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FINAL REMEDIAL ACTION PLAN FOR UST SITE 20 WITH TRANSMITTAL NAS PENSACOLA FL
9/11/2003
TETRA TECH

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September 11, 2003

Project Number N2640

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Reference: CLEAN Contract Number N62467-94-D-0888
Contract Task Order (CTO) Number 0273

Subject: Final Remedial Action Plan
Underground Storage Tank (UST) Site 20
Naval Air Station (NAS) Pensacola, Florida

Dear Ms. Vaught:

Tetra Tech NUS Inc. (TtNUS) is pleased to submit the Final Remedial Action Plan for UST Site 20 at NAS Pensacola, Pensacola, Florida for your review. This report has been prepared for the United States Navy Southern Division, Naval Facilities Engineering Command under CTO 0273, for the Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Number N62467-94-D-0888.

If you have any questions regarding the enclosed material, or if I can be of assistance in any way, please contact me at (850) 385-9899, or e-mail at walkerg@ttnus.com.

Sincerely,

Gerald Walker, P.G. /FOR
Project Manager

Enclosures

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Mr. M. Perry, TtNUS (unbound copy)
Project Office File

Remedial Action Plan
for
Underground Storage Tank Site 20

Naval Air Station Pensacola
Pensacola, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0273

September 2003

The professional opinions rendered in this decision document identified as Remedial Action Plan for Underground Storage Tank Site 20, Naval Air Station Pensacola, Pensacola, Florida were developed in accordance with commonly accepted procedures consistent with applicable standards of practice. Decision documents were prepared under the supervision of the signing engineer and are based on information obtained from others. If conditions are determined to exist differently than those described in this document, then the undersigned professional engineer should be notified to evaluate the effects of any additional information on the project described in this document.

September 10, 2003
Gregory S. Roof, P.E.
Professional Engineering Number 50842
Tetra Tech NUS, Inc. Engineering Number 7988

03JAX0187

REMEDIAL ACTION PLAN
FOR
UNDERGROUND STORAGE TANK SITE 20

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Naval Facilities Engineering Command
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SEPTEMBER 2003

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ACRONYMS

acfm	Actual cubic feet per minute
AS	Air Sparging
BTEX	Benzene, Toluene, Ethylbenzene, Total Xylenes
bls	Below Land Surface
btoc	Below Top of Casing
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Constituents of Concern
CTO	Contract Task Order
CS	Characterization Study
DO	Dissolved Oxygen
DPT	Direct Push Technology
EDB	Ethylene Dibromide
EPDM	Ethylene Propylene Diene Monomer
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FID	Flame Ionization Detector
FL-PRO	Florida-Petroleum Range Organics
ft	Feet (Foot)
ft^2	Square Feet
ft/yr	Feet per Year
GAC	Granular Activated Carbon
G&M	Geraghty and Miller, Inc.
GCTLs	Groundwater Cleanup Target Levels
gpm	Gallons per Minute
HDPE	High Density Polyethylene
HP	Horsepower
IAS	Initial Assessment Study
k	Hydraulic Conductivity
kV	Kilovolt
kVA	Kilovolt Ampere
lbs	Pounds
lbs/day	Pounds per Day
LTTD	Low Temperature Thermal Desorption
µg/L	Micrograms per Liter
mg/kg	Milligrams per Kilogram

ACRONYMS (Continued)

mg/L	Milligrams per Liter
NA	Not Available
NADSC	Natural Attenuation Default Source Concentration
NAS	Naval Air Station
Navy	United States Navy
ND	Not Detected
NEESA	Naval Energy and Environmental Support Activity
NF	Not Filtered
NPWC	Navy Public Works Center
NS	Not Sampled
O&M	Operations & Maintenance
OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Analyzer
PAH	Polynuclear Aromatic Hydrocarbons
ppm	Parts per Million
PSI	Pounds per Square Inch
RAP	Remedial Action Plan
RMA	Rubber Manufacturers Association
SA	Site Assessment
SAR	Site Assessment Report
SARA	Site Assessment Report Addendum
SCTL	Soil Cleanup Target Level
SVE	Soil Vapor Extraction
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
VS	Verification Study
WTDI	Waste Transportation and Disposal, Inc.
yd^3	Cubic Yards

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (TtNUS) has completed a Remedial Action Plan (RAP) for Underground Storage Tank (UST) Site 20 at Naval Air Station (NAS) Pensacola in accordance with the requirements of Chapter 62-770, Florida Administrative Code (FAC). This RAP is being submitted to the Florida Department of Environmental Protection (FDEP) for approval.

