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WORK PLAN FOR INVESTIGATION OF CONTAMINATED SOIL AND GROUNDWATER AT STUDY AREA 36 NTC ORLANDO FL
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WORK PLAN FOR THE INVESTIGATION OF CONTAMINATED SOIL AND GROUNDWATER

STUDY AREA 36

Naval Training Center
Orlando, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0024

APRIL 2000

R4703006

WORK PLAN
FOR THE INVESTIGATION OF
CONTAMINATED SOIL AND GROUNDWATER

STUDY AREA 36

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
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North Charleston, South Carolina 29406

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CONTRACT NO. N62467-94-D-0888
CONTRACT TASK ORDER 0024

APRIL 2000

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PROFESSIONAL GEOLOGIST CERTIFICATION

I hereby certify that this document, *Work Plan for the Investigation of Contaminated Soil and Groundwater, Study Area 36,* Naval Training Center, Orlando, was prepared under my direct supervision in accordance with acceptable standards of geological practice.

4/6/00

Allan T. Jenkins, P.G. / Date
License No. PG-0000663

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ACRONYMS

ABB-ES	ABB Environmental Services
B&R Environmental	Brown & Root Environmental
bgs	below ground surface
CLP	Contract Laboratory Program
DO	dissolved oxygen
DPT	direct push technology
DQO	Data Quality Objective
GCTL	Groundwater Cleanup Target Level
HLA	Harding Lawson Associates
IDW	investigation-derived waste
MS	matrix spike
MSD	matrix spike duplicate
NA	Natural Attenuation
NSF	National Sanitation Foundation
NTC	Naval Training Center
NTU	Nephelometric Turbidity Unit
OPT	Orlando Partnering Team
ORP	oxidation reduction potential
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCE	tetrachloroethene
POP	Project Operations Plan
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
SA	Study Area
SOUTHDIV	Southern Division
TCL	Target Compound List
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 SITE DESCRIPTION

Study Area 36 (SA 36) is located on the Main Base of Naval Training Center (NTC) south of Langley Street and west of Grace Hopper Avenue (Figure 1-1). The SA includes a Paint Shop, Building 2122, a lumber storage facility, Building 2121, and the western half of the Public Works Yard. Paint and paint thinner were stored inside Building. 2122. A drainage swale located on the western edge of the site receives runoff from paved storage areas of SA 36. Paint residue and stained soil were observed in the swale south and north of the storm drain adjacent to the Paint Shop, Building. 2122.

The North Storage Area is a paved area north and east of the Paint Shop. A flammable materials storage cabinet, a 55-gallon drum containing used motor oil and stockpiles of sand and gravel were observed during the environmental baseline survey by ABB-ES (1994).

The western half of the Public Works Yard is the area to the east of the lumber storage facility (Building 2121). It is paved with asphalt and used to store a variety of hazardous and non-hazardous materials prior to disposal including waste oil drums, transformers and batteries.

The South Storage Area has a lime rock surface and is located south of the lumber storage facility. The area was used to store bulky items including pipes, fire hydrants and bricks. Stained soil was removed at some earlier time along the southern fence line.

1.2 BACKGROUND

Initial site screening investigations were performed from July to November of 1997. Additional screening activities were conducted in two phases in 1998, from March to July and from October to December. Harding Lawson Associates (HLA) documented field activities in the Environmental Site Screening Report in July 1999. The site screening results are summarized in Figures 1-2 and 1-3.

1.3 SITE HYDROGEOLOGY

A cemented sand layer at 15-20 feet below ground surface (bgs) impacts the distribution of groundwater contaminants at the site. Figure 1-4 is a hydrogeologic cross-section illustrating site geology and TCE concentrations in groundwater. Measurements of static water levels above and below the cemented sand layer indicate a head difference of 3-4 feet and a downward vertical gradient of 0.42 ft/ft. Evaluation of groundwater flow direction indicates flow above the cemented sand layer towards the northwest with a hydraulic gradient of 0.008 ft/ft, below the layer to the east towards Lake Susannah at 0.04 ft/ft, and at the base of the aquifer towards the southeast at 0.003 ft/ft.

1.4 OBJECTIVES

The objectives of this investigation are to conduct a soil investigation to confirm and define the horizontal extent of mercury, barium, arsenic, antimony, and TRPH contamination at "hot spots" in surface soil exceeding background or regulatory guidance at SA 36. The following soil samples and analyses are proposed (see Figure 1-5):

In the North Storage Area near well OLD-36-02A, collect five surface soil samples for mercury analysis. Four samples will be collected at the corners of a 10-ft square with the well at the center and one sample will be collected adjacent to the well.

In the drainage swale north of the storm drain adjacent to the Paint Shop (Building 2122), collect two surface soil samples: one 10 feet north of former sample 36S00701 and one east of the swale between 36S00701 and the flame cabinet. These surface soil samples will be analyzed for barium.

In the South Storage Area, collect 17 surface soil samples. Three samples will be collected at the locations of former wells (OLD-36-03A, -04A, and –05A), ten at new locations within the storage area, and four around the perimeter of the storage area to characterize surface soils. Only arsenic and antimony analyses will be performed to confirm the previous exceedances and to obtain a statistically valid data set representative of the area.

Surface soil samples will be collected and analyzed for only TRPH at four locations in the North Storage Area and one location in the South Storage Area (one of the 17 samples described above) where previous samples exceeded screening criteria. These samples are proposed to characterize TRPH impacts since overlying asphalt is assumed to be the source.

