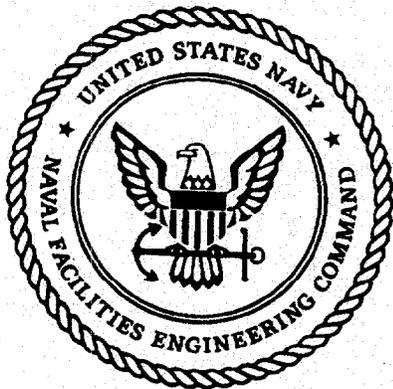


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FINAL REMEDIAL INVESTIGATION AND FEASIBILITY STUDY AND TECHNICAL
MEMORANDUM 5 GROUNDWATER ASSESSMENT NAS WHITING FIELD FL
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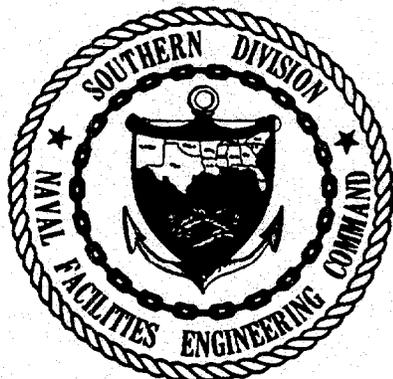
FINAL

**REMEDIAL INVESTIGATION AND
FEASIBILITY STUDY**

**TECHNICAL MEMORANDUM NO. 5
GROUNDWATER ASSESSMENT**

**NAVAL AIR STATION
WHITING FIELD
MILTON, FLORIDA**

MAY 1992



**SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA
29411-0068**

FINAL
RELEASE OF THIS DOCUMENT REQUIRES THE
PRIOR NOTIFICATION OF THE COMMANDING OFFICER
OF NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

1D 00228

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

PHASE I

**NAVAL AIR STATION, WHITING FIELD
MILTON, FLORIDA**

**Technical Memorandum No. 5
Groundwater Quality Assessment**

UIC: N60508

Contract No. N62467-88-C-0382

Prepared by:

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May 1992

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AIMD	Aircraft Intermediate Maintenance Department
AVGAS	aviation gasoline
BAT	Bengt-Arne-Torstensson
BEHP	bis-(2-ethylhexyl)phthalate
bls	below land surface
BX	Base Exchange
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CS ₂	carbon disulfide
CWA	Clean Water Act
DCA	dichloroethane
DCE	dichloroethylene
DQOs	data quality objectives
FAC	Florida Administrative Code
FDER	Florida Department of Environmental Regulation
FS	Feasibility Study
ft/day	feet per day
ft ² /day	square foot per day
ft/ft	feet per foot
GC/MS	gas chromatography/mass spectroscopy
HRS	Hazard Ranking System
HRS II	Hazard Ranking System, Final Rule, December 1990
IAS	Initial Assessment Study
IR	Installation Restoration
MCL	maximum contaminant level
μg/l	micrograms per liter
μg/kg	micrograms per kilogram
umhos/cm	micromhos per centimeter
mg/kg	milligrams per kilograms
mg/l	milligrams per liter
ml	milliliters
MS/MSD	matrix spike/matrix spike duplicates
msl	mean sea level

GLOSSARY (Continued)

NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NGVD	National Geodetic Vertical Datum of 1929
NPL	National Priorities List
OVA	organic vapor analyzer
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCPT	piezocone penetrometer test
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SI	Site Inspection
SOUTHNAV- FACENCOM	Southern Division, Naval Facilities Engineering Command
SVOC	semivolatile organic compounds
TAL	target analyte list
TCA	trichloroethane
TCE	trichloroethylene
TCL	target compound list
TCLP	Toxicity Characteristics Leaching Procedure
TRAWING- FIVE	Training Air Wing Five
USEPA	U.S. Environmental Protection Agency
UST	underground storage tanks
VOC	volatile organic compounds

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), under contract to the Department of Navy, is submitting Technical Memorandum No. 5 for the Phase I Remedial Investigation and Feasibility Study (RI/FS) for Naval Air Station (NAS) Whiting Field located in Milton, Florida, to the Department of Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM). The RI/FS is being conducted under contract number N62467-88-C-0382.

Technical Memorandum No. 5, Groundwater Quality Assessment, is the fifth in a series of six technical memoranda that summarizes the results and transmits data gathered during the Phase I RI. The Phase I RI field program was carried out during the period December 1990 to May 1991. These technical memoranda form the supporting basis for scoping a Phase II RI Sampling and Analysis Plan for NAS Whiting Field.

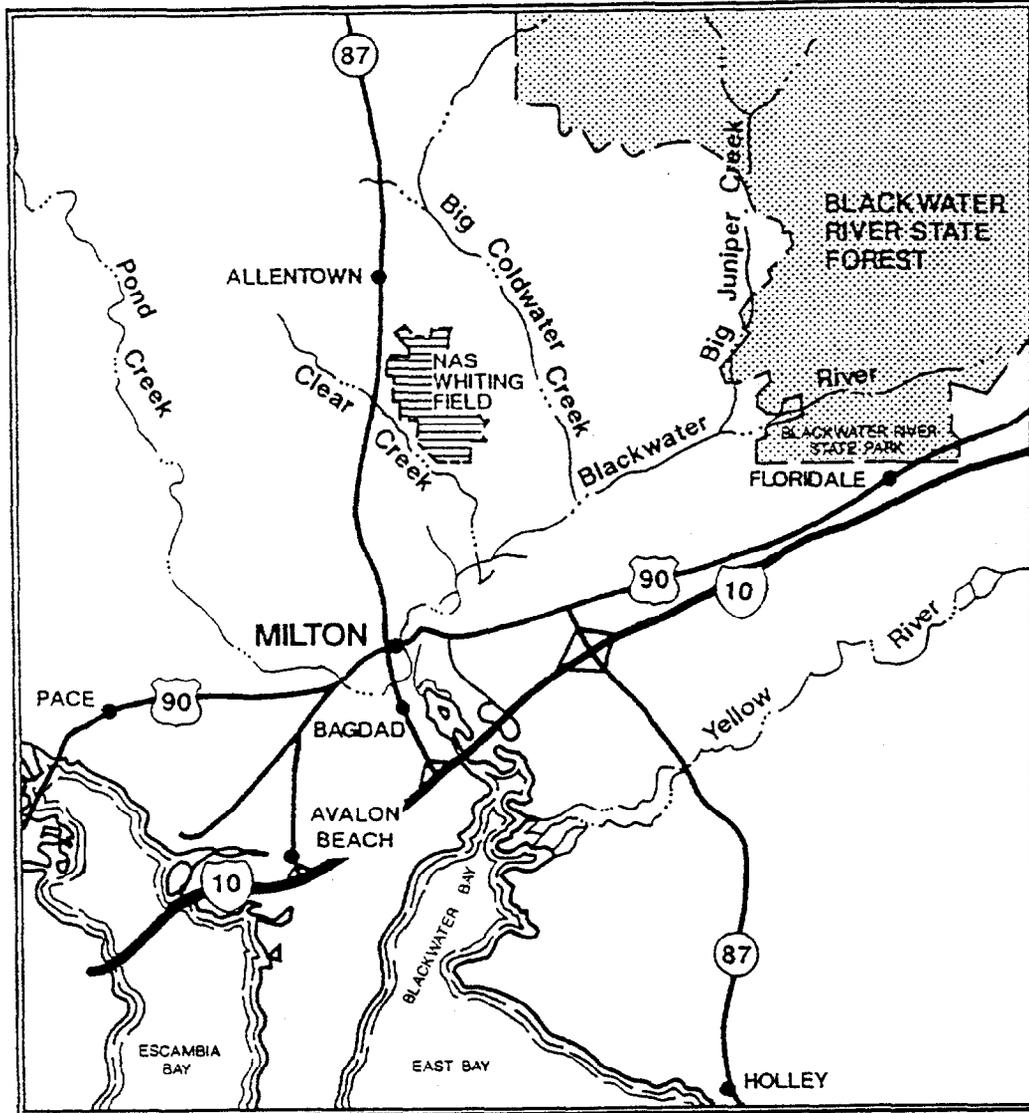
NAS Whiting Field is located in Florida's northwest coastal area approximately 7 miles north of Milton and 20 miles northeast of Pensacola (Figure 1-1). NAS Whiting Field presently consists of two air fields separated by an industrial area and covers approximately 2,560 acres in Santa Rosa County. Figure 1-2 presents the installation layout.

NAS Whiting Field, home of Training Air Wing Five (TRAWING FIVE), was constructed in the early 1940's. It was commissioned as the Naval Auxiliary Air Station Whiting Field in July 1943 and has served as a naval aviation training facility ever since. The field's mission has been to train student naval aviators in basic instruments, formation and tactic phases of fixed-wing, and propeller-driven aircraft, and in the basic and advanced portions of helicopter training.

NAS Whiting Field lies within the Western Highlands physiographic division of Santa Rosa County in the Coastal Plain Province. The Western Highlands are characterized by a well drained, southward sloping, plateau with numerous streams. Land surrounding NAS Whiting Field primarily consists of agricultural land to the northwest, residential and forested areas to the south and southwest, and forested land around the remaining boundaries. This land use distribution is shown in Figure 1-3.

Located on an upland area, elevations at Whiting Field range from 150 to 190 feet above sea level. The facility is bounded by low-lying receiving waters; Clear Creek to the west and south and Big Coldwater Creek to the east. These two streams are tributaries of the Blackwater River, which discharges to the estuarine waters of the East Bay of the Escambia Bay coastal system.

1.1 PURPOSE AND BACKGROUND. The purpose of the NAS Whiting Field RI/FS is to identify a range of remedial alternatives to address any identified risks to public health and the environment posed by toxic or hazardous chemicals present as a result of past waste disposal practices or spills. To achieve this objective, the RI must collect data sufficient to assess the nature and distribution of chemicals associated with each site. The data collected in the RI will be used in the FS to screen, evaluate, and select remedial alternatives to provide permanent, feasible solutions to environmental contamination problems at NAS Whiting Field.



SITE MAP



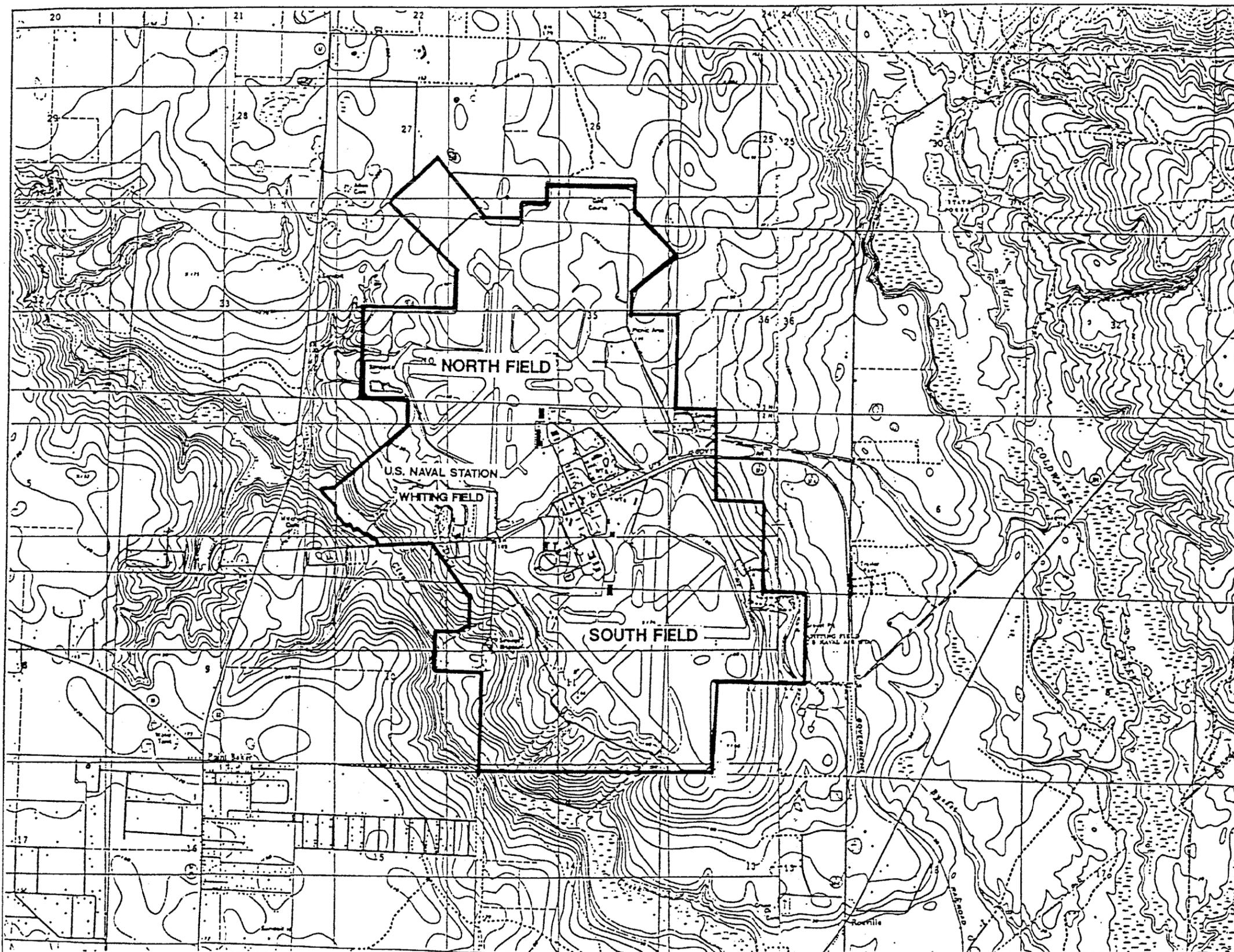
MAP LOCATION

SOURCE: ABB ENVIRONMENTAL SERVICES, INC., 1991

FIGURE 1-1
FACILITY LOCATION MAP



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA



SOURCE:
USGS QUADRANGLE MILTON NORTH, FLORIDA
PHOTOREVISED 1987
AND USGS QUADRANGLE HAROLD, FLORIDA 1973.

FIGURE 1-2
NAS WHITING FIELD



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

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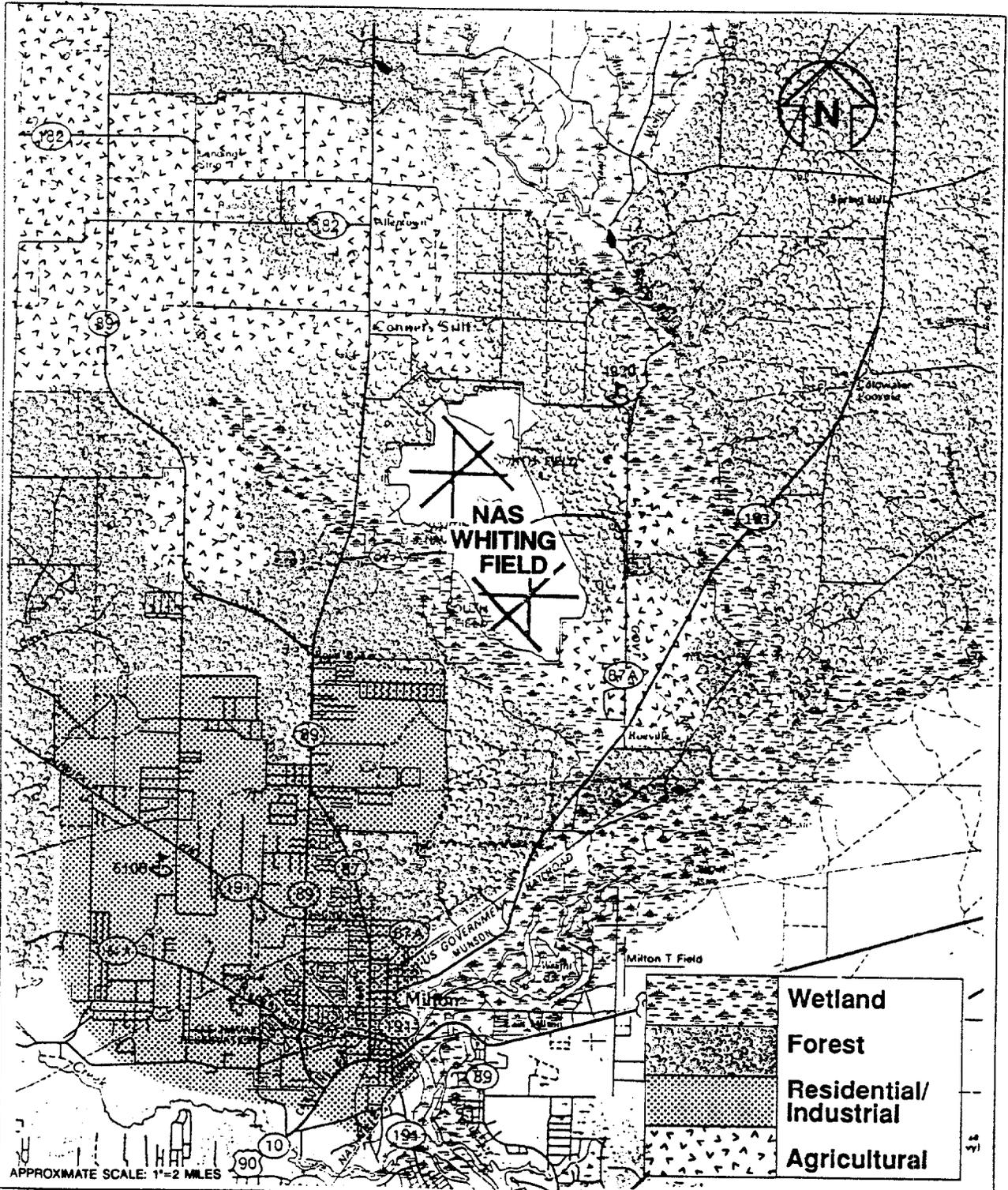


FIGURE 1-3

Land Use Distribution in the
Vicinity of NAS Whiting Field



RI/FS PROGRAM

NAS WHITING FIELD
MILTON, FLORIDA

The Navy Installation Restoration (IR) program was designed to identify and abate or control contaminant migration resulting from past operations at Naval installations. The IR program is the Navy response authority under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and Executive Order 12580. CERCLA requires that Federal facilities comply with the act, both procedurally and substantively. SOUTHNAVFACENCOM is the agency responsible for the Navy IR program in the Southeastern United States. Therefore, SOUTHNAVFACENCOM has the responsibility to process NAS Whiting Field through Preliminary Assessment (PA), Site Inspection (SI), priority listing, RI/FS, and remedial response selection in compliance with the guidelines of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 Code of Federal Regulations (CFR) 300].

Section 105(a)(8)(A) of SARA required the U.S. Environmental Protection Agency (USEPA) to develop criteria in order to set priorities for remedial action based on relative risk to public health and the environment. To meet this requirement, USEPA has established the Hazard Ranking System (HRS) as Appendix A to the NCP. The HRS is a scoring system designed to assess relative threat due to documented or potential releases at a site. First promulgated in 1982, the HRS was amended in December 1990, effective March 14, 1991 (55 Federal Register No. 241:51532-51667), to comply with requirements of Section 105(c)(1) of SARA to increase the accuracy of the assessment of relative risk. The newly promulgated HRS II has been substantially revised and is designed to prioritize sites after the SI phase of the CERCLA process. The SI or extended SI is used to present the required data to expeditiously perform an HRS II ranking. At NAS Whiting Field, the SI was conducted as a Contamination Study, Verification Phase.

The RI/FS conducted at NAS Whiting Field is a component of the Navy IR program. The preliminary HRS score for NAS Whiting Field indicates that it may qualify for the National Priorities List (NPL). As such, the RI/FS for NAS Whiting Field follows the requirements of the NCP, as amended by SARA, and guidance for conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, October 1988).

Prior to the implementation of the Phase I RI/FS Program, a PA and two sampling and analysis programs had been conducted at NAS Whiting Field. The PA, conducted as an Initial Assessment Study (IAS), was performed by Envirodyne Engineers in 1984 and published in 1985 (Envirodyne Engineers, 1985). Based on historical data, aerial photographs, field inspections, and personnel interviews, 16 disposal or spill sites of potential contamination and/or contaminant migration were initially identified at NAS Whiting Field by the IAS team. These are sites where waste disposal or accidents have occurred in the past.

The May 1985 IAS concluded that 15 of the 16 sites warranted further investigation, under the Navy's IR Program, to assess potential long-term impacts. Only Site 2, the Northwest Open Disposal Area, was judged to not warrant further consideration. A Confirmation Study, including sampling and monitoring of the sites, was recommended to confirm or deny the existence of the suspected contamination and to quantify the extent of any problems that may exist. The results of the Confirmation-Verification Study would then be used to evaluate the necessity of conducting mitigating actions or cleanup operations.

In November 1985, Geraghty & Miller, Inc., prepared for the Navy a plan of action entitled *Naval Assessment and Control of Installation Pollutants, Verification Study, NAS Whiting Field* (Geraghty & Miller, 1985b), which was subsequently submitted to the Florida Department of Environmental Regulation (FDER). This plan contained details of the proposed scope of work for the Verification Study. During discussion with FDER in December 1985, two additional sites (17 and 18) were added to the Verification Study. Both were active sites at that time where waste oils and fuels were burned in firefighting training exercises.

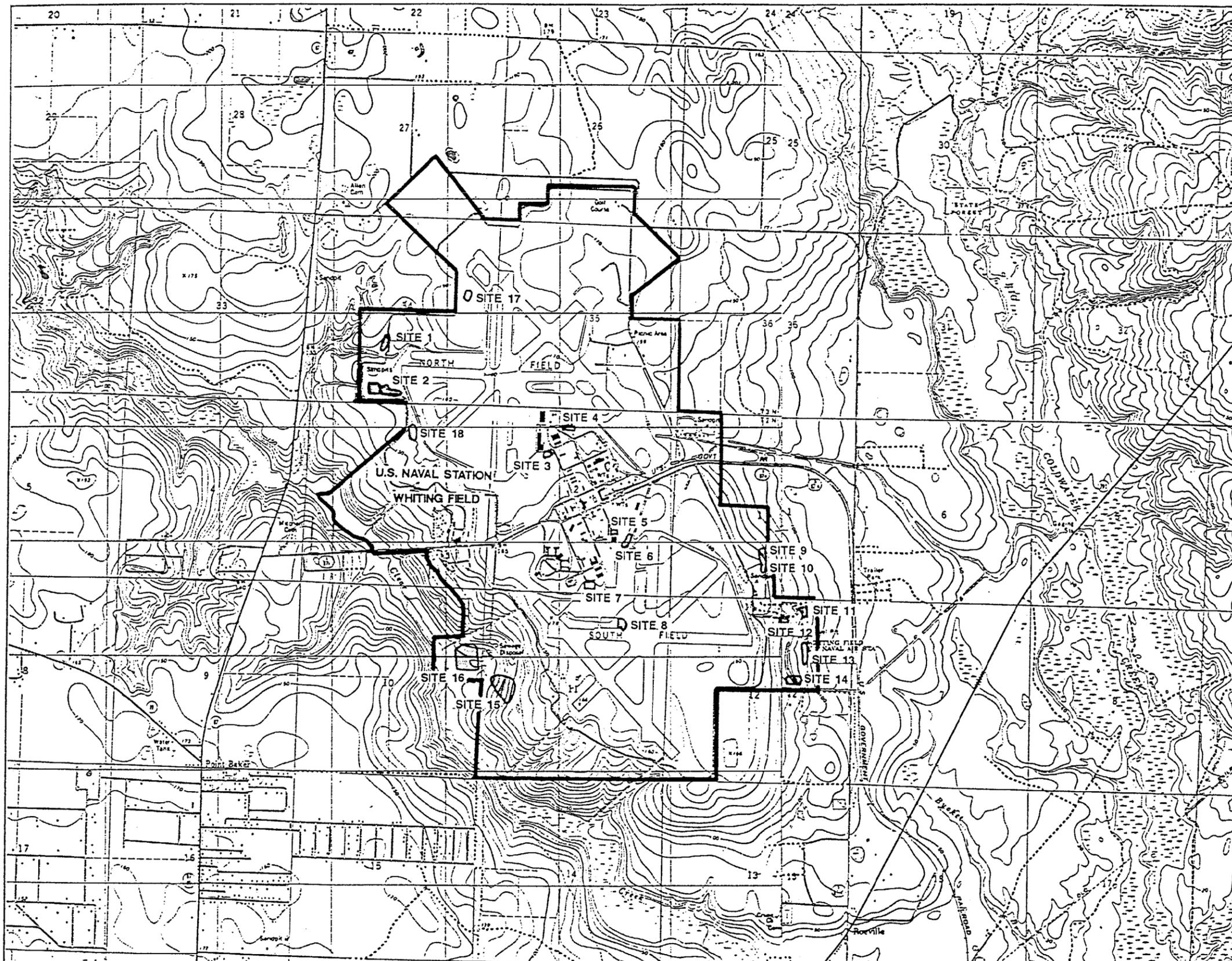
In addition, during 1985 one of the sites (Site 5, Battery Acid Seepage Pit) was investigated a under Consent Order with the FDER. Data from this investigation has been compiled in a report entitled *Detection and Monitoring Program, Battery Shop Site, NAS Whiting Field, Florida* (Geraghty & Miller, November 1985a).

The location of the 18 sites are shown in Figure 1-4. Each of the sites was evaluated with regard to contamination characteristics, migration pathways, and pollutant receptors. Table 1-1 summarizes the information collected on these sites.

Work conducted during the course of the Verification Study began with the collection and assimilation of existing data and literature pertinent to the project and included the findings from the IAS. The field work was performed in May and June of 1986. Sixteen monitor wells were installed at locations around the facility. One surface water, 16 groundwater, and 46 soil samples were then collected for chemical analyses.

Historical records indicate that throughout the years of operation, NAS Whiting Field has generated a variety of wastes related to pilot training, the operation and maintenance of aircraft along with ground support equipment, and the station's facility maintenance activities. Prior to the establishment of hazardous waste management programs and programs to recycle waste oil, most of the hazardous wastes were reportedly disposed of onsite. Waste materials were disposed either in dumpsters that were emptied into onsite disposal areas or they went into waste oil bowlers, which probably were used for firefighting training. Envirodyne Engineers (1985) estimated that thousands of gallons of wastes including waste paints, paint thinners, solvents, waste oils, waste gasoline, hydraulic fluids, aviation gasoline (AVGAS), tank bottom sludges, polychlorinated biphenyls (PCBs) transformer fluids, and paint stripping wastewater were potentially dumped into onsite disposal areas. These disposal areas consisted of natural or man-made depressions located within the confines of the air station. In addition to the waste materials routinely disposed of onsite in the disposal areas, additional materials were reportedly released onsite as the result of accidents or equipment failure.

The results of the Verification Study reported to SOUTHNAVFACENGCOCM by Geraghty & Miller (*Verification Study: Assessment of Potential Ground-Water Pollution at Naval Air Station Whiting Field*, December 1986) provided an incomplete assessment of the physical as well as the chemical conditions currently existing at NAS Whiting Field. Groundwater contamination was detected at some sites and not at others. The study concluded that many of the monitoring wells were not located downgradient of the intended study site and that additional work was needed to characterize the hydrogeologic conditions and the chemical contamination condi-



SOURCE:
 USGS QUADRANGLE MILTON NORTH, FLORIDA
 PHOTOREVISED 1987
 AND USGS QUADRANGLE HAROLD, FLORIDA 1973.

FIGURE 1-4
Location of Sites at
NAS Whiting Field



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

002281022

**Table 1-1
Summary of Potential Disposal Sites**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Site No.	Site Name and Type	Location	Period of Operation	Types of Material Disposed	Comments
1	Northwest Disposal Area (landfill)	North Field, west side	1943-1965	Refuse, waste paints, thinners, solvents, waste oils, and hydraulic fluids.	Secondary disposal area during this period; site covers 5 acres.
2	Northwest Open Disposal Area (landfill)	North Field, west side	1976-1984	Construction and demolition debris, tires, and furniture.	Former borrow pit location, commonly referred to as the "Wood Dump."
3	Underground Waste Solvent Storage Area (tank)	North Field, south of Building 2941	1980-1984	Waste solvents, paint stripping residue, and 120-gallon spill.	Wastes generated by paint stripping operations.
4	North AVGAS Tank Sludge Disposal Area	North Field, north of Tow Lane	1943-1968	Tank bottom sludge containing tetraethyl lead.	Sludge disposal in shallow holes near tanks.
5	Battery Acid Seepage Pit (contaminated soil)	South Field, near Building 1478	1964-1984	Waste electrolyte solution containing heavy metals and waste battery acid.	Pits located 110 feet from potable supply well (W-S2).
6	South Transformer Oil Disposal Area (contaminated soil)	South Field, Building 1478	1940's-1960's	PCB-contaminated dielectric fluid.	Disposal in "0-2" drainage ditch.
7	South AVGAS Tank Sludge Disposal Area (landfill and tanks)	South Field, west of Building 1406	1943-1968	Tank bottom sludge containing tetraethyl lead.	Sludge disposed in shallow holes near tanks.
8	AVGAS Fuel Spill Area (contaminated soil)	South Field, south of Building 1406	Summer 1972	AVGAS containing tetraethyl lead.	Fuel spill of about 25,000 gallons on an area of about 2 acres.
9	Waste Fuel Disposal Pit (landfill)	South Field, east side	1950's-1960's	Waste AVGAS containing tetraethyl lead.	Fuel disposed in former borrow pit.
10	Southeast Open Disposal Area (A) (landfill)	South Field, southeast area	1965-1973	Construction and demolition debris, waste solvents, paint, oils, hydraulic fluid, PCBs, pesticides, and herbicides.	Secondary disposal area during this period; site covers about 4 acres.

See notes at end of table.