TtNUS performed the following tasks during the preparation of this RAP:

- Reviewed the information provided in the Site Assessment Report (SAR) [Navy Public Works Center (NPWC), 1998] and SAR Addendum (SARA) (TtNUS, 2001), and SAR Addendum II (SARA II) (TtNUS, 2003).

- Evaluated remedial alternatives for soil and groundwater at UST Site 20.

- Prepared a RAP to provide a conceptual design for the remediation of soil and groundwater and provide remedial equipment specifications.

- Specified a monitoring plan to track the remediation status of the site.

- Specified a system start-up, operation, and maintenance plan to operate the system.

This RAP identified soil excavation and off-site disposal as the selected remedial alternative to address soil contamination. The soil remedial alternative, excavation and off-site disposal, was selected over in-situ methods due to the shallow water table present at the site. The shallow water table, which typically averages less than 3 feet (ft) below land surface (bls), presents uncertainty for the effective remediation of the soil by in-situ methods. Additionally, with the shallow water table present at the site, in-situ soil remediation technologies such as bioventing and soil vapor extraction will likely reduced radius of influence, therefore increasing the number of wells and the size of the remediation system required. As a result of these factors and the known effectiveness of excavation and on-site treatment and its short remediation time, TtNUS recommends excavation and of-site disposal for the soil.

This RAP identified PHOSter II™ technology as the selected remedial alternative for the groundwater at UST Site 20. PHOSter II™ technology is an innovative technology using bioremediation in which there is a controlled injection of vapor phase phosphorus and air into the aquifer. PHOSter II™ technology was selected over other groundwater remedial alternatives based on it being cost-effective and having the shortest remediation time for the site. PHOSter II™ technology is a patented technology and therefore

the PHOSter II™ vendor will provide a final remedial design and the operation and maintenance (O&M) procedures for the system.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This RAP was prepared by TtNUS for the United States Navy (Navy) Southern Division Naval Facilities Engineering Command under Contract Task Order (CTO) 0273, for the Comprehensive Long-term Environmental Action Navy (CLEAN) III, Contract Number N62467-94-D-0888. The RAP was prepared to evaluate and recommend treatment options for the contaminated soil and groundwater at Site 20 at NAS Pensacola, Pensacola, Florida (Figure 1-1).

Site 20 has been investigated on several occasions dating back to 1983. The Naval Energy and Environmental Support Activity (NEESA) performed an Initial Assessment Study (IAS) in 1983. In 1984, Geraghty & Miller, Inc. (G&M) conducted a Verification Study (VS) and returned in 1986 to perform a Characterization Study (CS). The NPWC at NAS Pensacola conducted a Site Assessment (SA) in 1998, TtNUS performed an initial SA addendum in 2001, and TtNUS performed a second SA addendum in 2002 at the site.

The purpose of this RAP is to select a remedial alternative that will remediate the soil and groundwater in accordance with the requirements of Chapter 62-770, FAC. This RAP considers applicable alternatives to protect human health and the environment, reduce contaminant concentrations within impacted soil and groundwater, and retard further migration of contaminants to downgradient areas. This RAP also selects the preferred remedial alternative to remediate the site in a cost effective and timely manner, and provides a conceptual design for the selected alternative.

1.2 SITE DESCRIPTION

NAS Pensacola covers approximately 5,800 acres and is located on a peninsula bounded on the east by Pensacola Bay, south by Big Lagoon, and on the north by Bayou Grande (NPWC, 1998). Site 20 lies within the confines of NAS Pensacola and is located southwest of Forrest Sherman Field, approximately 1,300 ft west of the southern portion of Aircraft Runway 36 (See Figure 1-1). The source of contamination was a pipeline leak that reportedly occurred near the center of an aboveground section of the dual pipeline, which runs between the fuel farm and the tank truck loading facility at Forrest Sherman Field (Buildings 1879 and 1880). Parallel to the pipeline is an unimproved dirt road. The site is surrounded on all sides by scattered brush and woods, and the site terrain is generally flat. The only building located in the immediate vicinity of the site is the Naval Base Pistol Range, approximately 1,300 ft north of the site (NPWC, 1998). A site plan for UST Site 20 is provided as Figure 1-2.