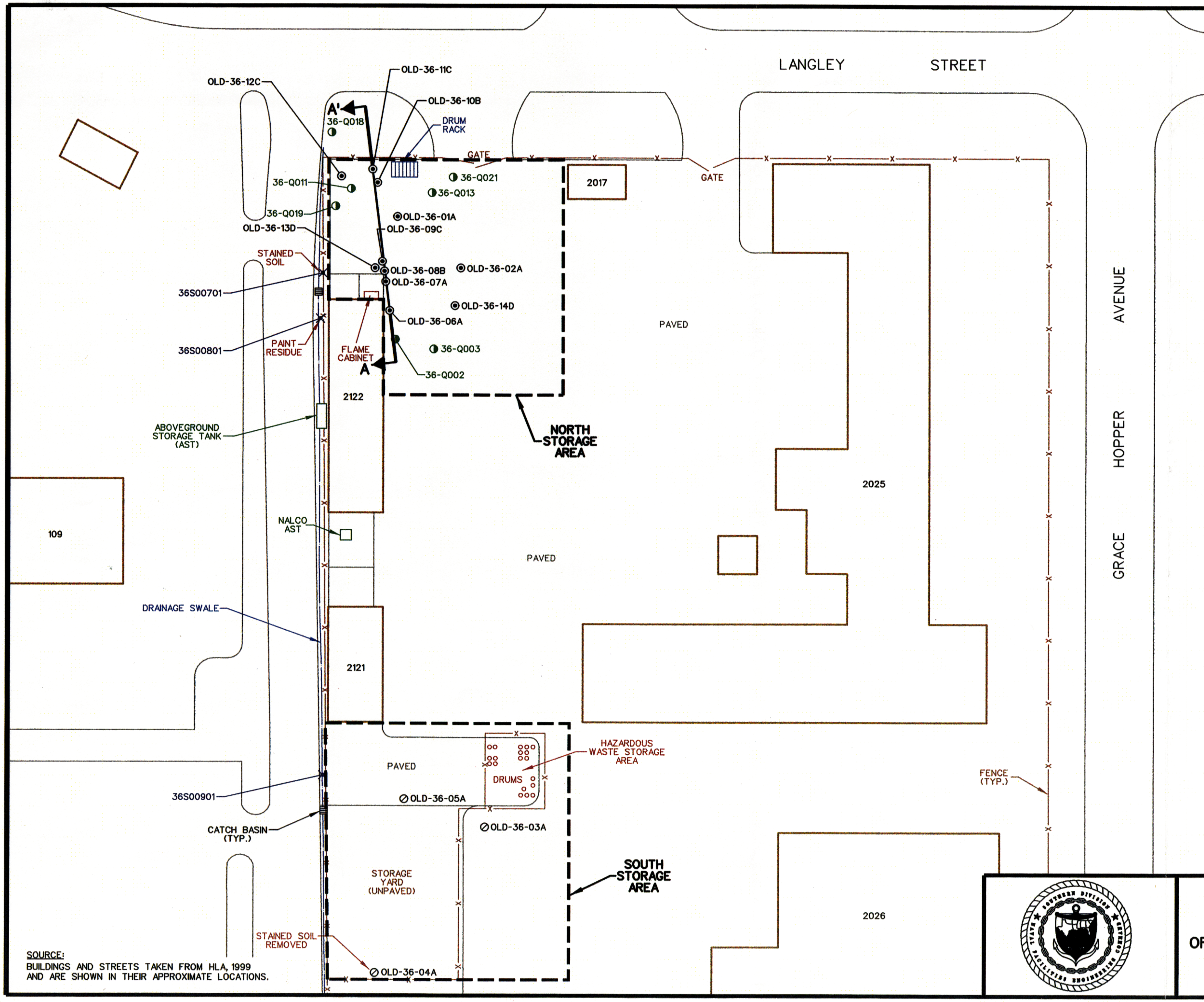

FIGURE 1-1

SITE PLAN
STUDY AREA 36 - MAIN BASE
WORK PLAN FOR THE INVESTIGATION
OF CONTAMINATED SOIL AND GROUNDWATER

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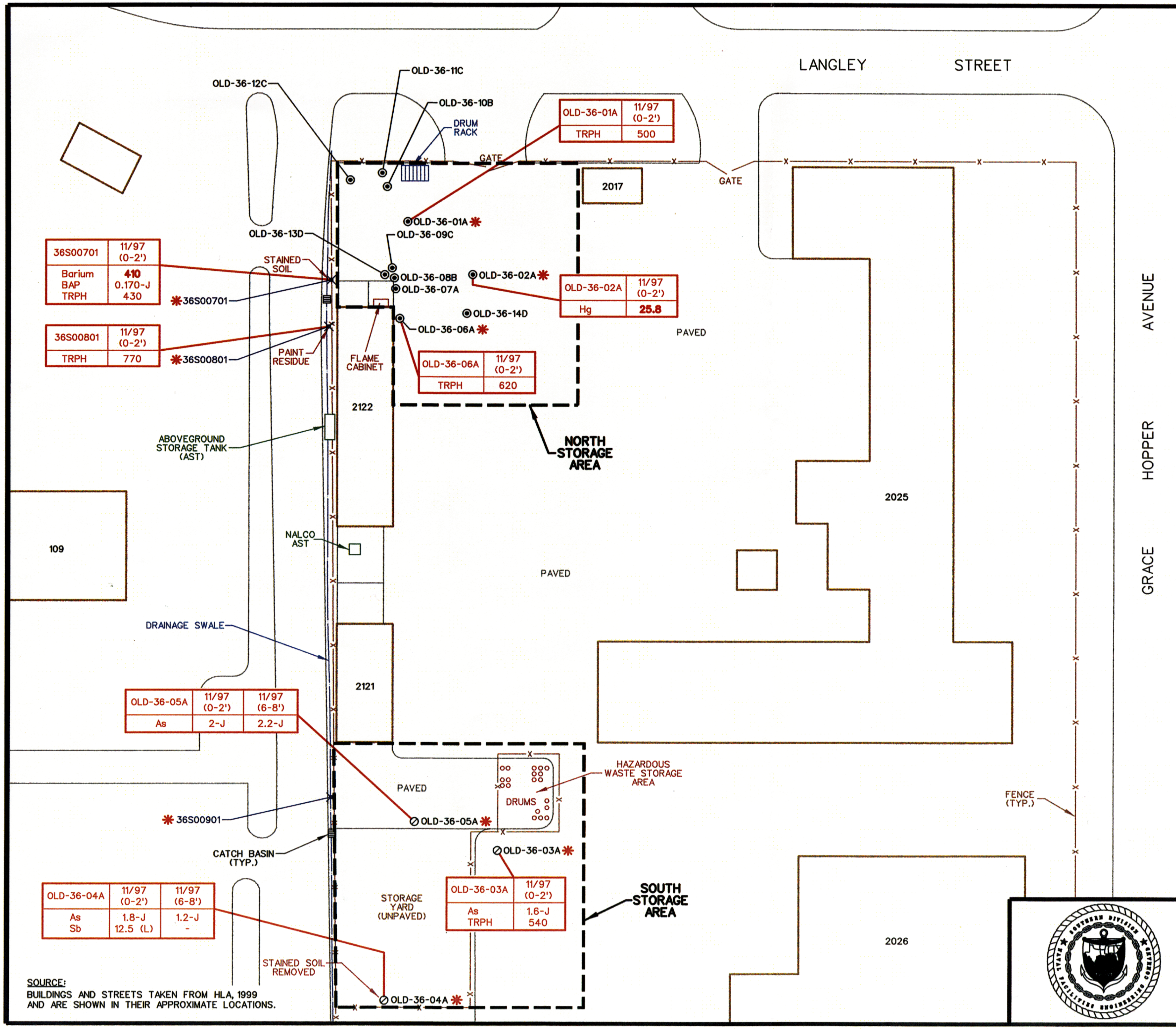

LEGEND

ASTERISK INDICATES BORINGS SAMPLED — *OLD-36-02A

MONITORING WELL — ◎

SOIL SAMPLE — ✕

ABANDONED MONITORING WELL — ⊘

WELL/SAMPLE I.D. — SAMPLE COLLECTION DATE — SAMPLE DEPTH

OLD-36-04A	11/97 (0-2')	11/97 (6-8')
As Sb	1.8-J 12.5 (L)	1.2-J -

ANALYTE — ANALYTE CONCENTRATION [1,2]

INDICATES CONCENTRATION IS ABOVE THE SCTL LEACHING VALUE — (L)

ESTIMATED VALUE — J

1-CONCENTRATION IN MILLIGRAMS PER KILOGRAM (mg/Kg)

2-BOLD CONCENTRATION INDICATES EXCEEDANCE 3 x SCTL OR EXCEEDANCE OF SCTL BASED ON TOXICITY IN CHILDREN

SCREENING CRITERIA

ABBREVIATION	ANALYTE	SCTL[1]	BGSV[1]
As	Arsenic	0.8	1.0
Barium	Barium	105	8.7
BAP	Benzo(a)pyrene	0.1	-
Hg	Mercury	3.7	0.07
Sb	Antimony	26 (LEACHING-5)	-
TRPH	Total Recoverable Petroleum Hydrocarbons	350	-

SCTL-SOIL CLEANUP TARGET LEVEL (RESIDENTIAL)
BGSV-BACKGROUND SCREENING VALUE

NOTE:
ONLY COMPOUNDS EXCEEDING SCREENING CRITERIA IN AT LEAST ONE SAMPLE ARE PRESENTED.

N

50 0 50
SCALE IN FEET

FIGURE 1-2

ANALYTES IN SOIL EXCEEDING SCREENING CRITERIA STUDY AREA 36 - MAIN BASE WORK PLAN FOR THE INVESTIGATION OF CONTAMINATED SOIL AND GROUNDWATER

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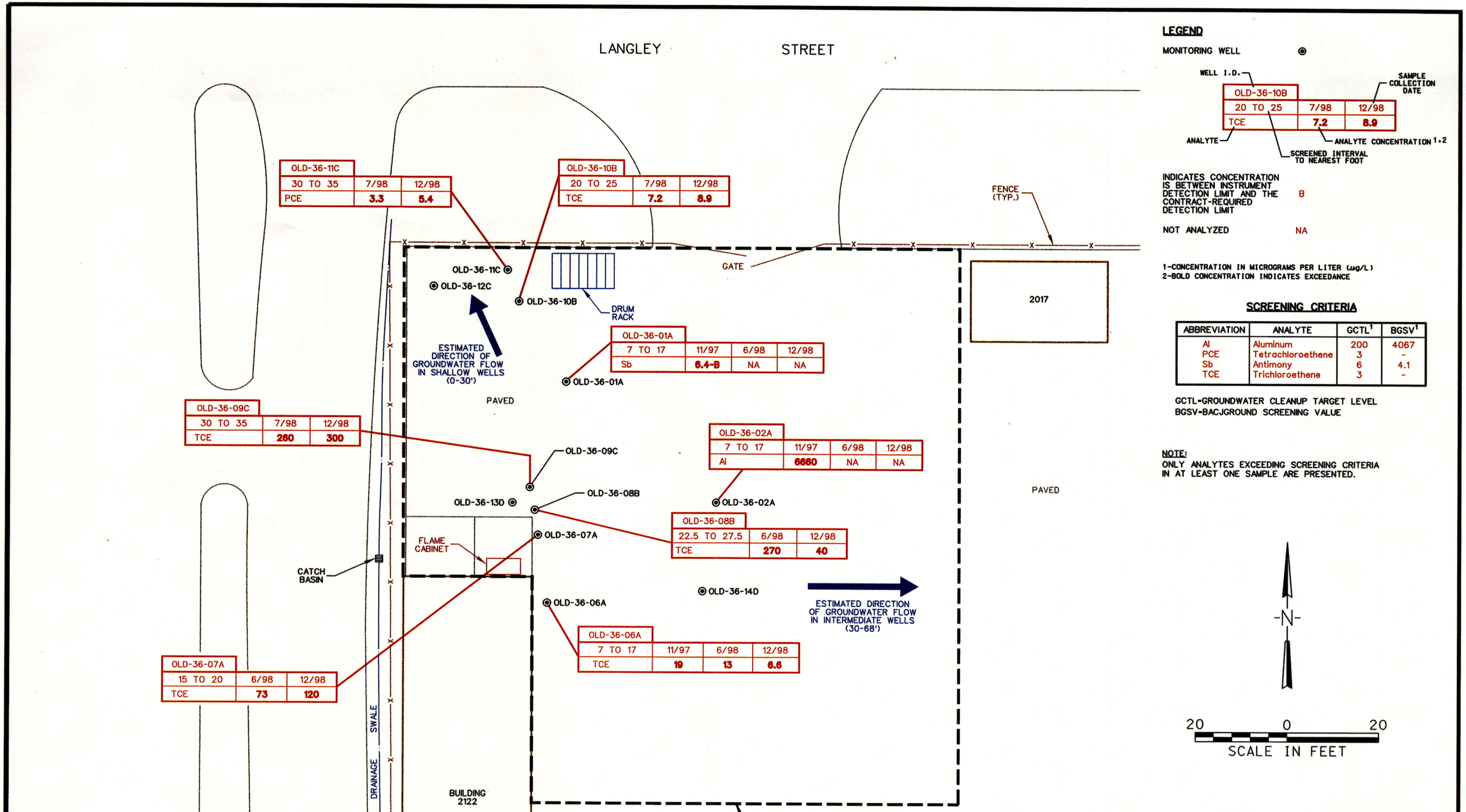

FIGURE 1-3

GROUNDWATER EXCEEDANCES
STUDY AREA 36 - MAIN BASE
WORK PLAN FOR THE INVESTIGATION OF CONTAMINATED SOIL AND GROUNDWATER
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ORLANDO, FLORIDA