**Table 1-1 (Continued)
Summary of Potential Disposal Sites**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Site No.	Site Name and Type	Location	Period of Operation	Types of Material Disposed	Comments
11	Southeast Open Disposal Area (B) (landfill)	South Field, southeast area	1943-1970	Construction and demolition debris, waste solvents, paint, oils, hydraulic fluid, and PCBs.	Secondary disposal area during this period; site covers about 3 acres.
12	Tetraethyl Lead Disposal Area (waste pile)	South Field, southeast area	May 1, 1968	Tank bottom sludge and fuel filters contaminated with tetraethyl lead.	Disposal area posted with warning; site consists of two earth covered mounds; 25 foot by 25 foot area.
13	Sanitary Landfill (landfill)	South Field, southeast area	1979-1984	Refuse, waste solvents, paint, hydraulic fluids, and asbestos.	Primary sanitary landfill, potentially received hazardous wastes the first year of operation.
14	Short-Term Sanitary Landfill (landfill)	South Field, southeast area	1978-1979	Refuse, waste solvents, oils, paint, and hydraulic fluids.	Primary sanitary landfill for brief period; relocated due to drainage problems.
15	Southwest Landfill (landfill)	South Field, southwest area	1965-1979	Refuse, waste paints, oils, solvents, thinners, asbestos, and hydraulic fluid.	Primary landfill for this time period; covers about 15 acres.
16	Open Disposal and Burning Area (landfill)	South Field, southwest area	1943-1965	Refuse, waste paints, oils, solvents, thinners, PCBs, and hydraulic fluid.	Primary disposal area for this time period; covers about 10 acres.
17	Crash Crew Training Area (contaminated soil)	North Field, west side	1951-Present	JP-4.	Waste fuels and some solvents ignited, then extinguished.
18	Crash Crew Training Area (contaminated soil)	North Field, west side	1951-Present	JP-4.	Waste fuels and some solvents ignited, then extinguished.

Notes: AVGAS = aviation gasoline.
PCB = polychlorinated biphenyls.

tions that exist at NAS Whiting Field. The Verification Study is the former IR program counterpart to the SI.

Of the 18 sites identified to date, 13 are scheduled for further study under the Navy's IR program. Due to the fact that it only received construction and demolition debris, Site 2, the Northwest Open Disposal Area, was judged to warrant no further consideration early in the IR program. Site 5, the Battery Acid Seepage Pit, was extensively studied in 1985 (Geraghty & Miller, 1985) in response to an FDER Consent Order (84-0253). Results indicated no significant contamination resulting from past activities at the Battery Acid Shop and the Consent Order was recommended to be rescinded on April 15, 1987. However, the presence of benzene in the existing monitoring wells surrounding the seepage pit warrants further consideration. As such, the investigation of benzene contamination around Site 5 is coupled with the field and laboratory investigation proposed for production well W-S2. Sites 4, 7, and 8 are slated for investigation and remediation, if necessary, under the Navy's Underground Storage Tank (UST) program and, therefore, are not incorporated in the Navy's IR program. Table 1-2 presents a summary of past and projected investigative programs for the 18 sites within the RI/FS and UST programs.

The Jordan Phase I RI Workplan (June 1990) provides a summary of the regional and installation-specific environmental setting, current and historical industrial operations, and summary of the verification study, and the Site 5, Battery Shop data, which will not be repeated in the technical memorandum. As appropriate, data from these sources has been incorporated into the assessment.

1.2 OBJECTIVES OF THE GROUNDWATER SCREENING PROGRAM. A groundwater quality screening program was carried out as a component of the Phase I RI subsurface exploration program at NAS Whiting Field. The other components of the subsurface exploration program were geophysical logging, well installation and aquifer testing, groundwater elevation measurement, and piezocone penetrometer (PCPT) testing. The physical measurements taken and the interpretation of the subsurface geology and hydrogeology have been presented in Technical Memoranda Number 1 and Number 2. The overall purpose of the subsurface exploration was to more completely characterize the hydrogeological setting in the vicinity of the identified sites of potential groundwater contamination as well as the hydrogeological setting of the industrial area in the capture zone of the installation water supply wells. These studies focused especially on delineating the lateral and vertical extent of a semiconfining to confining clay layer that potentially underlies NAS Whiting Field. Boring logs generated during the Verification Study (Geraghty and Miller, 1986) suggest that a laterally extensive clay layer exists at a depth of 90 to 110 feet below land surface (bls) throughout most of the Air Station and that the layer may be more than 10 feet thick over much of its extent. An additional focus of the Phase I RI was more precise delineation of groundwater flow direction. At a number of sites, Verification Study well placement did not appear to be truly downgradient of identified disposal sites. Verification Study wells also were screened below clay layers encountered during drilling. Because of that, the piezometric surface as well as the contamination status of the water table component of the aquifer was largely unexplored. The Phase I groundwater quality investigation was conducted as an *in situ* screening program in conjunction with PCPT soundings to cost effectively screen the overall installation in order to limit the number of required monitoring wells and to maximize the effectiveness of their placement

**Table 1-2
Summary of Site Investigations**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Site Number	Site Name	Previous Studies			Ongoing RI/FS	Navy's UST Program
		IAS	Verification Study	Consent Order		
1	Northwest Disposal Area	*	*		*	
2	Northwest Open Disposal Area	*				
3	Underground Waste Solvent Storage Area	*	*		*	
4	North AVGAS Tank Sludge Disposal Area	*	*			*
5	Battery Acid Seepage Pit	*		*		
6	South Transformer Oil Disposal Area	*	*		*	
7	South AVGAS Tank Sludge Disposal Area	*	*			*
8	AVGAS Fuel Spill Area	*	*			*
9	Waste Fuel Disposal Pit	*	*		*	
10	Southeast Open Disposal Area (A)	*	*		*	
11	Southeast Open Disposal Area (B)	*	*		*	
12	Tetraethyl Lead Disposal Area	*	*		*	
13	Sanitary Landfill	*	*		*	
14	Short-Term Sanitary Landfill	*	*		*	
15	Southwest Landfill	*	*		*	
16	Open Disposal and Burning Area	*	*		*	
17	Crash Crew Training Area		*		*	
18	Crash Crew Training Area		*		*	

Notes: IAS = Initial Assessment Study.
RI/FS = Remedial Investigation/Feasibility Study.
UST = underground storage tank.
AVGAS = aviation gasoline.

in the upper and/or lower aquifer zones. As outlined in Section 2.1, and described more fully in the Workplan (Volume I) and Sampling and Analysis Plan (Volume II) (Jordan, 1990), groundwater sampling for volatile organic compounds (VOCs) and metals was accomplished by *in situ* placement of a Bengt-Arne-Torstensson (BAT) sampling system based on results of PCPT logs. Figure 1-5 represents overall rationale and objectives of the Phase I groundwater screening program. VOCs and metals were selected for *in situ* screening because these analytes tend to be mobile in groundwater and because of the finding of VOCs and metals during the Verification Study and in sampling of the installation production wells. Specific objectives are as follows:

- evaluate the upper water table contamination status and further delineate the production zone VOC contamination status at Site 3, Underground Waste Solvent Storage Area release;
- confirm the absence of contamination in the water table aquifer component at Site 2, Northwest Open Disposal Area rubble dump;
- screen the upper and lower components of the aquifer downgradient of the following sites to determine if any release has occurred,
 - Site 1, Northwest Disposal Area (former landfill),
 - Site 9, Waste Fuel Disposal Pit,
 - Site 10, Southeast Open Disposal Area (A),
 - Site 11, Southeast Open Disposal Area (B),
 - Site 12, Tetraethyl Lead Disposal Area,
 - Site 13, Sanitary Landfill, 1979-1984,
 - Site 14, Short-term Sanitary Landfill, 1978-1979;
- evaluate the effect of any confining layers on contaminant migration and the extent of releases from the Southwest Landfill (Site 15) and adjoining Open Disposal and Burning Area (Site 16);
- evaluate whether surface clay layers prevent groundwater contamination resulting from firefighting training exercises at the Crash Crew Training Areas, Sites 17 and 18; and
- determine the probable direction of unidentified sources of VOC contamination from the production wells W-S2 and W-W3 (South and West wells) and overall contamination status of the upper and lower zones of the aquifer in the Industrial Area of NAS Whiting Field.

To accomplish these objectives, 40 shallow and 28 deep BAT samples were collected and analyzed during the period February to May 1991. Shallow BAT samples were collected at the surface or near the surface of the water table. Deep samples were collected in the production zone of the sand-and-gravel aquifer. These data are interpreted by site or site group in Section 3.0 of this Memorandum.

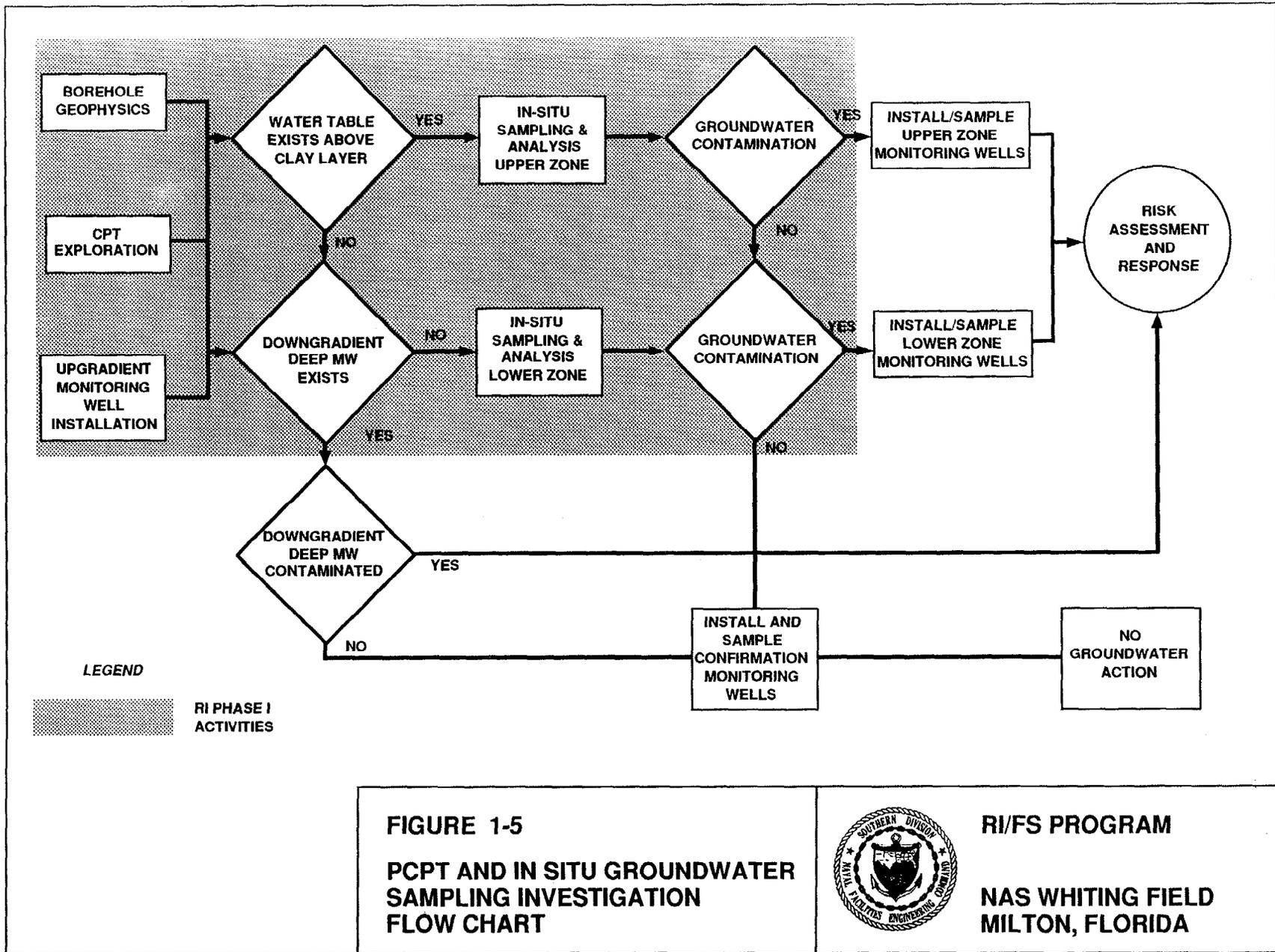


FIGURE 1-5
PCPT AND IN SITU GROUNDWATER
SAMPLING INVESTIGATION
FLOW CHART



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

2.0 FIELD PROGRAM SUMMARY

2.1 Bengt-Arne-Torstensson (BAT) SAMPLING TECHNIQUE. The BAT groundwater sampling program was conducted in conjunction with the PCPT subsurface exploration program to verify the contamination of groundwater downgradient of each site. Based on subsurface exploration data (lithology and pore pressure) collected from the PCPT soundings, the depth of the *in situ* BAT groundwater sample was determined.

Upon determination of the groundwater sampling location, a drilling rig was used to advance a borehole (using the mud rotary technique) to approximately 2 to 3 feet above the desired sampling location. A sampling device connected to a pushrod was lowered to the bottom of the borehole and was hydraulically or manually driven 2 to 3 feet to the sampling interval. The sampling device was driven beyond the bottom of the borehole to prevent drilling mud from being sampled. Once the sampling depth was reached, the pushrod was retracted from the borehole approximately 6 inches, opening the sampling device to the formation fluids.

A hermetically sealed evacuated vial was then lowered into the pushrod through the use of a weighted, sampling assembly. The assembly mechanism contained a double-ended hypodermic needle, which first pierced the well tip seal, followed immediately thereafter by the vial seal, located in the vial screw cap. Formation fluids were drawn into the vial until the pressure in the vial was equivalent to the formation pore fluid pressure. When the sampling assembly was pulled from the rod tip, the needle was pulled from both disks, and both the vial and tip were re-sealed.

Thus, a sample was obtained in a closed system, with little opportunity for cross contamination, human contact, volatilization, or chemical changes due to oxidation-reduction potential and pH changes resulting from exposure to surface pressures of the atmosphere. Although some headspace existed in the vial, this headspace is equivalent to the pore fluid pressure and research has shown that the sample integrity is greater than if sampled by more conventional methods, such as a manual bailer.

The groundwater samples were shipped to Savannah Laboratories and Environmental Services, Inc. (Savannah), Tallahassee, Florida, for volatile organic compound and metals analysis. Three 40 milliliter (ml) vials were collected for each volatile organic sample and four 130 ml volumes of groundwater were collected for each metals sample.

2.2 EXPLORATION LOCATIONS. A total of 68 groundwater samples were collected by Williams and Associates (Clearwater, Florida) from Sites 1, 2, 3, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and production well areas S2 and W3. Groundwater sample identification and sampling depths are summarized in Table 2-1. *In-situ* BAT sampling locations and results are shown graphically in Figures 2-1 through 2-7. Of the 68 samples collected, 6 were duplicate samples and 7 were optional samples. The seven optional *in-situ* BAT groundwater samples were collected from Sites S2 and 15. Samples at Site S2 were collected from 180 feet bls to ascertain the vertical extent of contamination in the production zone of the sand-and-gravel aquifer that may have resulted from vertical migration of

**Table 2-1
In-Situ Groundwater Samples and Depths**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Site Number	Sample Number	Sampling Depth (feet bls)
1	WHF-01-WP-01-01	¹ 88.0
1	WHF-01-WP-01-01	¹ 98.0
1	WHF-01-WP-01-01	¹ 109.0
1	WHF-01-WP-01-01	130.0
2	WHF-02-WP-01-01	99.0
3	WHF-03-WP-01-01	118.0
	WHF-03-WP-01-01A	118.0
	WHF-03-WP-01-02	183.0
	WHF-03-WP-01-02A	183.0
	WHF-03-WP-02-01	117.0
	WHF-03-WP-02-02	180.0
9	WHF-09-WP-01-01	100.0
10	WHF-10-WP-01-01	102.0
10	WHF-10-WP-02-01	102.0
10	WHF-10-WP-02-02	152.0
10	WHF-10-WP-01-01	102.0
11	WHF-11-WP-01-01	92.0
11	WHF-11-WP-01-02	132.0
12	WHF-12-WP-01-01	102.0
12	WHF-12-WP-01-02	162.0
13	WHF-13-WP-01-01	82.0
13	WHF-13-WP-01-01	82.5
13	WHF-13-WP-02-01	132.0
14	WHF-14-WP-01-01	107.0
14	WHF-14-WP-01-02	160.0
15	WHF-15-WP-01-01	55.0
15	WHF-15-WP-02-01	33.0
15	WHF-15-WP-02-02	72.0
15	WHF-15-WP-03-01	50.0
15	WHF-15-WP-04-01	40.0
16	WHF-16-CPT-01-01	28.0
16	WHF-16-CPT-01-02	82.5
16	WHF-16-WP-02-01	40.0
16	WHF-16-WP-02-02	100.0
17	WHF-17-WP-01-01	128.0

See notes at end of table.

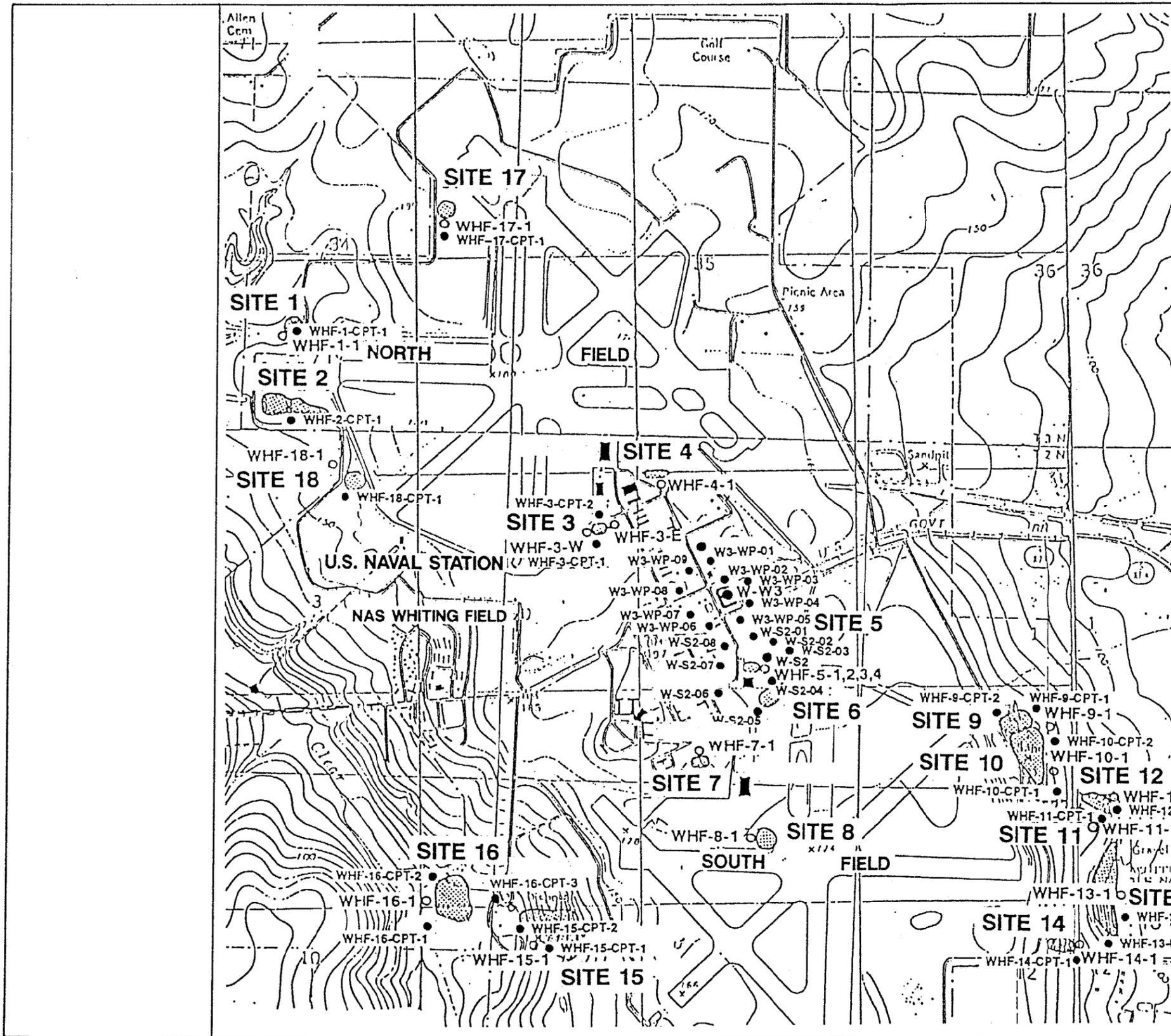
Table 2-1 (Continued)
***In-Situ* Groundwater Samples and Depths**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Site Number	Sample Number	Sampling Depth (feet bls)
18	WHF-18-WP-01-01	95.0
18	WHF-18-WP-01-01A	95.0
18	WHF-18-WP-01-02	183.0
18	WHF-18-WP-01-02A	183.0
S2	WHF-S2-WP-01-01	114.0
S2	WHF-S2-WP-01-02	180.0
S2	WHF-S2-WP-02-01	118.0
S2	WHF-S2-WP-03-01	133.0
S2	WHF-S2-WP-04-01	121.0
S2	WHF-S2-WP-04-02	180.0
S2	WHF-S2-WP-05-01	130.5
S2	WHF-S2-WP-05-02	180.0
S2	WHF-S2-WP-06-01	126.0
S2	WHF-S2-WP-06-02	180.0
S2	WHF-S2-WP-07-01	127.5
S2	WHF-S2-WP-08-01	122.0
S2	WHF-S2-WP-08-02	180.0
W3	WHF-W3-WP-01-01	117.0
W3	WHF-W3-WP-01-02	182.0
W3	WHF-W3-WP-02-01	125.0
W3	WHF-W3-WP-02-02	182.0
W3	WHF-W3-WP-03-01	126.0
W3	WHF-W3-WP-03-02	182.0
W3	WHF-W3-WP-04-01	127.0
W3	WHF-W3-WP-04-02	182.0
W3	WHF-W3-WP-05-01	132.0
W3	WHF-W3-WP-05-02	182.0
W3	WHF-W3-WP-06-01	¹ 115.0
W3	WHF-W3-WP-06-01	¹ 149.0
W3	WHF-W3-WP-06-02	180.0
W3	WHF-W3-WP-07-01	132.0
W3	WHF-W3-WP-07-02	182.0
W3	WHF-W3-WP-08-01	132.0
W3	WHF-W3-WP-08-02	182.0
W3	WHF-W3-WP-09-01	133.0
W3	WHF-W3-WP-09-02	183.0

¹No water.

Note: bls = below land surface.



LEGEND

- Existing Monitoring Well
- PCPT/BAT Exploration

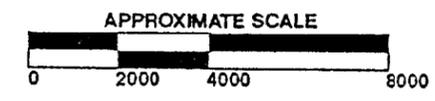


FIGURE 2-1
LOCATION OF EXISTING
MONITORING WELLS & PHASE I
PCPT/BAT EXPLORATIONS

RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

00228I03Z

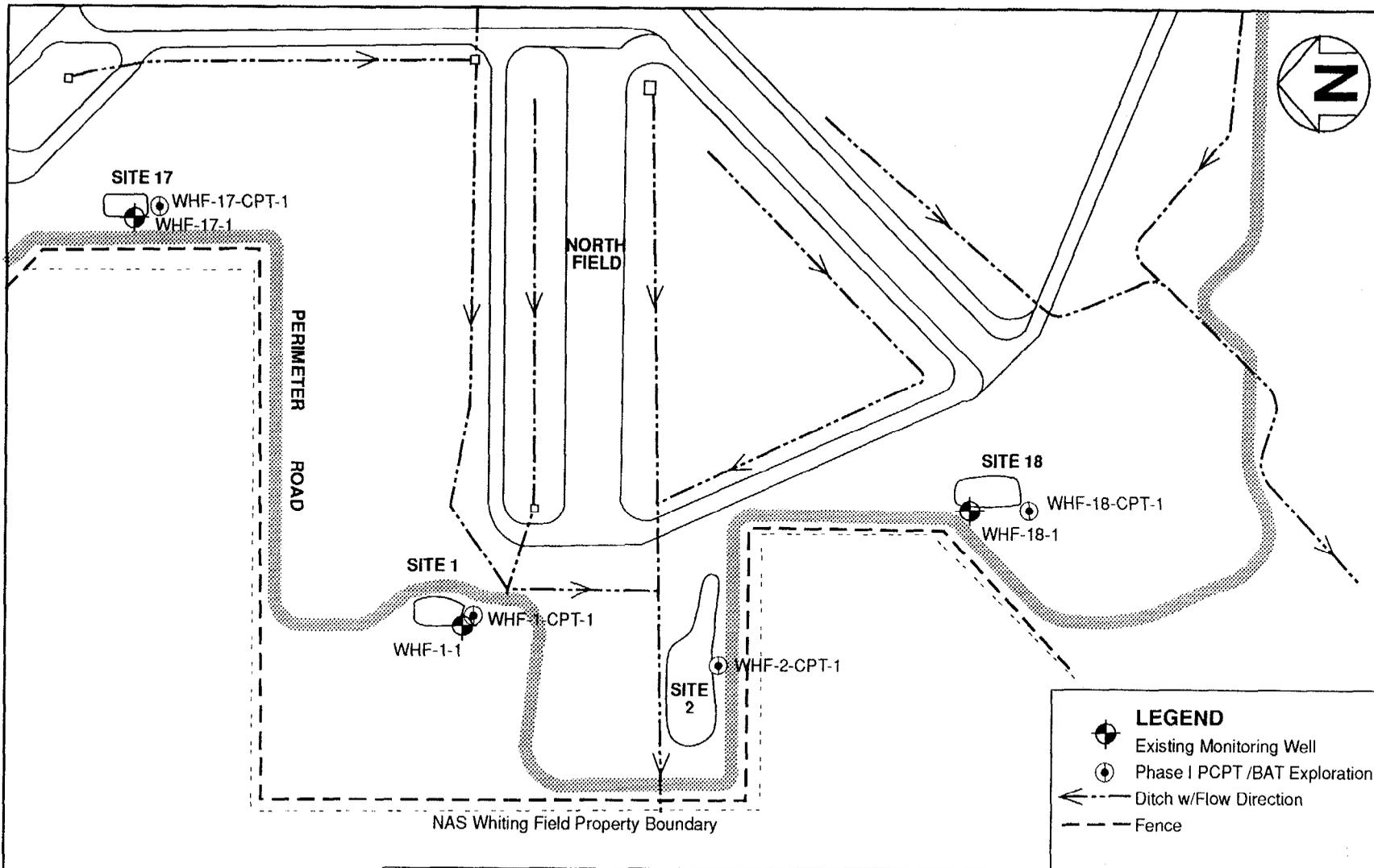
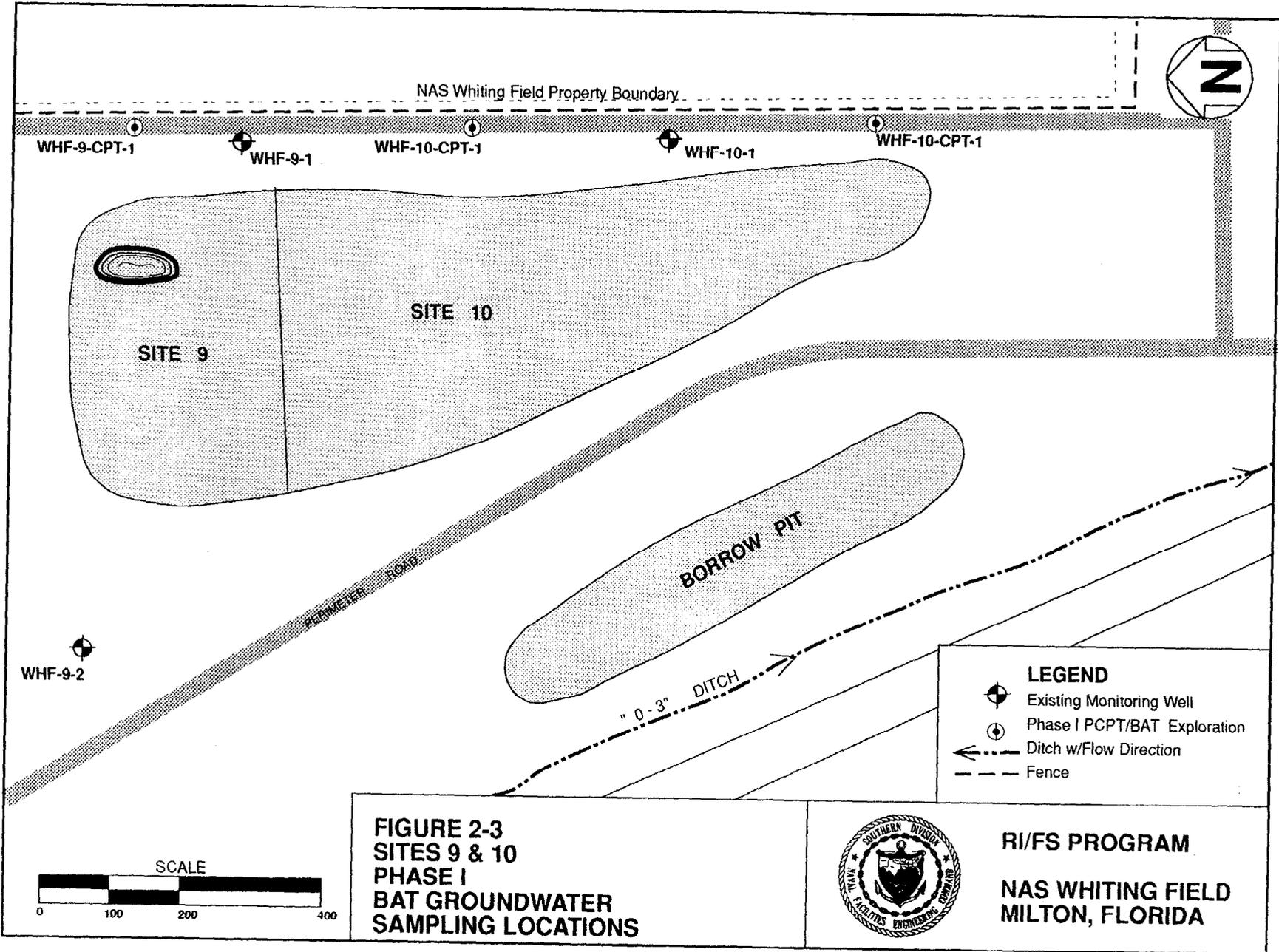


