling and sampling could begin. Constructed of unreinforced concrete, the apron varies in thickness from 16 to 18 inches. The upper 12 to 14


TAYLOR RD.
INDUSTRIAL RD.
MURRAY RD.
BLDG. 3557
BLDG. 3460
34GM53
34S03
34GM61
34GR02
34GR01
09GR01
09GR02
09GR03
09M01
09GM30
09GR04
09GR05
09GR06
09GR07
09GR08
09GR09
09GM29
29GR08
29GR01
29GR02
29GR03
29GR04
29GR05
29GR06
29GR07
29GR09
29GM07
EES01
EES02
200 0 200
SCALE FEET
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– PERMANENT MONITORING WELL
– SOIL BORING
REMEDIAL INVESTIGATION SITES 9, 29, & 34 NAS PENSACOLA
FIGURE 5–1
PHASE I SOIL BORING AND TEMPORARY WELL LOCATIONS
DWG DATE: 03/18/96
DWG NAME: 70PISBTW

inches is a concrete/chert aggregate mixture. The bottom four to six inches is a softer concrete without aggregate. An eight-inch diameter, diamond drill bit lubricated with potable water was used to core the concrete. The concrete core consistently broke at the boundary between the upper concrete and bottom concrete material. Once the core was withdrawn, the hole was bailed dry of cuttings and potable water. A 6.75-inch auger bit was used to chip away at any remaining concrete until soil was encountered. Most of the borings were done in this manner; however coring for the two borings added to the scope of work for Site 29 (EES01/EES02) were advanced through the concrete using an eight-inch concrete bit lubricated with potable water. At 14 inches below concrete, the bit was withdrawn from the hole so broken concrete and water could be cleared. The hole was then advance to dry natural soil for sampling. Soil samples were retrieved using a 24-inch stainless steel split spoon pushed or hammered into the subsurface. Boreholes converted to temporary monitoring wells were advanced to the appropriate depth using decontaminated 4.25-inch inside diameter (ID) hollow stem augers. The following intervals were sample at each boring location: 0- to 1-foot, 1- to 3-feet, 3- to 5-feet bls, etc., until the saturated zone was reached. Lithologic descriptions, time and depth of sample, and vapor concentrations were noted on boring logs. Additional samples were taken at or just below the water table if odor and/or visual contamination was noted. Soil aliquots for VOC analysis were collected immediately after retrieving the split spoon sampler to reduce degassing. Samples were directly collected from the sampler with little agitation using a stainless steel spoon, and placed in clean two-ounce soil jars with no headspace. The remaining sampler contents were removed to a stainless steel bowl, homogenized, and collected in two clean four-ounce jars (E/A&H 1994d). Soil borings were performed at each site as follows:

Site 9

In all, 15 soil samples, plus two duplicate samples were collected from the nine soil borings advanced during the Phase I investigation. All samples were processed for TAL/TCL analysis.

The water table varied in depth from 2 to 4 feet across the site. Borings were advanced to between 11.5 to 13.5 feet bls across the site for temporary well installation (E/A&H 1994d). Sampling interval lithologies on Site 9 are described in Section 6, Table 6-1.

Site 29

Twenty-eight soil samples, plus four duplicate samples were collected from the 11 soil borings advanced during the Phase I investigation. All samples were processed for full TAL/TCL analysis. The water table varied in depth between 2 to 5 feet bls across the site. The nine borings converted into temporary monitoring wells were advanced to depths between 13 and 15 feet bls for well installation (E/A&H 1994d). Sampling interval lithologies on Site 29 are described in Section 6, Table 6-1.

Site 34

Eleven soil samples, plus two duplicate samples were collected from three soil borings during the Phase I investigation. All samples were processed for full TAL/TCL analysis. The water table varied in depth between 3 to 9 feet bls across the site. The two borings converted into temporary monitoring wells were advanced to depths between 14 and 16 feet bls for well installation (E/A&H 1994d). Sampling interval lithologies on Site 34 are described in Section 6, Table 6-1. Table 5-1 lists the Site 9, 29, and 34 Phase I soil samples and analytical parameters.

Table 5-1
Sites 9, 29, and 34 Phase I Soil Samples

Boring Location	Sample Identifier	Sample Interval	Date Sampled	Remarks
09S01	009S000101 009S000103	0-1 ft. 1-3 ft.	2/2/94	Temporary well location.
09S02	009S000201	0-1 ft.	2/2/94	Temporary well location.
09S03	009S000301 009S000303	0-1 ft. 1-3 ft.	2/2/94	Temporary well location.
09S04	009S000401 009C000401[a] 009S000403	0-1 ft. 1-3 ft.	2/1/94	Temporary well location.
09S05	009S000501	0-1 ft.	2/1/94	Temporary well location.
09S06	009S000601 009C000601[a] 009S000603	0-1 ft. 1-3 ft.	2/1/94	Temporary well location.
09S07	009S000701	0-1 ft.	2/1/94	Temporary well location.
09S08	009S000801 009S000803	0-1 ft. 1-3 ft.	2/1/94	Temporary well location.
09S09	009S000901 009S000903	0-1 ft. 1-3 ft.	2/1/94	Temporary well location.
09M01	009M000101 009M000101D	0-0.5 ft.	3/2/94	Sediment sample.
29S01	029S000101 029C000101[a] 029S000103 029S000105	0-1 ft. 1-3 ft. 3-5 ft.	2/2/94	Temporary well location.
29S02	029S000201 029S000203 029S000205	0-1 ft. 1-3 ft. 3-5 ft.	2/2/94	Temporary well location.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-1
Sites 9, 29, and 34 Phase I Soil Samples

Boring Location	Sample Identifier	Sample Interval	Date Sampled	Remarks
29S03	029S000301 029C000301[a] 029S000303 029S000305	0-1 ft. 1-3 ft. 3-5 ft.	2/3/94	Temporary well location.
29S04	029S000401 029S000403 029S000405	0-1 ft. 1-3 ft. 3-5 ft.	2/3/94	Temporary well location.
29S05	029S000501 029S000503	0-1 ft. 1-3 ft.	2/3/94	Temporary well location.
29S06	029S000601 029S000603	0-1 ft. 1-3 ft.	2/4/93	Temporary well location.
29S07	029S000701 029C000701[a] 029S000703	0-1 ft. 1-3 ft.	2/4/94	Temporary well location.
29S08	029S000801 029S000803	0-1 ft. 1-3 ft.	2/2/94	Temporary well location.
29S09	029S000901 029C000901[a] 029S000903 029S000905	0-1 ft. 1-3 ft. 3-5 ft.	2/3/94	Temporary well location.
EES01 (Site 29)	EES0101 EES0103 EES0105	0-1 ft. 1-3 ft. 3-5 ft.	2/11/94	Soil boring only.
EES02 (Site 29)	EES0201 EES0203	0-1 ft. 1-3 ft.	2/11/94	Soil boring only.
34S01	034S000101 034C000101[a] 034S000103 034S000105 034S000107 034S000109	0-1 ft. 1-3 ft. 3-5 ft. 5-7 ft. 7-9 ft.	2/7/94	Temporary well location.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-1
Sites 9, 29, and 34 Phase I Soil Samples

Boring Location	Sample Identifier	Sample Interval	Date Sampled	Remarks
34S02	034S000201 034S000203 034C000203[a] 034S000205 034S000206	0-1 ft. 1-3 ft. 3-5 ft. 5-6 ft.	2/7/94	Temporary well location.
34S03	034S000301 034S000303	0-1 ft. 1-3 ft.	2/7/94	Soil boring only.

Note:
a = Duplicate sample.

Sediment Sample

A lone sediment sample was collected from the channelized ditch to the west of Site 9 to characterize possible contaminants which may be migrating off of Site 9 in surface runoff. A single sample, plus one duplicate sample were collected for TAL/TCL analysis. This sample was collected in accordance with procedures outlined in Chapter 7 of the CSAP (E/A&H 1994e).

5.1.2 Phase I Groundwater Monitoring

Temporary Monitoring Well Installation

Twenty of the 23 soil borings completed on Sites 9, 29, and 34 were constructed into temporary monitoring wells (Figure 5-1). Following collection of all appropriate soil samples, boreholes were advanced using hollow-stem auger techniques with decontaminated 4.25 ID hollow stem augers. During temporary well construction, boreholes were advanced deep enough for the screened interval to bracket the water table. Each well was constructed of flush threaded, two-inch diameter Schedule 40 polyvinyl chloride (PVC) casing, terminating with a ten foot length of 0.01-inch factory slotted well screen. At the appropriate depth, the screen/riser

assembly with security cap was placed inside the auger and 20/30 silica sand was used to fill the annular space between the well assembly and borehole. The sand filter pack was installed through a tremie pipe to approximately two feet above the top of the screen. Ten of the 11 monitoring wells on Sites 29 and 34 were installed through holes cored through the concrete apron surrounding these sites.

Risers on these wells were terminated at ground surface due to the high traffic activity within the site area. One Site 29 well, along with all Site 9 wells were constructed off of the pavement. The risers on these wells extended approximately 18 to 40 inches above land surface. Temporary monitoring well locations for Sites 9, 29 and 34 are shown on Figure 5-1. No cement surface seals or protective casings were installed at temporary well locations. The open end of each PVC well riser was, however, secured with a locked well cap. A six-inch bentonite seal was emplaced around the top of each well riser to prevent infiltration of surface runoff through the borehole. The seal was constructed by scooping out about six inches of fill around each riser, filling the void with bentonite pellets, and hydrating with about 5 gallons of deionized water. During drilling activities, all pertinent information was recorded in site logbooks and on boring log forms (E/A&H 1994d). The latter are provided in Appendix C. Table 5-2 lists construction details for Site 9, 29, and 34 temporary monitoring wells.

Table 5-2
Construction Details for Site 9, 29, and 34 Temporary Monitoring Wells

Well No.	Surface Elev. (ft.)	TOC* Elev. (ft.)	Total Depth (ft./bls)	Screened Interval (ft./bls)	Depth to H2O (ft./bls)	GW Elev. (ft./msl)
09GR01	5.26	8.51	12.02	1.52-10.52	2.78	2.48
09GR02	5.31	6.82	11.72	1.37-11.37	4.37	0.94
09GR03	4.82	6.73	11.52	1.02-11.02	2.36	2.46
09GR04	5.70	7.17	11.87	1.37-11.37	2.44	3.26
09GR05	4.86	6.53	12.63	2.13-12.13	1.91	2.95
09GR06	7.11	9.54	12.58	2.08-12.08	3.86	3.25
09GR07	5.88	7.76	11.32	0.82-10.82	2.45	3.43
09GR08	5.47	7.56	11.63	1.13-11.13	2.31	3.16
09GR09	6.58	10.39	11.57	1.07-11.07	2.98	3.60
29GR01	8.34	7.86	11.92	1.42-11.42	4.88	3.46
29GR02	8.81	8.24	13.86	3.36-13.36	5.48	3.33
29GR03	8.73	8.78	13.08	2.58-12.58	5.35	3.38
29GR04	8.27	8.20	12.46	1.96-11.96	4.99	3.28
29GR05	7.90	7.56	12.46	1.96-11.96	4.65	3.25
29GR06	7.47	7.33	13.43	2.93-12.93	4.04	3.43
29GR07	7.16	6.63	12.59	2.09-12.09	3.56	3.60
29GR08	7.22	10.64	11.72	1.22-11.22	3.83	3.39
29GR09	8.52	7.77	14.53	4.03-14.03	5.17	3.35
34GR01	9.78	10.00	16.24	5.74-15.74	7.89	1.89
34GR02	8.80	8.03	15.00	4.50-14.50	6.78	2.02

Notes:
TOC = Top of casing.
Datum = mean sea level (NAD-89).
Depths to water measured February 15, 1994.

[Bold items in brackets denote changes to the first draft of document.]

Existing Monitoring Wells

Six existing monitoring wells in the site area were sampled along with the temporary wells. These wells were installed by G&M during the 1984 and 1986 Verification/Characterization studies. Table 5-3 lists construction details for Site 9, 29, and 34 existing monitoring wells.

Well Development

After the temporary wells were installed, they were developed, purged and the groundwater sampled. All site area wells were developed within days after installation. A 3.5 hp centrifugal pump/decontaminated 0.75-inch PVC hose and footvalve assembly were used to develop the wells. Wells were first surged for 10 minutes with a two-inch PVC surge block/extension assembly to loosen fines within the filter pack before development. After surging, the development hose was carefully inserted in the well to about mid-screen level, and the pump started at low speed. Development continued until turbidity, conductivity, pH, and temperature stabilized. In many cases, to realize lower turbidity, development continued after the other parameters had stabilized. Once turbidity had stabilized under 20 NTU, the well was considered developed. On average, 40 gallons of groundwater was pumped from each temporary well during development (E/A&H 1994d).

Groundwater Contamination Assessment Sampling

Wells were purged and sampled using a "quiescent" sampling method. Before well purging, two-mil plastic sheeting was laid on the ground around the well to be sampled and equipment was set up. The well cap was removed and a PID reading recorded. The water level was measured and compared to total depth to calculate the appropriate purge volume.

Temporary wells were purged with a peristaltic pump and dedicated, decontaminated, 0.25-inch outside diameter (OD) Teflon tubing at a slow, controlled, pumping rate (varying from 0.04 to

Table 5-3
Construction Details for Site 9, 29, and 34 Existing Monitoring Wells

Well No.	Surface Elev. (ft.)	TOC Elev. (ft.)	Total Depth (ft./bls)	Screened Interval (ft./bls)	Depth to H2O (ft.)	GW Elev. (ft.)
GM-07 (Site 29)	7.10	8.59	10.75	8.25-10.75	3.57	3.53
GM-29 (Site 9)	6.60	7.55	11.62	9.12-11.62	3.19	3.41
GM-30 (Site 9)	4.56	5.71	11.65	9.15-11.65	2.77	1.79
GM-53 (Site 34)	3.27	5.62	15.50	13.00-15.50	3.59	2.03
GM-61 (Site 34)	8.76	8.52	86.89	84.39-86.89	6.76	2.00
GM-57 (Site 34)	9.03	8.68	13.20	10.70-13.20	6.64	2.39

Note:
TOC = Top of casing.
Datum = mean sea level (NAD-89).
Depths to water measured February 15, 1994.
bls = below land surface

0.25 gpm). The depth of the inserted end of the Teflon purge tubing was adjusted inside the well in order to draw groundwater from the upper six inches of the water column. Temperature, conductivity, pH, turbidity, and purge volume were monitored and recorded. Purging continued until at least three well volumes were obtained and terminated when field parameters and turbidity stabilized to within $\pm$ 10 percent over three consecutive readings. If high turbidity was encountered, additional water was purged until turbidity fell within acceptable limits (20 NTU or less). Groundwater samples were collected immediately after wells were purged. Using the dedicated Teflon tubing, groundwater was collected under a low vacuum pressure via an in-line

transfer cap, attached to a 300 series, laboratory certified, 80 oz. glass jug ("transfer bottle"). The Teflon purge tubing was disconnected from the peristaltic pump and inserted into one aperture, while a 10-inch piece of decontaminated Teflon tubing was inserted into the second aperture. This 10-inch stem was then reconnected to the peristaltic pump. The transfer cap and aperture fittings were adjusted to minimize air leaks, and the peristaltic pump restarted. It took approximately two to three minutes for the pump to evacuate the air from the transfer bottle before it began to slowly fill. When the transfer bottle was filled, the pump was shut off, the transfer cap removed, and the sample was carefully decanted into the appropriate sample bottles. The order of sampling from the transfer bottle was metals, cyanides, and SVOCs/ pesticides/PCBs. Volatiles were collected directly from the teflon purge tubing. Water was run through the tubing until its volume was filled. The tubing was then disconnected from the peristaltic pump and unagitated groundwater was allowed to flow backward into 40 ml VOA vials. Existing wells were purged and sampled in the same manner as the temporary wells (E/A&H 1994d). Table 5-4 outlines Site 9, 29, and 34 groundwater samples and analytical parameters.

5.2 Phase II Investigation

A second phase (Phase IIa) of field work was conducted on Sites 9, 29, and 34 during May 1994. Follow-on Phase II (Phase IIb) sampling took place during August, September, and December 1994. The Phase IIa work was based on analysis of results from the Phase I sampling effort. The Phase IIb work was conducted to further delineate contamination, to verify/clarify the findings of the earlier phases, and to fill data gaps. The Phase IIa/b effort included select soil borings across all three sites, the installation of two permanent monitoring wells on Site 34, and select groundwater sampling. Analyses of samples collected during the Phase IIa/b sampling were based on data requirements resulting from previous sampling. Phase II sample analyses

Table 5-4
Site 9, 29, and 34 Phase I Groundwater Samples

Well Number	Sample Number	Date Sampled
09GR01	009G000100 009H000100[a]	2/4/94
09GR02	009G000200	2/3/94
09GR03	009G000300	2/3/94
09GR04	009G000400 009H000400[a]	2/3/94
09GR05	009G000500	2/3/94
009GR06	009G000600	2/3/94
09GR07	009G000700	2/3/94
09GR08	009G000800	2/3/94
09GR09	009G000900	2/3/94
GM-29	009GGM2900	2/4/94
GM-30	009GGM3000	2/4/94
29GR01	029G000100	2/8/94
29GR02	029G000200	2/8/94
29GR03	029G000300	2/8/94
29GR04	029G000400	2/8/94
29GR05	029G000500	2/8/94
29GR06	029G000600	2/8/94
29GR07	029G000700	2/8/94
29GR08	029G000800 029H000800[a]	2/8/94
29GR09	029G000900	2/8/94
GM-07	029GGM0700	2/8/94

[Bold items in brackets denote changes to the first draft of document.]

Table 5-4
Site 9, 29, and 34 Phase I Groundwater Samples

Well Number	Sample Number	Date Sampled
34GR01	034G000100	2/10/94
34GR02	034G000200 034H000200[a]	2/10/94
GM-53	034GGM5300	2/10/94
GM-57	034GGM5700	2/10/94
GM-61	034GGM6100	2/10/94

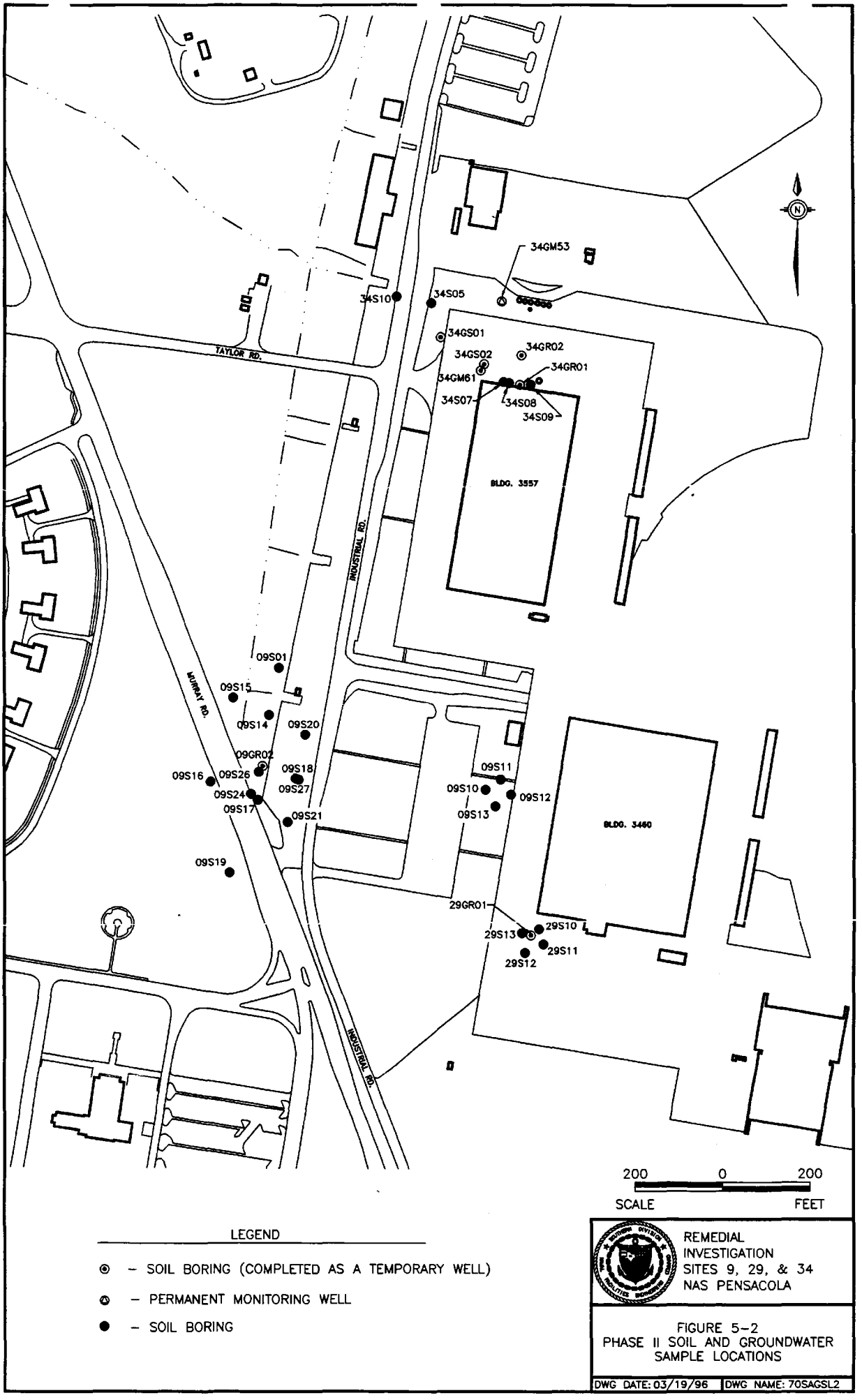
Note:
a = Duplicate sample.

thus varied from the full TAL/TCL component list to select contaminants from the list. PPS, GS, and PPW samples were also collected during the Phase IIb sampling. Figure 5-2 depicts the Site 9, 29, and 34 Phase II Soil and Groundwater Sample Locations across the site area.

5.2.1 Phase II Soil Investigation

In all, 33 borings were advanced across the site area during the Phase II investigation:

- Site 9 — 19 borings
- Site 29 — 6 borings
- Site 34 — 8 borings


34GM53
34S10
34S05
34GS01
34GS02
34GR02
34GR01
34GM61
34S07
34S08
34S09
TAYLOR RD.
BLDG. 3557
INDUSTRIAL RD.
09S01
09S15
09S14
09S20
MURRAY RD.
09GR02
09S16
09S26
09S18
09S27
09S24
09S17
09S21
09S19
09S11
09S10
09S12
09S13
BLDG. 3460
29GR01
29S10
29S13
29S11
29S12
INDUSTRIAL RD.
200 0 200
SCALE FEET
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– PERMANENT MONITORING WELL
– SOIL BORING
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 5-2
PHASE II SOIL AND GROUNDWATER SAMPLE LOCATIONS
DWG DATE: 03/19/96
DWG NAME: 70SAGSL2

Phase IIa/b soil samples were analyzed according to data requirements determined during previous sampling. Some samples were analyzed for the full TAL/TCL component, while others were analyzed for select contaminants. PPS and GS samples were also collected on each site to delineate the physical properties of the soil within the site area. Additionally, soil leachability samples were collected within areas of known contamination in the site area. These Phase IIb samples were collected to define site-specific leachability values for soil types across the site area. Borings for these samples were advanced adjacent to Phase I/II borings which displayed levels of contamination in earlier sample results. Because Sites 9 and 29 were determined to have similar soil types, leachability samples for both sites were collected from Site 9.

Leachability samples were also collected on Site 34, which had its own soil type. Leachability samples were analyzed for full TAL/TCL, SPLP, and TOC. The SPLP leachate was analyzed using CLP low concentration analysis to attain quantitation limits at or below the PRGs.

Phase II Soil Boring and Sampling Methodology

Eight Phase II borings on Sites 29/34 were situated on the concrete apron surrounding Buildings 3460 and 3557 and required coring prior to sampling. This was done as described for the Phase I sampling. Other samples, which were located on grassy or sandy soil, could be retrieved without any site preparation. Phase II soil samples were retrieved using a decontaminated stainless-steel hand auger, rather than by the 24" split-spoon method used during Phase I. Before sampling, clean plastic sheeting was laid down next to the sampling location and equipment set up. Grass and/or debris was cleared from the sampling point, and the hand auger was carefully advanced to a depth of one foot. As the auger bucket filled with soil, it was carefully retrieved from the borehole. Volatiles samples were extracted directly from the auger bucket using a decontaminated stainless steel spoon, and placed in appropriate soil jars with no headspace. The remaining auger bucket contents were removed to a stainless-steel bowl,

homogenized, and collected in appropriate jars. A clean hand auger bucket, and clean stainless-steel bowl and spoon were used for each sampling interval (0- to 1-foot, 1- to 3-feet, 3- to 5-feet, etc.), until saturated soil was reached. Care was taken to minimize cave-in from upper to lower sampling intervals. Samples from succeeding collection intervals were handled and packaged identically as with the first interval. The Phase IIb leachability samples were collected using the same hand auger techniques. However, the samples were subsurface composite samples collected from the one-foot bls-to-water table interval. Lithological descriptions, time and depth of sample, and vapor concentrations were noted on boring logs. Boreholes were backfilled with unused auger cuttings once sampling was completed. Soil borings were performed on each site as follows:

Site 9

Ten Phase IIa soil borings were advanced across the site during the period May 18-19, 1994. Twenty-four samples, plus two duplicate samples were collected from nine borings. These were analyzed for semivolatiles only, based on the distribution of semivolatiles concentrations found to exceed applicable PRGs during the Phase I sampling. Two samples from boring 09S18 were analyzed for full TAL/TCL due to the appearance of an unidentified "burned" material in the borehole cuttings. Three Phase IIb soil borings were advanced across the site area on August 30, 1994 and sampled for PPS and GS analyses. Two Phase IIb borings were performed on September 12, 1994 to bracket and further characterize sample results from Phase IIa boring 09S18, which had concentrations of inorganics and semivolatiles above PRGs. Five samples were collected from these borings and were analyzed for semivolatiles, cyanide, and metals. Three final Phase IIb borings were advanced between December 7, 1994 and December 9, 1994 to characterize soil leachability. These borings were paired with earlier phase borings found to contain high levels of contamination:

- Boring 09S24 was paired with Phase IIa boring 09S17.
- Boring 09S26 was paired with Phase I boring 09S02.
- Boring 09S27 was paired with Phase IIa boring 09S18.

Three samples, and one duplicate were collected from these borings and analyzed for TAL/TCL, SPLP, and TOC. With all Phase II borings, the water table level and subsurface lithologies were as in the Phase I investigation.

Site 29

Four Phase IIa borings were advanced across the site on May 24, 1994. These borings were spaced around Phase I boring location 29S01, to further characterize elevated pesticides and semivolatiles found at this location. Eight samples, plus one duplicate sample were collected and analyzed for semivolatiles and pesticides only. Two Phase IIb borings were advanced on August 30, 1994 and sampled for PPS and GS analyses. The water table level and subsurface lithologies were as in the Phase I investigation.

Site 34

Four Phase IIa borings were advanced across the site on May 23, 1994. One soil boring was located near Phase I sample location 34S01 to characterize elevated lead concentrations found at this location during the Phase I sampling. Four samples were collected from this boring and analyzed for lead only. A second Phase IIa soil boring was advanced near the industrial waste water sewer line to characterize soil contaminants adjacent the sewer line where it passes Site 34. Two samples, plus one duplicate sample were collected and analyzed for full TAL/TCL. A third Phase IIa boring on Site 34 was advanced near the shallow/deep well cluster installed on Site 34 by G&M in 1985. Cuttings from this boring were not sampled, and a permanent shallow monitoring well replacing shallow well GM-56 (found to need replacement

during a previous well inventory) was constructed within the borehole. The fourth Phase IIa boring was advanced at the western edge of Site 34 to characterize contaminants in the path of groundwater migration from the site. Three samples from this boring were analyzed for semivolatiles and volatiles only. One Phase IIb boring was advanced on August 30, 1994 and sampled for PPS and GS analyses. Two sediment samples were also collected from two locations on September 20, 1994 and analyzed for GS analysis. Two Phase IIb borings were advanced on December 7, 1994 to characterize soil leachability. Borings 34S08 and 34S09 were located approximately 25 feet east and west of Phase I boring 34S01. Two samples collected from these borings were analyzed in similar fashion as the Site 9 leachability samples. A final Phase IIb boring was advanced on January 16, 1995 near the northwestern edge of the site. This sample was collected because of high headspace readings found by another contractor during a soil removal from another site (the aviation gas pipeline on the west side of Industrial Blvd.) directly adjacent to Site 34 and to ensure that Site 34 was not the source of the elevated headspace readings. One sample, plus one duplicate sample were collected from the auger cuttings and analyzed for full TAL/TCL. The water table level and subsurface lithologies at Site 34 were as in the Phase I investigation.

Table 5-5 lists the Site 9, 29, and 34 Phase II soil samples, analytical parameters, and sampling rationale.

5.2.2 Phase II Groundwater Monitoring

Two permanent monitoring wells were installed on Site 34 and subsequently sampled during the Phase IIa investigation conducted in May, 1994. These wells were constructed in accordance with Section 5 of the CSAP (E/A&H 1994e). Table 5-6 lists the construction details for the Phase IIa permanent monitoring wells. The Phase IIa wells were developed, purged, and sampled using the same procedures utilized during the Phase I groundwater sampling.

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
09S01 (Phase IIb)	009S000101 009C000101[a]	0-1 ft.	12/7/94	TCL VOCs	Phase I sample contained elevated detection limits for VOCs.	Soil boring only.
09S02 (Phase IIb)	009S000203 009S000205	0-3 ft. 3-5 ft.	8/30/94	PPS/GS	Sampled to define physical properties of soil.	Soil boring only.
09S04 (Phase IIb)	009S000402 009S000404	0-2 ft. 2-4 ft.	8/30/94	PPS/GS	Sampled to define physical properties of soil.	Soil boring only.
09S09 (Phase IIb)	009S000902	0-2 ft.	8/30/94	PPS	Sampled to define physical properties of soil.	Soil boring only.
09S10 (Phase IIa)	009S001001 009S001003 009C001003[a] 009S001004	0-1 ft. 1-3 ft. 3-4 ft.	5/18/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
09S11 (Phase IIa)	009S001101 009S001103 009S001104	0-1 ft. 1-3 ft. 3-4 ft.	5/18/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.
09S12 (Phase IIa)	009S001201 009S001203 009S001204	0-1 ft. 1-3 ft. 3-4 ft.	5/18/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.
09S13 (Phase IIa)	009S001301 009S001303 009S001304	0-1 ft. 1-3 ft. 3-4 ft.	5/18/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.
09S14 (Phase IIa)	009S001401 009S001403 009S001404	0-1 ft. 1-3 ft. 3-4 ft.	5/18/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.
09S15 (Phase IIa)	009S001501 009S001503	0-1 ft. 1-3 ft.	5/19/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.
09S16 (Phase IIa)	009S001601 009C001601[a] 009S001603 009S001604	0-1 ft. 1-3 ft. 3-4 ft.	5/19/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
09S17 (Phase IIa)	009S001701 009S001703	0-1 ft. 1-3 ft.	5/19/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.
09S18 (Phase IIa)	009S001801 009S001803	0-1 ft. 1-3 ft.	5/23/94	CLP TAL/TCL	Sampled for full CLP due to observed materials in bore cuttings.	Soil boring only.
09S19 (Phase IIa)	009S001901 009S001903	0-1 ft. 1-3 ft.	5/19/94	TCL SVOCs	Phase I sample contained SVOCs.	Soil boring only.
09S20 (Phase IIb)	009S002001 009C002001 009S002012	0-1 ft. 1-2 ft.	9/12/94	TCL SVOCs/CN; TAL Metals	Confirmatory sampling adjacent boring 09S18.	Soil boring only.
09S21 (Phase IIb)	009S002101 009S002112	0-1 ft. 1-2 ft.	9/12/94	TCL SVOCs/CN; TAL Metals	Confirmatory sampling adjacent boring 09S18.	Soil boring only.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
09S22 (Phase IIb)	—	—	12/7/94	—	—	Sample collected; deleted.
09S23 (Phase IIb)	—	—	12/7/94	—	—	Sample collected; deleted.
09S24 (Phase IIb)	009S002403	0-3 ft.	12/7/94	CLP TAL/TCL; SPLP; TOC	Sampled to define site specific leachability values for soil.	Collocated with boring 09S17.
09S25 (Phase IIb)	—	—	12/7/94	—	—	Sample collected; deleted.
09S26 (Phase IIb)	009S002603 009C002603[a]	0-3 ft.	12/9/94	CLP TAL/TCL; SPLP; TOC	Sampled to define site specific leachability values for soil.	Collocated with boring 09S02.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
09S27 (Phase IIb)	009S002703	0-3 ft.	12/9/94	CLP TAL/TCL; SPLP; TOC	Sampled to define site specific leachability values for soil.	Collated with boring 09S18.
29S01 (Phase IIb)	029S000103 029S000105	0-3 ft. 0-5 ft.	8/30/94	PPS/GS	Sampled to define physical properties of soil.	Soil boring only.
29S06 (Phase IIb)	029S000603 029S000605	0-3 ft. 0-5 ft.	8/30/94	PPS/GS	Sampled to define physical properties of soil.	Soil boring only.
29S10 (Phase IIa)	029S001001 029C001001[a] 029S001003	0-1 ft. 1-3 ft.	5/24/94	TCL SVOCs/ Pesticides	Phase I sample contained SVOCs/pesticide.	Soil boring only.
29S11 (Phase IIa)	029S001101 029S001103	0-1 ft. 1-3 ft.	5/24/94	TCL SVOCs/ Pesticides	Phase I sample contained SVOCs/pesticide.	Soil boring only.
29S12 (Phase IIa)	029S001201 029S001203	0-1 ft. 1-3 ft.	5/24/94	TCL SVOCs/ Pesticides	Phase I sample contained SVOCs/pesticide.	Soil boring only.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
29S13 (Phase IIa)	029S001301 029S001303	0-1 ft. 1-3 ft.	5/24/94	TCL SVOCs/ Pesticides	Phase I sample contained SVOCs/pesticide.	Soil boring only.
34S01 (Phase IIb)	034S000103 034S000105 034S000106 034S000108	0-3 ft. 3-5 ft. 5-6 ft. 6-8 ft.	8/30/94	PPS/GS	Sampled to define physical properties of soil.	Soil boring only.
34S04 (Phase IIa)	034S000401 034S000403 034S000405	0-1 ft. 1-3 ft. 3-5 ft.	5/23/94	TCL VOCs/SVOCs	Sampled to characterize constituents in the path of groundwater migration from the site.	Permanent Well 34GS01 installed.
34S05 (Phase IIa)	034S000501 034C000501[a] 034S000503	0-1 ft. 1-3 ft.	5/23/94	CLP TAL/TCL	Sampled to characterize constituents adjacent to IWTP sewer line segment passing through Site 34.	Soil boring only.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
34S06 (Phase IIa)	No Samples taken (well construction only).	0-18 ft.	5/23/94	—	Replace shallow monitoring well GM-56.	Permanent well 34GS02 installed.
34S07 (Phase IIa)	034S000701 034S000703 034S000705 034S000707	0-1 ft. 1-3 ft. 3-5 ft. 5-7 ft.	5/23/94	Lead Only	Phase I sample contained lead.	Soil boring only.
34S08 (Phase IIb)	034S000803	0-3 ft.	12/7/94	CLP TAL/TCL; SPLP; TOC	Sampled to define site specific leachability values for soil.	Soil boring only.
34S09 (Phase IIb)	034S000903	0-3 ft.	12/7/94	CLP TAL/TCL; SPLP; TOC	Sampled to define site specific leachability values for soil.	Located adjacent to boring 34S01.
34S10 (Phase IIb)	034S001002 034C001002	0-2 ft.	1/16/95	CLP TAL/TCL	Confirmatory sample collected adjacent western edge of site.	Located adjacent to boring 34S01.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-5
Sites 9, 29, and 34 Phase II Soil Samples, Analytical Parameters, and Sampling Rationale

Boring Location	Sample Identification/ Interval	Sample Interval	Date Sampled	Sample Analysis	Sampling Rationale	Remarks
34M01 (Phase IIb)	034M000101	0-.5 ft.	9/20/94	GS	Sampled to define physical properties of soil.	Sediment sample.
34M02 (Phase IIb)	034M000201	0-.5 ft.	9/20/94	GS	Sampled to define physical properties of soil.	Sediment sample.

Note:
a = Duplicate sample.

Table 5-6
Construction Details for Phase II Permanent Monitoring Wells (Site 34)

Well No.	Surface Elev. (ft.)	TOC Elev. (ft.)	Total Depth (ft.)	Screened Interval (ft.)	Depth to H2O (ft.)	GW Elev. (ft.)
34GS01	7.07 ft.	6.87 ft.	12.07 ft.	1.57-11.57 ft.	5.04 ft.	1.83
34GS02	8.70 ft.	8.50 ft.	17.02 ft.	6.52-16.52 ft.	6.58 ft.	1.92

Notes:
TOC = Top of casing.
Datum = mean sea level (NAD-89).

Additional groundwater sampling was conducted during the Phase IIb work. As with Phase II soil sampling, Phase II groundwater monitoring was conducted to further delineate sources of contamination, to verify/clarify the findings of the earlier phases, and to fill data gaps. Analyses of Phase II groundwater samples were tailored according to data requirements determined during previous sampling. Some samples were analyzed for the full TAL/TCL component, while others were analyzed for select contaminants. Physical parameters water samples were also collected on each site to delineate the physical properties of the groundwater within the site area for potential remedial design purposes. Phase II groundwater monitoring was performed at each site as follows:

Site 9

Three temporary monitoring wells were re-sampled for PPW analysis on August 30, 1994. Additionally, well 09GR02 was re-sampled on December 15, 1994 for TAL metals only. This sample was collected to verify the lead concentration found in the Phase I sample collected from this well.

Site 29

Two temporary monitoring wells were re-sampled for PPW analysis on August 30, 1994. Additionally, well 29GR01 was re-sampled on December 15, 1994 for TCL pesticides only. This sample was collected to verify the dieldrin concentration found in the Phase I sample collected from this well.

Site 34

Samples collected from the two newly constructed permanent monitoring wells on May 24, 1994, were analyzed for volatiles and semivolatiles. Several wells were re-sampled on Site 34 during the Phase IIb work. On August 30, 1994, two monitoring wells were sampled for PPW analysis. On December 14, 1994, three wells were re-sampled for volatiles and semivolatiles. These wells were re-sampled for those compounds because the Phase I results contained detection limits above the CLP method detection limits. Also on December 14, two wells were re-sampled for full TAL/TCL analysis. This was done to better clarify the range of contamination found in previous Site 34 groundwater results.

Table 5-7 details the Phase II groundwater sampling analytical parameters, and sampling rationale.

Table 5-7
Phase II Groundwater Samples and Analytical Parameters

Well Number	Sample Number	Date Sampled	Analytical Parameters	Sampling Rationale
09GR02	009GR00201	8/30/94	PPW	Sampled to define physical properties of groundwater.
	009GGR0202	12/15/94	TAL Metals	Phase I sample contained lead.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-7
Phase II Groundwater Samples and Analytical Parameters

Well Number	Sample Number	Date Sampled	Analytical Parameters	Sampling Rationale
09GR04	009GR00401	8/30/94	PPW	Sampled to define physical properties of groundwater.
09GR09	009GR00901	8/30/94	PPW	Sampled to define physical properties of groundwater.
29GR01	029GR00101	8/30/94	PPW	Sampled to define physical properties of groundwater.
	029GGR0102	12/15/94	TCL Pesticides	Phase I sample contained dieldrin.
29GR06	029GR00601	8/30/94	PPW	Sampled to define physical properties of groundwater.
34GR01	034GR00101	8/30/94	PPW	Sampled to define physical properties of groundwater.
	034GGR0102	12/14/94	TCL VOCs/SVOCs	Phase I sample contained elevated detection limits for VOCs/SVOCs.
34GR02	034GGR0202	12/14/94	TCL VOCs/SVOCs	Phase I sample contained elevated detection limits for VOCs/SVOCs.

[Bold items in brackets denote changes to the first draft of document.]

Table 5-7
Phase II Groundwater Samples and Analytical Parameters

Well Number	Sample Number	Date Sampled	Analytical Parameters	Sampling Rationale
34GS01	034G000100	5/24/94	TCL VOCs/SVOCs	Sampled to characterize constituents in the path of groundwater migration from the site.
	034GS00101	8/30/94	PPW	Sampled to define physical properties of groundwater.
34GS02	034G000200 034H000200[a]	5/24/94	TCL VOCs/SVOCs	Well replaced previously installed GM-56.
	034GGS0202 034HGS0202[a]	12/14/94	CLP TAL/TCL	Sampled to better clarify the range of contamination found in previous Site 34 groundwater results.
34GM53	034GGM5302	12/14/94	TCL VOCs/SVOCs	Phase I sample contained elevated detection limits for VOCs.
34GM61	034GGM6102	12/14/94	CLP TAL/TCL	Sampled to better clarify the range of contamination found in previous Site 34 groundwater results.

Note:
a = Duplicate sample.

Monitoring Well Abandonment

All temporary and permanent monitoring wells within the Sites 9, 29, and 34 area were abandoned during March 2-3, 1994. Well abandonment was performed to facilitate ongoing BRAC demolition and construction occurring within the site area. Abandonment was performed by a permitted, certified well contractor, in accordance with Northwest Florida Water Management District guidelines. Abandonment included all wells installed by E/A&H, and previously installed permanent monitoring wells.

[5.3] Interim Soil Removals

The interim soil removals performed on Sites 9, 29, and 34 occurred subsequent to the field investigation, in conjunction with commencement of BRAC construction within the site area. The removals were based on the presence of soil contamination above 1995 Preliminary Remediation Goals (PRGs), which were established to support the removals and to formulate the Baseline Risk Assessment (BRA). The soil removals were mandated by the BRAC construction schedule at Chevalier Field, and were performed by Hyman Construction, Inc. Under the Resident Officer In Charge of Construction (ROICC) (E/A&H 1996).

The interim soil removals performed on Sites 9, 29, and 34 were performed subsequent to the field investigation, in conjunction with commencement of BRAC construction within the site area. They are briefly described as follows:

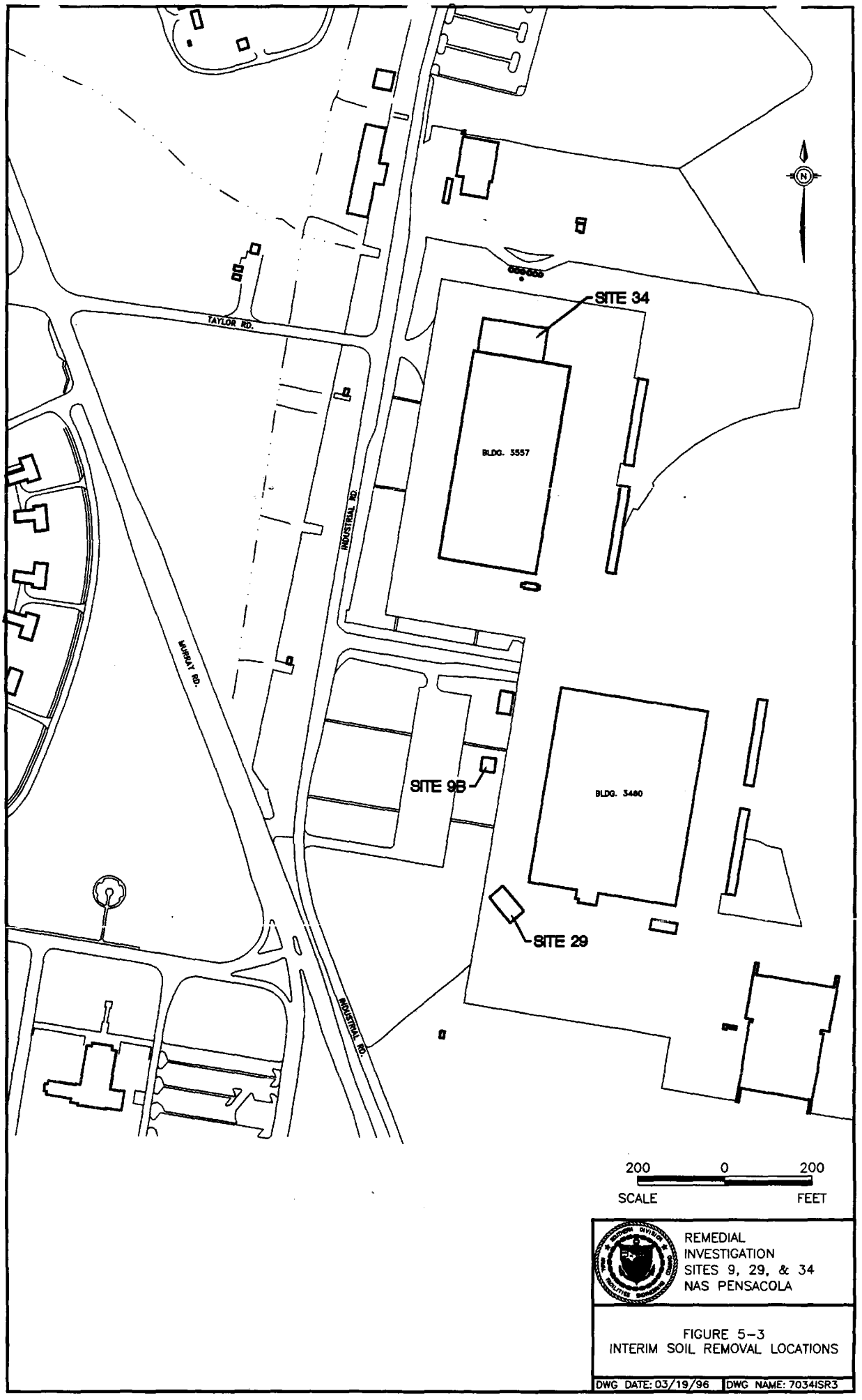
- **Site 9. This site was divided into two areas for removal, Sites 9A (encompassing the PAH contamination in the west central portion of the site), and 9B (encompassing the PAH contamination in and around boring location 09S06). Site 9A was not remediated and will be transferred to the UST program due to its association with**

the petroleum spill on site 23. Approximately 214.9 cubic yards of soil were excavated from Site 9B to remove PAH contaminated soil between December 11-14, 1995. The site was backfilled prior to confirmatory sampling by E/A&H, and portions of the location had to be re-excavated for confirmatory sampling on December 29, 1995 (E/A&H 1996).

- **Site 29. The removal for this site was performed to remove dieldrin contaminated soil from in and around boring location 29S01. About 422.22 cubic yards of soil were removed from this location on May 1-2, 1995, and confirmatory samples were collected by E/A&H on May 15, 1995 (E/A&H 1996).**

- **Site 34. The removal for this site was conducted to remove lead and naphthalene contaminated soil from in and around boring location 34S01. About 1,111.1 cubic yards of materials were excavated from this site between December 11-14, 1995. As with Site 9B, the site was backfilled prior to confirmatory sampling by E/A&H, and portions of the location had to be re-excavated for confirmatory sampling on December 28, 1995 (E/A&H 1996).**

Confirmatory soil samples were collected by E/A&H subsequent to each removal using methods prescribed in Section 4.0 of the CSAP. Samples were collected from the approximate mid-point of each wall of the excavated pit, just above the water table. Where fill had to be re-excavated, undisturbed in-situ soils along the excavation boundary were sampled. The center of Sites 9B and 34 were also sampled. All samples were submitted for full TAL/TCL analyses (E/A&H 1996). Table 5-8 describes the confirmatory samples collected. Figure 5-3 shows the removal locations for Sites 9, 29, and 34].