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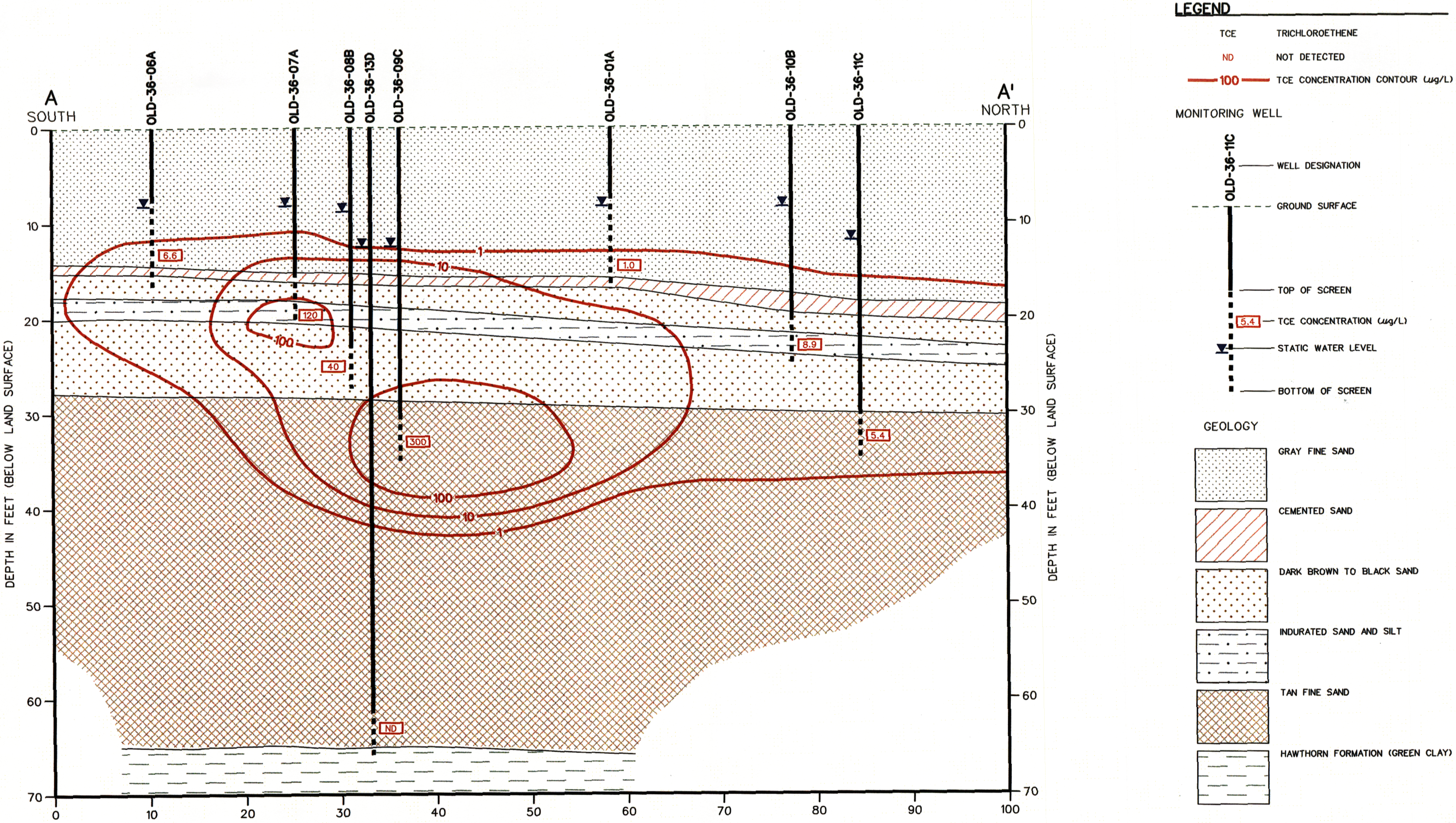

CROSS SECTION A-A'

SOURCE: HLA, 1999

FIGURE 1-4

INTERPRETIVE HYDROGEOLOGIC CROSS SECTION AND TCE PLUME CONCENTRATIONS STUDY AREA 36 - MAIN BASE
WORK PLAN FOR THE INVESTIGATION OF CONTAMINATED SOIL AND GROUNDWATER
NAVAL TRAINING CENTER
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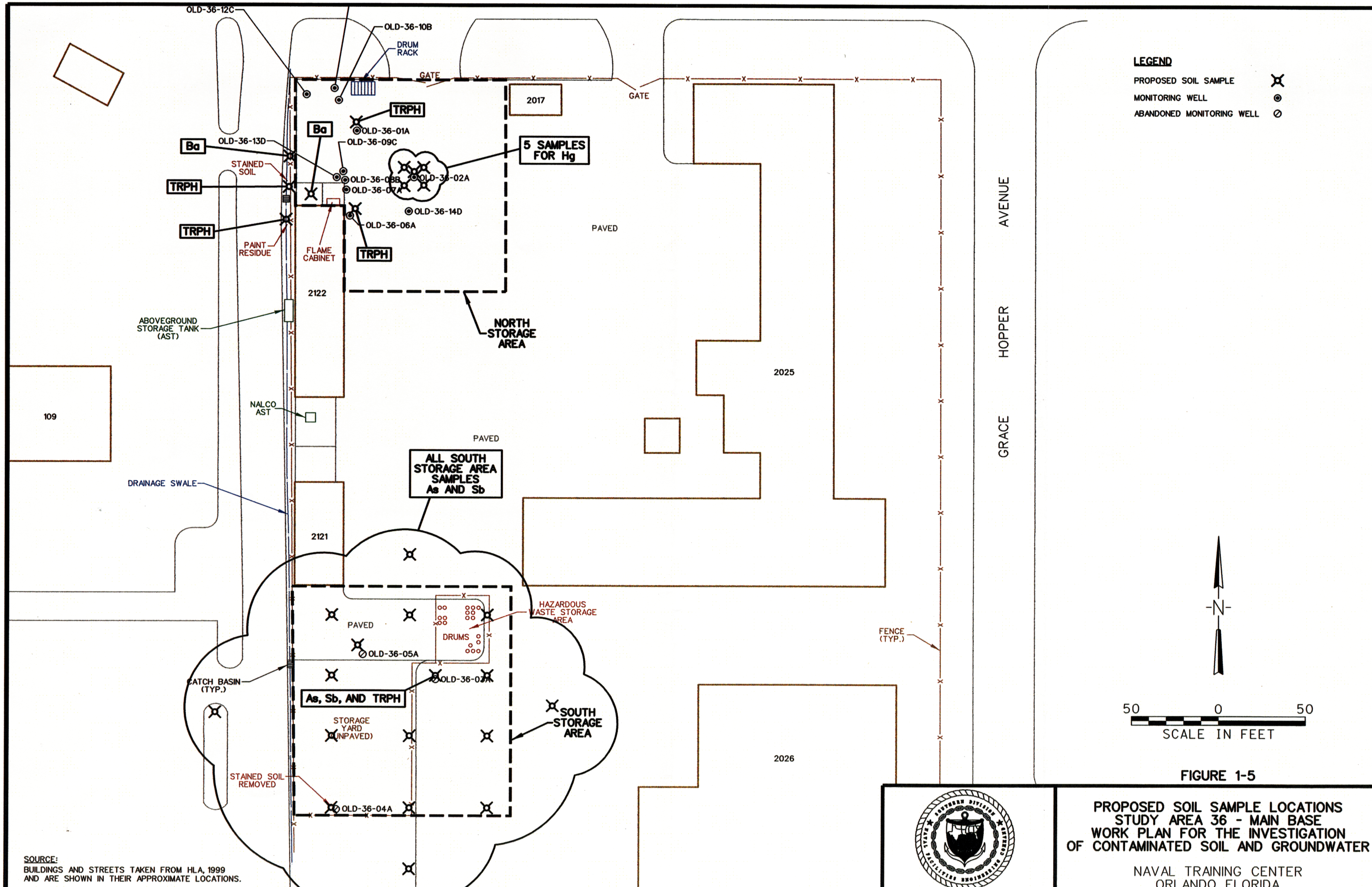

SOURCE:
BUILDINGS AND STREETS TAKEN FROM HLA, 1999
AND ARE SHOWN IN THEIR APPROXIMATE LOCATIONS.

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FIGURE 1-5

PROPOSED SOIL SAMPLE LOCATIONS
STUDY AREA 36 - MAIN BASE
WORK PLAN FOR THE INVESTIGATION
OF CONTAMINATED SOIL AND GROUNDWATER

NAVAL TRAINING CENTER
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CAD FILE NO./DATE: 74570042.dgn/3-20-00

A groundwater investigation will be conducted to confirm current concentrations of TCE, PCE, and antimony contamination in groundwater. Wells in the North Storage Area sampled for VOCs will help evaluate plume trends and the need to install additional wells. The following samples and analyses are propsed (see Figure 1-6):

- In the South Storage Area install new shallow well OLD-36-15A at former well location OLD-36-4A along the south fence line (wells in south storage area were abandoned 12/98) and collect one groundwater sample for analysis of antimony.
- In the north storage area at the impacted soil gas location collect one groundwater sample from OLD-36-01A for analysis of antimony.
- Resample all existing monitoring wells and the new well (OLD-36-15A), a total of 11 wells, for VOCs to evaluate plume trends and to determine need/location of additional wells.