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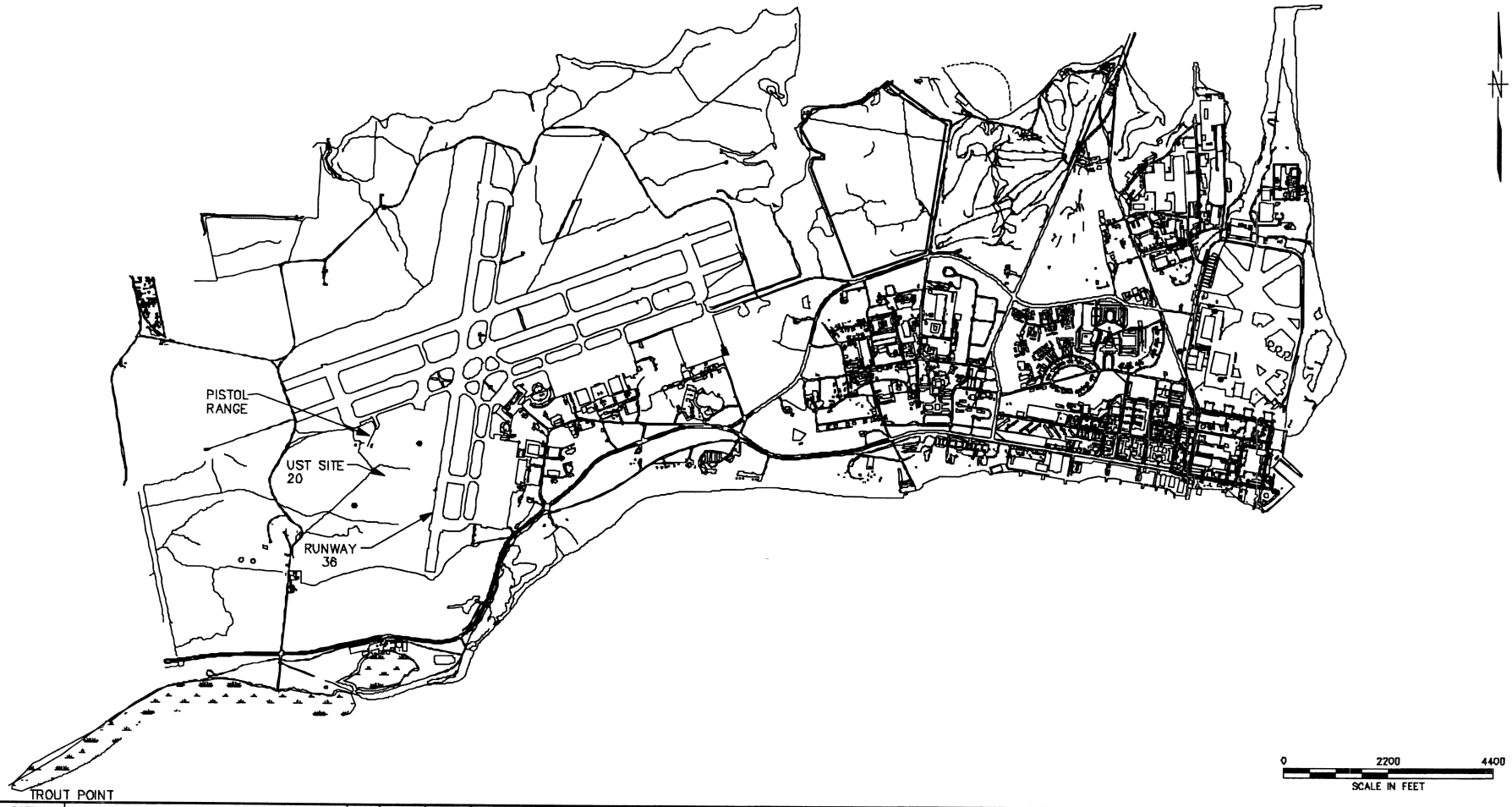

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 9/4/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SITE VICINITY MAP
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
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REV. 0