SITE 34
TAYLOR RD.
BLDG. 3557
INDUSTRIAL RD.
MURRAY RD.
SITE 9B
BLDG. 3480
SITE 29
INDUSTRIAL RD.
200 0 200
SCALE FEET
REMEDIAL
INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 5-3
INTERIM SOIL REMOVAL LOCATIONS
DWG DATE: 03/19/96
DWG NAME: 7034ISR3

[Table 5-8] Sites 9, 29, and 34 Soil Removal-Confirmatory Samples			
Sample Location	**Sample Identifier**	**Date Sampled**	**Remarks**
09B01	09B0000101	12/29/95	Northern perimeter sample.
09B02	09B0000201	12/29/95	Southern perimeter sample.
09B03	09B0000301	12/29/95	Eastern perimeter sample.
09B04	09B0000401	12/29/95	Western perimeter sample.
09B05	09B0000501	12/29/95	Site center sample.
29S14	029S001401	5/15/95	Southern perimeter sample.
29S15	029S001501	5/15/95	Eastern perimeter sample.
29S16	029S001601	5/15/95	Western perimeter sample.
29S17	029S001701	5/15/95	Northern perimeter sample.
34S11	034S110101	12/28/95	Northern perimeter sample.
34S12	034S120101	12/28/95	Southern perimeter sample.
34S13	034S130101	12/28/95	Western perimeter sample.
34S14	034S140101	12/28/95	Eastern perimeter sample.
34S15	034S150101	12/28/95	Site center sample.]

[5.4] Field Work and Sampling Protocols

All sampling activities were conducted in accordance with the U.S. Navy-, FDEP- and U.S. EPA-approved SAPs for Sites 9, 29, and 34; the CSAP, and the USEPA Region IV Standard Operations Procedures and Quality Assurance Manual (SOP/QAM) (USEPA 1991). Where

warranted by field conditions, deviations from the approved procedures were carried out and appropriately documented in accordance with the SOP/QAM. Specific sampling procedures varied with each task and are detailed in Sections 5.1 and 5.2 of this report.

Sample Handling

Handling of sample media was conducted in accordance with the CSAP. Clean plastic sheeting was laid down at each sampling location to minimize the potential for contamination of samples. Clean latex gloves were donned each time a new sample was collected. Decontaminated sampling devices were kept wrapped until the samples were collected. Samples were carefully and quickly transferred to sample containers, which were kept in a clean environment until needed. Care was made to correctly label each sample as it was collected, and to document all necessary sampling information. If necessary, the appropriate protocols were reviewed prior to each sampling event.

Aqueous samples were preserved with the correct chemical preservatives as soon as collected, and all samples were placed in a chilled environment until packaged for shipment.

Quality Assurance/Quality Control (QA/QC) Samples

QA/QC samples were collected to monitor the quality of field and laboratory procedures. These samples tested the levels of reproducibility attainable in the sampling and analytical process, quality of equipment decontamination, quality of source waters and materials, sample exposure to ambient contamination during handling, and level of laboratory precision. Quality assurance samples were analyzed for the same contamination assessment parameters as the environmental samples.

All field QA/QC samples were collected in accordance with the Site SAPs, the CSAP, and the SOP/QAM. The samples taken are as follows:

- Duplicate samples were collected for every 10 samples for each sampling task (due to Navy requirements, this frequency was changed to one duplicate sample per 20 samples during March, 1994).

- Equipment rinsates were collected from the sampling equipment specific to each task on a frequency of one per sampling event (or one per week) per sampled media.

- Material blanks were collected once for each accessory material used in drilling and well construction (filter sand, etc.).

- One field blank was collected per sampling event (or one per week) per sampled media. Field blanks were also collected for potable water and reagent grade water. Field blanks were collected considering the Category V sites as a whole, and not necessarily by individual site.

- MS/MSD samples were collected at a frequency of one per every 20 for each sampling medium.

[Confirmatory samples collected to verify removal of contaminated soils were not subject to the same QA/QC as contamination assessment samples. This was due to the small sample population submitted and the desire for cost savings. The data were exclusively used to provide confirmation for the removal of contaminants.]

Sample Containers and Preservation

All laboratory-provided containers were precleaned and certified. Table 5-9 lists the sample containers, sample media, and analyses for which they were used.

Chain-of-Custody

To preserve the integrity of the sample-transfer process, strict chain-of-custody (COC) was followed for all samples collected. Proper COC was initiated in the field for each sampling event and carried out through custody transfer to the contracted laboratory. A COC form was completed for each shipping cooler. The COC form itemized each sample number, the date/time of collection, the sample medium, type and size of container, type of preservation (temperature and/or chemical), number of containers, and analysis required. Custody transfer information included the name of the person relinquishing the samples, date and time of relinquishing, reason for relinquishing, method of shipment, and shipping number. Pertinent information was included in the remarks section on the COC form as required.

Sample Packing and Shipment

All samples were carefully packed in accordance with the USEPA Region IV SOP/QAM and the CSAP. Each sample container was labeled with the correct sample number, date/time of collection, and sampling personnel. Container lids were sealed with a custody seal, and each container was wrapped in bubble wrap and sealed in a Ziplock-type plastic bag. Sturdy, 48 or 54 quart coolers were used for shipping containers. One inch of bubble wrap padding was added to the bottom of each cooler, and these were lined with a heavy-duty garbage bag. Drains on the coolers were taped shut both on the inside and out. Containers were carefully arranged in the cooler to allow ice and packing materials to be placed around them. Containers were not allowed to abut against each other. Enough double bagged ice was packed in between and around the containers to maintain sample temperatures at or below 4° Celsius, and voids were

Table 5-9
Sample Containers and Preservation Per Medium and Analysis

Medium	Analysis	Sample Container	Preservative
Soil	CLP TAL/TCL; TCLP; SPLP	Pace Labs - 4 oz. glass jars (2 ea.) CompuChem Labs - 8 oz. glass jars (2 ea.)	4°C
Soil	CLP TCL VOCs	Pace Labs - 2 oz. glass jars (1 ea.) CompuChem Labs - 4 oz. glass jar (1 ea.)	4°C
Soil	Heterotrophic Plate Count/TKN/Total Phosphate/Cation Exchange Capacity	100 ml Sterile Polyethylene jar	4°C
Soil	Grain Size Analysis	1 liter polyethylene bottle	N/A
Groundwater	CLP TCL VOCs	Pace/CompuChem Labs - 40 ml. glass vial (3 ea.)	4°C - HCL (pH<2)
Groundwater	CLP TCL SVOCs CLP TCL Pesticides/PCBs	Pace Labs - 1 liter amber bottle (3 ea.) CompuChem Labs - 1 liter amber bottle (4 ea.)	4°C
Groundwater	CLP TAL Metals	Pace Labs - 500 ml polyethylene bottle CompuChem Labs - 1 liter polyethylene bottle	4°C - HNO_3 (pH<2)
Groundwater	Cyanide	Pace Labs - 1 liter polyethylene bottle CompuChem Labs - 1 liter amber bottle	4°C - NaOH (pH>12)
Groundwater	Heterotrophic Plate Count	100 ml sterile bottle	4°C
Groundwater	BOD	1 qt. polyethylene bottle	4°C
Groundwater	COD	250 ml polyethylene bottle	4°C - H_2SO_4 (pH<2)
Groundwater	Hardness	250 ml polyethylene bottle	4°C - HNO_3 (pH<2)

[Bold items in brackets denote changes to the first draft of document.]

filled with styrofoam packing. A temperature blank or temperature strip was included in each cooler. Once packed, the garbage bag was sealed, the COC form was placed in the cooler, and the cooler was closed and sealed. Each cooler was tightly taped with strapping tape and sealed with custody seals, appropriately addressed, and shipped for overnight delivery.

Field Data

Auxiliary data pertinent to field sampling activities were collected in accordance with Chapter 14 of the CSAP:

- Weather conditions, sampling personnel, time of sampling, sampling location.
- Methodology, test equipment used, physical/chemical parameters measured.
- Soil lithology and stratigraphy, problems encountered, procedural deviations.

Field data was recorded in appropriate field logbooks, boring logs, well completion logs, groundwater sampling forms, etc. Daily site activities were summarized in a site master log.

Decontamination

All exploration and sampling equipment used in the field investigation was decontaminated in accordance with guidelines set forth in the site-specific SAP, the CSAP, and the SOP/QAM:

- Wash and scrub with a laboratory-grade detergent and clean water wash solution.
- Rinse with clean water.
- Rinse with ASTM Type III water.
- Rinse twice with pesticide-grade isopropanol.
- Rinse with ASTM Type III water.
- Air dry

Decontaminated sampling equipment was wrapped in aluminum foil for storage prior to use. Large equipment was decontaminated at a dedicated decontamination area set up for such purpose. A high-pressure-steam washing machine was used to spray down the large equipment and drill rig/hollow-stem auger bits with water and soap. Small equipment was decontaminated by field personnel at the E/A&H field trailer.

Investigation Derived Wastes

Wastes derived from the field investigation were handled in accordance with the Investigation Derived Waste Plan for NAS Pensacola (E/A&H 1994f). Wastes generated included drill cuttings, well development and purge waters, decontamination water, used personal protective equipment (PPE), and drilling site materials used in well construction. Generated wastes were handled in a manner minimizing contact with the environment. Generated wastes at each well site and at the decontamination station were containerized and sealed in federal Department of Transportation (DOT) approved 55-gallon drums pending proper disposal by the U.S. Navy. All drums were marked with the sample location (well number, etc.), date, and type of investigation-derived waste. Soil retrieved from shallow hand-auger borings were contained on plastic sheeting, and unused cuttings were backfilled down the borehole. Drill cuttings were also contained on plastic ground covers prior to containerization. Waste water from activities at the decontamination area was contained within the liner of the station until being pumped into the appropriate containers. PPE and well construction materials were containerized appropriately.

[5.5] Site Area Land Survey

A land survey of the Site 9, 29 and 34 site area was conducted by E/A&H personnel using Global Positioning System (GPS) surveying equipment. All temporary monitoring well, and soil boring locations were surveyed using this technique. At boring locations, position and ground surface elevation were surveyed. At well locations, position, ground surface elevation, and top

of casing elevation were surveyed. These data were utilized to produce accurate maps of all sampling locations within the site area.

[5.6] Site Area Hydrologic Investigation

A hydrologic investigation was conducted across the Site 9, 29, and 34 area. Water levels were measured across the sites and normalized to elevation data gathered during the GPS survey. These data were used to develop a map of the piezometric surface across Chevalier Field, and analyze the flow direction, gradient, and velocity of groundwater through the sites. The hydrology of the site area is discussed in detail in Section 6 of this report.

6.0 GEOLOGIC AND HYDROLOGIC RESULTS

6.1 Site Hydrogeological Setting

The subsurface stratigraphy across the Site 9, 29, and 34 area is consistent with previous NAS Pensacola studies. All borings were limited to the uppermost portion of the surficial zone of the Sand-and-Gravel Aquifer (see Appendix C). Records indicate that the Chevalier Field area was likely elevated with fill during construction of the airfield. The upper 3- to 5-feet generally consists of fine-to-medium grained quartz sand, varying in color, mixed with clayey silt, organics, limonite, and fragments of rock, gravel, oyster shell, asphaltic slag, etc., depending upon the location within the site area. Beginning at the water table (3- to 5-feet), apparently native fine- to medium-grained quartz sands are encountered. No borings were advanced through the low permeability zone of the Sand-and-Gravel Aquifer within the site area, or into deeper stratigraphic horizons during the field investigation. However, borings to the low permeability zone in the vicinity of the site area during previous field investigations indicate that the clay of the low permeability zone of the Sand-and-Gravel Aquifer is encountered about 50 feet bls in the vicinity of Site 34, and about 36 feet bls to the east of Site 29. The estimated depth of the clay unit is predicted to be between these intervals from the northwestern to the southeastern extremes of Chevalier Field. Table 6-1 displays the results of lithologic examination of the surficial zone of the Sand-and-Gravel Aquifer underneath Sites 9, 29, and 34.

6.2 Water Level Elevations and Piezometric Results

Water level measurements were collected from all new monitoring wells for Sites 9, 29, and 34 and several previously installed wells to define the piezometric surface for the site area. Groundwater elevations for each well used in the site hydrologic investigation, along with other relevant monitoring well information are listed in Section 5 of this report.

Table 6-1
Generalized Soil Boring Sample Interval Lithology
Sites 9, 20 and 34

Site Number	Sample Interval	Lithology
Site 9	0-1 ft.	White-to-tan-to-dark brown, reddish, gray, fine-to-medium grained quartz sand, mixed with sandy loam, loamy soil, clayey silt, organics, rock fragments, gravel, oyster shell, debris, and asphaltic slag.
	1-3 ft.	White-to-tan-to-dark brown, red-to-orange, gray mottled, fine-to-medium grained quartz sand, mixed with limonite, gravel, rock fragments, and clay fragments.
	3-5 ft.	White-to-tan-to-dark brown, fine-to-medium grained quartz sand.
	Screened Interval (well locations)	Tan-to-brown, light-to-dark gray, silty, fine-to-medium grained quartz sand.
Site 29	0-1 ft.	Light tan-to-brown, red-to-orange, fine-to-medium-grain, quartz sand, mixed with some organics and pea gravel.
	1-3 ft.	White-to-orange-to-medium brown, fine-to-medium-grain, quartz sand, mixed with a grayish tint, a brown silty interval, limonite, and organics.
	3-5 ft.	White-to-tan-to brown, orange, gray, silty clayey, fine-to-medium grain quartz sand, occasionally mixed with gravel and burned material.
	Screened Interval (well locations)	White-to-tan-to-gray, fine-to-medium grained quartz sand.
Site 34	0-1 ft.	Light tan-to-brown, red-to-orange, fine-to-medium grained quartz sand, mixed with silt, clay, limonite, and organics.
	1-3 ft.	White-to-tan-to-brown, red-to-orange, grayish, fine-to-medium-grained quartz sand, mixed with silty clay sand and concrete pieces.
	3-5 ft.	White-to-tan to brown, silty, clayey, brown mottled, fine-to-medium grained quartz sand.
	5-7 ft.	White-to-tan-to-brown, grayish, red-to-orange, brown mottled, fine-to-medium grained quartz sand, with silty clay streaks.
	7-9 ft.	Tan-to-brown, grayish, red-to-orange, fine-to-medium grained quartz sand.
	Screened Interval (well locations)	White-to-tan-to-dark brown, orange, silty, clayey, fine-to-medium grained quartz sand.

[Bold items in bracket denote changes to the first draft of document.]

Groundwater elevation varies from roughly 3.5 feet in the southeastern portion of the site area (Site 29), to 2-feet along the western and northwestern portions of the site area (westernmost part of Site 9/northwestern part of Site 34). This highest-to-lowest groundwater elevation drop occurs across an approximate 800 to 1000 feet horizontal distance, depending on the reference point within the site area. Groundwater elevations generally indicate a west-to-northwest flow in the uppermost part of the surficial zone of the Sand-and-Gravel Aquifer in the area. Groundwater generally flows toward the concrete tile-lined drainage ditch which traverses the western edge of the site area, however, there is an element of flow from Site 29 to the southeast. This finding is verified by earlier studies, which state that horizontal movement of groundwater in the surficial sand generally mimics topography (G&M, 1984). Figure 6-1 displays the shallow surficial piezometric surface for Sites 9, 29, and 34.

The horizontal hydraulic gradient varies slightly across the site area, with the gradient becoming less steep at the northern extreme (Site 34 area). As an exception gradient is very low across the interior and immediately to the west of Site 29. The horizontal hydraulic gradient across most of remaining portions of the site area (east to west) averages about 0.002. This includes the gradient extending across Site 9 from Site 29 (southern portion of the site area), toward the west. Included also is the gradient to the northwest, extending from the northern portion of the Site 9 area. The horizontal hydraulic gradient lessens from the center of Site 9/north Site 29 area, to the north across Site 34, becoming approximately 0.001. Table 6-2 presents horizontal hydraulic gradients for selected well pairs within the site area. These well pairs were selected with the intervening distance azimuth to isopleths in order to determine the horizontal hydraulic gradient along the predominant flow directions across the site. The table generally depicts how the horizontal hydraulic gradient lessens as groundwater flow shifts west to northwest across the site area.

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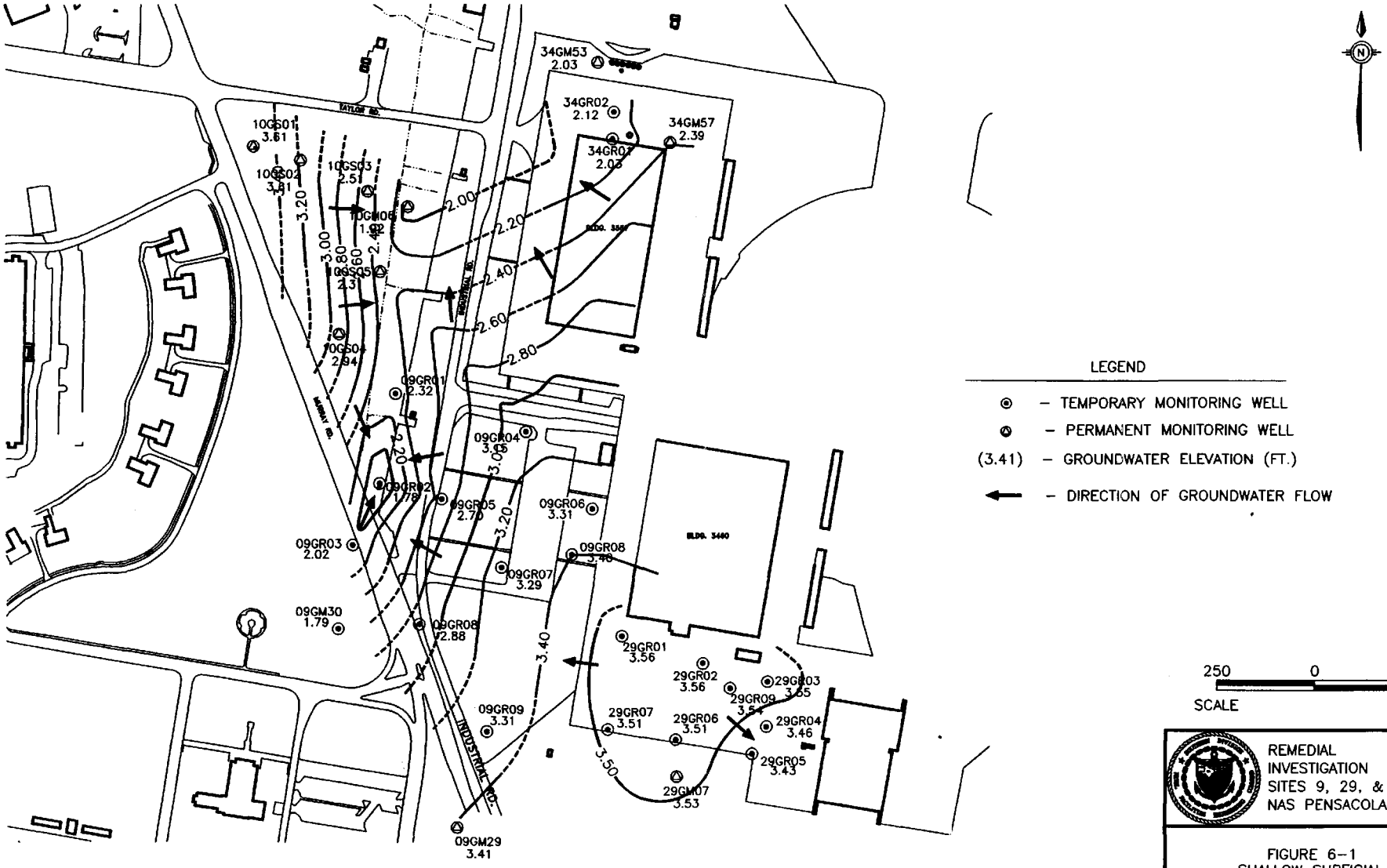
34GM53
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34GR07
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10GS01
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10GS02
3.81
10GS03
2.51
10GM06
1.92
10GS05
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10GS04
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29GR05
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29GM07
3.53
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2.20
2.40
2.60
2.80
3.00
3.20
3.40
3.50
LEGEND
– TEMPORARY MONITORING WELL
– PERMANENT MONITORING WELL
(3.41) – GROUNDWATER ELEVATION (FT.)
– DIRECTION OF GROUNDWATER FLOW
250 0 250
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 6-1
SHALLOW SURFICIAL
PIEZOMETRIC SURFACE
DWG DATE:03/14/96
DWG NAME:70SSPS61

Table 6-2
Horizontal Hydraulic Gradients
Sites 9, 29, and 34

Well Pair	Distance Between Wells (feet)	Difference Between Water Levels (feet)	Hydraulic Gradient	Groundwater Horizontal Velocity (feet/day)
29GR07/09GGM30	738	1.72	0.00233	0.410
29GR01/09GR03	719	1.54	0.00214	0.377
09GR06/09GR01	571	0.99	0.00173	0.304
09GR04/10GGM06	547	0.85	0.00154	0.271

Average transmissivity and hydraulic conductivity data were calculated for the shallow and intermediate portions of the surficial aquifer during the field investigation conducted for NAS Pensacola's Operable Unit (OU) 10 and Site 13. Given the close proximity of these sites and the lithologic similarity, this information is extrapolative for use on Chevalier Field. The geometric mean of the hydraulic conductivity for the shallow wells at OU 10 was calculated at 44.0 ft./day (E/A&H, 1994g).

Using this value, the average darcian groundwater velocity for the upper level of the surficial zone beneath the site area was calculated using the following formula:

$$V = Ki/n_e$$

Where:

V = horizontal groundwater velocity

K = hydraulic conductivity

i = horizontal hydraulic gradient

n_e = effective porosity

An effective porosity of 0.25 was estimated for unconsolidated sand from Heath (1989). Table 6-2 also lists the horizontal flow velocities of groundwater at various points within the site area. Toward the southern end of the Site 9, groundwater flows west at **[a calculated velocity of]** 0.410 ft./day, whereas in the Site 34 area, groundwater flows northwest at **[a calculated velocity of]** 0.271 ft./day.

7.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at Sites 9, 29 and 34 will be discussed by site. The sampling approach, methods, and sample locations for this investigation were discussed in Sections 5.1 through 5.2 of this report. **[The nature and extent comparison for soil data will encompass correlation of analytical data with the list of PRGs used for the draft RI report (1995 PRGs) as well the most up-to-date list (1996 PRGs). The analytical data for soils were initially compared to risk-based, surface soil PRGs exclusively (1995 PRGs). The 1995 PRGs considered conservative assumptions, fast-track remediation requirements, and Tier 1 agreement. The 1995 PRGs were used to formulate the BRA and to justify interim soil removals on each site. Subsequent comparisons (1996 PRGs) used subsurface leaching values. This was because state/federal leachability standards were available, the extensive placement of fill over Chevalier Field during BRAC construction removed the soil pathway for risk, and Tier 1 agreement. Compared to the 1995 study, the 1996 comparison focused only on the leachability of contaminants to groundwater.**

7.1 Comparison to 1995 PRGs

For initial comparisons to support BRAC construction,] the analytical results were compared to the following general and site-specific PRGs.

Soil

- Risk-based concentrations (RBCs) for residential soil, as derived from the USEPA Region III Contaminant of Concern Screening Table (USEPA 1994b).

- Selected soil cleanup goals (CGs) based on an aggregate or child resident scenario (lowest level) as derived from The Florida Department of Environmental Protection (FDEP) list of cleanup goals for the Military Sites in Florida (FDEP 1994a).

- EPA, Office of Solid Waste and Emergency Response (OSWER) draft revised Interim Soil Lead Guidance (USEPA 1994c).

Groundwater

- USEPA Maximum Contaminant Levels (MCLs) (USEPA 1994d).
- Florida Primary Drinking Water Standards (FPDWS) (FDEP 1994b).
- USEPA Secondary Maximum Contaminant Levels (SMCLs) (USEPA 1994d).
- Florida Secondary Drinking Water Standards (FSDWS) (FDEP 1994b).
- Florida Groundwater Guidance Concentrations (FGGC) (FDEP 1994b).

Soil RBCs and CGs were derived for surface soil comparisons (0-1 for USEPA/0-2 for FDEP) but were used for comparative screening purposes on all soil samples. In addition, soil and groundwater were compared to NAS Pensacola-specific reference concentrations, developed by the Navy during the Site 1 investigation. These are equal to two times the detected mean for any given parameter (E/A&H 1994h).

The PRGs for soil and groundwater contaminants are listed in Appendix A. The validated analytical data for soil and groundwater sampling at each site are tabulated in Appendix B. A tabulated summary of analytical data is in Appendix D. Additionally, maps within this section illustrate the distribution of inorganic and organic soil and groundwater contamination for each site within the area of investigation. These figures display the highest concentration between Phase I and Phase II samples where applicable. For the soil contamination assessment, surface soils are defined as the 0- to 1-foot bls interval, while subsurface soils are the interval 1-foot bls to the water table.

[7.1.1] Site 9

[7.1.1.1] Soil Contamination Assessment

Soil at Site 9 exhibited several contaminants above respective **[1995]** PRGs for several parameters. Although down hole vapor concentrations ranged from 2.8 to 8.0 ppm, only trace VOCs were verified by laboratory analysis. Metals exceeding **[1995]** PRGs were limited to manganese, arsenic, and beryllium, except at Boring 09S18, where lead, copper and other inorganics were found. At two spatially isolated locations surface soil dieldrin contamination was found. SVOCs detected were predominantly PAH compounds, with the highest encountered in the western part of the site at borings 09302, 09S03, 09S17, 09S18 and 09S27. Boring 09S02 also contained fill material, including concrete rubble and aircraft wire. Boring 09S18 contained visible metal objects such as screws and wire, solder, metal oxides, electrical components, and burned/charred materials. Table B-1 summarizes analytical data for Site 9 soil sampling, and Figure 7-1 diagrams inorganics detected on Site 9 which exceeded **[1995]** PRGs in surface soils. Figure 7-2 exhibits inorganics detected at the site exceeding **[1995]** PRGs in subsurface soils.

Contamination Assessment — Inorganics

Arsenic and manganese were found to be the most prevalent inorganic soil parameters detected across Site 9. Arsenic concentrations exceeded **[1995]** PRGs at seven of nine Phase I soil borings, ranging from 0.78 mg/kg to 2.5 mg/kg in surface soil. Arsenic concentrations also exceeded PRGs in subsurface soil at two Phase I borings, at 1.1 mg/kg and 1.2 mg/kg, respectively. Manganese concentrations exceeded the RBC in surface soil at six of nine Phase I soil borings, ranging from 48.6 mg/kg to 683 mg/kg. Subsurface soil manganese concentrations exceeded the RBC at one boring at 115 mg/kg. One boring contained beryllium above the RBC at a concentration of 0.2 mg/kg.

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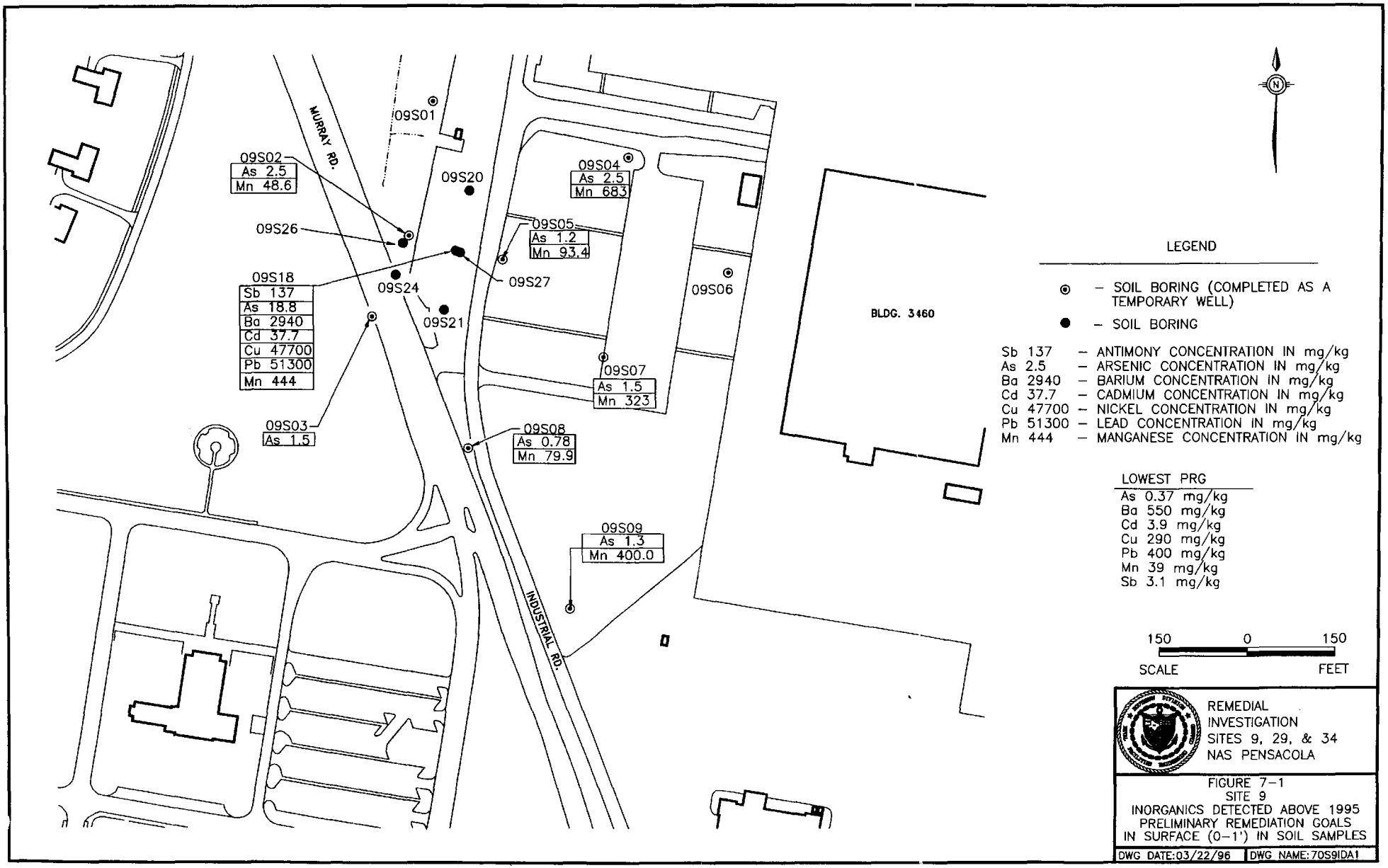
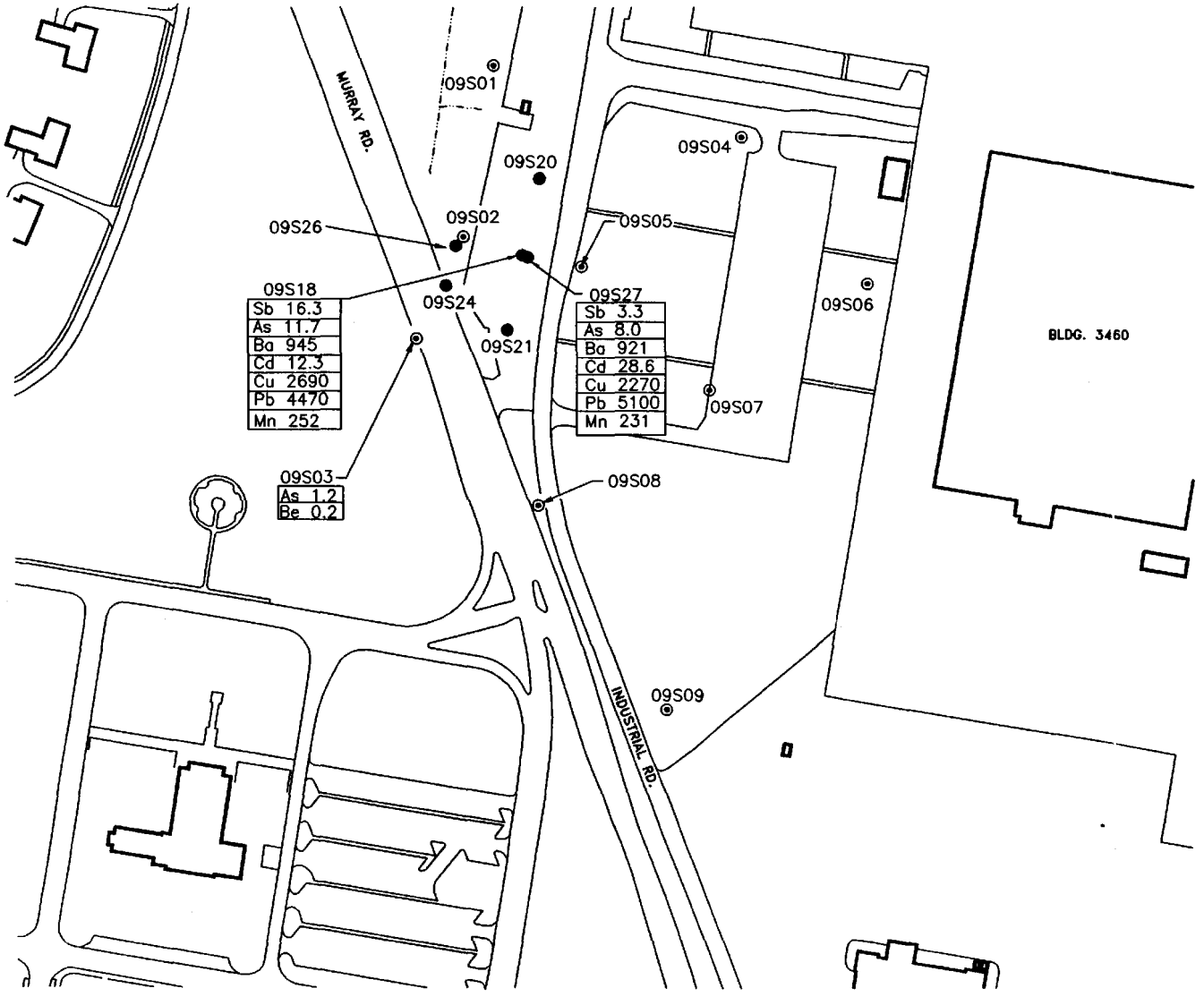

MURRAY RD.
INDUSTRIAL RD.
BLDG. 3460
09S01
09S02
As 2.5
Mn 48.6
09S20
09S04
As 2.5
Mn 683
09S26
09S05
As 1.2
Mn 93.4
09S18
Sb 137
As 18.8
Ba 2940
Cd 37.7
Cu 47700
Pb 51300
Mn 444
09S24
09S27
09S06
09S21
09S07
As 1.5
Mn 323
09S03
As 1.5
09S08
As 0.78
Mn 79.9
09S09
As 1.3
Mn 400.0
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– SOIL BORING
Sb 137 – ANTIMONY CONCENTRATION IN mg/kg
As 2.5 – ARSENIC CONCENTRATION IN mg/kg
Ba 2940 – BARIUM CONCENTRATION IN mg/kg
Cd 37.7 – CADMIUM CONCENTRATION IN mg/kg
Cu 47700 – NICKEL CONCENTRATION IN mg/kg
Pb 51300 – LEAD CONCENTRATION IN mg/kg
Mn 444 – MANGANESE CONCENTRATION IN mg/kg
LOWEST PRG
As 0.37 mg/kg
Ba 550 mg/kg
Cd 3.9 mg/kg
Cu 290 mg/kg
Pb 400 mg/kg
Mn 39 mg/kg
Sb 3.1 mg/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7-1
SITE 9
INORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN SURFACE (0-1') IN SOIL SAMPLES
DWG DATE:03/22/96
DWG NAME:70S9IDA1



LEGEND

- ◉ – SOIL BORING (COMPLETED AS A TEMPORARY WELL)
- ● – SOIL BORING

Sb 16.3 – ANTIMONY CONCENTRATION IN mg/kg
As 11.7 – ARSENIC CONCENTRATION IN mg/kg
Ba 945 – BARIUM CONCENTRATION IN mg/kg
Be 0.2 – BERYLLIUM CONCENTRATION IN mg/kg
Cd 12.3 – CADMIUM CONCENTRATION IN mg/kg
Cu 2690 – COPPER CONCENTRATION IN mg/kg
Pb 4470 – LEAD CONCENTRATION IN mg/kg
Mn 252 – MANGANESE CONCENTRATION IN mg/kg

LOWEST PRG
As 0.37 mg/kg
Ba 550 mg/kg
Be 0.15 mg/kg
Cd 3.9 mg/kg
Cu 290 mg/kg
Pb 400 mg/kg
Mn 39 mg/kg
Sb 3.1 mg/kg

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7-2
SITE 9
INORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN SUBSURFACE (1'-WATER TABLE) SOIL SAMPLES

DWG DATE:03/18/96 | DWG NAME:70S90DA2

Boring 09S18

Phase II soil sampling was conducted at Site 9 to further characterize soil contamination at the site. Phase IIa soil samples were analyzed for semivolatiles only. However, due to the visual appearance of the soil cuttings (color of materials/presence of debris in the sample) as Phase IIa boring 09S18 was advanced, it was decided to analyze samples from this boring for the full TAL/TCL. Inorganics analysis for this boring revealed the presence of seven analytes above PRGs in both surface and subsurface soils, including antimony, arsenic, barium, cadmium, copper, lead, and manganese. The highest concentrations of inorganics within the site area were found in the surface soil sample analyzed from this boring, included copper at 47,700 mg/kg, and lead at 51,300 mg/kg. Notably, these same analytes appeared above **[1995]** PRGs from the TAL/TCL sample collected from the Phase IIb leachability boring collocated with boring 09S18 (boring 09S27).

Soil Reference Concentration Comparison

The NAS Pensacola soil reference concentration for arsenic (1.56 mg/kg) exceeds both the RBC and CG. Most surface soil arsenic concentrations at Site 9 exceeded both the NASP reference concentration and the **[1995]** PRGs, while subsurface arsenic concentrations were below the reference level, but still above the **[1995]** PRGs. Like arsenic, the NAS Pensacola soil reference concentration for beryllium (0.41 mg/kg) exceeds the RBC. The single elevated beryllium concentration found at Site 9 was above the RBC, but below the reference level.

Contamination Assessment — Organics

Figure 7-3 displays organics detected on Site 9 which exceeded **[1995]** PRGs in surface soils. Figure 7-4 charts organics detected at the site exceeding **[1995]** PRGs in subsurface soils. Organic soil contaminants detected above PRGs on Site 9 included semivolatiles and the pesticide

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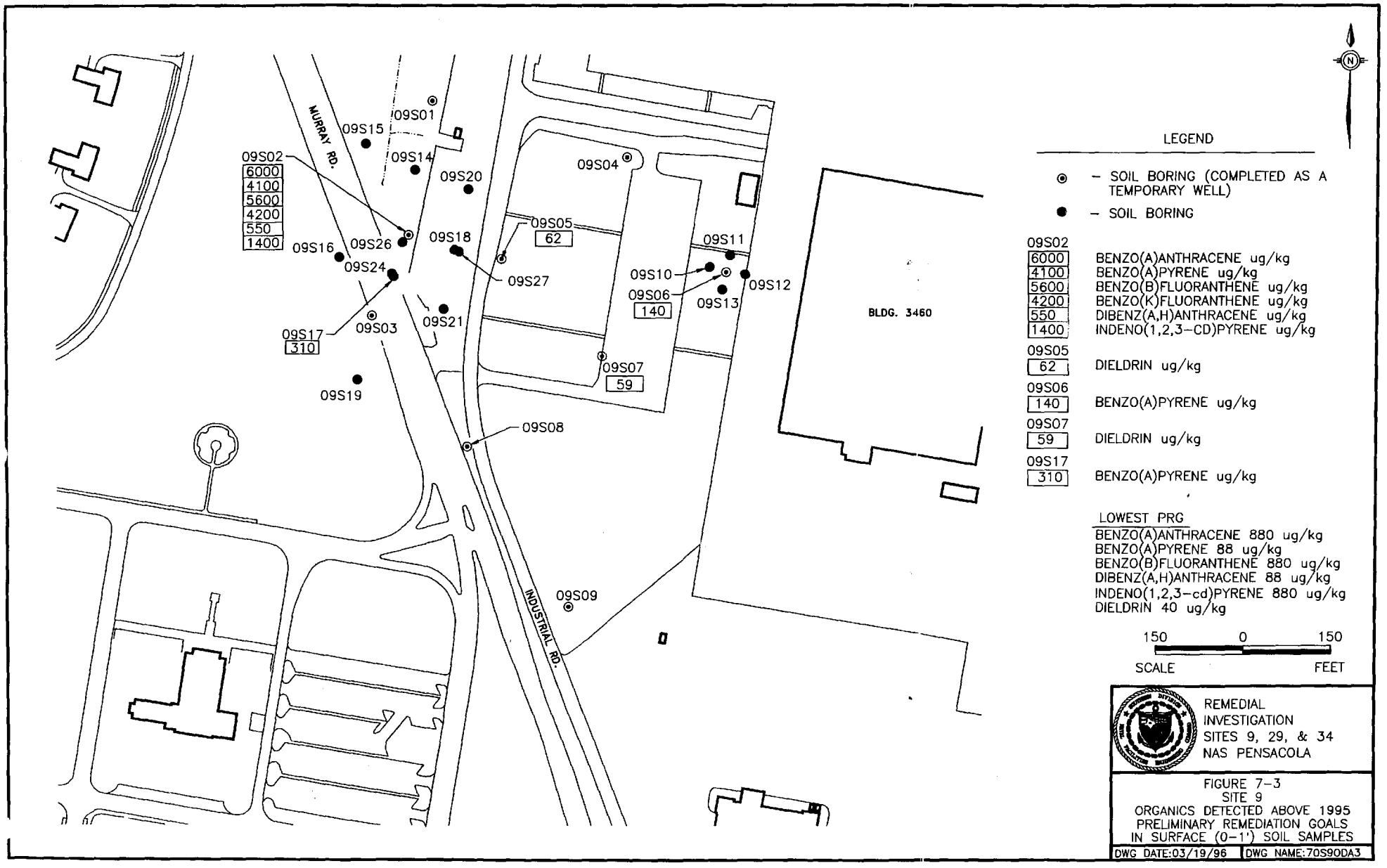
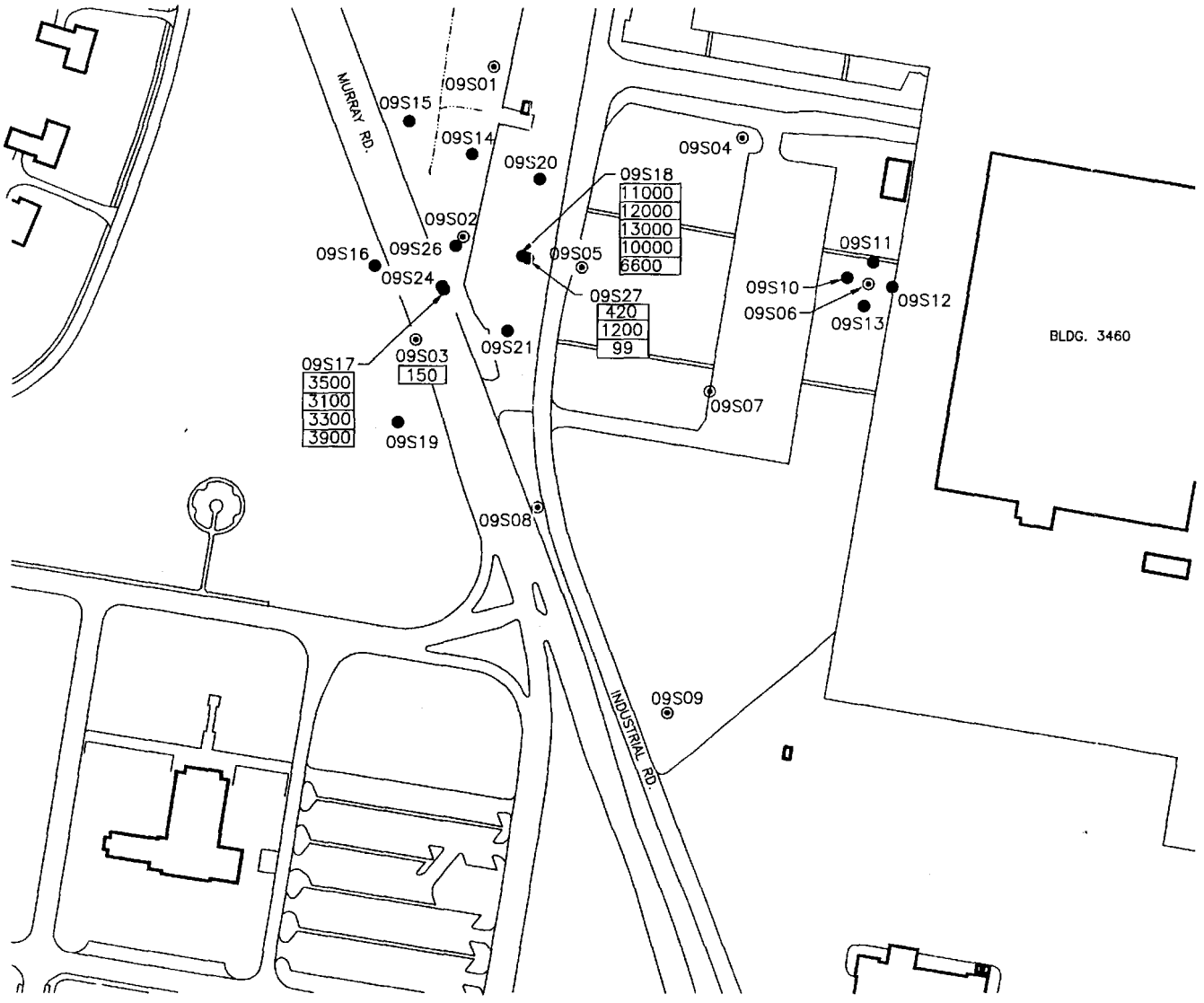

MURRAY RD.
INDUSTRIAL RD.
BLDG. 3460
09S01
09S02
6000
4100
5600
4200
550
1400
09S03
09S04
09S05
62
09S06
140
09S07
59
09S08
09S09
09S10
09S11
09S12
09S13
09S14
09S15
09S16
09S17
310
09S18
09S19
09S20
09S21
09S24
09S26
09S27
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– SOIL BORING
09S02
6000 BENZO(A)ANTHRACENE ug/kg
4100 BENZO(A)PYRENE ug/kg
5600 BENZO(B)FLUORANTHENE ug/kg
4200 BENZO(K)FLUORANTHENE ug/kg
550 DIBENZ(A,H)ANTHRACENE ug/kg
1400 INDENO(1,2,3–CD)PYRENE ug/kg
09S05
62 DIELDRIN ug/kg
09S06
140 BENZO(A)PYRENE ug/kg
09S07
59 DIELDRIN ug/kg
09S17
310 BENZO(A)PYRENE ug/kg
LOWEST PRG
BENZO(A)ANTHRACENE 880 ug/kg
BENZO(A)PYRENE 88 ug/kg
BENZO(B)FLUORANTHENE 880 ug/kg
DIBENZ(A,H)ANTHRACENE 88 ug/kg
INDENO(1,2,3–cd)PYRENE 880 ug/kg
DIELDRIN 40 ug/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7–3
SITE 9
ORGANICS DETECTED ABOVE 1995
PRELIMINARY REMEDIATION GOALS
IN SURFACE (0–1') SOIL SAMPLES
DWG DATE:03/19/96
DWG NAME:70S9ODA3



LEGEND

- ⊙ – SOIL BORING (COMPLETED AS A TEMPORARY WELL)
- ● – SOIL BORING

09S03
150 BENZO(A)PYRENE ug/kg

09S17
3500 BENZO(A)ANTHRACENE ug/kg
3100 BENZO(A)PYRENE ug/kg
3300 BENZO(B)FLUORANTHENE ug/kg
3900 BENZO(K)FLUORANTHENE ug/kg

09S18
11000 BENZO(A)ANTHRACENE ug/kg
12000 BENZO(A)PYRENE ug/kg
13000 BENZO(B)FLUORANTHENE ug/kg
10000 BENZO(K)FLUORANTHENE ug/kg
6600 INDENO(1,2,3-CD)PYRENE ug/kg

09S27
420 BENZO(A)PYRENE ug/kg
1200 BENZO(B)FLUORANTHENE ug/kg
99 DIBENZ(A,H)ANTHRACENE ug/kg

LOWEST PRG

BENZO(A)ANTHRACENE 880 ug/kg
BENZO(D)PYRENE 88 ug/kg
BENZO(B)FLUORANTHENE 880 ug/kg
BENZO(K)FLUORANTHENE 1470 ug/kg
DIBENZ(A,H)ANTHRACENE 88 ug/kg
INDENO(1,2,3-CD)PYRENE 880 ug/kg

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7-4
SITE 9
ORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN SUBSURFACE (1'-WATER TABLE) SOIL SAMPLES

DWG DATE:03/22/96 | DWG NAME:70S9ODA4

dieldrin. Surface soils contained dieldrin above the RBC at two Phase I boring locations near the site's center. Boring 09S05 had a dieldrin concentration of 62 μg/kg, while boring 09S07 had a dieldrin concentration of 59 μg/kg. Several semivolatiles were detected above **[1995]** PRGs at a cluster of Phase I/II borings in the west central portion of the site (boring 09S02, 09S03, 09S17, 09S18, and 09S27), and at the easternmost Phase I boring (boring 09S06). Semivolatiles above **[1995]** PRGs in surface/subsurface soils included the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)flouranthene, benzo(k)flouranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Similar to inorganics, boring 09S18 contained the highest concentrations of semivolatiles within the site area, including benzo(a)anthracene at 11000 μ/kg, benzo(a)pyrene at 12000 μg/kg, benzo(b)flouranthene at 13000 μg/kg, benzo(k)flouranthene at 10000 μg/kg, and indeno (1,2,3-cd)pyrene at 6600 μg/kg. All of these concentrations exceeded both the RBC and CG. The area surrounding Phase I boring 09S06 was examined during the Phase II investigation to further clarify semivolatile contamination at this location. Boring 09S06 was bracketed by four soil borings (borings 09S10 through 09S13), which were sampled for semivolatiles only. Analytical results indicated there were no semivolatile constituents in the bracketing samples.