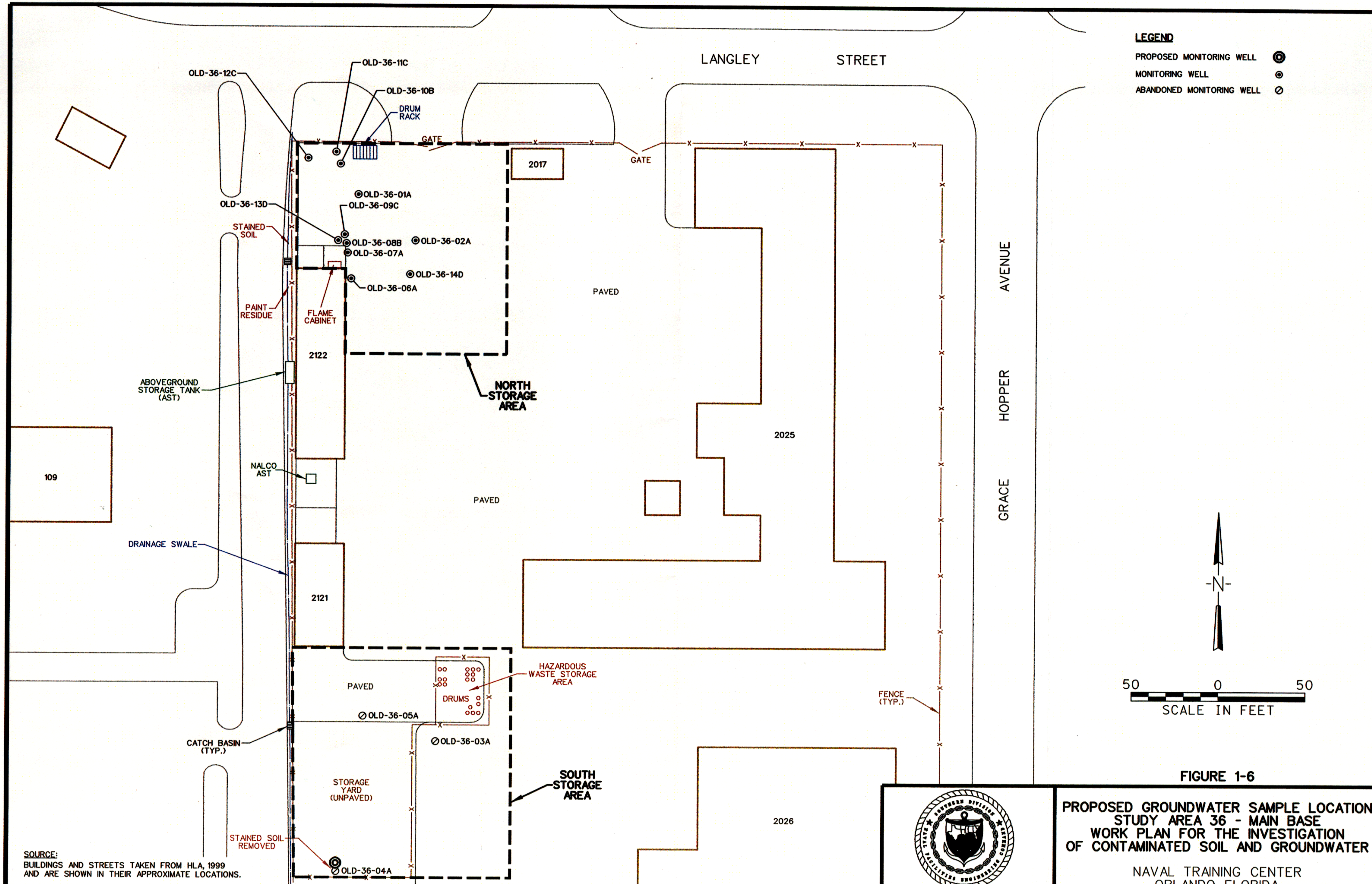

FIGURE 1-6

PROPOSED GROUNDWATER SAMPLE LOCATION
STUDY AREA 36 - MAIN BASE
WORK PLAN FOR THE INVESTIGATION
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Proposed soil and groundwater samples for SA 36 are summarized in the following table.

PROPOSED SOIL SAMPLES FOR SA 36		
Area of Concern	Recommendation	Rationale
North Storage Area – mercury at OLD-36-02A	Collect 5 samples Four at each Corner One adjacent to well	Exceeds 3X Residential SCTL for Hg Delineate extent of hot spot
North and South Storage Areas - TRPH	Confirmation Samples at 5 locations	Asphalt may be the source of TRPH exceedances
Drainage Swale – Barium at 36S00701	Collect 2 samples One between 36S00701 and Flame Cabinet One upstream of 36S00701	Exceeds Residential SCTL for Ba based on toxicity to child Delineate extent of hot spot
South Storage Area – arsenic and antimony at OLD-36-03A, -04A and -05A	Collect 17 samples	Exceeds Residential SCTL for As and/or Leaching SCTL for Sb Obtain more statistically representative estimate (need >10 samples for 95% UCL)
PROPOSED GROUNDWATER SAMPLES FOR SA 36		
North Storage Area – Sb at OLD-36-01A	Collect GW sample for VOC and Sb analysis	Antimony Investigation TCE GW plume delineation
South Storage Area – Sb at new well OLD-36-15A		Antimony Leaching from Surface Soil TCE GW plume delineation
North Storage Area: OLD-36-02A OLD-36-06A OLD-36-07A OLD-36-08B OLD-36-09C OLD-36-10B OLD-36-11C OLD-36-12C OLD-36-13D OLD-36-14D	Collect GW for VOC analysis	TCE GW plume delineation

If analytical data indicate that the TCE/PCE plume has impacted the groundwater at the base of the surficial aquifer, an additional phase of investigation including installation of additional monitoring wells could be warranted to define the extent of the plume and determine if the Hawthorn Group has been impacted. The sampling frequency and analyte list will be evaluated by Tetra Tech NUS, Inc., after each sampling event and a recommendation will be provided to the Orlando Partnering Team (OPT).

Unless otherwise specified herein, all work will be performed following guidance detailed in the *Project Operations Plan for Site Investigations and Remedial Investigations* [POP], Volume I (ABB-ES, 1997). Health and safety aspects of the work at SA 36 will be controlled in accordance with the *Health and Safety Plan for Completion of Investigative Work and Data Sampling* (B&R Environmental, 1997) and addenda.

2.0 SOIL INVESTIGATION

A soil investigation will be conducted to confirm and determine the horizontal extent of the mercury, barium, arsenic, antimony, and TRPH contamination at "hot spots" in surface soil exceeding background or regulatory guidance at SA 36. The soil sampling will consist of collecting surface soil samples at selected locations for various analyses. The analyses will be performed in accordance with U.S. Environmental Protection Agency (USEPA) Level IV Data Quality Objectives (DQOs) by Severn Trent Laboratories in North Canton, Ohio.

The soil sample locations are shown on Figure 1-5. If these locations provide lateral definition of the contamination, no additional soil sampling will be required. However, if the data show the limits of contamination exceeding background or regulatory guidance have not been fully defined, additional soil sample locations will be approved by the OPT at secondary locations as appropriate to define the extent of contamination.

2.1 SOIL SAMPLE NUMBERING

The soil sample numbers will be numbered as follows:

NTC36S*NNNDD*

where:	NTC	=	Naval Training Center
	36	=	two-digit SA designation (36)
	S	=	sample type ("S" for surface soil, "D" for duplicate)
	NNN	=	location number (e.g., 001 or 015)
	DD	=	sample depth (e.g., 01 or 02)

For example, the sample collected at the 5th soil location at a depth of 2 feet will be designated NTC36S00502. Samples for field duplicates will be identified with a "blind" number (e.g., NTC36D1000). The corresponding environmental sample will be noted in the field logbook.

2.2 QUALITY CONTROL SAMPLES

Quality control samples will be collected at the frequencies listed below.

- One field duplicate per 10 environmental samples.
- One matrix spike/matrix spike duplicate (MS/MSD) per 20 environmental samples.

"MS/MSD" will be added to the sample number on the labels and the chain of custody. New sample numbers will not be created for these samples. Additional volume of sample will be collected for each MS and MSD.

If any nondisposable sampling equipment is decontaminated and reused, the additional quality control samples listed below will be collected.

- One rinsate blank per 10 environmental samples.
- One field blank from each water source used for decontamination.

3.0 MONITORING WELL INSTALLATION

One monitoring well will be installed to replace the abandoned well OLD-36-4A (see Figure 1-6). Additional wells may be installed in the surficial aquifer to define the horizontal and vertical extent of the TCE/PCE plume and to provide compliance monitoring locations. The locations of these wells will be based upon the results of the groundwater sampling and will be approved by the OPT prior to installation. Monitoring wells installed in the upper portion of the surficial aquifer will intersect the water table using a 10-foot screened interval to accommodate seasonal groundwater fluctuations and to help prevent dry wells during lower rainfall conditions. It will be acceptable if the water table rises above the top of the screen during wet periods.

Deep monitoring wells may be installed to define the vertical gradient and to determine if the TCE/PCE plume has impacted the groundwater at the base of the surficial aquifer or the upper portion of the Hawthorn Group. These wells may be double cased and constructed with a 6-inch-diameter Schedule 80 polyvinyl chloride (PVC) outer casing set into low-permeability layers that are thought to separate water-bearing zones. The inner well casings will be constructed of 2-inch-diameter Schedule 40 PVC and will be installed with a 5-foot screens.

All wells will be constructed in strict accordance with procedures and practices detailed in *Monitoring Well Design, Installation, Construction, and Development Guidelines* (Interim Final), Southern Division (SOUTHDIV), Naval Facilities Engineering Command, March 27, 1997. The well construction details are presented in Section 3.1.

Split-spoon samples will be collected from each monitoring well location. If more than one well is installed at a given location (i.e., a well cluster), only the deepest boring will be logged. The samples will be collected at 5-foot intervals from the ground surface to the terminal depth of the boring. If double-cased wells are installed, split-spoon samples will be collected continuously beginning 10 feet above the terminal depth of the previous boring. If installation of a Hawthorn Group monitoring well is required, split-spoon samples will be collected continuously beginning 10 feet above the terminal depth of the deepest boring previously installed.

In one deep boring, samples will be collected for grain size analysis at a frequency of approximately one sample per 10 feet. Additional grain size samples will be collected as needed to characterize each lithology.

Split-spoon samples will be monitored with an organic vapor analyzer, but soil samples will not be collected for chemical analysis.

3.1 WELL CONSTRUCTION PROCEDURES

Monitoring wells installed in the surficial aquifer and the Hawthorn Group will be constructed of Schedule-40, flush-joint threaded, 2-inch-ID PVC riser pipe and flush-joint threaded, factory-slotted well screen with a threaded end cap. All well screens will be factory slotted to 0.010-inch size. Each section of well casing and screen will be National Sanitation Foundation (NSF) approved. Well screens are anticipated to be 10 feet long for the shallow surficial aquifer wells and 5 feet long for the other wells, but may be longer or shorter based on subsurface conditions encountered. Bottoms of well screens will be placed a minimum of 6 inches but no more than 3 feet above the bottom of the drilled borehole. Bottom plugs will be flush threaded. Solvents or glues will not be permitted during construction of monitoring or observation wells.

3.1.1 Shallow Surficial Aquifer

Shallow surficial aquifer monitoring wells will be installed through hollow-stem augers immediately upon completion of each well boring. A clean silica sand pack will be installed through the augers as the augers are removed from the boring. The sand pack will be extended from 0.5 to 3 feet below the well screen to a minimum of 3 feet above the top of the well screen unless site conditions warrant a change.