FIGURE 2-2
SITES 1, 2, 17, & 18
PHASE I
BAT GROUNDWATER
SAMPLING LOCATIONS



RI/FS PROGRAM

NAS WHITING FIELD
MILTON, FLORIDA



**FIGURE 2-3
SITES 9 & 10
PHASE I
BAT GROUNDWATER
SAMPLING LOCATIONS**



**RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA**

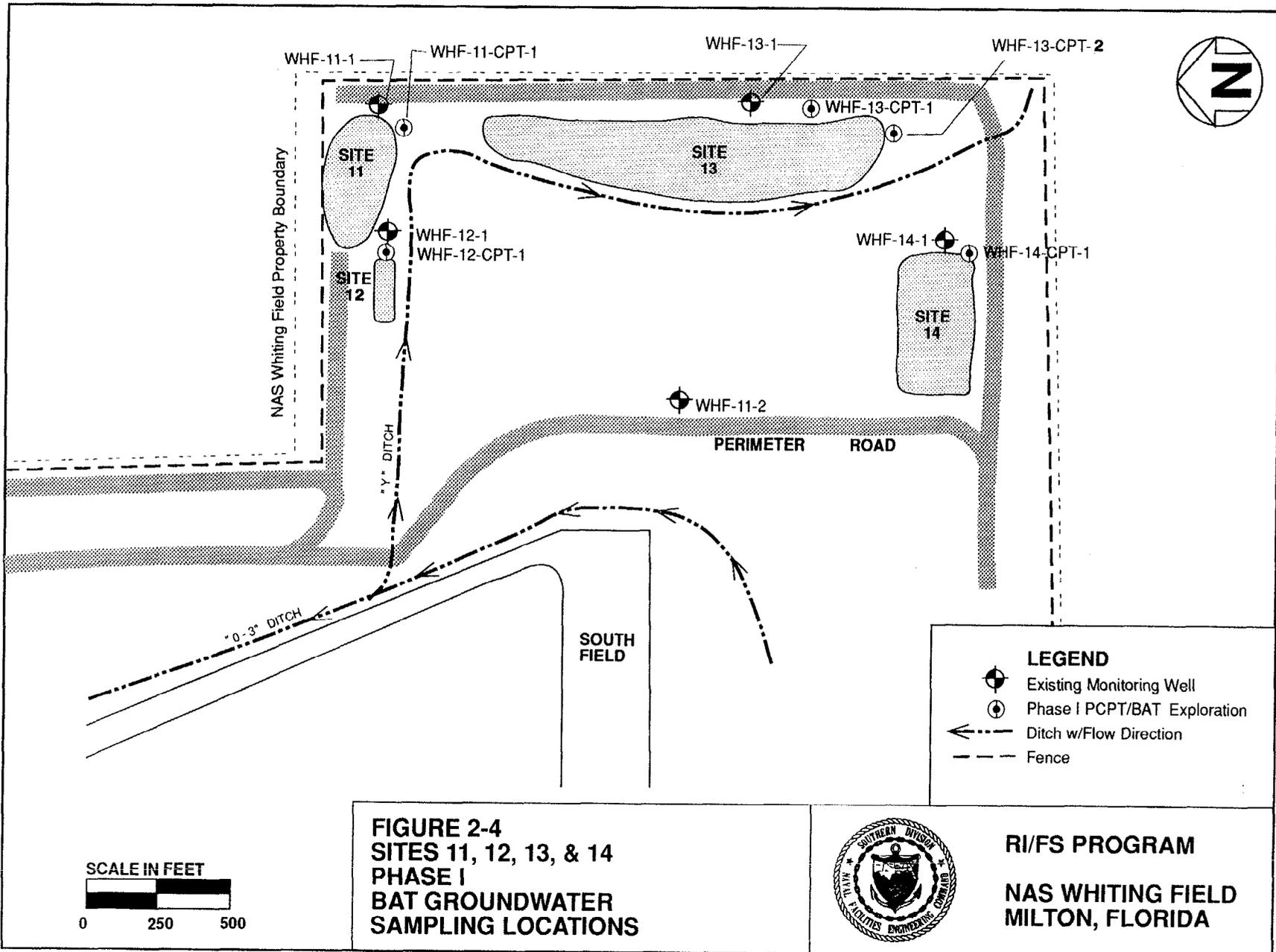
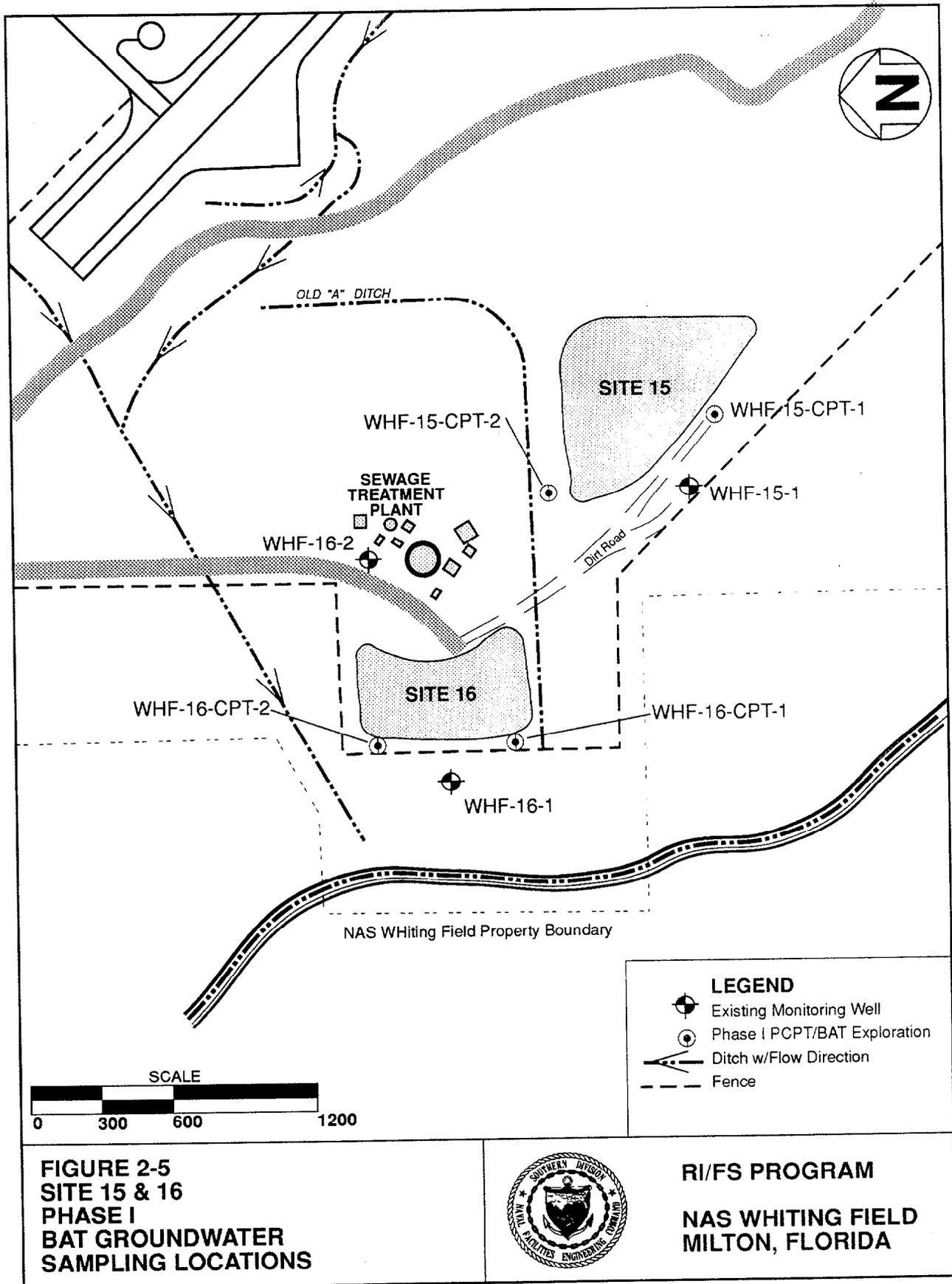


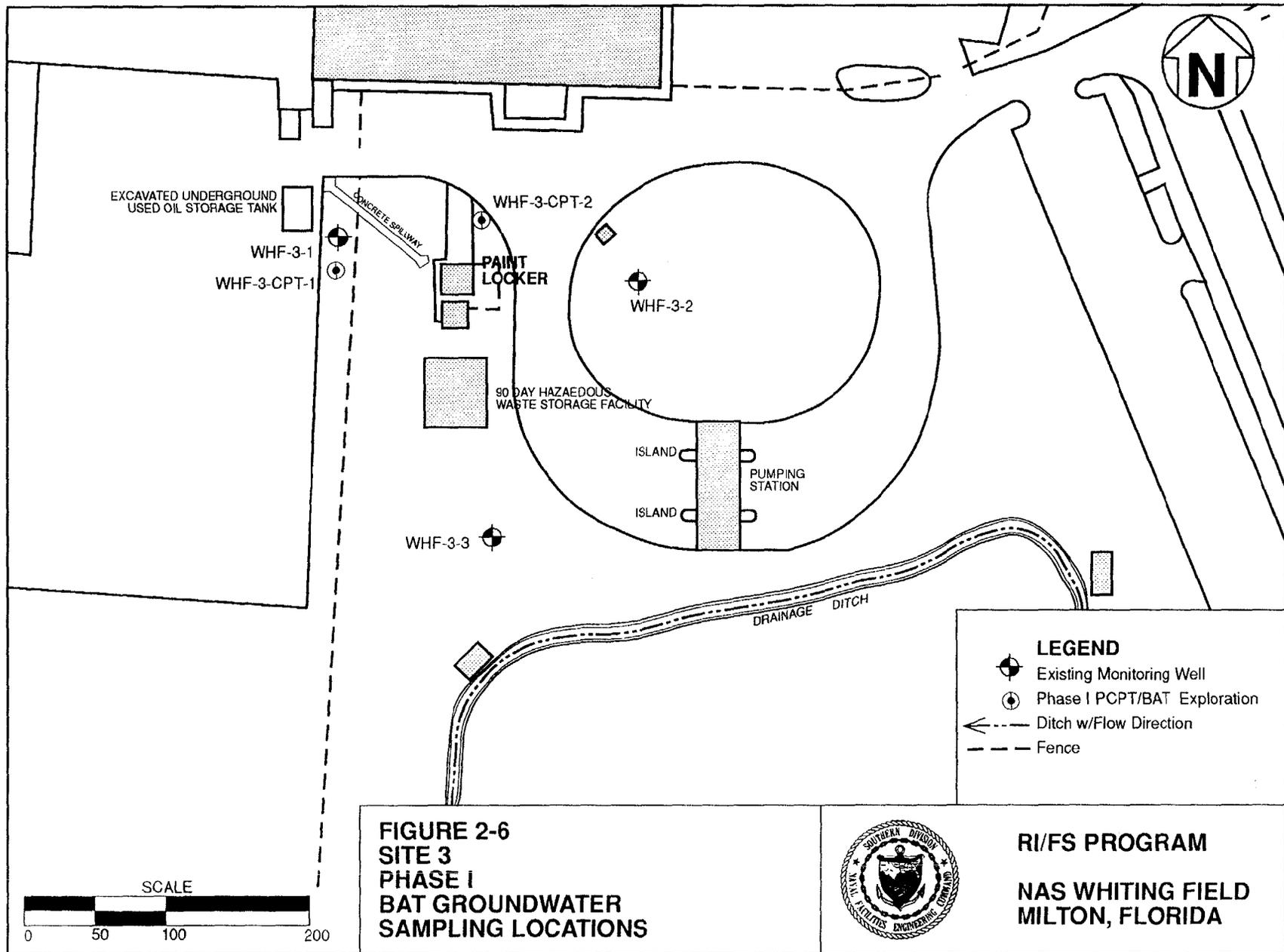
FIGURE 2-4
SITES 11, 12, 13, & 14
PHASE I
BAT GROUNDWATER
SAMPLING LOCATIONS

SCALE IN FEET
 0 250 500



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA





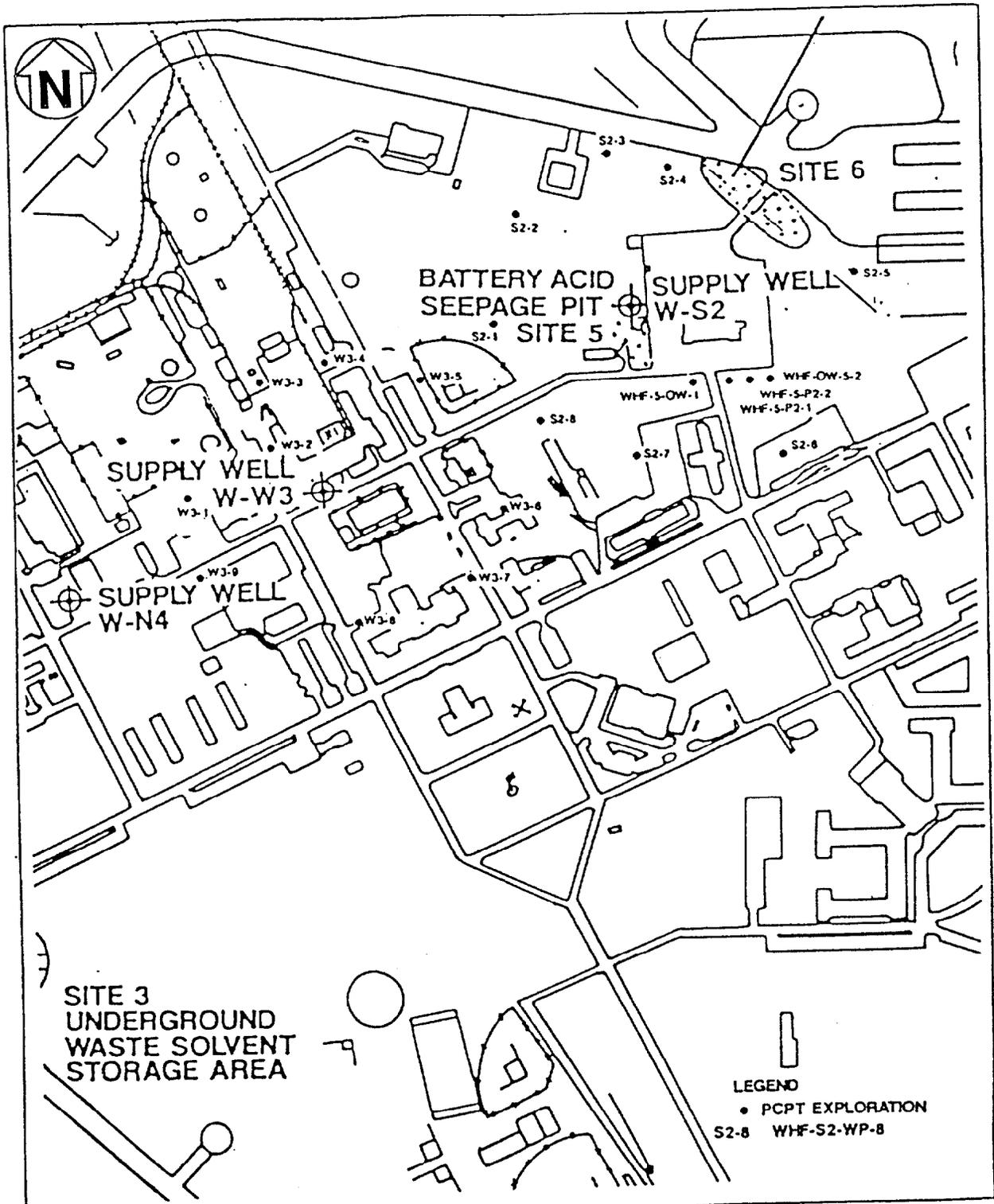


FIGURE 2-7

PCPT AND BAT EXPLORATIONS IN THE PRODUCTION WELL AREA



R/FS PROGRAM

NAS WHITING FIELD
MILTON, FLORIDA

contaminants detected in shallow groundwater samples at Site S2 locations S2-01, S2-04, S2-05, S2-06, and S2-08, previously. The remaining two optional BAT groundwater samples were collected from the shallow groundwater zone at Site 15.

2.3 QUALITY ASSURANCE PROGRAM AND DATA QUALITY ASSESSMENT.

2.3.1 Sample Handling, Delivery, Chain-of-Custody, and Quality Control Samples

Collection of groundwater samples was performed in accordance with the procedures outlined in the Site-Specific Quality Assurance Plan Addendum and Quality Assurance Plan Field Program of June 1990.

All samples were properly preserved, placed in coolers, and packed with bagged ice immediately after their collection and remained in the custody of the field operations leader until shipment to the laboratory. All samples were shipped, complete with chain-of-custody forms, to Savannah Laboratories and Environmental Services, Inc., for analysis. Upon arrival at Savannah, the chain-of-custody form and preservation were checked with the contents of each cooler by Savannah personnel. After verification, the chain-of-custody form was signed by Savannah personnel and the samples accepted for analysis.

Review of the field notebooks and chain-of-custody forms did not indicate any nonconformance relative to sample handling. Table 2-2 tabulates the field quality control (QC) samples collected for analysis. These include field duplicate, equipment rinsate blanks, and VOC trip blanks for each VOC water sample shipment. All required field QC samples were collected in conformance with the requirements of the USEPA, NEESA, and the FDER-approved Jordan Quality Assurance Plans and the June 1988 NEESA *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program* (NEESA Document 20.2-047B).

Review of the field duplicate results showed adequate agreement for VOCs and inorganic compounds.

The target compound list (TCL) VOC carbon disulfide was detected in one trip blank, one rinsate blank and all four duplicate samples at concentrations ranging from 7.2 to 170 micrograms per liter ($\mu\text{g}/\ell$). Carbon disulfide is an industrial solvent and intermediate reactant in the rubber manufacturing business. Because carbon disulfide is used in the quenching of the butyl rubber septa employed in the BAT VOC sample vial, it appears to have leached into the groundwater samples collected for VOC analysis.

Another TCL VOC, acetone, was detected in the trip blanks, four rinsate blanks and all four duplicate samples at concentrations ranging from 13 to 300 $\mu\text{g}/\ell$. As discussed in Technical Memoranda 3, 4, and 6, the field decontamination of sampling equipment with pesticide grade isopropanol appears to be the source of the acetone contamination in the QC samples. Acetone has been interpreted to result from transformation of the pesticide grade isopropanol during storage and use. No distribution pattern at any of the sampling sites can be interpreted that would suggest environmental acetone contamination.

2.3.2 Chemical Analysis Data Quality Assessment VOC groundwater samples were analyzed by USEPA SW-846 Method 8240 using a 25 ml sample volume in order to meet FDER groundwater maximum contaminant levels (MCLs). VOC analysis was conducted

**Table 2-2
Field Quality Control Samples and Results**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Control Sample	Results
<u>Field Duplicates</u>	<u>Inorganics</u>
WHF-12-WP-01-01/01A	Barium 11.5/11.6
	Calcium 695/36.0
	Copper ND/52.5
	Iron 431/463
	Sodium 2390/2200
	Zinc 134/128
WHF-9-WP-01-01/01A	Aluminum 1,070/325
	Barium 14.6/ND
	Calcium 1,310/1,160
	Chromium 88.5/42.2
	Copper 80/33.4
	Iron 5,900/3,330
	Lead 8.4/5.2
	Manganese 40.2/26.6
	Nickel 102/59.1
	Sodium 6,180/4,400
Zinc 281/161	
WHF-18-WP-01-01/01A	Aluminum 238/1,130
	Barium 346/353
	Calcium 5,180/5,140
	Chromium 17.5/22.0
	Copper 28/25
	Iron 1,840/1,310
	Lead 3/3
	Magnesium 8,540/8,440
	Manganese 82.9/81.0
	Mercury 0.29/0.30
	Sodium 5,770/5,830
	Zinc 178/177
	WHF-18-WP-01-02/02A
Barium 31.5/84.4	
Calcium 2,100/3,140	
Chromium 47.2/436	
Copper 98.5/471	
Iron 19,200/98,600	
Lead 6.9/36.9	
Magnesium 548/1,140	
Manganese 179/315	
Nickel 119/519	
Sodium 7,210/9,440	
Vanadium 20.7/104	
Zinc 466/1,610	

See notes at end of table.

Table 2-2 (Continued)
Field Quality Control Samples and Results

Technical Memorandum No. 5
 NAS Whiting Field
 Milton, Florida

Control Sample	Results
<u>Field Duplicates</u> —continued	<u>Organics</u>
WHF-3-WP-01-01-01/01A	Acetone 61/50 Carbon disulfide 13/7.2 1,2-Dichloroethylene 250/250 1,2-Dichloroethane 34/34 Trichloroethylene 11/9.2 Benzene 1,800/2,000 Ethyl benzene 97/73 Xylene 310/230
WHF-3-WP-01-02/02A	Acetone 22/19 Carbon disulfide 7.8/56
WHF-18-WP-01-02/02A	Acetone 130/57 Carbon disulfide 75/110
WHF-18-WP-01-01/01A	Acetone 84/59 Carbon disulfide 110/87
<u>Rinsate Blanks</u>	<u>Inorganics</u>
WHF-12-EB-01	Sodium 2,800
WHF-02-EB	No inorganics detected
WHF-18-EB	Iron 96.4
WHF-01-EB	Sodium 41,200
WHF-17-EB	Calcium 505
	<u>Organics</u>
WHF-12-EB-1	No VOCs detected
WHF-01-EB	Acetone 180 Carbon disulfide 110
WHF-S2-EB	Acetone 40
WHF-17-EB	Acetone 300
WHF-S2-EB-1	No VOCs detected
WHF-S2-EB-2	No VOCs detected
WHF-3-EB	No VOCs detected
WHF-18-EB	No VOCs detected
WHF-02-EB	Acetone 43
<u>Field Blanks</u>	<u>Inorganics</u>
Field Blank	No inorganics detected
	<u>Organics</u>
Field Blank	No VOCs detected

See notes at end of table.

Table 2-2 (Continued)
Field Quality Control Samples and Results

Technical Memorandum No. 5
 NAS Whiting Field
 Milton, Florida

Control Sample	Results
<u>Trip Blanks</u>	<u>Organics</u>
WHF-16-CPT-1-TB	Carbon disulfide 170
WHF-15-TB-1	No VOCs detected
WHF-16-TB-2	No VOCs detected
WHF-S2-TB-1	No VOCs detected
WHF-W3-TB-01	No VOCs detected
WHF-W3-TB-02	No VOCs detected
WHF-W3-TB-03	No VOCs detected
WHF-W3-TB-04	No VOCs detected
WHF-W3-TB-05	No VOCs detected
WHF-12-TB-01	No VOCs detected
WHF-14-TB-01	No VOCs detected
WHF-10-TB-01	No VOCs detected
WHF-02-TB	No VOCs detected
WHF-17-TB	No VOCs detected
WHF-S2-TB	Acetone 13
WHF-15-TB	No VOCs detected
WHF-01-TB	Acetone 19
WHF-02-TB	No VOCs detected

Notes: All concentrations are presented in micrograms per liter ($\mu\text{g}/\text{L}$).

ND = not detected.

VOCs = volatile organic compounds.

as a screening analysis at Naval Energy and Environmental Support Activity (NEESA) QC Level E. Target analyte list (TAL) metals were analyzed using the USEPA Contract Laboratory Inorganics Protocol at NEESA QC Level C.

The analytical results presented in Appendices A and B were evaluated relative to meeting NEESA Level C (inorganics) and E (VOCs) QC criteria. Level C criteria are outlined in Table 2-3 and described in Section 7.3.2 of NEESA (1988) document 20.2-047B. Data review indicated that the laboratory met all analytical QC criteria for organic and inorganic analyses. Holding times were met for all sample lots.

2.3.3 Data Quality Objectives (DQOs) Assessment The quality and completeness of the field sampling data generated during the field program met the established field QC criteria and were traceable to sample location. The data generated, therefore, meets the Level I field screening and Level C and E DQOs established for the RI. The Level C data is adequate for use in site characterization and evaluation whereas the Level E data is adequate for site screening of groundwater.

No loss of analytical data due to rejection occurred in the RI analytical program. Detection of the VOC carbon disulfide in the QC samples appears to be a result of the leaching of this VOC from the butyl rubber septum in the BAT sample vials. Detection of acetone in the QC appears to be an artifact of the decontamination procedure. Based on the assessment of the analytical data, the data are acceptable for use in the RI characterization and screening.

Table 2-3
Laboratory Quality Control Criteria

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Analytes	Quality Control Criteria
Organic analytes	<ol style="list-style-type: none">1. Surrogate recovery limits for VOC, SVOCs, pesticides, and PCBs2. Matrix spike/matrix spike duplicate (MS/MSD)3. Method blanks and method blank spikes4. GC/MS tuning results5. Initial and continuing calibration6. Internal standard area (VOCs and SVOCs)7. Second column confirmation results for gas chromatography8. Holding times
Metals and elements	<ol style="list-style-type: none">1. Initial and continuing calibration2. Blanks3. Digestion method blanks4. ICP interference checks5. MS/MSD recovery and agreement6. Post digestion spike recovery ICP7. Post digestion spike recovery graphite furnace atomic absorption8. Duplicate agreement9. Method blanks spike recovery10. Holding times
Cyanide	<ol style="list-style-type: none">1. Blanks spike2. Method blanks3. MS/MSD4. Calibration check percent RSD for initial and continuing calibration5. Holding time

Notes: VOCs = volatile organic chemicals.
SVOCs = semivolatile organic chemicals.
PCBs = polychlorinated biphenyls.
MS/MSD = matrix spike/matrix spike duplicate.
GC/MS = gas chromatography/mass spectroscopy.
ICP = inductively coupled argon plasma.
RSD = relative standard deviation.

3.0 RESULTS AND INTERPRETATION

The purpose of this section is to present and interpret the site-specific results of the *in-situ* groundwater program conducted as a component of the Phase I RI. This section is organized to present and interpret the data for sites grouped according to spatial and hydrogeological relationships. As such, the subsections describe results for the industrial area in the vicinity of the base water supply production wells and Site 3 (the northern industrial area); Sites 15 and 16 (the Southwest part of NAS Whiting Field); Sites 1, 2, 17, and 18 (the Northwestern part of NAS Whiting Field); and Sites 9, 10, 11, 12, 13, and 14 (the Eastern part of NAS Whiting Field). This organization and order of presentation also addresses the site groups in order of highest priority relative to extent of groundwater contamination.

3.1 INTERPRETATION OF RESULTS. Because the *in situ* water quality samples have not been collected from developed monitoring wells, the data are appropriate for preliminary screening but would not support risk assessment conclusions or decision making relative to response actions. In addition, comparison of analyte concentrations to Florida or Federal MCLs cannot be done directly because the *in situ* sampling procedure does not provide samples that can be used to identify a verified violation of standards. State and Federal standards and criteria for metals and VOCs in groundwater are presented as Table 3-1 for comparison, however.

3.1.1 Volatile Organic Compounds VOC screening was conducted as described in Section 2.0 by gas chromatography/mass spectroscopy (GC/MS) analysis method SW-846 No. 8240 using a 25 ml sample volume in order to achieve a detection limit of 1 µg/l for benzene and 3 µg/l for several other halogenated VOCs (see Table 3-1). This represents a modification in the Workplan. The rationale for the change was to meet Florida groundwater MCLs that are more stringent than Federal for several chemicals. The Florida MCL is below the standard quantification limit for several VOCs as shown in Table 3-1. Because that change in procedure is not in accordance with USEPA Contract Laboratory Program (CLP) protocol, and because the *in-situ* sampling procedure only justified a screening analysis, VOC results were reported at NEESA QC Level E. This change in DQO from NEESA QC level C and D was approved by FDER and USEPA Region IV.

The complete database of VOC screening results are summarized in Appendix A. The complete database and QC results are appended as Appendix A. Detection limits achieved are presented in Table 3-2. For interpretive purposes, groundwater VOC data are displayed graphically in Sections 3.2 through 3.5.

As discussed in the data quality assessment (Section 2.3), two artifacts are prevalent in the VOC data as a result of the decontamination and sampling procedures. Neither significantly affect the interpretation for screening purposes. Forty-two of 56 environmental samples contained acetone at concentrations ranging from 6 µg/l to 320 µg/l. Field decontamination of the BAT sampling ampules using pesticide grade isopropanol and organic free water was required. The acetone has been interpreted to result from transformation of the pesticide grade isopropanol decontamination fluid during storage and use. No distribution pattern at any of the sampling sites can be interpreted that would suggest an

**Table 3-1
Federal and State of Florida Groundwater Standards for
Volatile Organic Compounds in Groundwater¹**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Analyte	Federal Standards ²		Florida Standards ³	
	MCL ($\mu\text{g}/\ell$)	MCLG ($\mu\text{g}/\ell$)	Primary ($\mu\text{g}/\ell$)	Secondary ($\mu\text{g}/\ell$)
Volatile organic compounds				
Chloromethane				
Bromomethane				
Vinyl chloride	2	0	1	
Chloroethane				
Methylene chloride				
Acetone				
Carbon disulfide				
1,1-Dichloroethene (total)			100	
1,2-Dichloroethene (trans)	^{4,2} 100			
1,2-Dichloroethene (cis)	^{4,2} 70	70		
Chloroform				
1,2-Dichloroethane	² 5	0	3	
2-Butanone				
1,1,1-Trichloroethane	200	200	200	
Carbon tetrachloride	5	0	3	
Vinyl acetate				
Bromodichloromethane	⁴ 100		100 ⁴	
1,2-Dichloropropane	² 5	0 ²		
trans-1,3-Dichloropropene	² 5	0 ²	3	
Trichloroethene	5	0	3	
Dibromochloromethane	⁴ 100		100 ⁴	
1,1,2-Trichloroethane				
Benzene	5	0		
cis-1,3-Dichloropropene				
2-Chloroethylvinyl ether				
Bromoform	⁴ 100		100 ⁴	
4-Methyl-2-pentanone				
2-Hexanone				

See notes at end of table.