FORM CADD NO. SDIV_BH.DWG - REV B - 1/20/99

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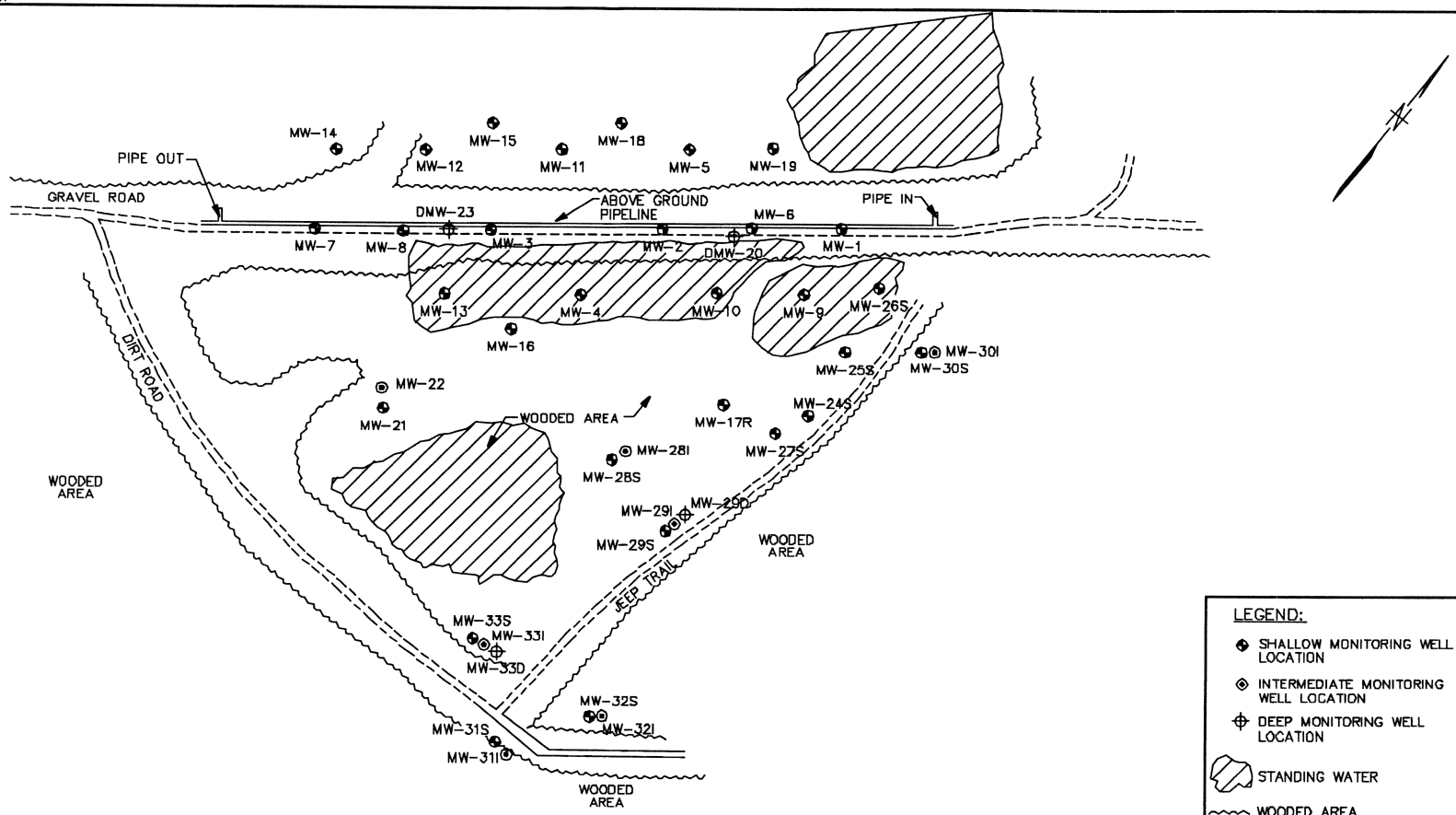


LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- STANDING WATER
- WOODED AREA

0 150 300
APPROXIMATE SCALE IN FEET

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 8/11/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SITE PLAN
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-2
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/99

1.3 SITE HISTORY

An underground/aboveground pipeline supplies fuel for aircraft at Forrest Sherman Field from the fuel farm located to the south. A leak from the aboveground portion of the pipeline was reported to have occurred in 1958, releasing JP-4 fuel to the surrounding environment. The amount of fuel initially discharged was not measured, but it was estimated that more than 360,000 gallons of JP-4 fuel was discharged at the site (TtNUS, 2003).