The portion of the well above the screen and sand pack will be completed using one of the two techniques described below.

- If the well screen extends above the static water table, a 2-foot-thick layer of fine sand (uniformly graded with 100 percent by weight passing the No. 30 Standard sieve and less than 2 percent by weight passing the No. 200 Standard sieve) will be placed on top of the filter pack. A bentonite seal is inappropriate for such a well because it will not remain hydrated.

- If the full length of the screen lies below the static water table, a 1-foot-thick layer of fine sand will be placed on top of the filter pack. A minimum 2-foot-thick bentonite pellet seal will be installed above the fine sand and allowed to hydrate as recommended by the manufacturer. Only 100 percent, certified pure, sodium bentonite will be used for well construction.

The depths of backfill materials will be constantly monitored during well installation using a weighted stainless steel or fiberglass tape measure. The remaining annulus above the fine sand layer will be backfilled to the surface, using a tremie pipe, with cement/bentonite grout at a ratio of one 94-pound bag of Portland Type I cement, plus 3 to 5 pounds of bentonite, and 6 to 7 gallons of water.

3.1.2 Deep Surficial Aquifer and Hawthorn Group

Installation of double-cased monitoring wells may be required at SA 36. The groundwater analytical data will be used to determine when double-cased wells are necessary.

Type III wells may be installed at the base of the surficial aquifer at the top of the Hawthorn Group, approximately 65 feet depth. To protect the deeper groundwater from infiltration of surficial contaminants, each Type III well will require the installation of 6-inch-diameter Schedule 80 PVC casing grouted into the low-permeability layer. Casing installation will be completed prior to well installation.

Double-cased wells may be installed using the mud rotary method. A minimum 10-inch drill bit will be used to advance the boring through the overburden and into the lower permeability layer. Drilling mud will consist of a mixture of potable water and 100 percent Wyoming bentonite and will be of sufficient consistency to hold the borehole open during split-spoon sampling and surface casing installation. The outer casing will be pressure grouted in place with cement-bentonite grout at a ratio of one 94-pound bag of Portland Type I cement, plus 3 to 5 pounds of bentonite, and 6 to 7 gallons of water and allowed to set for a minimum of 24 hours. The casing will be set so a 6- to 12-inch stick-up exists above the ground surface.

Drilling will resume through the 6-inch casing after the grout has cured for at least 24 hours. Using the mud rotary method, a nominal 6-inch drill bit will be used to advance the boring to the target zone depth. The well will have a 5-foot screen and will be constructed in the same manner described for the shallow wells. A minimum 2-foot-thick bentonite pellet seal will be installed above the 1-foot-thick fine sand layer and allowed to hydrate as per the manufacturer's recommendations. Only 100 percent, certified pure, sodium bentonite will be used for well construction.

3.2 WELL DEVELOPMENT

Prior to placement of well materials into the borehole, the well string will be centered and suspended so it does not rest on the bottom of the borehole. After the sand filter pack is emplaced, the well will be gently surged with a surge block for 10 minutes to ensure no bridging has occurred. The top of the sand pack will be sounded to verify its depth during placement. If after surging the well the sand level subsides, additional sand will be placed into the annulus to return the top of the sand to at least 3 feet above the top of the screen. In that case, the well will be gently surged again for an additional 10 minutes and, if necessary, sand added again to bring its level to 3 feet above the top of the screened interval. The filter pack will not extend across more than one significantly different water-bearing unit.

Monitoring wells will be developed no sooner than 24 hours after well installation. Due to recent concerns over poorly developed monitoring wells, great care must be taken to adequately develop each of the monitoring wells. Preliminary well development will be performed before the well seal is installed as described previously.

Wells will be developed by bailing and surging, and/or pumping, as determined by the Field Geologist. The wells will be developed until the discharge water is visibly clear and all fine material has been removed, or as determined by the Field Geologist (approximately 1 hour per 2-inch well). Particular attention will be given to the development of wells drilled by mud rotary. The Field Geologist will obtain a minimum of three sequential measurements of field parameters (temperature, conductivity, pH, and turbidity) recorded near the end of the development process. Development will be performed in accordance with Section 4.4.6.7 of the POP (ABB-ES 1997).

3.3 PROTECTIVE CASINGS AND WELL PADS

A protective steel casing (minimum 4-inch diameter for 2-inch wells) equipped with a locking steel cap will be installed around each well. A metal temporary identification tag will be placed on the outside of the protective casing. Protective casings will be grouted at least 3 feet into the ground and will have at least one drain hole immediately above the concrete pad. Pea gravel will be placed in the annular space from the ground surface to approximately 6 inches below the top of the well riser. Approximately 6 inches of clearance will be left between the lid of the well cover and the top of the well riser. Prior to installation of the protective casing, a 1/8-inch vent hole will be drilled or slotted in the well riser approximately 6 inches below the well cap. A locking "J-plug type" cap will be placed and secured on top of each well riser to protect from tampering/opening. All locks on all wells (caps and casing covers) will be keyed alike with heavy-duty, brass, weather-resistant locks.

A 3-foot by 3-foot by 6-inch-thick concrete apron with a 1-inch per foot slope from the center will be constructed around each well. Pad edges should be squared to surrounding structures, other concrete pads in the area, and/or property lines. For wells in high traffic areas, four marker posts (4-inch nominal diameter, 5-foot-long steel pipe filled with cement) will be cemented approximately 2 feet into the ground around the outside of the concrete apron.

In some areas, such as parking lots or residential areas, flush-mount, sealing well covers will be installed. Vent holes will not be used for flush-mounted well completions. The flush-mount cover will be a 10-inch-round security vault provided with sealing gasket to reduce the water infiltration. Approximately 6 inches of clearance will be left between the lid of the well cover and the top of the well riser. A 2-foot by 2-foot (saw-cut or saw-scored and jack-hammered hole) by 6-inch-thick concrete apron will be constructed around each flush-mount well. The flush-mounted casings will be completed 2 inches above existing grade and the apron tapered to be flush with existing grade at the edges so water will run off the apron.

3.4 WELL NUMBERING

Wells will be numbered in accordance with the Navy monitoring well guidance document (SOUTHDIV, 1997). The shallow wells will be designated with an "A." For example, the shallow (water table) well at location Number 15 (first well number to be used for this work) will be designated OLD-36-15A. The intermediate wells will contain a "B" (e.g., OLD-36-16B). The deep wells will contain a "C" (e.g., OLD-36-17C). Wells at the base of the surficial aquifer will be "D" wells (e.g., OLD-36-18D). Wells completed in the Hawthorn Group sand will contain an "E" (e.g., OLD-36-19E). A metal temporary identification tag will be placed on the outside of the protective casing for each well.

4.0 MONITORING WELL PURGING AND SAMPLING

4.1 PURGING PROCEDURES FOR MONITORING WELLS

Unless otherwise specified herein, all work will be performed following guidance detailed in the POP (ABB-ES, 1997). In addition, wells will be purged and sampled meeting or exceeding the guidance detailed in *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual* (USEPA, 1996).

Peristaltic pumps using dedicated Teflon®-lined discharge tubing will be used for both purging and sampling of the wells. Flow-through cells will be used to collect purged groundwater in-line for real-time parameter monitoring.

The newly installed monitoring wells are to be purged using micro-flow purging techniques prior to sampling. The steps listed below are to be followed for the purging procedure.

1. The water level will be measured and recorded prior to placing the tubing into the well.

2. The discharge tubing will be lowered into the well as slowly as possible to minimize disturbance to the water in the well.

3. The end of the tubing will be positioned at the midpoint of the saturated screen length. The end of the tubing will be kept at least 2 feet above the bottom of the well to minimize mobilization of any particulates present (where practical).

4. The water level will be measured and recorded before starting the pump.

5. Purging will begin with the pump at the lowest setting and will slowly increase until discharge occurs.

6. The water level will be checked again.

The following guidance applies to the purging of monitoring wells.

- The pumping rate will be adjusted until there is little or no water level drawdown. Drawdown should be less than 0.3 foot unless site conditions warrant a change. If the least drawdown that can be achieved exceeds 0.3 foot but remains stable, the purging procedure will continue.

- The water level and pumping rate will be monitored and recorded every 3 to 5 minutes (or as appropriate) during purging. Pumping rate adjustments will be recorded (both time and flow rate). Adjustments are best made during the first 15 minutes of pumping to minimize purging time. During pump start-up, drawdown may exceed the 0.3 foot target and then recover as pump flow adjustments are made. Unless site conditions warrant a change, purging will proceed at approximately 100 ml/min.

- Field parameters will be monitored and recorded every 3 to 5 minutes (or as appropriate) for stabilization. Note: During the early phase of purging, emphasis will be placed on minimizing and stabilizing pumping stress and recording those adjustments.

- Purging will be considered complete when temperature, specific conductance, pH, oxidation reduction potential (ORP), and dissolved oxygen (DO) have stabilized and turbidity has stabilized below 10 Nephelometric Turbidity Units (NTUs) (USEPA, 1996).

- Stabilization is considered to be achieved when three consecutive readings, taken at 3- to 5-minute intervals, are within the limits listed below. If turbidity is greater than 10 NTUs and has not decreased significantly after 60 minutes, purging will be discontinued and sample collection will be performed at the discretion of the Project Manager.

Parameter	**Unit**	**Limit**
Temperature	Degrees Fahrenheit (°F)	± 5%
Specific Conductance	Micro-siemens/centimeter (μs/cm)	± 5%
pH	Standard Unit (SU)	± 0.1
Oxidation Reduction Potential (ORP)	Millivolts (mV)	± 5%
Dissolved Oxygen (DO)	Milligrams per liter (mg/L)	± 5%
Turbidity	Nephelometric Turbidity Unit (NTU)	± 5% for values > 7 ± 10% for values < 7

4.2 MONITORING WELL SAMPLING PROCEDURES

When purging is complete, the flow-through cell will be disconnected and sample bottles will be filled directly from the Teflon or Teflon-lined tubing prior to its interface with the silastic tubing used in the peristaltic pump head.