Table 3-1 (Continued)
Federal and State of Florida Groundwater Standards for
Volatile Organic Compounds in Groundwater¹

Technical Memorandum No. 5
 NAS Whiting Field
 Milton, Florida

Analyte	Federal Standards ²		Florida Standards ³	
	MCL ($\mu\text{g}/\ell$)	MCLG ($\mu\text{g}/\ell$)	Primary ($\mu\text{g}/\ell$)	Secondary ($\mu\text{g}/\ell$)
Volatile organic compounds--continued				
Tetrachloroethene	5	0	3	3
1,1,2,2-Tetrachloroethane				
Toluene	² 1,000	² 1,000		
Ethyl benzene	² 700	² 700		
Chlorobenzene	² 100	² 100		
Utyrene	² 100	² 100		
Xyienes (total)	² 10,000	² 10,000		
Inorganic compounds				
Aluminum				
Antimony				
Arsenic	² 50	50	50	
Barium	2,000	2,000	1,000	
Beryllium				
Cadmium	5	5	10	
Calcium				
Chromium, total	100	100	50	
Cobalt				
Copper		1,300		1,000
Iron				300
Lead	² 5	0	50	
Magnesium				
Manganese				50
Mercury	2	2	2	
Nickel				
Potassium				
Selenium	² 50	50	10	
Silver	50		50	

See notes at end of table.

Table 3-1 (Continued)
Federal and State of Florida Groundwater Standards for
Volatile Organic Compounds in Groundwater¹

Technical Memorandum No. 5
 NAS Whiting Field
 Milton, Florida

Analyte	Federal Standards ²		Florida Standards ³	
	MCL ($\mu\text{g}/\ell$)	MCLG ($\mu\text{g}/\ell$)	Primary ($\mu\text{g}/\ell$)	Secondary ($\mu\text{g}/\ell$)
Inorganic compounds—continued				
Sodium			100	
Thallium				
Vanadium				
Zinc				5,000

¹Groundwater at NAS Whiting Field is classified as Class G-II in accordance with Florida Administrative Code Chapter 17-3.405.

²National Safe Drinking Water Act as amended March 1991, effective March 1992.

³In accordance with Florida Administrative Code Chapters 17-3.404 and 17-550.310 and 17-550.320.

⁴As sum of total trihalomethanes.

Notes: $\mu\text{g}/\ell$ = micrograms per liter.
 MCL = Maximum Contaminant Level
 MCLG = Maximum Contaminant Level Goal.

Table 3-2
Volatile Organic Compounds Detection Limits

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Volatile Organic Compounds	Detection Limit ($\mu\text{g}/\ell$)
Chloromethane	<10
Bromomethane	<10
Vinyl chloride	<10
Chloroethane	<10
Methylene chloride	<5.0
Acetone	<10
Carbon disulfide	<5.0
1,1-Dichloroethylene	<5.0
1,1-Dichloroethane	<5.0
cis/trans-1,2-Dichloroethylene	<5.0
Chloroform	<5.0
1,2-Dichloroethane	<3.0
2-Butanone	<10
1,1,1-Trichloroethane	<5.0
Carbon tetrachloride	<3.0
Vinyl acetate	<10
Bromodichloromethane	<5.0
1,1,2,2-Tetrachloroethane	<5.0
1,2-Dichloropropane	<5.0
trans-1,3-Dichloropropene	<5.0
Trichloroethylene	<3.0
Dibromochloromethane	<5.0
1,1,2-Trichloroethane	<5.0
Benzene	<5.0
cis-1,3-Dichloropropene	<5.0
2-Chloroethylvinyl ether	<10
Bromoform	<5.0

See note at end of table.

Table 3-2 (Continued)
Volatile Organic Compounds Detection Limits

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Volatile Organic Compounds	Detection Limit ($\mu\text{g}/\ell$)
2-Hexanone	<10
4-Methyl-2-pentanone	<10
Tetrachloroethylene	<3.0
Toluene	<5.0
Chlorobenzene	<5.0
Ethyl benzene	<5.0
Styrene	<5.0
Xylenes (total)	<5.0

Note: $\mu\text{g}/\ell$ = micrograms per liter.

environmental source of acetone. In addition, although acetone is a target analyte and is present as a component of industrial solvents, particularly paint removers, the quantities required to generate the widespread detection in groundwater were not in use at NAS Whiting Field. Because of these factors, acetone results have not been interpreted as signifying groundwater contamination, subject to confirmation by appropriate monitoring well installation.

Analogous results and interpretation were made for the presence of carbon disulfide (CS₂) in the BAT samples. This target compound is an industrial solvent and intermediate reactant in the plastics, chemical, and rubber manufacturing industry. It has not been a solvent in widespread military use. CS₂ was detected in 42 of the 56 environmental samples at concentrations ranging from 7.2 µg/ℓ to 1,500 µg/ℓ with no interpretable spatial pattern. Because CS₂ is used in the quenching of the butyl rubber septa employed in the BAT VOC ampule, it appears this chemical leached into samples collected using the BAT system.

Because CS₂ is not a priority pollutant, it is undetected unless tentatively identified by mass spectroscopy or unless the TCL is requested. Because of the physical properties of the septa required to: (1) hold a vacuum against significant water pressure, (2) withstand insertion to depth, and (3) perforate readily yet completely seal, less pliable inert septa, such as TeflonTM, are not acceptable.

Acetone and CS₂ were not detected in the majority of equipment rinsate and trip blanks as shown in Appendix A. Acetone was detected in 3 out of 20 trip blanks, and 4 out of 9 equipment rinsate blanks. The CS₂ was detected in one trip blank and one equipment rinsate blank. The presence of the two prevalent artifact VOCs in a limited number of trip blanks is expected due to their widespread presence in the sample set. When a chemical is present in a large number of samples a small amount of volatilization in shipping can be taken up by the trip blanks. Because of its presence in decontamination fluid, acetone was present in half of the equipment rinsate blanks. The rinsate consisted of organic-free water poured through the BAT sampling head and body in all but the single instance where CS₂ was detected. In this particular instance the rinsate water was also placed in a BAT ampule, capped, and mixed. These data also indicate that CS₂ and acetone are sampling artifacts. No other VOCs were detected in the trip blanks, field blanks, or equipment rinsate blanks.

3.1.2 Metals TAL metals analysis was performed on 30 BAT samples collected using a specially fabricated stainless-steel ampule as described in Section 2.0. Metals detected are summarized by sample in Appendix B. These data contain the CLP qualifiers resulting from NEESA QC Level C data review. The level C data package has been forwarded under separate cover both to SOUTHNAVFACENGCOM and to Martin-Marietta Energy Systems for quality assurance (QA) review. In addition to the major ion metals calcium (Ca), magnesium (Mg), aluminum (Al), iron (Fe), sodium (Na), and potassium (K) found in all groundwaters, barium (Ba) was present in all samples at low levels but also in laboratory method blanks. Barium and aluminum concentrations, which appeared to be abnormally high compared to the other data, were present in several samples. The metals chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), vanadium (V), and zinc (Zn) were found in several samples at concentrations that are several times greater than the majority of sample values. To interpret the metals data, the two to three highest

concentrations observed were compared to the overall data array for each metal in which 10 or more detectable results were observed. If an obvious gap in the distribution of concentrations existed, these upper concentrations were excluded and the mean concentration calculated. Concentrations greater than three times this mean have been interpreted as indicating a potential impact. Such an impact could be due to a metals release or indirect effects on the geochemical conditions (e.g., changes in redox potential due to decomposition of a hydrocarbon, which mobilized the subject metal). Mercury was detected at two locations at a single site but not in the remaining data. Chromium and lead maximum concentrations exceeded Florida or Federal MCLs.

One field blank and a total of five equipment rinsate blanks were analyzed as a component of the data set. The metals, with the exception of Na, were not detected in these blanks.

As indicated previously, because of the screening nature of the BAT *in situ* sampling procedure, as contrasted with a sample from a properly constructed and developed monitoring well, metals data must be interpreted with some caution, especially as related to exact comparability to monitoring well data and violations of standards. Installation of a monitoring well creates extensive aquifer trauma and may cause destabilization of the geochemical environment and/or introduce metals along with drilling fluids. Well development mitigates such trauma to a degree depending on the nature of the aquifer and installation technique. On the other hand, the well materials and filter packs represent a system that is known to have effects on groundwater cations. The factors acting on the aquifer in BAT sampling differ from those in well installation. The effect of these differences on raising or lowering metals concentrations has not been studied. Pushing the BAT probe 2 to 3 feet beyond the end of a boring minimizes aquifer trauma due to drilling effects. There are no filter pack, well materials, nor open annular space to affect geochemistry. These factors suggest that an *in situ* BAT sample may be more representative of aquifer conditions than a well sample under certain conditions. On the other hand, the BAT had to be installed below the water table through a mud rotary boring. Potentially, drilling mud could either be carried below the bottom of the boring during hydraulic advancement of the BAT sampling device or leakage could occur during water sample collection. Drilling mud can contain metals such as chromium, copper, zinc, calcium, magnesium, sodium, potassium, iron, and aluminum.

Based on an assessment of the overall database and comparisons to data from the verification, Table 3-3 represents the range of probable background metals concentrations as measured from BAT samples. Data interpreted as representing potential metals contamination are presented in Sections 3.2 through 3.5. Of the metals other than major cations, only zinc appeared to be uninterpretable and may be an artifact of the sampling procedure.

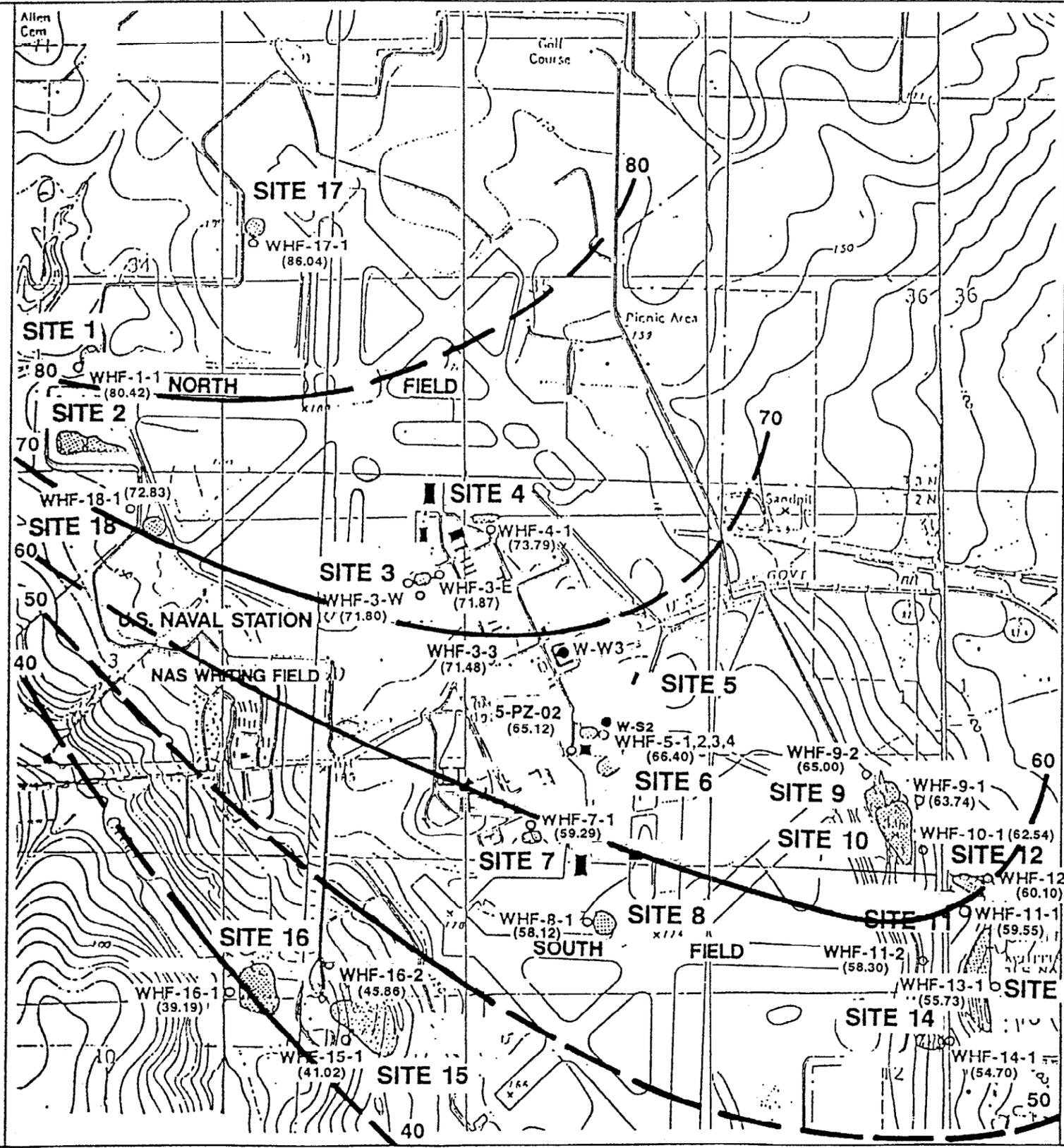
3.2 INDUSTRIAL AREA. The industrial area of NAS Whiting Field is located in the center of the installation on the plateau. Figure 3-1 shows the contours of the piezometric surface of the sand-and-gravel aquifer over the entire installation. Figure 3-2 shows details of the contours in the industrial area. Groundwater lies at a depth of 90 to 105 feet bls, except where perched systems lie on top of clay lenses. The geologic and hydrogeologic attributes of the installation described in the Technical Memoranda Number 1 and Number 2.

**Table 3-3
Range of Interpreted Background Metals Concentration
in Groundwater at NAS Whiting Field (using the BAT System)**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Metal	Background Concentration Range (mg/ℓ)
Aluminum	<200 to 1,070
Antimony	<50
Barium	<10 to 109
Arsenic	<10
Beryllium	<5
Cadmium	<5
Calcium	36 to 7,110
Copper	<25 to 152
Chromium	<10 to 42.2
Cobalt	<10
Iron	<50 to 5,900
Lead	<3 to 8.1
Magnesium	<500 to 8,540
Manganese	<10 to 125
Mercury	<0.2 to 0.30
Nickel	<40 to 107
Potassium	<1,000 to 1,520
Selenium	<5
Silver	<10
Sodium	1,260 to 6,180
Thallium	<10
Vanadium	<10 to 20.7
Zinc	42.4 to 189

Note: mg/ℓ = milligram per liter.



LEGEND

- MONITORING WELL
(ELEVATIONS IN FEET NGVD)
(XX.XX) WATER LEVEL
- GROUNDWATER SUPPLY WELL

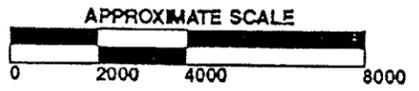


FIGURE 3-1
GROUNDWATER CONTOUR MAP
JULY 1991



R1/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

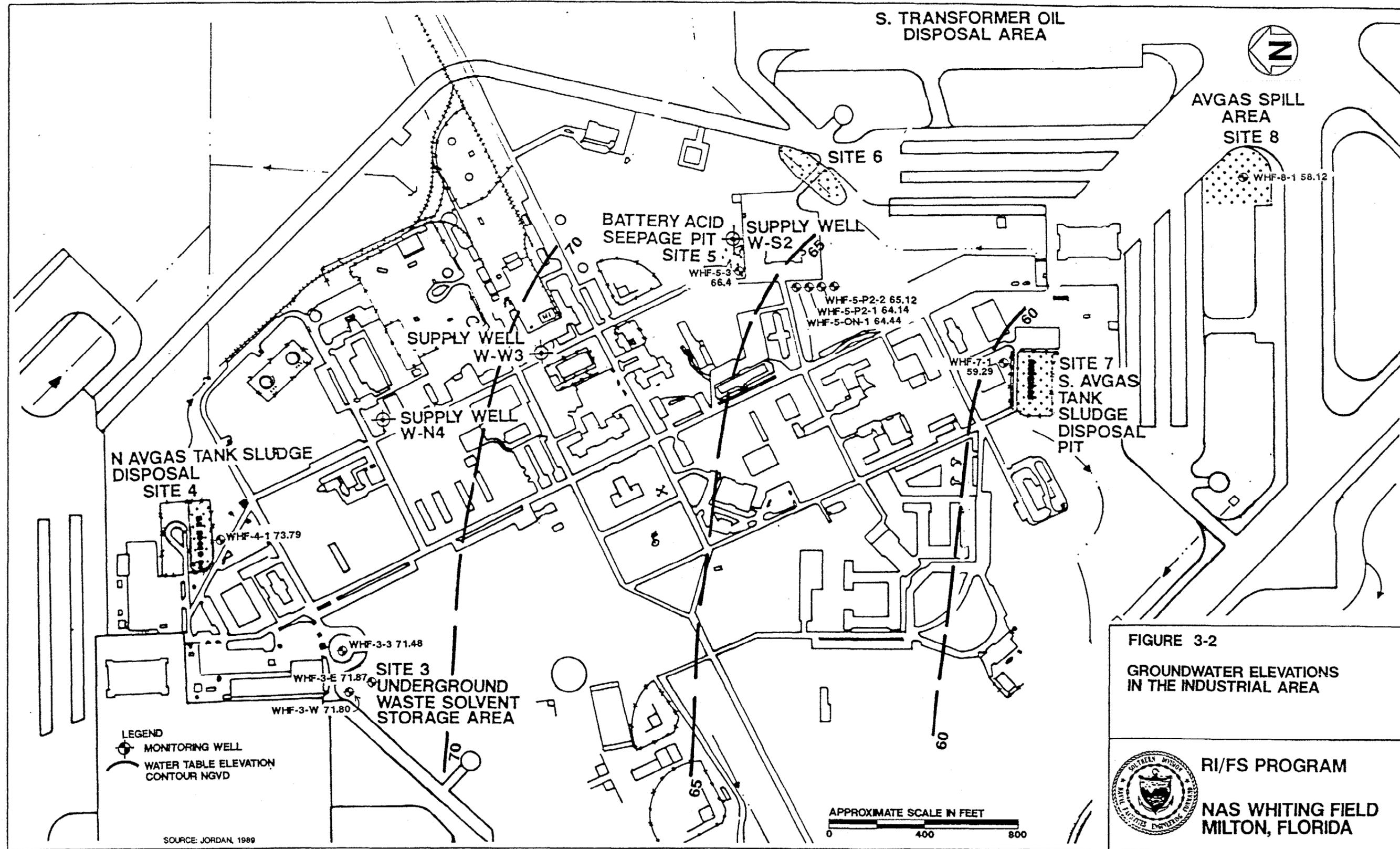


FIGURE 3-2
GROUNDWATER ELEVATIONS
IN THE INDUSTRIAL AREA



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

SOURCE: JORDAN, 1989

During the Verification Study (Geraghty and Miller, 1986) groundwater contamination was detected at Sites 3, 4, 5, 7, and 8. Location of these sites is shown on Figure 3-1 and described in Table 3-4, which summarizes the contaminants detected and the maximum concentrations observed. In addition, contamination by benzene and by trichloroethylene (TCE) has been detected in two of the production wells since 1985. Table 3-5 shows the observed contamination in these production wells. These wells are screened at approximately 170 to 210 feet bls and 169 to 215 feet bls for the wells W-W3 (West well) and W-S2 (South well), respectively. The North supply well, W-N4, is located north of the contaminated wells and is also screened from 180 to 215 feet bls. Well W-N4 has not shown any historical evidence of contamination. Contamination status at each of the disposal sites, as well as the history of industrial operations at NAS Whiting Field, has been summarized in the Workplan, Volume I (Jordan, 1990) based on data from the IAS (Envirodyne Engineers, 1985) and the Verification Study (Geraghty and Miller, 1986). Based on the contamination detected previously, the groundwater screening program conducted in the industrial area consisted of the *in situ* sampling of the shallow part of the aquifer by means of 19 BAT samples ranging in depth from 114 to 133 feet bls. The deeper production zone was sampled below the zone of clay and silt lenses by means of 17 BAT samples taken at depths ranging from 180 to 183 feet bls. Locations of these samples are shown in Figure 3-3 and 3-4. These also show the VOCs detected. The explorations were designed to sample zones in a radial pattern around the production wells and to evaluate the contamination status of the two zones at Site 3. As indicated in Appendix B no evidence of elevated metals concentration was detected in any of the screening groundwater samples from either zone of the aquifer in the industrial area. VOC contamination was detected in both zones of the aquifer; however, the production zone contamination appeared to be limited to the areas near and downgradient of production wells W-W3 and W-S2. Well W-S2 was sampled three times during the aquifer test, during the first 4 hours of the test, during the middle of the test, and just before beginning the recovery phase. Benzene was detected at 18 mg/l, 6.3 mg/l, and <0.1 mg/l, respectively. Historical data on well W-S2 indicate that the production zone in this area is contaminated by volatile aromatics rather than solvents. West production well (W-W3), on the other hand, is contaminated by TCE.

Verification Study data (Table 3-4) also indicate substantial fuels-related VOC contamination in the upper part of the aquifer at the South Fuel Farm Area (Site 7).

The BAT sampling program also confirmed that the upper part of the aquifer is heavily contaminated by VOCs in the vicinity of Site 3 at the north end of the industrial area. At site 3, deeper BAT samples (in the production zone) showed no contamination. Because Sites 4, 7, and 8 are to be investigated under the UST program no *in situ* sampling was conducted at these sites.

Because of the effects of production well pumping at different wells in a complex pattern, temporal changes in localized groundwater flow directions and gradient are probably complex. In addition, the geologic explorations indicated that a definable clay aquiclude does not appear to exist; however, complex interbedded clay and silt layers exist as well as clay (at Sites 3 and 4) that restrict vertical migration, except where induced by pumpage. The results of the aquifer test (Technical Memorandum Number 2) indicated that, although the response of the aquifer above the production zone was slower than would be expected for a non-

Table 3-4
Summary of Available Data on Contamination in the Industrial Area

Technical Memorandum No. 5
 - NAS Whiting Field
 Milton, Florida

Site Number	Site Name	Materials Disposed	Soil Chemical	Frequency of Detection ¹	Maximum Conc. (mg/kg)	Groundwater Chemical	Frequency of Detection ¹	Maximum Conc. (µg/l)
3	Underground Waste Solvent Storage Area	Waste solvents, paint stripping residue, 120 gal. spill	Cadmium	1/2	0.28	1,1,1-TCA	1/2	13
			Chromium	2/2	43	1,1,2-TCA	1/2	111
			Mercury	2/2	0.20	TCE	1/2	18
			Silver	2/2	1.85	Lead	2/2	12
			Zinc	2/2	586	Arsenic	1/2	1
			Phenois	1/2	0.61			
4	North AVGAS Tank Sludge Disposal Area	Tank bottom sludge with tetraethyl lead	Lead	2/2	27	Benzene	1/1	17
						Toluene	1/1	10
						Lead	1/1	5
5	Battery Acid Seepage Pit	Waste electrolyte solution with heavy metals, waste battery acid	Arsenic	21/26	1.4	Benzene	6/8	26
			Cadmium	12/26	0.55	Aldrin	1/8	0.13
			Lead	19/26	24	g-BHC (lindane)	1/8	0.02
			Mercury	24/26	0.212	Heptachlor	2/8	0.04
						Antimony	4/8	170
						Cadmium	2/8	3
						Chromium	4/8	20
						Copper	4/8	33
						Lead	4/8	37
						Zinc	7/8	360
6	Seepage Area	PCB contaminated dielectric fluid	PCB	0/10	ND	NT		
7	South AVGAS Tank Sludge Disposal Area	AVGAS with tetraethyl lead	Lead	2/2	575	Toluene	1/1	43,000
						Benzene	1/1	8,800
						EDB	1/1	23.56
						Lead	1/1	862
						Xylene	1/1	1,000

See notes at end of table.

Table 3-4 (Continued)
Summary of Available Data on Contamination in the Industrial Area

Technical Memorandum No. 5
 NAS Whiting Field
 Milton, Florida

Site Number	Site Name	Materials Disposed	Soil Chemical	Frequency of Detection ¹	Maximum Conc. (mg/kg)	Groundwater Chemical	Frequency of Detection ¹	Maximum Conc. (µg/l)
8	AVGAS Fuel Spill Area	AVGAS with tetra-ethyl lead	Lead	12/12	27	Benzene	1/1	2
						Toluene	1/1	26
						Lead	1/1	7
9	Waste Fuel Disposal Area	AVGAS with tetra-ethyl lead	Lead	12/12	14	Lead	1/1	7

¹ = (1/2) number of samples with detectable levels of contaminant per total number of samples analyzed.

Conc. = concentration
 mg/kg = milligrams per kilogram.
 µg/l = micrograms per liter.
 TCA = trichloroethane.
 TCE = trichloroethene.
 BEHP = bis(2-ethylhexyl)phthalate.

PCB = polychlorinated biphenyls.
 ND = Not detected.
 NT = Not tested.
 AVGAS = aviation gasoline.
 EDB = ethylene dibromide.

**Table 3-5
Analyses of Samples From Water Supply Wells**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

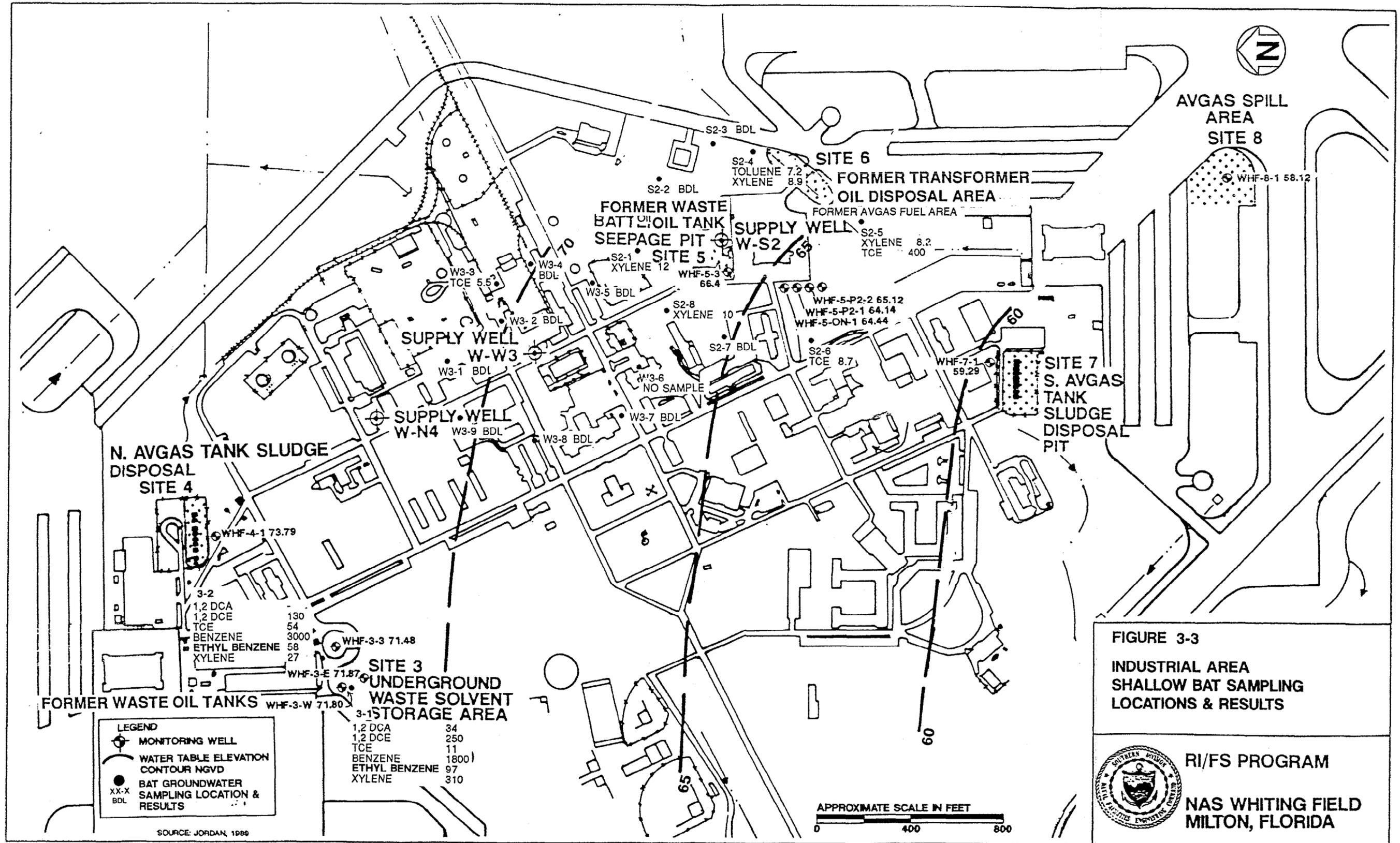
Date of Sample	Contaminant	Analyst
<u>South Well (W-S2)</u>		
1 November 1985	4 µg/l Trichloroethylene ¹	Pioneer Lab
21 March 1986	4 µg/l Benzene	Pioneer Lab
21 April 1986	2 µg/l Benzene	Pioneer Lab
14 September 1986	29 µg/l Benzene	DHRS
1 October 1986	14 µg/l Benzene	Pioneer Lab
1 October 1986	17 µg/l Benzene	Compu Chem
1 October 1986	6 µg/l Benzene ²	Pioneer Lab
1 October 1986	7.4 µg/l Benzene ²	Compu Chem
6 October 1986	11.9 µg/l Benzene	DHRS
6 October 1986	Trace total xylenes	DHRS
9 December 1986	4.96 µg/l Benzene	DHRS
5 January 1987	7.82 µg/l Benzene	DHRS
<u>West Well (W-W3)</u>		
14 September 1986	7.9 µg/l Trichloroethylene	DHRS
1 October 1986	10 µg/l Trichloroethylene	Pioneer Lab
1 October 1986	6 µg/l Trichloroethylene ²	Pioneer Lab
1 October 1986	10.5 µg/l Trichloroethylene	DHRS
9 December 1986	Trace trichloroethylene	DHRS
5 January 1987	Trace trichloroethylene	DHRS
9 January 1987	Trace trichloroethylene	DHRS
<u>North Well (W-N4)</u>		
14 September 1986	Trace toluene	DHRS
1 October 1989	No organics detected	Pioneer Lab
6 October 1986	No organics detected	DHRS
9 December 1986	No organics detected	DHRS
5 January 1987	No organics detected	DHRS
<u>Distribution System</u>		
6 October 1986	Trace total xylenes	DHRS
9 December 1986	No organics detected	DHRS
5 January 1987	Trace chlorodibromomethane	DHRS

¹ Trichloroethylene, also known as trichloroethene or TCE.