During the Phase II investigation, the surface soil interval at Boring 09S01 was re-sampled for volatiles because of concerns about elevated laboratory detection limits for volatiles in the Phase I sample. No volatiles were detected above detection limits in the second sample (009S000101).

[7.1.1.2] Groundwater Contamination Assessment

Table B-2 summarizes analytical data for Site 9 groundwater sampling.

Contamination Assessment — Inorganics

Aluminum, iron, lead, and manganese were the inorganics above PRGs in the Site 9 Phase I groundwater samples. Aluminum exceeded the SMCL/FSDWS at 9 sample locations, with concentrations ranging from 258 μg/L to 2050 μg/L. Iron exceeded the SMCL/FSDWS at 10 sample locations, with concentrations ranging from 318 μg/L to 3940 μg/L. Manganese exceeded PRGs at 7 sampling locations, ranging in concentration from 51.6 μg/L to 693 μg/L. Lead exceeded MCL/FPDWS at a single sampling location (09GR02) at a concentration of 27 μg/L. During the Phase II investigation, temporary well 09GR02 was resampled for metals only to further clarify the lead contamination found in the Phase I groundwater sample from this well. Lead was not detected in the second sample. Figure 7-5 maps inorganics detected in groundwater on Site 9 which exceeded PRGs.

Reference Concentration Comparison

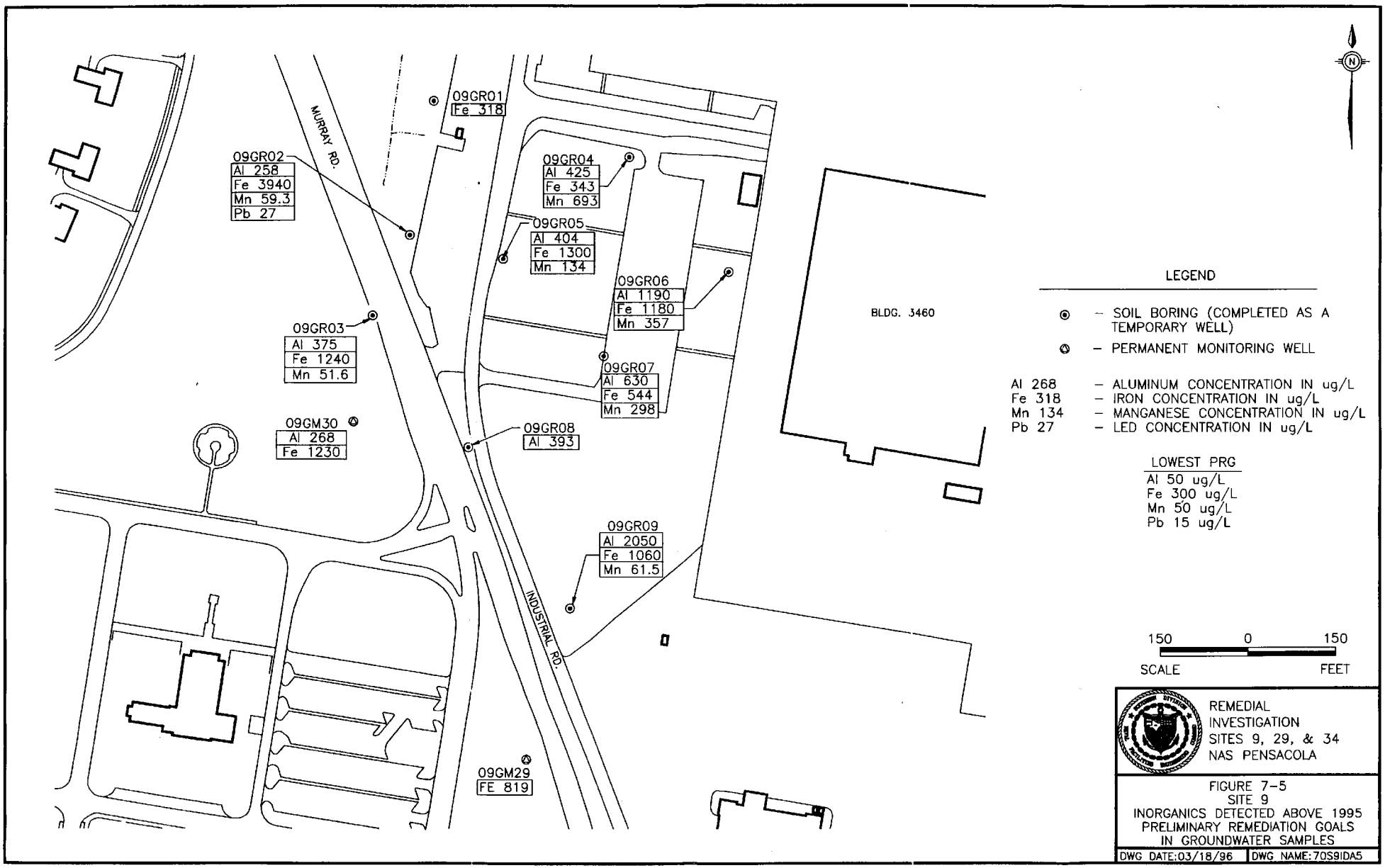
The NASP groundwater reference concentrations for aluminum and iron both exceed the SMCL/FSDWS for each analyte. Though above PRGs, aluminum concentrations in groundwater at Site 9 ranged below the NASP groundwater reference concentration. All but one iron concentration above PRGs in Site 9 groundwater were below NASP the reference concentration for iron.

Contamination Assessment — Organics

No organics were found to exceed the applicable PRGs in the Site 9 groundwater samples.

Sediment Analysis

The single sediment sample collected from the drainage ditch to the west of Site 9 was for the purpose of evaluating potential contaminant migration from the site area to downgradient wetlands. The analytical data for this sample is included in Table B-1. A more complete


09GR01
Fe 318
09GR02
Al 258
Fe 3940
Mn 59.3
Pb 27
MURRAY RD.
09GR04
Al 425
Fe 343
Mn 693
09GR05
Al 404
Fe 1300
Mn 134
09GR06
Al 1190
Fe 1180
Mn 357
BLDG. 3460
09GR03
Al 375
Fe 1240
Mn 51.6
09GR07
Al 630
Fe 544
Mn 298
09GM30
Al 268
Fe 1230
09GR08
Al 393
09GR09
Al 2050
Fe 1060
Mn 61.5
INDUSTRIAL RD.
09GM29
FE 819
N
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– PERMANENT MONITORING WELL
Al 268 – ALUMINUM CONCENTRATION IN ug/L
Fe 318 – IRON CONCENTRATION IN ug/L
Mn 134 – MANGANESE CONCENTRATION IN ug/L
Pb 27 – LED CONCENTRATION IN ug/L
LOWEST PRG
Al 50 ug/L
Fe 300 ug/L
Mn 50 ug/L
Pb 15 ug/L
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7-5
SITE 9
INORGANICS DETECTED ABOVE 1995
PRELIMINARY REMEDIATION GOALS
IN GROUNDWATER SAMPLES
DWG DATE:03/18/96
DWG NAME:70S9IDA5

investigation of this potential will be forthcoming in the Site 41 (NASP wetlands) investigation. Inorganics exceeding sediment screening values were copper and lead. For inorganics, the pesticide 4,4'-DDT also exceeded the sediment screening value. PAHs found were below individual constituent screening values, and also below the screening value for total PAHs.

[7.1.1.3] Summary and Conclusions — Site 9

Inorganic Contaminants

Arsenic and manganese appear to be ubiquitous inorganic soil constituents throughout surface soil. These also seem to be more localized in subsurface soils. High levels of inorganic parameters are also localized in both surface and subsurface soils near the center of the site at boring 09S18. It should be noted that the 1992 Interim Data Report published by E&E (E&E 1992c) referred to repeated disturbance of soil at the site from grading, backfilling, and construction activities, and how these activities have likely affected the redistribution of contaminants on the site. As soils in and around the old Navy Yard Disposal Area have been redistributed on site along with construction fill, constituents associated with the dump have also been spread and localized in small pockets throughout the area. The high concentrations of localized inorganic contamination associated with samples from boring 09S18 (and collocated boring 09S27) can be attributed to the types of materials extracted from this location. Auger cuttings contained visible metal objects such as screws and wire, solder, oxidants, electrical components, and burned/charred materials, indicating that a remnant of the old disposal area had been found. Importantly, this area of fill is delineated and characterized sufficiently for the purposes of this RI (resampled area contaminated with metals and PAHs). The high levels of arsenic, and the single elevated beryllium concentration in soil can be further explained by the fact that the NASP reference levels for arsenic and beryllium are both above the **[1995]** PRGs for these analytes.

Aluminum, iron, and manganese above PRGs were found throughout the site in groundwater. These parameters appear ubiquitous in groundwater both in and around the investigation locale. Combinations of same analytes above PRGs can be found in groundwater from adjacent Sites 29 and 34. A recent preliminary investigation (conducted by E/A&H in 1994) at Site 10, northwest of Site 9, revealed that several monitoring wells contained aluminum and iron above PRGs in groundwater at similar ranges as those found on Site 9. Site 14, to the extreme east of the Chevalier Field area was characterized during the same investigation. Aluminum, iron, and manganese above PRGs were found in similar ranges in groundwater from wells at Site 14 (E/A&H 1994i). The portion of the industrial waste sewer line passing through the Chevalier Field area was also investigated by E/A&H in 1994. Again, aluminum, iron and manganese above PRGs were found in groundwater in similar ranges as were found in these other investigations (E/A&H 1995). Also, NASP-specific groundwater reference concentrations for aluminum and iron are above PRGs for these analytes. Inorganic groundwater contamination is considered delineated for the purpose of the RI.

Elevated lead was found in the Phase I groundwater sample from temporary well 09GS02. Lead was not detected in the Phase II sample from this well, indicating that the initial sample results may have been caused by an adsorption of lead out in the sample.

Organic Contaminants

Pesticides

Dieldrin above **[1995]** PRGs was found localized in surface soils at two soil boring locations on Site 9. These detections are consistent with surface application of dieldrin for pest control around the site.

Semivolatiles

PAHs were found in three general locations. Two localized concentrations of benzo(a)pyrene were found at borings 09S03 and 09S06. Boring 09S03 is located directly adjacent Murray Road, a major traffic artery for the base. Pavement runoff may be one likely source of these constituents. Activities during major road construction in this area in the late 1970s may also be a contributing source. The grassy field surrounding boring 09S03 is also heavily maintained by NASP landscaping contractors. Workmen are often seen in this area on self-propelled lawn tractors and with gasoline powered weed trimmers. These could also be a source for the PAHs found at boring 09S03. Boring 09S06 is located in a grassy area between a heavily trafficked portion of the concrete parking apron west of Building 3460, and a parking lot used by NADEP employees. The parking apron immediately adjacent to boring 09S06 was also observed to frequently be cluttered with aircraft support equipment. Fuels, oils, and greases from this equipment, along with combustion emissions from high vehicular traffic in the immediate vicinity may be the source of the PAH contamination at Boring 09S06.

The area surrounding borings 09S02, 09S17, 09S18, and 09S26 (center of the site) contained several PAH compounds above PRGs. Boring logs from these locations indicate the presence of debris, burned materials, asphaltic slag, coal, and other materials in auger cuttings retrieved from these borings. The presence of waste materials indicates that a remnant of the former dump at Site 9 was likely found. Though the Initial Assessment Study for Naval Air Station, Pensacola (NEESA 1983) did not indicate the types of activities which took place at the former Navy Yard Disposal Site, the burning of wastes deposited there would certainly contribute to the presence of the types of semivolatile compounds found at the site. An additional source is the release of fuel at Site 23. Semivolatile contamination is considered delineated for the purpose of the RI.

[7.1.2] Site 29

[7.1.2.1] Soil Contamination Assessment

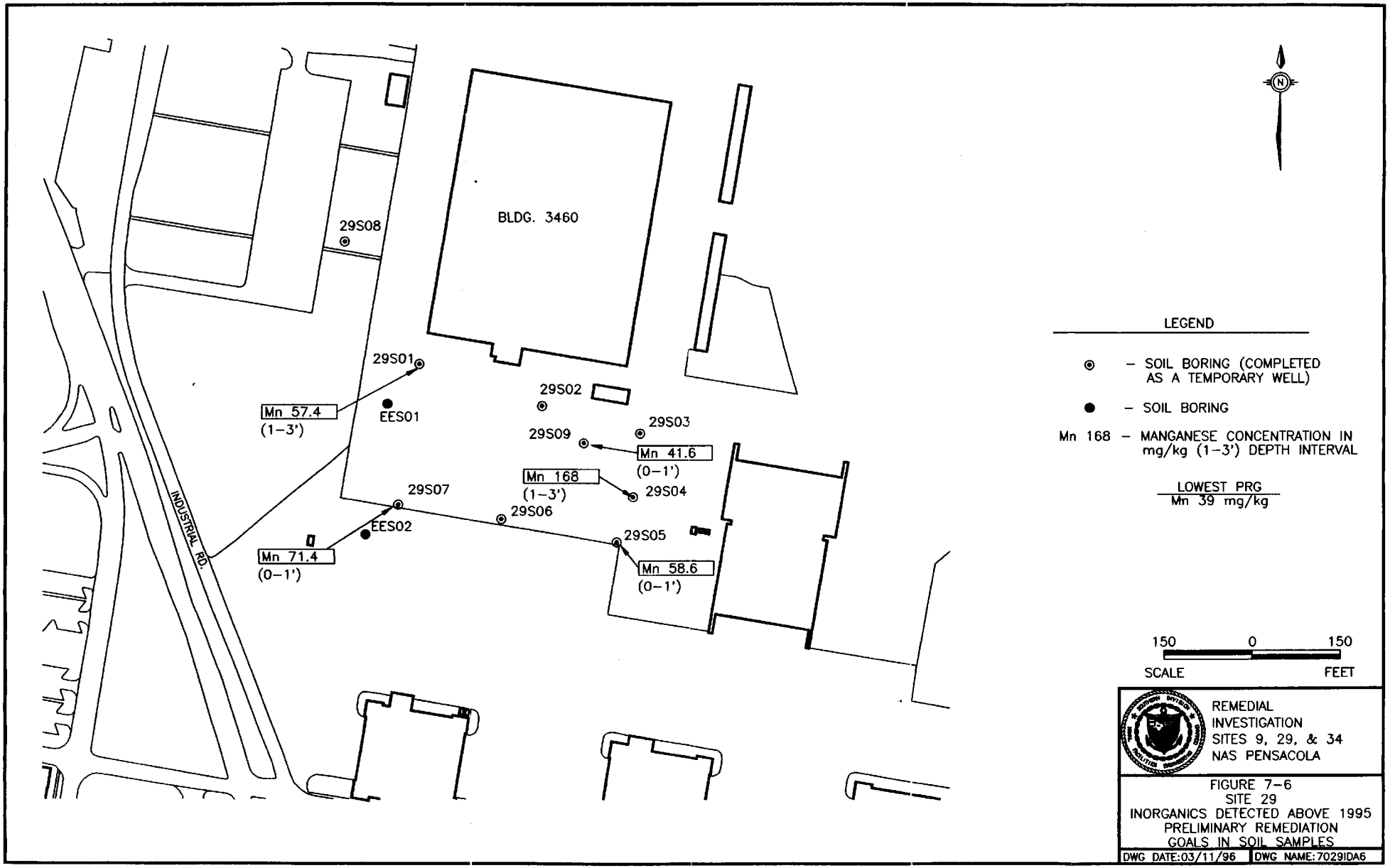
Down hole concentrations at Site 29 ranged from 0 to 38.1 ppm, with the highest encountered in the eastern part of the site in borings 29S03, 29S04 and 29S09 (E/A&H 1994d). Table B-3 contains the summary of analytical data for Site 29.

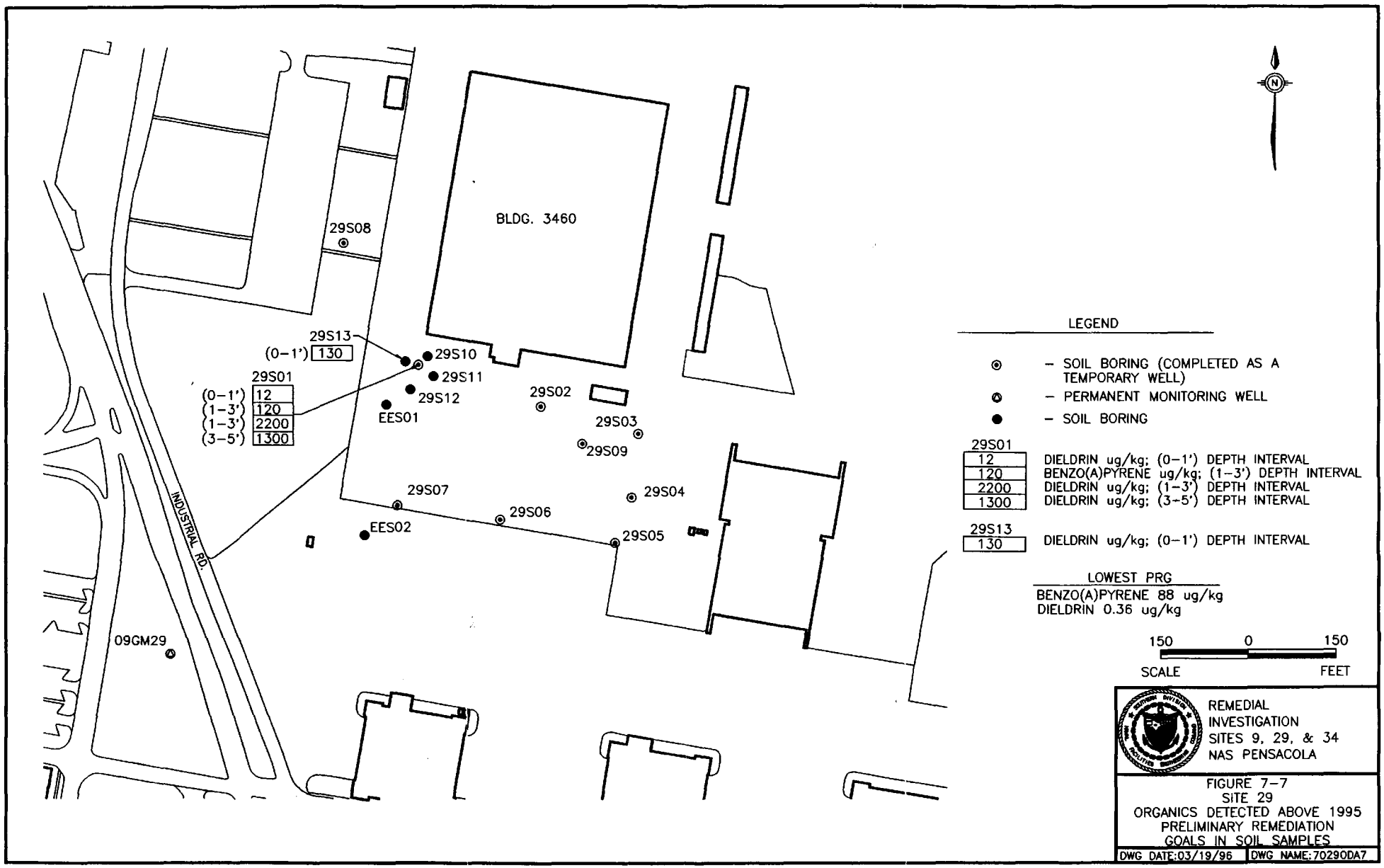
Contamination Assessment — Inorganics

Figure 7-6 diagrams soil inorganics detected on Site 29 which exceeded **[1995]** PRGs. Manganese was the only inorganic analyte found to exceed **[1995]** PRGs in soil on Site 29. Manganese exceeded PRGs in surface soils at three of nine Phase I soil borings, ranging in concentration from 41.6 mg/kg to 71.4 mg/kg. Manganese also exceeded the RBC in subsurface soils at two borings containing concentrations of 57.4 mg/kg and 168 mg/kg.

Contamination Assessment — Organics

Figure 7-7 displays Site 29 soil organics which exceeded **[1995]** PRGs. Organic soil contaminants detected above PRGs on Site 29 included the semivolatile benzo(a)pyrene and the pesticide dieldrin. Due to the detection of dieldrin above the FGGC in groundwater (sampled from the temporary well collocated at boring 29S01 (well 29GR01), the surface soil dieldrin concentration (11 μg/kg) at this boring exceeded the Florida clean-up goal based on leachability (FDEP CG for leachability applies when a constituent in soil is also found in groundwater.) The 1-3' subsurface sample interval at boring 29S01 also contained dieldrin at 2,200 μg/kg, while the 3-5' subsurface sample interval at 29S01 contained dieldrin at 1,300 μg/kg. Benzo(a)pyrene was detected in subsurface soil at boring 29S01 at 120 μg/kg.


BLDG. 3460
29S08
29S01
EES01
Mn 57.4
(1-3')
29S02
29S03
29S09
Mn 41.6
(0-1')
Mn 168
(1-3')
29S04
29S07
29S06
EES02
Mn 71.4
(0-1')
29S05
Mn 58.6
(0-1')
INDUSTRIAL RD.
N
LEGEND
- SOIL BORING (COMPLETED AS A TEMPORARY WELL)
- SOIL BORING
Mn 168 - MANGANESE CONCENTRATION IN mg/kg (1-3') DEPTH INTERVAL
LOWEST PRG
Mn 39 mg/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7-6
SITE 29
INORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN SOIL SAMPLES
DWG DATE:03/11/96
DWG NAME:7029IDA6


BLDG. 3460
29S08
29S13
(0-1') 130
29S10
29S11
29S12
EES01
29S01
(0-1') 12
(1-3') 120
(1-3') 2200
(3-5') 1300
29S02
29S03
29S09
29S04
29S07
29S06
EES02
29S05
INDUSTRIAL RD.
09GM29
LEGEND
- SOIL BORING (COMPLETED AS A TEMPORARY WELL)
- PERMANENT MONITORING WELL
- SOIL BORING
29S01
12 DIELDRIN ug/kg; (0-1') DEPTH INTERVAL
120 BENZO(A)PYRENE ug/kg; (1-3') DEPTH INTERVAL
2200 DIELDRIN ug/kg; (1-3') DEPTH INTERVAL
1300 DIELDRIN ug/kg; (3-5') DEPTH INTERVAL
29S13
130 DIELDRIN ug/kg; (0-1') DEPTH INTERVAL
LOWEST PRG
BENZO(A)PYRENE 88 ug/kg
DIELDRIN 0.36 ug/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7-7
SITE 29
ORGANICS DETECTED ABOVE 1995
PRELIMINARY REMEDIATION
GOALS IN SOIL SAMPLES
DWG DATE:03/19/96
DWG NAME:70290DA7

The four Site 29 Phase II soil borings were spaced around boring 29S01 to better characterize the source of semivolatile/pesticide contamination. Boring 29S13, approximately 30 feet northwest of boring 29S01, revealed a concentration of dieldrin at 130 μg/kg in surface soil. No semivolatiles above PRGs were found in the Phase II borings.

[7.1.2.2] Groundwater Contamination Assessment

Table B-4 contains the summary of analytical data for Site 29 groundwater sampling analyses which exceeded the appropriate PRGs.

Contamination Assessment — Inorganics

Figure 7-8 depicts inorganics detected above PRGs in Site 29 groundwater samples. Aluminum, iron, manganese, and cyanide were the inorganics found above PRGs in Site 29 groundwater samples. Aluminum was found at seven sample locations, ranging in concentration from 203 μg/L to 2060 μg/L. Iron was found at three sample locations, ranging in concentration from 740 μg/L to 1400 μg/L. Manganese was found at eight sample locations, ranging in concentration from 69.1 μg/L to 270 μg/L. Cyanide was found at one sample location at a concentration of 276 μg/kg.

Groundwater Reference Concentration Comparison

The NASP groundwater reference concentrations for aluminum and iron both exceed the SMCL/FSDWS for each constituent. Though they were above the SMCL and/or FSDWS, aluminum and iron concentrations detected on Site 29 were below the groundwater reference concentrations for these analytes.

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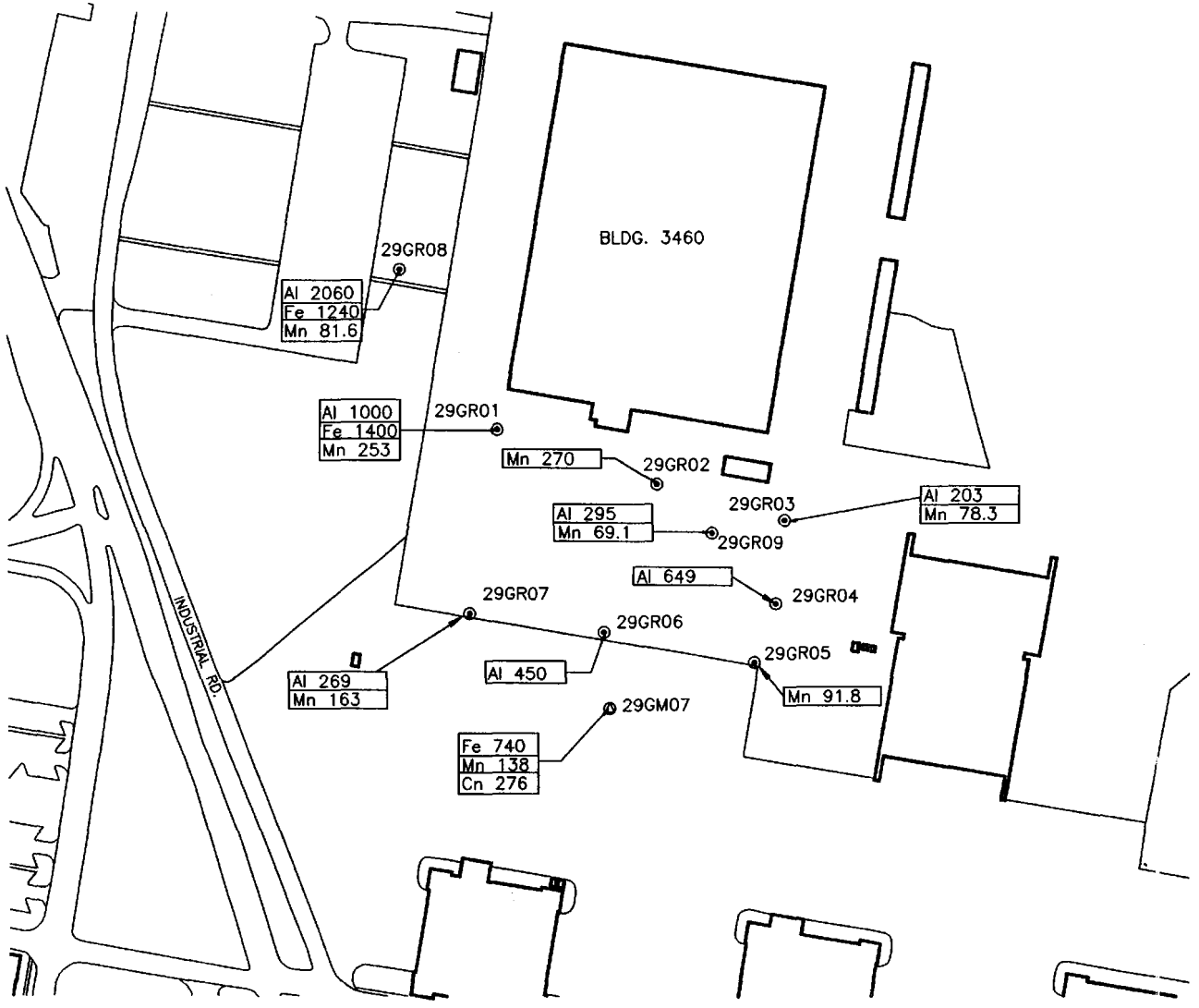

LEGEND

- TEMPORARY MONITORING WELL
- PERMANENT MONITORING WELL

Al 269 – ALUMINUM CONCENTRATION IN ug/L
Fe 1240 – IRON CONCENTRATION IN ug/L
Mn 163 – MANGANESE CONCENTRATION IN ug/L
Cn 276 – CYANIDE CONCENTRATION IN ug/L

LOWEST PRG

Al 50 ug/L
Fe 300 ug/L
Mn 50 ug/L
Cn 0.52 ug/L

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7-8
SITE 29
INORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN GROUNDWATER SAMPLES

DWG DATE:03/19/96 | DWG NAME:7029IDA8

Contamination Assessment — Organics

Figure 7-9 displays organics detected on Site 29 which exceeded PRGs in groundwater. Dieldrin at 0.13 μg/L (above the FGGC) was found in Phase I sample 29GR01. During the Phase II investigation, temporary well 29GR01 was resampled for pesticides to confirm the Phase I finding for dieldrin. No dieldrin was detected in the Phase II sample.

[7.1.2.3] Summary and Conclusions — Site 29

Inorganic Contaminants

Sporadic manganese concentrations above **[1995]** PRGs were found in surface and subsurface soils on the site. While detected concentrations were consistent with NASP reference concentrations, the randomness of these concentrations can be attributed to the fact that the southern portion of Chevalier Field has undergone tremendous redevelopment over the years. Early aerial photos show that the site contained portions of the early airfield's asphalt macadam area and taxiways, and part of a grassy field. Major reconstruction occurred when the current NADEP facilities were built, to include the construction of the concrete parking apron, the upgrade of the industrial waste sewer line, etc. Grading, backfilling, introduction of fill, etc., may have served to redistribute surface and subsurface soil around the site.

As discussed for Site 9, aluminum, iron, and manganese above PRGs were also found throughout groundwater at Site 29. Cyanide above PRGs was also found in a single groundwater sample from the permanent well directly south of the site (29GM07). The cyanide sample found is upgradient from Site 29 and is not related to any contaminant source found at the site. No history of cyanide exists at the site and this concentration may have resulted from the laboratory distillation procedure for this sample (see Section 8.3.8 of this report).

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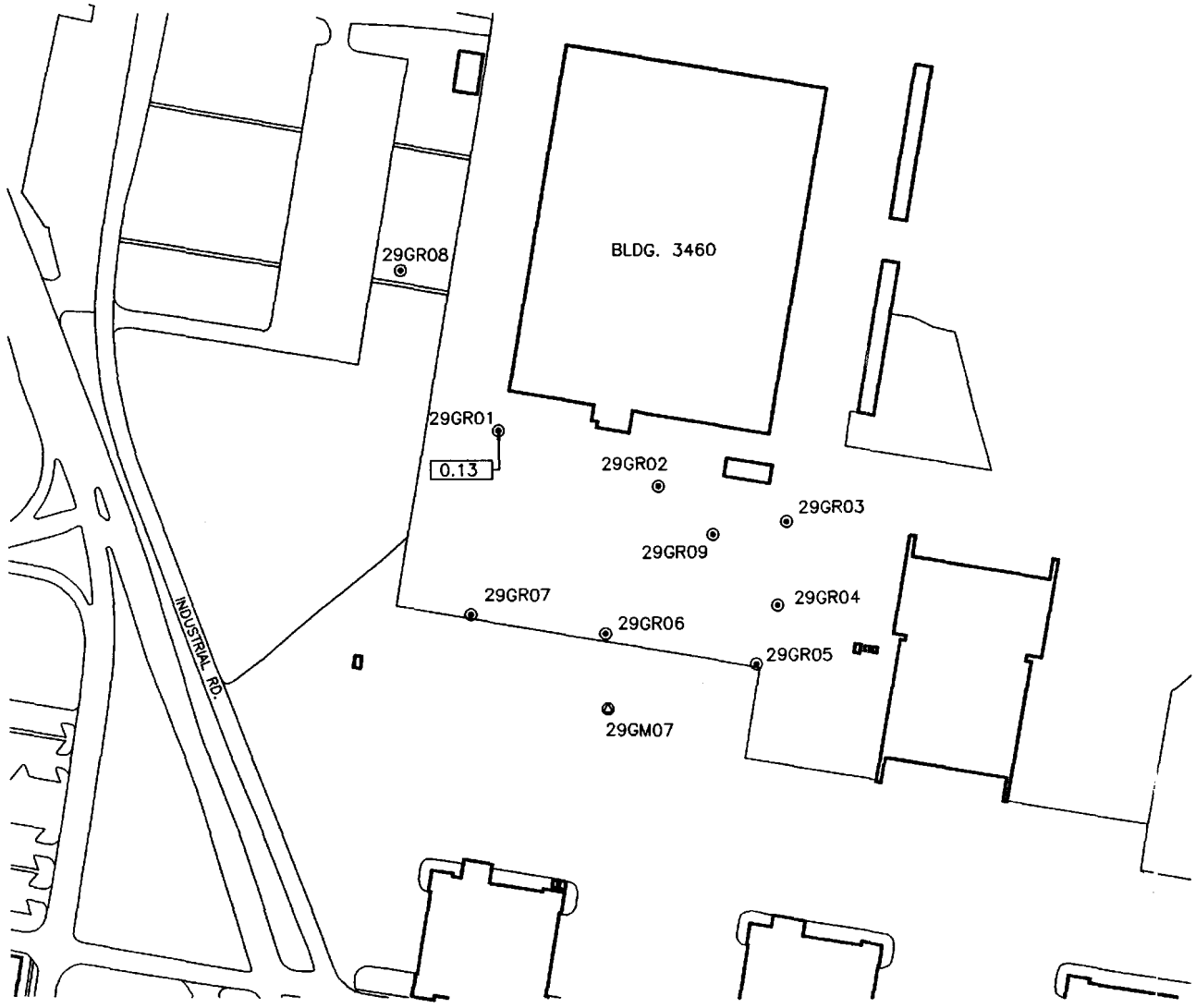


LEGEND

- TEMPORARY MONITORING WELL
- PERMANENT MONITORING WELL

29GR01 / 0.13 DIELDRIN CONCENTRATION IN ug/L

LOWEST PRG
DIELDRIN 0.1 ug/L

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7-9
SITE 29
ORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN GROUNDWATER SAMPLES

DWG DATE:03/19/96 DWG NAME:70290DA9

Organic Contaminants

The presence of dieldrin in surface soil at borings 29S01/29S13 are likely the result of application residue from pesticide control activities. The presence of dieldrin and benzo(a)pyrene at depth is inconsistent with surface application/exposure. These concentrations are likely associated with the grading, backfilling, and other construction/rework activities which have taken place at the site over time. This area is considered to be delineated. Furthermore, the soil at this location **[was removed during BRAC construction]**.

The Phase I groundwater sample from well 29GS01 contained dieldrin at 0.13 μg/L. While this exceeded the FGGC, the Phase II sample from this well displayed no detectable dieldrin. The low concentration in the first sample and the undetected concentration in the second sample make the validity of the first sample remarkably suspect.

[7.1.3] Site 34

[7.1.3.1] Soil Contamination Assessment

Down hole concentrations on Site 34 varied between boring locations, ranging from 0 to 31 ppm. Field personnel noted that some of the higher readings were attributed to emissions from the northern end of Building 3557 where aircraft cleaning operations were being conducted. During advancement of boring 34S01, vapor concentrations up to 60 ppm were found at the nearby concrete trench where solvent pipes from the tank farm enter the foundation of Building 3557 (E/A&H 1994d). Table B-5 contains the summary of analytical data for the Site 34 soil sampling analyses which exceeded the applicable PRGs.

Contamination Assessment — Inorganics

Figure 7-10 displays Site 34 inorganics above **[1995]** PRGs in soil samples. One soil sample from Site 34 exceeded PRGs for inorganics. Subsurface soil at Phase I boring 34S01 contained lead at 689 mg/kg.

Contamination Assessment — Organics

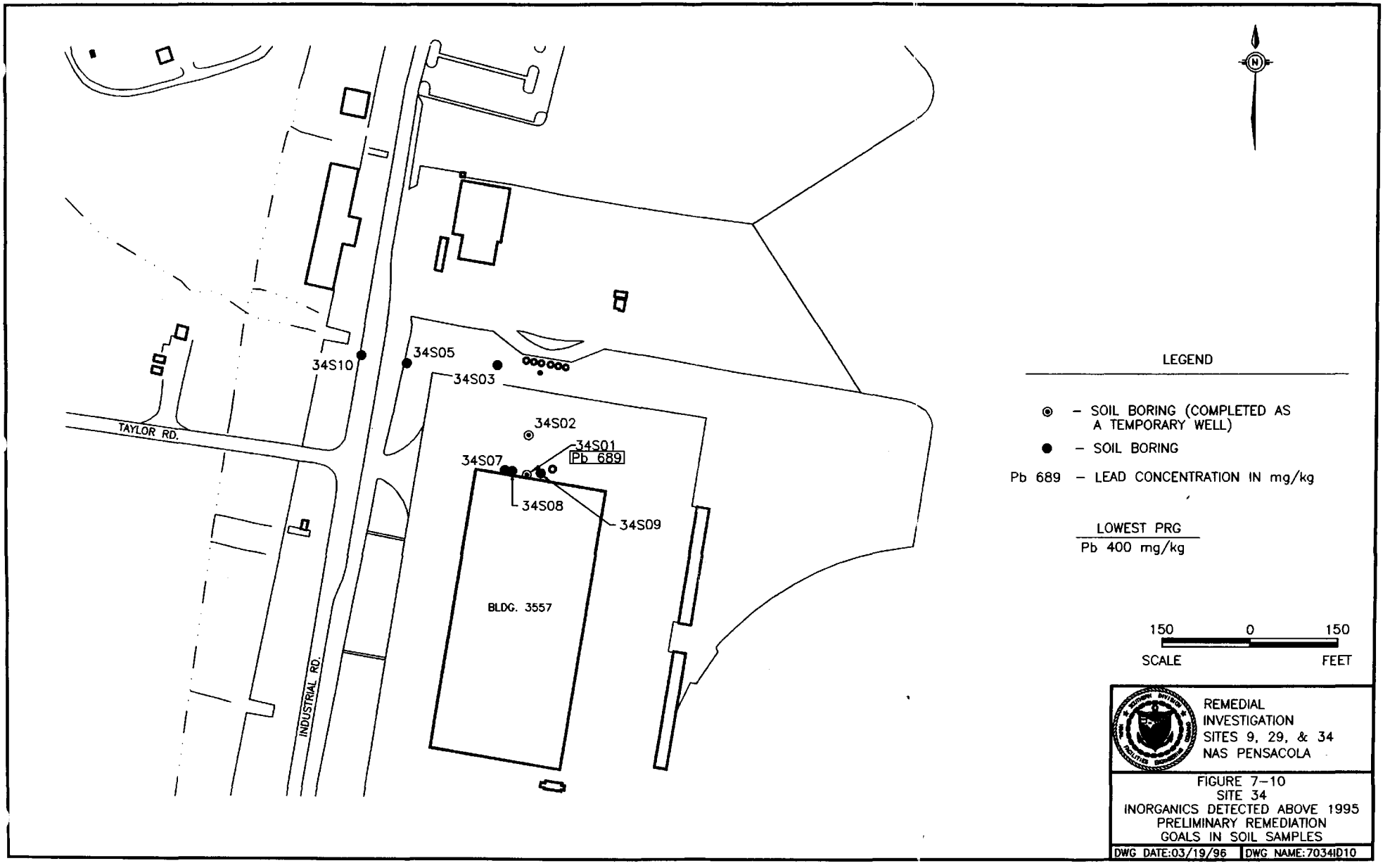
Figure 7-11 displays Site 34 organics detected above **[1995]** PRGs in soil samples. Two soil samples from Site 34 exceeded PRGs for organics. Because naphthalene above the FGGC was detected in the groundwater sample from temporary well 34GR01 (located with boring 34S01), the naphthalene concentration in the 7- to 9-foot subsurface sampling interval at this boring (170 μg/kg) exceeded the Florida clean-up goal based on leachability. Additionally, 7- to 9-foot interval of Phase IIb boring 034S08, located 25 feet west of boring 34S01 contained naphthalene at 50 μg/kg.

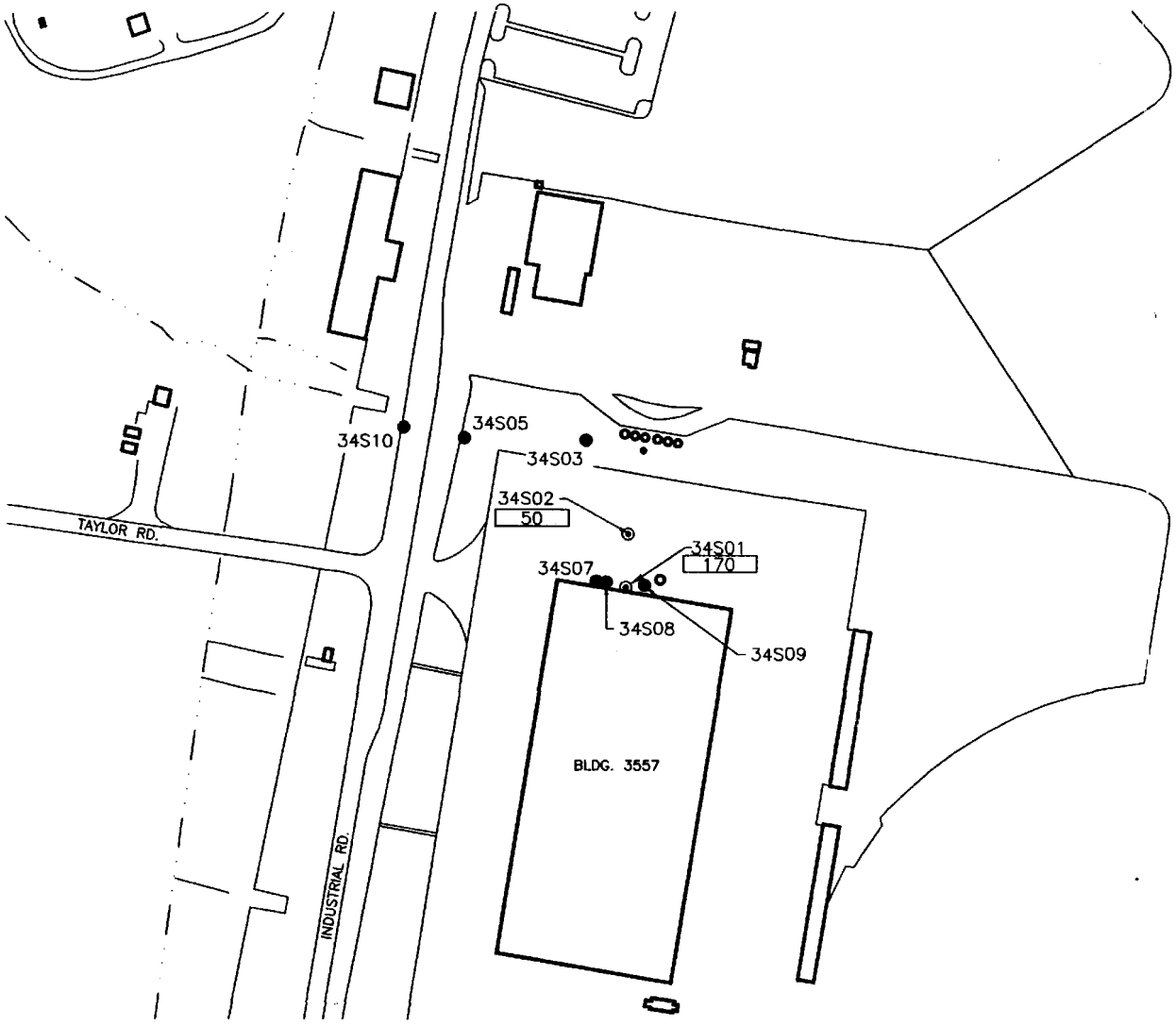
[7.1.3.2] Groundwater Contamination Assessment

Table B-6 contains the summary of analytical data for Site 34 groundwater samples, listing groundwater samples which exceeded the applicable PRGs.