Samples for Target Compound List (TCL) VOCs will be collected using the tube evacuation method.

Samples will be shipped on a daily basis with accompanying trip blanks to:

Severn Trent Laboratories, Inc
4101 Shuffel Drive NW
North Canton, Ohio 44720
Attn: Dave Heakin
Phone: (330) 497-7269

4.2.1 Sample Numbering

The groundwater samples will be numbered as follows:

NTC36TWWWRR

where:
NTC = Naval Training Center
36 = two-digit SA designation (36)
T = sample type ("G" for groundwater, "D" for duplicate)
WWW = well location and screen depth designation (e.g., 15A)
RR = sampling round number (e.g., 10)

For example, the sample collected from well OLD-36-15A will be designated as NTC36G15A10. Dashes will not be used in the sample numbers. Samples for field duplicates will be identified with a "blind" number (e.g., the first duplicate would be NTC36D00110, the second would be NTC36D00210). The corresponding environmental sample will be noted in the field logbook.

Rinsate and field blanks are not required because all sampling will be done with dedicated Teflon tubing. Trip blanks are to be numbered consecutively (e.g., NTC36TB0110 for the first field blank).

4.2.2 Chemical Analyses and Bottle Requirements

The following table describes the analyses, methods, bottle requirements, and preservatives for the groundwater sampling.

Analytical Parameter	Analytical Method	Bottle Requirement	Preservative	Quantity Required
TCL VOCs	8260B	40-ml glass vial	HCl; 4°C	2

4.2.3 Quality Control Samples

Quality control samples will be collected at the frequencies listed below.

- One set of trip blanks will accompany each cooler shipment containing VOCs.
- One field duplicate per 10 environmental samples.
- One MS/MSD per 20 environmental samples.
- No rinsate blanks (unless downhole pumps or non-dedicated tubing are used for sampling).
- No field blanks (unless decontamination of sampling equipment is required).

"MS/MSD" will be added to the sample label and the chain of custody. New sample numbers will not be created for these samples. MS/MSD samples will be selected in the field by the Field Operations Leader and will require 3X sample volume for each set (1X for environmental sample, 1X for MS sample, and 1X for MSD sample).

If a rinsate blank is required (should downhole submersible pumps be used), analyte-free water from a decontaminated bucket or other decontaminated container will be pumped through the entire reel of discharge tubing directly into the sample bottles.

4.3 WELL LIST AND ANALYTICAL PARAMETERS

All wells are to be sampled for VOCs and analyzed by the laboratory using Method 8260B. The following wells were destroyed and/or abandoned and therefore are not available for sample collection: OLD-36-3A, -4A, and -5A. In addition to VOC analysis, wells OLD-36-01A and OLD-36-15A will be sampled for antimony. Samples are to be collected and analyzed in accordance with USEPA Level IV DQOs.

Natural attenuation (NA) parameters of interest will be collected during a future groundwater sampling event. These data will be used to evaluate the potential for NA of the groundwater plume. The analyses to be conducted, analytical methods, and other technical guidance regarding this sampling is provided in Table 4-1. NA samples are to be collected and analyzed in accordance with Level I DQO's.

TABLE 4-1

NATURAL ATTENUATION PARAMETERS AND METHODS FOR GROUNDWATER SAMPLING

STUDY AREA 36, MAIN BASE NAVAL TRAINING CENTER, ORLANDO, FLORIDA

ANALYTICAL PARAMETER	METHOD	GUIDANCE
Alkalinity	Laboratory	USEPA Method E310.1
Biogenic gases: H, DO, CO_2, N, Ethene, Ethane, Methane	Field gas extraction; laboratory analysis of fixed gases and light hydrocarbons	Extraction and analysis using MICROSEEPS propriety methodology
Cations & Anions: NO_2, NO_3, NH_4, Cl, PO_4	Laboratory	USEPA 300 series; 48-hour hold time for nitrate and nitrite
Carbon dioxide	Field Test Kit	HACH kit CA-DT; to confirm biogenic gas results
Dissolved Organic Carbon (DOC)	Laboratory	SW-846 Method 9060; sample from one or more clean, upgradient well(s)
Dissolved Oxygen (DO)	Field Meter and Field Test Kit	Previous data show D.O. <1 mg/L; will verify with CHEMetrics field kits K-7501 (<1 mg/L) and K7512 (>1 mg/L); to confirm biogenic gas results
$Iron^{+2}$ (ferrous)	Field Test Kit	Filter in the field if NTU >20 HACH kit IR-18C
Iron and Manganese (total)	Laboratory	Filter in the field (0.45μ)
pH, conductivity, ORP, temperature, turbidity	Field Flow-through Cell	Recorded during well purging
Sulfate	Laboratory	USEPA Method 8051
Sulfide	Field Test Kits for Hydrogen Sulfide and Total Sulfide	HACH kits HS-C and HS-WR
Fraction of Organic Carbon (FOC) in soil	Laboratory	SW-846 Method 9060 modified; sample of aquifer matrix from one or more clean, upgradient location(s)

The wells to be sampled for NA parameters will be selected after the proposed well installation and sampling, and any additional well installation, are completed. Typical well locations for NA evaluation include one clean, upgradient location; one well in the most contaminated portion of the groundwater plume; one or more wells located in the downgradient extent of the plume; and one well located just beyond the downgradient margin of the plume. Because the previous sampling has indicated some vertical migration of the groundwater plume, the wells selected for NA parameters may include both surficial aquifer and deeper aquifer well locations.

5.0 DATA QUALITY

5.1 DATA QUALITY OBJECTIVES

DQOs are qualitative or quantitative statements developed by the data user to specify the quality of data needed from a particular data activity to support specific decisions. The DQOs are the starting point in the design of an investigation. The DQO development process matches sampling and analytical capabilities to the data targeted for specific uses and ensures that the quality of the data satisfies project requirements.

The DQOs to be used in this project will be those set by the Contract Laboratory Program (CLP) for Level IV DQOs. Level IV DQOs are characterized by rigorous quality assurance/quality control (QA/QC) protocols and documentation, providing qualitative and quantitative analytical data.

The objective of the hydrogeologic and analytical data collected will be to evaluate groundwater migration, flow gradients, and stratigraphy to determine if exposure potential from contaminant plumes exists and to predict if contaminant migration will occur in the future.

5.2 DATA VALIDATION

The approach to providing reliable data that meet the DQOs will include QA/QC requirements for each of the analytical data types generated during the field investigation. The QA/QC efforts for laboratory analyses will include collection and submittal of QC samples and the assessment and validation of data from the subcontract laboratory. Level IV analytical data will be subjected to rigorous data validation.

Data quality indicators include the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. These parameters will be used within the data validation process to evaluate data quality. The achievable limits for these parameters vary with the DQO level of the data. The limits used for laboratory analytical data in this program will be those set by the CLP for Level IV DQOs. The data will be validated in accordance with the USEPA's CLP *National Functional Guidelines for Organic Data Review* (USEPA, 1994) as amended for use in USEPA Region 4.

Level I NA data provided by laboratory analysis will be subjected to a limited review.

6.0 DECONTAMINATION

All downhole drilling equipment, including the rear of the drill/DPT rig, will be steam cleaned on these occasions:

- Prior to arrival onsite.
- Prior to beginning work.
- Between drilling locations.
- Any time the rig leaves and returns to a hole prior to completing a boring.
- Any time the drill rig leaves the site.
- At the conclusion of the drilling/DPT program.

All large equipment decontamination activities will take place at a location designated by base personnel. However, all loose soil material and debris will be removed at the individual site prior to decontamination. Decontamination operations will consist of washing large equipment (drill rig, augers, push probes, down-hole tools, etc.) using a high-pressure potable steam wash.

All sampling tools and miscellaneous sampling equipment coming in contact with contaminated media will be decontaminated using the steps identified below.

1. Wash with potable water and Alconox.
2. Rinse thoroughly with potable water.
3. Rinse with deionized water or analyte-free water.
4. Rinse with isopropanol.
5. Rinse with analyte-free water and air dry.

Clean sampling equipment will be wrapped in aluminum foil to prevent contamination during storage or transport.

7.0 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

Soil cuttings and drilling mud from monitoring well installation and soil borings will be stored in Department of Transportation-approved 55-gallon steel drums or disposed of in a manner approved by the base contact. Each drum will be clearly marked with the following information or as otherwise directed by the base contact:

- Company name (Tetra Tech NUS)
- Base contact (Wayne Hansel) and phone number (407-895-6714)
- Boring or well identification where the IDW originated
- Material contained in the drum
- Date the IDW was produced

Decontamination fluids, well development water, and purge water will be temporarily stored in a poly tank located at SA 36. Liquid and solid IDW will be sampled, analyzed, and disposed of by a licensed waste hauler following completion of monitoring well sampling at the site.

Miscellaneous sampling material (e.g., gloves, tubing, and plastic) will be disposed of in approved dumpsters located in Area C near Building 1056 on Seabee Street.

8.0 LOGBOOKS AND FORMS

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major on-site activities are documented. The following activities/events will be recorded in the site logbook in real time on a daily basis:

- Study Area, Operable Unit, or tank site.
- All field personnel present.
- Arrival/departure of site visitors.
- Arrival/departure of major equipment.
- Start/completion of borehole/monitoring well installation or sampling event.
- Weather conditions.
- Health and safety issues.
- Problems encountered.
- Deviations from standard operating procedures and documentation explaining rationale.
- Record of pertinent phone calls.
- Documentation of decontamination activities.
- Documentation of sample storage and shipping information, including all sample numbers the shipper's airbill number used for each shipment.
- Signature and date at the completion of daily entries.

All pertinent information gathered during the monitoring well installation activities -- including installation, development, purging, and sampling -- will be written in detail on boring logs, well construction logs, and purging/sampling logs. In addition to the general entries placed into the logbook, detailed entries will be made on the purge/sample forms and will include (at a minimum) those items listed below:

- Approximate soil sample recovery, if less than 100 percent.
- Observations and field parameters during well development.
- Times, water level, and flow rate during purging (at 3- to 5-minute intervals, or as appropriate).
- Time and values of field parameters during purging (at 3- to 5-minute intervals after drawdown stabilization, or as appropriate).
- Estimated volume of purge water, time, sample number, and all analytical parameters during sampling.