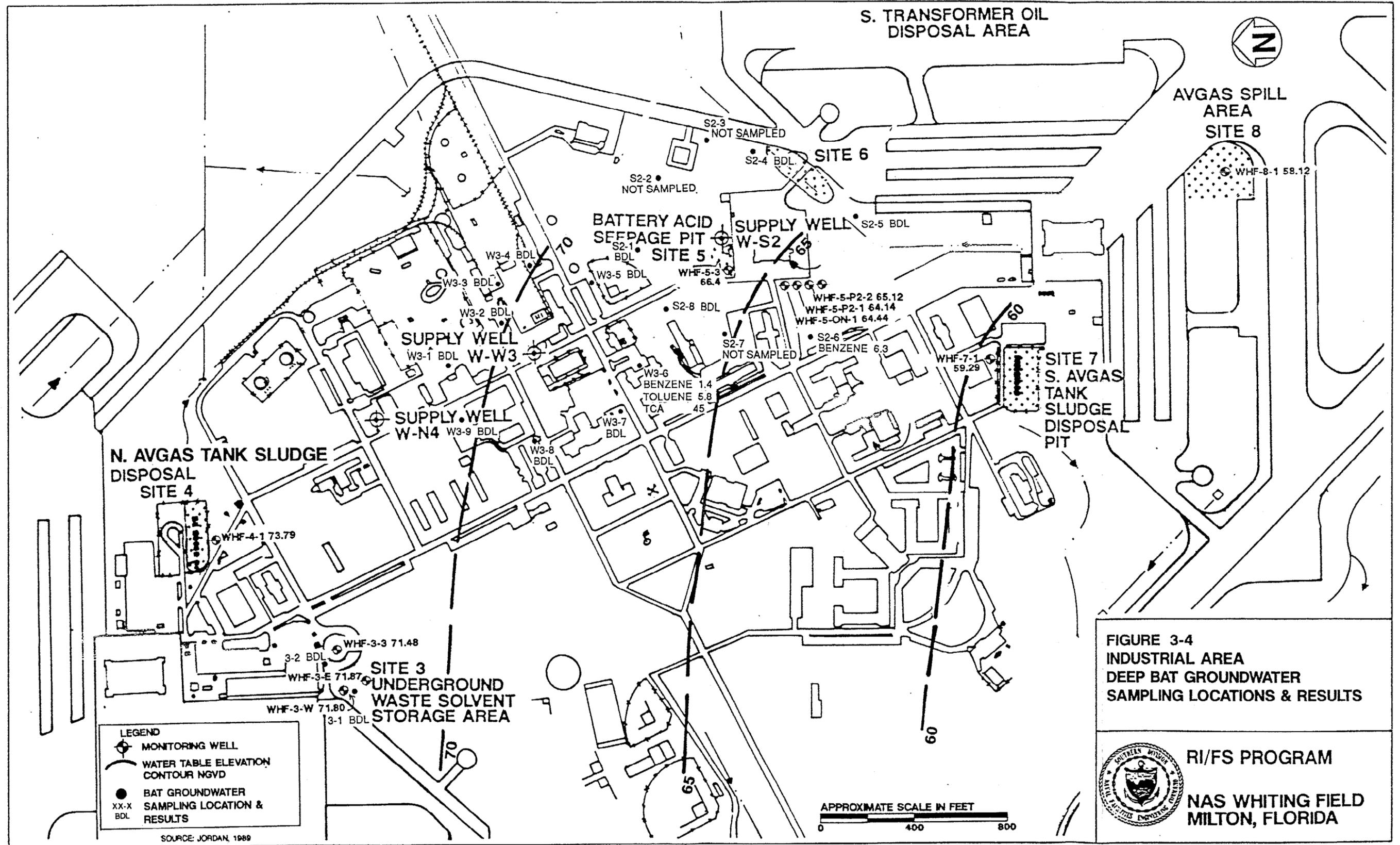
² Samples taken after treatment by chlorination and stability control.

Notes: µg/l = micrograms per liter

DHRS = Florida Department of Health and Rehabilitation Services



002287B5Z



N. AVGAS TANK SLUDGE DISPOSAL SITE 4

WHF-4-1 73.79

SITE 3 UNDERGROUND WASTE SOLVENT STORAGE AREA

WHF-3-3 71.48
 3-2 BDL
 WHF-3-E 71.87
 WHF-3-W 71.80
 3-1 BDL

SUPPLY WELL W-W3

SUPPLY WELL W-N4

BATTERY ACID SEPPAGE PIT W-S2

W3-1 BDL
 W3-2 BDL
 W3-3 BDL
 W3-4 BDL
 W3-5 BDL
 W3-6 BENZENE 1.4
 TOLUENE 5.8
 TCA 45
 W3-7 BDL
 W3-8 BDL
 W3-9 BDL

SUPPLY WELL W-S2

S2-1 BDL
 S2-2 NOT SAMPLED
 S2-3 NOT SAMPLED
 S2-4 BDL
 S2-5 BDL
 S2-6 BENZENE 6.3
 S2-7 NOT SAMPLED
 S2-8 BDL

WHF-5-3 66.4
 WHF-5-P2-2 65.12
 WHF-5-P2-1 64.14
 WHF-5-ON-1 64.44

WHF-7-1 59.29

AVGAS SPILL AREA SITE 8

WHF-8-1 58.12

FIGURE 3-4 INDUSTRIAL AREA DEEP BAT GROUNDWATER SAMPLING LOCATIONS & RESULTS



RI/FS PROGRAM
NAS WHITING FIELD MILTON, FLORIDA

confined system, the system behaved as one overall flow system. These factors complicate the interpretation of groundwater flow and contaminant movement in the sand-and-gravel aquifer.

Based on the pattern of contamination, hydrogeologic properties of the aquifer (described in Technical Memoranda Number 1 and Number 2), and historical operations in the industrial area, groundwater VOC contamination distribution and movement can be interpreted in a general way. However, additional confirming data are necessary to map the full vertical and horizontal extent of contamination, the complete spectrum of chemicals of concern, location of past sources, and the strength and exact location of residual sources. Based on the screening data and the history of industrial operations, VOCs (both fuel-derived VOCs and cleaners, solvents, thinners, and degreasers) represent major groundwater contamination problems at NAS Whiting Field.

Contamination released to the upper component of the aquifer to the north of production wells W-W3 and W-S2 appears to be drawn downward to the production zone of the aquifer in the vicinity of the three production wells. The North Well appears to be upgradient of this contamination. Migration to the south in the production zone has apparently occurred as shown in Figure 3-3. Benzene, toluene, and 1,1,1-trichloroethane (1,1,1-TCA) have been observed south of well W-W3. The 1,1,1-TCA concentration detected was 45 $\mu\text{g}/\ell$. This indicates potential that the zone of deeper contaminated groundwater extends a substantial distance to the south. Based on the monitoring well data, the flow path from the production well area curves westerly toward Clear Creek. There are approximately 6,000 feet of flow distance from the production well area to the point where the land surface slopes off rapidly to Clear Creek. Using the hydraulic conductivity of the aquifer of 100 feet per day (ft/day) calculated from the pumping test and the estimated hydraulic gradients, time of travel to the creek could be approximately 13 to 26 years.

Examination of the BAT VOC results from the shallower zone sampling indicate three areas of groundwater contamination. One of these is located to the immediate northeast of Production Well W-W3. This source appears to be in the Public Works Transportation Department area behind Building 1429. The ground vehicle maintenance activities have been performed at this location by NAS Whiting Field from the 1940's until the present. Currently a contractor performs maintenance for NAS Whiting Field Public Works Vehicles.

Shallow groundwater downgradient of this area contains trace (<20 mg/ ℓ) concentrations of TCE and xylene. Sample WHF-W3-WP-03-01, collected in the transportation area, contained 5.5 mg/ ℓ TCE. No VOCs were detected in samples collected to the north of this sample area. The pattern of positive VOC results suggest that the Base Exchange (BX) service station petroleum tanks and activities and the current JP-5 storage and pumping facility do not contribute substantially to groundwater contamination. The BX service station is located between Well W-W3 and W-N4 but is upgradient of Building 1429.

Another source of groundwater VOC contamination exists in the shallow parts of the aquifer near Site 3 as shown in Figure 3-3. In the Verification Study (Geraghty and Miller, 1986), soil contamination attributed to two 500-gallon waste solvent tanks was detected to the south of Building 1429. These tanks were reportedly removed in 1984. Table 3-4 shows the maximum concentration of soil

contaminants. Although the tanks were reportedly used for paint and metals preparation, and wastes including thinners and solvents, no VOCs were detected in soil. VOCs, including 1,1,1-TCA, 1,1,2-TCA, TCE, 1,2-dichloroethane (1,2-DCA), 1,2-dichloroethylene (1,2-DCE), benzene, ethyl benzene, and xylene were detected in the shallow zone of the aquifer, but not in the production zone at 180 feet bls, as shown in the Verification Study samples from Wells WHF-3-1 and WHF-3-2 and the shallow zone BAT samples.

Examination of the historical industrial operations indicate that Building 2941 located just north of Site 3 has been used since the 1960's for Aircraft Intermediate Maintenance Department (AIMD) activities. Prior to 1968, all AIMD activities were done in hangars; since that time airframe, power plant, and painting activities have been conducted in Building 2941. Prior to that time such activities were conducted at Hangar 1424, immediately north of Building 2941. The IAS indicates that an underground liquid waste tank existed at the south and southwest corner of Building 2941. The location of this tank is shown in Figure 3-3. This tank was used for storage of airframe, power plant, and ground support equipment waste since at least 1968. Prior to AIMD activities, disposal of aircraft maintenance wastes from Hangar 1424 reportedly was sent to base landfills. However, spills and uncontrolled disposals of solvents at or near the sites of generation were common practice in the 1940's and 1950's. Additional record search and source exploration in the vicinity of Buildings 1424 and 2941 are required to evaluate the status of the former waste oil tank and to locate any areas of residual soil contamination. The waste oil tank at Building 2941 was reportedly removed (NAS Whiting Field Public Works Department, 1991) in 1987 during expansion of the hard stand at Building 2941.

Based on the interpreted groundwater flow direction and the velocity interpreted from the pumping test, VOCs from the Site 3 North Hangar Area could have migrated to Clear Creek. As is discussed in Section 3.3, VOCs deep in the aquifer were observed at Site 16, in the southwest corner of the installation. These were not interpreted to be from Site 16 due to the depth at which they were encountered and the absence of any contamination at shallow depths. Interpretation is made that these VOCs (including benzene at 410 $\mu\text{g}/\ell$) may have migrated from the North Hangar Area or North Fuel Farm area (Site 4). This interpretation must be confirmed by further data gathering.

Shallow aquifer zone VOC contamination was also detected south and southeast of Hangar Building 1451 in the vicinity of, but downgradient of, Production Well W-S2, and near Sites 5 and 6. Production zone groundwater at this location was not contaminated. Xylene was detected upgradient of Well W-S2 as discussed previously. According to the IAS and interviews with NAS Whiting Field Public Works Department personnel, a waste oil tank (now removed) existed from the 1940's until the 1980's at the northwest corner of the hardstand at the Middle Hangar (Building 1451). The location of this tank and a former AVGAS Fueling Point at the north side of the hardstand is shown in Figures 3-3 and 3-4. According to the IAS, oily wastes from the electrical shop were discharged to the storm drainage ditch at the south side of the handstand. It is possible that aircraft maintenance wastes were also discharged. The upper zone of the aquifer downgradient of the former waste oil tanks and storm drain disposal area was observed to contain 400 $\mu\text{g}/\ell$ TCE and 8.2 $\mu\text{g}/\ell$ xylene. To the southeast of the waste oil tank, traces of toluene and xylene were detected. These are shown on Figure 3-3. These findings indicate past or residual sources of contamination

in the vicinity of Building 1451 which must be located and evaluated. Further exploration of groundwater must be conducted downgradient of the waste oil tanks to determine the full nature and extent of migration from this and/or other sources in the area of the hangar.

In addition to the above identified potential sources, not previously identified as sites in either the IAS or Verification Study program, additional sources or potential sources of groundwater contamination exist in the industrial area. The North and South Fuel Farms, Site 4 and 7, are to be investigated under the Navy UST Program. At the south Fuel Farm, Verification Study data from 10 feet below the water table surface indicated 43,000 $\mu\text{g}/\text{l}$ toluene, 8,800 $\mu\text{g}/\text{l}$ benzene, 1,000 $\mu\text{g}/\text{l}$ xylene, and 24 $\mu\text{g}/\text{l}$ ethylene dibromide (See Table 3-4) in groundwater. Because of the placement of the well screen below the water table surface no evaluation of floating fuel could be made. At the North Fuel Farm groundwater contamination was relatively low compared to the South Fuel Farm, (see Table 3-4). However, Well WNF-4-1 was installed below a clay layer. A perched water table may exist above this layer. The contamination status of this perched zone is unknown.

In addition to the UST program issues discussed above, two other former or current underground waste oil tanks exist at NAS Whiting Field. From 1972 to 1984, helicopter maintenance waste oils, solvents, thinners, etc., were stored in three underground waste oil tanks located at Building 1406 as shown in Figure 3-5.

No explorations of this area have been conducted. Figure 3-5 shows the orientation of the Building 1406 and the waste oil tanks to the South Fuel Farm and AVGAS Sludge Disposal Area. A fourth waste oil tank was located at the Auto Hobby Shop, Building 1404. This tank stored waste oils, solvents, and thinners from 1970 to 1984. The status of this tank also is unexplored. This tank location is also indicated on Figure 3-5.

3.3 SITES 15 AND 16, SOUTHWESTERN DISPOSAL AREAS. Sites 15 and 16 are located in the southwestern corner of NAS Whiting Field, on and at the base of the slope from the highland plateau and the floodplain of Clear Creek. Immediately west of Site 16 the land surface drops off at greater than 1:10 slope to the wooded swamp and marshy floodplain of the creek. Figure 3-6 shows the general location of Sites 15 and 16. Figure 3-6 shows the orientation of these sites as well as localized groundwater flow direction. The stratigraphy and subsurface hydrology are described in Technical Memoranda Number 1 and Number 2. Site 15, the Southwest Landfill, was used from 1965 to 1979. Reportedly refuse and industrial wastes were disposed in trenches at this location. Reported wastes disposed were paints and thinners, oily wastes, solvents, and hydraulic fluids. Site 16, Open Disposal and Burning Area, was used for burning combustible wastes from 1943 to 1965. Reportedly this area also received paints, thinners, oils, solvents, and transformer oils. Table 3-6 shows the results of the verification sampling and analysis. As shown, only bis(2-ethylhexyl)phthalate (BEHP) and traces of lead and zinc were detected at Site 15. No groundwater contamination was detected at Site 16. No subsurface soil sampling has been conducted at these sites. As discussed in Technical Memoranda Number 3 and Number 4, surface soils showed no

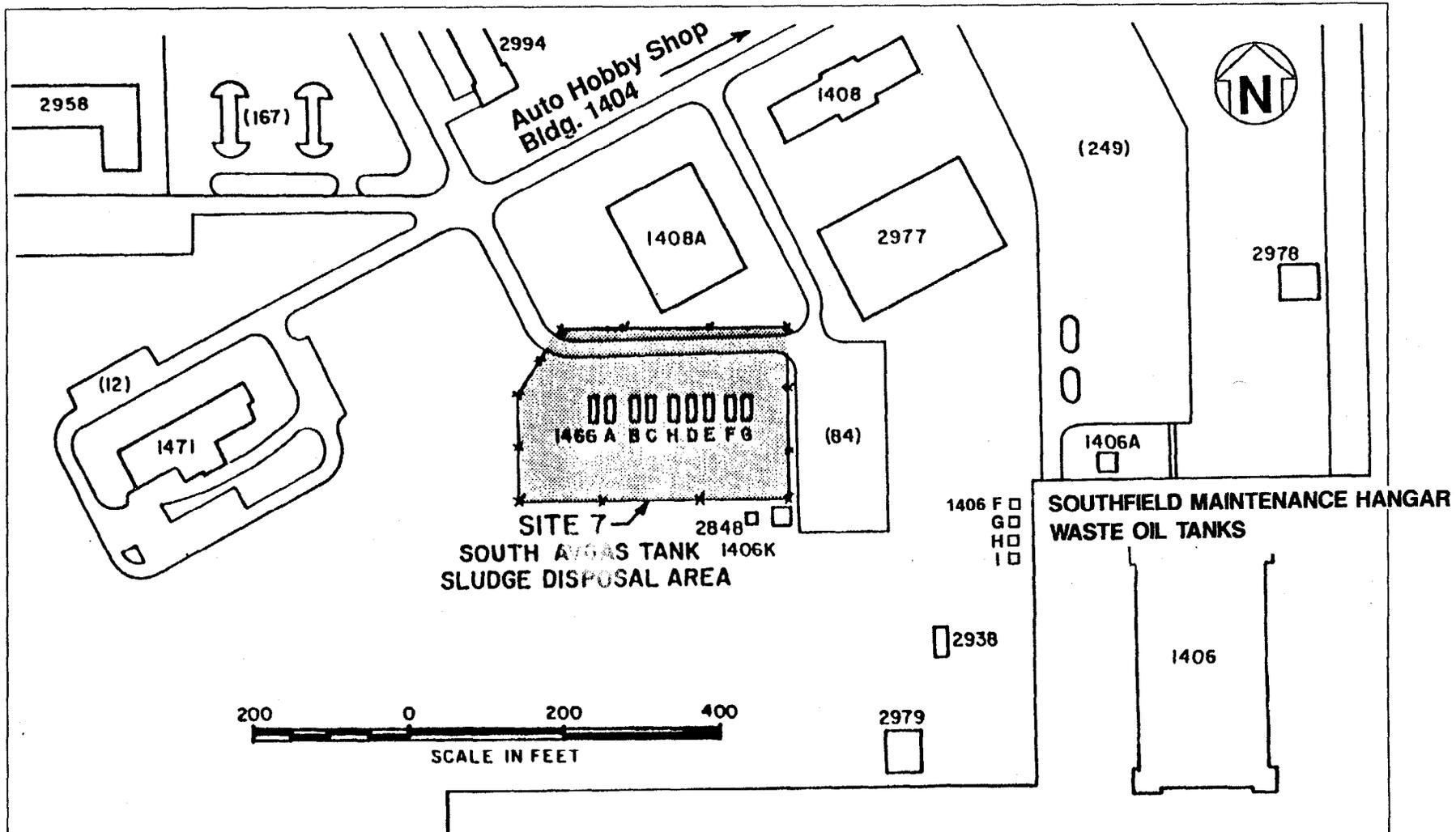
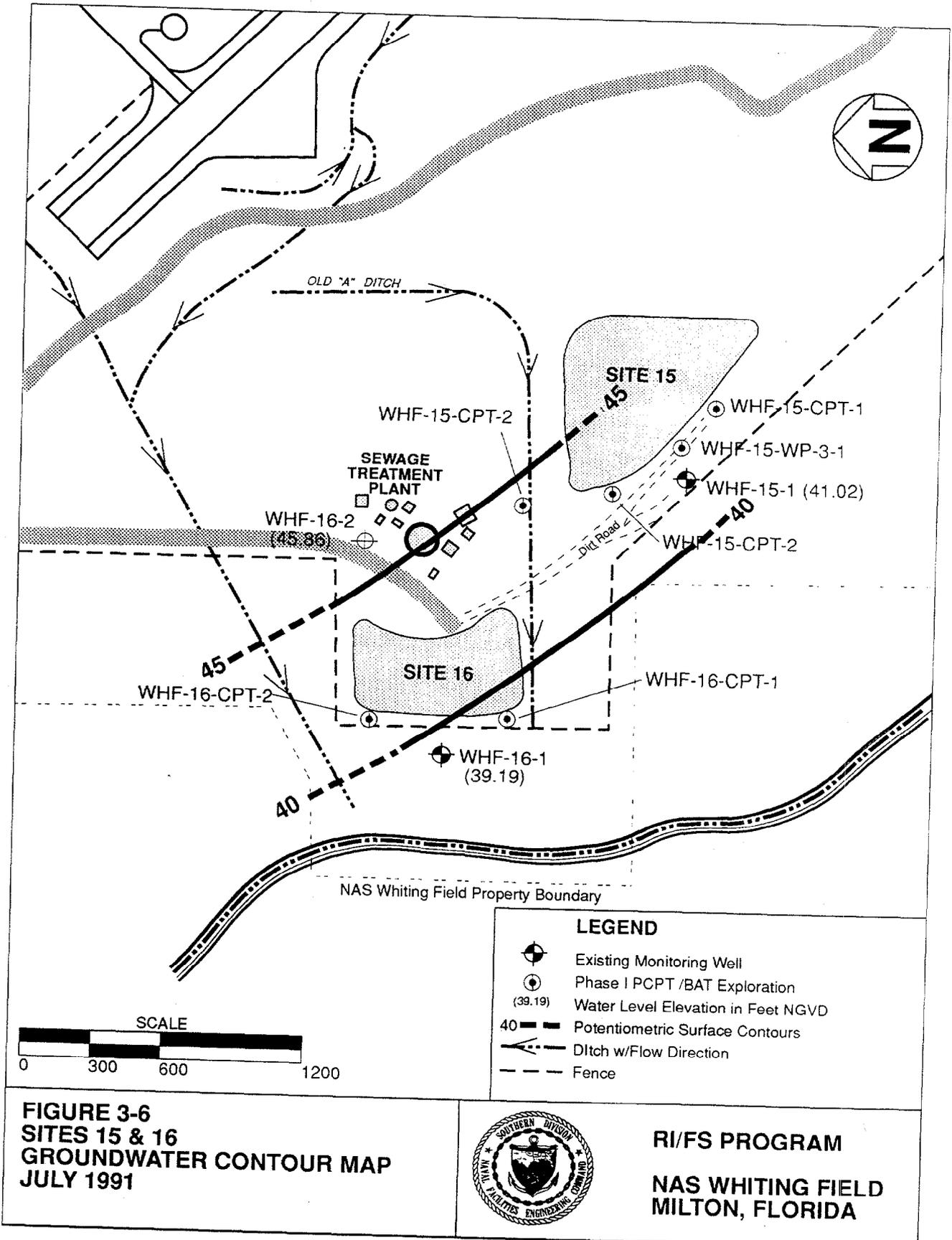


FIGURE 3-5
SITE 7
SOUTH AVGAS TANK FARM AND
SOUTHFIELD MAINTENANCE AREA



R/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA



**Table 3-6
Summary of Available Data for Contamination, Sites 15 and 16**

Technical Memorandum No. 5
NAS Whiting Field
Milton, Florida

Site Number	Site Name	Materials Disposed	Soil Chemical	Frequency of Detection ¹	Maximum Conc. (mg/kg)	Groundwater Chemical	Frequency of Detection ¹	Maximum Conc. (µg/l)
15	Southwest Land-fill	Refuse, waste solvents, paint, oils, and hydraulic fluids.	Not detected			BEHP	1/1	36
						Lead	1/1	3
						Zinc	1/1	30
16	Open Disposal and Burn Area	Refuse, waste paint, oils, solvents, thinners, and PCBs hydraulic fluids.	Not detected			Not detected		

¹1/2 = number of samples with detectable levels of contaminant per total number of samples analyzed.

Notes: µg/l = micrograms per liter.
BEHP = bis(2-ethylhexyl)phthalate.
PCBs = polychlorinated biphenyls.

substantial evidence of contamination. The floodplain sediments adjacent to Clear Creek, downslope from Site 16, showed evidence of VOC contamination by the halocarbons *cis*- and *trans*-1,2-dichloroethylene (290 $\mu\text{g}/\text{kg}$ and 83 $\mu\text{g}/\text{kg}$, respectively), 1,1-dichloroethane, and the metals chromium, copper, lead, manganese, mercury, vanadium, and zinc.

Figures 3-7 and 3-8 show the VOC results from the *in situ* BAT sampling program at Site 15 and 16. Samples collected for metals at these same locations showed no concentrations suggesting a metals release at either site. The only anomalous metals result was aluminum, which was detected at WHF-15-CPT-2-1 at 3,330 $\mu\text{g}/\text{l}$.

VOC results indicate groundwater contamination by VOCs. Shallow groundwater downgradient of Site 15 contains aromatic VOCs (benzene, toluene, and xylenes). At site 16, the shallower part of the aquifer is not apparently contaminated. The deeper zone contains both aromatic and halogenated VOCs at substantial concentrations as shown in Figure 3-8. The distribution pattern for VOC results at these two sites is somewhat complicated to interpret. Further groundwater and subsurface soils investigation is required to develop a complete understanding of the location of residual contamination, vertical and horizontal flow patterns, interaction with the creek, the nature of chemicals capable of migrating, and the extent of migration.

At site 15, the PCPT logs from the southwest (upward slope) of the interpreted landfill area indicate the existence of a thick clayey layer, which may extend from near the surface to depths of 20 to 40 feet bls. This layer is apparently not present at the western tip (down slope) of the interpreted fill area. This latter stratigraphic sequence is similar to that along the western edge of Site 16. It is possible that either the rate of disposal, the presence of clay, or the absence of substantial quantities of halocarbons or other liquid wastes more dense than water has resulted in migration within only the upper part of the groundwater system. The VOC contaminants detected are fuel-related aromatics. Any substantial waste oil or fuel disposal would not be expected to sink deeply into the aquifer. The shallow BAT samples at Site 15 were collected at depths of 33 to 50 feet bls, which is approximately 10 to 20 feet into the water table. The uncontaminated deeper samples were collected at 72 feet bls. Other deep BAT samples were not collected at this site to prevent any downward contaminant migration because buried solid waste was encountered in boreholes of WHF-15-SP-02-01 and WHF-15-WP-03-01.