Contamination Assessment — Inorganics

Figure 7-12 displays inorganics detected on Site 34 which exceeded PRGs for groundwater. Aluminum, iron, manganese, and lead were the inorganics found above PRGs in Site 34 groundwater samples. Aluminum exceeded the lowest value for the SMCL at three sample locations, ranging in concentration from 63.2 μg/L to 482 μg/L. Iron exceeded the SMCL/FSDWS at six sample locations, ranging in concentration from 295 μg/L to 5520 μg/L. Manganese exceeded the SMCL/FSDWS at four sample locations, ranging in concentration from


TAYLOR RD.
INDUSTRIAL RD.
34S10
34S05
34S03
34S02
34S01
Pb 689
34S07
34S08
34S09
BLDG. 3557
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– SOIL BORING
Pb 689 – LEAD CONCENTRATION IN mg/kg
LOWEST PRG
Pb 400 mg/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7–10
SITE 34
INORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN SOIL SAMPLES
DWG DATE:03/19/96
DWG NAME:7034ID10



LEGEND

- ⊙ – SOIL BORING (COMPLETED AS A TEMPORARY WELL)
- ● – SOIL BORING
- 34S01 [170] – NAPHTHALENE (ug/kg)
- 34S02 [50] – NAPHTHALENE (ug/kg)

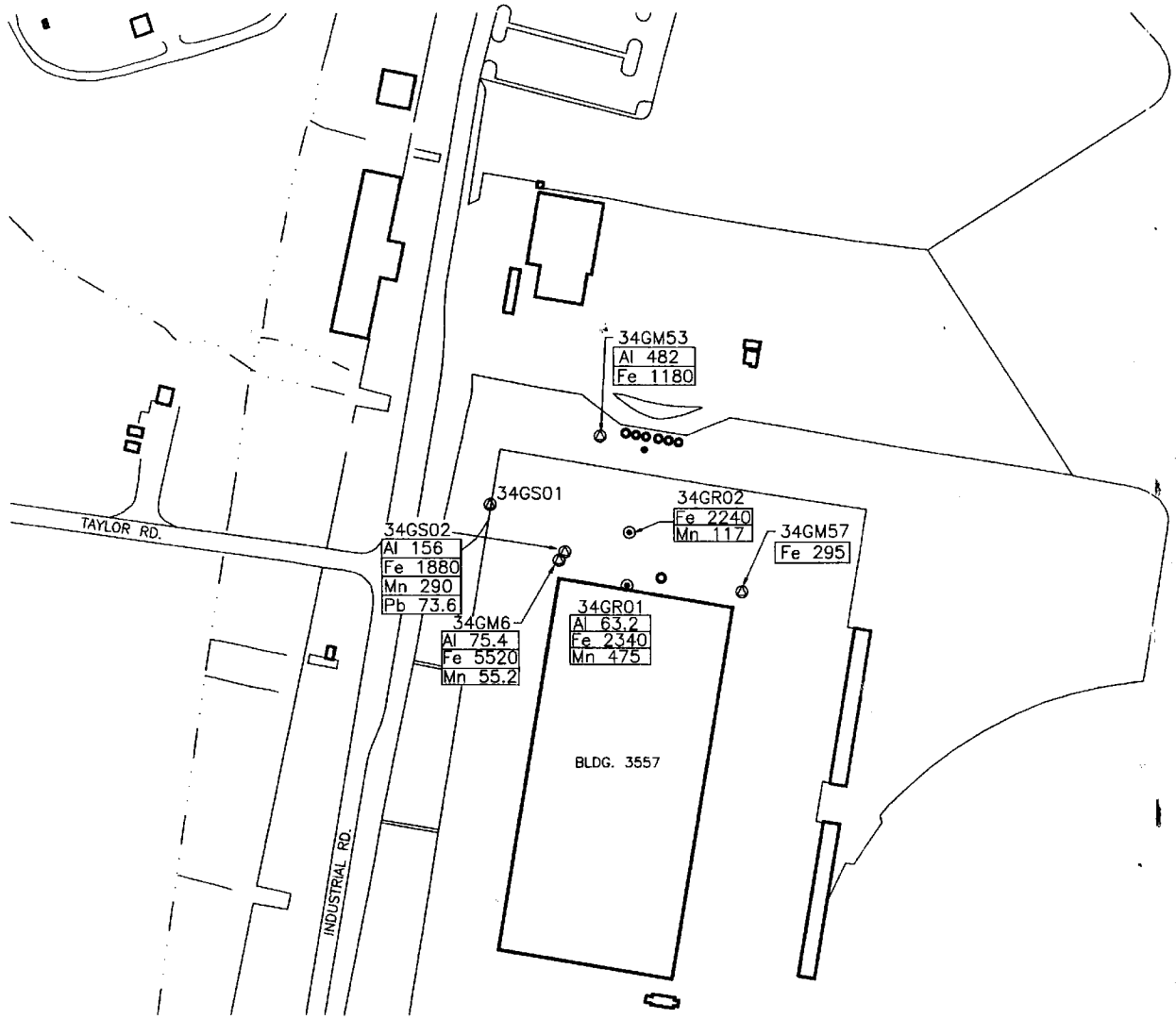
LOWEST PRG
NAPHTHALENE 14.1 ug/kg

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7-11
SITE 34
ORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN SOIL SAMPLES

DWG DATE:03/19/96 | DWG NAME:70340D11



LEGEND

- ⊙ – SOIL BORING (COMPLETED AS A TEMPORARY WELL)
- ⊗ – PERMANENT MONITORING WELL

Al 632 – ALUMINUM CONCENTRATION IN ug/L
Fe 2340 – IRON CONCENTRATION IN ug/L
Mn 475 – MANGANESE CONCENTRATION IN ug/L
Pb 73.6 – LEAD CONCENTRATION IN ug/L

LOWEST PRG

Al 50 ug/L
Fe 300 ug/L
Mn 50 ug/L
Pb 15 ug/L

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7–12
SITE 34
INORGANICS DETECTED ABOVE 1995 PRELIMINARY REMEDIATION GOALS IN GROUNDWATER SAMPLES

DWG DATE:03/13/96 | DWG NAME:7034ID12

55.2 μg/L to 475 μg/L. Lead was detected above MCL/FPDWS in the Phase IIb sample from well 34GS02 at 73.6 μg/L. This Phase IIa well had previously been sampled for semivolatiles and volatiles only.

Groundwater Reference Concentration Comparison

The NASP groundwater reference concentrations for aluminum and iron both exceed the SMCL/FSDWS for each compound. Site 34 aluminum concentrations above the SMCL were below the NASP reference concentration for this analyte. While four of six iron concentrations above the SMCL in Site 34 groundwater samples were also above the NASP reference concentration for iron, they were consistent with the range detected in the NASP reference concentrations.

Contamination Assessment — Organics

Figure 7-13 displays organics detected on Site 34 which exceeded PRGs groundwater. The only organic contaminant which exceeded applicable PRGs for groundwater on Site 34 was naphthalene. The Phase I samples from temporary wells 34GR01 and 34GR02 each contained naphthalene at a concentration of 320 μg/L. The Phase II sample from 34GR01 naphthalene at 39 μg/L.

[7.1.3.3] Summary and Conclusions — Site 34

Inorganic Contaminants

The elevated soil lead concentration at boring 34S01 is a localized occurrence. Seven soil borings to the north, east and west of boring 34S01 showed minor lead concentrations ranging from 0 to 6.8 mg/kg (under the NASP reference concentration value for lead). Though not clearly delineated to the south, two borings advanced during the Site 36 investigation provide

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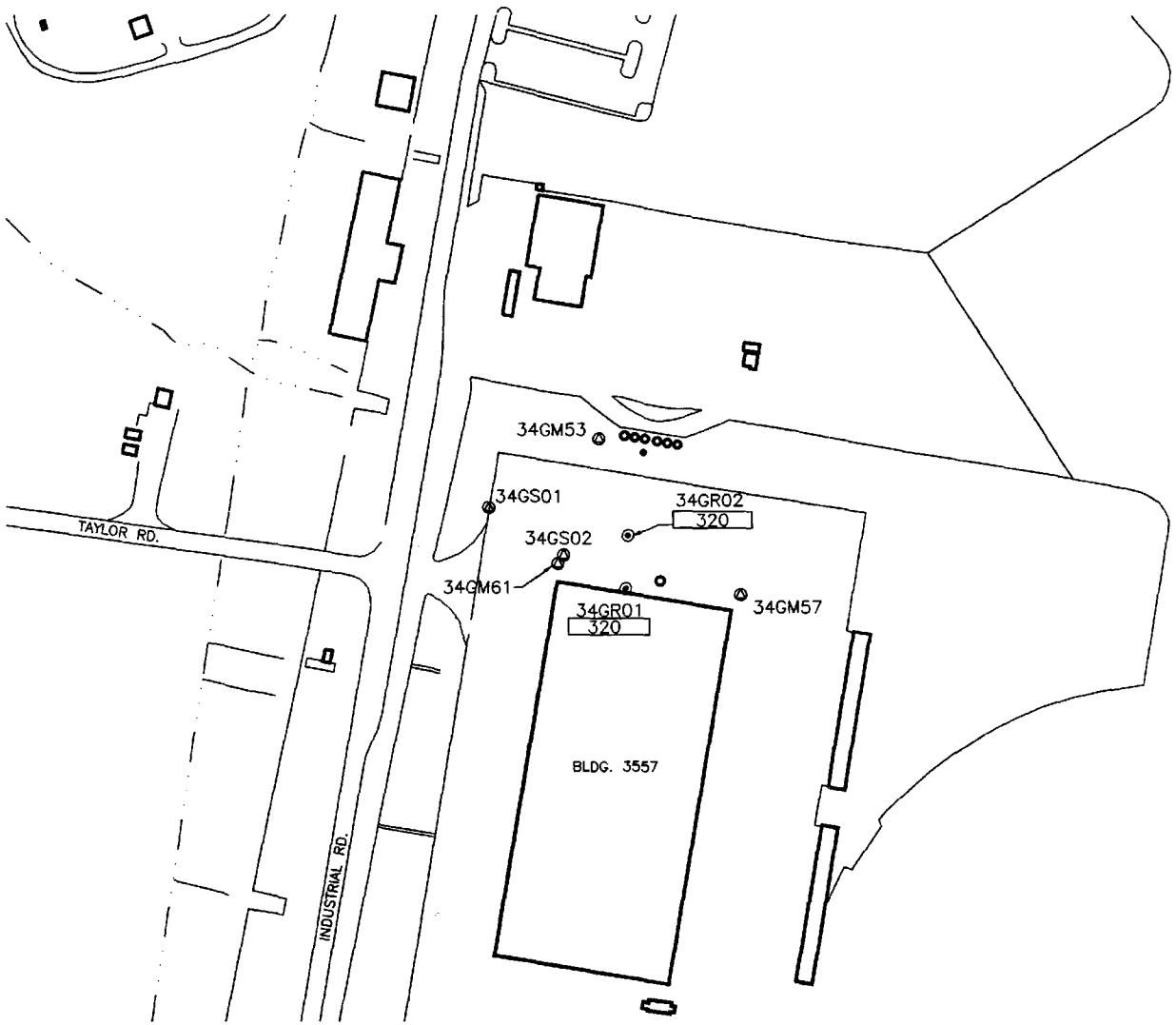

LEGEND

- TEMPORARY MONITORING WELL
- PERMANENT MONITORING WELL

34GR01 / 320 — NAPHTHALENE CONCENTRATION IN ug/L

LOWEST PRG
NAPHTHALENE 6.8 ug/L

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7-13
SITE 34
ORGANICS DETECTED ABOVE 1995
PRELIMINARY REMEDIATION GOALS
IN GROUNDWATER SAMPLES

DWG DATE:03/19/96 | DWG NAME:70340D13

some insight to soil lead concentrations south of boring 34S01. Boring 36S20, approximately 270 feet southeast of boring 34S01 had a lead concentration of 7.6 mg/kg. Boring 36S18, approximately 440 feet south of boring 34S01 displayed lead at 41 mg/kg (above the NASP reference concentration, but below the PRG for lead) (E/A&H 1994i). The soil to south protected from surface exposure by building, thus limiting potential for human exposure and leaching. **[The soil at this location was removed during the BRAC construction.]**

As discussed for Sites 9 and 29, aluminum, iron, and manganese above PRGs were also found throughout groundwater at Site 34. Lead above PRGs was also found in the groundwater from 34GS02. Lead was not detected in groundwater from the deep well (34GM61) adjacent to 34GS02. Lead was also not detected in groundwater from monitoring wells downgradient from 34GS02 (34GM53 and 30GS118 [Site 30 well]). While adsorption to a suspended particulate may have caused the elevated lead in this sample, it is apparently present only in a small area of groundwater and is sufficiently delineated for purpose of this report.

Organic Contaminants

Naphthalene above **[1995]** PRGs was found in soils at boring 34S01 and adjacent boring 34S08. Naphthalene was also found above PRGs in the Phase I groundwater samples collected from temporary wells 34GR01 and 34GR02. A minor naphthalene concentration (2 μg/L) was found downgradient from 34GR02 in the groundwater sample from 34GGM53. These wells were resampled during the Phase II investigation, and the results were remarkably different from the Phase I findings. Though still above the FGGC, the Phase II sample from 34GR01 had a concentration that was 88% less than the Phase I sample (Phase I sample, 320 μ/L; Phase II sample, 39 μg/L). Only a trace of naphthalene was found in the Phase II sample from 34GR02 (1 μg/L). Naphthalene was not detected in the Phase II sample from 34GM53. Naphthalene was also not detected in any other wells downgradient from 34GR01/34GR02. The difference

in concentrations may be attributable to natural attenuation and/or different analyzing labs. Naphthalene concentrations in the soil are correlatable to groundwater at 346S01, but correlations are not present at 346S02 or 346S03. **[The soil was removed during construction.]** The presence of naphthalene in the soil at 34S01 can be tied to naphthalene in groundwater at well 34GR01. However, no naphthalene was found in soil samples from boring 34S02, located with 34GR02, or at boring 34S03, located adjacent to 34GM53.

[7.2 Comparison to 1996 PRGs

Pursuant to agreements made by the Tier 1 Team subsequent to the original PRG comparison, this report also presents comparisons of detected contaminants to subsurface PRGs (1996 PRGs). Due to the lack of a surface exposure pathway (see Section 10), the 1996 comparison focuses exclusively on the leachability of contaminants to groundwater. The following updated general and site-specific subsurface soil PRGs were used for the 1996 comparison:

- **Soil Screening Levels (SSLs)-transfer scenario from soil to groundwater (USEPA 1995).**
- **Selected Cleanup Goals (CGs) for leaching (FDEP 1995).**
- **USEPA, Office of Solid Waste and Emergency Response (OSWER) draft revised Interim Soil Lead Guidance (USEPA 1994b).**

The figures within this section illustrate the distribution of inorganic and organic contamination for each site as compared to the 1996 PRGs.

7.2.1 Site 9

Contamination Assessment — Inorganics

Figure 7-14 diagrams soil inorganics detected on Site 9 which exceeded 1996 PRGs. In comparing the 1996 PRGs to the 1995 PRGs, some inorganics on Site 9 fall below PRGs, while other constituents emerge above PRGs. Arsenic and manganese generally fall below 1996 PRGs, except for boring 09S18, where arsenic remains above the SSL. Antimony, beryllium, and copper fall below PRGs, while nickel and thallium emerge above PRGs. Barium detections above PRGs increase when compared to 1996 standards.

Contamination Assessment — Organics

Figure 7-15 diagrams soil organics detected on Site 9 which exceeded 1996 PRGs. In comparing the 1996 PRGs to the 1995 values, PAHs continue to represent the largest family of contaminants, with carbazole, chrysene, and phenanthrene being added to the list of PAHs exceeding the 1996 PRGs. There is an increase in pesticides above PRGs, notably, DDT and metabolites, dieldrin, and alpha-BHC.

Summary and Conclusions — Site 9

Inorganic soil contamination appears to be aggregated in the west central portion of the site, concentrated among four borings (09S02, 09S18, 09S26, 09S27). PAH contamination appears to be collected in the same area. Similarly, this was the most contaminated area of the site according to the 1995 PRG comparisons. The 1996 PRGs show a wide distribution of pesticides above SSLs or CGs for leaching. This may be, in part, due to the low values for the subsurface PRGs (i.e., the SSL for dieldrin is 1.0 μg/kg). In any case, almost all of the borings containing pesticides were located in sodded areas maintained by

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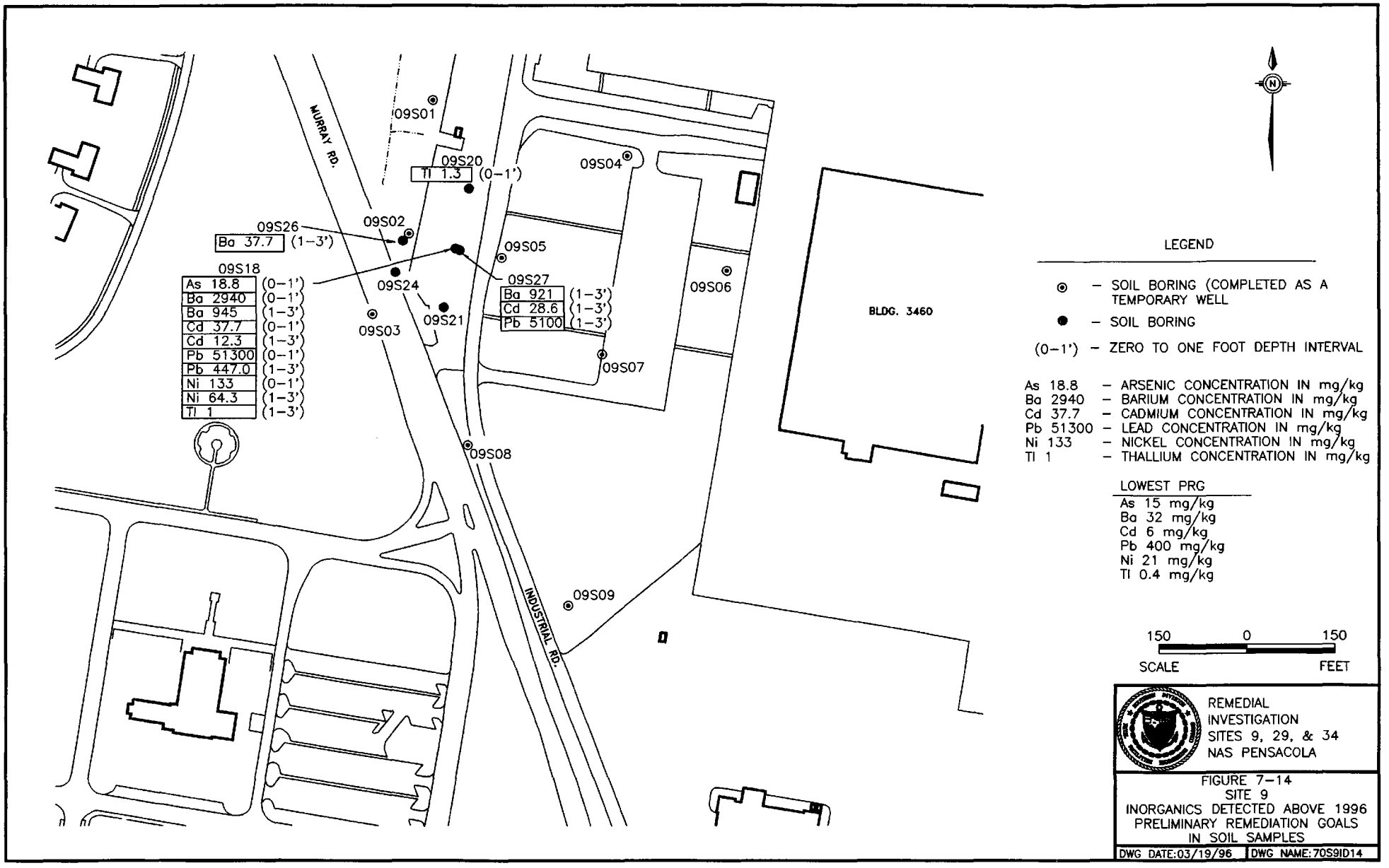
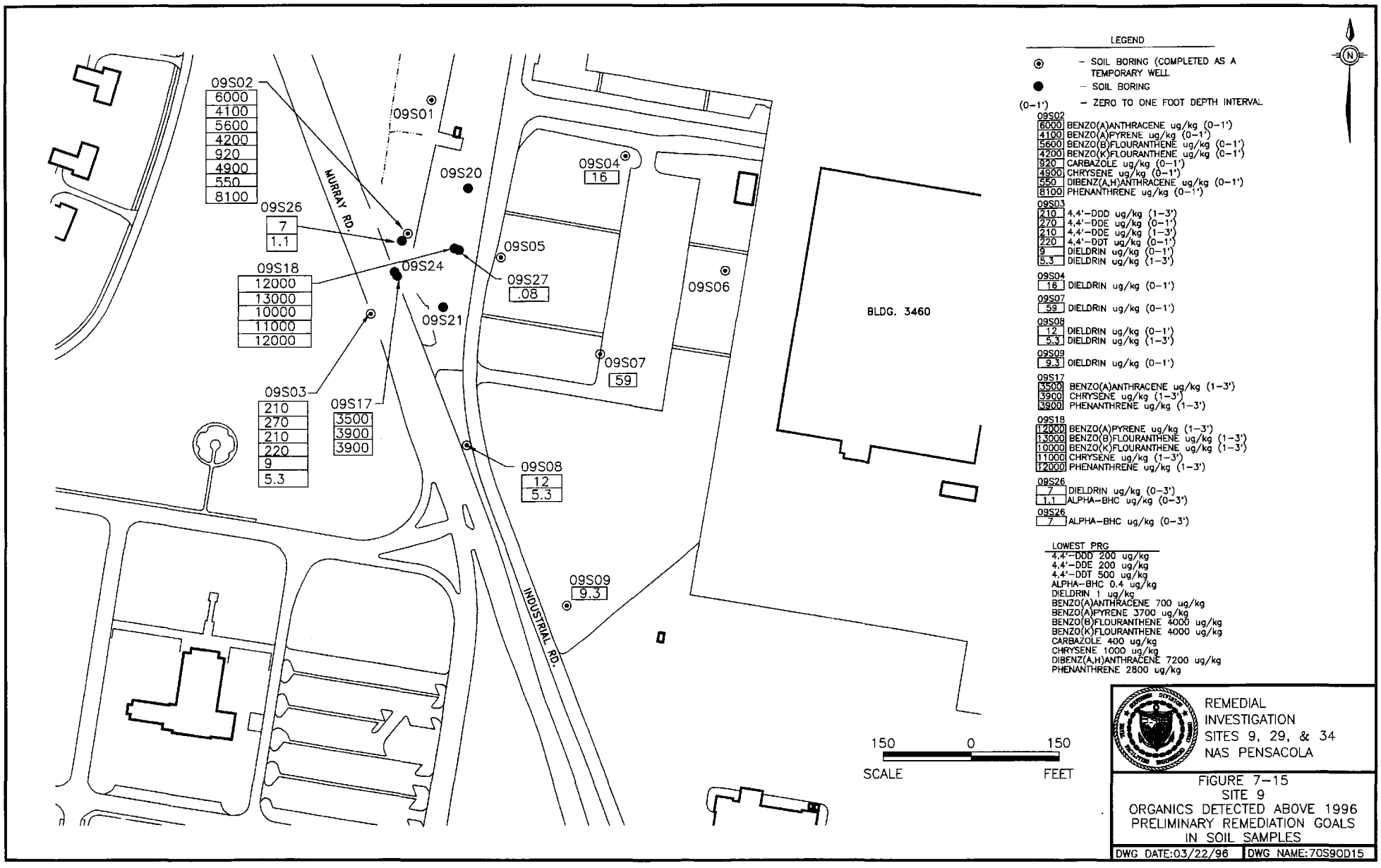

MURRAY RD.
INDUSTRIAL RD.
BLDG. 3460
09S01
09S20
Tl 1.3 (0–1')
09S04
09S26
Ba 37.7 (1–3')
09S02
09S05
09S18
As 18.8 (0–1')
Ba 2940 (0–1')
Ba 945 (1–3')
Cd 37.7 (0–1')
Cd 12.3 (1–3')
Pb 51300 (0–1')
Pb 447.0 (1–3')
Ni 133 (0–1')
Ni 64.3 (1–3')
Tl 1 (1–3')
09S24
09S27
Ba 921 (1–3')
Cd 28.6 (1–3')
Pb 5100 (1–3')
09S06
09S03
09S21
09S07
09S08
09S09
N
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL
– SOIL BORING
(0–1') – ZERO TO ONE FOOT DEPTH INTERVAL
As 18.8 – ARSENIC CONCENTRATION IN mg/kg
Ba 2940 – BARIUM CONCENTRATION IN mg/kg
Cd 37.7 – CADMIUM CONCENTRATION IN mg/kg
Pb 51300 – LEAD CONCENTRATION IN mg/kg
Ni 133 – NICKEL CONCENTRATION IN mg/kg
Tl 1 – THALLIUM CONCENTRATION IN mg/kg
LOWEST PRG
As 15 mg/kg
Ba 32 mg/kg
Cd 6 mg/kg
Pb 400 mg/kg
Ni 21 mg/kg
Tl 0.4 mg/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7–14
SITE 9
INORGANICS DETECTED ABOVE 1996 PRELIMINARY REMEDIATION GOALS IN SOIL SAMPLES
DWG DATE:03/19/96
DWG NAME:70S9ID14


09S02
6000
4100
5600
4200
920
4900
550
8100
09S01
09S20
09S04
16
09S26
7
1.1
MURRAY RD.
09S05
09S18
12000
13000
10000
11000
12000
09S24
09S27
.08
09S06
09S21
BLDG. 3460
09S07
59
09S03
210
270
210
220
9
5.3
09S17
3500
3900
3900
09S08
12
5.3
09S09
9.3
INDUSTRIAL RD.
150
0
150
SCALE
FEET
LEGEND
- SOIL BORING (COMPLETED AS A TEMPORARY WELL
- SOIL BORING
(0-1') - ZERO TO ONE FOOT DEPTH INTERVAL
09S02
6000 BENZO(A)ANTHRACENE ug/kg (0-1')
4100 BENZO(A)PYRENE ug/kg (0-1')
5600 BENZO(B)FLOURANTHENE ug/kg (0-1')
4200 BENZO(K)FLOURANTHENE ug/kg (0-1')
920 CARBAZOLE ug/kg (0-1')
4900 CHRYSENE ug/kg (0-1')
550 DIBENZ(A,H)ANTHRACENE ug/kg (0-1')
8100 PHENANTHRENE ug/kg (0-1')
09S03
210 4,4'-DDD ug/kg (1-3')
270 4,4'-DDE ug/kg (0-1')
210 4,4'-DDE ug/kg (1-3')
220 4,4'-DDT ug/kg (0-1')
9 DIELDRIN ug/kg (0-1')
5.3 DIELDRIN ug/kg (1-3')
09S04
16 DIELDRIN ug/kg (0-1')
09S07
59 DIELDRIN ug/kg (0-1')
09S08
12 DIELDRIN ug/kg (0-1')
5.3 DIELDRIN ug/kg (1-3')
09S09
9.3 DIELDRIN ug/kg (0-1')
09S17
3500 BENZO(A)ANTHRACENE ug/kg (1-3')
3900 CHRYSENE ug/kg (1-3')
3900 PHENANTHRENE ug/kg (1-3')
09S18
12000 BENZO(A)PYRENE ug/kg (1-3')
13000 BENZO(B)FLOURANTHENE ug/kg (1-3')
10000 BENZO(K)FLOURANTHENE ug/kg (1-3')
11000 CHRYSENE ug/kg (1-3')
12000 PHENANTHRENE ug/kg (1-3')
09S26
7 DIELDRIN ug/kg (0-3')
1.1 ALPHA-BHC ug/kg (0-3')
09S26
7 ALPHA-BHC ug/kg (0-3')
LOWEST PRG
4,4'-DDD 200 ug/kg
4,4'-DDE 200 ug/kg
4,4'-DDT 500 ug/kg
ALPHA-BHC 0.4 ug/kg
DIELDRIN 1 ug/kg
BENZO(A)ANTHRACENE 700 ug/kg
BENZO(A)PYRENE 3700 ug/kg
BENZO(B)FLOURANTHENE 4000 ug/kg
BENZO(K)FLOURANTHENE 4000 ug/kg
CARBAZOLE 400 ug/kg
CHRYSENE 1000 ug/kg
DIBENZ(A,H)ANTHRACENE 7200 ug/kg
PHENANTHRENE 2800 ug/kg
REMEDIAL
INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7-15
SITE 9
ORGANICS DETECTED ABOVE 1996
PRELIMINARY REMEDIATION GOALS
IN SOIL SAMPLES
DWG DATE:03/22/96
DWG NAME:70S9OD15

NASP landscaping contractors. Although above standards, the low levels of pesticides encountered would be consistent with an application scenario. Notably, none of the pesticides nor PAHs were detected above PRGs in site groundwater.

7.2.2 Site 29

Contamination Assessment — Inorganics

Figure 7-16 diagrams soil inorganics detected on Site 29 which exceeded 1996 PRGs. In comparing the 1996 PRGs to the 1995 PRGs, inorganic contamination, which consisted mostly of manganese above the RBC in surface and subsurface soils, falls below standards. Nickel above the SSL is present at a single boring in the southeast portion of the site (boring 29S05).

Contamination Assessment — Organics

Figure 7-17 diagrams soil organics detected on Site 29 which exceeded 1996 PRGs. In comparing the 1996 PRGs to the 1995 values, dieldrin remains the major contaminant, with the focus of contamination located in and around boring 29S01 and outlying confirmatory borings. Isolated dieldrin above the SSL also appears at borings EES02, 29S03, and 29S08.

Summary and Conclusions — Site 29

Comparing the 1996 PRGs to the 1995 values, inorganic contamination appears to be insignificant at site 29. Organic contamination, primarily by dieldrin, is present at locations to the northwest, southwest, and northeast of the site. The area of highest dieldrin levels (northwest) was subjected to interim soil removal/confirmatory sampling. Notably, dieldrin, nor any other organic contaminant was detected above PRGs in groundwater. Additionally, inorganics above PRGs in groundwater were limited mostly to

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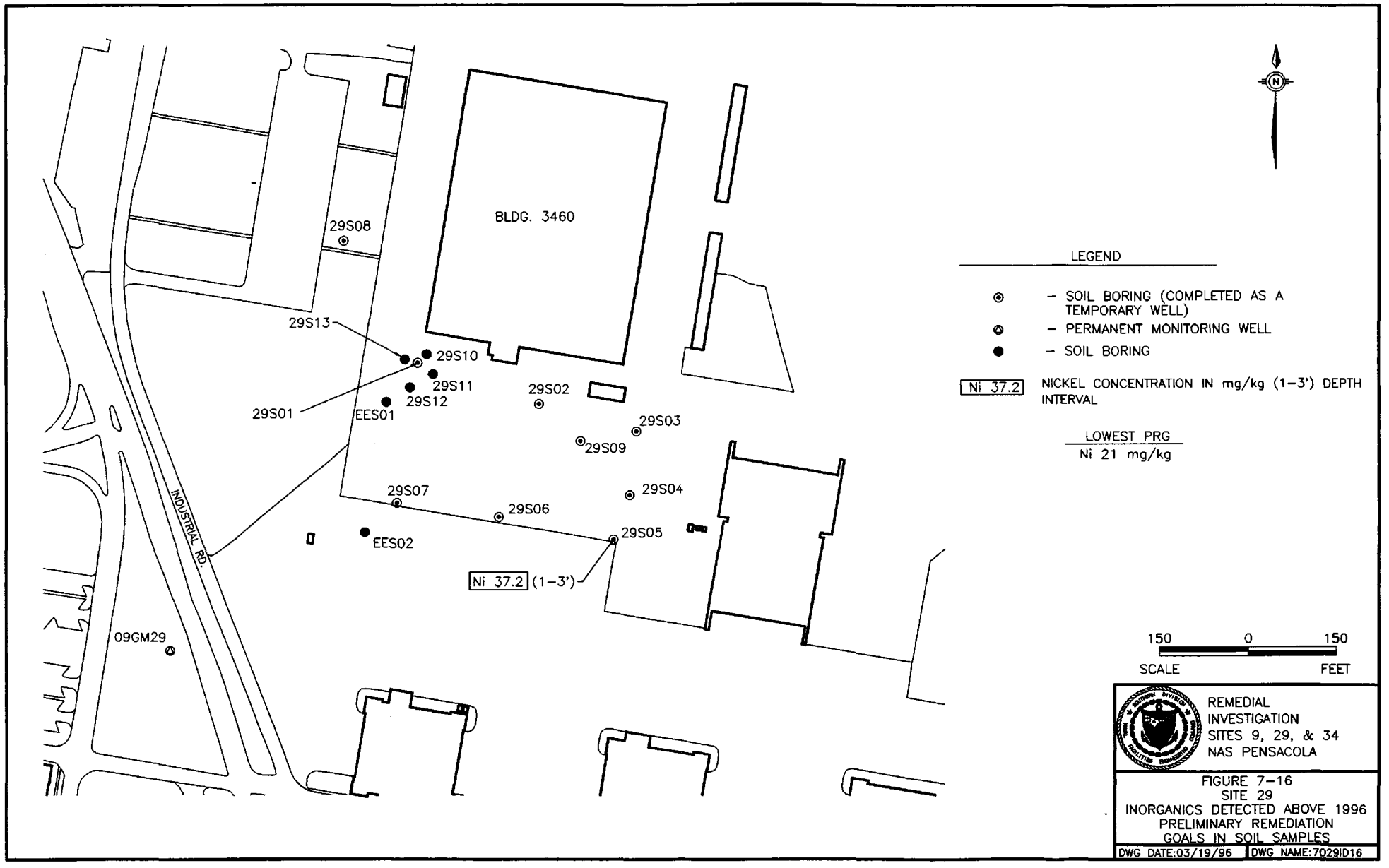
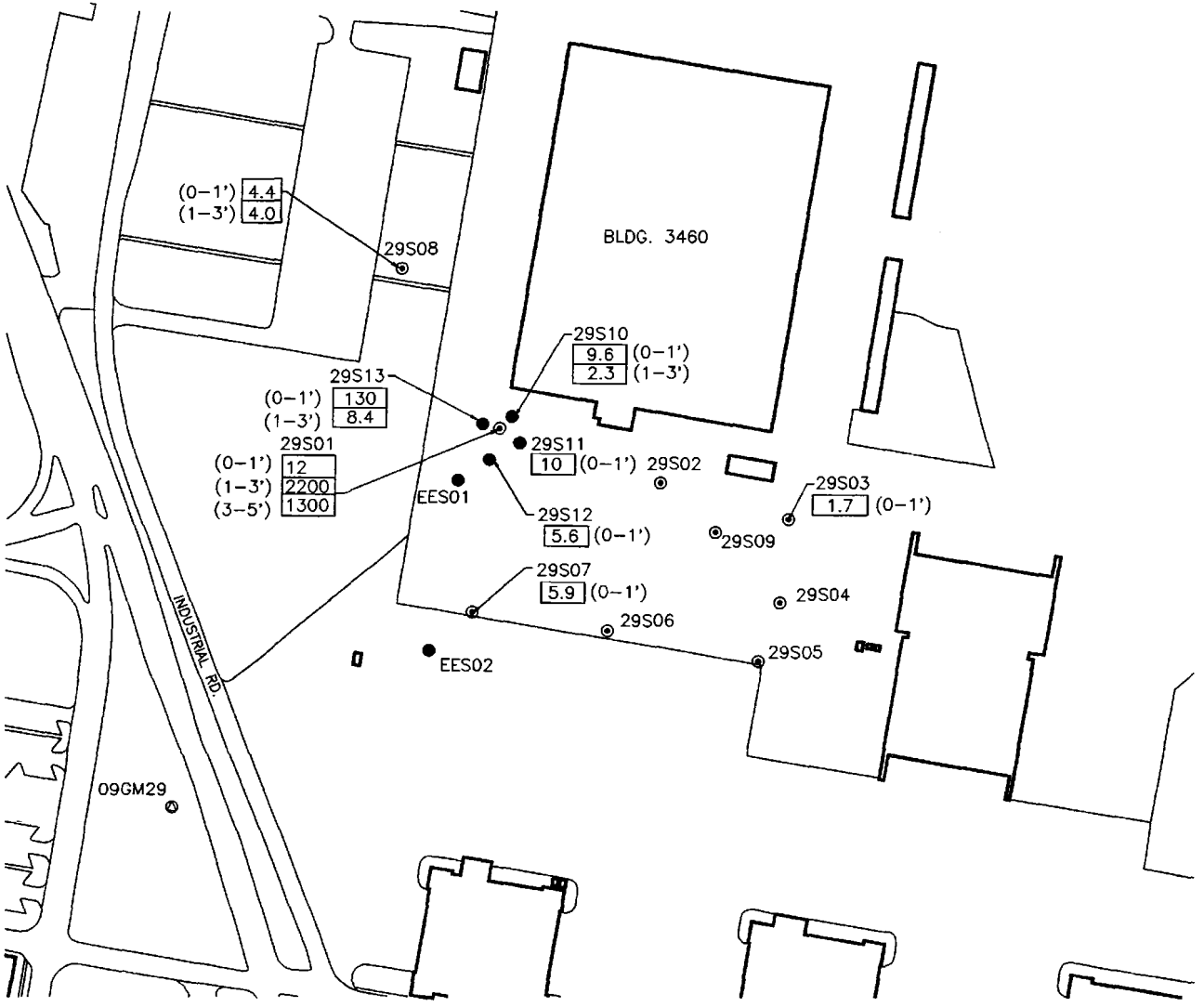

BLDG. 3460
29S08
29S13
29S10
29S11
29S12
29S01
EES01
29S02
29S03
29S09
29S04
29S07
29S06
29S05
EES02
Ni 37.2 (1-3')
09GM29
INDUSTRIAL RD.
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– PERMANENT MONITORING WELL
– SOIL BORING
Ni 37.2 NICKEL CONCENTRATION IN mg/kg (1-3') DEPTH INTERVAL
LOWEST PRG
Ni 21 mg/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7-16
SITE 29
INORGANICS DETECTED ABOVE 1996 PRELIMINARY REMEDIATION GOALS IN SOIL SAMPLES
DWG DATE:03/19/96
DWG NAME:7029ID16



LEGEND

- SOIL BORING (COMPLETED AS A TEMPORARY WELL)
- PERMANENT MONITORING WELL
- SOIL BORING

29S01 / 12 — DIELDRIN (ug/kg); (0-1') DEPTH INTERVAL

LOWEST PRG
DIELDRIN 1.0 ug/kg

150 0 150
SCALE FEET

REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA

FIGURE 7-17
SITE 29
ORGANICS DETECTED ABOVE 1996 PRELIMINARY REMEDIATION GOALS IN SOIL SAMPLES

DWG DATE:03/13/96 | DWG NAME:7029OD17

aluminum, iron, and manganese. These were found to be ubiquitous contaminants in shallow groundwater at all sites in and around the Chevalier Field area. Also, there is no correlation between soil and groundwater concentrations of these parameters.

7.2.3 Site 34

Contamination Assessment — Inorganics

The contamination assessment for soil inorganics on Site 34 does not change when compared to the 1996 PRGs. Lead remains as the only inorganic constituent above standards, with the PRG for lead (EPA OSWER Soil Interim Lead Guidance) unchanging between the 1995 and 1996 PRG lists.

Contamination Assessment — Organics

Figure 7-18 diagrams soil organics detected on Site 34 which exceeded 1996 PRGs. Aside from naphthalene at boring 34S01, which remains above the 1996 FDEP CG for Leaching, dieldrin above the SSL is present on the north and northwest areas of the site.

Summary and Conclusions — Site 34

Comparing the 1996 PRGs to the 1995 values, inorganic soil contamination remains unchanged, while organic soil contamination includes dieldrin, in addition to the previous finding of naphthalene. The dieldrin contamination, as with the 1996 PRG comparisons at the other sites, can be attributable to application, grading/backfilling/construction activities. Notably, however, dieldrin was not detected in site groundwater.

7.3 Interim Soil Removals

The unvalidated analytical data for the confirmatory samples collected subsequent to the interim soil removals performed on Sites 9, 29, and 34 are tabulated in Appendix B. These

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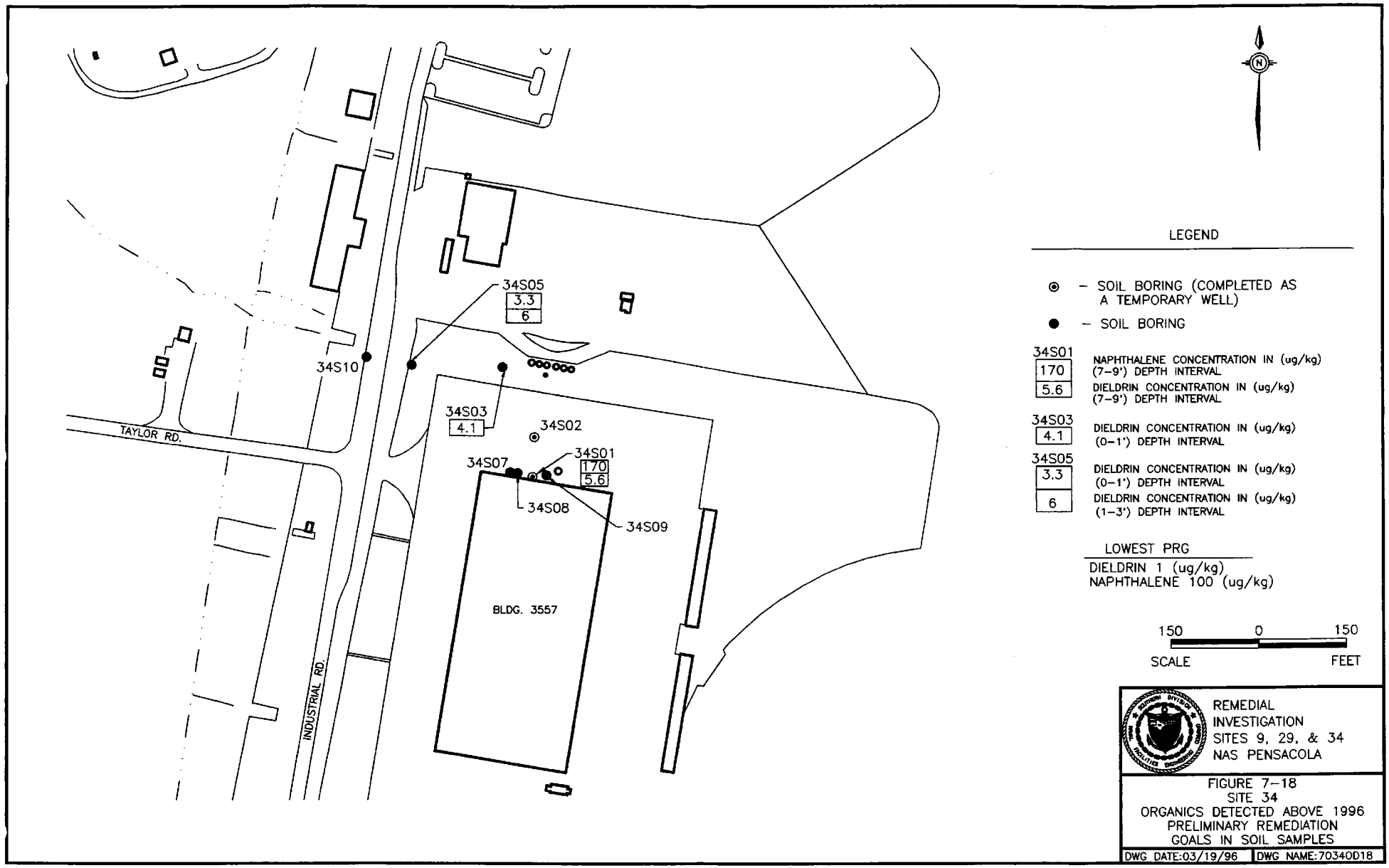
34S05
3.3
6
34S10
34S03
4.1
34S02
34S01
170
5.6
34S07
34S08
34S09
TAYLOR RD.
INDUSTRIAL RD.
BLDG. 3557
LEGEND
– SOIL BORING (COMPLETED AS A TEMPORARY WELL)
– SOIL BORING
34S01
170
NAPHTHALENE CONCENTRATION IN (ug/kg) (7–9') DEPTH INTERVAL
5.6
DIELDRIN CONCENTRATION IN (ug/kg) (7–9') DEPTH INTERVAL
34S03
4.1
DIELDRIN CONCENTRATION IN (ug/kg) (0–1') DEPTH INTERVAL
34S05
3.3
DIELDRIN CONCENTRATION IN (ug/kg) (0–1') DEPTH INTERVAL
6
DIELDRIN CONCENTRATION IN (ug/kg) (1–3') DEPTH INTERVAL
LOWEST PRG
DIELDRIN 1 (ug/kg)
NAPHTHALENE 100 (ug/kg)
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7–18
SITE 34
ORGANICS DETECTED ABOVE 1996 PRELIMINARY REMEDIATION GOALS IN SOIL SAMPLES
DWG DATE:03/19/96
DWG NAME:70340D18

removals were performed in conjunction with BRAC construction and demolition activities within the Sites 9, 29, and 34 areas on Chevalier Field and is documented in a separate report (E/A&H 1996). A brief discussion of each site's confirmatory sampling results are discussed below. Confirmatory samples for the removals were compared to the 1996 PRGs.

Site 9

Figure 7-19 depicts the interim soil removal and confirmatory sample results for Site 9. Confirmatory samples collected from Site 9B (the area in and around boring 09S06) reveal only dieldrin above the SSL. Dieldrin (1.9 μg/kg) was found in the center of the excavation at confirmatory sample location 9B05. No PAH's above PRGs were found in the confirmatory samples.

Site 29

Figure 7-20 depicts the interim soil removal and confirmatory sample results for Site 29. Confirmatory samples revealed dieldrin above the SSL at two locations (sample location 29S15/22 μg/kg, sample location 29S17/2.9 μg/kg).

Site 34

Figure 7-21 depicts the interim soil removal and confirmatory sample results for Site 34. All perimeter confirmatory samples contained dieldrin above the SSL (34S11/1.8 μg/kg, 34S12/2.1 μg/kg, 34S13/2.7 μg/kg, 34S14/4.3 μg/kg). No lead or naphthalene above PRGs were found in the confirmatory samples.]