9.0 CONTACTS

The following personnel are approved contacts for their respective project areas.

Project Area	Responsible Personnel	Phone Number
Base Contact	Wayne Hansel	407-895-6714
Task Order Management	Steve McCoy	865-220-4730
Technical Issues	Michael Campbell or Allan Jenkins	865-220-4714 or -4724
Health & Safety	Matt Soltis	412-921-8912
Procurement	Sandy D'Alessandris	412-921-8435
Laboratory Services	Dave Heakins, Severn Trent Laboratory	330-966-7269
Analytical Issues	Joe Samchuck	412-921-8510
Drilling Contractor	Todd Fullerton, GPI	407-426-7885

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ABB-ES (ABB Environmental Services, Inc.), 1995a. *Site Screening Plan, Groups I through V Study Areas and Miscellaneous Additional Sites,* Naval Training Center, Orlando, Florida.

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B&R Environmental (Brown & Root Environmental), 1997. *Health and Safety Plan for Completion of Investigative Work and Data Sampling,* Naval Training Center, Orlando, Florida, Contract No. N62467-94-D-0888, May.

Beck, B.F., and W.C. Sinclair, 1968. *Sinkholes in Florida:* Florida Sinkhole Research Institute Report 85-86-4.

HLA (Harding Lawson Associates), 1999. *Base Realignment and Closure Environmental Site Screening Report, Study Area 39,* Naval Training Center, Orlando, Florida, Unit Identification Code N65928, Contract No. N62467-89-D-0317/107, April.

SOUTHDIV (Southern Division), Naval Facilities Engineering Command, 1997. *Monitoring Well Design, Installation, Construction, and Development Guidelines* (Interim Final), Rev. 0, March 27.

USEPA (U.S. Environmental Protection Agency), 1994. *Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA/540/R-94-012. Office of Emergency and Remedial Response, Washington, D.C. February.

USEPA, 1996. *Environmental Investigations, Standard Operating Procedures and Quality Assurance Manual,* California, May.

APPENDIX A

GROUNDWATER SAMPLING GUIDANCE
POP SECTIONS 4.5.2.2 (ABB-ES 1997)

to stabilize for at least 24 hours before sample collection. During the period before sampling, the sumps will be covered to minimize the introduction of surface soil and debris. Samples will be collected by direct immersion of sample containers. If the sump is too deep for direct immersion, stainless-steel or Teflon™ sampling equipment may be used to collect and transfer the water to the sample containers. Digging tools and sampling equipment will be decontaminated prior to each use, as described in Section 4.3.

4.5.2.2 Groundwater Sampling The groundwater sampling of all monitoring wells (or, under special circumstances, well points) will be conducted to delineate the distribution of chemicals and to quantify, to the extent possible, the chemicals in the aquifer(s) underlying the POIs. The products of monitoring well sampling are as follows:

- groundwater samples from each well;
- measurements of specific conductance, temperature, turbidity, and pH; and
- depth to static water level at each new, and designated existing, well.

The purging-and-sampling techniques outlined below help to ensure the collection of representative groundwater samples.

Sampling Preparation Activities. Groundwater sampling equipment will be decontaminated prior to use in accordance with the procedures outlined in Section 4.3. Calibration of the sampling equipment will be in accordance with the manufacturers' suggested procedures and will be completed prior to each day's sampling activities. Daily instrument calibration data will be recorded on a Field Instrumentation Quality Assurance Record (Figure 4-9) or in the bound field logbook.

Groundwater samples will be collected from each monitoring well using one of the procedures described in the following paragraphs. Data generated during groundwater sampling will be recorded on the Groundwater Sample Field Data Record (Figure 4-10) or in the bound field logbook. Groundwater Sample Data Records will be submitted to the Navy upon completion of the written report.

Sampling of groundwater wells will proceed from the upgradient (background) wells to the downgradient (contaminated) wells as best as can be determined, based on existing data.

Prepurging Activities. The following activities will be performed immediately prior to purging each well. These activities will be conducted regardless of the sampling method used.

1. Check the well for proper identification and location.
2. Measure and record the height of protective casing.
3. After unlocking the well and removing any well caps, measure and record the ambient and well-mouth organic vapor levels using the FID or PID. If the ambient air quality at breathing level reaches 5 ppm, the sampler will use the appropriate safety equipment as described in the HASP.

FIELD INSTRUMENTATION & MATERIAL QUALITY ASSURANCE RECORD

Project ______________ Site ________________________________

Project No. ____________ Sampler Signature ______________________________

Date ______________

Field Instrumentation Calibration Data

Equipment Type/I.D.	Battery Condition	Calibration Information
____________________	______	pH 4 ____ pH 7 ____ pH 10 ____
____________________	______	pH 4 ____ pH 7 ____ pH 10 ____
____________________	______	pH 4 ____ pH 7 ____ pH 10 ____
____________________	______	Cond. Std. ____/____ Cond. Std. ____/____
____________________	______	Cond. Std. ____/____ Cond. Std. ____/____
____________________	______	Cond. Std. ____/____ Cond. Std. ____/____
Dissolved Oxygen		
____________________	______	Avg. Winkler Value ____ ppm Meter Value ____ ppm
Redox		
____________________	______	Zobell Sol. Value ____ Meter Value ____
Photoionization Meter		
____________________	______	Zero/Zero Air? ☐Yes ☐No Span Gas Value ___ ppm Equiv. Meter Value ___ ppm Equiv.
____________________	______	Zero/Zero Air? ☐Yes ☐No Span Gas Value ___ ppm Equiv. Meter Value ___ ppm Equiv.
Other		
____________________	______	______________________________

Fluids/Materials Record

Deionized Water Source: ____ ABB Staging Portable System Other

Trip Blank Water Source: ____ ABB Lab; Lot No. ________

____ Other; Type ______________ ID ________

Decontamination Fluids: ____ Methyl Hydrate; Lot No. ____________

____ Other; Type ______________ ID ________

HNO_3/DI Rinse Solution: ____ ABB Staging; Lot No. ____________

Filtration Paper ID: (In Line) Manuf/Type ____________ Lot No. ________ / ________

(Vacuum) Manuf/Type ____________ Lot No. ________ / ________

Chemicals Used: HNO_3 Lot No. ____________ ZnAOC Lot No. ____________

H_2SO_4 Lot No. ____________ Other Lot No. ____________

HCL Lot No. ____________ Other Lot No. ____________

NaOH Lot No. ____________

FIGURE 4-9

EXAMPLE FIELD INSTRUMENTATION AND MATERIAL QUALITY RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

GROUNDWATER SAMPLE FIELD DATA

Project:______________________ Point of Interest:______________________

Project Number:______________________ Date:______________________

Sample Location ID:______________________

Time: Start:__________ End:__________ Signature of Sampler:______________________

Water Level/Well Data

Well Depth ______ Ft. ___ Measured ___ Historical

___ Top of Well ___ Top of Protective Casing ___ ______

Well Riser Stick-up ______ Ft. (from ground)

Protective ______ Ft. Casing/Well Difference

Protective ______ Ft. Casing

Depth to Water ______ Ft.

Well Material: ___ PVC ___ SS ______

Well Locked?: ___ Yes ___ No

Well Dia. ___ 2 inch ___ 4 inch ___ 6 inch ___ ______

Water Level Equip. Used: ___ Elect. Cond. Probe ___ Float Activated ___ Press. Transducer ___ ______

Height of Water Column ______ Ft. X ___ .16 Gal/Ft. (2 in.) ___ .65 Gal/Ft. (4 in.) ___ 1.5 Gal/Ft. (6 in.) ___ ___ Gal/Ft. (__ in.) = [______ Gal/Vol ______ Total Gal Purged]

Well Integrity:	Yes	No
Prot. Casing Secure	___	___
Concrete Collar Intact	___	___
Other ______	___	___

Equipment Documentation

Purging/Sampling Equipment Used:

(✓ If Used For)

Purging	Sampling		Equipment ID
___	___	Peristaltic Pump	______
___	___	Submersible Pump	______
___	___	Bailer	______
___	___	PVC/Silicon Tubing	______
___	___	Teflon/Silicon Tubing	______
___	___	Airlift	______
___	___	Hand Pump	______
___	___	In-line Filter	______
___	___	Press/Vac Filter	______
___	___		______

Decontamination Fluids Used:

(✓ All That Apply at Location)

___ Methanol (100%)
___ 25% Methanol/75% ASTM Type II water
___ Deionized Water
___ Liquinox Solution
___ Hexane
___ HNO_3/D.I. Water Solution
___ Potable Water
___ None
___ ______

Field Analysis Data

Ambient Air VOC ______ ppm Well Mouth ______ ppm Field Data Collected ___ In-line ___ In Container

Sample Observations: ___ Turbid ___ Clear ___ Cloudy ___ Colored ___ Odor

Purge Data	@ ______ Gal.	@ ______ Gal.	@ ______ Gal.	@ ______ Gal.	@ ______ Gal.
Temperature, Deg. C	______	______	______	______	______
pH, units	______	______	______	______	______
Specific Conductivity (umhos/cm. @ 25 Deg. C)	______	______	______	______	______
Oxidation - Reduction, +/- mv	______	______	______	______	______
Dissolved Oxygen, ppm	______	______	______	______	______

Sample Collection Requirements

(✓ If Required at this Location)

Analytical Parameter	✓ If Field Filtered	Preservation Method	Volume Required	✓ If Sample Collected	Sample Bottle IDs
VOA	______	HCL	______	___	____/____/____/____
SVOA	______	4OC	______	___	____/____/____/____
Pest/PCB	______	4OC	______	___	____/____/____/____
Inorganics	______	HNO_3	______	___	____/____/____/____
Explosives	______	4°C	______	___	____/____/____/____
TPH	______	H_2SO_4	______	___	____/____/____/____
TOC	______	H_2SO_4	______	___	____/____/____/____
Nitrate	______	H_2SO_4	______	___	____/____/____/____

Notes: ______________________

____

____

____

FIGURE 4-10

EXAMPLE GROUNDWATER SAMPLE FIELD DATA RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

4. Measure and record the distance between the top of the well casing and the top of the protective casing.

5. Using the electronic water-level meter, measure and record the static water level from the reference point to an accuracy of 0.01 foot. Upon removing the water-level wire, rinse it with water from an approved water source.