VOC contamination was detected in the deep BAT samples collected downgradient of Site 16. As shown in Figure 3-8, low levels of toluene and xylene were detected in WHF-16-CPT-02-02 at 80 feet BLS. To the south and at 80 feet bls in WHF-16-CPT-01-02, high concentrations of benzene (410 $\mu\text{g}/\text{l}$) and 13 $\mu\text{g}/\text{l}$ of 1,2-dichloroethane (1,2-DCA) were observed. Because of the difference in the topographic surface, these two collections sampled groundwater at elevations of -32 and -15 feet National Geodetic Vertical Datum (NGVD) of 1929, respectively, or 72 and 55 feet below the water table surface. Monitoring Well WHF-16-1, screened at 35 to 40 feet bls and sampled during the Verification Study, and BAT samples from WHF-16-CPT-01-01 and WHF-16-CPT-02-01, taken 28 feet and 40 feet bls, respectively, did not contain detectable contaminants. Monitoring Well WHF-16-2, installed upgradient of Site 16, was completed to a depth of 70 feet bls. Because of the ground elevation difference, this well is screened at an elevation

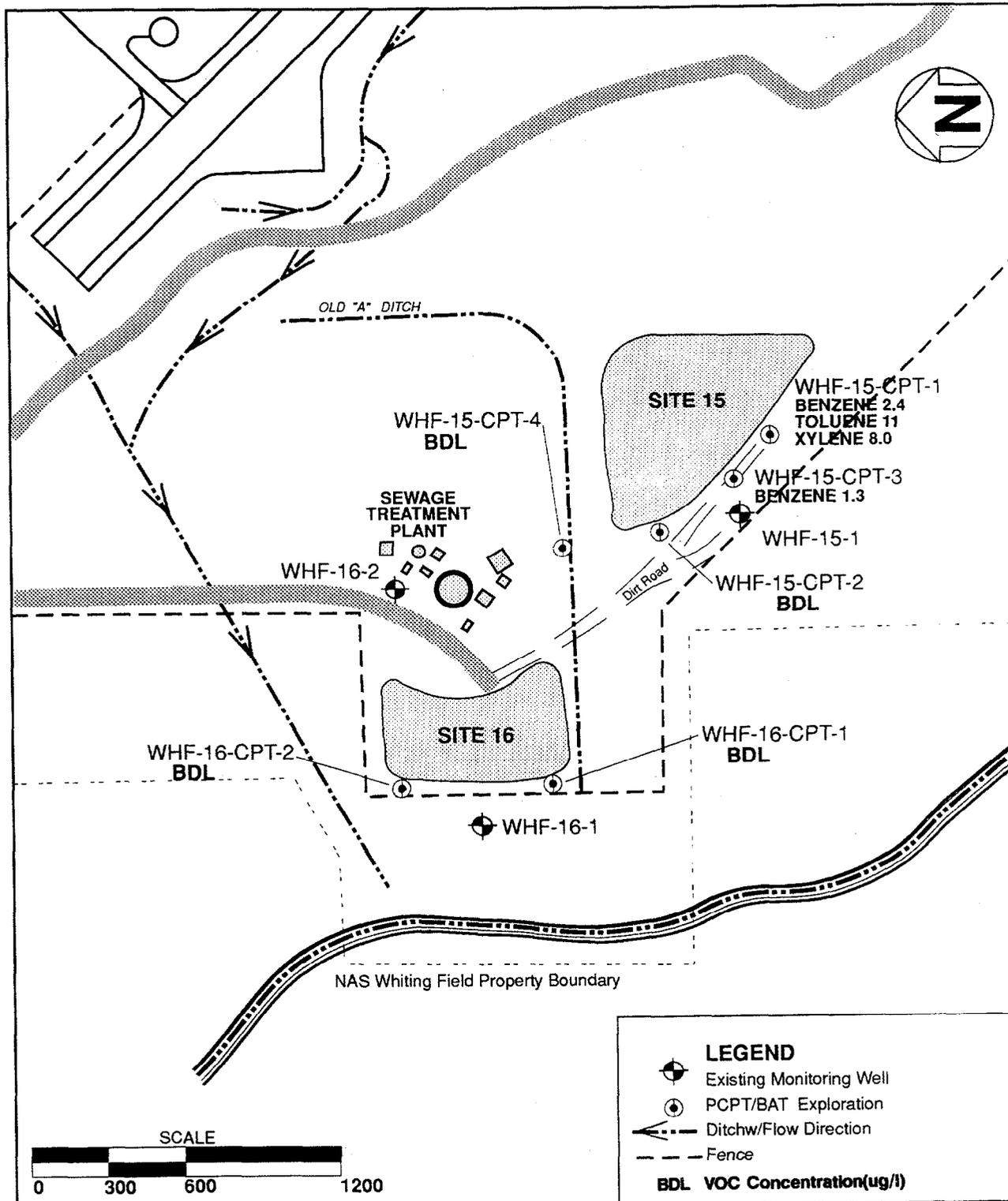


FIGURE 3-7
SITES 15 & 16
PHASE I
SHALLOW BAT GROUNDWATER
VOC RESULTS



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

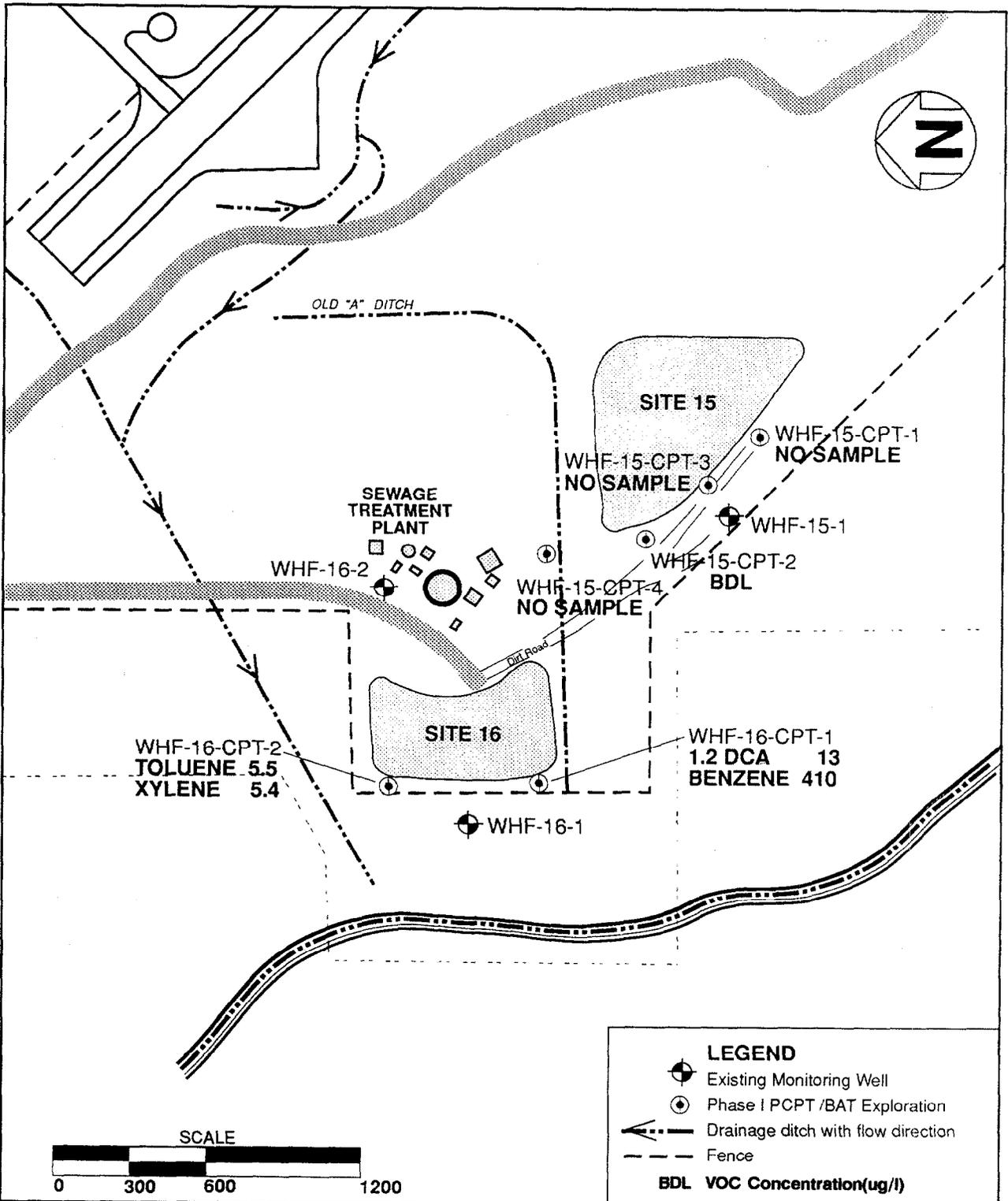


FIGURE 3-8
SITES 15 & 16
PHASE I
DEEP BAT GROUNDWATER
VOC RESULTS



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

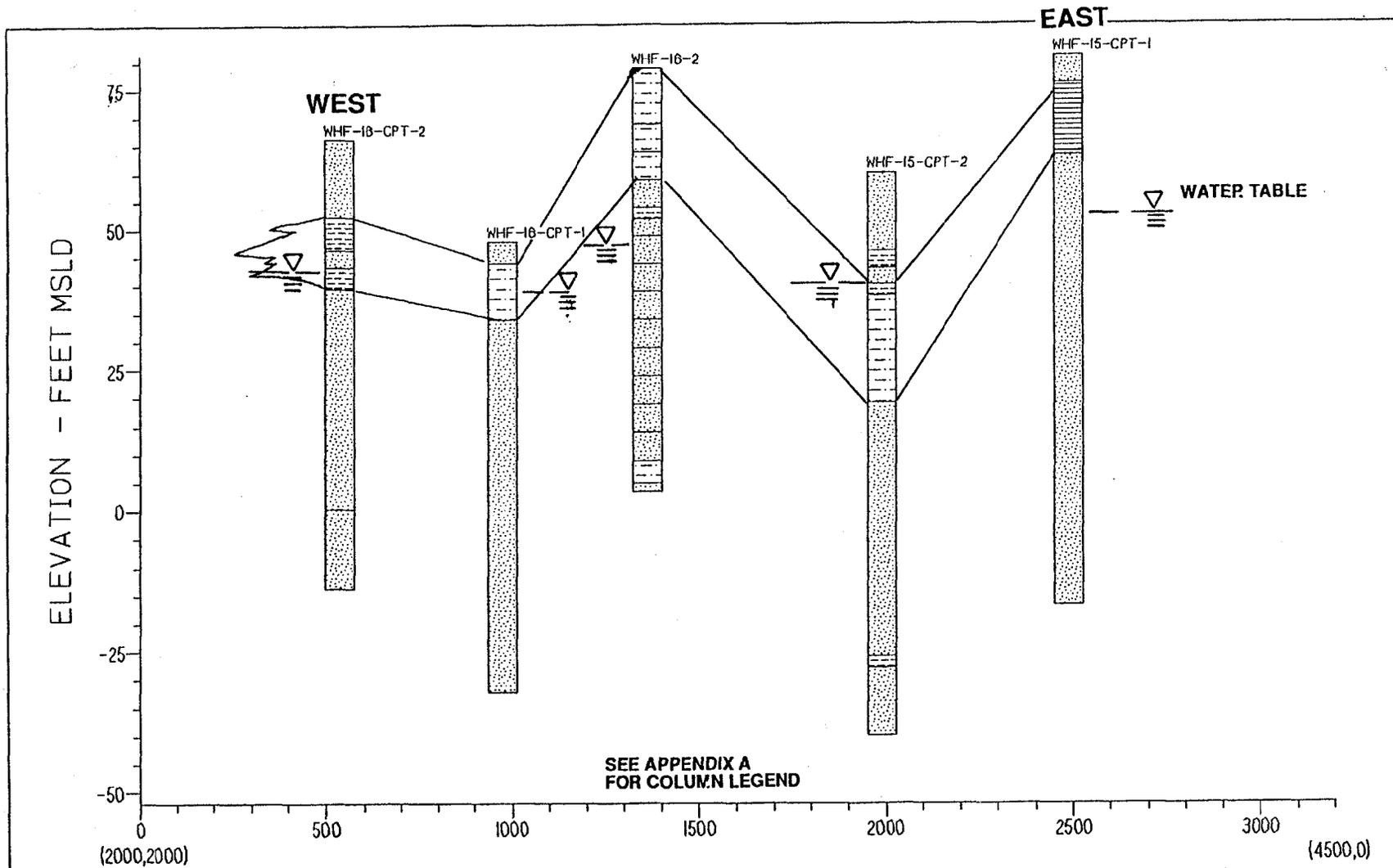


FIGURE 3-9
INTERPRETED CROSS SECTION
THROUGH THE SOUTHWEST
DISPOSAL AREAS



RI/FS PROGRAM

NAS WHITING FIELD
MILTON, FLORIDA

of approximately 10 to 20 feet mean sea level (msl), which is similar to the elevation of the shallow downgradient BAT samples. Figure 3-9 shows a cross section of sites 15 and 16 piezicone logs looking northeast as shown in Figure 3-7 in plan view.

Because of the depth of the observed groundwater contamination, approximately 55 to 72 feet below the water table, and lack of detectable VOCs in the upper portion of the water table, the VOCs appear to be coming from a source a substantial distance upgradient of site 16. Figure 3-1, taken from the Hydrogeologic Assessment (Technical Memorandum No. 2), shows the piezometric surface contours of the sand-and-gravel aquifer at NAS Whiting Field. Slug test data indicated hydraulic conductivities ranging from 9 to 23 feet per day in the NAS Whiting Field industrial area (North Field and South Field intermediate maintenance hangars, the NAS Whiting Field ground vehicle maintenance area, and the North and South Fuel Farms). As discussed in Technical Memorandum No. 2, seepage velocities based on these conductivities ranged from 0.07 to 0.21 foot per day in the industrial area. The curvilinear flow path from the northern and central parts of the industrial area of NAS Whiting Field to the location of the Site 16 BAT samples is 6,500 to 7,000 feet. Groundwater migration from the industrial area to Site 16 at seepage velocities in the range estimated by the slug test data would require more than 80 years. On the other hand, based on a hydraulic conductivity of 100 feet per day as measured in the pumping test, the time of travel would range from 13 to 26 years. Because of the presence of lenses, etc., of silty or clayey material and chemical or physical interaction of contaminants with aquifer solids, retardation would be likely to slow the migration of VOCs to some extent compared to the actual average flow velocity of groundwater. However, considering typical retardation factors of 2 to 5 times for VOCs in a sand aquifer, it is reasonable for contaminants to have migrated to the location of site 16 since the beginning of operations in the 1940's. Contamination traveling in groundwater from such a distance would be expected to have been pushed down into the aquifer a substantial vertical distance due to infiltration of groundwater recharging along the flow path from the sources to site 16. The Site 16 data, therefore, are consistent with a source of VOC contamination from the northern or central industrial area causing the site 16 findings. The absence of contamination at a shallower depth probably rules out Site 16 as the source.

Findings of 410 $\mu\text{g}/\text{l}$ benzene at Site 16 at a depth below the creek elevation suggests also that VOCs detected may underflow Clear Creek and migrate off-installation. Groundwater discharges from the water table surface into the floodplain of Clear Creek. It is possible that the source of sediment VOCs at sediment sample location 2 is due to discharge of such contaminated groundwater.

3.4 SITES 1, 2, 17, AND 18; NORTHWESTERN DISPOSAL AREAS. Sites 1, 2, 17, and 18 are located at the edge of the highland plateau in the northwest quadrant of NAS Whiting Field as shown in Figure 3-1. To the immediate west and southwest of each site, the surface slopes steeply toward Clear Creek or toward ravines that drain to Clear Creek. Groundwater flow direction is generally south-southwest in the direction of flow of Clear Creek. This is shown in Figure 3-10. However, no monitoring wells are located to the west of the sites on the slopes to evaluate where groundwater flow direction becomes more westerly toward the creek. In the area of Site 17 the ground surface contains significant amounts of clay. A clay layer exists as shown in Figure 3-11. The geologic stratigraphy

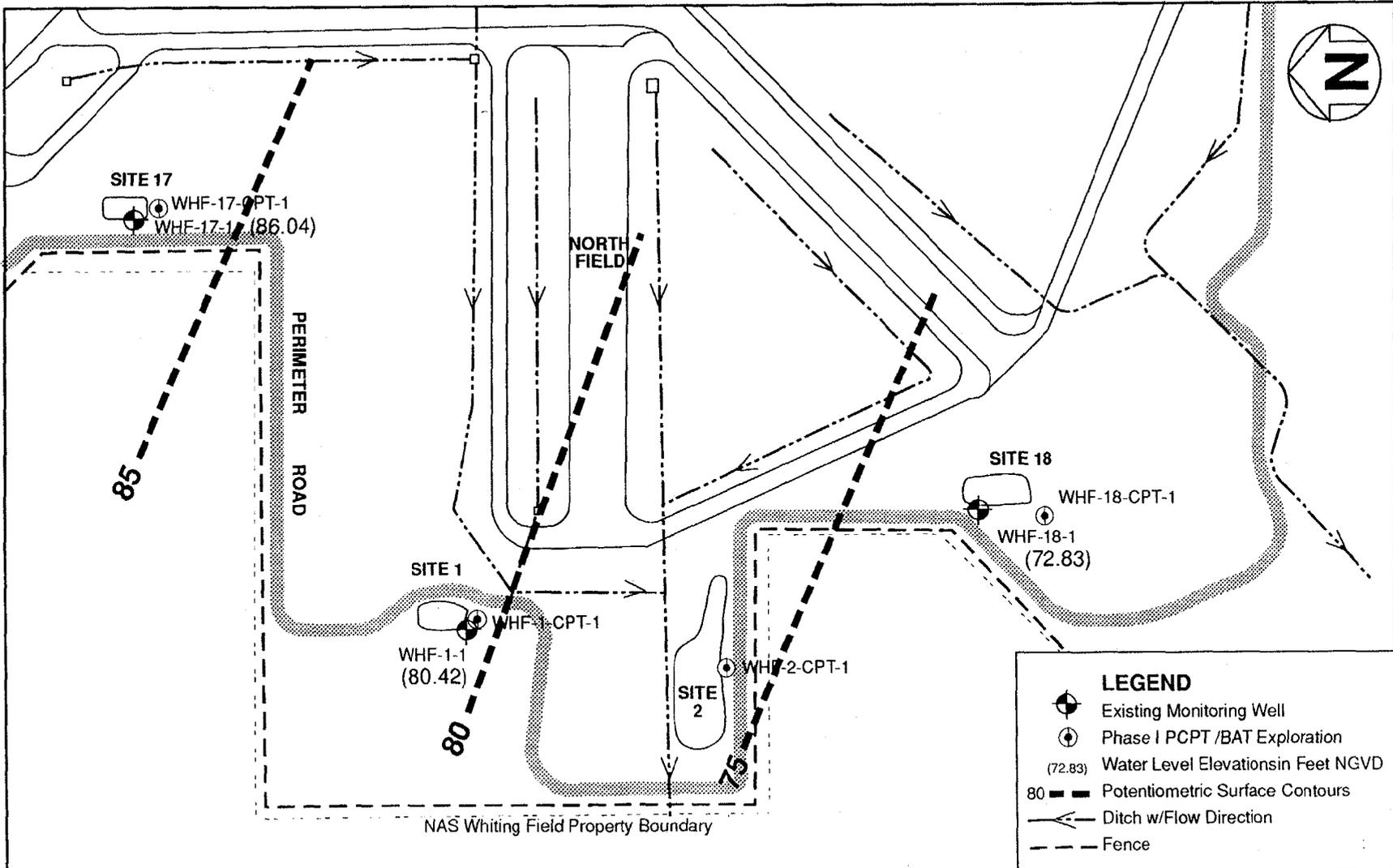
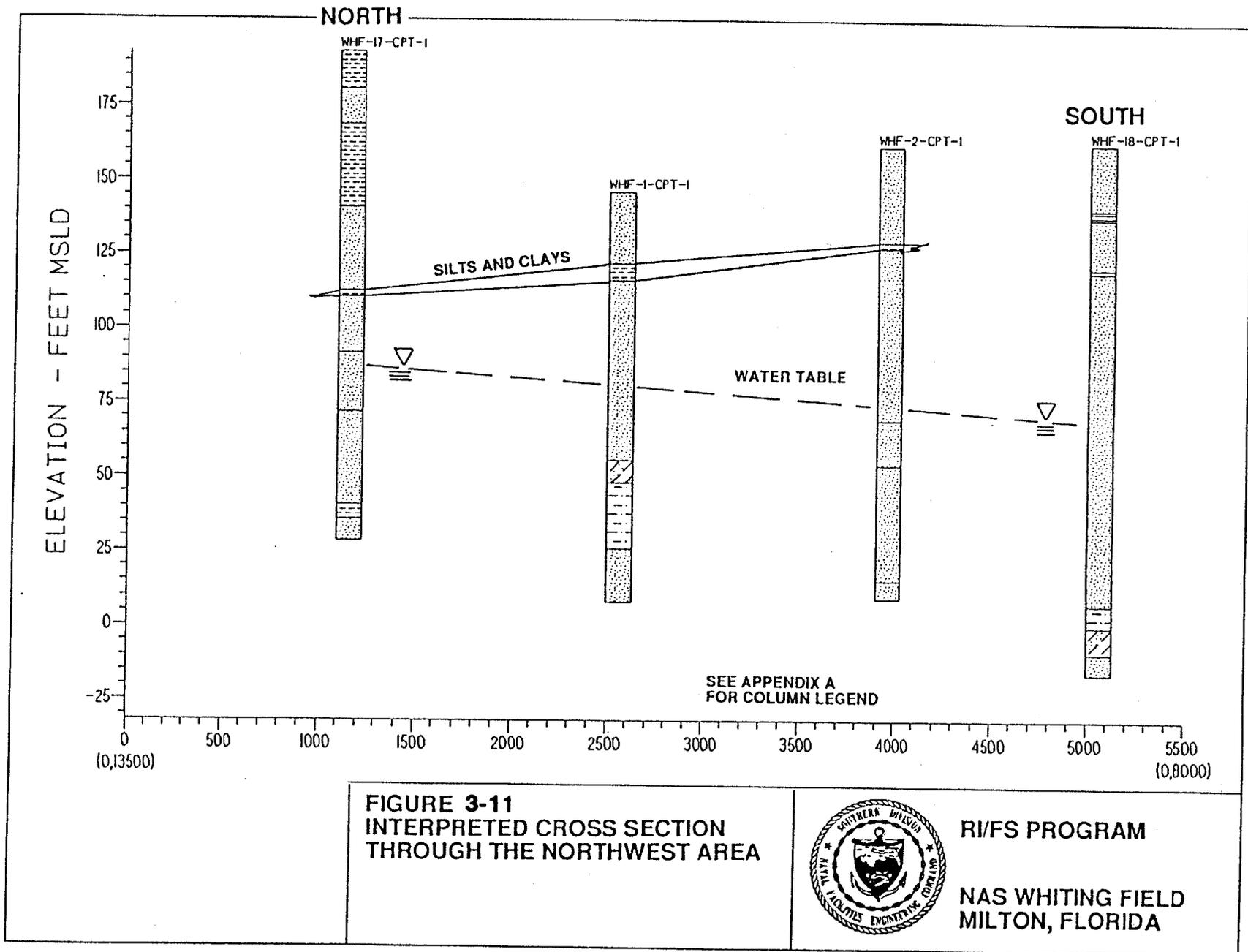


FIGURE 3-10
SITES 1, 2, 17, & 18
GROUNDWATER CONTOUR MAP
JULY 1991
NORTHWEST AREA



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA



and hydrogeology in the northwest part of NAS Whiting Field are presented in Technical Memoranda Number 1 and Number 2.

The four sites were identified during the IAS. Potential disposals are summarized in Table 3-7. No explorations have been conducted at Site 2. Site 2, reportedly, is a construction debris dump. Site 1 was a landfill, reportedly operated from 1943 to 1965. Reported disposals in Site 1 included refuse, waste paints and thinners, solvents, waste oils, and hydraulic fluids. Based on groundwater flow, Well WHF-1-1 may not have intercepted any release due to its placement somewhat crossgradient of the flow direction and its being screened below an 8-foot clay layer (see Figure 3-1). Sites 17 and 18 are Crash Crew Training Areas used since 1951 for firefighting training. Site 17 is no longer in use. Surface soil staining by oil is evident at this location. These stains show that the downslope side of the burning area was frequently flooded and that oily liquids were able to migrate along the land surface toward the patrol road ditch. No data exist regarding any liners under the burning pod; however, the surface soil contains large amounts of clay in the vicinity of the site. The Geraghty and Miller (1986) well log and borehole geophysics for WHF-17-1 indicated a clay substrate to a depth of 85 feet. The PCPT log also indicated clay layers interbedded with sand to a depth of 85 feet. No contamination was detected during the Verification Study in Well WHF-17-1. This well was completed and screened below the clay. At Site 18, Verification Study Well WHF-18-1 was placed apparently crossgradient to the path of groundwater flow. At this site the water table is less than 20 feet bls. The well is completed and screened from 32 to 42 feet. No contamination was detected in Well WHF-18-1 during the Verification Study. Site 18 is currently in use for firefighting training. Firefighting training is an essential base function vital to the mission of NAS Whiting Field.

No surface or subsurface soils explorations have been conducted at either Sites 17 or 18.

Figures 3-12 and 3-13 show the results of VOC and metals analysis of BAT samples from the water table and below the clay layer, respectively, at each of the four sites. No evidence of VOC contamination was detected at the water table. Because of the absence of contamination above the clay layer, BAT samples below the layer were not collected at Site 2 and Site 17.

Metals analysis from the BAT sampling program showed no evidence of elevated groundwater metals at Sites 1 and 2. At Site 17 and 18, evidence of elevated aluminum, barium, chromium, copper, lead, mercury, nickel, vanadium, and zinc were observed in the shallow part of the aquifer. The distribution of these metals are shown in Figure 3-12. No evidence for elevated metals was detected in the deeper zone where it was sampled. Because of the screening nature of the sampling program, firm conclusions relative to metals release cannot be made for the reasons discussed in Section 3.1.2. The metals detected, however, may be due to the combination of waste oils or the release of cations from the geologic matrix as residual fuel product is biologically transformed and causes changes in the geochemical environment. No evidence of fuels-related VOCs were detected in groundwater, however. Further confirmation of the metals concentrations and/or the geochemical processes responsible for elevating metals concentrations in groundwater at these two sites are required. Chromium as reported exceeds Federal and Florida MCLs. Lead exceeds the newly promulgated Federal standards.

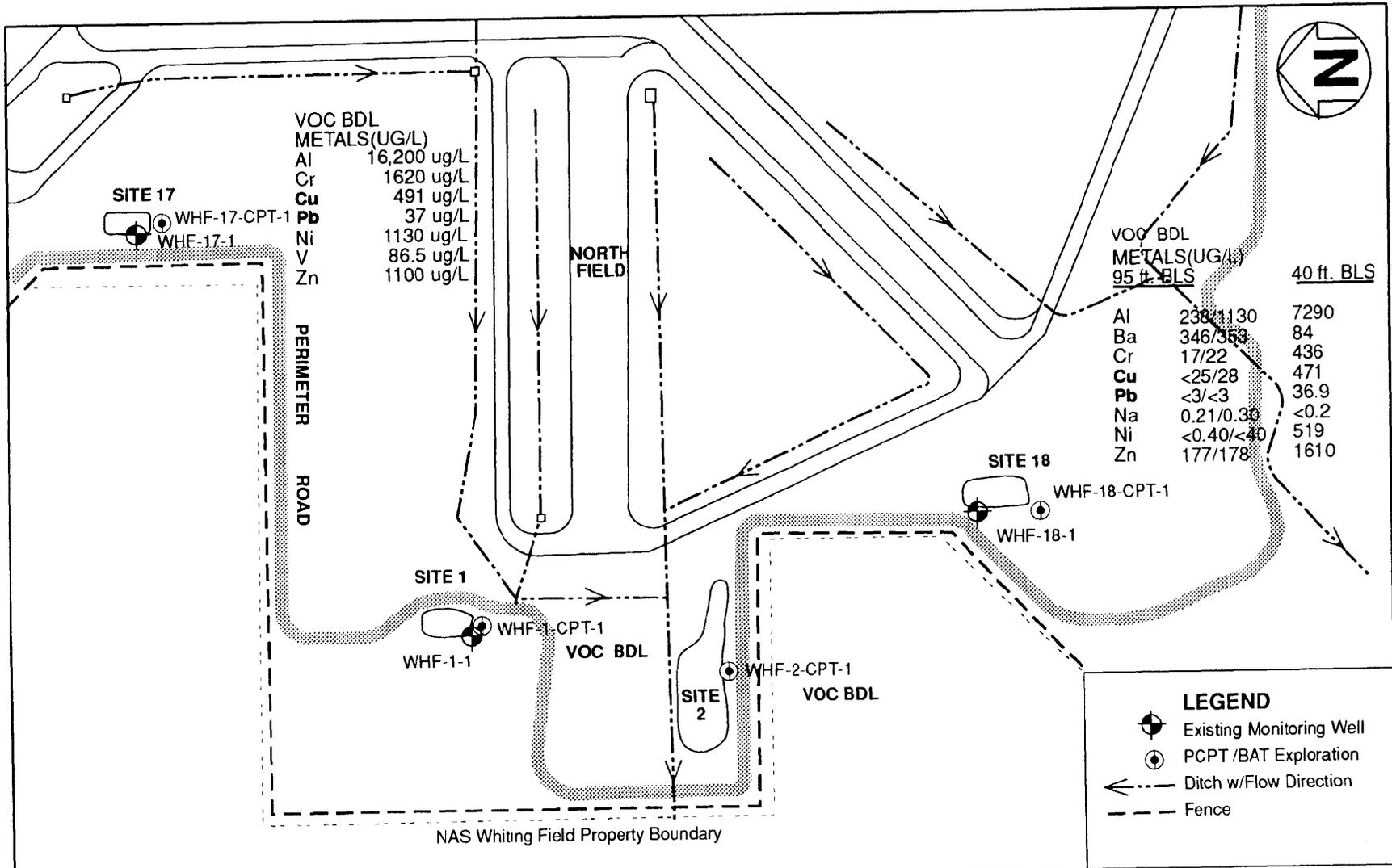
Table 3-7
Summary of Available Data for Contamination, Sites 1, 2, 17, and 18

Technical Memorandum No. 5
 NAS Whiting Field
 Milton, Florida

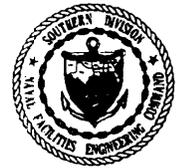
Site Number	Site Name	Materials Disposed	Soil Chemical	Frequency of Detection ¹	Maximum Conc. (mg/kg)	Groundwater Chemical	Frequency of Detection ¹	Maximum Conc. (µg/l)
1	Northwest Disposal Area	Refuse waste paints, paint, paint thinner, solvents waste oils, and hydraulic fluids.	Not tested			Lead	1/1	1
2	Northwest Open Disposal Area	Construction and demolition debris.	Not tested			Not tested		
17, 18	Crash Crew Training Area	JP-4 fuel	Not tested			None detected		

¹1/2 = number of samples with detectable levels of contaminant per total number of samples analyzed.

Notes: conc. = concentration.
 mg/kg = milligrams per kilogram.
 µg/l = micrograms per liter.
 mg/kg = milligrams per kilogram.