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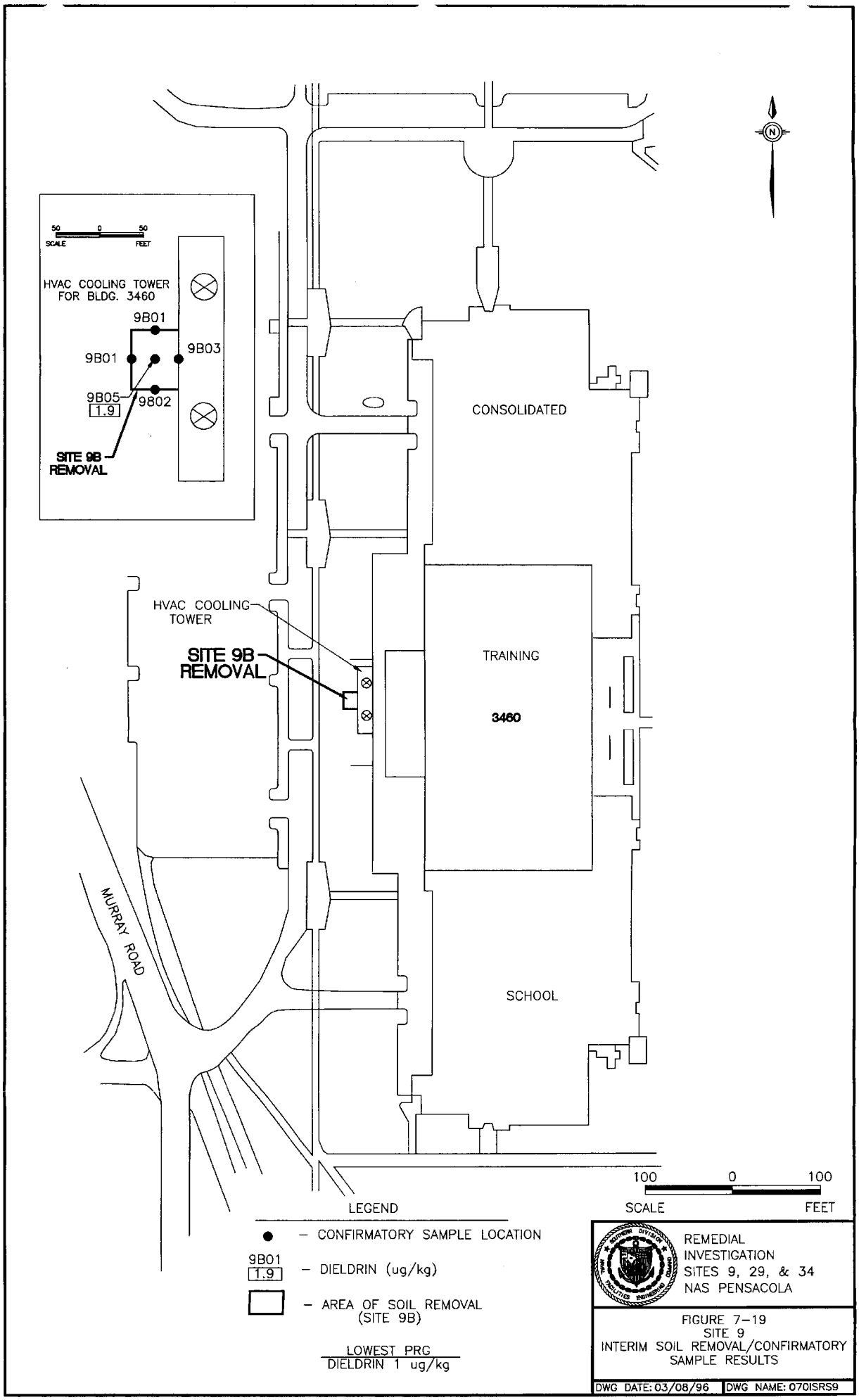
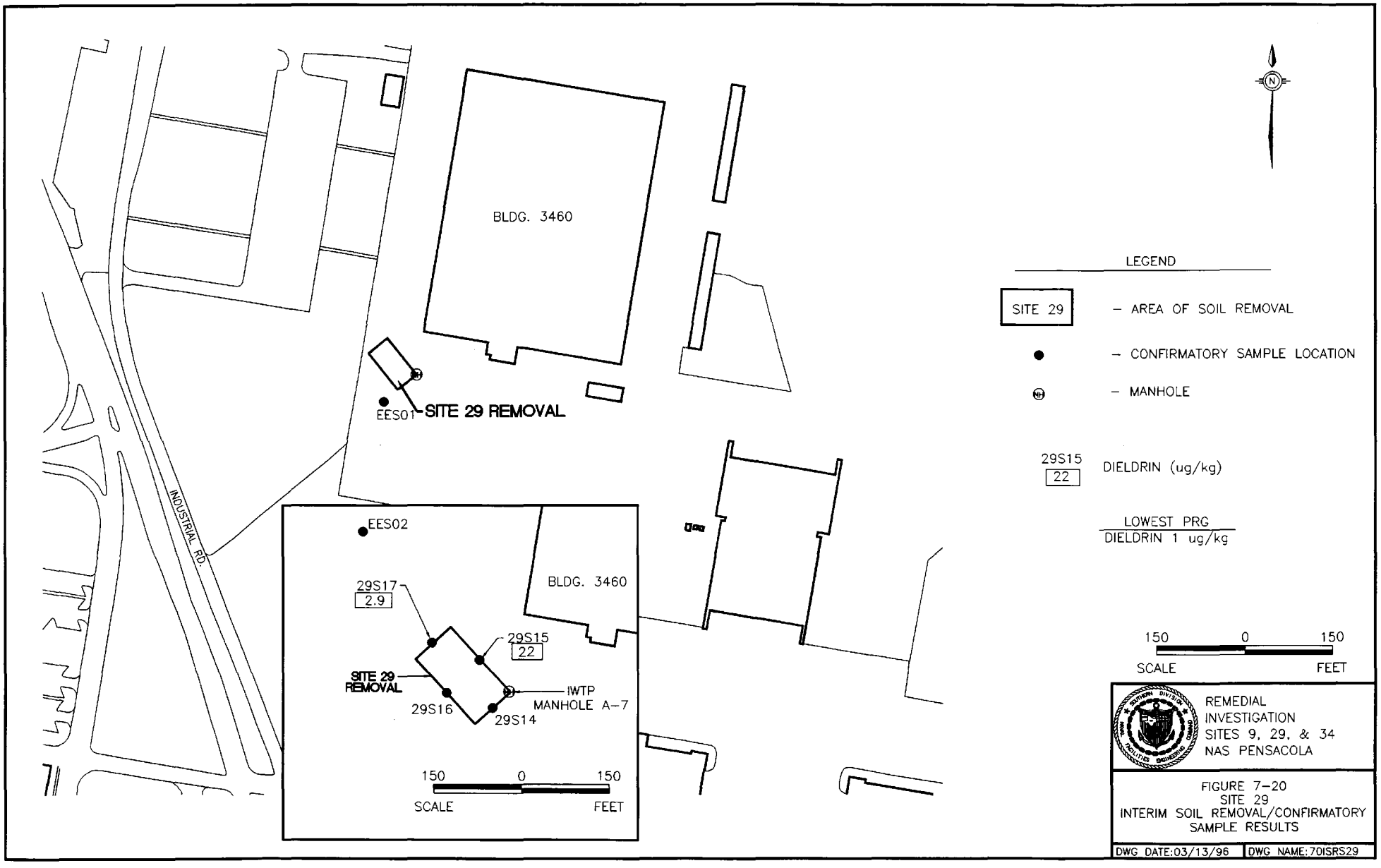
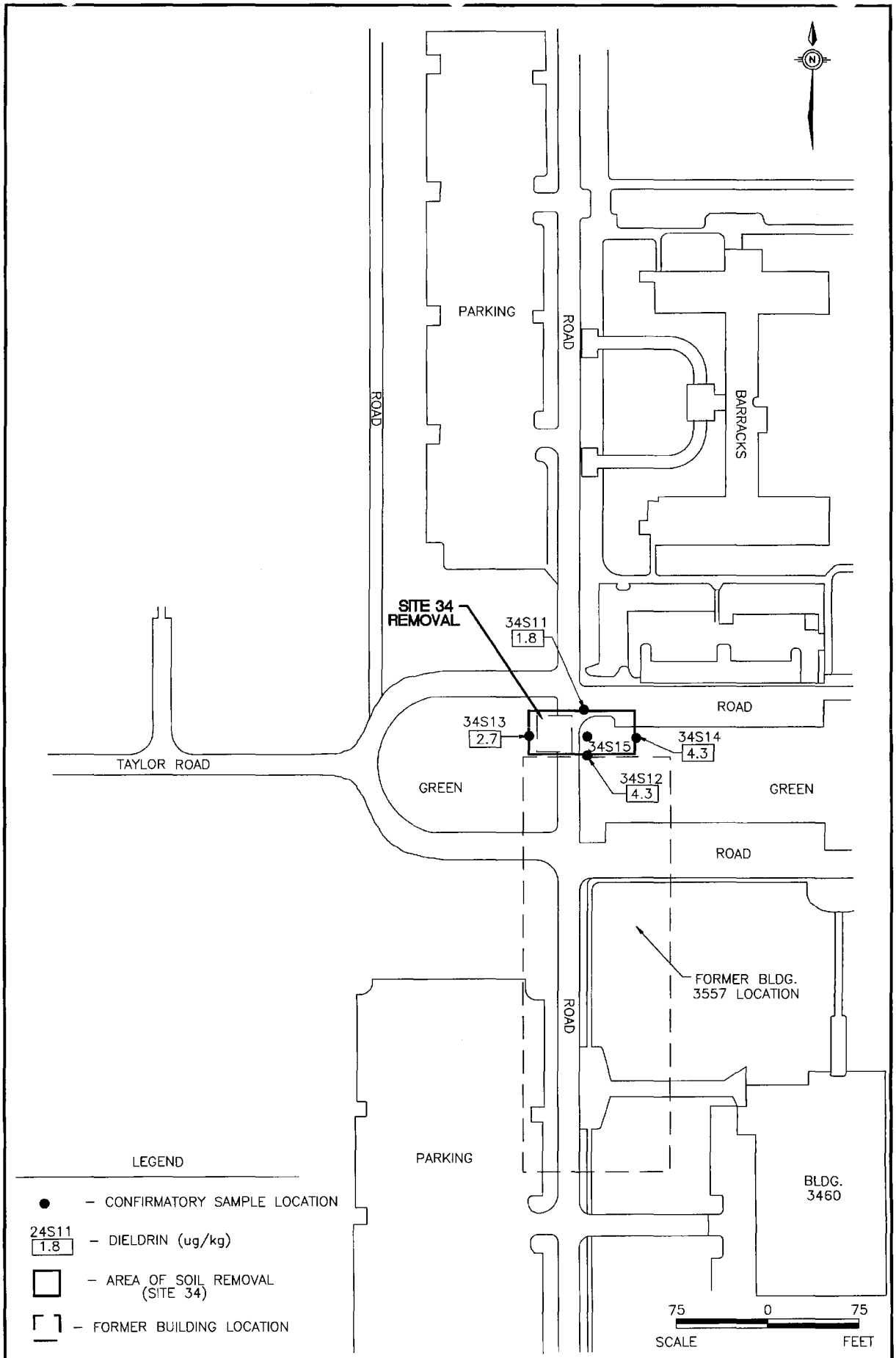

50 0 50
SCALE FEET
HVAC COOLING TOWER FOR BLDG. 3460
9B01
9B01
9B03
9B05
1.9
9B02
SITE 9B REMOVAL
CONSOLIDATED
HVAC COOLING TOWER
SITE 9B REMOVAL
TRAINING
3460
MURRAY ROAD
SCHOOL
100 0 100
SCALE FEET
LEGEND
– CONFIRMATORY SAMPLE LOCATION
9B01
1.9
– DIELDRIN (ug/kg)
– AREA OF SOIL REMOVAL (SITE 9B)
LOWEST PRG
DIELDRIN 1 ug/kg
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7–19
SITE 9
INTERIM SOIL REMOVAL/CONFIRMATORY SAMPLE RESULTS
DWG DATE: 03/08/96
DWG NAME: 070ISRS9


BLDG. 3460
EES01
SITE 29 REMOVAL
INDUSTRIAL RD.
EES02
29S17
2.9
29S15
22
SITE 29 REMOVAL
29S16
29S14
IWTP MANHOLE A-7
BLDG. 3460
150 0 150
SCALE FEET
LEGEND
SITE 29 – AREA OF SOIL REMOVAL
– CONFIRMATORY SAMPLE LOCATION
– MANHOLE
29S15
22
DIELDRIN (ug/kg)
LOWEST PRG
DIELDRIN 1 ug/kg
150 0 150
SCALE FEET
REMEDIAL INVESTIGATION
SITES 9, 29, & 34
NAS PENSACOLA
FIGURE 7-20
SITE 29
INTERIM SOIL REMOVAL/CONFIRMATORY SAMPLE RESULTS
DWG DATE:03/13/96
DWG NAME:70ISRS29



LOWEST PRG
DIELDRIN 1 ug/kg

REMEDIAL
INVESTIGATION
SITES 9,29, AND 34
NAS PENSACOLA

FIGURE 7–21
SITE 34
INTERIM SOIL REMOVAL/CONFIRMATORY
SAMPLE RESULTS

DWG DATE: 03/22/96 | DWG NAME: 701SRS34

8.0 DATA VALIDATION

Data has been validated for all field and analytical data collected from the investigation of Sites 9, 29, and 34 at NAS Pensacola, Pensacola Florida**[, with the exception of the confirmatory sampling data for the soil removals performed at these sites, which were not validated]**. The initial analytical work was conducted by Pace Laboratories, Inc., at its facility at Hampton, New Hampshire, and Minneapolis, Minnesota. Secondary sample analyses were performed by CompuChem Laboratories, Inc., Research Triangle Park, North Carolina. The analytical protocols were performed in accordance with the following guidance documents:

- USEPA Contract Laboratory Program, *Statement of Work for Organic Analyses (CLP 3/90).*

- USEPA Contract Laboratory Program, *Statement of Work for Inorganic Analyses (CLP 3/90).*

- Determination of Total Organic Carbon in soil, sediment, sludge and aqueous samples based on *EPA Method 505,* contained in *Standard Methods for Examination of Water and Wastewater (17th Edition, 1989).*

- Determination of the mobility of both organic and inorganic analytes in liquid, solid and multiphasic waste samples, by using the Toxicity Characteristic to identify hazardous waste based on the *Toxicity Characteristic Leaching Procedure (TCLP) EPA Method 1311* contained in *Test Methods for Evaluating Solid Wastes (SW-846, 3d Edition).*

- Determination of the mobility of both organic and inorganic analytes in liquid, solid, and multiphasic waste samples, by using the Toxicity Characteristic to identify hazardous

waste based on the *Synthetic Precipitation Leaching Procedure (SPLP) EPA Method 1312* contained in *Test Methods for Evaluating Solid Wastes (SW-846, 3d Edition).*

- NEESA Level D QA/QC guidelines as stated in the *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation and Restoration Program (NEESA 20.2-047B).*

- Data validation was performed in accordance with the *USEPA Contract Laboratory Program National Functional Guidelines For Organic and Inorganic Data Review, February 1994.* Office of Solid Waste and Emergency Response.

8.1 Data Quality

The overall quality of the investigational data received for Sites 9, 29, and 34 at NAS Pensacola for site remediation and risk assessment was evaluated and validated with the appropriate data qualifiers based on data usability and CLP contractual satisfaction. Sample collection and analysis for Sites 9, 29, and 34 at NAS Pensacola was performed under twelve organic and twelve inorganic CLP Sample Delivery Groups (SDGs). Secondary sample collection and analysis was performed under 16 organic and five inorganic SDGs. All case numbers were designated with the name PENSA, an abbreviation used to designate Pensacola.

8.2 Organic Analysis

Each SDG was received by the laboratory in good condition with the proper chain-of-custody documents and seals intact. All technical and contractual holding times from sampling date and Verified Time of Sample Receipt (VTSR) until the time of sample extraction and/or analysis were found to be within compliance with contract and technical requirements.

8.2.1 Blanks

Blanks assist in determining the existence and the magnitude of any contamination resulting from the laboratory or field. All associated data were evaluated to determine whether there are an inherent variability in the data, or if the problem is an isolated occurrence and does not affect the data. The blank data provided for the investigation of Sites 9, 29, and 34 indicated various concentrations of toluene, methylene chloride, and acetone for volatiles and several phthalate esters for semivolatiles. These compounds are considered common laboratory artifacts and were evaluated and qualified based on the action levels found for each SDG.

Action levels are based on the highest positive sample concentration of any laboratory artifact found in each method blank(s) or QC sample above the Contract Required Quantitation Limit (CRQL). In other words, no positive sample result for a common laboratory artifact is reported unless the concentration of that particular artifact exceeds the action level of 10 times (10X) the amount found in any blank(s). For compounds that are not considered to be common laboratory artifacts, the action level is five times (5X) the amount found in any blank or QC sample.

Two types of blanks were created in the laboratory during preparation and sample analysis. Each sample designation will be followed by a number corresponding to that blank. For example, the third volatile method blank would be designated "VBLK03."

Method Blank

VBLK	—	Volatile Method Blank
SBLK	—	Semivolatile Method Blank
PBLK	—	Pesticide/PCB Method Blank

These blanks are used by the laboratory to determine the concentrations of contamination associated with the processing and analysis of samples. Method blanks are identified by the laboratory using the first letter of the analysis fraction performed followed by the abbreviation BLK for "Blank."

Instrument Blank

PIBLK — Pesticide/PCB Instrument Blank

The laboratory uses the instrument blank to determine if any contamination is present before, during, or after pesticide/PCB sample analysis can be attributed to the gas chromatography instrumentation.

SDG 501 Volatile Organic Analyses

In SDG 501, the compound methylene chloride was detected at concentrations of 5 μg/L, 3 μg/L, and 740 μg/L in method blanks VBLKCP, VBLKCQ, and VBLKCT. The trip blank 09ST01 and the equipment blank 09SE01 contained 4 μg/L of methylene chloride.

SDG 504 Volatile Organic Analyses

In SDG 504, the compounds acetone, 2-butanone, and 2-hexanone were detected at concentrations of 3 μg/kg, 2 μg/kg, and 5 μg/kg, respectively, in soil method blank VBLK01. Acetone and 2-hexanone were detected at 5 μg/kg and 4 μg/kg, respectively, in soil method VBLK02. Acetone and 2-hexanone were detected at 3 μg/kg and 4 μg/kg, respectively, in soil method blank VBLK03. There were no positive detections of acetone, 2-butanone, and 2-hexanone in the associated samples. All positive results for acetone were qualified using the equipment blank 29SE03 because acetone was detected at 47 μg/L in that blank. Detections of acetone in the associated samples below 10X this amount were flagged as undetected with a

U-flag. Also, the detection limit was raised to the concentration of contamination and/or quantitation limit for each sample.

Acetone was also detected at 12 μg/L in the field blank 70FB04. Because the concentration in the field blank was less than the concentration in the equipment blank, the equipment blank was used to qualify all associated sample results. In trip blank 29ST05, acetone and methylene chloride were detected at 4 μg/L and 2 μg/L, respectively. The detection of methylene chloride in the associated sample 29S0601 below 10X the amount was flagged as undetected with the detection limit being raised to the concentration of contamination in the sample. Acetone and methylene chloride contamination were also detected at 4 μg/L and 2 μg/L, respectively, in trip blank 29ST05. Acetone was qualified using equipment blank 29SE03. The detection of methylene chloride in the associated sample 29S0601 below 10X the amount was flagged as undetected with the detection limit being raised to the level of contamination in the sample. Acetone and methylene chloride were detected at 3 μg/L and 2 μg/L, respectively, in trip blank 29ST03. Acetone was qualified using equipment blank 29SE03, and methylene chloride was qualified using trip blank 29ST05. Blank contaminations below the CRQL were raised to the CRQL and flagged as undetected (U).

SDG 504 Semivolatile Organic Analyses

In SDG 504, dioctyl ester hexanedioic acid a tentatively identified compound (TIC) was detected at 4,900 μg/kg in soil method blank SBLK41. Using the 5X rule, this concentration was sufficient to eliminate the detection in associated sample 29S0703, and the compound was flagged as undetected (U-flag). Di-n-butylphthalate and bis(2-ethylhexyl)phthalate were both detected at 5 μg/L in field blank 70FB04. The detection of bis(2-ethylhexyl)phthalate in associated sample 29S0701 below 10X this amount was flagged as undetected with the detection

limit being raised to the concentration of contamination in the sample. Blank contaminations below the CRQL were raised to the CRQL and flagged as undetected (U).

During the laboratory's day-to-day activities and operations, samples from several different NAS Pensacola sites were analyzed together within several SDGs. As a result, equipment rinsate blanks, equipment rinsate/trip blanks, potable water blanks and trip blanks from these other sites were also used in the evaluation of pesticide/PCB sample results for Sites 9, 29, and 34. Although none of the target pesticide/PCB analytes are considered to be common laboratory artifacts, E/A&H believes that the associated QA/QC blank sample contamination was introduced by the laboratory at the time of sample preparation, dilution, and/or sample analysis. Therefore, as in the case of volatiles, semivolatiles, and pesticides/PCBs, action levels were calculated based on the analyte concentrations indicated in each SDG and all associated sample results were qualified accordingly.

SDG 508 Volatile Organic Analysis

Acetone and methylene chloride were detected at 12 μg/L and 2 μg/L, respectively, in water method blank VBLKGU. Detections of these compounds in the associated samples below 10X these amounts were flagged as undetected (U) with the detection limit being raised to the concentration of contamination in each sample. The TIC compound trimethylsilanol was detected at 8 μg/L in rinsate blank 29GE01. Using the 5X rule, this concentration was sufficient to eliminate the detection in associated sample 29GR07 and the compound was flagged as undetected (U). Acetone was detected at 11 μg/L in trip blank 29GE01. Acetone was qualified using method blank VBLKGU. No further action was necessary. Blank contaminations below the CRQL were raised to the CRQL and flagged as undetected (U).

SDG 511 Volatile Organic Analyses

Acetone was detected at 3.0 μg/L in method blank VBLKGW. There were no positive detections for acetone in the associated samples. Also, there were no positive detections in any of the associated blanks for semivolatile and pesticide/PCB analysis, therefore no action was taken.

In evaluating the data provided by these QC samples, all frequencies and compliance requirements were found to be satisfactory. E/A&H believes that these common laboratory artifacts and other blank contaminants are partially, if not all, a result of laboratory conditions at the time of sample analysis. Therefore, no conclusions or recommendations for Site 9, 29, and 34 at NAS Pensacola are based on laboratory artifacts.

8.2.2 Calibration

Requirements for instrument calibration were established to ensure that the data provided are acceptable qualitatively and quantitatively. The initial calibration measures the instrument's stability, which gives an indication of its sensitivity and capabilities before the analytical run. The continuing calibration indicates the instrument's performance throughout and at the end of each subsequent analytical run. Historical performance data indicate poor response and/or erratic behavior by those compounds known as common laboratory artifacts. Since no contractual criteria for these compounds exists, for review and data validation purposes, all compounds including the common laboratory artifacts were considered for qualification when the following criteria were <u>not</u> met.

- Initial/continuing calibration standard relative response factors (RRFs) for all target compounds and surrogates must be equal to or greater than 0.05.

- Percent relative standard deviation (%RSD) must not exceed ± 30 percent in the initial calibration.

- Percent difference (%D) not exceeding ± 25 percent in the continuing calibration.

SDG 504 Volatile Organic Analyses

Several volatile compounds, including methylene chloride, acetone, 2-butanone, 2-hexanone, and chloromethane, consistently failed %RSD criteria during the initial calibration analysis for almost every organic SDG. Also, acetone, 2-butanone, 2-hexanone, chloromethane each failed %D criteria during the continuing calibration analysis for several SDGs. In SDG 504, the %RSDs exceeded the 30 percent QC limit for the initial calibration standard analysis on September 17, 1993, for the following compounds:

Compounds	**%RSD**
Chloromethane	34.9%
Acetone	39.9%

There were no positive detections of chloromethane in the associated samples. Also in SDG 504, positive detections of acetone in associated samples 29S0403 and 29S0701D were flagged as estimated with a J-flag. In the continuing calibration the %Ds for the standard analysis on February 7, 1994 exceeded the 25 percent QC limit for the following compounds:

Compounds	**%RSD**
Chloromethane	34.3%
Acetone	33.7%

The %Ds for the continuing calibration standard analyzed on February 8, 1994, exceeded the 25 percent QC limit for the following compounds:

Compounds	**%RSD**
Chloromethane	26.9%
Acetone	32.3%

The %Ds for the continuing calibration standard analyzed on February 9, 1994, exceeded the 25 percent QC limit for the following compounds:

Compounds	**%RSD**
Chloromethane	34.1%
Chloroethane	38.7%
2-Butanone	61.1%
4-Methyl-2-pentanone	36.8%
2-Hexanone	139.6%

There were no positive detections of these compounds in the associated samples, no action was required.

SDG 504 Semivolatile Organic Analyses

In the case of semivolatile analysis, the compounds 4-chloroaniline, 3,3-dichlorobenzidine, di-n-octylphthalate, bis(2-ethylhexyl)phthalate, 4-chlorophenyl-phenylether, and hexachlorocyclopentadiene failed %D criteria due to poor response and/or frequent intervals of erratic behavior. Although this was a systematic occurrence, these poor responders represent the large majority of compounds that failed both %D and/or %RSD for nearly each SDG. If

the %RSD was greater than 30 percent and elimination of either the high point or the low point on the initial calibration curve and recalculating did not restore the %RSD result to a value less than or equal to 30 percent, all associated positive sample results outside the linear portion of the initial calibration curve were qualified with a J flag. However, if this action did restore the %RSD result to a value below 30 percent, no action is deemed necessary based on CLP QC protocols. The initial calibration semivolatile standard analyzed on October 11, 1993, exceeded the 30 percent QC limit for %RSDs for the following compounds:

Compounds	**%RSD**
4-Chloroaniline	97.5%
Hexachlorocyclopentadiene	42.8%
Diethylphthalate	44.5%
4-Chlorophenyl-phenylether	33.0%
Fluorene	33.9%
3,3'-dichlorobenzidine	48.3%

Associated nondetect results for 4-chloroaniline are flagged as estimated (UJ). Because there were no positive detections of the other compounds in the associated samples, no data qualification was necessary.

The continuing calibration semivolatile standard analyzed on February 9, 1994, exceeded the 25 percent QC limit for the following compounds:

Compounds	**%D**
4-Chloroaniline	54.4%
Hexachlorocyclopentadiene	26.6%

No data qualification was required because there were no positive detections of these compounds in the associated samples. The RRF for 4-chloroaniline was 0.039, which was below the QC limit of 0.050. All results for this compound in associated samples 29S0405, 29S0601, 29S0603 and 29SO701D, which consisted entirely of nondetects, were rejected (R-flagged). The %Ds exceeded the 25 percent QC limit for the continuing calibration standard analyzed on February 12, 1994, for the following compounds:

Compounds	**%D**
4-Chloroananiline	70.2%
Hexachlorocyclopentadiene	53.1%
2,4-Dinitrophenol	64.3%
4,6-Dinitro-2-methylphenol	45.7%
3,3'-Dichlorobenzidine	60.0%
Di-n-octylphthalate	28.2%
Benzo(g,h,i)perylene	31.6%

No data qualification was necessary because there were no positive detections of the other compounds in the associated samples. The RRFs were below the QC limit of 0.05, for the following compounds:

Compounds	**RRF**
4-Chloroaniline	0.026
Hexachlorocyclopentadiene	0.048
2,4-Dinitrophenol	0.047
3,3'-Dichlorobenzidine	0.022

The results for these compounds in associated sample 29S0703, which consisted entirely of nondetects, were flagged as rejected (R).

SDG 50 Volatile Organic Analyses 8

In the case of volatile analysis for the initial calibration standard analyzed on December 10, 1993, the %RSD was 58.9 percent for acetone, which exceeded the 30 percent QC limit. There were no positive detections of acetone in the associated samples, so no action was taken. In the continuing calibration standard analyzed on February 10, 1994, the %D exceeded the 25 percent QC limits for the following compounds:

Compounds	**%D**
Chloromethane	27.7%
1,2-Dichloroethane	26.6%
4-Methyl-2-pentanone	56.9%
2-Hexanone	31.4%

There were no positive detections of these compounds in the associated samples, so no action was taken. The %Ds for the calibration standard analyzed on February 8, 1994, exceeded the 25 percent QC limit for the following compounds:

Compounds	**%D**
Acetone	28.5%
4-Methyl-2-pentanone	56.9%

Because there were no positive detections of these compounds in the associated samples, no action was required.

SDG 508 Semivolatile Organic Analyses

The %Ds for the continuing calibration standard analyzed on February 10, 1994, exceeded the 25 percent QC limit for the following compounds:

Compounds	**%D**
2,4-Dinitrophenol	27.4%
Pentachlorophenol	39.7%

Because there were no positive detections of these compounds in the associated samples, no data qualification was required.

SDG 508 Pesticide/PCB Organic Analyses

The %RSDs for alpha-BHC and gamma-BHC were 29.3 percent and 22.1 percent, respectively, for the initial calibration analyses on February 8, 1994, on the primary column (SPB-1701), which exceeded the 20 percent QC limit. Because these were the only two exceedances, no action was required. The %RSD for methoxychlor was 23.3 percent for the initial calibration analyses on February 8, 1994, on the secondary column (SPB-608), which exceeded the 20 percent QC limit. Because this was the only exceedance, no action was necessary. The relative %D was 28.5 percent for the surrogate DCB reported in the continuing calibration analyses analyzed on February 8, 1994, on the secondary column (SPB-608). All results for associated sample 29GR07, which consisted entirely of nondetects, were flagged as estimated (UJ).

SDG 511 Semivolatile Organic Analyses

All the initial calibration CLP QC criteria were met for SDG 511, therefore no action was deemed necessary. However, the %Ds for the continuing calibration standard analyzed on February 14, 1994, exceeded the 25 percent QC limit for the following compounds:

Compounds	**%D**
2,2'-Oxybis(1-chloropropane)	45.8%
Hexachlorocyclopentadiene	39.6%
2,4-Dinitrophenol	33.1%
4-Chlorophenyl-phenylether	26.0%
4,6-Dinitro-2-methylphenol	29.8%
Hexachlorobenzene	25.2%
Pentachlorophenol	30.9%

Because there were no positive detections of these compounds in the associated samples, data qualification was not required. The %Ds for the continuing calibration standard analyzed on February 15, 1994, exceeded the 25 percent QC limit for the following compounds:

Compounds	**%D**
2,2'-Oxybis(1-chloropropane)	49.6%
2,4-Dinitrophenol	41.1%
4-Chlorophenyl-phenylether	32.0%
pentachlorophenol	35.4%

Continuing Calibration Standard Analyzed on February 17, 1994

Compounds	**%D**
2,2'-Oxybis(1-chloropropane)	62.6%
2,4-Dinitrophenol	44.8%
2,4-Dinitrotoluene	30.5%
4,6-Dinitro-2-methylphenol	47.3%
4-Chlorophenyl-phenylether	30.2%
Pentachlorophenol	35.9%

Continuing Calibration Standard Analyzed on February 18, 1994

Compounds	**%D**
2,2'-Oxybis(1-chloropropane)	57.0%
2,4-Dinitrophenol	31.9%
4-Chlorophenyl-phenylether	25.4%
4,6-Dinitro-2-methylphenol	38.9%
Pentachlorophenol	29.8%

There were no positive detections of these compounds in the associated samples, therefore no action was necessary.

8.2.3 Precision

In each analytical method used to analyze environmental samples, there are variations in the reported results that may be due to the random differences in the handling and analysis of that matrix. These variations are referred to as the *precision* or the *reproducibility of results*. To

demonstrate reproducibility, the CLP SOW specifies the addition of known quantities of several compounds to two separate aliquots of each sample matrix type. The "spiked" aliquots are referred to as the matrix spike (MS) and the matrix spike duplicate (MSD). These samples then can be analyzed by applying the same preparation techniques and analytical methods used for all the samples of similar matrix types. This enables the MS and MSD to be used to detect matrix effects caused by contamination during analysis that could also interfere and/or cover up target compounds present within the sample.

SDG 508 Semivolatile Organic Analysis

The percent recovery of 4-nitrophenol was 84 percent for MSD sample 29GR07MSD, which exceeded the 10 percent - 80 percent QC limits. Because there were no positive detections of this compound in the associated samples, no action was required.

E/A&H believes the MS/MSD results indicate the effect of sample matrix on the associated sample data, including the MS/MSD samples themselves. This can be determined by consistent high percent recoveries when deionized water is analyzed and the inconsistent percent recoveries and %RPDs reported when soil samples were analyzed. As a general rule, no action is taken on MS/MSD data alone. However, the MS and MSD results are used in conjunction with other QC criteria such as surrogate recoveries, internal standard area QC requirements, and the comparison of %RSD results of nonspiked compounds with the original sample results to determine the need to qualify some of the associated positive sample results as estimated or unusable.

8.2.4 Accuracy

Accuracy is the degree to which a given result agrees with the *true* value. To check the accuracy in a volatile, semivolatile, pesticide, and/or PCB analysis, the CLP SOW requires the

addition of known amounts of *surrogate compounds and internal standard compounds* or compounds which are not likely to be found in the actual samples. If upon analysis of the sample, the percent recovered for the surrogate and/or internal standard compounds are accurate, that is, close to the known concentrations as defined within the limits set by the CLP, then the reported target compound concentrations are assumed to be accurate.

Also, the accuracy of the overall measurement system is an indication of any bias that may exist in the environmental laboratory and/or in the field sampling/analysis plan. Possible sources of error may include the sampling process, field and/or laboratory contamination, preservation, and handling or the sample matrix itself. Other methods used to determine field inaccuracies include trip blanks and the preparation and analysis of field blanks, potable water blanks, and equipment rinsate blanks.

In SDG 504, the internal standard area counts were below the 50 percent to 200 percent QC limits for the following samples and internal standards:

Internal Standards Performance		
Sample	**Internal Standards**	**Area Count**
29S0501	Bromochloromethane	17%
29S0501	1,4-Difluorobenzene	14%
29S0501	Chlorobenzene-d5	11%
29S0403	Chlorobenzene-d5	37%
29S0405	1,4-Difluorobenzene	41%
29S0405RE	Chlorobenzene-d5	45%
70FB04	1,4-Difluorobenzene	26%
70FB04RE	1,4-Difluorobenzene	47%

All laboratory data were considered acceptable with qualification. Samples 29S0501, 29S0403, 29S0701, and 29S0701D were diluted and re-analyzed. The concentrations of acetone exceeded the five standards calibration range in the undiluted samples. The values of this compound in the diluted samples are considered more accurate. Two samples, 29S0405 and 70FB04, were re-analyzed. Because the two re-analyses are essentially the same as the first analyses, they are considered to be of comparable data quality.

SDG 508 Pesticide/PCB Organic Analyses

The Percent Recoveries of tetrachloro-m-xylene (TCX) and decachlorobiphenyl (DCB) for the following samples were below the 60 percent to 150 percent QC limits:

Samples	TCX (%R)	DCB (%R)
29GR07		In/58
29GR06		51/48
29GR05		49/46
29GR02		40/38
29GR09		36/34

Samples	TCX (%R)	DCB (%R)
29GR01		40/36
29GR04		39/37
29GR03		55/52
29GR08		31/30
29GR08D		56/54
29GGW07	15/15	6/6
29GE01		20/19

All sample data for sample 29GGW07 due to low surrogate recoveries (< 10 percent). All remaining laboratory data were acceptable with qualification.

However, as indicated earlier, the pesticide/PCB analytical data within each SDG were determined to be reliable and usable with the appropriate data qualifiers based on the evaluation of all associated QC such as the initial and continuing calibrations, retention time criteria, and %D and %RSD criteria because CLP QC limits are advisory and no action is provided for samples with failing surrogate recoveries.

8.2.5 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristic of a population, parameter variations at a sampling point, or an environmental condition. The duplicate samples assist in giving an indication of overall field and laboratory precision. A greater variance should be expected for the soil sample duplicates than for water sample duplicates due to the differences in matrix. In all cases, the duplicate results were found to be in close agreement with the original results because most variations are due mainly to common laboratory artifacts.

8.2.6 Completeness

Completeness is defined as the percentage of measurement made that are judged to be valid measurements. One hundred eighty-four samples were analyzed for full CLP TCLP investigation of Sites 9, 29, and 34. All positive organic sample results were determined to be valid with some qualification. Therefore, the data meet the 90 percent completeness level.

8.2.7 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. All samples for Sites 9, 29 and 34 were collected using the USEPA Region IV SOPs and analyzed according to CLP SOW protocol.

8.3 Inorganic Analysis

The analytical methods were performed in accordance with the USEPA CLP SOW for Inorganics Analyses (3/90) guidelines. However, for hexavalent chromium analysis the laboratory employed Method 7196A and for the determination of characterized contaminants in hazardous waste leachate, TCLP Method 1311. Each method is listed in the USEPA's *Test Methods for Evaluating Solid Wastes, SW-846, 3d Edition.* Results were reported according to CLP format outlined, including forms, but were not limited to those listed under NEESA Level D guidelines.

8.3.1 Holding Times

All inorganic SDGs indicated that all inorganic samples were received by the laboratory in good condition with the proper custody documents and seals intact. From the date of collection to the date of sample digestion/preparation, sample holding times were within contractual requirements.

8.3.2 Calibration

The purpose of initial and continuing calibration is to ensure the instrument is capable of acceptable and quantitative performance at the beginning and throughout each analytical run. Initial and continuing calibrations were performed for the inorganics analysis within the criteria established by the EPA CLP Inorganics SOW.

8.3.3 Blanks

Blank results are used to determine the presence and magnitude of any contamination problems. In review of the data, the following blank results represent the highest detections associated with the samples and were used for data qualification:

SDG 501 Inorganic Analyses For:

Blank	Element	Max. Conc. (μg/kg)	Action Level (μg/kg)
CCB1	Antimony	17.2	86
CCB1	Barium	8.0	40
CCB2	Copper	2.7	13.5
CCB2	Iron	29.58	147.9
CCB1	Zinc	6.1	30.5
CCB2	Manganese	1.1	5.5
CCB1	Magnesium	24.6	123

SDG 504 Inorganic Analyses For:

Blank	Element	Max. Conc. (mg/kg)	Action Level (mg/kg)
PBW1	Arsenic	0.96	4.80
CCB3	Barium	0.58	2.90
PBS1	Calcium	26.1	130
ICB1	Copper	0.96	4.8
FB	Iron	3.76	18.8
PBS1	Magnesium	14.8	74.2
FB	Sodium	3.16	15.8
FB	Zinc	2.40	12.0

Notes:

CCB = Continuing Calibration Blank
ICB = Initial Calibration Blank
PBW = Water Preparation Blank
PBS1 = Soil Preparation Blank
FB = Field Blank (70FB04)

All results greater than the instrument detection limit (IDL) but less than 5X the blank amount (action level, μg/L for water samples, mg/kg for soil samples) for which the contaminated blank is an associated calibration or field/equipment blank were flagged as undetected. Continuing calibration blank CCB3 analysis indicated that silver had a negative value of -1.90 mg/kg. The absolute value of the negative blank contamination was greater than its IDL. All associated positive sample results less than 5X the absolute value of the negative blank result and all non-detects were flagged as estimated (J) and (UJ).

Inorganic Analyses for SDG 508

Blank	Element	Max. Conc. (μg/L)	Action Level (μg/L)
CCB6	Aluminum	19.5	97.5
CCB4	Barium	6.8	34.0
PBW1	Calcium	103	515
ICB1	Chromium	2.4	12.0
CCB1	Iron	37.1	186
CCB6	Manganese	1.9	9.5
ICB1	Silver	4.0	20.0
CCB6	Sodium	66.9	335
CCB5	Vanadium	4.1	20.5
CCB3	Zinc	4.2	21.0

All results greater than the IDL but less than 5X the blank amount (Action Level, μg/L for water samples, mg/kg for soil samples) for which the contaminated blank is an associated calibration or field/equipment blank were flagged as undetected (U).

Copper had a negative value (-4.3 μg/L) in continuing calibration blank CCB5. The absolute value of the negative blank contamination was greater than its IDL. All associated positive sample results less than 5X the absolute value of the negative blank result were flagged as estimated (J), and all nondetects were flagged as estimated (UJ).

8.3.4 ICP Interference Check Sample Analyses

The inductive coupled plasma interference check sample analysis (ICSA) is performed to check the laboratory's instrument and the background correction factors.

SDG 504

Negative results were observed for antimony (-21.6 mg/kg), copper (-0.80 mg/kg), and manganese (-2.80 mg/kg) in ICSA Solution A, therefore all associated positive sample results less than 5X the absolute value of the ICS result and all nondetects were flagged as estimated

(J) and (UJ). The ICSA samples also satisfactorily met the contractual compliance requirements as stated under CLP.

SDG 508

All Percent Recovery criteria for the method were met, so no action was taken. Also in SDG 508, barium at 8.0 μg/L, manganese at 4.0 μg/L, and sodium at 179 μg/L were detected in ICSA Solution A at concentrations greater than 2X IDL. These analytes should not be present. Since neither aluminum, calcium, iron, nor manganese were present at concentrations greater than 50 percent of the amount in Solution A in any of the associated samples, no data qualification was required. Negative results in ICSA Solution A were observed for the following analytes:

Compounds	**Neg. Detection (μg/L)**	**5X Absolute Value (μg/L)**
Arsenic	-3.0	15.0
Copper	-7.0	35.0
Selenium	-4.0	20.0
Thallium	-4.0	20.0
Zinc	-8.0	40.0

8.3.5 Laboratory Control Sample Analyses

The Laboratory Control Sample Analysis (LCSA) is designed to monitor the efficiency of the overall performance in all steps of analysis, including the digestion procedures. All LCSS samples were within QA/QC control limits.

8.3.6 Duplicate/Spike

Duplicate samples are used to determine the precision of analytical methods for each parameter. Spiked sample analysis is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. If the spike is added

to the sample prior to any distillation steps, or before the digestion, it is referred to as a spiked sample, a predigestion/predistillation spike. If the spike is added to the sample after the completion of the distillation or digestion procedures, it is then referred to as a postdigestion/postdistillation spike. In SDG 501, the analytes antimony, manganese, selenium and silver reported a spike recovery of 44.1 percent, 38.1 percent, 70.3 percent, and 71 percent, respectively. All associated positive sample data were qualified as estimated with a "J" and all nondetects were qualified with a UJ flag.

In SDG 504, one set of field duplicates, 29S0701 and 29S0701D, was analyzed by the laboratory. The calculable RPDs are listed below:

Analyte	**29S0701 (mg/kg)**	**29S0701D (mg/kg)**	**RPD**
Aluminum	3,870	8,880	79
Barium	21.4	9.8	74
Calcium	739	883	17
Chromium	4.8	9.9	69
Iron	2,290	4,730	70
Lead	25.2	44.5	55
Magnesium	89.5	81.8	9.0
Manganese	71.4	58.3	20
Vanadium	6.1	14.2	80

The RPDs for aluminum, barium, chromium, iron, and vanadium exceeded the 60 percent QC limit for soil samples. The positive results for these analytes in the associated samples were flagged as estimated (J).

8.3.7 Validation Worksheets

In every E/A&H data validation project, worksheets are used which detail the evaluation of the analytical data. On certain sheets, the validation procedures will be equivalent to the Standard Operating Procedures provided by the *USEPA CLP National Functional Guidelines for Organic*

and Inorganic Data Review. Other sections will cover those areas which are more subjective due to the complexities of the analytical methods, and will only provide documentation on the actions taken by the data evaluator. The worksheets will be provided upon request or and will be included in the NAS Pensacola Sites 9, 29 and 34 *Final Report.*

8.3.8 Data Assessment

The method blanks, trip blanks, potable water blanks, de-ionized (DI) system blanks, equipment rinsate blanks and the equipment rinsate trip blanks contained several volatile target compounds which were reported by the laboratory as contamination introduced during preparation, handling, and/or analysis of the samples. Volatile analyses of SDG 504 indicated that all laboratory data were acceptable with qualification. Samples 29S0501, 29S0403, 29S0701, and 29S0701D were diluted and re-analyzed. The concentrations of acetone exceeded the calibration range in the undiluted samples. The values of this compound in the diluted samples are considered more accurate. Two samples, 29S0405 and 70FB04, were re-analyzed. Because the two re-analyses are essentially the same as the first analyses, they are considered to be of comparable data quality. Low RRFs (<0.050) resulted in the rejection of nine analyses. The remaining laboratory data in SDG 504 for semivolatiles and all the laboratory pesticide/PCB data were acceptable with qualification.

The cyanide contamination found in sample 29GGM07 should be considered an isolated occurrence and is not an indication of the inherent variability normally associated with sample data. The cyanide concentration was significantly higher in this groundwater sample than in any other sample. This includes all of the surrounding monitoring wells and soil borings. Furthermore, the cyanide contamination is questionable due to the fact that the cyanide is in a highly oxidizing environment. Oxidizing agents such as chlorine, bromine, and fluorine decompose most cyanides quite readily. However, in this case, uncharacteristically high

concentrations can be attributed to samples that contain nitrate and/or nitrite contamination. This occurs in the distillation procedure for cyanides, nitrates and when nitrites will form nitrous acid, which react with several organic compounds to form oxime. These newly formed compounds will decompose under test conditions to generate HCN (Hydrocyanic acid). This hydrocyanic acid produces a false and an unusually high reading for cyanides.

In conclusion, the overall data quality of the analytical work done for Sites 9, 29, and 34 at NAS Pensacola, except for those sample results that were qualified as unusable, were considered to be satisfactory and usable for site remediation and risk assessment.

9.0 CONTAMINANT FATE AND TRANSPORT

9.1 Extent of Contamination

Site 9

Inorganics exceeding applicable **[1995 and 1996]** PRGs in the Site 9 soils included antimony, arsenic, **[barium,]** beryllium, cadmium, copper, lead, manganese**[, nickel, and thallium.]** Semivolatile compounds exceeding **[these]** PRGs included benzo(a)anthracene, benzo(a)pyrene, benzo(b+k)flouranthene, **[chrysene,]** dibenz(a,h,)anthracene, indeno(1,2,3-cd)pyrene**[, and phenanthrene. Pesticides included dieldrin, DDT and metabolites, and alpha-BHC.]** The highest concentrations of constituents from each group were found in the west-central portion of the site, in the vicinity of soil borings 09S02, 09S17, and 09S18.

Arsenic was detected **[above 1995 PRGs]** site wide at concentrations ranging from 0.78 to 2.5 mg/kg. Manganese ranged **[above 1995 PRGs]** from 48.6 mg/kg to 683 mg/kg throughout the site. Several inorganics above **[1995]** PRGs were found at Boring 09S18, including lead (51300 mg/kg) and copper (47700 mg/kg)**[, while nickel (133 mg/kg), and thallium (1.0 mg/kg) were above 1996 PRGs.]** Beryllium at 0.2 mg/kg was found **[above 1995 PRGs]** at boring 09S03.

Concentrations of semivolatiles above **[1995 and 1996]** PRGs were also detected in a cluster of borings at the site's center (borings 09S02, 09S17, and 09S18). **[Concentrations above 1995 and/or 1996 PRGs at]** boring 09S02 **[were]** benzo(a)anthracene (6000 μg/kg), benzo(a)pyrene (4100 μg/kg), benzo(b)flouranthene (5600 μg/kg), benzo(k)flouranthene (4200 μg/kg), **[carbazole (920 μg/kg), chrysene (4900 μg/kg),]** dibenz(a,h,)anthracene (550 μg/kg), indeno(1,2,3-cd)pyrene (1400 μg/kg)**[, and phenanthrene (8100 μg/kg).]** Boring 09S17 **[also]** revealed benzo(a)anthracene (3500 μg/kg), benzo(a)pyrene (3100 μg/kg), benzo(b)flouranthene (3300 μg/kg), benzo(k)flouranthene (3900μg/kg)**[, chrysene (3900 μg/kg), and phenanthrene**

(3900 μg/kg) above 1995 and/or 1996 PRGs.] Boring 09S18 contained benzo(a)anthracene (11000 μ/kg), benzo(a)pyrene (12000 μg/kg), benzo(b)flouranthene (13000 μg/kg), benzo(k)flouranthene (10000 μg/kg), **[chrysene (11000 μg/kg),]** indeno (1,2,3-cd)pyrene (6600 μg/kg)**[, and phenanthrene (12000 μg/kg) above 1995 and/or 1996 PRGs.]** Benzo(a)pyrene **[above 1995 PRGs]** was also found at borings 09S03 (150μg/kg), and 09S06 (140 μg/kg).