6. Inspect the well head for any signs of forced entry, which could invalidate the sampling data.

Groundwater purging and sampling may be completed using one of several methods. Two methods, referred to herein as the standard method and the low-flow method, are described below. The standard method has been widely used and accepted for many years. The low-flow method has developed out of a decade of research supported by USEPA and others (e.g., Puls and Powell, 1992), which indicates that excess disturbance of formation water during well purging and sampling potentially compromises data quality. Use of a low-flow purge and sample method is becoming increasingly commonplace and has been adopted as a standard procedure by some regulatory agencies (e.g., USEPA, 1994). Both sampling and purging methods are described below. Selection of a groundwater sampling method will be made on a case-by-case basis and specified in the appropriate workplans.

Purging and Sample Collection, Standard Method. Wells will be purged prior to sampling of groundwater to remove stagnant water so that a representative sample can be collected. The following steps outline the purging and sample collection activities using pumps and bailers.

1. The sampler will calculate the volume to be purged, assuming a total of 3 to 5 well volumes. Well volume includes the volume of standing water in the well, plus the volume of water in the filter pack (assume 30 percent porosity).

2. In all shallow water table wells, the sampler will lower a submersible pump intake to just below the top of the water column and begin purging 3 to 5 well volumes. The pump intake will not be lowered below the top of the well screen. If the well screen is dewatered, air may enter the formation, altering the chemistry of the aquifer.

3. In all deep aquifer wells, the sampler will place the pump intake at the static water level and begin purging 3 to 5 well volumes. The pump intake will not be lowered below the top of the well screen. In both water table and deep aquifer wells, low permeability formations may require the pumping rate to be reduced to allow continuous pumping. In this situation, the pumping rate will be reduced to allow the 5-volume purge without depressing the water level drastically. If the pumped flow rate drops below 1 gallon per minute, modifications to the standard purging procedures may be necessary.

4. Purging is considered complete when 3 to 5 well volumes have been purged and when the *in situ* parameters (pH, specific conductance, turbidity, and temperature) vary by less than approximately 10 percent. For wells in low permeability locations (i.e., less than 1 gallon per minute recharge), the well will be purged of 1 volume and then sampled.

Purging of less than 5 volumes, and sampling before stabilization of *in situ* parameters, will only be done with prior approval of the ABB-ES onsite geologist or if the well purges dry.

5. The sampler will record the *in situ* parameters (pH, specific conductance, turbidity, and temperature), once for every volume purged, on a Groundwater Sample Field Data Record (Figure 4-10) or in the bound field logbook. Redox potential may be monitored and recorded at the completion of purging activities.

6. After purging and pump removal, the sampler will lower a Teflon™, stainless-steel, or polypropylene bailer to the middle of the screened interval or midpoint of the static water level.

7. The sampler will collect the sample(s) in appropriate containers as listed in Section 4.2. Samples will be placed directly from the bailer into the appropriate containers. VOC sample containers will be filled with as little agitation as possible. Water samples to be analyzed for dissolved inorganic compounds will be pumped through a 0.45-micron, high capacity, inline disposable filter. Sample preservation methods are discussed in Section 4.2.

8. The pump assembly and bailer will be removed from the well.

9. Using the electronic water-level meter, measure and record the static water level from the reference point and the depth of the well to an accuracy of 0.01 foot. Rinse the water-level wire with water from an approved source.

10. The sampler will record sampling data on a Groundwater Sample Field Data Record (Figure 4-10) or the bound field logbook.

11. The well cap and lock will be secured.

12. Pumps and discharge lines used to purge the monitoring wells will be decontaminated between wells, as described in Section 4.3.

Purging and Sample Collection, Low-Flow Method. Collection of groundwater samples from monitoring wells is required to characterize the nature and extent of contamination. Because of concerns about turbidity in the wells and the effects on metals sampling results, the low-flow purge and sample method may be used. This method is required for purging temporary monitoring wells.

The low-flow method creates less disturbance and agitation in the formation; therefore, excess turbidity is not generated during the purging and sampling process. The result is a more rapid stabilization of turbidity and other parameters (pH, temperature, specific conductivity, DO, and Eh) and a sample more representative of conditions in the formation is collected. This method is considered most appropriate for wells with moderate to high recharge rates.

The low-flow purge and sample method consists using a submersible or peristaltic pump to purge the well at a very low flow rate (less than 1 liter per minute [ℓ/min]). The pump intake is set approximately in the middle of the well screen, with a stagnant water column over the top of the pump. The well is purged at the low-flow rate until the field parameters (temperature, pH, specific conductance, turbidity, DO, and Eh) have stabilized. The sample is then collected using the peristaltic pump/vacuum jug technique (USEPA, 1996). The following steps outline the purging and sampling activities. Refer to Paragraph 4.4.6.6 for purging and sampling methods for temporary wells.

1. The sampler will attach and secure the 0.25-inch OD Teflon™-lined polyethylene tubing to the adjustable flow-rate submersible or peristaltic pump. As the pump is slowly lowered into the well, secure the safety drop cable, tubing, and electrical lines to each other using nylon stay-ties placed approximately 5 feet apart, as necessary.

2. The pump should be set at approximately the middle of the screen. Be careful not to place the pump intake less than 2 feet above the bottom of the well because this may cause mobilization of any sediment present in the bottom of the well. Start pumping the well at less than 1 ℓ/min. If purging a temporary well, begin pumping with the tubing set at the bottom of the well and slowly raise through the water column.

3. The water level in the well should be monitored during pumping and, ideally, the pump rate should equal the well recharge rate with little or no water-level drawdown in the well (the water level should stabilize for the pumping rate). There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken or entrainment of air in the sample. Record the pumping rate adjustments and depth(s) to water in the logbook. If the recharge rate of the well is very low and the well is purged dry, then wait until the well has recharged to a sufficient level and collect the appropriate volume of sample with the pump, or use standard purge-and-sample techniques.

4. The well should be purged at a low-flow rate (ideally, less than 1 ℓ/min). During purging, monitor the field parameters (temperature, pH, turbidity, specific conductance, DO, and Eh) approximately every 3 to 5 minutes (or as often as practical) until the parameters have stabilized to within 10 percent (plus or minus 5 percent) over a minimum of three readings. Turbidity and DO are typically the last parameters to stabilize. Note: once turbidity readings get below 7 nephelometric turbidity units (NTUs), then the stabilization range can be amended to 20 percent (plus or minus 10 percent) over a minimum of three readings.

5. The sampler will record the *in situ* parameters (pH, temperature, specific conductance, turbidity, DO, and Eh), along with the corresponding volume purged, on a Groundwater Sample Field Data Record (Figure 4-10) or in a bound field logbook.

6. Once the field parameters have stabilized, the sampler will collect the samples using the peristaltic pump/vacuum jug technique (USEPA, 1996). Sampling protocols for some natural attenuation parameters (e.g., hydrogen) require the use of a bladder pump in place of the peristaltic. Refer to site-specific workplans for appropriate equipment. The bottles should be preserved and filled according to the procedures specified in Section 4.2. All sample bottles should be filled by allowing the water to flow gently down the inside of the bottle with minimal turbulence. Cap each bottle as it is filled. Volatiles and analytes that degrade by aeration must be

collected first. Volatile samples will be collected by shutting off the pump, disconnecting the tubing, holding a thumb over the end of the tubing, and withdrawing the tubing from the well. The sample containers will be filled by removing the thumb and allowing groundwater to flow, by gravity, into the containers containing preservatives.

The vacuum jug assembly allows for sample collection without the sample coming into contact with the pump tubing. The vacuum assembly is created by using a new, standard-cleaned 2.5-liter or 1-gallon amber glass bottle fitted with a rubber stopper. The rubber stopper (number 5 size for a 2.5-liter bottle) is wrapped in a Teflon™ swatch and placed in the bottle mouth. Two 0.25-inch OD Teflon™ tubing lengths are fitted into holes in the stopper. One length of tubing is connected to the peristaltic pump, and the other to the monitoring well, set at the screen midpoint. When the pump is turned on, a vacuum is created in the jug, and groundwater is slowly drawn in. When the jug is full, or sufficient volume is collected to fill all sample containers, the pump is turned off. Remove the stopper assembly from the jug, and decant the water directly into sample containers as necessary. Reassemble the jug if additional sample is needed. A new jug should be used for each well to be sampled.

7. Filtered samples should be collected for approximately 10 percent of the wells sampled using the low-flow method for which metals analyses will be conducted. The remaining wells will only have unfiltered metals samples analyzed. Samples for TSS analysis are also recommended, especially for temporary wells. The filtered metals samples will be collected by pumping the sample through a high-capacity, 0.45 micron, inline filter installed between the jug and the well and collecting the filtrate in the jug. Document all field procedures used and any pertinent field observations.

8. Samples will be preserved, labeled, and placed immediately into a cooler and maintained at 4 degrees Celsius (°C) throughout the sampling and transportation period. Samples should be labeled, recorded on the COC, and shipped according to the procedures specified elsewhere in Chapter 4.0.

9. The pump assembly should be carefully removed from the well. The Teflon™-lined polyethylene tubing will be dedicated to each well, wherever possible. The tubing should be returned to the well casing following each sampling event. The pump and discharge lines will be decontaminated between wells as described in Section 4.3.

10. The sampler will measure and record the static water level from the reference point and the total depth of the well, using an electronic water level meter. Rinse the water-level wire with water from an approved source.

11. The sampler will record all sampling information on a Groundwater Sampling Record (Figure 4-10) or in a bound field logbook.

12. The sampler will secure the well cap and lock.

<u>4.5.3 General Sediment Sampling Methodology</u> Sediment samples will generally be collected in conjunction with surface water samples to help define partitioning of chemicals between the sediment and water. The shape, flow pattern,