**FIGURE 3-12
SITES 1, 2, 17, & 18
PHASE I
SHALLOW BAT GROUNDWATER
VOC & METALS RESULTS**



**RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA**

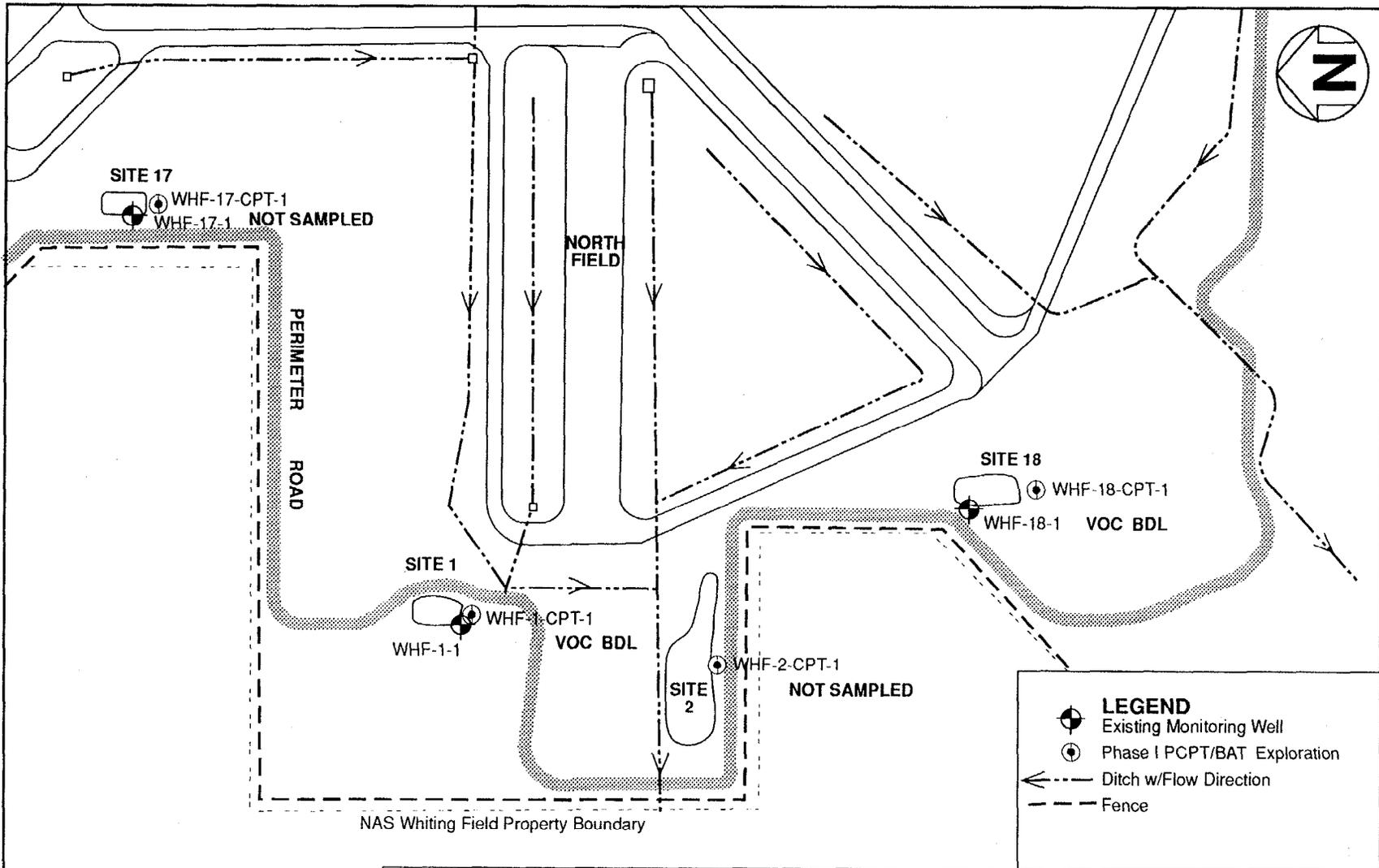


FIGURE 3-13
SITES 1, 2, 17, & 18
PHASE I
DEEP BAT GROUNDWATER
VOC RESULTS



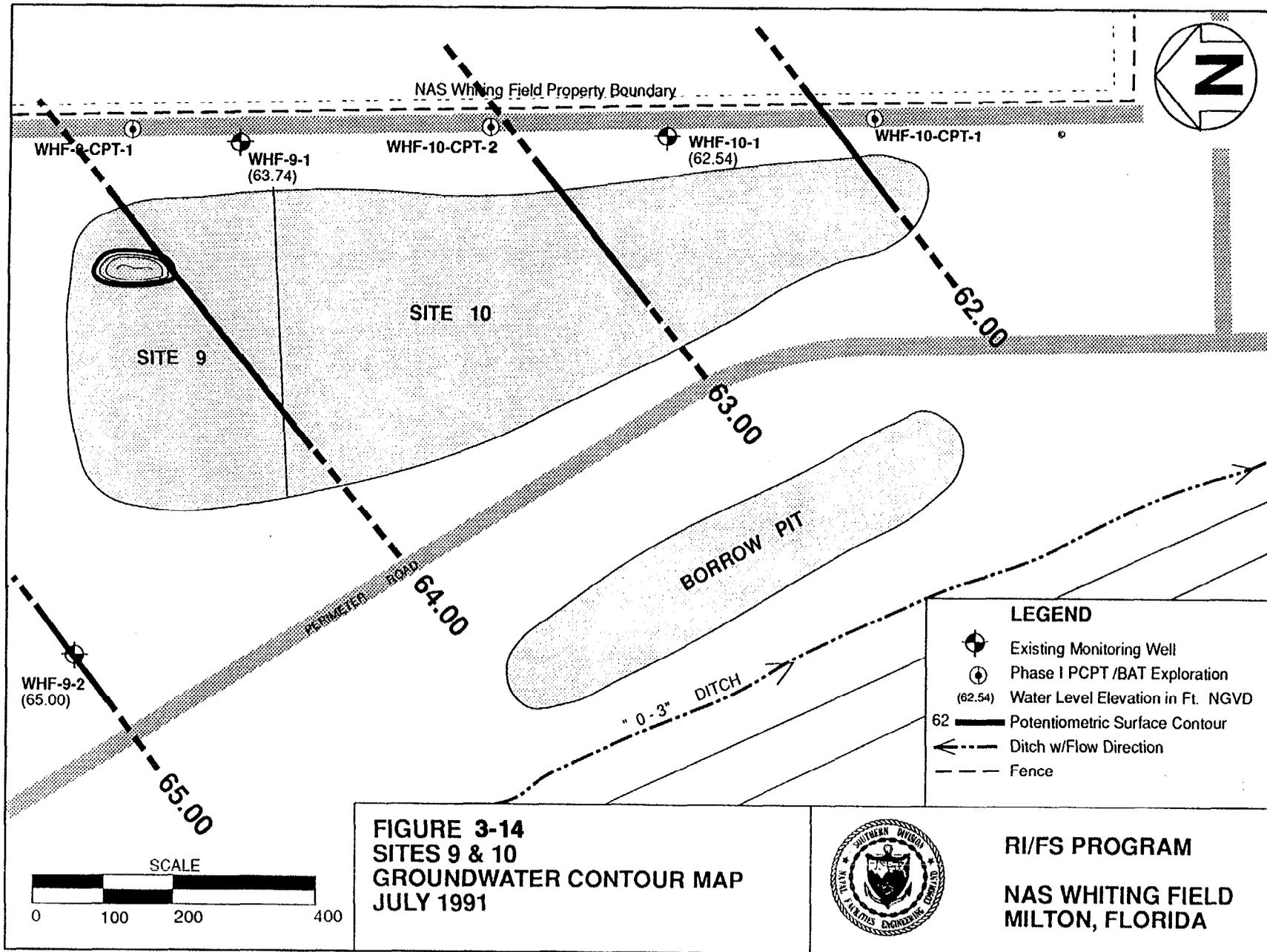
RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

Other metals combinations cited in Figure 3-12 are elevated above apparent background concentrations in groundwater at NAS Whiting Field.

3.5 SITES 9, 10, 11, 12, 13, AND 14: EASTERN DISPOSAL AREAS. Sites 9 through 14 are located along the eastern boundary of NAS Whiting Field as shown in Figure 3-1. In this area, groundwater flow direction is from north or north-northwest toward the south or southeast. Groundwater flow contours and the geological strata were presented in Technical Memoranda Number 1 and Number 2. Detailed contours through this group of sites are shown in Figures 3-14 and 3-15. In the area of these sites, flat-lying clay layers ranging from 125 to 140 feet NGVD and 50 to 100 feet NGVD underlie sites as shown in cross section Figure 3-16 looking west through the area. These six sites identified during the IAS consist of the potential disposals shown in Table 3-8. During the Verification Study (Geraghty and Miller, 1986) groundwater was investigated via the installation of six monitoring wells. Limited soils exploration at sites 9 and 12 did not indicate releases of toxic and hazardous material at these sites. No surface or subsurface soils investigations have been conducted at Sites 10, 11, 13, and 14, which were either landfills or open disposal areas. Figures 3-14 and 3-15 show the location of the Verification Study monitoring wells. All of these wells and groundwater contours through this area were completed below the clay layer that may function as a confining layer in the area of the sites. As shown in Figures 3-14 and 3-15, Wells WHF-9-1, WHF-11-1, WHF-12-1, and WHF-14-1 placement may not intercept contaminants in that part of the aquifer below the clay. Well WHF-12-1 appears to be completely outside of any area of potential impact and may represent background conditions. Sampling and analysis during the Verification Study was carried out for fuels-related VOCs and lead in groundwater at sites 9 and 12 and for priority pollutant organic chemicals and metals, as well as pesticides at the remaining sites. Results of analysis during the Verification Study are shown in Table 3-8. Trace concentrations of lead and silver were present. Zinc was detected at 50 $\mu\text{g}/\ell$ and 240 $\mu\text{g}/\ell$ at Sites 11 and 13, respectively. Nickel was also detected at Site 13 (at 60 $\mu\text{g}/\ell$). BEHP detected at site 11 was not tested in the Phase I RI screening groundwater program. BEHP is a common plasticizer, and while frequently present in landfill leachate, BEHP is one of the most common sampling and analysis artifacts, because it is present on or in numerous plastic items, some of which are contacted commonly during field work. The presence of traces of BEHP in a single sample from a well, apparently cross gradient from Site 11, probably, therefore, represents an artifact rather than a contaminant release.

Phase I RI BAT sampling results for VOCs and metals are presented in Figures 3-17 through 3-20 for sites 9 through 14 for the aquifer zone above and below the clay confining layer, respectively. No evidence of VOC release was detected in either zone. Samples collected above the clay layer ranged in depth from 82 to 107 feet BLS. Samples collected below the clay layer ranged in depth from 132 to 162 feet BLS.

Based on the screening assessment of metals, the only metals concentrations that suggest potential impact are the replicated chromium results at WHF-09-WP-01 and WHF-09-WP-01A. Sample WHF-WP-01 contained chromium at 88.5 $\mu\text{g}/\ell$. The duplicate contained 42.2 $\mu\text{g}/\ell$. Excluding two extreme values (See Appendix B), the chromium mean was 23 $\mu\text{g}/\ell$ overall at NAS Whiting Field. At sites 9 through 14, chromium ranged from 410 $\mu\text{g}/\ell$ to 88.5 $\mu\text{g}/\ell$. Zinc was detected in all the BAT groundwater samples at concentrations ranging from 52.4 $\mu\text{g}/\ell$ to 281 $\mu\text{g}/\ell$. Overall mean zinc



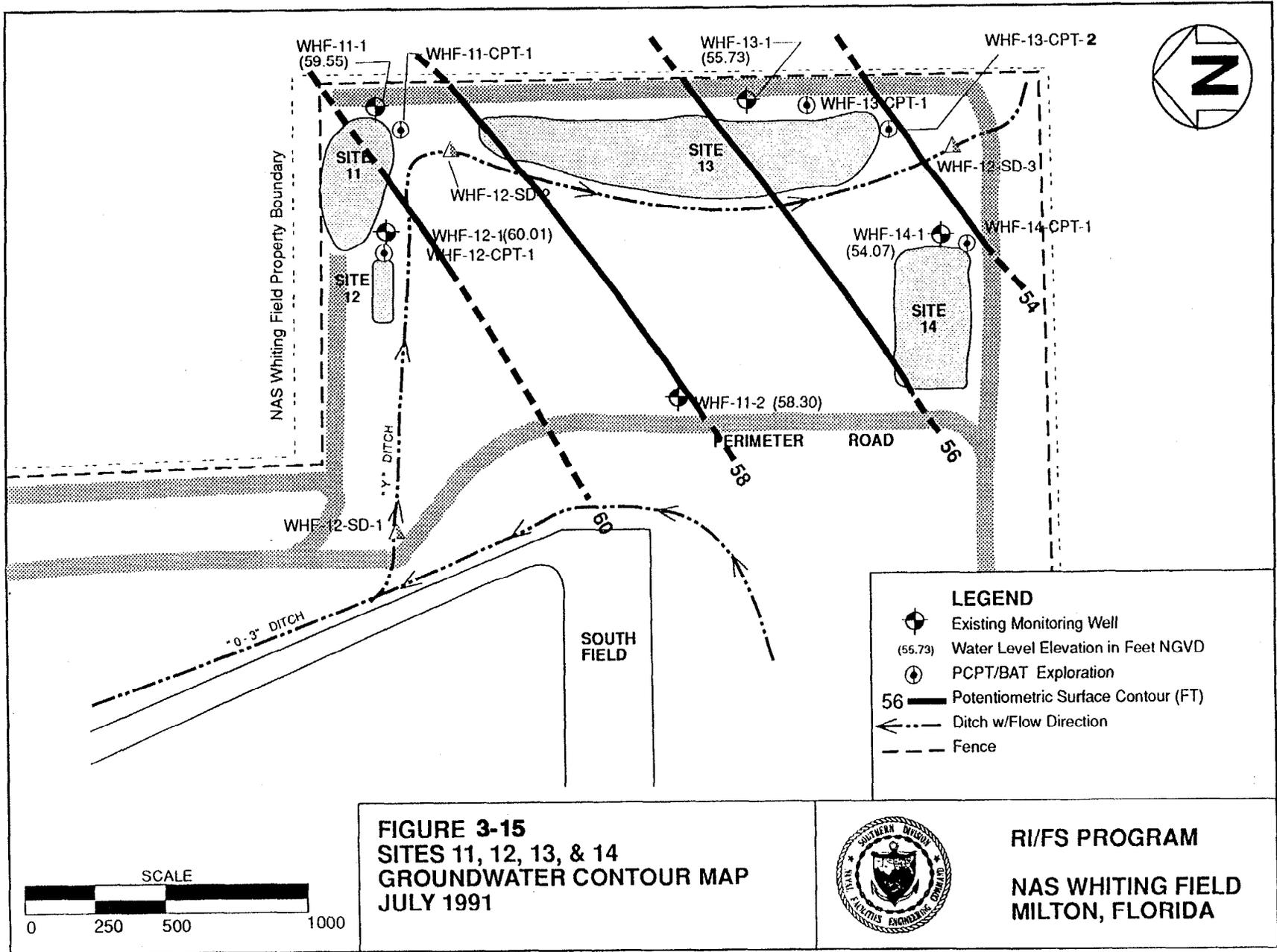
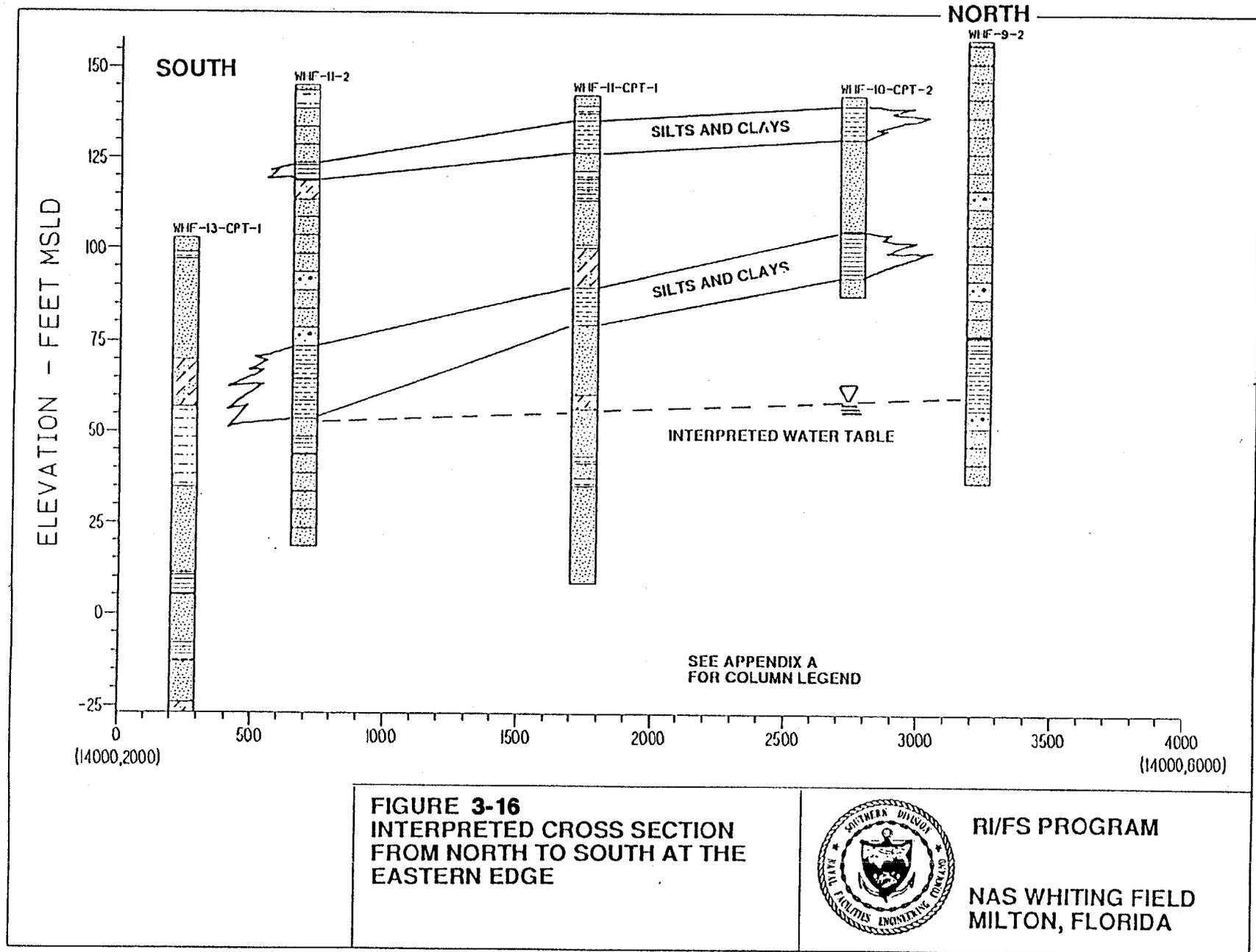
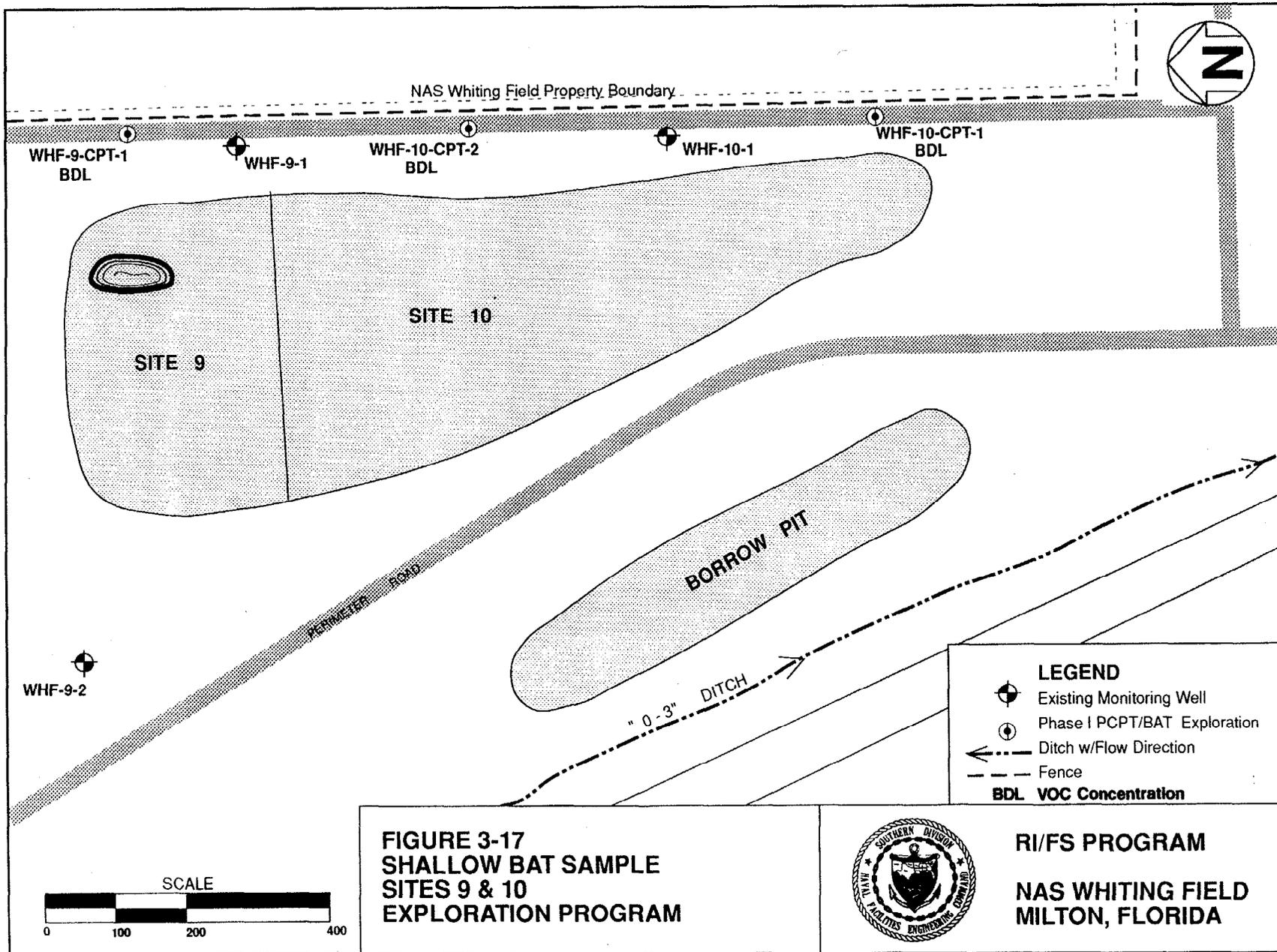


FIGURE 3-15
SITES 11, 12, 13, & 14
GROUNDWATER CONTOUR MAP
JULY 1991



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA





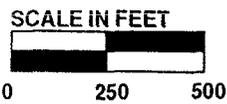
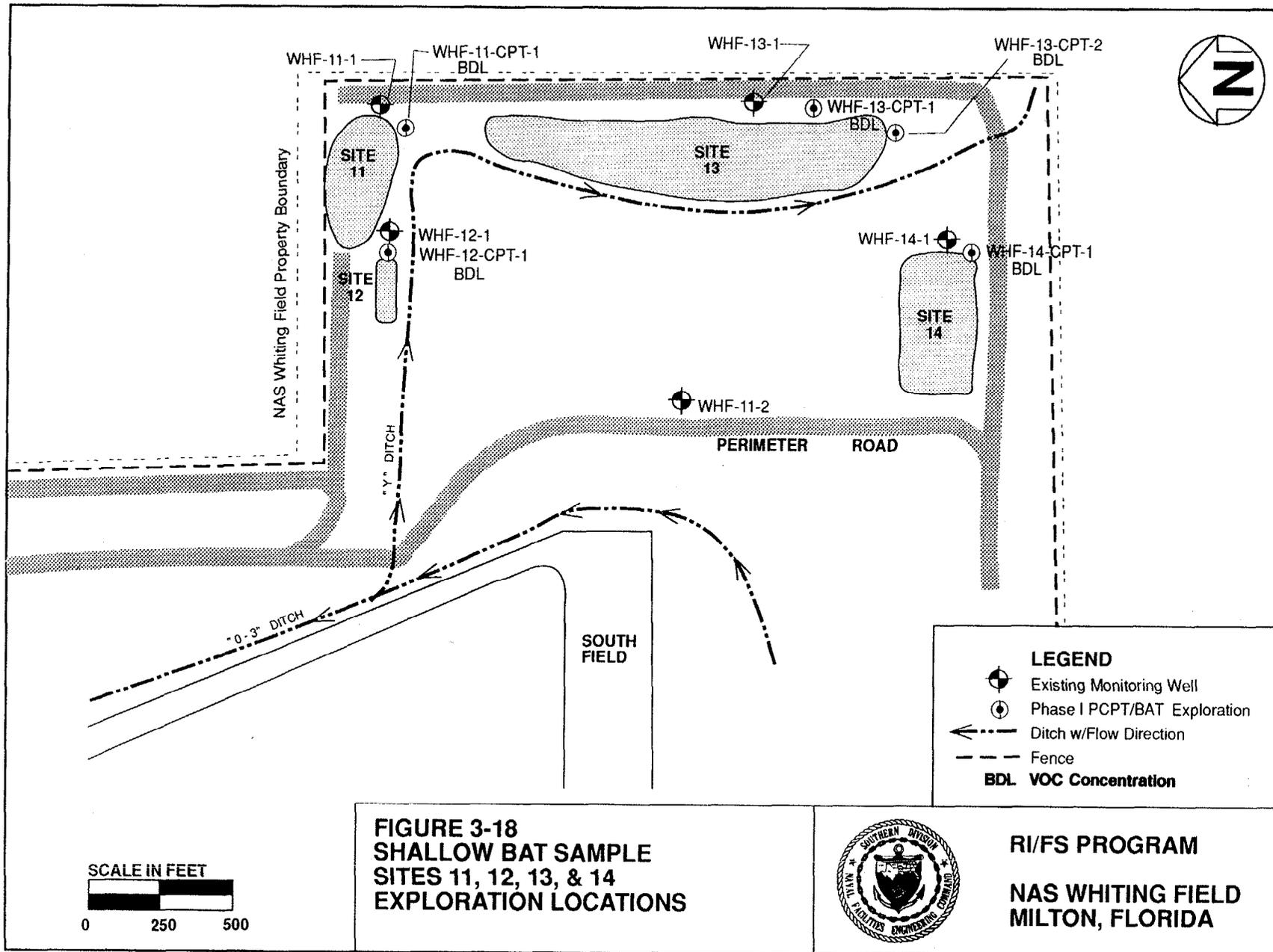
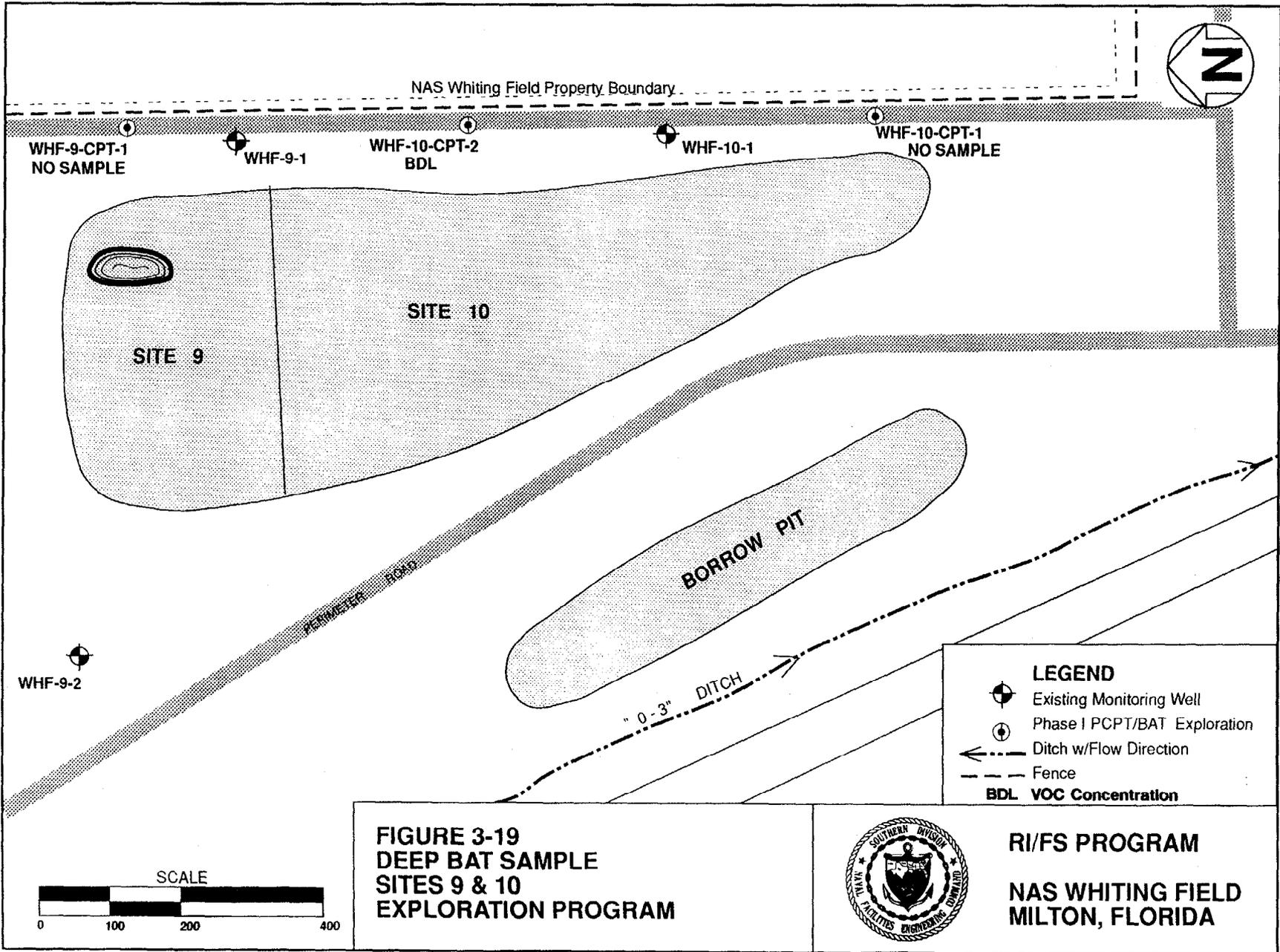


FIGURE 3-18
SHALLOW BAT SAMPLE
SITES 11, 12, 13, & 14
EXPLORATION LOCATIONS



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA



**FIGURE 3-19
DEEP BAT SAMPLE
SITES 9 & 10
EXPLORATION PROGRAM**



**RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA**

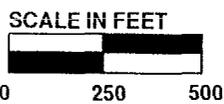
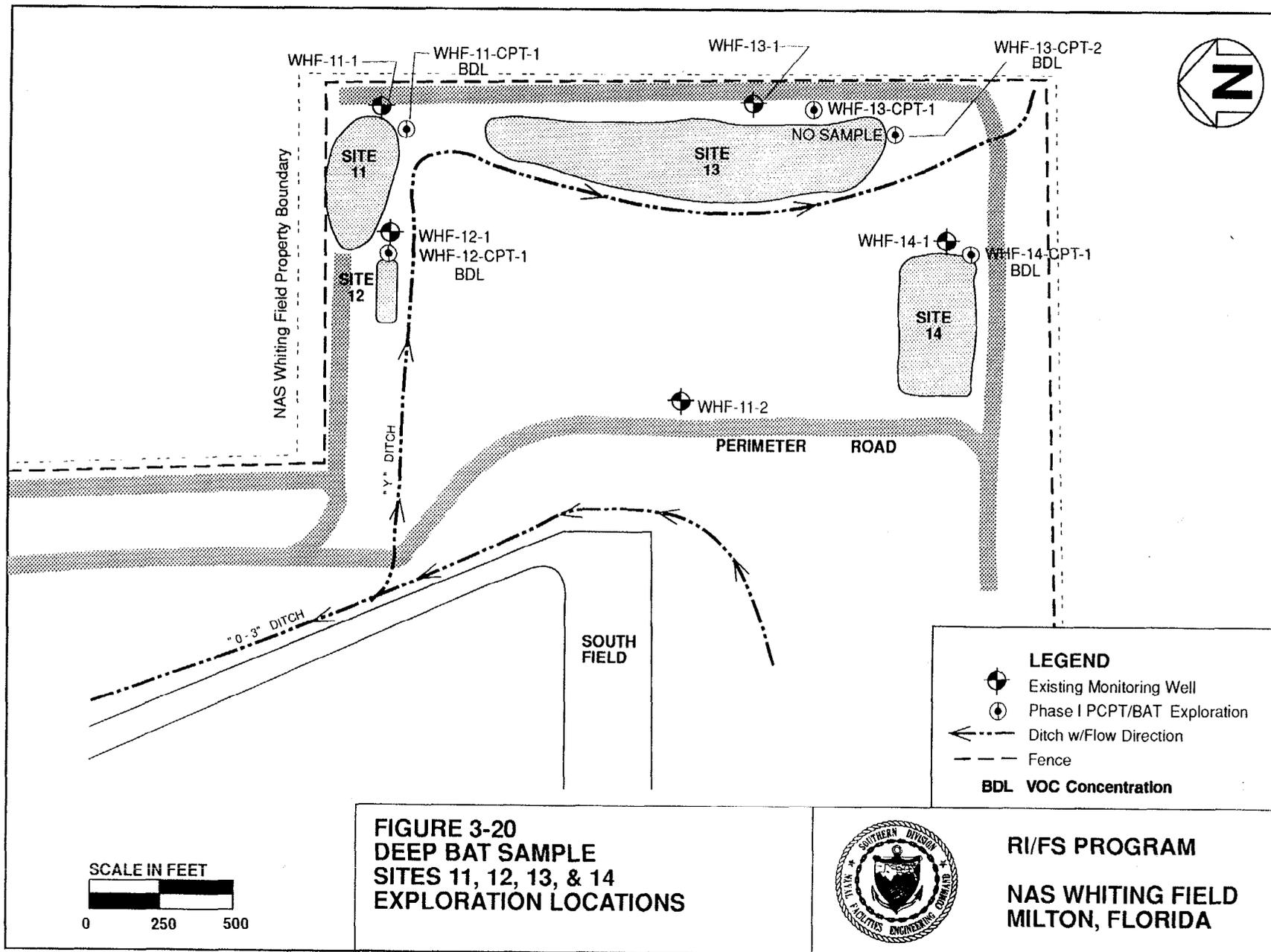


FIGURE 3-20
DEEP BAT SAMPLE
SITES 11, 12, 13, & 14
EXPLORATION LOCATIONS



RI/FS PROGRAM
NAS WHITING FIELD
MILTON, FLORIDA

LEGEND

- Existing Monitoring Well
- Phase I PCPT/BAT Exploration
- Ditch w/Flow Direction
- Fence

BDL VOC Concentration

Table 3-8
Summary of Verification Study Data on Contamination

Technical Memorandum No. 5
 NAS Whiting Field
 Milton, Florida

Site Number	Site Name	Materials Disposed	Soil Chemical	Frequency of Detection ¹	Maximum Conc. (mg/kg)	Groundwater Chemical	Frequency of Detection ¹	Maximum Conc. (µg/l)
9	Waste Fuel Disposal Area	AVGAS with tetraethyl lead.	Lead	12/12	14	Lead	1/1	7
10	Southeast Open Disposal Area (A)	Waste solvents, paints, oil, hydraulic fluids, PCBs, pesticides, and herbicides.	Not tested	--	--	Lead Silver	1/1 1/1	6 0.8
11	South Open Disposal Area (B)	Waste solvents, paints, oils, hydraulic fluids, and PCBs.	Not tested	--	--	BEHP Lead Zinc	1/1 1/1 1/1	23 1.5 50
12	Tetraethyl Lead Disposal Area	Tank bottom sludge with tetraethyl lead.	Lead	3/3	11	Lead	1/1	2
13	Sanitary Landfill	Refuse, waste solvents, paint, and asbestos.	Not tested			Lead Nickel Zinc	1/1 1/1 1/1	6 60 240
14	Short-term Sanitary Landfill	Refuse, waste solvents, paint, oils, and hydraulic fluid.	Not tested			Not detected		

¹1/2 = number of samples with detectable levels of contaminant per total number of samples analyzed.