Dieldrin above **[1995/1996]** PRGs was found at **[six]** isolated locations **[(borings 09S03, 09S04, 09S07, 09S08, 09S09, 09S26), while alpha-BHC was found above 1996 PRGs at two boring locations (borings 09S26/09S27). DDT and its metabolites were found above 1996 standards at a single boring location (09S03).**

Site 29

Other than localized manganese above **[1995]** PRGs (ranging in concentration from 41.6 mg/kg to 168 mg/kg) in a few of the surface and subsurface samples **[(borings 29S01, 29S04, 29S05, 29S07, and 29S09), and a single nickel concentration (boring 29S05/37.2 mg/kg) above 1996 PRGs,]** the principal soil contaminants on Site 29 were semivolatile compounds and the pesticide dieldrin. Surface soils at Boring 29S01 contained dieldrin at 12 μg/kg (above the **[1995]** FDEP CG for leachability), while subsurface soil at this boring contained dieldrin at 2200 μg/kg. **[Review of 1996 standards also revealed dieldrin above the SSL at the four confirmatory borings around boring 29S01 (29S10, 29S11, 29S12, 29S13), and at two other isolated borings on-site (borings 29S03/29S07).]** Dieldrin at 0.13 μg/kg (above the FGGC) was **[initially detected in the groundwater but was non-detect in a subsequent confirmatory sampling effort.]** Benzo(a)pyrene (120 μg/kg) above the RBC was also found at Boring 29S01.

Site 34

The principal soil contaminant on Site 34 was lead, found in subsurface soils (7- to 9-foot bls interval) at boring 34S01 at 689 mg/kg. The semivolatile naphthalene was also detected in subsurface soil at boring 34S01 (170 μg/kg) at the same interval. **[Lead and naphthalene remained above both 1995 and 1996 standards at boring location 34S01. The 1996 PRGs also revealed dieldrin above standards at borings 34S01, 34S03, and 34S05.]**

9.2 Contaminant Migration

9.2.1 Leaching of Soil Constituents to Groundwater

Contaminants identified in soil may be leached from the soil through percolation of rainwater toward the water table or through direct continual contact with groundwater; however, the relative absence of most contaminants in groundwater indicates that leaching of contaminants from soil to groundwater is not substantial. Soil within the site area is very permeable, resulting in quick infiltration and minimal contact time between percolating water and soil above the water table. Section 9.2.2 specifically addresses the potential for constituent leaching.

Site 9

Elevated concentrations of lead and copper, as well as elevated concentrations of arsenic, cadmium, and manganese were detected in surface and subsurface soils at boring 09S18. However, groundwater samples from the nearest downgradient well (09GR02) indicate only slight **[elevation]** above PRGs for lead and manganese (lead was not found in a second groundwater sample collected from this well). Other inorganics above PRGs in groundwater samples across the site have no corresponding concentrations in associated soil samples. There is also an absence of semivolatiles in groundwater on Site 9 despite detections above PRGs of PAH compounds in soil samples on the site. Though elevated concentrations of dieldrin **[and**

other pesticides] were found in surface **[and subsurface]** soils at **[several]** locations on Site 9, no **[pesticides were]** found in groundwater on the site.

Site 29

Detectable concentrations of dieldrin (up to 2,200 μg/kg) were found in all sampling intervals at boring 29S01**[. Dieldrin was also found at the four confirmatory borings adjacent to 29S01 (borings 29S10, 29S11, 29S12, and 29S13), and at two other isolated borings (29S03/29S07) on-site. However,]** a much smaller quantity was found in the groundwater sample collected from **[29S01's]** collocated temporary well (29GR01 - 0.13 μg/L [above the FGGC])**[. Dieldrin was not found in a second groundwater sample collected from 29GR01, nor was dieldrin or any other pesticide found above standards in groundwater elsewhere on-site.]**

Site 34

Detectable quantities of lead were found in subsurface soils at boring 34S01; however, no lead was found in the groundwater sample from the associated temporary well (34GR01). Other inorganics above PRGs in groundwater samples had no corresponding constituent detections in soil samples. **[Naphthalene above groundwater standards was found in two wells on Site 34 (34GR01 and 34GR02). No pesticides above standards appeared in Site 34 groundwater samples.]**

Soil Physical Analyses

The soil migration potential for inorganic species depends on TOC, pH, redox potential, and CEC of the bearing soil. These parameters measure ionic strength relative to solution, precipitation, co-precipitation, chelation, and ionic particle binding. Sites 9 and 29 have almost identical soil types, consequently the following discussions treat their associated data together.

CEC varied across Site 9 and 29, from 4.2 meq/100g in the Site 9 area to 0.49 meq/100g at Site 29, averaging 2.5 meq/100g (derived from five samples). CEC varied across Site 34, from a high of 1.5 meq/100g to a low of 1.2 meq/100g, with an average of 1.3 meq/100g (derived from three samples). TOC varied across Site 9 and 29 from 2,500 mg/kg to 57 mg/kg, averaging 1299 mg/kg. This indicates a heterogenous and highly variable TOC content across the two sites. TOC varied across Site 34 from 650 mg/kg to 500 mg/kg, indicating a less variable matrix.

9.2.2 Leachability Study

Supplemental sampling was performed at Sites 9 and 34 to determine if chemicals could leach in appreciable quantities to the shallow water bearing zone, and if so, to define the maximum constituent concentrations that are still protective of groundwater. Three samples were collected at Site 9, as well as two samples at Site 34 from areas found to contain soil contamination during previous sampling phases (see Figure 5-2 for sample locations). Samples were subsequently analyzed for the full CLP TCL/TAL list. Additional aliquots were also subjected to the synthetic precipitation leaching procedure (SPLP). The leachate from the SPLP was analyzed for low concentration CLP analysis. The multiple samples from each site represented a single soil-type (see Appendix containing boring logs); thus, the samples from Site 9 represent Site 9 and 29 soil, and Site 34 samples are representative of that site respectively.

In order to provide a frame of reference for evaluating the significance of reported SPLP leachate concentrations, a comparison was made to tap water risk-based concentrations from USEPA Region III's COC Screening Table, March 18, 1994 (RBC) and FDEP's updated Florida Ground Water Guidance Concentrations (listing primary and secondary standards and guidance concentrations), June 2, 1994. USEPA's RBC values were computed to correspond with an individual excess lifetime cancer risk of 1E-6 and/or a hazard quotient of 0.1, and are used as

screening values. The Florida Ground Water Guidance Concentrations are considered applicable or relevant and appropriate requirements (ARARs) for this project. USEPA Region III RBCs and Florida Ground Water Guidance concentrations are provided for reference in Tables 9-1 and 9-2, and are collectively referred to as preliminary remediation goals (PRGs). These concepts are discussed in greater detail in the baseline risk assessment (Section 10). A conservative dilution/attenuation factor (DAF) of 10 was assumed in accordance with Soil Screening Guidance, USEPA/OSWER, EPA/540/R-94/101, December 1994. Application of the DAF may be accomplished by dividing reported SPLP results by 10. The DAF adjusted results represent the theoretical groundwater quality in the shallow groundwater directly beneath the source area immediately after leachate introduction.

Based upon the outcome of the RBC and FDEP groundwater guidance concentrations comparison to DAF-adjusted SPLP data, additional evaluation of the soil TCL/TAL analysis results was performed. The purpose of this step was to estimate total soil concentrations protective of the underlying shallow water bearing zone. It was necessary to estimate a bracket of values (if possible) based on concentrations which produced leachate levels that resulted in concentrations below the applicable groundwater standard. Every effort was made by the analyzing lab to ensure that CLP low concentration quantitation limits were attained. The following paragraphs discuss the results of these analyses.

Site 9 and Site 29

Table 9-1 shows SPLP data for soil along with groundwater PRGs. The adjusted concentrations of arsenic, barium, beryllium, cadmium, copper, lead, manganese, nickel, thallium and zinc exceeded corresponding RBCs in at least one instance. The table also shows that at least one adjusted SPLP result for aluminum, cadmium, copper, lead, manganese, sodium and zinc

Table 9-1
Site 9 CLP vs. SPLP Data Comparison

Parameter	009S002403		009S002603		009S002702		Tap Water RBC (µg/L)	FDEP GW STD (µg/L)	Basis for Standard
	CLP mg/kg	SPLP µg/L	CLP mg/kg	SPLP µg/L	CLP mg/kg	SPLP µg/L			
Aluminum	423	ND	728	ND	12100	**2600[b]**	3700 n	200	Secondary Std.
Antimony	ND	ND	0.22	3.7	3.3	5.7	1.5 n	6	Primary Std.
Arsenic	ND	ND	ND	**4.4[a]**	8	0	0.038 c	50	Primary Std.
Barium	4.5	145	34.7	665	921	**4060[a]**	260 n	2000	Primary Std.
Beryllium	ND	ND	0.08	**0.21[a]**	0.65	**0.2[a]**	0.016 c	0.5	Carcinogen
Cadmium	ND	2.2	1.745	12.5	28.6	**908[c]**	1.8 n	5	Primary Std.
Chromium	0.83	ND	2.5	ND	262	88.8	18 n	100	Primary Std.
Copper	4.3	23.1	20.75	127	2270	**43400[c]**	140 n	1000	Secondary Std.
Iron	430	58.8	2020	42.5	22500	1260	NA	300	Secondary Std.
Lead	9.7	56.9	126.5	**1250[c]**	5100	**61100[c]**	15 n	15	Primary Std.
Magnesium	25.1	7870	165	1030	3290	5970	NA	NA	Not Applicable
Manganese	17.1	69.2	24.9	153	231	**4200[c]**	18 n	50	Secondary Std.
Mercury	ND	ND	0.48	0.22	ND	0.26	1.1 n	2	Primary Std.
Nickel	ND	3.3	1.2	4.4	60.5	**883[a]**	73 n	100	Primary Std.
Selenium	ND	8.9	ND	11.8	1.8	20.6	18 n	50	Primary Std.

[Bold items in brackets denote changes to the first draft of document.]

Table 9-1
Site 9 CLP vs. SPLP Data Comparison

Parameter	009S002403		009S002603		009S002702		Tap Water RBC (µg/L)	FDEP GW STD (µg/L)	Basis for Standard
	CLP mg/kg	SPLP µg/L	CLP mg/kg	SPLP µg/L	CLP mg/kg	SPLP µg/L			
Sodium	229	1240000	293	1130000	977	**1870000[b]**	NA	160000	Primary Std.
Thallium	ND	ND	ND	ND	ND	**15.7[a]**	0.29 n	2	Primary Std.
Vanadium	0.85	0.75	73	1.3	4090	0	26 n	49	Systemic Tox.
Zinc	7.4	159	72.5	1080	4090	**68000[c]**	1100 n	5000	Secondary Std.
Organic Carbon Frac.	NA	0.00112	NA	0.00453	NA	0.036	NA	NA	Not Applicable

Notes:

a = Indicated the SPLP concentration exceeds the tap water RBC when a dilution/attenuation factor (DAF) of 10 is applied.
b = Indicates the SPLP concentration exceeds the Florida Ground Water Guidance Concentration when a dilution/attenuation factor (DAF) of 10 is applied.
c = Indicates the SPLP concentration exceeds both the tap water RBC and the Florida Ground Water Guidance Concentration when a dilution/attenuation factor (DAF) of 10 is applied.
ND = Parameter was below detectable limits.
NA = Not applicable.

For duplicated samples, the average of the two hit values is reported if detected in both. If the compound was detected in only one duplicate sample, that value was reported.
CLP results presented in mg/kg and SPLP results in micrograms/liter unless otherwise noted.
Tap Water RBCs were derived from USEPA Region III's Risk Based Concentration Tables, March 18, 1994 (hazard quotient goal = 0.1 and risk goal - 1E-6).
FDEP GW Standards were derived from the updated 1989 Florida Ground Water Guidance Concentrations Booklet (June 2, 1994).
Basis for Application indicates the chapter designation provided in updated 1989 Florida Ground Water Guidance Concentration Booklet (June 2, 1994).

[Bold items in brackets denote changes to the first draft of document.]

Table 9-2
Site 34 CLP vs. SPLP Data

Parameter	034S000803A		034S000903A		Tap Water RBC (µg/L)	FDEP GW STD (µg/L)	Basis for Standard
	CLP Data mg/kg	SPLP Data µg/L	CLP Data mg/kg	SPLP Data µg/L			
Aluminum	1320	1700	762	ND	3700 n	200	Secondary Std
Antimony	ND	ND	ND	ND	1.5 n	6	Primary Std
Arsenic	ND	ND	ND	ND	0.038 c	50	Primary Std
Barium	1.8	882	1.8	78.1	260 n	2000	Primary Std
Beryllium	ND	ND	ND	ND	0.016 c	0.5	Primary Std
Cadmium	ND	ND	ND	ND	1.8 n	5	Primary Std
Chromium	1.5	2.6	5.6	4.1	18 n	100	Primary Std
Copper	0.43	6.4	0.67	5.9	140 n	1000	Secondary Std
Iron	827	1020	528	60.2	NA	300	Secondary Std
Lead	1.2	11.7	3.8	91.2	15 n	15	Primary Std
Magnesium	60.5	281	35.2	483	NA	NA	Not Applicable
Manganese	4.1	44.2	6	93.6	18 n	50	Secondary Std
Nickel	ND	3.2	ND	3.8	73 n	100	Primary Std
Potassium	71	4510	68.5	3410	NA	NA	Not Applicable
Selenium	ND	13.4	ND	14.1	18 n	50	Primary Std

[Bold items in brackets denote changes to the first draft of document.]

Table 9-2
Site 34 CLP vs. SPLP Data

Parameter	034S000803A		034S000903A		Tap Water RBC (µg/L)	FDEP GW STD (µg/L)	Basis for Standard
	CLP Data mg/kg	SPLP Data µg/L	CLP Data mg/kg	SPLP Data µg/L			
Sodium	251	1230000	266	1410000	NA	160000	Primary Std
Thallium	ND	ND	ND	ND	0.29 n	2	Primary Std
Vanadium	2.1	2.3	1.2	1.3	26 n	49	Systemic Tox
Zinc	2.9	417	3.3	107	1100 n	5000	Secondary Std
beta-BHC	ND	ND	ND	0.0028	0.0037 c	0.1	Carcinogen
gamma-BHC	ND	ND	ND	0.0005	0.052 c	0.2	Primary Std
Heptachlor	ND	ND	ND	0.0012	0.0023 c	0.4	Primary Std
Heptachlor epoxide	ND	ND	ND	0.0009	0.0012 c	0.2	Primary Std
Dieldrin	ND	ND	ND	0.0008	0.0042 c	0.1	Carcinogen
4,4'-DDE	ND	ND	ND	0.0005	0.2 c	0.1	Carcinogen
Endrin	ND	ND	ND	ND	1.1 n	2	Primary Std
4,4'-DDD	ND	ND	ND	ND	0.28 c	0.1	Carcinogen
4,4'-DDT	ND	ND	ND	0.0007	0.2 c	0.1	Carcinogen
Endrin ketone	ND	ND	ND	0.0004	1.1 n	2	Primary Std
alpha-Chlordane	ND	ND	ND	ND	0.052 c	2	Primary Std

[Bold items in brackets denote changes to the first draft of document.]

Table 9-2
Site 34 CLP vs. SPLP Data

Parameter	034S000803A		034S000903A		Tap Water RBC (µg/L)	FDEP GW STD (µg/L)	Basis for Standard
	CLP Data mg/kg	SPLP Data µg/L	CLP Data mg/kg	SPLP Data µg/L			
gamma-Chlordane	ND	ND	ND	0.0008	0.052 c	2	Primary Std
Organic Carbon Frac.	0.00129	ND	0.000869	ND	NA	NA	NA

Notes:
ND = Parameter was below detectable limits.
NA = Not applicable.
For duplicated samples, the average of the two hit values is reported if detected in both. If the compound was detected in only one duplicate sample, that value was reported.
CLP results presented in mg/kg and SPLP results in micrograms/liter unless otherwise noted.
Tap Water RBCs were derived from USEPA Region III's Risk Based Concentration Tables, March 18, 1994 (hazard quotient goal = 0.1 and risk goal - 1E-6).
FDEP GW Standards were derived from the updated 1989 Florida Ground Water Guidance Concentrations Booklet (June 2, 1994).
Basis for Application indicates the chapter designation provided in updated 1989 Florida Ground Water Guidance Concentration Booklet (June 2, 1994).

[Bold items in brackets denote changes to the first draft of document.]

exceeded its corresponding Florida Groundwater Guidance concentration. The SPLP results for sample 009S002702 showed the highest concentrations for every chemical detected except arsenic and beryllium.

No arsenic was detected in the total TCL/TAL analysis for 009S002603, but its associated SPLP leachate contained 4.4 μg/l. The adjusted leachate concentration is above the USEPA RBC. Because arsenic was not reported in the total soil analysis, there is no basis for establishing groundwater protective soil concentrations. Thallium was not detected in any total soil analysis; and therefore, no approximation of groundwater protective soil cleanup goals was possible. A similar situation exists for beryllium where essentially equal SPLP concentrations were produced by soil samples with total beryllium concentrations spanning an order of magnitude (0.06 to 0.65 mg/kg).

The groundwater PRGs for aluminum, barium, cadmium, copper, manganese, nickel, and zinc were exceeded exclusively in the adjusted SPLP results for sample 009S002702. A lead exceedance was shown in samples 009S002603 and 009S002702. The following shows total soil concentrations (in mg/kg) expected to bracket a level at which shallow groundwater protection could be ensured relative to the lower PRG.

Aluminum	728 to 12100 mg/kg
Barium	34.7 to 921 mg/kg
Cadmium	1.75 to 28.6 mg/kg
Copper	20.75 to 2270 mg/kg
Lead	9.7 to 126.5 mg/kg
Manganese	24.9 to 231 mg/kg
Nickel	1.2 to 60.5 mg/kg
Zinc	72.5 to 4090 mg/kg

It should be mentioned that the PRGs for aluminum, copper, manganese, and zinc are organoleptically based secondary standards. Furthermore, local climatological and hydrogeologic conditions may result in a DAF above or below that used to adjust SPLP results.

Site 34

Table 9-2 shows adjusted SPLP data for soil along with groundwater PRGs. No adjusted RBC or Florida Ground Water Guidance concentration was exceeded by any SPLP result. As a result, no further analysis is necessary for Site 34.

9.2.3 Surface Water Transport

The site area contains grass covered sandy soil, open patches of sandy soil, and impervious surfaces, which affect the transport of surface water in different ways. Much of Site 9 encompasses a grassy field, paved areas, and unvegetated soil. Surface runoff which does not percolate through the soil on Site 9 is conducted across the site to the west, toward the channelized drainage ditch to the west of the site area. The eastern bank of the ditch contains several drainage conduits which receive surface runoff from the western Chevalier Field area and convey it into the ditch. Site 29 is covered with concrete, and has no storm-drains or conduits for surface runoff. The soil and groundwater are protected beneath the concrete and therefore surface water transport is not a viable pathway. Surface runoff from Site 29 is conducted across the Site 9 area, to the drainage ditch. The northern edge of Site 34 contains a drainage swale which also conducts stormwater into the channelized drainage ditch. In general, stormwater that does not percolate through unpaved tracts within the site areas is conducted toward the west to the drainage ditch.

9.2.4 Groundwater Transport

The direction of groundwater flow shifts from a westerly direction at Site 29 to a northwesterly direction at or near Site 34. The average calculated Darcian groundwater flow velocity also slows as it shifts from a westerly to northwesterly direction. Travel time for constituents directly west off of Site 29 to the drainage ditch (approximately 710 feet to the west) would be about 4.7 years, assuming advective transport only (the rate of migration is equal to groundwater velocity [0.410 ft/day]). The most contaminated area of Site 9 lies about 139 feet east of the drainage ditch. With an average calculated groundwater flow of 0.304 ft/day, travel time for contaminants from this area would be approximately 1.25 years. Constituents from the eastern portions of Site 9 would take about 5.7 years to travel roughly 630 feet to the drainage ditch. Groundwater flows from Site 34 to the northwest at an acute angle to the drainage ditch, and appears to intercept the ditch roughly 790 feet from the site. With an average calculated groundwater velocity of 0.271 ft/day, it would take eight years for contaminants to reach the ditch. Notably, these travel times assume advective transport only. Given that dispersion (which would alter both travel time and ending concentrations) and retardation are not considered, this is a very conservative transport determination. For example a physical constant, called the distribution coefficient, (K_d), may be used as a relative measure of a soil's adsorptive capacity. The K_d may be estimated as a function of site organic carbon content and literature values for the organic carbon partitioning coefficient (K_{oc}). The K_{oc} indicates the degree to which a specific chemical partitions between organic matter and water under equilibrium conditions. The partitioning coefficient may also be estimated as the product of organic carbon fractions of site soil times the organic carbon partitioning coefficient by the equation:

$$K_d = f_{oc} * K_{oc}$$

Based on soil samples collected at Sites 9 and 29, organic carbon values in subsoil range from 2.5 percent to a low of .057 percent with an average of 1.30 percent. The value .013 (f_{oc}) has been used to calculate the K_d for the sites constituents. The median value for K_{oc} for Dieldrin is 9440 (Howard, 1991).

$$K_d = .013 * 9440$$
$$K_d = 123$$

The actual K_d for Site constituents could be derived by plotting the log of the soil concentration versus the log of the concentration in groundwater. The slope of this fitted to the data would represent the K_d, however because of the limited number of data points and groundwater nondetects, these K_d values would have limited utility.

A retardation factor for contaminant migration can be calculated based on the following assumptions and laboratory data:

- Average bulk dry density of the media (1.62 gram/cubic centimeter (g/cc))
- An effective porosity of 30 -50% for the surficial sand (Freeze and Cherry, 1979)

Where:

Rf	=	retardation factor
Pb	=	average dry density of the media, 1.62 g/cc
n	=	effective porosity, 30-50 % (Freeze, 1979)
Rf	=	$[1 + (K_d)(Pb)/n]$

The retardation factor range calculated from this equation is 4.99 to 7.64. The contaminant velocity can be estimated by dividing the velocity of the groundwater by the calculated retardation factor. These numbers suggest significant retardation is occurring at the site. Also, mechanical dispersion and chemical diffusion are taking place which could further retard contaminant migration. However, these processes may actually increase travel time.

9.3 Current and Potential Receptors

The primary receiving aquifer within the Site 9, 29, and 34 area is the surficial zone of the Sand-and Gravel Aquifer. Monitoring wells on all 3 sites indicate levels of aluminum, iron, and manganese above PRGs, with lead above PRGs in one Site 9 groundwater sample. Dieldrin was above PRGs in one Site 29 groundwater sample, while one Site 34 sample contained naphthalene. Based on previous RIs, and regional water quality analysis, the general quality of groundwater at NAS Pensacola and the shallow Sand-and-Gravel in southern Escambia County has been shown to contain aluminum and iron concentrations exceeding SMCLs/FSDWS. Based on these natural qualities, the surficial zone of the Sand-and-Gravel aquifer does not appear suitable as a drinking water supply without treatment for these constituents, and is currently not used as such at NAS Pensacola.

Potential receiving water bodies of contamination are:

- The main producing zone of the Sand-and-Gravel Aquifer, which is used as a potable water source in Escambia County and underlies the surficial zone but is separated from it by a confining unit.

- The tile-lined drainage ditch, also known as NASP Wetland 6.

- Bayou Grande, which receives runoff from the drainage ditch traversing the western portion of the site area.

The low permeability clay layer between the surficial and main producing zones may inhibit any downward contaminant migration into the deeper groundwater below the clay. The coastal waters of surrounding NAS Pensacola have been classified by the Florida Department of Environmental Protection as Class II water, indicating their use for recreation and maintenance of a well-balanced fish and wildlife population. Conservatively estimating the rate of contamination migration to equal groundwater velocity, the low concentrations of contaminants, and the amount of dilution they are likely to undergo before reaching Bayou Grande, minimizes their impact to nearby coastal waters. Potential ecological impacts on Bayou Grande, will be addressed in separate upcoming RI/FSs for Bayou Grande (Site 40), and the NASP Wetlands (Site 41).

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10.0 BASELINE RISK ASSESSMENT

10.1 Introduction

A baseline risk assessment (BRA) analyzes the potential adverse effects on actual or hypothetical human and ecological receptors that could arise from exposures to hazardous substances released from a site if no remedial actions are taken to reduce the extent of present environmental contamination. This BRA is divided into two subsections — the first addresses human health risk, and the second, assesses ecological risk.

10.1.1 Human Health Risk Assessment

Human health risk was assessed as part of the BRA for Sites 9, 29, and 34. Algorithms and procedures used in data management and risk calculations are discussed, and the results of their application were used to reach the conclusions of this human health risk assessment. The following BRA was prepared in accordance with the guidelines set forth in:

- *Risk Assessment Guidance for Superfund, Volume I — Human Health Evaluation Manual, Part A*, U.S. Environmental Protection Agency (USEPA)/Office of Emergency and Remedial Response (OERR), EPA/540/1-89/002, December 1989 (Interim). (RAGS Part A).

- *RAGS, Volume I — Human Health Evaluation Manual, (Part B, Development of Risk-based Preliminary Remediation Goals)*, EPA/OERR, EPA/540/R92/003, December 1991 (Interim). (RAGS Part B).

- *RAGS, Volume I — Human Health Evaluation Manual, Supplemental Guidance-Standard Default Exposure Factors — Interim Final,* EPA/OERR, OSWER Directive: 9285.6-03, March 25, 1991. (RAGS Supplement).

- *RAGS, Volume I — Human Health Evaluation Manual, Supplemental Guidance-Dermal Risk Assessment — Interim Guidance,* EPA/OERR, August 18, 1992. (Supplemental Dermal Guidance).

- Supplemental Guidance to RAGS: Region IV Bulletin, *Development of Health based Preliminary Remediation Goals, Remedial Goal Options (RGO) and Remediation Levels* (Supplemental RGO Guidance).

- Supplemental Guidance to RAGS: Region IV Bulletin, *Exposure to Volatile Organic Compounds (VOCs) during Domestic Water Use: Contributions from Ingestion, Showering, and Other Uses* (Supplemental Groundwater VOC Guidance).

- Supplemental Guidance to RAGS: Region IV Bulletin, *Provisional Guidance of Quantitative Risk Assessment of PAHs* (USEPA Document EPA/600/R-93-089 July 1993).

- USEPA Region III *Selecting Exposure Routes and Contaminants of Concern by Risk-Based Table*, March 18, 1994, (Roy L. Smith); (RBC Screening Tables).

10.1.1.1 Objectives

The objectives of the baseline risk assessment are to:

- Characterize the source media and determine the chemicals of potential concern (COPCs) for Sites 9, 29, and 34 at NAS Pensacola;

- Identify potential receptors and quantify potential exposures under current and future conditions;

- Qualitatively and quantitatively evaluate the adverse effects associated with the site-specific COPCs;

- Characterize the potential baseline risks associated with Sites 9, 29, and 34 at NAS Pensacola under current and future conditions; and

- Evaluate the uncertainties related to exposure predictions, toxicological data, and resultant carcinogenic risk and non-carcinogenic hazard predictions.

The value of the risk assessment as a basis for making remedial decisions and determining whether detected site concentrations pose a potential for any toxic effects or increased cancer risk depends on an adequate characterization of chemical contamination. Variables considered in characterizing the study area and its associated risk are the amount, type, and location of sources; the pathways of exposure (media type and migration routes); and the type, sensitivities, exposure duration, and dynamics of the exposed populations (receptors). The RI presented in previous chapters provided the site characterization data used in this assessment.

The focus of the investigation at Sites 9, 29, and 34 was the assessment of a Navy Yard Disposal Area (Site 9), soils located south of Building 3460 (Site 29), and solvent north of Building 3557 (Site 34). Grab soil samples from the surface and various depths were collected and analyzed for the TCL and TAL using CLP March 1990 Statement of Work methods. In addition, groundwater samples were collected from monitoring wells. Groundwater was analyzed for the same list of parameters as soil samples.

10.1.1.2 Site Background

NAS Pensacola is five miles southwest of the City of Pensacola, on a peninsula in southern Escambia County. Sites 9, 29, and 34 of Category V are located near the southwest portion of Chevalier Field as shown on Figure 2-1, Site Location Map. This industrial area is used by the Naval Aviation Depot (NADEP) to rebuild, repair, and paint aircraft. The projected future use for these sites is a military operations school in which training classes and exercises will be conducted for military aircraft mechanics, firefighters, etc.

Site 9, the Navy Yard Disposal Area, includes a large grassy area and parking lot west of Building 3460. Portions of Murray Road, Industrial Road, Moffett Road, and Ellyson Avenue are also included in Site 9. Building 3615, a picnic shelter, is the only structure on Site 9, and portions of this site are covered with asphalt/concrete. This site was used for the disposal of trash and refuse between 1917 and the early 1930's. Part of Site 9 was excavated in the late 1960s during trenching for an IWTP sewer line. Although glass, scrap metal, and debris were unearthed, no unusual odor was reported.

Site 29, the soil south of Building 3460, lies near the concrete aircraft parking apron on the southern side of Building 3460. A small portion of the grassy field mentioned in the Site 9 description is included as part of Site 29, and portions of this site are covered with concrete (i.e., Chevalier Field). This site is bounded by a helicopter repair area (to the south — Buildings 607 and 630) which include an area previously used to store helicopter rotor blades and fuel tanks, an airframe painting facility (to the east — Building 3588), and a parking area (north of Building 630). The IWTP sewer line runs southeast to northwest across the site. While repairing a water main south of Building 3460, workers received minor skin burns from contact with a black liquid in the soil. This liquid was also floating on water in an excavated trench, and an odor similar to paint remover was noted by the workers.

Site 34, which lies beneath the concrete apron immediately north of Building 3557, includes a small tank farm at the edge of the concrete apron (approximately 150 feet north of the building). The tank farm consists of above ground storage tanks — six larger and two smaller cylindrical storage tanks on concrete foundations. A paved trench from the tank farm to Building 3557 contains pipes which transfer materials from the tanks to inside the building. The reported contents of the larger tanks are: T-101 (epoxy stripper MIL-R-81924), T-105 (detergent MIL-C-43616), T-106 (Stoddard solvent PD680-Type II), and T-107 (unknown).

In may 1984, a leak in a pipeline at the north end of Building 3557 reportedly resulted in the loss of approximately 45,000 gallons of a solvent detergent used to clean aircraft (G&M 1986). The solution contained approximately 1.7 percent chlorinated aromatic hydrocarbon solvent, resulting in the release of approximately 750 gallons of solvent. In addition to the potential impact on Site 34 soils and groundwater, escaped solvent detergent might have run off via an unpaved drainage swale that leads from the tank farm to the west. This pathway discharges via culverts beneath Industrial Road into the paved drainage ditch west of Chevalier Field (NAS Pensacola Wetland 6). Wetland 6 will be investigated as part of the Site 41 RI for NAS Pensacola and is not addressed in this report.

10.1.1.3 Organization

A human health risk assessment, as defined by RAGS Part A, includes the following steps:

- Site characterization: data regarding site geography, geology, hydrogeology, climate, and demographics in the area are evaluated.

- Data collection: samples of environmental media, including reference samples, are analyzed.

- Data evaluation: the analytical data are analyzed statistically to identify the nature and extent of contamination and establish a preliminary list of COPCs that will subsequently be refined to identify chemicals of concern (COCs).

- Exposure assessment: potential receptors are identified under current and future conditions, potential exposure pathways are identified, and exposure point concentrations and chemical intakes are quantified.

- Toxicity assessment: the adverse effects of the COPCs are qualitatively evaluated, and quantitative estimates of the relationship between exposure and severity or probability of effect are made.

- Risk characterization: the output of the exposure assessment and the toxicity assessment are combined to quantify the total non-cancer and cancer risk to the hypothetical receptors.

- Uncertainty: discuss and evaluate the areas of recognized uncertainty in human health risk assessments in addition to medium- and exposure pathway-specific influences.

- Risk/Hazard Summary: presentation and discussion of the results of the quantification of exposure (risk and hazard) for the potential receptors and their exposure pathways identified under the current and future conditions.

- Remedial Goal Options: quantification of exposure concentrations within the USEPA target risk range of 10^{-6} to 10^{-4} for carcinogenic COCs and 0.1, 1, and 10 for non-carcinogenic COCs.

10.1.2 Identification of Chemicals of Potential Concern

When performing a BRA, data for environmental media are compiled to determine potential site-related chemicals and exposures for each medium as outlined in RAGS Part A. Sites 9, 29, and 34 are considered one area of investigation; however, this BRA separately addresses the potential risks posed by chemicals detected in groundwater. Sites 9, 29, and 34 are partially paved (40, 91, and 65 percent paved, respectively). As part of ongoing BRAC construction activities, five feet of fill soil is being placed over each site, and each site will be paved after the military operations school construction is completed. Because five feet of soil will be on top of the current surface soils and the percent paved area for each site will increase, no populations were identified which would be exposed to site soils other than hypothetical site residents (i.e., no complete direct exposure pathways for soil). The future land use of these sites is currently being implemented, the classification of such is clearly non-residential use for military training. Hypothetical future site residents could be exposed to groundwater, assuming the residents choose to derive potable water from a well in the surficial aquifer rather than using more commonly used base/municipal water.

10.1.2.1 Data Sources

As part of the site investigation, soil and groundwater samples were collected and analyzed to delineate the sources, nature, magnitude, and extent of any soil and groundwater contamination. E/A&H performed the RI at Sites 9, 29, and 34 in three phases. Phase I was conducted during February 1994, which included full TAL/TCL analysis of all samples. A total of 23 soil borings and 20 temporary monitoring wells were completed during the Phase I investigation. Nine, 11,

and three soil borings were advanced across Sites 9, 29, and 34, respectively. All borings were converted into temporary monitoring wells except two at Site 29 and one at Site 34.

In December of 1994, a second round of groundwater samples was collected at Sites 9, 29, and 34 to verify some of the results of the Phase I sampling. Only wells of concern (noted in the Nature and Extent of Contamination Section 7.0) of the previously installed monitoring wells were resampled, and specific parameters were targeted (such as volatiles and semi-volatiles only). Sample results gathered during the Phase I and Phase II sampling rounds were combined and used in the risk/hazard evaluation of the shallow and intermediate groundwater. Because of the targeted sampling effort, the number of organic analyses performed differs from the number of inorganics analyses. Sample identification numbers, sample dates, and analytes targeted are listed in Tables 10-1 and 10-2 for Sites 9, 29, and 34. The first three digits of the sample number indicate the site (i.e., 009G000100 is a Site 9 sample location), and the sample identification methods are discussed in detail in Section 5.

10.1.2.2 Data Validation

Data validation is an after-the-fact, independent, systematic process of evaluating data and comparing them to preestablished criteria to confirm that they are of the technical quality necessary to support the decisions made in the remedial investigation/feasibility study (RI/FS) process. Specific parameters associated with the data are reviewed to determine whether they meet the stipulated data quality objectives. The quality objectives address five principal parameters: precision, accuracy, completeness, comparability, and representativeness. To verify that these objectives are met, field measurements, sampling and handling procedures, laboratory analysis and reporting, and non-conformances and discrepancies in the data are examined to determine compliance with appropriate and applicable procedures. The procedures and criteria for validation are defined in the *RI/FS Data Validation Program Guidelines*, which are based on

the *USEPA National Functional Guidelines for Data Review* (EPA 1988a; EPA 1988b). For further discussion of data validation, please refer to Section 8 of the RI.

Table 10-1
Site 9, 29, and 34 Phase I Groundwater Samples

Well Number	Sample Number	Date Sampled
09GR01	009G000100 009H000100[a]	2/4/94
09GR02	009G000200	2/3/94
09GR03	009G000300	2/3/94
09GR04	009G000400 009H000400[a]	2/3/94
09GR05	009G000500	2/3/94
009GR06	009G000600	2/3/94
09GR07	009G000700	2/3/94
09GR08	009G000800	2/3/94
09GR09	009G000900	2/3/94
GM-29	009GGM2900	2/4/94
GM-30	009GGM3000	2/4/94
29GR01	029G000100	2/8/94
29GR02	029G000200	2/8/94
29GR03	029G000300	2/8/94
29GR04	029G000400	2/8/94
29GR05	029G000500	2/8/94
29GR06	029G000600	2/8/94
29GR07	029G000700	2/8/94
29GR08	029G000800 029H000800[a]	2/8/94
29GR09	029G000900	2/8/94
GM-07	029GGM0700	2/8/94
34GR01	034G000100	2/10/94

Table 10-1
Site 9, 29, and 34 Phase I Groundwater Samples

Well Number	Sample Number	Date Sampled
34GR02	034G000200 034H000200[a]	2/10/94
GM-53	034GGM5300	2/10/94
GM-57	034GGM5700	2/10/94
GM-61	034GGM6100	2/10/94

Notes:
a = Duplicate Sample
all Phase I samples were analyzed for full CLP TAL/TCL

Table 10-2
Phase II Groundwater Samples and Analytical Parameters

Well Number	Sample Number	Date Sampled	Analytical Parameters	Sampling Rationale
09GR02	009GR00201	8/30/94	PPW	Sampled to define physical properties of groundwater
	009GGR0202	12/15/94	TAL Metals	Phase I sample contained lead
09GR04	009GR00401	8/30/94	PPW	Sampled to define physical properties of groundwater
09GR09	009GR00901	8/30/94	PPW	Sampled to define physical properties of groundwater
29GR01	029GR00101	8/30/94	PPW	Sampled to define physical properties of groundwater
	029GGR0102	12/15/94	TCL Pesticides	Phase I sample contained dieldrin
29GR06	029GR00601	8/30/94	PPW	Sampled to define physical properties of groundwater
34GR01	034GR00101	8/30/94	PPW	Sampled to define physical properties of groundwater
	034GGR0102	12/14/94	TCL VOCs/SVOCs	Phase I sample contained elevated detection limits for VOCs/SVOCs
34GR02	034GGR0202	12/14/94	TCL VOCs/SVOCs	Phase I sample contained elevated detection limits for VOCs/SVOCs

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-2
Phase II Groundwater Samples and Analytical Parameters

Well Number	Sample Number	Date Sampled	Analytical Parameters	Sampling Rationale
34GS01	034G000100	5/24/94	TCL VOCs/SVOCs	Sampled to characterize constituents in the path of groundwater migration from the site
	034GS00101	8/30/94	PPW	Sampled to define physical properties of groundwater
34GS02	034G000200 034H000200[a]	5/24/94	TCL VOCs/SVOCs	Well replaced previously installed GM-56
	034GGS0202 034HGS0202[a]	12/14/94	CLP TAL/TCL	Sampled to better clarify the range of contamination found in previous Site 34 groundwater results.
34GM53	034GGM5302	12/14/94	TCL VOCs/SVOCs	Phase I sample contained elevated detection limits for VOCs
34GM61	034GGM6102	12/14/94	CLP TAL/TCL	Sampled to better clarify the range of contamination found in previous Site 34 groundwater results.

Note:
a = Duplicate Sample

10.1.2.3 Management of Site-Related Data

All environmental sampling data were evaluated for suitability for use in the quantitative BRA. Data obtained via the following methods were not considered appropriate for the quantitative BRA:

- Analytical methods that are not specific for a particular chemical, such as total organic carbon or total organic halogens.

- Field screening instruments including total organic vapor monitoring units (HNu) and organic vapor analyzers.

Once the dataset was complete, statistical methods were used to evaluate the RI analytical results to (1) identify chemicals of potential concern (COPCs) and (2) establish exposure point concentrations of potential receptor locations. The statistical methods used in data evaluation are discussed below. The rationale used to develop this methodology and the statistical techniques are based on the following sources:

- RAGS Part A
- *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987)

Foxpro and Quattro Pro were used for data management and statistical calculations. For each set of data used to describe the concentration of chemicals in a contaminated area, the following information was tabulated: frequency of detection, range of detected values, mean concentrations, and upper confidence limit (UCL) on the mean of the concentration. In accordance with RAGS, the lesser of either the maximum concentration detected or the UCL was used in the risk calculations.

10.1.2.4 Selection of Chemicals of Potential Concern

The objective of this section of the BRA is to screen information that is available on the substances detected at Sites 9, 29, and 34 (chemicals present in site samples or CPSSs) in order to develop a list or group of COPCs. The information, as discussed herein, consists of both federal and State of Florida cleanup criteria and standards for groundwater. COPCs are those chemicals selected in consideration of their comparison to screening concentrations (risk-based and reference), intrinsic toxicological properties, persistence, fate and transport characteristics, and cross-media transfer potential. Any COPC that is carried through the risk assessment process and found to contribute to a pathway that exceeds a 10^{-6} incremental lifetime cancer risk (ILCR) or hazard index (HI) greater than 1 for any of the exposure scenarios evaluated in this risk assessment and has an individual risk greater than 10^{-6} or hazard quotient (HQ) greater than 0.1 is referred to as a chemical of concern (COC).

Prior to evaluating the potential risks/hazards at Sites 9, 29, and 34, it was first necessary to determine the nature and extent of the contamination at the site. This was accomplished by noting the chemicals detected in each medium. These chemicals represent the CPSSs for Sites 9, 29, and 34. The nature and extent of CPSSs was discussed in detail in Section 7 of the RI. In order to reduce the list of CPSSs and focus the risk assessment on COPCs, two comparisons were performed which are described below.

Comparison of Site-Related Data to Screening Concentrations

The maximum concentrations of CPSSs detected during the June 1994 groundwater sampling round were compared to the lesser of up to four screening values: RBCs for tap water as listed in the RBC screening table, maximum contaminant levels (MCLs), secondary maximum contaminant levels (SMCLs), and Florida Drinking Water Standards (FDWS). These values were obtained from FDEP and USEPA, and the most conservative of screening values was used

in this BRA. As stated in the text of the USEPA Region III document referenced in this BRA, a target hazard quotient of 0.1 and a risk goal of 10^{-6} were used by USEPA Region III to calculate screening concentrations for non-carcinogens and carcinogens, respectively. The maximum detected concentrations in shallow and intermediate depth groundwater for the CPSSs were compared to the lowest of the four groundwater screening criteria. CPSSs with maximum detected concentrations exceeding their corresponding concentrations, goals, levels, and/or standards were retained for further evaluation and reference screening in the risk assessment.

Comparison of Site-Related Data to Reference Concentrations

Reference data for Sites 9, 29, and 34 consist of groundwater results for inorganic chemicals. Table 10-3 lists the results of samples numbered 01GS67, 01GI69, 01GS69, and 01GI70, which identify reference (background) concentrations for inorganic chemicals detected in shallow groundwater.

Groundwater CPSSs exceeding screening concentrations, goals, levels, and/or standards were compared to reference concentrations established for Sites 9, 29, and 34. The procedure for comparing the concentrations of inorganic chemicals onsite with those in reference samples is referred to as the "twice reference criterion," or two times the reference concentration. Inorganic CPSSs from Sites 9, 29, and 34 whose maximum detected concentrations exceeded corresponding reference concentrations were retained for further consideration for inclusion as a COPC in the BRA. This comparison assists in accounting for naturally occurring chemicals that are ubiquitous in nature such as aluminum.

Table 10-3
Reference Concentrations — Shallow Groundwater
NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	01GS67 (µg/L)	01GI69 (µg/L)	01GS69 (µg/L)	01GI70 (µg/L)	Average Concentration (µg/L)	2X Average Concentration (µg/L)
Aluminum	***4,240***	146.5 U	***3,270***	109 U	***1,941.4***	***3882.8***
Arsenic	1.4 U	1.4 U	1.4 U	1.4 U	1.4	2.8
Barium	5.5 U	6.75 U	9.45 U	4.75 U	6.6	13.2
Cadmium	1.7 U	1.7 U	1.7 U	1.7 U	1.7	3.4
Calcium	17,800	5,670	6,300	5,350	8,780	17,560
Chromium	4.85 U	2.6 U	59.9	2.6 U	16.9	34
Cobalt	2.05 U	2.05 U	2.05 U	2.05 U	2.05	4.1
Copper	5.4 U	5.4 U	16.2	5.4 U	8.1	16.2
Iron	***677***	***942***	***1,770***	26.65	***853.9***	***1,707.8***
Lead	0.8 U	0.8 U	0.8 U	0.8 U	0.8	1.6
Magnesium	795 U	665 U	1,255 U	3,030	1,256.25	2,512.5
Manganese	5.7	8.9	26.7	1.55 U	11.0	22
Mercury	0.1 U	0.1 U	0.1 U	0.1 U	0.1	0.2
Nickel	19.95 U	19.95 U	19.95 U	19.95 U	19.95	39.9
Potassium	13,300	1,275 U	6,560	3,200	6,083.8	12,167.6
Sodium	10,700	8,350	7,830	9,810	9,172.5	18,345
Vanadium	7.9	3.75 U	3.75 U	3.75 U	4.8	9.6
Zinc	8.75 U	3.9 U	290	3.75 U	75.3	150.6

Notes:
µg/L = Micrograms per liter.
U = Chemical not detected, value reported equals one-half detection limit.
Bold Italics = The reported value exceeds the Florida Secondary Drinking Water Standard (FSDWS).
— One-half the lowest reported detection limit or the lowest positive detection, whichever was lower, was used in the calculation of the average concentration.
— Shallow and intermediate well results were combined to evaluate shallow groundwater reference.
— Monitoring wells 01GS67 and 01GS69 (shallow depth) and 01GI68/69 and 01GI70 (intermediate depth) were resampled using low-flow purge methods to reduce turbidity suspected to have been a source for elevated metal concentrations in the initial groundwater reference sampling round.

For organic CPSSs, the twice reference criterion can be applied to eliminate chemicals from the risk assessment. However, it is assumed that organic chemicals are not present in reference samples. Deviations from this assumption are discussed in the Risk Characterization Section. Those chemicals with maximum concentrations less than two times reference are not considered further in this risk assessment unless deemed appropriate based on chemical-specific characteristics.

Comparison of Essential Elements to U.S. Recommended Daily Allowances

In accordance with RAGS Part A, essential elements that are potentially toxic only at extremely high concentrations may be eliminated from further consideration as COPCs in a risk assessment. Specifically, an essential nutrient may be screened out of a risk assessment if it is shown to be present at concentrations that are not associated with adverse health effects. Based on RAGS, the lack of risk-related data, and USEPA Region IV's recommendations, the following essential nutrients were eliminated from the human health risk assessment: calcium, iron, magnesium, potassium, and sodium.

Calculation of Risk and Hazard

Those CPSSs with chemical-specific exceedances of RBCs, FSCGs, MCLs, SMCLs, FDWS, and reference concentrations are considered COPCs. The final step in identifying COCs from the refined list of COPCs involves calculating chemical-specific cancer risks and HQs for COPCs, and evaluating frequency and consistency of detection and relative chemical toxicity.

A COC is defined by FDEP as any chemical having an incremental lifetime excess cancer risk (ILCR) greater than 1E-6 or a HI greater than 1.0. As previously discussed, the identification of COCs is a two-phase process. First, exposure pathways which exceed the criteria established by FDEP are identified. Those COPCs which individually exceed 1E-6 ILCR or a HQ greater

than 0.1 in a pathway of concern are retained as COCs. Section 10.1.4, Toxicity Assessment, provides a more detailed discussion of cancer risk thresholds and non-cancer toxicity.

10.1.2.5 COPCs in Groundwater

Tables 10-4, 10-5, and 10-6 list the maximum detected concentrations of CPSSs in shallow and intermediate depth groundwater with their corresponding chemical-specific concentrations/standards for groundwater and twice reference criteria for Sites 9, 29, and 34, respectively. In groundwater, CPSSs that exceed the lowest of the four groundwater criteria and reference concentrations are denoted with the symbol "*" next to the chemical name and are so identified as COPCs. CPSSs eliminated from further consideration in this risk assessment due to their maximum detected concentrations falling below the lower of the four groundwater criteria, and/or reference concentrations are denoted in the tables by the numerical symbols of "1," and "2", respectively. As previously discussed, sample results gathered during the Phase I and Phase II sampling rounds were combined and used in the risk/hazard evaluation of shallow and intermediate groundwater. Because of the targeted resampling effort (i.e., Phase II as discussed in Section 7.0), the number of organics analyzed differs from the number of inorganics.