During the June 1983 IAS conducted by NEESA, an investigation of this pipeline release was performed and included a review of historical records, field inspections, and personnel interviews. NEESA concluded that further investigation at the site was warranted and recommended that the potential for free product be evaluated. (TtNUS, 2003).

In 1984, G&M performed a VS to investigate the presence of free product. During the investigation, four (4) monitoring wells were installed and 11 soil borings were completed at the site. Free product was not detected at the site, but a fuel odor was noted in soil samples collected in an area where dead trees were located. In response to FDEP recommendations, G&M returned to the site in 1986 to conduct a CS. This study involved the collection and laboratory analysis of groundwater samples from the four monitoring wells installed during the VS. Volatile Organic Compound (VOC) analysis detected elevated levels of benzene and xylenes in samples from three of the four wells.

Between January and September 1997, the NPWC conducted a field investigation in support of a SAR for Site 20. The SAR field activities included the advancement of 30 hand auger soil borings, a headspace gas survey to identify "excessively contaminated soil", and the installation of 20 groundwater monitoring wells.

TtNUS completed a SARA in April 2001 to further characterize the petroleum-impacted soil and groundwater at the site. The SARA field activities included the installation of three (3) additional monitoring wells and 54 soil borings. As a result of the findings presented in the SARA (TtNUS, 2001), TtNUS recommended that a RAP be prepared for the site. FDEP approved the recommendation, however, in addition they requested a deep replacement well be installed adjacent to monitoring well MW-17, which previously was dry and could not be sampled. The FDEP letter is provided in Appendix A. The monitoring well was installed and sampled during the preparation of the RAP. The analytical data from the replacement well indicated constituents of concern (COCs) present at concentrations exceeding FDEP Groundwater Cleanup Target Levels (GCTLs). Six additional monitoring wells were then installed to assist in delineating the contaminant plume. Analytical data from these additional wells indicated that the plume boundaries were not yet defined and additional site characterization was required.

TtNUS performed the additional site assessment in November and December of 2002. Sixteen additional temporary monitoring wells were installed and sampled. Based on the analytical data collected from the temporary wells, 12 new groundwater monitoring wells were installed. Twenty-two groundwater monitoring wells (including the 12 newly installed monitoring wells and 10 previously existing wells) were then sampled and analyzed for COCs. A SARA II was submitted to FDEP on May 8, 2003 detailing the results of the additional site characterization work that was performed. The analytical results indicated that multiple VOCs, polynuclear aromatic hydrocarbons (PAHs), and total recoverable petroleum hydrocarbons (TRPHs) exceeded GCTLs. Analytical results also indicated that benzene, toluene, ethylbenzene, and total xylenes (BTEX) compounds were present at concentrations exceeding Natural Attenuation Default Source Concentration (NADSC). Therefore, based on the results of the direct push technology (DPT) investigation and groundwater sampling, TtNUS recommended resuming preparation of a RAP incorporating the additional data.

1.4 REPORT ORGANIZATION

This report is organized into eight sections. Below is a list of the sections and a brief description of their purpose:

Section 1.0	Introduction	Summarizes the report's purpose, scope, site information, and report organization.
Section 2.0	Previous Investigation Findings and Conclusions	Reviews the approved SARA II, SARA, and other investigations and summarizes their findings and conclusions.
Section 3.0	RAP Goals	Establishes the soil and groundwater treatment objectives for the remedial system/plan.
Section 4.0	Contaminant Distribution	Estimates the mass of contaminants in the soil and groundwater.
Section 5.0	Remedial Alternative Technology Screening	Presents the alternatives for remediation, determines the suitability for the site, and develops budgetary costs for each.
Section 6.0	Remedial System Design	Presents all of the assumptions made and provides the detailed design of the preferred remedial alternative.
Section 7.0	O&M and Monitoring	Establishes start-up up O&M procedures and provides a monitoring plan for the remediation system and sampling frequencies to evaluate the system's effectiveness.
	References	Lists all references used.