Notes: Conc. = concentration.
 mg/kg = milligrams per kilogram.
 µg/l = micrograms per liter.
 AVGAS = aviation gas.
 PCBs = polychlorinated biphenyls.
 BEHP = Bis(2-ethylhexyl)phthalate.

concentration installation wide was 123 $\mu\text{g}/\ell$. The highest zinc also occurred in one replicate of WHF-09-WP-01.

These data do not indicate firm evidence of groundwater impact due to metals releases at any of the six sites.

Based on the above screening data, no evidence of current releases of VOCs or metals exists at Sites 9, 10, 11, 12, 13, and 14. The maximum chromium concentration (at Site 9) exceeds the Florida MCL for chromium. To complete a groundwater evaluation at these sites, confirmatory upgradient samples should be collected from a water table monitoring well and from a well placed in the water table immediately downgradient of sites 9, 10, 11, 13, and 14. These should be sampled for TCL organics and the TAL compounds.

No further groundwater explorations are necessary for Site 12.

4.0 GROUNDWATER QUALITY STATUS SUMMARY AND CONCLUSIONS

This section is a summary of the significant findings resulting from the screening groundwater quality program conducted as a component of the NAS Whiting Field Phase I RI and assessment of past investigations. Overall, groundwater contamination resulting from past releases, primarily in the industrial area of the installation, directly or indirectly represents the most significant problem identified at NAS Whiting Field. Based on the Verification Study, the Battery Shop Investigation, and the screening metals program conducted in this RI phase, VOCs rather than metals or other chemicals appear to be the major chemicals of concern. Additional data are required to confirm this tentative conclusion relative to existing or future identified sources of contamination.

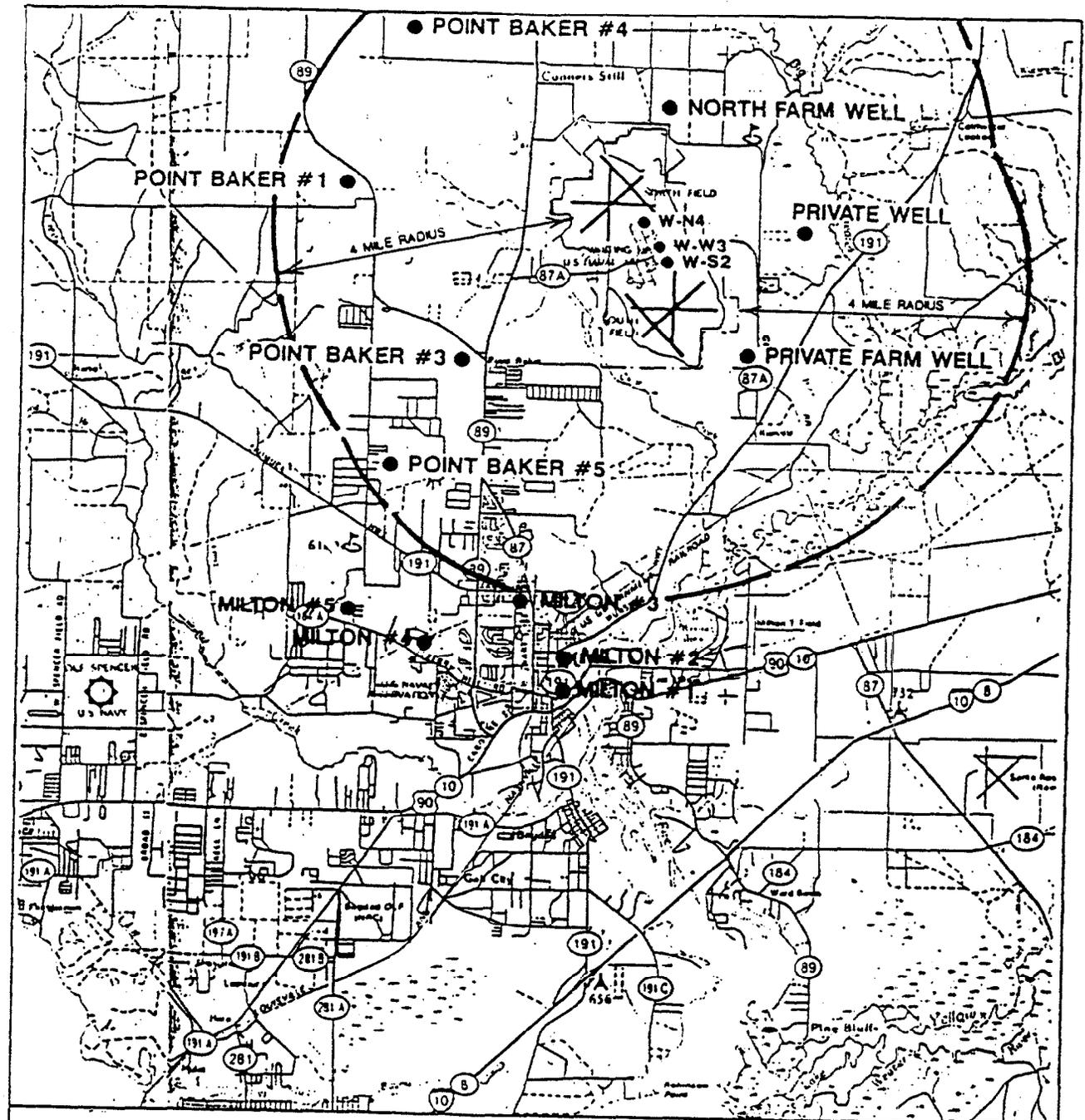
Although a major focus of the IAS and Verification Study was on potential releases from industrial wastes disposed into the landfills and open disposal areas located near to the installation boundaries (Sites 1, 2, 9, 10, 11, 12, 13, and 14) and the two new crash training areas (Sites 17 and 18), significant contamination by VOCs or metals in groundwater was detected at only Site 15, a former landfill in the southwestern quadrant of the installation. The nature and extent of soils and groundwater contamination at Site 15 should be confirmed.

At Site 16, VOC contamination was observed but only at a depth of 50 feet below the water table surface. At this location contamination was interpreted to result from a release that had migrated from the northern part of the industrial area in the vicinity of the Site 3/Building 2941 area or the North Fuel Farm. Benzene was detected at 410 $\mu\text{g}/\ell$ and 1,2-DCE at 13 $\mu\text{g}/\ell$. Because this location is within 200 feet of the installation boundary, off-installation contaminant migration at benzene concentrations above Florida groundwater standards is likely to occur. Because of the depth of the contamination, underflow of Clear Creek is likely. On the other hand, floodplain sediment contamination detected in the surface water and sediment program may be due to contaminated groundwater discharge in this flow path. At Site 16, the lack of relationship of the site to the observed deep contamination must be confirmed. The overall status of site 16 should be confirmed and any off-installation potable water supplies potentially affected due to the contamination under Site 16 should be investigated.

Based on information provided by NAS Whiting Field Public Works Department and the Milton and Point Baker Water Works, all potable and industrial water supplies within 4 miles of NAS Whiting Field are obtained from the sand-and-gravel aquifer.

Two municipal water systems, Milton and Point Baker, serve a part or all of the population that falls between the 0- to 4-mile distance radii from the NAS Whiting Field sites. NAS Whiting Field's potable water is supplied by three wells. Public water supply well locations for these three systems are presented in Figure 4-1.

Based on time of travel estimates, it is possible that the contamination that has been detected at Site 16 could have traveled an additional 1/2 to 1 mile. According to the utilities, the population to the west of NAS Whiting Field is supplied by the Point Baker or Milton systems. These supply wells are greater than 3 miles from the industrial area of NAS Whiting Field. However, based on



SOURCE: ATLAS AND GAZATTEER
DELORME PUBLISHING CO.

LEGEND
#X ● WATER SUPPLY WELL

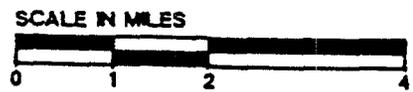


FIGURE 4-1
WATER SUPPLY WELLS
IN THE VICINITY OF
NAS WHITING FIELD



RI/FS PROGRAM

NAS WHITING FIELD
MILTON, FLORIDA

the U.S. Geological Survey 1988 quadrangle map, 22 private residences lie within 1 to 2 miles from the industrial area. Confirmation of the sources of water for these residences, and the extent of any off installation migration of contaminated groundwater should be a priority activity in Phase II of the RI.

In the industrial area, additional probable sources of groundwater contamination not highlighted in the IAS or Verification Study appear to account for the observed pattern of VOC contamination of the upper zone of the sand-and-gravel aquifer. This contamination appears to be drawn downward into the contaminated production wells W-W3 and W-S2 from sources in the Public Works Transportation Area.

The following potential sources and their significance in the groundwater contamination problem at NAS Whiting Field require source identification, verification, and confirmation of the full nature and extent of groundwater contamination.

1. The former waste oil tank south of Building 2941 (former AIMD Shop Area) and the Hangar 1424 Aircraft Maintenance Area may be responsible for shallow zone VOC contamination near Site 3 and may possibly be causing groundwater contaminant migration 6,500 feet downgradient at Site 16. Further investigation is required to determine the extent of downgradient contamination, interaction if any with Sites 15 and/or 16, the complete nature of contamination, and the further extent of any contamination off of NAS Whiting Field.
2. At the North Fuel Farm Area, it is unknown whether this contamination is due to leaking fuels. This possibility is to be investigated under the UST Program.
3. At the Public Works Department Transportation Area, east of Building 1429, pre-1984 maintenance activities appear to be responsible for groundwater contamination at the two production wells (W-W3 and W-S2) and in the production zone of the aquifer downgradient. The full nature and extent of groundwater contamination and verification and identification of residual source locations in the ground vehicle maintenance area are required.
4. Confirmation of the lack of contamination from the BX Service Station and current JP-5 fuel handling facility is required.
5. Residual soils contamination at the edges of the Building 1451 hardstand, the drainage ditch, and the former waste oil storage tank require investigation. The shallow groundwater zone downgradient of the former tank and storm drainage contains 410 $\mu\text{g}/\text{l}$ TCE. The full nature and extent of contaminated groundwater due to this site should be confirmed.
6. At the South Fuel Farm, high levels of aromatic VOC contamination exists in the aquifer. The flow direction and the nature and extent of contamination at this site will be addressed under the UST program.

7. The contamination status of soils and groundwater due to the underground waste oil tank at the Building 1406, Helicopter Maintenance Shop, has not been investigated. The contamination status of soil and groundwater should be evaluated at this location.
8. The contamination status of soils and groundwater due to the underground waste oil tanks at the Building 1404, Auto Hobby Shop, has not been investigated. The contamination status of soil and groundwater should be evaluated at this location.

Confirmation of the lack of groundwater contamination at the open disposal sites and landfills located along the eastern boundary of NAS Whiting Field (Sites 9, 10, 11, 12, 13, and 14) and the Northwest (Sites 1, 2, 17, and 18) should be conducted using a minimum of monitoring wells in order to support no-action or monitoring-only decisions depending on results of further soils explorations.

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APPENDIX A

**COMPLETE SCREENING GROUNDWATER VOLATILE ORGANIC
COMPOUNDS RESULTS NEESA QC LEVEL E**

Locator	WHF-01-WP-01-01	WHF-01-WP-01-02	WHF-02-WP-01-01	WHF-3-WP-01-01	WHF-3-WP-01-01A	WHF-3-WP-01-02	WHF-3-WP-01-02A	WHF-3-WP-02-01	WHF-3-WP-02-02	WHF-09-WP-01-01	WHF-09-WP-01-01A
Sample Data	04-29-91	04-29-91	04-26-91	05-13-91	05-13-91	05-13-91	05-13-91	05-13-91	05-13-91	04-26-91	04-26-91
Volatile Organics	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
Chloromethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromomethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methylene chloride	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Acetone	<10	10	13	61	50	22	19	50	80	320	110
Carbon disulfide	41	140	440	13	72	7.8	56	14	82	290	6.2
1,1-Dichloroethylene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1-Dichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis/trans-1,2-Dichloroethylene	<5.0	<5.0	<5.0	250	250	<5.0	<5.0	130	<5.0	<5.0	<5.0
Chloroform	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloroethane	<3.0	<3.0	<3.0	34	34	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2-Butanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon tetrachloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Vinyl acetate	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromodichloromethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2-Tetrachloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,3-Dichloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethylene	<3.0	<3.0	<3.0	11	9.2	<3.0	<3.0	54	<3.0	<3.0	<3.0
Dibromochloromethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2-Trichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzene	<1.0	<1.0	<1.0	1800	2000	<1.0	<1.0	3000	<1.0	<1.0	<1.0
cis-1,3-Dichloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Chloroethylvinyl ether	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromoform	<5.0	<5.0	<3.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Hexanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Methyl-2-pentanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tetrachloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Toluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ethylbenzene	<5.0	<5.0	<5.0	97	73	<5.0	<5.0	58	<5.0	<5.0	<5.0
Styrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Xylenes	<5.0	<5.0	<5.0	310	230	<5.0	<5.0	27	<5.0	<5.0	<5.0

Locator	WHF-16-WP-2-2	WHF-17-WP-01-01	WHF-18-WP-01-01	WHF-18-WP-01-01A	WHF-18-WP-01-02	WHF-18-WP-01-02A	WHF-S2-WP-01-01	WHF-S2-WP-01-02	WHF-S2-WP-02-01	WHF-S2-WP-03-01	WHF-S2-WP-04-01
Sample Data	03-15-91	05-02-91	04-30-91	04-30-91	04-30-91	04-30-91	03-19-91	05-10-91	03-19-91	03-20-91	03-26-91
Volatile Organics	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
Chloromethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromomethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methylene chloride	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Acetone	33	31	84	59	130	57	76	170	23	38	490
Carbon disulfide	<5.0	<5.0	110	87	75	110	14	130	190	19	94
1,1-Dichloroethylene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1, 1-Dichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis/trans-1,2-Dichloroethylene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chloroform	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<5.0	<3.0	<5.0	<5.0	<5.0
2-Butanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon tetrachloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<5.0	<3.0	<5.0	<5.0	<3.0
Vinyl acetate	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromodichloromethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2,2-Tetrachloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,3-Dichloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<5.0	<3.0	<5.0	<5.0	<3.0
Dibromochloromethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2-Trichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,3-Dichloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Chloroethyvinyl ether	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromoform	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Hexanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Methyl-2-pentanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tetrachloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<5.0	<3.0	<5.0	<5.0	<3.0
Toluene	5.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	7.2
Chlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ethylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Styrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Xylenes	5.4	<5.0	<5.0	<5.0	<5.0	<5.0	12	<5.0	<5.0	<5.0	8.9

Locator	WHF-S2-WP-04-02	WHF-S2-WP-05-01	WHF-S2-WP-05-02	WHF-S2-WP-06-02	WHF-S2-WP-07-1	WHF-S2-WP-08-1	WHF-S2-WP-08-02	WHF-W3-WP-01-01	WHF-W3-WP-01-02	WHF-W3-WP-02-01	WHF-W3-WP-02-02
Sample Data	05-13-91	03-28-91	05-13-91	05-10-91	03-16-91	03-17-91	05-10-91	03-28-91	03-28-91	03-29-91	03-29-91
Volatile Organics	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
Chloromethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromomethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chloroethane	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Methylene chloride	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Acetone	290	72	<10	89	44	35	54	34	300	<10	170
Carbon disulfide	70	140	120	34	9.9	34	30	180	28	130	15
1,1-Dichloroethylene	<5.0	13	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1, 1-Dichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
cis/trans-1,2-Dichloroethylene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chloroform	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloroethane	<3.0	<5.0	<3.0	<3.0	<5.0	<5.0	<3.0	<3.0	<3.0	<3.0	<3.0
2-Butanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon tetrachloride	<3.0	<3.0	<3.0	<3.0	<5.0	<5.0	<3.0	<3.0	<3.0	<3.0	<3.0
Vinyl acetate	<10	<10	<10	<10	<10	<10	<10	<10	<5.0	<5.0	<5.0
Bromodichloromethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2,2-Tetrachloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,3-Dichloropropene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethylene	<3.0	<3.0	<3.0	<3.0	<5.0	<5.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dibromochloromethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,1,2-Trichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzene	<1.0	<1.0	<1.0	6.3	<5.0	<5.0	<1.0	<10	<1.0	<1.0	<1.0
cis-1,3-Dichloropropene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Chloroethyvinyl ether	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromoform	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Hexanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
4-Methyl-2-pentanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tetrachloroethylene	<3.0	<3.0	<3.0	<3.0	<5.0	<5.0	<3.0	<3.0	<3.0	<3.0	<3.0
Toluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ethylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Styrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Xylenes	<5.0	8.2	<5.0	<5.0	<5.0	10	<5.0	<5.0	<5.0	<5.0	<5.0

Locator	WHF-W3-TB-03	WHF-W3-TB-04	WHF-W3-TB-05							
Sample Data	04-02-91	04-10-91	04-11-91							
Volatile Organics	Conc.	Conc.	Conc.							
Chloromethane	<10	<10	<10							
Bromomethane	<10	<10	<10							
Vinyl Chloride	<10	<10	<10							
Chloroethane	<10	<10	<10							
Methylene chloride	<5.0	<5.0	<5.0							
Acetone	<10	<10	<10							
Carbon disulfide	<5.0	<5.0	<5.0							
1,1-Dichloroethylene	<5.0	<5.0	<5.0							
1, 1-Dichloroethane	<5.0	<5.0	<5.0							
cis/trans-1,2-Dichloroethylene	<5.0	<5.0	<5.0							
Chloroform	<5.0	<5.0	<5.0							
1,2-Dichloroethane	<3.0	<5.0	<5.0							
2-Butanone	<10	<10	<10							
1,1,1-Trichloroethane	<5.0	<5.0	<5.0							
Carbon tetrachloride	<3.0	<3.0	<3.0							
Vinyl acetate	<10	<10	<10							
Bromodichloromethane	<5.0	<5.0	<5.0							
1,1,2,2-Tetrachloroethane	<5.0	<5.0	<5.0							
1,2-Dichloropropane	<5.0	<5.0	<5.0							
trans-1,3-Dichloropropene	<5.0	<5.0	<5.0							
Trichloroethylene	<3.0	<3.0	<3.0							
Dibromochloromethane	<5.0	<5.0	<5.0							
1,1,2-Trichloroethane	<5.0	<5.0	<5.0							
Benzene	<1.0	<1.0	<1.0							
cis-1,3-Dichloropropene	<5.0	<5.0	<5.0							
2-Chloroethyvinyl ether	<10	<10	<10							
Bromoform	<5.0	<5.0	<5.0							
2-Hexanone	<10	<10	<10							
4-Methyl-2-pentanone	<10	<10	<10							
Tetrachloroethylene	<3.0	<3.0	<3.0							
Toluene	<5.0	<5.0	<5.0							
Chlorobenzene	<5.0	<5.0	<5.0							
Ethylbenzene	<5.0	<5.0	<5.0							
Styrene	<5.0	<5.0	<5.0							
Xylenes	<5.0	<5.0	<5.0							

APPENDIX B

**SUMMARIZED AND QUALIFIED NEESA QC LEVEL C
METALS ANALYSIS RESULTS**

	WHF-15-WP-1-1 (ug/l)	WHF-15-WP-2-1 (ug/l)	WHF-15-WP-2-2 (ug/l)	WHF-16-CP-1-1 (ug/l)	WHF-16-CP-1-2 (ug/l)	WHF-16-WP-2-1 (ug/l)	WHF-16-WP-2-2 (ug/l)	WHF-W3-WP-11-01 (ug/l)	WHF-W3-WP-11-02 (ug/l)	WHF-13-WP-01-01 (ug/l)
Aluminum	224	3330	200 U	200 U	279	305	360	200 U	252	200 U
Antimony	50 U	50 U	50 U							
Barium	23.8 J	23 J	17.2 J	21 J	54.5 J	15.3 J	67 J	16.5 J	13.5 J	52.4 J
Arsenic	10 U	10 U	10 U							
Beryllium	5.0 U	5.0 U	5.0 U							
Cadmium	5.0 U	5.0 U	5.0 U							
Calcium	1210 J	7110	2010 J	813 J	1870 J	1690 J	1880 J	1310 U	850 J	18600
Chromium	34.5	91.8	10 U	10 U	25.7	117	14.5	13	10 U	10 U
Cobalt	10 U	10 U	10 U							
Copper	25 U	25 U	37.6	25 U	25 U	25 U	25 U	27.1	25 U	25 U
Iron	517	11600	227	816	720	1050	696	731	624	584
Lead	3.0 U	8.1	3.0 U	3.0 U						
Magnesium	862 J	3130 J	1070 J	500 U	1040 J	916 J	1230 J	500 U	500 U	4410 J
Manganese	11.8 J	125	12.3 J	17.7	57.7	33.2	14.5 J	54.1	51.6	16.8
Mercury	0.2 U	0.2 U	0.2 U							
Nickel	44.1	61.6	40 U	40 U	46	88.3	40 U	40 U	40 U	40 U
Potassium	1000 U	1520 J	1000 U	1000 U	1000 U					
Selenium	5.0 U	5.0 U	5.0 U							
Silver	10 U	10 U	10 U							
Sodium	2620 J	2500 J	2630 J	5010	3420 J	1660 J	2580 J	2120 J	1860 J	2950 J
Thallium	10 U	10 U	10 U							
Vanadium	10 U	15.1 J	10 U	10 U	10 U					
Zinc	111	76	106	86.4	161	62.6	42.4	208	63	113

ug/l = microgram per liter

	WHF-13-WP-02-01 (ug/l)	WHF-13-WP-02-02 (ug/l)	WHF-12-WP-01-01 (ug/l)	WHF-12-WP-01-01A (ug/l)	WHF-12-EB-01 (ug/l)	WHF-12-WP-01-02 (ug/l)	WHF-14-WP-01-01 (ug/l)	WHF-14-WP-01-02 (ug/l)	WHF-10-WP-02-01 (ug/l)	WHF-10-WP-02-02 (ug/l)
Aluminum	200 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U	200 U
Antimony	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Barium	12.6 J	36.6 J	11.5 J	11.6 J	10 U	10 U	57.6 J	28.8 J	11.5 J	14.8 J
Arsenic	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Beryllium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Cadmium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	739	1420	695	36	500 U	743 J	1190 J	1050 J	633 J	506 J
Chromium	10 U	10 U	10 U	10 U	10 U	10 U	11.3	10 U	10 U	10 U
Cobalt	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Copper	25 U	25 U	25 U	52.5	25 U	25 U	25 U	25 U	25 U	25 U
Iron	383	661	431	463	50 U	280	822	495	564	1240
Lead	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U	3.0 U
Magnesium	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U
Manganese	10 U	18.7	10 U	10 U	10 U	17.1	11.4 J	10 U	10 U	33.7
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Nickel	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U	40 U
Potassium	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Silver	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Sodium	1790 J	1870 J	2390 J	2200 J	2800 J	2510 J	2180 J	1840 J	2060 J	2010 J
Thallium	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vanadium	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Zinc	96.4	111	134	128	20 U	102	112	52.4	153	94.4

ug/l = microgram per liter

	WHF-10-WP-01-01 (ug/l)	WHF-09-WP-01-01 (ug/l)	WHF-08-WP-01-01A (ug/l)	WHF-02-WP-01-01 (ug/l)	WHF-01-WP-01-01 (ug/l)	WHF-01-WP-01-02 (ug/l)	WHF-18-WP-01-01 (ug/l)	WHF-18-WP-01-01A (ug/l)	WHF-18-WP-01-02 (ug/l)	WHF-18-WP-01-02A (ug/l)
Aluminum	435	1070	325	200 U	884	200 U	238	1130	997	7290
Antimony	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Barium	10.4 J	14.6 J	10 U	38.5 J	14.4 J	109 J	346	353	31.5 J	84.4 J
Arsenic	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Beryllium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Cadmium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	500 U	1310 J	1160 J	5040	1770 J	1190 J	5180	5140	2100 J	3140 J
Chromium	17.8	88.5	42.2	10 U	37.9	24.8	17.5	22	47.2	436
Cobalt	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Copper	25 U	80	33.4	25 U	152	25 U	28	25 U	98.5	471
Iron	720	5900	3330	1430	12100	3100	1840	1310	19200	98600
Lead	3.0 U	8.4	5.2	3.0 U	8.1	3.0 U	3.0 U	3.0 U	6.9	36.9
Magnesium	500 U	500 U	500 U	682 J	543 J	500 U	8540	8440	548 J	1140 J
Manganese	33.7	40.2	26.6	24.8	93.2	79.4	82.9	81	179	315
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.29	0.3	0.2 U	0.2 U
Nickel	40 U	102	59.1	40 U	107	40 U	40 U	40 U	119	519
Potassium	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Silver	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Sodium	1490 J	6180	4400 J	1260 J	5770	1910 J	5770	5830	7210	9440
Thallium	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vanadium	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	20.7 J	104
Zinc	97.5	281	161	189	331	107	178	177	466	1610

ug/l = microgram per liter

	WF-02-EB (ug/l)	WF-16-EB (ug/l)	WF-01-EB (ug/l)	WHF-17-WP-01-01 (ug/l)	WF-17-EB (ug/l)	FLDBLK (ug/l)
Aluminum	200	200 U	200 U	16200	200 U	200 U
Antimony	50 U	50 U	50 U	50 U	50 U	50 U
Barium	10 U	10 U	10 U	75.3 J	10 U	10 U
Arsenic	10 U	10 U	10 U	10 U	10 U	10 U
Beryllium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Cadmium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Calcium	500 U	500 U	500 U	2880 J	500 U	500 U
Chromium	10 U	10 U	10 U	1620	10 U	10 U
Cobalt	10 U	10 U	10 U	16.3 J	10 U	10 U
Copper	25 U	25 U	25 U	491	25 U	25 U
Iron	50 U	96.4 J	50 U	50000	50 U	50 U
Lead	3.0 U	3.0 U	3.0 U	37	3.0 U	3.0 U
Magnesium	500 U	500 U	500 U	1110 J	500 U	500 U
Manganese	10 U	10 U	10 U	388	10 U	10 U
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Nickel	40 U	40 U	40 U	1130	40 U	40 U
Potassium	1000 U	1000 U	1000 U	1000 U	1000 U	1000 U
Selenium	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Silver	10 U	10 U	10 U	10 U	10 U	10 U
Sodium	500 U	500 U	41200	29300	500 U	500 U
Thallium	10 U	10 U	10 U	10 U	10 U	10 U
Vanadium	10 U	10 U	10 U	86.5	10 U	10 U
Zinc	20 U	20 U	20 U	1100	48.7	20 U

ug/l = microgram per liter