As indicated in Table 10-4, arsenic, lead, and manganese were identified as COPCs in Site 9 groundwater. Sites' 29 and 34 screening evaluation, shown in Tables 10-5 and 10-6, respectively, identified cyanide, dieldrin, and manganese as COPCs for Site 29 and arsenic, cadmium, lead, manganese, and naphthalene for Site 34. These chemicals were further evaluated in this risk assessment.

Table 10-4
Chemicals Detected in Site 9 Groundwater
NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	Frequency of Detection	Range of Detected Concentrations (ug/l)	Average of Detected Concentrations (ug/l)	Screening Value (ug/l)	Source	Reference Concentration (ug/l)	Notes
Aluminum	10 / 12	221 - 2050	606	3800	RBC r	3882.8	1 2
* Arsenic	2 / 12	6.6 - 10.2	8.4	0.038	RBC r	2.8	
Barium	9 / 12	15.4 - 129	41	260	RBC r	13.2	1
Calcium	12 / 12	3600 - 36100	15618	NA		17560	
* Copper	4 / 12	4.6 - 5.9	5.5	140	RBC r	16.2	1 2
Iron	11 / 12	318 - 3940	1239	NA		1707.8	
* Lead	8 / 12	2 - 27	6	15	TT	1.6	
Magnesium	12 / 12	1340 - 5210	2574	NA		2512.5	
* Manganese	12 / 12	10.8 - 691	147	18	RBC r	22	
Potassium	12 / 12	601 - 2550	1555	NA		12167.6	2
Selenium	2 / 12	5.2 - 6.1	5.65	18	RBC r	NA	1
Sodium	12 / 12	2430 - 20000	8054	NA		18345	
Zinc	10 / 12	11 - 75.1	40.74	1100	RBC r	150.6	1 2

NOTES:

*	Retained as a chemical of potential concern based on comparison to the most conservative screening value
1	Does not exceed the screening value
2	Does not exceed reference concentration
CG and/or RBC	Residential screening value from FDEP or USEPA Region III Screening Concentration Table (March 1994
TT	Treatment technique action level for lead in tap water
r	Residential Risk Based Screening Value
CG	FDEP residential soil screening value; excerpted from July 1994 CG table

[Bold items in brackets denote changes to the first draft of documents.]

NA Indicates not available

- CG are based on noncarcinogenic or carcinogenic effects; screening values for aggregate residents were use for carcinogen based CG, and child exposure (more conservative) was used for noncarcinogen based C
- The screening value for endrin was used as a surrogate for endrin aldehyde based on structural similarity
- The screening value for endosulfan was used as a surrogate for endosulfan sulfate due to structural similarit
- The aluminum RBC was modified to reflect the recent change in the RfD (i.e., from 2.9 to 1.0 mg/kg-day)

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-5
Chemicals Detected in Site 29 Groundwater
NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	Frequency of Detection	Range of Detected Concentrations (ug/l)	Average of Detected Concentrations (ug/l)	Screening Value (ug/l)	Source	Reference Concentration (ug/l)	Notes
Aluminum	7 / 10	203 - 2060	704	3800	RBC r	3882.8	1 2
Barium	1 / 10	53.6 - 53.6	53.6	260	RBC r	13.2	1
Calcium	10 / 10	19900 - 36900	30200	NA		17560	
* Cyanide	1 / 10	276 - 276	276	73	RBC r	NA	
* Dieldrin	1 / 11	0.13 - 0.13	0.13	0.0042	RBC r	NA	
Iron	8 / 10	39.1 - 1400	521	NA		1707.8	2
Lead	4 / 10	4.1 - 9.2	6.4	15	TT	1.6	1
Magnesium	10 / 10	631 - 1840	1212	NA		2512.5	2
* Manganese	8 / 10	69.1 - 270	143	18	RBC r	22	
Potassium	10 /. 10	1250 - 15600	7467	NA		12167.6	
Silver	1 / 10	3.9 - 3.9	3.9	18	RBC r	NA	1
Sodium	10 / 10	2210 - 10000	5243	NA		18345	2
Vanadium	9 / 10	4.4 - 7.6	6.2	26	RBC r	9.6	1 2
Zinc	5 / 10	4.2 - 22.1	13.3	1100	RBC r	150.6	1 2

NOTES:

*	Retained as a chemical of potential concern based on comparison to the most conservative screening value
1	Does not exceed the screening value
2	Does not exceed reference concentration
CG and/or RBC	Residential screening value from FDEP or USEPA Region III Screening Concentration Table (March 1994)
TT	Treatment technique action level for lead in tap water
r	Residential Risk Based Screening Value

[Bold items in brackets denote changes to the first draft of documents.]

CG FDEP residential soil screening value; excerpted from July 1994 CG table

NA Indicates not available

- CG are based on noncarcinogenic or carcinogenic effects; screening values for aggregate residents were used for carcinogen based CG, and child exposure (more conservative) was used for noncarcinogen based CG
- The aluminum RBC was modified to reflect the recent change in the RfD (i.e., from 2.9 to 1.0 mg/kg-day)

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-6
Chemicals Detected in Site 34 Groundwater
NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	Frequency of Detection	Range of Detected Concentrations (ug/l)	Average of Detected Concentrations (ug/l)	Screening Value (ug/l)	Source	Reference Concentration (ug/l)	Notes
2-Methylnaphthalene	7 / 12	2 - 270	65	3800	RBC r	NA	1
4,4'-DDD	1 / 7	0.0021 - 0.0021	0.0021	0.28	RBC r	NA	1
4,4'-DDT	1 / 7	0.0009 - 0.0009	0.0009	0.2	RBC r	NA	1
Acenaphthene	1 / 12	1 - 1	1	220	RBC r	NA	1
Aluminum	3 / 7	63.2 - 482	207	3800	RBC r	3882.8	1 2
* Arsenic	2 / 7	3.1 - 4.3	3.7	0.038	RBC r	2.8	
Barium	2 / 7	26.3 - 37.5	31.9	260	RBC r	13.2	1
* Cadmium	1 / 7	4.4 - 4.4	4.4	1.8	RBC r	3.4	
Calcium	7 / 7	8550 - 78900	56050	NA		17560	
Chromium	1 / 7	7.8 - 7.8	7.8	18	RBC r	34	1 2
Cobalt	1 / 7	3.7 - 3.7	3.7	220	RBC r	4.1	1 2
Copper	1 / 7	53.2 - 53.2	53.2	140	RBC r	16.2	1
Cyanide	1 / 7	4 - 4	4	73	RBC r	NA	1
Heptachlor	1 / 7	0.0012 - 0.0012	0.0012	0.0023	RBC r	NA	1
Iron	7 / 7	295 - 5520	2581	NA		1707.8	
* Lead	1 / 7	75.6 - 75.6	75.6	15	TT	1.6	
Magnesium	7 / 7	1560 - 6440	3771	NA		2512.5	
* Manganese	5 / 7	42.3 - 475	195.9	18	RBC r	22	
* Naphthalene	5 / 12	1 - 320	136.4	150	RBC r	NA	
Nickel	1 / 7	11.8 - 11.8	11.8	73	RBC r	39.9	1 2
Potassium	7 / 7	1600 - 4470	2736	NA		12167.6	2
Sodium	7 / 7	2850 - 124000	37470	NA		18345	

[Bold items in brackets denote changes to the first draft of documents.]

Vanadium	2 / 7	0.56 - 1.8	1.18	26	RBC r	9.6	1	2
Zinc	1 / 7	55.9 - 55.9	55.9	1100	RBC r	150.6	1	2
delta-BHC	1 / 7	0.0019 - 0.0019	0.0019	0.011	RBC r	NA	1	

NOTES:

*	Retained as a chemical of potential concern based on comparison to the most conservative screening value
1	Does not exceed the screening value
2	Does not exceed reference concentration
CG and/or RBC	Residential screening value from FDEP or USEPA Region III Screening Concentration Table (March 1994)
TT	Treatment technique action level for lead in tap water
r	Residential Risk Based Screening Value
CG	FDEP residential soil screening value; excerpted from July 1994 CG table
NA	Indicates not available
-	CG are based on noncarcinogenic or carcinogenic effects; screening values for aggregate residents were used for carcinogen based CG, and child exposure (more conservative) was used for noncarcinogen based CG
-	The RBCr for alpha-BHC, the most conservative of the BHC isomers, was used as a surrogate RBCr for delta-BHC
-	The aluminum RBC was modified to reflect the recent change in the RfD (i.e., from 2.9 to 1.0 mg/kg-day)

[Bold items in brackets denote changes to the first draft of documents.]

10.1.3 Exposure Assessment

The purpose of this section of the BRA is to determine the magnitude of contact that a potential receptor may have with site-related COPCs. Exposure assessment involves four stages:

- Characterizing the physical setting and land use of the site
- Identifying COPC release and migration pathways
- Identifying the potential receptors, under various land use or site condition scenarios, and the pathways by which they might be exposed
- Quantifying of intakes, or contact rates, of COPCs.

10.1.3.1 Characterization of Exposure Setting

10.1.3.1.1 Physical Setting

NAS Pensacola is a 5,800-acre facility on the western edge of the Florida panhandle, on a peninsula bounded by Pensacola Bay to the east and Bayou Grande to the west. The Sites' history and physical settings were previously discussed in Sections 5.0 and 10.1.1.2. As discussed in Section 10.1.1.2, Sites 9, 29, and 34 are partially paved (40, 91, and 65 percent paved, respectively).

Climate

NAS Pensacola has a mild, subtropical climate, with average annual temperature ranging from 55°F in the winter to 81°F in the summer. Extremes in temperatures can range from less than 7°F in the winter to more than 102°F in the summer. November is the driest month of the year, with an average rainfall of 3.2 inches based on climatological data from 1962 to 1991. Annual

rainfall averages approximately 60 inches, with the highest amounts in July and August. During the spring and fall, rainfall is the lowest (an average of 4 inches per month).

Winds originate from the north during the winter and the south during the summer. Hurricanes and tornadoes can substantially damage the nearshore environment. According to recorded history, six hurricanes have passed within 50 miles of Pensacola.

Hydrogeology

Three main regional hydrogeologic units have been identified within the stratigraphy beneath the Florida Panhandle. In descending order the units are the Sand-and-Gravel Aquifer, the Intermediate System, and the Floridan Aquifer System. The surficial aquifer comprises unconsolidated clastic deposits approximately 300 feet thick at NAS Pensacola. It is referred to as the Sand-and-Gravel Aquifer and is used as a major source of drinking water in the region (SEGS 1986). Due to the Sand-and-Gravel Aquifer being the uppermost unit contiguous with land surface and receiving recharge through direct infiltration, it is susceptible to contamination from surface activities. The Sand-and-Gravel Aquifer is not used within Sites 9, 29, and 34 as a potable water source. Investigations at Sites 9, 29, and 34 have been limited to the upper portion (surficial zone) of the Sand-and-Gravel Aquifer.

The groundwater zones defined at Sites 9, 29, and 34 are the shallow and intermediate groundwater zones. These zones refer to two general depths at which monitoring wells have been completed. The two monitoring well depths are present within the Sand-and-Gravel Aquifer, with shallow and intermediate depth monitoring wells having been completed within the surficial zone. The shallow wells monitor conditions near the water table, whereas the intermediate wells monitor conditions at the base of the surficial zone immediately above the underlying clays and silts of the low-permeability zone.

Groundwater flow studies at the site have indicated that groundwater flows within the upper and lower surficial zones southeast and south, respectively, toward the Pensacola Bay. The flow direction is consistent with the site topography. Piezometric maps constructed from the low- and high-tide groundwater elevations measured on September 14, 1993, indicate the water table lies between 3 and 7 feet below the surface and ranges in elevation from 3.9 to 2.9 feet above mean sea level.

The vertical groundwater gradients measured between paired wells indicate an upward potential component of flow from the lower surficial zone to the upper surficial zone. The potential communication between the surficial zone and the underlying main producing zone is minimized due to this upward potential component of flow coupled with the presence of a low-permeability zone underlying the site between the two water-bearing zones.

Tidal effects on water levels are considered to be minimal, but appear most substantial on the intermediate depth monitoring wells, varying from 0.00 to 0.05 feet or more. The overall groundwater flow directions and gradients are minimally affected by the tidal fluctuations.

10.1.3.1.2 Potentially Exposed Populations

Access to NAS Pensacola is restricted. However, under current land use conditions at Sites 9, 29, and 34, access is not specifically restricted for each site other than general restrictions applicable to construction zones. The projected future use for these sites is a military operations school in which training classes and exercises will be conducted for military aircraft mechanics, firefighters, etc. These plans are currently being implemented by the Navy, which indicates the site conditions are currently changing.

As previously discussed, Sites 9, 29, and 34 are partially paved (40, 91, and 65 percent paved, respectively). As part of ongoing construction activities, **[extensive fill]** is being placed over each site, and each site will be paved after the military operations school construction is completed. Because five feet of soil will be on top of the current surface soils and the percent paved area for each site will increase, no populations were identified which would be exposed to site soils other than hypothetical site residents (i.e., no complete direct exposure pathways for soil). The future land use of these sites is currently being implemented, the classification of such is clearly non-residential use for military training. Hypothetical future site residents could be exposed to groundwater, assuming the residents choose to derive potable water from a well in the surficial aquifer rather than using more commonly used base/municipal water.

10.1.3.2 Identification of Exposure Pathways

The potential pathways of exposure to COPCs identified in shallow and intermediate groundwater are listed in Table 10-7. Details regarding the rationale for exposure pathway selection/rejection for both the soil and groundwater media are also provided in Table 10-5 and detailed in the following paragraphs.

10.1.3.2.1 Soil

The projected future use for these sites is a military operations school in which training classes and exercises will be conducted for military aircraft mechanics, firefighters, etc. These plans are currently being implemented by the Navy, which indicates the current site conditions are changing, and the latest soils data do not reflect current site conditions. As previously discussed, Sites 9, 29, and 34 are partially paved (40, 91, and 65 percent paved, respectively).

Table 10-7
Exposure Pathways Summary
NAS Pensacola Sites 9, 29, and 34
Pensacola, Florida

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Recreational Residents (Child and Adult)	Air, Inhalation of gaseous contaminants emanating from soil	No	Current Site land use is non-residential. Residential and/or recreational exposure would not be expected in the foreseeable future due to the construction activities currently underway and the projected non-residential use of the area following construction. The construction activities include five feet of clean soil being placed on top of surface soils.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Current Site land use is non-residential. Residential and/or recreational exposure would not be expected in the foreseeable future due to the construction activities currently underway and the projected non-residential use of the area following construction. The construction activities include five feet of clean soil being placed on top of surface soils.
	Groundwater, Ingestion of contaminants during potable or general use	No	Groundwater is not currently used as a source of potable or non-residential water at Sites 9, 29, and 34.
	Groundwater, Inhalation of volatilized groundwater contaminants	No	Groundwater is not currently used as a source of potable or non-residential water at Sites 9, 29, and 34.
	Soil, Incidental ingestion	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Soil, Dermal contact	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved. The construction activities include five feet of clean soil being placed on top of surface soils.

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-7
Exposure Pathways Summary
NAS Pensacola Sites 9, 29, and 34
Pensacola, Florida

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Infrequent Child Trespasser	Air, Inhalation of gaseous contaminants emanating from soil	No	Current Site land use is non-residential. Residential and/or recreational exposure would not be expected in the foreseeable future due to the construction activities currently underway and the projected non-residential use of the area following construction. The construction activities include five feet of clean soil being placed on top of surface soils.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Current Site land use is non-residential. Residential and/or recreational exposure would not be expected in the foreseeable future due to the construction activities currently underway and the projected non-residential use of the area following construction. The construction activities include five feet of clean soil being placed on top of surface soils.
	Soil, Incidental ingestion	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Soil, Dermal contact	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved. The construction activities include five feet of clean soil being placed on top of surface soils.

Table 10-7
Exposure Pathways Summary
NAS Pensacola Sites 9, 29, and 34
Pensacola, Florida

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Uses			
Future Site Residents (Child and Adult)	Air, Inhalation of gaseous contaminants emanating from soil	No	The gaseous air pathway is not considered due to the absence of significant volatile chemicals in soil. In addition, the sites are partially paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Air, Inhalation of chemicals entrained in fugitive dust	No	The sand grains, described as fine-medium grain quartz, are not respirable. In addition, the sites are partially paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Groundwater, Ingestion of contaminants during potable or general use	Yes	The combined shallow and intermediate depth water-bearing zones could hypothetically be used as a residential water source.
	Groundwater, Inhalation of volatilized contaminants during domestic use	No	Groundwater is neither currently used as a source of potable or non-residential water at Sites 9, 29, and 34, nor is this groundwater projected for such uses.
	Soil, Incidental ingestion	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved The construction activities include five feet of clean soil being placed on top of surface soils..
	Soil, Dermal contact	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited at all naval bases and air stations.

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-7
Exposure Pathways Summary
NAS Pensacola Sites 9, 29, and 34
Pensacola, Florida

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Fruits and vegetables, Ingestion of plant tissues grown in contaminated media	No	The potential for significant exposure via this pathway is low. The construction activities include five feet of clean soil being placed on top of surface soils.
Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	The gaseous air pathway is not considered due to the absence of volatile chemicals in soil. In addition, the sites are partially paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Air, Inhalation of chemicals entrained in dust resulting from construction activities such as digging	No	The sand grains, described as fine-medium grain quartz, are not respirable. In addition, the sites are partially paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Groundwater, Ingestion of contaminants during potable or general use	No	The combined shallow and intermediate depth water-bearing zones are not likely to be used as an occupational water source.
	Soil, Incidental ingestion	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved. The construction activities include five feet of clean soil being placed on top of surface soils.
	Soil, Dermal contact	No	No complete soil exposure pathway exists for current or future land use scenarios. The future land use of these sites is a military operations school, and the majority of the sites are paved. The construction activities include five feet of clean soil being placed on top of surface soils.

As part of ongoing construction activities, **[extensive fill]** soil is being placed over each site, and each site will be paved after completing the military operations school. Because five feet of soil will be on top of the current site soils and the percent paved area for each site will increase, no complete current or future land use exposure pathway exists for soils at Sites 9, 29, and 34 (i.e., no complete direct exposure pathway exists for soil). Hypothetical future site residents could potentially be exposed to site soils; however the soil interval is unknown and would likely be the five feet of clean fill soil. As agreed between USEPA Region IV and the Navy, no complete current or future soil exposure pathway exists at Sites 9, 29, and 34, and soil exposure was not addressed in the human health risk assessment.

10.1.3.2.2 Groundwater

Shallow and intermediate monitoring well data were combined to assess the potential future residential well scenario which could include both water-bearing zones. Some well locations were sampled again for specific parameters (i.e., Phase II sampling). These data were incorporated into the dataset used in this assessment. Although none of the aquifers studied currently serves as a source of potable water at Sites 9, 29, and 34, this approach is consistent with the NCP, which calls for protecting groundwater to allow for its maximum beneficial use. To facilitate this approach, the assumption was made that each water-bearing depth studied has the same potential viability as a potable water source and that an unfiltered well would be installed. Although there are no plans to initiate use of surficial aquifer groundwater onsite for potable or industrial purposes, the ingestion of groundwater was included in this human health assessment for hypothetical future site residents.

10.1.3.3 Exposure Point Concentrations

The exposure point concentration is the concentration of a contaminant in an exposure medium that will be contacted by a real or hypothetical receptor. Determining the exposure point concentration depends on factors such as:

- Availability of data
- Amount of data available to perform statistical analysis
- Reference concentrations not attributed to site impacts
- Location of the potential receptor

USEPA Region IV guidance calls for assuming lognormal distributions for environmental data and the calculation of 95 percent of the UCL mean for use in exposure quantification. Applying the UCL is generally inappropriate when the number of samples is less than 10. The maximum concentrations detected were used for all datasets having less than 10 samples. Because of the uncertainty associated with characterizing potentially non-homogeneous areas, the mean was reported for each COPC identified in Sites 9, 29, and 34 media. In general, outliers have been included in calculating of the UCL because high values seldom appear as outliers for a lognormal distribution. Including outliers increases the overall uncertainty of the calculated risks and increases the estimate of the risk in a conservative manner.

For sample sets of 10 and greater, the UCL was calculated for a lognormal distribution as follows:

$$UCL = e^{\left(\bar{a}+0.5s_a^2 + \frac{H_{0.95}\ x\ s_a}{\sqrt{n-1}}\right)}$$

where:

$\bar{a}$ = $\Sigma a/n$ = sample arithmetic mean of the log-transformed data, $a = \ln(x)$

s_a = sample standard deviation of the log-transformed data

n = number of samples in the data set

$H_{0.95}$ = value for computing the one-sided upper 95 percent confidence limit on a lognormal mean from standard statistical tables (Gilbert, 1987)

The calculated values for upper 95 percent confidence limit are presented in Tables 10-8, 10-9, and 10-10 for COPCs identified in shallow and intermediate groundwater at Sites 9, 29, and 34, respectively. The tables provide a statistical summary of COPCs identified within Sites 9, 29, and 34, which includes for each COPC the number of samples analyzed, mean and standard deviation of the natural log-transformed data, the H-statistic, the maximum of detected concentrations, and the reference (background) criterion (where applicable). For shallow and intermediate groundwater, the lowest of either the maximum of positive detections or the 95 percent UCL mean concentration of each COPC identified, referred to as the EPC, was used to compute risk/hazard.

Analytical results are presented as "non-detects" whenever chemical concentrations in samples do not exceed the detection or quantitation limits for the analytical procedures. Generally, the detection limit is the lowest concentration of a chemical that can be quantified above the normal, random noise of an analytical instrument or method. To apply the above-mentioned statistical procedures to a dataset with reported "non-detects," it was assumed that the chemical was present at the lesser of one-half the sample quantitation limit or one-half the lowest reported hit for the specific medium, as suggested by RAGS Part A. Using this algorithm is a reasonable compromise between use of zero and using the sample quantitation limit to reduce the bias (positive or negative) in the calculated UCL.

Table 10-8
Statistical Analysis of COPCs in Site 9 Groundwater
NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	n	Natural Log Transformed mean	SD	H stat	Default Values (ug/l)	UCL (ug/l)	Max Hit (ug/l)		Reference Concentration (ug/l)	EPC (ug/l)
Arsenic	12	0.817135	0.608553	2.599	1.75	4.9	10.2	UCL used	2.8	4.9
Lead	12	0.850612	1.050007	2.655	0.8	8.1	27	UCL used	1.6	8.1
Manganese	12	4.192652	1.300088	3.491	NA	605	691	UCL used	22	605

NOTES:

n Number of samples collected and analyzed
mean Mean of detected values including defaults for log transformed dataset
SD Standard deviation for a sample of a population of data
H stat "H" statistic, from Gilbert, 1987; cuboidal linear interpolation was used to determine this value in accordance with USEPA Guidance, Calculating the Concentration Term
NA Not Applicable
EPC exposure point concentration used for risk assessment
UCL 95% Upper Confidence Level Mean calculated using the H stat
- Max used and UCL used indicate the concentration used as EPC in the risk assessment
- The default value is one-half the lesser of either the lowest hit or the lowest quantitation limit; this value was substituted into all non-detects in accordance with RAGS

[Bold items in brackets denote changes to the first draft of d ıents.]

Table 10-9
Statistical Analysis of COPCs in Site 29 Groundwater
NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	n	Natural Log Transformed mean	SD	H stat	Default Values (ug/l)	UCL (ug/l)	Max Hit (ug/l)		Reference Concentration (ug/l)	EPC (ug/l)
Cyanide	10	-0.06179	1.996519	5.388	0.5	248	276	UCL used	NA	248
Dieldrin	11	-3.539	0.497089	2.177	0.025	0.05	0.13	UCL used	NA	0.05
Manganese	10	3.995407	1.829795	4.987	1.9	6070	270	Max used	22	270

NOTES:

- n — Number of samples collected and analyzed
- mean — Mean of detected values including defaults for log transformed dataset
- SD — Standard deviation for a sample of a population of data
- H stat — "H" statistic, from Gilbert, 1987; cuboidal linear interpolation was used to determine this value in accordance with USEPA Guidance, Calculating the Concentration Term
- NA — Not Applicable
- EPC — exposure point concentration used for risk assessment
- UCL — 95% Upper Confidence Level Mean calculated using the H stat
- Max used and UCL used indicate the concentration used as EPC in the risk assessment
- The default value is one-half the lesser of either the lowest hit or the lowest quantitation limit; this value was substituted into all non-detects in accordance with RAGS

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-10
Statistical Analysis of COPCs in Site 34 Groundwater
NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	n	Natural Log Transformed mean	SD	H stat	Default Values (ug/l)	UCL (ug/l)	Max Hit (ug/l)		Reference Concentration (ug/l)	EPC (ug/l)
Arsenic	7	NA	NA	NA	NA	NA	4.3	Max used	2.8	4.3
Cadmium	7	NA	NA	NA	NA	NA	4.4	Max used	0.0034	4.4
Lead	7	NA	NA	NA	NA	NA	75.6	Max used	1.6	75.6
Manganese	7	NA	NA	NA	NA	NA	475	Max used	22	475
Naphthalene	12	2.02	1.86	5.005	2.5	1038	320	Max used	NA	320

NOTES:

- n — Number of samples collected and analyzed
- mean — Mean of detected values including defaults for log transformed dataset
- SD — Standard deviation for a sample of a population of data
- H stat — "H" statistic, from Gilbert, 1987; cuboidal linear interpolation was used to determine this value in accordance with USEPA Guidance, Calculating the Concentration Term
- NA — Not Applicable; the sample set was less than 10 for the Site 39 groundwater COPCs
- EPC — exposure point concentration used for risk assessment
- UCL — 95% Upper Confidence Level Mean calculated using the H stat
- \- Max used and UCL used indicate the concentration used as EPC in the risk assessment
- \- The default value is one-half the lesser of either the lowest hit or the lowest quantitation limit; this value was substituted into all non-detects in accordance with RAGS

[Bold items in brackets denote changes to the first draft c cuments.]

10.1.3.4 Quantification of Exposure

This section describes the models, equations, and input parameter values used to quantify doses or intakes of the COPCs for the groundwater pathway as discussed in Section 10.1.3.2. The models are designed to estimate route- and medium-specific factors, which are multiplied by the EPC to estimate chronic daily dose. The intake model variables generally reflect 50th or 95th percentile values, which when applied to the EPC ensure that the estimated intakes represent the reasonable maximum exposure (RME). Formulae were derived from RAGS, Part A unless otherwise indicated. Table 10-11 lists input parameters used to compute chronic daily intake (CDI) for future site residents.

Table 10-11
Parameters Used to Estimate Potential Exposures for Future Land Use Receptors

Pathway Parameters	Resident Adult	Resident Child	Units
Groundwater Ingestion			
Ingestion Rate	2[a]	1[a]	liters/day
Exposure Frequency	350[b]	350[b]	days/year
Exposure Duration	24[c]	6[c]	years
Exposure Duration$_{LWA}$	24[c]	6[c]	years
Body Weight	70[a]	15[a]	kg
Averaging Time, Noncancer	8,760[d]	2,190[d]	days
Averaging Time, Cancer	25,550[e]	25,550[e]	days

Notes:

a = USEPA (1989a) "Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual (Part A)."
b = USEPA (1991b) "Risk Assessment Guidance for Superfund Vol. I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors, "Interim Final, OSWER Directive: 9285.6-03.EPA/600/8-89/043.
c = USEPA (1991a), Risk Assessment Guidance for Superfund: Vol. I — Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)," OSWER Directive 9285.7-01B.
d = Calculated as the product of ED (years) x 365 days/year.
e = Calculated as the product of 70 years (assumed lifetime) x 365 days per year.
NA = Not applicable.
CSV = Chemical-specific value

Age-adjusted ingestion factors were derived for the potential future residential receptors (resident adult and resident child combined) for carcinogenic endpoints. These factors consider the difference in daily ingestion rates for groundwater, body weights, and exposure durations for children (ages 1 to 6 years) and adults (ages 7 to 31 years). The exposure frequency is assumed to be identical for the two exposure groups.

Ingestion of COPCs in Groundwater

The following equation is used to estimate the ingestion of COPCs in groundwater:

$$CDI_w = (C_w)(IR)(EF)(ED)/(BW)(AT)$$

where:

CDI_w	=	ingested dose (mg/kg-day)
C_w	=	concentration of contaminant in groundwater (mg/L)
IR	=	ingestion rate (L/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)

Figure 10-1 provides the formulae for calculating the CDI for groundwater, which includes calculating the ingestion of groundwater by hypothetical residential receptors. Tables 10-12, 10-13, and 10-14 present groundwater ingestion CDI for the potential future site residents for the Site 9, 29, and 34 shallow and intermediate water-bearing zones, respectively.

Figure 10-1

Formulae for Calculating CDI for Groundwater

WATER INGESTION PATHWAY

Residential Scenario:

Non-Carcinogens - Child - Residential Scenario:

$$CDI_{NC\text{-}C} = \frac{C_w \times IR_{water/age1\text{-}6} \times EF_{res} \times ED_{age1\text{-}6}}{AT_{NC\text{-}C} \times BW_{age1\text{-}6}}$$

Non-Carcinogens - Adult - Residential Scenario:

$$CDI_{NC\text{-}A} = \frac{C_w \times IR_{water/age7\text{-}31} \times EF_{res} \times ED_{age7\text{-}31}}{AT_{NC\text{-}A} \times BW_{age7\text{-}31}}$$

Carcinogens (based on a lifetime weighted average):

$$CDI_C = \frac{C_w}{AT_C} \times \frac{IR_{water/age1\text{-}6} \times EF_{res} \times ED_{age1\text{-}6}}{BW_{age1\text{-}6}} + \frac{IR_{water/age7\text{-}31} \times EF_{res} \times ED_{age7\text{-}31}}{BW_{age7\text{-}31}}$$

Figure 10-1 is continued on the following page

Figure 10-1 (continued)

Formulae for Calculating CDI for Groundwater

Variable	Description
BW_{age1-6}	average body weight from ages 1-6 (kg)
$BW_{age7-31}$	average body weight from ages 7-31 (kg)
ED_{age1-6}	exposure duration during ages 1-6 (yr)
$ED_{age7-31}$	exposure duration during ages 7-31 (yr)
EF_{res}	residential exposure frequency (days/year)
$IR_{water/age1-6}$	water intake rate — age 1-6 (L/day)
$IR_{water/age7-31}$	water intake rate — age 7-31 (L/day)
AT_C	Averaging time (carcinogen)
AT_{NC-A}	Averaging time (non-carcinogen adult)
AT_{NC-C}	Averaging time (non-carcinogen child)
C_W	Chemical concentration in groundwater

Note:
CDI indicates Chronic Daily Intake

Table 10-12
Chronic Daily Intake for Site 9 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

		Potential Future Land Use Chronic Daily Intake		
Chemical	Exposure Point Concentration (mg/l)	Future Resident lwa C-CDI (mg/kg-day) (a)	Future Resident Adult H-CDI (mg/kg-day)	Future Resident Child H-CDI (mg/kg-day)
Arsenic	0.0049	7.29E-05	1.34E-04	3.13E-04
Lead	0.0081	1.20E-04	2.22E-04	5.18E-04
Manganese	0.605	9.00E-03	1.66E-02	3.87E-02

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

CDI Chronic Daily Intake

H-CDI hazard based CDI

C-CDI excess cancer risk based CDI

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-13
Chronic Daily Intake for Site 29 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

		Potential Future Land Use Chronic Daily Intake		
Chemical	Exposure Point Concentration (mg/l)	Future Resident lwa C-CDI (mg/kg-day) (a)	Future Resident Adult H-CDI (mg/kg-day)	Future Resident Child H-CDI (mg/kg-day)
Cyanide	0.248	3.69E-03	6.79E-03	1.59E-02
Dieldrin	4.63E-05	6.88E-07	1.27E-06	2.96E-06
Manganese	0.27	4.02E-03	7.40E-03	1.73E-02

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

CDI Chronic Daily Intake

H-CDI hazard based CDI

C-CDI excess cancer risk based CDI

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-14
Chronic Daily Intake for Site 34 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

		Potential Future Land Use Chronic Daily Intake		
Chemical	Exposure Point Concentration (mg/l)	Future Resident lwa C-CDI (mg/kg-day) (a)	Future Resident Adult H-CDI (mg/kg-day)	Future Resident Child H-CDI (mg/kg-day)
Arsenic	0.0043	6.40E-05	1.18E-04	2.75E-04
Cadmium	0.0044	6.54E-05	1.21E-04	2.81E-04
Lead	0.0756	1.12E-03	2.07E-03	4.83E-03
Manganese	0.475	7.06E-03	1.30E-02	3.04E-02
Naphthalene	0.32	4.76E-03	8.77E-03	2.05E-02

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

CDI Chronic Daily Intake

H-CDI hazard based CDI

C-CDI excess cancer risk based CDI

[Bold items in brackets denote changes to the first draft of documents.]

10.1.4 Toxicity Assessment

10.1.4.1 Carcinogenicity and Non-cancer Effects

The USEPA has established a classification system for rating the potential carcinogenicity of environmental contaminants based on the weight of scientific evidence. The cancer classes are described below. Cancer weight-of-evidence class "A" (human carcinogens) means that human toxicological data have shown a proven correlation between exposure and the onset of cancer (in varying forms). The "B1" classification indicates some human exposure studies have implicated the compound as a probable carcinogen. Weight-of-evidence class "B2" indicates a possible human carcinogen, a description based on positive laboratory animal data (for carcinogenicity) in the absence of human data. Weight-of-evidence class "C" identifies possible human carcinogens, and class "D" indicates a compound not classifiable with respect to its carcinogenic potential. The USEPA has established slope factors (SF) for carcinogenic compounds. The SF is defined as a "plausible upper-bound estimate of the probability of a response (cancer) per unit intake of a chemical over a lifetime."

In addition to potential carcinogenic effects, most substances also can produce other toxic responses at doses greater than experimentally derived threshold concentrations. The USEPA has derived Reference Dose (RfD) values for these substances. A chronic RfD is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure concentration for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime." These toxicological values are used in risk formulae to assess the upper-bound level of cancer risk and non-cancer hazard associated with exposure to a given concentration of contamination.

For carcinogens, the potential risk posed by a chemical is computed by multiplying the CDI (as mg/kg-day) by the SF (in reciprocal mg/kg-day). The hazard quotient (for non-carcinogens) is

computed by dividing the CDI by the RfD. The USEPA has set standard limits (or points of departure) for carcinogens and non-carcinogens to evaluate whether significant risk is posed by a chemical (or combination of chemicals). For carcinogens, the point-of-departure range is 10^{-6}, with a generally accepted range of 10^{-4} to 10^{-6}. These risk values correlate with 1 in 10,000 and 1 in 1,000,000 excess incidence of cancer resulting from exposure to xenobiotics (all pathways). The FDEP risk and hazard thresholds are 1E-6 and 1, respectively.

For non-carcinogens, other toxic effects are generally considered possible if the HQ (or sum of HQs for a pathway — hazard index) exceeds unity (a value of 1). Although both cancer risk and non-cancer hazard are generally additive (within each group) only if the target organ is common to multiple chemicals, a most conservative estimate of each may be obtained by summing the individual risks or hazards regardless of target organ. This BRA has taken the universal summation approach for each class of toxicant. Additional details regarding the risk formulae applied to Sites 9, 29, and 34 media are provided in Section 10.1.5.

Critical studies used in establishing toxicity classifications by USEPA are shown in the Integrated Risk Information System (IRIS) database (primary source) and/or Health Effects Assessment Summary Tables (HEAST) Fiscal Year 1994 (secondary source). In addition, the USEPA Region III, Risk-based Concentration Tables, Third Quarter 1994, contained toxicological values not listed in primary or secondary sources. Where applicable, these values were also included in the database for this BRA. Table 10-15 summarizes toxicological data in the form of RfDs and SFs obtained for each COPC identified in Sites 9, 29, and 34 shallow and intermediate groundwater.

Table 10-15
Toxicological Database Information for NAS Pensacola, Sites 9, 29, and 34
Pensacola, Florida

Chemical	Oral Reference Dose (mg/kg/day)	Oral Cancer Slope Factor [(mg/kg/day)]-1	Cancer Classification	Uncertainty Factor/Modifying Factor Oral
Arsenic	0.0003 [a]	1.75 [a]	A	1000 / 3
Cadmium	0.0005 [a]	NA	D	10 / 1
Cyanide	0.02 [a]	NA	D	100 / 5
Dieldrin	0.00005 [a]	16	B2	100 / 1
Lead	NA	NA	B2	NA
Manganese	0.005 [a]	NA	NA	1 /1
Naphthalene	0.04 [d]	NA	D	see note ([d])

Notes:
ARARs for the COPCs above are discussed in Section 10.1.6.

a	=	Integrated Risk Information System (IRIS)
b	=	Oral reference dose provided in a meeting with Julie Keller, USEPA Region IV Office of Health Assessment
c	=	Environmental Criteria and Assessment Office (ECAO)
d	=	This reference dose has been withdrawn from IRIS/HEAST; the uncertainty and modifying factors are unknown
NA	=	Not applicable
mg/kg/day	=	milligrams per kilogram per day
Cancer Class A	=	Classified as a known, human carcinogen by USEPA
Cancer Class B2-C	=	Classified as a probable to possible human carcinogen by USEPA

Drinking standards in the form of federal and State of Florida MCLs and guidance concentrations have been established for a number of chemicals detected in groundwater in the study area. These chemicals include hazardous substances identified as toxicants (carcinogens and/or non-carcinogens) in published research studies. These standards are considered ARARs

for groundwater potentially used as potable water source. The available drinking water standards for compounds detected in groundwater are included in the groundwater risk characterization and risk uncertainty discussions for reference.

10.1.4.2 Toxicity Profiles for COPCs

In accordance with RAGS, brief toxicological profiles were included for all COPCs. Most information for the brief profiles below was gleaned from IRIS as a primary source, and HEAST, as mentioned in the preceding text and toxicological database information table. Another main source of information was Smith, R.L., USEPA Region III *Risk-Based Screening Concentrations Table*, March 1994. Any additional references are noted specifically in the profiles below (in parentheses). The profiles summarize adverse effects of COPCs and the amount of the COPC associated with adverse effects.

Arsenic exposure via the ingestion route causes darkening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects. USEPA set 0.3 μg/kg-day in a human exposure study. Arsenic's effect on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingesting is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.75 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.038 μg/L (Klaassen, et al., 1986).

Cadmium can upset the stomach, leading to vomiting and diarrhea in acute exposure; acute inhalation of cadmium containing dust can irritate the lungs. Chronic exposure to cadmium, either via inhalation or ingestion, has been shown to cause kidney damage (including kidney

stones), emphysema, and high blood pressure. Other tissues reportedly injured by cadmium exposure in animals and humans include the lungs, testes, liver, immune system, blood, and the nervous system. An oral RfD of 0.001 (mg/kg-day) has been determined by USEPA, based on human studies (food) involving chronic exposure in which significant increased protein was found in the urine. A separate oral RfD for water has been determined by USEPA to be 0.0005 mg/kg-day. For inhalation exposure, cadmium has been classified by USEPA as a group B1, or probable human carcinogen, based on limited evidence from epidemiological studies in which an excess risk of lung cancer was observed in cadmium smelter workers. There is sufficient evidence of increased risk of lung cancer in rats and mice exposed to cadmium via inhalation. Seven studies in which cadmium was administered orally to rats and mice have shown no evidence of carcinogenic response following exposure via this route. (Klaassen, et al, 1986).

Manganese is an essential nutrient. Chronic exposure to manganese, 0.8 mg/kg-day, causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children. Because of the different uptake rates in water and food, USEPA set two oral RfDs- one for water and one for food. These RfDs are 0.005 and 0.14 mg/kg-day, respectively. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia, and an inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese can not be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. The typical vitamin supplement dose of manganese is 2.5 mg/day (Klaassen, et al, 1986) (Dreisbach, et al, 1987).

Dieldrin is a polycyclic chlorinated pesticide. Short-term exposure to high doses of dieldrin causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular

disturbances. Exposed individuals revert to normal approximately one week after the dieldrin source is removed. Dieldrin is classified as a B2 carcinogen by USEPA; the SFo, SFi, and RfDo were set to 16 $(mg/kg\text{-}day)^{-1}$, 16.1 $(mg/kg\text{-}day)^{-1}$, and 0.00005 mg/kg-day, respectively (Dreisbach, et al, 1987).

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level for soil has been proposed by USEPA Region IV, 400 mg/kg. An RfD and SF has not been set because of the confounding nature of lead toxicity. Lead accumulates in fat tissue, affects the brain, blood, and mental development of children. RfD's are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate- sometimes the lead is attached to binding sites, and sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight, and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen, et al, 1986).

Cyanide, a non-metal, is a combination of carbon and nitrogen resulting from many industrial processes as a byproduct, a necessary component, or both. It is also a naturally occurring compound, found in apple seeds, lima beans, and other natural sources. For example, the American white lima bean contains approximately 10 mg cyanide per 100 g of bean (approximately three and one-half ounces, slightly less than a typical serving (3.75 oz.) of beans) (Kirchner, 1991). Some lima beans contain as much as 300 mg cyanide per 100 g of bean (Dreisbach, et al, 1987). This compound prevents oxygen binding in red blood cells, whose physiological function is to transport oxygen to other cells in the body. Sufficient exposure to cyanide can lead to cytotoxic anoxia, or cellular toxicity due to the interference with cells'

ability to transport (or use) oxygen. The clinical signs of this effect are gasping for breath, blueish lips and skin, and other signs similar to drowning or choking. In addition, the heart is affected, resulting in low blood pressure. Decreased body weight, effects on the thyroid, and effects on myelin (i.e., tissue that shields some of the body's nerve cells) have been observed in chronic animal exposure studies. Based on this animal study, USEPA determined the oral RfD to be 0.02 mg/kg-day for cyanide ingestion, and the federal MCL is 0.2 mg/l. In RAGS, the default gastrointestinal absorption efficiency is five percent for ingested compounds. Five percent of 10 mg is 0.5 mg, which is the amount absorbed from lima bean ingestion. For the average adult (70 kg) this would result in approximately one-half the USEPA RfD. Two servings of lima beans would exceed the RfD for the average adult; a smaller serving would exceed the RfD for an child. Inhalation would be an exposure pathway of concern (if the scenario exists), but USEPA has not established an inhalation RfD for this compound. Chronic inhalation exposure to cyanide can lead to weakness, dizziness, and possibly neurological effects (targeting the white matter of the brain) (Klaassen, et al, 1986).

Naphthalene, obtained from coal tar, is used as a moth repellant and a synthetic intermediate. This compound causes hemolysis which can lead to blocked renal tubules. Hemolysis occurs primarily in individuals who are have genetically deficiency levels of glucose-6-phosphate dehydrogenase in red blood cells (i.e., primarily black males). USEPA determined that the RfD is 0.04 mg/kg-day; however, this value was withdrawn from IRIS and HEAST (Dreisbach, et al, 1987).

10.1.5 Risk Characterization

Risk characterization combining the results of the exposure assessment and toxicity assessment to yield qualitative and quantitative expressions of risk for the exposed receptors. The quantitative component expresses the probability of developing cancer, or a non-probabalistic

comparison of estimated dose with a reference dose for non-cancer effects. These quantitative estimates are developed for individual chemicals, exposure pathways, transfer media, and source media, and for each receptor for all media to which one may be exposed. The qualitative component usually involves comparing COC concentrations in media with established criteria or standards for chemicals for which there are no suitable toxicity values. The risk characterization is used to guide risk management decisions.

Generally, the risk characterization follows the methodology prescribed by RAGS Part A, as modified by more recent information and supplemental guidance cited in the earlier sections of this document. The USEPA methods are, appropriately, designed to be health-protective, and tend to overestimate, rather than underestimate, risk. The risk results, however, are generally overly conservative, because risk characterization involves multiplying the conservatisms built into the exposure and toxicity assessments.

This section characterizes the potential health risks associated with the intake of chemicals originating from Sites 9, 29, and 34. The methods used to estimate the types and magnitudes of health effects associated with exposure to chemicals.

10.1.5.1 Risk Characterization Methodology

Potential risks to humans following exposure to COPCs are estimated using methods established by USEPA when available. These methods are health-protective and are likely to overestimate, rather than underestimate, risk. Risks from hazardous chemicals are calculated for either carcinogenic or non-carcinogenic effects. Some carcinogenic chemicals may also pose a non-carcinogenic hazard. The potential human health effects associated with chemicals that produce systemic toxic and carcinogenic influences are characterized for both types of health effects.

10.1.5.2 Carcinogenic Effects of Chemicals

The risk attributed to exposure to carcinogens is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. In the low-dose range, which would be expected for most environmental exposures, cancer risk is estimated from the following linear equation (USEPA, 1989a):

$$ILCR = (CDI)(SF)$$

where:

ILCR	=	incremental lifetime cancer risk, a unitless expression of the probability of developing cancer, adjusted for reference incidence
CDI	=	chronic daily intake, averaged over 70 years (mg/kg-day)
SF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$

For a given pathway with simultaneous exposure of a receptor to several carcinogens, the following equation is used to sum cancer risks:

$$Risk_p = ILCR(chem_1) + ILCR(chem_2) + \ldots ILCR(chem_i)$$

where:

$Risk_p$	=	total pathway risk of cancer incidence
$ILCR(chem_i)$	=	individual chemical cancer risk

Cancer risk for a given receptor across pathways and across media is summed in the same manner.

10.1.5.3 Non-carcinogenic Effects of Chemicals

The risks associated with the non-carcinogenic effects of chemicals are evaluated by comparing an exposure level or intake with a reference dose. The HQ, defined as the ratio of intake to RfD is defined as (RAGS, Part A):

$$HQ = CDI/RfD$$

where:

HQ	=	hazard quotient (unitless)
CDI	=	intake of chemical (mg/kg-day)
RfD	=	reference dose (mg/kg-day)

Chemical non-carcinogenic effects are evaluated on a chronic basis, using chronic RFD values. An HQ of unity or 1 indicates that the estimated intake equals the RfD. If the HQ is greater than unity, there may be a concern for potential adverse health effects.

In the case of simultaneous exposure of a receptor to several chemicals, a HI will be calculated as the sum of the HQs by:

$$HI = HQ_1 + HQ_2 + \ldots HQ_i$$

where:

HI	=	Hazard Index (unitless)
HQ	=	Hazard Quotient (unitless)

10.1.5.4 Shallow and Intermediate Groundwater Pathways

Exposure to groundwater onsite was evaluated exclusively under a future site resident scenario. Ingestion through potable use of contaminant exposure pathways was evaluated. For non-carcinogenic contaminants evaluated relative to future site residents, hazard was computed separately to address child and adult exposure. The shallow and intermediate water-bearing zones monitored during the RI were combined for assessment. Tables 10-16, 10-17, and 10-18 present the computed carcinogenic risks and/or HQs associated with the potable use of shallow and intermediate groundwater for drinking water for Sites 9, 29, and 34, respectively.

Hypothetical Future Site Resident Pathways

Site 9

The computed hazard indices for ingesting of shallow and intermediate groundwater used as a potable source for the future child and adult resident were 9 and 4, respectively. The primary contributors were arsenic and manganese. In addition, arsenic was the only contributor to ILCR, which was 1E-4. COCs identified were arsenic and manganese. Lead was detected at a concentration in excess of the treatment technique action level; however, the average lead concentration (hits only) did not exceed the treatment technique action level, nor did the UCL. Therefore, lead was not considered to be a COC.

Site 29

The hazard indices calculated for Site 29 child and adult residents were 4 and 2, respectively. The primary contributor to hazard was manganese. However, cyanide contributed more than 0.1 to the hazard index. Due solely to dieldrin, ILCR was calculated to be 1E-5 for this site. COCs identified were cyanide, dieldrin, and manganese.

Table 10-16
Hazard Quotients and Incremental Lifetime Cancer Risks
Site 9 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florid

Chemical	Reference Dose Used (mg/kg-day)	Slope Factor Used (mg/kg-day)-1	Resident ILCR lwa (a)	Resident Adult Hazard Quotient	Resident Child Hazard Quotient
Arsenic	0.0003	1.75	1.3E-04	0.4	1.0
Lead	ND	ND	ND	ND	ND
Manganese	0.005	ND	ND	3.3	7.7
Total Risks/Hazard Indices			1E-04	4	9

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

ND Not determined due to lack of available information

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-17
Hazard Quotients and Incremental Lifetime Cancer Risks
Site 29 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Flori

Chemical	Reference Dose Used (mg/kg-day)	Slope Factor Used (mg/kg-day)-1	Resident ILCR lwa (a)	Resident Adult Hazard Quotient	Resident Child Hazard Quotient
Cyanide	0.02	ND	ND	0.3	0.8
Dieldrin	5E-05	16	1.1E-05	0.03	0.06
Manganese	0.005	ND	ND	1.5	3.5
Total Risks/Hazard Indices			1E-05	2	4

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

ND Not determined due to lack of available information

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-18
Hazard Quotients and Incremental Lifetime Cancer Risks
Site 34 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

Chemical	Reference Dose Used (mg/kg-day)	Slope Factor Used (mg/kg-day)-1	Resident ILCR lwa (a)	Resident Adult Hazard Quotient	Resident Child Hazard Quotient
Arsenic	0.0003	1.75	1.1E-04	0.39	0.92
Cadmium	0.0005	ND	ND	0.24	0.56
Lead	ND	ND	ND	ND	ND
Manganese	0.005	ND	ND	2.6	6.1
Naphthalene *	0.04	ND	ND	0.2	0.5
Total Risks/Hazard Indices			1E-04	3	8

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

ND Not determined due to lack of available information

* the reference dose used for naphthalene has been withdrawn from IRIS/HEAST

[Bold items in brackets denote changes to the first draft of documents.]

Site 34

Hazard indices for child and adult residents at Site 34 were 8 and 3, respectively. The primary contributor to the hazard index was manganese. Arsenic, cadmium, and naphthalene also contributed more than 0.1 to the hazard index, and the 1E-4 ILCR is attributable solely to arsenic. COCs identified were arsenic, cadmium, manganese, and naphthalene. Lead was detected in excess of the treatment technique action level at this site; however, only one lead concentration was reported in all samples analyzed.

10.1.6 Risk Uncertainty

This section presents and discusses the uncertainty inherent in the risk assessment process in addition to medium- and exposure pathway-specific influences. Risk assessment sections are discussed separately below, and specific examples of uncertainty sources are included where appropriate. Alternative risk projections are also included which provide estimates of the range of risk. These alternative risk results are based on Central Tendency (CT) exposure (average or 50th percentile) rather than RME as presented in the Risk Characterization Section for comparison. CT exposure assessment was performed for the ingestion of shallow/intermediate groundwater exposure pathway.

General

Uncertainty is a factor in each step of the exposure and toxicity assessments presented in the preceding sections. Overall, uncertainties associated with the initial stages of the risk assessment process become magnified when they are combined with other uncertainties. For example, the use of the 95th percentile UCL as the EPC is a method of reducing uncertainty with respect to falsely concluding that insignificant risk is posed. However, a "safety factor" based on the standard deviation and number of samples is included in the UCL. During the risk characterization process, individual chemical risk is added to determine the incremental excess

cancer risk for each exposure pathway. If the individual risk projections were calculated based on the UCL, the "safety factor" of the incremental risk is the sum of all the individual "safety factors." Inclusion of outliers in the UCL calculation increases the overall uncertainty of the calculated risks and increases the estimate of the risk in a conservative manner. This multiplicative influence on conservatism is inherent in the risk assessment process, and is also evident in the uncertainty factor and modifying factor applied to RfDs. It is not possible to eliminate all uncertainties; however, recognizing the uncertainties is fundamental to understanding and subsequently using risk assessment results.

This section presents the uncertainty of site-specific and medium/pathway-specific factors introduced as part of the risk assessment process, in addition to other factors influencing the uncertainty of the calculated incremental excess cancer risks and hazard quotients/indices. It is important to note that the exposure pathways considered for selection in the Exposure Assessment Section of this BRA are extremely conservative.

Assumptions are made as part of the risk assessment process based on population studies and USEPA guidance. This guidance divides the assumptions into two basic categories: the upper bound (90 to 95th percentile) and the mean or 50th percentile (CT) exposure assumptions. As discussed in the Exposure Assessment Section, the RME exposure is based on the upper-bound assumptions, and the CT exposure is based on mean assumptions. Therefore, risk/hazard calculated using RME exposure assumptions are generally overestimates rather than underestimates. The following paragraphs discuss sources of uncertainty pertinent to each exposure pathway evaluated.

Quality of Data

Groundwater

Tidal and seasonal differences could add uncertainty to the results of the human health risk assessment. Temporal differences (i.e., differences in the groundwater conditions between February and December) resulted in different groundwater results, and the tide's influence on groundwater could also lead to different concentrations or contaminants being detected during one season or tide cycle as compared to another. The second sampling phase was focused as specific analyte groups (i.e., VOC, SVOC, etc.) were targeted to further assess contamination identified in the first sampling phase. For example, Site 34 groundwater was analyzed for CLP volatiles and semi-volatiles in a select group of monitoring wells, as discussed previously in Sections 5 and 10.1.2.1 of this RI. The result of this uncertainty would be to either increase or decrease the reported results, which would similarly affect the projected risk and hazard presented in Section 10.1.5.

Soil

Although the soil exposure pathway was not evaluated in this BRA, some discussion of the uncertainties associated with this medium is necessary. The future land use is known and is now being implemented. As discussed in Section 10.1.2.1, Sites 9, 29, and 34 are approximately 40, 90, and 65 percent paved, respectively. The percent paved area of each site is expected to increase after the construction is completed. In addition, **[extensive fill]** soil is being placed on each site as part of construction activities, so current surface soils will become vadose soils. Therefore, no complete exposure pathway for current or future land use populations will exist. However, a hypothetical future site resident could be exposed to soil if residential land use were approved for the sites in the distant future. The surface soil interval included in a hypothetical resident scenario would consist solely of fill material.

As part of the RI for Sites 9, 29, and 34, the synthetic precipitation leaching procedure (SPLP) was performed on site soils to measure the potential for contaminants in site soils to leach into groundwater. This information was presented and detailed in Section 9, a conclusion of which was that the dilution/attenuation factor (DAF) recommended in Soil Screening Guidance, USEPA/OSWER, EPA/540/R-94/101 is not appropriate for site conditions. The recommended DAF of 10 theoretically accounts for shallow groundwater immediately underneath a source material. However, significant leachable contaminant fractions (primarily inorganic parameters) did not manifest themselves in shallow groundwater immediately downgradient of possible source areas. These observations indicate that the site-specific DAF is substantially higher than 10. Horizontal dispersion, sorption phenomena, and chemical diffusion, all of which would play major roles in diluting/attenuating the concentrations as the contaminants migrate, likely accounts for the disparity between predicted and observed groundwater conditions.

Identification of COPCs

Prior to addressing risk/hazard for all chemicals detected, screening values were used to focus the BRA on COPCs which individually exceed 1E-6 risk, a hazard quotient of 0.1 (or a hazard quotient of 1), or an ARAR. This information was obtained from telephone conversations with David Clowes (FDEP), Julie Keller (USEPA Region IV Risk Assessment Reviewer), Allison Humphries (the USEPA Region IV RPM for NAS Pensacola), the Navy, and previous USEPA Region IV comments on Federal Facility BRAs which were signed by Elmer Akin, USEPA Region IV.

Exposure Pathways and Contaminants

CPSSs were initially eliminated from the BRA based on the criteria agreed on by USEPA, FDEP, and the Navy. The risk/hazard thresholds of 1E-6 and 0.1 were selected to account for potential cumulative effects of various chemicals, and the maximum concentration detected was

compared to the corresponding screening value. As discussed previously in this BRA, the comparison was made using the most conservative screening value provided by USEPA and FDEP for each exposure medium. Although some uncertainty exists regarding potential cumulative effects, the fact that maximum concentrations detected were used in the screening comparison in concert with low range risk/hazard thresholds alleviates much uncertainty. A large number (i.e., greater than 10) of constituents would have to be present at near-RBC concentrations to elicit a concern for cumulative effects.

Comparison to Reference Concentrations (Background)

Because the intent of the BRA is to estimate the excess cancer risk or health hazard posed by COPCs, a comparison to reference concentrations was performed subsequent to comparison to screening values. The maximum concentration detected for each chemical that exceeded its corresponding screening value was compared to two-times the mean reference concentration, if a reference concentration was available. Because low frequency of detection could indicate a contaminant should not be addressed in the BRA, all detected chemicals that failed the screening comparisons were evaluated with respect to frequency of detection and consistency of detection in two or more sampled environmental media. This approach was selected as a conservative screening approach.

Additional uncertainty is introduced by a comparison of site data to non-specific screening reference data. This uncertainty stems from using reference concentrations obtained from a limited number of samples and locations. The limited number of samples and sample locations increases the uncertainty as natural variability in media composition may not be fully characterized. Although the reference concentrations are specific to NAS Pensacola, they are not site-specific.

Elimination of Essential Nutrients

According to RAGS Part A, before eliminating essential nutrients from the risk assessment, they must be shown to be at concentrations that are not associated with adverse health effects. USRDAs for adults and children age 4 or more were compared to those essential nutrients detected in groundwater. USEPA recommends excluding many essential nutrients from the BRA, regardless of the concentrations detected. In large doses (i.e., larger than the USRDA), toxic effects due to essential nutrient overdose are possible.

Characterization of Exposure Setting and Identification of Exposure Pathways

Uncertainty in the exposure setting and pathways exists due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. As previously discussed, no potable (or non-residential water) wells exist at Sites 9, 29, and 34, and none are projected for installation.

Determination of Exposure Point Concentrations

Based on the guidance provided by USEPA, EPCs are those concentrations used to estimate CDI. The uncertainty associated with EPC primarily stems from their statistical determination or imposition of maximum concentrations, described below.

Statistical Estimation of Exposure Point Concentrations

The available Supplemental Guidance to RAGS outlines a statistical estimation of EPC. These calculated concentrations are 95 percent UCL which are based on certain assumptions. USEPA assumes that most (if not all) environmental data are lognormally distributed. Uncertainty exists in this assumption because many environmental data are neither normally nor lognormally distributed.

The UCL calculation is provided in the *Supplemental Guidance to RAGS: Calculating the Concentration Term*, May 1992. This calculation includes a statistical value, the H-statistic, is based on the number of samples analyzed for each COPC and the standard deviation of the results. To obtain this number, a table must be referenced, and the value must be interpolated (an estimation) from the table. The equation for the H-statistic has not been provided in the supplemental guidance, nor does the document referred to in the guidance provide the equation. Although the statistic appears to be non-linear, a linearity assumption was made to facilitate interpolation of the statistic for each COPC addressed in the BRA.

Linear interpolation is a good estimate of H; however, it is important to note that the formula and H are natural log values, and H is applied as a multiplier. The effect of multiplying natural log numbers is not equivalent to multiplying untransformed values. While data are log transformed, adding two numbers is the equivalent of multiplying the two numbers if they were not transformed. The effect of multiplying a number while in log form is exponential, and H is applied as a multiplier. In summary, using this method to calculate the UCL includes much uncertainty (an overestimation of risk/hazard), and often provides concentrations greater than the maximum detected onsite. For all datasets having less than ten total samples, the maximum concentrations detected were used as EPC. The datasets in this risk assessment are small; however, most consisted of ten or more samples, and the UCL was calculated for those groups. Some uncertainty exists due to the somewhat limited number of samples and monitoring wells used to delineate the sites.

Although RAGS advocates using neither worst-case scenarios nor maximum concentrations as EPCs, the use of the H-statistic often necessitates using the reported maximum concentration as EPC. In accordance with RAGS, the lesser of either the maximum concentration or the UCL is used as the EPC. Summation of risk based on maximum concentrations leads to

overestimating risk/hazard, especially in the case of low detection frequency or spatially segregated COPCs. This concept is further discussed below.

Frequency of Detection and Spatial Distribution

Because of the influence of standard deviation on EPC, low frequency of detection can cause COPCs to be inappropriately addressed in the risk assessment. More specifically, COPCs detected only once or twice in all samples analyzed (having concentrations exceeding the RBCs and reference concentrations) would be expected to have relatively higher standard deviation as concentration variability or range widens. Higher standard deviation results in a high H-statistic, and this typically leads to a UCL greater than the maximum concentration detected onsite. If that is the case, then using the UCL or maximum concentration detected as EPC (or possibly the inclusion of the COPC in question) may not be appropriate when EPC is assumed to be ubiquitous. The likelihood that a receptor is simultaneously exposed to maximum concentrations at several locations is infinitesimally small.

Of the COCs identified in risk characterization, many were detected in only one sample. In addition, some were detected during Phase I sampling, and were not detected in corresponding Phase II sampling. This indicates that the presence of the COCs is questionable. At Site 29, cyanide and dieldrin were detected in only one sample. In addition, dieldrin was not detected in a corresponding confirmatory Phase II sample. Cadmium and lead were detected in only one sample at Site 34. The use of the maximum concentrations (or the UCL) is questionable for these contaminants, and the calculated risk and hazard could be skewed upwards or downwards due to the low frequency of detection.

Toxicity Assessment Information

There is a generally recognized uncertainty in human risk values developed from experimental data primarily due to the uncertainty of data extrapolation in the areas of: (1) high- to low-dose exposure and (2) animal data to human experience. The site-specific uncertainty is mainly in the degree of accuracy of the exposure assumptions. Most of the assumptions used in this and any risk assessment have not been verified. For example, the degree of chemical absorption from the gut or through the skin or the amount of soil contact is not known with certainty.

The uncertainty of toxicological values from the IRIS and HEAST databases (provided by USEPA) were summarized (where available) in Table 10-15 (previously presented). The uncertainty factors assigned to these values account for acute to chronic dose extrapolation, study inadequacies, and sensitive subpopulations among other factors. Although uncertainty factors for a specific compound may be 1,000 or higher, these safety factors are applied by USEPA to assist in guaranteeing the overall assessment of risk/hazard is conservative toward human health concerns. In the presence of such uncertainty, the USEPA and the risk assessor are obligated to make conservative assumptions so the chance is very small for the actual health risk to be greater than what is determined through the risk assessment process. On the other hand, the process is not to yield overly conservative risk values that have no basis in actual conditions. This balance was kept in mind in developing exposure assumptions and pathways and in interpreting data and guidance for this BRA.

Evaluation of Chemicals for Which No Toxicity Values Are Available

In addition to the typical uncertainties inherent in toxicity values, parameters which do not have corresponding RBCs due to the lack of approved toxicological values were included in the CDI calculation data. This information was provided to facilitate risk/hazard projections should toxicological values become available in the future. The maximum concentration reported for

lead in Site 9 and 34 groundwater exceeded the MCL/FPDWS of 0.015 mg/l. However, the average of the reported hits for Site 9 does not exceed this ARAR, and lead was detected in only one sample in Site 34 groundwater.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment. Exposure pathway-specific sources of uncertainty are discussed below.

Groundwater

The primary source of uncertainty in the groundwater exposure pathway is the potable use assumption. The combined shallow/intermediate water-bearing zone (WBZ) is not currently used onsite as an industrial or potable water source, nor is it anticipated to be in the future. If the future use scenario were to exist, and a future site resident did segregate the shallow from the intermediate, a change in the estimated risk could be expected. However, there is no identifiable aquitard between shallow and intermediate zones, and a residential well would require higher yield than a monitoring well. Thus, it is likely that any residential well would be screened across the two WBZs to maximize the volume of groundwater that could be extracted without excessive drawdown, and that well (like most residential wells) would be filtered. It is important to emphasize the fact that the future use scenario is not expected based on Navy plans for the base and Sites 9, 29, and 34. This exposure pathway was addressed as an extremely conservative risk estimate for future land use under the residential exposure scenario.

Because it would be implausible to expect an individual to be chronically exposed to the maximum concentration of each groundwater chemical, an approach for limiting RME uncertainties was taken for groundwater. Substituting the 95 percent UCL mean concentration

(where possible) for each chemical provides a reasonably conservative estimate of the chronic concentrations to which an individual may be exposed via the groundwater pathway.

In addition to the essential nutrients reported in groundwater, arsenic would be expected to be present (as it is in seafood). Arsenic did not exceed its federal MCL or FPDWS at the maximum concentration detected. At the maximum concentration detected, arsenic poses 1E-4 excess cancer risk — less risk than would be posed if arsenic was present at concentrations equal to the corresponding MCL/FPDWS.

Dieldrin was detected in only one sample and was not detected in the corresponding Phase II confirmatory sample. This compound accounted for 100 percent of the risk calculated for Site 29, which is, therefore, questionable. In addition, the corresponding FDEP ARAR based on carcinogenicity is generally equal to the maximum reported hit for dieldrin. No other carcinogenic COPCs were identified at Site 29. The EPC for cyanide, detected in only one sample at Site 29, was approximately equal to the FPDWS/MCL.

Manganese, as discussed in risk characterization, was the primary contributor to hazard at each of the sites. The manganese EPC was in excess of the FSDWS/SMCL at each site. It is important to note that the secondary standard for this essential element was based on an organoleptic endpoint. Surface coatings of apparent iron and manganese were observed in soil throughout Sites 9, 29, and 34 and NAS Pensacola in general; therefore, elevated groundwater concentrations are by no means surprising. The lead concentrations reported for Site 9 were generally less than the treatment technique action level. The average of the reported concentrations was also less than this ARAR, as was the 95 percentile UCL.

Ubiquitous exposure was assumed for all monitoring well data from Sites 9, 29, and 34. Percent area affected was not applied to the risk projections, and this is a highly conservative approach, especially in the case of low frequency of detection COPCs. These low frequency of detection COPCs would not be expected to be encountered at all residential locations assuming potable wells were established. Therefore, the risk calculations are likely overestimates.

As discussed above, the likelihood that the aquifer is used for a drinking water supply is extremely low. Presently, drinking water is supplied to Sites 9, 29, and 34 from Corry Station, and there are no indications that site groundwater will be used in the future for potable purposes. COCs were identified assuming potable water use by hypothetical site residents and the conservatism and resulting overestimation of risk projections is large.

Central Tendency (CT) analysis was performed for groundwater. Where applicable, 50th percentile exposure assumptions are substituted for 90 to 95 percentile exposure assumptions to assess the median to upper-bound cancer risk and hazard range. The exposure duration is reduced to 2 and 7 years for the child and adult, respectively. Ingestion rates are also reduced from 2 L/day to 1.4 L/d for adults and 0.5 L/d for children. The exposure frequency is also adjusted to the 50th percentile value for exposure to groundwater. The RME exposure frequency is 350 days/year, and the CT exposure frequency is reduced to 234 days/year. The CT CDI are shown in Tables 10-19, 10-20, and 10-21 for Sites 9, 29, and 34, respectively. Tables 10-22, 10-23, and 10-24 show the CT risk and hazard results for Sites 9, 29, and 34, respectively.

The results of the CT analysis of the ingestion of groundwater pathway indicate reductions in all risk/hazard projections for the future site adult and child. Based on the application of CT exposure parameters, an approximately one order of magnitude reduction in calculated risk when

Table 10-19
Central Tendency Chronic Daily Intake for Site 9 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

		Potential Future Land Use Chronic Daily Intake		
Chemical	Exposure Point Concentration (mg/l)	Future Resident lwa C-CDI (mg/kg-day) (a)	Future Resident Adult H-CDI (mg/kg-day)	Future Resident Child H-CDI (mg/kg-day)
Arsenic	0.0049	9.27E-06	6.28E-05	1.05E-04
Lead	0.0081	1.53E-05	1.04E-04	1.73E-04
Manganese	0.605	1.15E-03	7.76E-03	1.29E-02

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

CDI Chronic Daily Intake

H-CDI hazard based CDI

C-CDI excess cancer risk based CDI

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-20
Central Tendency Chronic Daily Intake for Site 29 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

		Potential Future Land Use Chronic Daily Intake		
Chemical	Exposure Point Concentration (mg/l)	Future Resident lwa C-CDI (mg/kg-day) (a)	Future Resident Adult H-CDI (mg/kg-day)	Future Resident Child H-CDI (mg/kg-day)
Cyanide	0.248	4.69E-04	3.18E-03	5.30E-03
Dieldrin	4.63E-05	8.76E-08	5.93E-07	9.89E-07
Manganese	0.27	5.11E-04	3.46E-03	5.77E-03

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

CDI Chronic Daily Intake

H-CDI hazard based CDI

C-CDI excess cancer risk based CDI

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-21
Central Tendency Chronic Daily Intake for Site 34 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

		Potential Future Land Use Chronic Daily Intake		
Chemical	Exposure Point Concentration (mg/l)	Future Resident lwa C-CDI (mg/kg-day) (a)	Future Resident Adult H-CDI (mg/kg-day)	Future Resident Child H-CDI (mg/kg-day)
Arsenic	0.0043	8.14E-06	5.51E-05	9.19E-05
Cadmium	0.0044	8.33E-06	5.64E-05	9.40E-05
Lead	0.0756	1.43E-04	9.69E-04	1.62E-03
Manganese	0.475	8.99E-04	6.09E-03	1.02E-02
Naphthalene	0.32	6.06E-04	4.10E-03	6.84E-03

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

CDI Chronic Daily Intake

H-CDI hazard based CDI

C-CDI excess cancer risk based CDI

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-22
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Site 9 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florid

Chemical	Reference Dose Used (mg/kg-day)	Slope Factor Used (mg/kg-day)-1	Resident ILCR lwa (a)	Resident Adult Hazard Quotient	Resident Child Hazard Quotient
Arsenic	0.0003	1.75	1.6E-05	0.2	0.3
Lead	ND	ND	ND	ND	ND
Manganese	0.005	ND	ND	1.6	2.6
Total Risks/Hazard Indices			2E-05	2	3

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

ND Not determined due to lack of available information

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-23
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Site 29 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Flori

Chemical	Reference Dose Used (mg/kg-day)	Slope Factor Used (mg/kg-day)-1	Resident ILCR lwa (a)	Resident Adult Hazard Quotient	Resident Child Hazard Quotient
Cyanide	0.02	ND	ND	0.2	0.3
Dieldrin	5E-05	16	1.4E-06	0.01	0.02
Manganese	0.005	ND	ND	0.7	1.2
Total Risks/Hazard Indices			1E-06	1	1

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

ND Not determined due to lack of available information

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-24
Central Tendency Hazard Quotients and Incremental Lifetime Cancer Risks
Site 34 Groundwater COPCs
Ingestion of Groundwater
NAS Pensacola
Pensacola, Florida

Chemical	Reference Dose Used (mg/kg-day)	Slope Factor Used (mg/kg-day)-1	Resident ILCR lwa (a)	Resident Adult Hazard Quotient	Resident Child Hazard Quotient
Arsenic	0.0003	1.75	1.4E-05	0.18	0.31
Cadmium	0.0005	ND	ND	0.11	0.19
Lead	ND	ND	ND	ND	ND
Manganese	0.005	ND	ND	1.2	2.0
Naphthalene *	0.04	ND	ND	0.1	0.2
Total Risks/Hazard Indices			1E-05	2	3

NOTES:

(a) Carcinogenic chronic daily intake is based on the lifetime weighted average (lwa) of an adult (age 7-31) and a child (age 1-6)

ND Not determined due to lack of available information

.* the reference dose used for naphthalene has been withdrawn from IRIS/HEAST

[Bold items in brackets denote changes to the first draft of documents.]

compared to risk was shown when compared to risk based on RME. As shown in the tables, the CT groundwater risk does exceed the 1E-6 threshold set by FDEP. It is important to note that the background RME risk associated with arsenic is approximately 6E-5, and the risk posed by arsenic at the MCL/FPDWS would exceed of both the FDEP and USEPA points of departure. With respect to hazard, CT-based hazard quotients for the adult and child residents were reduced an average of approximately 50 and 67 percent from the RME-based hazard quotients, respectively.

10.1.7 Risk Summary

The human health risk associated with exposure to environmental media at NAS Pensacola Sites 9, 29, and 34 was assessed for hypothetical future site residents. A military operations school is being constructed at the sites, **[extensive fill]** is being added on top of site soils, and the majority of each site not under buildings will be paved after construction is completed. Therefore, no complete soil exposure pathway exists at any site, and soil exposure was not addressed in this BRA.

The maximum groundwater concentrations reported for arsenic at Sites 9 and 29 do not exceed the ARAR, 0.05 mg/l (MCL/FPDWS). However, the risk posed by arsenic at Sites 9 and 34 (1E-4) exceeds the FDEP and USEPA point of departure (1E-6). The only reported concentration for dieldrin (0.00013 mg/l) is approximately equal to the FDEP ARAR (0.0001), and this compound was not detected in the confirmatory sampling effort. The single hit of dieldrin detected at Site 29 poses 1E-5 excess cancer risk, which exceeds the FDEP and USEPA risk point of departure. Although the calculated risk exceeds the FDEP and USEPA threshold, the frequency of detection of dieldrin and comparison of reported concentrations to ARARs supports a conclusion of no further action recommendation for groundwater based on risk.

The shallow/intermediate groundwater pathway hazard indices were found to be 9, 4, and 8 for the future child resident and 4, 2, and 3 for the adult at Sites 9, 29, and 24, respectively. The primary contributor to hazard at all sites is manganese. However, it is important to note that the future land use of these sites is known — a military operations school is currently under construction which will be used as a training facility for aircraft mechanics, firefighters, etc. The aquifer is not used as a potable or non-residential water supply, and the aquifer will not be used based on the Navy's future plans for the sites. Water for the military operations school is supplied by Corry Station, and based on the lack of complete exposure pathways, no further action is recommended for groundwater at Sites 9, 29, and 34.

10.1.8 Remedial Goal Options

RGOs are chemical concentrations computed to equate with specific risk and/or hazard goals that may be established for a particular site. Based on the algorithms described in this risk assessment, COCs were identified which required calculation of RGOs. In accordance with USEPA Supplemental RGO Guidance, RGOs were calculated at 1E-4, 1E-5, and 1E-6 risk levels for carcinogenic COCs and HQ goals of 10, 1, and 0.1 for non-carcinogenic COCs. RGOs for carcinogens were based on the lifetime weighted average, and RGOs for non-carcinogens were based on the child exposure assumptions. Where appropriate, discussion regarding the applicability of specific RGOs is provided.

Shallow/Intermediate Groundwater RGOs

Table 10-25, 10-26, and 10-27 provide RGOs for the shallow/intermediate groundwater ingestion pathway for Sites 9, 29, and 34, respectively. As shown in the Tables, the RGOs for arsenic, and dieldrin are below the ARAR. In addition, the RGOs based on a hazard quotient of 1 are similar to ARARs for manganese, cadmium, and cyanide. If a hazard quotient goal of 1 was selected for these elements, the merit of groundwater remediation would be questionable.

Table 10-25
Remedial Goal Options for Site 9 Groundwater COCs
NAS Pensacola
Pensacola, Florida

Chemical	Risk-Based RGOs 1E-4 (mg/l)	1E-5 (mg/l)	1E-6 (mg/l)	Hazard-Based RGOs 10 (mg/l)	1 (mg/l)	0.1 (mg/l)	Exposure Point Concentration (mg/l)	Reference Concentration (mg/l)	ARAR (mg/l)	Source
Arsenic	0.0038	0.00038	0.000038	0.047	0.0047	0.00047	0.0049	0.0028	0.05	MCL/FPDWS
Manganese	NA	NA	NA	0.78	0.078	0.0078	0.605	0.022	0.05	SMCL/FSDWS

NOTES:

RGO Remedial Goal Option
MCL Maximum Contaminant Level
FPDWS Florida Primary Drinking Water Standard
FSDWS Florida Secondary Drinking Water Standard
SMCL Secondary MCL
NA Not Applicable
- risk-based RGOs are based on the lifetime weighted average adult and child exposure
- hazard-based RGOs are based on childhood exposure

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-26
Remedial Goal Options for Site 29 Groundwater COCs
NAS Pensacola
Pensacola, Florida

Chemical	Risk-Based RGOs 1E-4 (mg/l)	1E-5 (mg/l)	1E-6 (mg/l)	Hazard-Based RGOs 10 (mg/l)	1 (mg/l)	0.1 (mg/l)	Exposure Point Concentration (mg/l)	Reference Concentration (mg/l)	ARAR (mg/l)	Source
Cyanide	NA	NA	NA	3.129	0.3129	0.03129	0.248	NA	0.2	MCL/FPDWS
Dieldrin	0.00042	4.2E-05	4.2E-06	0.00782	0.000782	7.82E-05	4.6E-05	NA	0.1	FDEP (carc)
Manganese	NA	NA	NA	0.78	0.078	0.0078	0.27	0.022	0.05	SMCL/FSDWS

NOTES:

RGO Remedial Goal Option
MCL Maximum Contaminant Level
FPDWS Florida Primary Drinking Water Standard
FSDWS Florida Secondary Drinking Water Standard
SMCL Secondary MCL
NA Not Applicable
FDEP (carc) Carcinogen-based standard calculated by FDEP
- risk-based RGOs are based on the lifetime weighted average adult and child exposure
- hazard-based RGOs are based on childhood exposure

[Bold items in brackets denote changes to the first draft of documents.]

Table 10-27
Remedial Goal Options for Site 34 Groundwater COCs
NAS Pensacola
Pensacola, Florida

Chemical	Risk-Based RGOs 1E-4 (mg/l)	1E-5 (mg/l)	1E-6 (mg/l)	Hazard-Based RGOs 10 (mg/l)	1 (mg/l)	0.1 (mg/l)	Exposure Point Concentration (mg/l)	Reference Concentration (mg/l)	ARAR (mg/l)	Source
Arsenic	0.0038	0.00038	0.000038	0.047	0.0047	0.00047	0.0043	0.0028	0.05	MCL/FPDWS
Cadmium	NA	NA	NA	0.078	0.0078	0.00078	0.0044	0.0034	0.005	MCL/FPDWS
Lead	NA	NA	NA	NA	NA	NA	0.0756	0.0016	0.15	TT
Manganese	NA	NA	NA	0.78	0.078	0.0078	0.475	0.022	0.05	SMCL/FSDWS
Naphthalene	NA	NA	NA	6.26	0.626	0.0626	0.32	NA	NA	

NOTES:

RGO Remedial Goal Option
MCL Maximum Contaminant Level
FPDWS Florida Primary Drinking Water Standard
FSDWS Florida Secondary Drinking Water Standard
TT Treatment Technique action level for lead in tap water
SMCL Secondary MCL
NA Not Applicable
- risk-based RGOs are based on the lifetime weighted average adult and child exposure
- hazard-based RGOs are based on childhood exposure
- the FDEP organoleptic standard for naphthalene is 0.006 mg/l

[Bold items in brackets denote changes to the first draft of documents.]

10.2 Ecological Risk Assessment

The purpose of the ecological risk assessment is to assess the actual or potential effects to ecological receptors due to contamination at Sites 9, 29, and 34. The history and description of these sites are presented in Section 2 of this document. Section 4 discusses previous investigations within the site area, which were conducted prior to the remedial investigation. Site specific information from these sections aided in determining the ecological risk associated with these sites.

10.2.1 Ecosystem at Risk

Section 4.3 of this report contains the results of the habitat and biota survey conducted within the site area. The sites are located in an industrial area within the confines of southwest Chevalier Field. The site area mostly encompasses the concrete aircraft parking apron in the vicinity of Buildings 3460 and 3557, and the grassy field west of Building 3460. No natural plant or animal habitats exist within the area, which is heavily trafficked during the work-week. Shorebirds might visit the site area during periods of reduced human activities (weekends, after working hours, etc.). This situation will likely remain unchanged during BRAC demolition and construction in the site area, and afterward. Approximately 65% of the site area before BRAC building construction was paved with concrete or asphalt, with the remaining area covered with grassy sod. After BRAC construction, approximately 68% of the area will be covered with pavement or buildings, with the remainder covered with sod. The lack of natural habitat within the Sites 9, 29, and 34 area will likely be limiting to faunal utilization in the immediate area.

10.2.2 Pathway Analysis

The RI presented possible scenarios of past practices and occurrences at Sites 9, 29 and 34. Full-scan analyses using CLP protocol were conducted on soil and groundwater to quantify suspected contaminants of concern.

Surface Water Transport

Surface water from the site area drains to the west toward the tile lined drainage ditch west of Site 9, also known as NASP Wetland 6. This feature conducts surface drainage from the western portion of the base toward the yacht basin of Bayou Grande. Several collection features containing culvert pipes and feeder ditches conduct surface runoff from the southwestern half of Chevalier Field into the tile lined ditch. Three of these features exist immediately west of Site 9, and one exits west of Site 34. A low grassy swale directly north of Site 34 leads directly into the drainage feature near Site 34, and serves to conduct surface runoff from that site. Surface soil contaminants could be transported from the Site 9 and 34 area into the drainage ditch and to downstream receptors via these drainage features. Surface waters from Site 29 would carry contaminants across Site 9, toward the same drainage features.

Groundwater Transport

Section 6 of this report discusses groundwater movement in and around the site area. Aquifer tests conducted at NAS Pensacola have shown that the horizontal movement of shallow groundwater in the surficial sand is generally from topographic highs to areas of discharge such as streams or nearby surface water bodies (G&M, 1984). The piezometric study of the site area indicates that the steepest hydraulic gradient occurs at the southern end of Site 9, where groundwater flows directly west toward the drainage ditch. Groundwater from Site 29 is conducted beneath the southern part of Site 9, also toward the ditch. Near Site 34, the hydraulic gradient is less steep, groundwater flow velocity lessens, and flow direction shifts to the northwest at an indirect angle to the ditch.

Groundwater seepage into the drainage ditch provides a potential pathway for contaminant migration. However, groundwater samples collected during the remedial investigation revealed very limited contamination. Site 9 groundwater samples contained only ubiquitous aluminum,

iron, and manganese above standards. Groundwater from Site 29 also contained the same ubiquitous contaminants found in groundwater at Site 9, and would be diluted by Site 9 groundwater during transport to the drainage ditch. Because of the reduced flow velocity and distance covered along the flow path from Site 34 to the ditch, it would take several years for groundwater from Site 34 to discharge to surface water there. Widespread dilution and dispersion of contaminants transported from Site 34 would occur. Groundwater samples from Site 34 revealed some localized lead and naphthalene contamination. However, samples from Site 34 wells downgradient from these areas displayed no contaminants other than ubiquitous ones. Ecological impact from groundwater discharge on Site 34 is therefore further limited by the fact that contaminants found in groundwater on the site seem to be immobile.

Sediment Transport

Much of the site area is covered with concrete or asphalt pavement, with the remainder being open turf covered with grassy sod. The soils within the site area are very sandy, with a low silt content. During the investigation, there was little evidence of erosion in the site area, or sedimentation near surface drainage features.

10.2.3 Receptor Evaluation

Two sediment samples were collected from the tile lined drainage ditch during Phase I of the investigation. One sample was collected upstream, adjacent Site 9, and the other was collected further downstream, adjacent Site 10. The Site 9 sample revealed copper, lead, zinc, benzo(a)pyrene, 4'4-DDT, and dieldrin above sediment screening values. The site 10 sample revealed lead, 4'4-DDD, 4'4-DDE, and 4'4-DDT above sediment screening values. This contamination cannot be totally attributed to surface runoff from Sites 9, 29, and 34. The pesticide concentrations are likely the result of mosquito control and surface application. The PAH concentration can be attributed to combustion emissions from high vehicular traffic on

nearby roads, or from base landscaping contractors, often seen removing vegetation from the ditch with gasoline powered weed trimmers. Paving and sodding within the site area also limits sedimentation from the area. In depth screening of Wetland 6, downstream wetlands, and Bayou Grande will take place during the Sites 40 and 41 investigations. These investigations should more thoroughly study the nature and extent of contamination in the Wetland 6 and downstream areas, and whether Sites 9, 29, and 34 are sources contributing to potential contamination there.

11.0 CONCLUSIONS AND RECOMMENDATIONS

This investigation's objectives were to identify the nature and extent of contamination in soil and groundwater at Sites 9, 29, and 34. The following section summarizes the findings and recommends subsequent remedial actions.

Historical records indicate that activities within the Chevalier Field area may have impacted Sites 9, 29, and 34 over the years. Site 9 was reportedly used as a dump between 1917 and the 1930s. In 1981, workers excavating a trench at Site 29 received burns when they came into contact with an unknown substance. It was assumed that the substance was attributable to a potential leak in the IWTP sewer line, which crosses the site. In 1984 at Site 34, approximately 45,000 gallons of a solvent/detergent mix leaked from piping leading from the small tank farm north of Building 3557. It was believed that the spilled material might have penetrated beneath the concrete apron at the site, or migrated off-site via the unpaved drainage swale that leads from the tank farm towards the west.

Subsurface stratigraphy across the sites area is consistent with previous NAS Pensacola studies, and generally consists of fine-to-medium grained quartz sand, varying in color, mixed with clayey silt, organics, limonite, and fragments of rock, gravel, oyster shell, asphaltic slag, etc., depending on location within the area. Apparently native fine- to medium-grained quartz sands are encountered beginning with the water table.

Groundwater in the uppermost part of the surficial zone of the Sand-and-Gravel Aquifer generally flows to the west in the southern portion of the site area, shifting to a west-to-northwest flow in the northern portion of the area. Groundwater generally flows toward the concrete tile-lined drainage ditch which traverses the western edge of the area; however, there is an element of flow from Site 29 to the southeast.

[The analytical data for soils were initially compared to risk-based, surface soil PRGs exclusively (1995 PRGs). The 1995 PRGs were considered because of conservative assumptions, fast-track remediation requirements, and Tier 1 agreement. The 1995 PRGs were used to formulate the BRA and to support the interim soil removals on each site. Subsequent comparisons (1996) PRGs used subsurface leaching values. This was due to the availability of state/federal leachability standards, the extensive placement of fill over the area of construction on Chevalier Field (thus removing the soil pathway for risk), and Tier 1 agreement. The 1996 comparison, as opposed to the 1995 study, focused only on the likelihood of contaminants leaching to groundwater.]

Analytical data revealed the following results for each site:

- Site 9 contains localized concentrations of arsenic and manganese above **[1995]** PRGs in soil. The central portion of the site (apparently near where the former dump was located) exhibits relatively elevated levels of inorganics in soil above **[1995/1996]** PRGs. **[However, when compared to 1996 PRGs in a subsurface scenario, the localized but site-wide arsenic and manganese contamination changes. Arsenic contamination is reduced to a single boring location (09S18) and manganese falls below PRGs entirely. The 1996 PRGs also indicate that other isolated inorganics previously above 1995 PRGs (antimony, beryllium, and copper) are no longer of concern, while there is a slight increase in barium over 1995 PRGs, and isolated nickel and thallium appear above standards.]** Localized pesticide constituents were found in soil that would be consistent with a surface application scenario. **[The 1996 PRGs reveal an increase in pesticide contamination above standards site-wide. This increase can be attributable to low EPA/FDEP PRG values for certain pesticides within the 1996 standards. The application scenario for pesticides on Site 9 is still valid for the 1996**

PRG comparison.] Soil around where the former dump was located exhibited elevated levels of PAH compounds, which may be attributable to a previous fuel release (Site 23). Isolated soil PAH constituents were found in other places on site, attributable to pavement runoff, nearby road construction, and vehicle activity. **[The 1996 PRGs indicate that PAH contamination is still a problem in the west central portions of the site, with carbazole, chrysene, and phenanthrene now appearing above standards. PAH contaminated soil from the east central portion of the site was excavated in a soil removal action during late 1995. Confirmatory samples revealed no PAH constituents above PRGs; however one confirmatory sample contained dieldrin above the SSL, consistent with dieldrin hits above 1996 PRGs on this site, as well as Sites 29, and 34.]** Groundwater contains ubiquitous inorganic constituents above PRGs that are consistent with the general quality of groundwater at NAS Pensacola and the Sand-and-Gravel in southern Escambia County. No PAHs **[nor pesticides]** were detected in site groundwater. An isolated lead hit above PRGs in groundwater during the first sampling phase was not substantiated in a follow-on sample.

- Site 29 exhibits localized manganese above **[1995]** PRGs in soil. **[However, according to the 1996 PRGs, manganese falls below standards, with an isolated nickel concentration appearing above the SSL at a single boring location.]** Localized surface and subsurface soil dieldrin and PAH contamination were determined to result from previous grading, backfilling and construction (and consequent soil redistribution) in the area. **[Dieldrin and PAH contaminated soil was excavated in a soil removal action during mid-1995. Though comparison of organic constituents to 1996 PRGs reveals localized dieldrin contamination above PRGs outside of the area targeted during the removal, the removal focused on the area of highest contamination (2200 μg/kg at boring 29S01). Two of the confirmatory samples performed**

subsequent to the removal showed dieldrin still above 1996 standards (29S15/22 μg/kg, 29S17/2.9 μg/kg, respectively); however, the highly contaminated area appears to have been removed. Notably, diedrin is non-detect in groundwater. On-site dieldrin contamination resulting from comparison to 1996 PRGs is not inconsistent with similar contamination on Sites 9 and 34. This dieldrin contamination may be attributable to application prior to construction of NADEP facilities at Chevalier Field in the 1970s, as well as from the extensive grading and backfilling that has occurred on-site over time.] Groundwater contains ubiquitous inorganic constituents as with Site 9. Localized cyanide was also detected in a single groundwater sample on the south side of the site. The cyanide appears to not be related to any soil source found at the site, and no history of cyanide exists where this constituent was found. An isolated dieldrin hit above PRGs in groundwater during the first sampling phase was not substantiated in a follow-on sample.

- Site 34 contains localized lead and naphthalene in soil above **[1995]** PRGs at a single location. **[Lead and naphthalene are also above 1996 PRGs. The 1996 standards also reveal localized dieldrin above PRGs at scattered locations as with Sites 9 and 29.]** Groundwater contains ubiquitous inorganic constituents as with Sites 9 and 29. Naphthalene was also found in groundwater above PRGs, correlatable to on-site soil naphthalene concentrations. A localized lead concentration above PRGs was also found in groundwater. **[Dieldrin was non-detect in site groundwater. Lead and naphthalene contaminated soil from the site was excavated in a soil removal action during late 1995. Confirmatory samples revealed no lead or naphthalene above PRGs; however four confirmatory samples contained dieldrin above the SSL, consistent the levels of dieldrin detected on Sites 9, 29, and 34.]**

The soil and groundwater contamination found on these sites are considered delineated for purposes of the RI. The main areas of soil contamination on each site include: 1) the area presumed to be the former dump on Site 9; 2) the area of dieldrin and PAH contamination on Site 29; and 3) the area of lead and naphthalene contamination on Site 34. **[The contaminated areas of Sites 29 and 34 were subject to interim soil removal, along with a PAH contaminated area on the eastern portion of Site 9. The metals and PAH contaminated area in the west central portion of Site 9 was not included in the soil removals, and since the nature of contamination here is likely associated with the petroleum spill on Site 23, remediation will be handled under the UST program.**

According to the 1996 leachability PRGs, the areas mentioned indicate a potential threat to groundwater. Groundwater constituents above PRGs were mostly inorganics, with a singular organic exceedance on Site 34 (naphthalene). It is notable, though, that no correlation can be found between the distribution and concentrations of inorganics above PRGs in soil and inorganics above PRGs in groundwater. Also, comparison to groundwater inorganics on other NASP sites does not indicate anything out of the ordinary. It can therefore be concluded that inorganic soil parameters are not leaching to groundwater anywhere within the site area, along with organics other than naphthalene on Site 34 (naphthalene contaminated soils on Site 34 were subject to interim soil removal).]

The primary receiving aquifer within the Site 9, 29 and 34 area is the surficial zone of the Sand-and-gravel. The primary surface water body receptors are the adjacent wetlands and Bayou Grande. Currently, groundwater within the surficial zone is not utilized for any purpose at NAS Pensacola. Elsewhere in southern Escambia County, it is typically used after being filtrated, a treatment which would be effective for constituents detected on Sites 9, 29, and 34. Contamination migration is conservatively equal estimated to the average calculated groundwater

velocity. This, coupled with the low concentrations of contaminants, retardation, mechanical dispersion, and chemical diffusion, act together to minimize the impact of constituents in groundwater to nearby surface waters.

The human health risk associated with exposure to environmental media at Sites 9, 29, and 34 was assessed for hypothetical future site residents. This assessment considered that approximately five feet of soil is being added to the sites during the BRAC construction, and that construction plans reveal that approximately 68% of the area will be either paved or covered with buildings when construction is complete. As a result of this, a soil exposure scenario was considered unnecessary. As discussed in Section 10.1.7 of the BRA, the maximum groundwater concentrations reported for arsenic at Sites 9 and 29 do not exceed the ARAR, 0.05 mg/L (MCL/FPDWS). However, the risk posed by arsenic at Sites 9 and 34 (1E-4) exceeds the FDEP and USEPA point of departure (1E-6). The only reported concentration for dieldrin (0.00013 mg/L on Site 29) is approximately equal to the FDEP ARAR (0.0001), and this compound was not detected in the confirmatory sampling effort. The single hit of dieldrin detected poses 1E-5 excess cancer risk, which exceeds the FDEP and USEPA risk point of departure. Although the calculated risk exceeds the FDEP and USEPA threshold, **[the]** absence of detected dieldrin **[in the confirmatory groundwater sample collected, the total absence of dieldrin in groundwater elsewhere on the sites, the relative absence of PAH contamination (except naphthalene on Site 34) in groundwater, and the inability to correlate soil and groundwater inorganic contamination, along with]** comparison of reported concentrations to ARARs, supports a conclusion of no further action recommendation for groundwater based on risk. Due to: 1) the localized concentrations of contaminants, 2) the **[interim]** removal of soil from the localized contaminated areas on each site, 3) the covering of the site area with fill, 4) the percent of the area scheduled to be paved or built on during BRAC construction, and 5) the no further action recommendation for groundwater based on risk; further delineation and

assessment within the Sites 9, 29, and 34 area is unwarranted. It is further recommended that the site area does not warrant the detailed evaluation of remedial alternatives associated with a feasibility study. **[Given the presence of several constituents in soil above PRGs, however, it is recommended that the NASP master plan be modified to include restrictions on the use of the surficial aquifer beneath Chevalier Field as a potable or non-potable water supply.]** No further action is recommended, along with a proposed plan leading to an interim record of decision for these sites.

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FLORIDA PROFESSIONAL GEOLOGIST SEAL

I have read and approve of this Remedial Investigation Report for Category 5 - Sites 9, 29, and 34 - and seal it in accordance with Chapter 492 of the Florida Statutes. In sealing this document, I certify the geological information contained in it is true to the best of my knowledge and the geological methods and procedures included herein are consistent with currently accepted geological practices.

Name:	Brian E. Caldwell
License Number:	#1330
State:	Florida
Expiration Date:	July 31, 1996

B E Caldwell

Brian E. Caldwell

3/26/96

Date