2.0 PREVIOUS INVESTIGATION FINDINGS AND CONCLUSIONS

Six site investigations (IAS, VS, CS, SAR, SARA, and SARA II) were previously conducted at Site 20 between 1983 and 2002. The following is a summary of the data and information presented in these reports.

2.1 LITHOLOGIC FINDINGS

The site is underlain by a brown to dark gray fine-grained silty sand with decayed organic material. This soil type extends to at least 40 ft bls, the maximum depth that soil samples were collected during the contamination assessment investigations. No other information regarding soil heterogeneities was available. Boring logs are contained within the SAR and SARA. No soil samples or lithological data were collected during the SARA II investigation.

2.2 GROUNDWATER AND AQUIFER CHARACTERISTICS

The depth to groundwater had ranged from 6 to 7 ft bls beneath the road, and from 3 to 4 ft bls for the rest of the site in November 2001. These measurements were collected during a very dry period. The most recent depth to groundwater measurements were collected on January 29, 2003. The water table has risen approximately 3 ft since the previous groundwater measurements in 2001. Current depth to groundwater ranges from land surface to 4 ft bls. Generally, the groundwater flows to the southeast at Site 20. Table 2-1 presents the monitoring well construction data for MW-17R and MW-24 through MW-33 that were installed during the SARA II investigation. Monitoring well construction data for all other site wells was unavailable. Known information (total depth and top of casing elevation) for all previously installed wells is presented in Table 2-2. Table 2-2 also presents groundwater elevations from June 21, 2000, November 21, 2001, and January 29, 2003. Figure 2-1 presents the groundwater potentiometric surface map from January 29, 2003.

The following aquifer parameters were estimated in the SARA (TtNUS, 2001).

Hydraulic conductivity	K	=	11.56 feet per day or 4.078×10^{-3} centimeters per second
Hydraulic gradient	i	=	0.18 feet per foot
Seepage Velocity	Vs	=	5,065 feet per year (ft/yr)
Seepage Velocity (w/ retardation)	Vr	=	3,381 ft/yr
Porosity	n_e	=	0.25 (unitless)

Table 2-1
Monitoring Well Construction Details

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Well No.	Date Installed	Drilling Method	Top of Casing Elevation	A/G Riser Length (approx.), If Applicable	Total Well Depth (ft btoc)	Screened Interval (ft btoc)	Well Diameter (Inches)
MW-17R	08/23/01	DPT	31.01	2.5	19.5	1.5 - 19.5	2
MW-24S	10/27/01	DPT	32.35	3.5	14.7	2.5 - 12.5	1
MW-25S	10/27/01	DPT	31.55	3.4	14.3	2 - 12	1
MW-26S	10/27/01	DPT	31.27	3.4	15.1	2 - 12	1
MW-27S	10/27/01	DPT	31.69	3.0	14.3	2.5 - 12.5	1
MW-28S	10/27/01	DPT	31.44	2.6	14.4	2.5 - 12.5	1
MW-28I	10/27/01	DPT	31.15	3.0	26.8	20 - 25	1
MW-29S	11/17/02	DPT	31.87	4.0	15.8	5.8 - 15.8	1.25
MW-29I	11/17/02	DPT	31.77	4.0	25.0	20 - 25	1.25
MW-29D	11/12/02	DPT	31.83	4.0	38.6	33.6 - 38.6	1.25
MW-30S	11/17/02	DPT	31.91	4.0	15.4	5.4 - 15.4	1.25
MW-30I	11/17/02	DPT	31.73	4.0	25.0	20 - 25	1.25
MW-31S	11/17/02	DPT	33.33	4.0	14.7	4.7 - 14.7	1.25
MW-31I	11/17/02	DPT	33.21	4.0	27.7	22.7 - 27.7	1.25
MW-32S	11/17/02	DPT	34.39	4.0	15.1	5.1 - 15.1	1.25
MW-32I	11/17/02	DPT	34.77	4.0	27.8	22.8 - 27.8	1.25
MW-33S	11/17/02	DPT	31.70	4.0	15.0	5 - 15	1.25
MW-33I	11/18/02	DPT	31.93	4.0	30.0	25 - 30	1.25
MW-33D	11/18/02	DPT	31.84	4.0	41.6	36.6 - 41.6	1.25

NOTES:
ft btoc = Feet Below Top of Casing

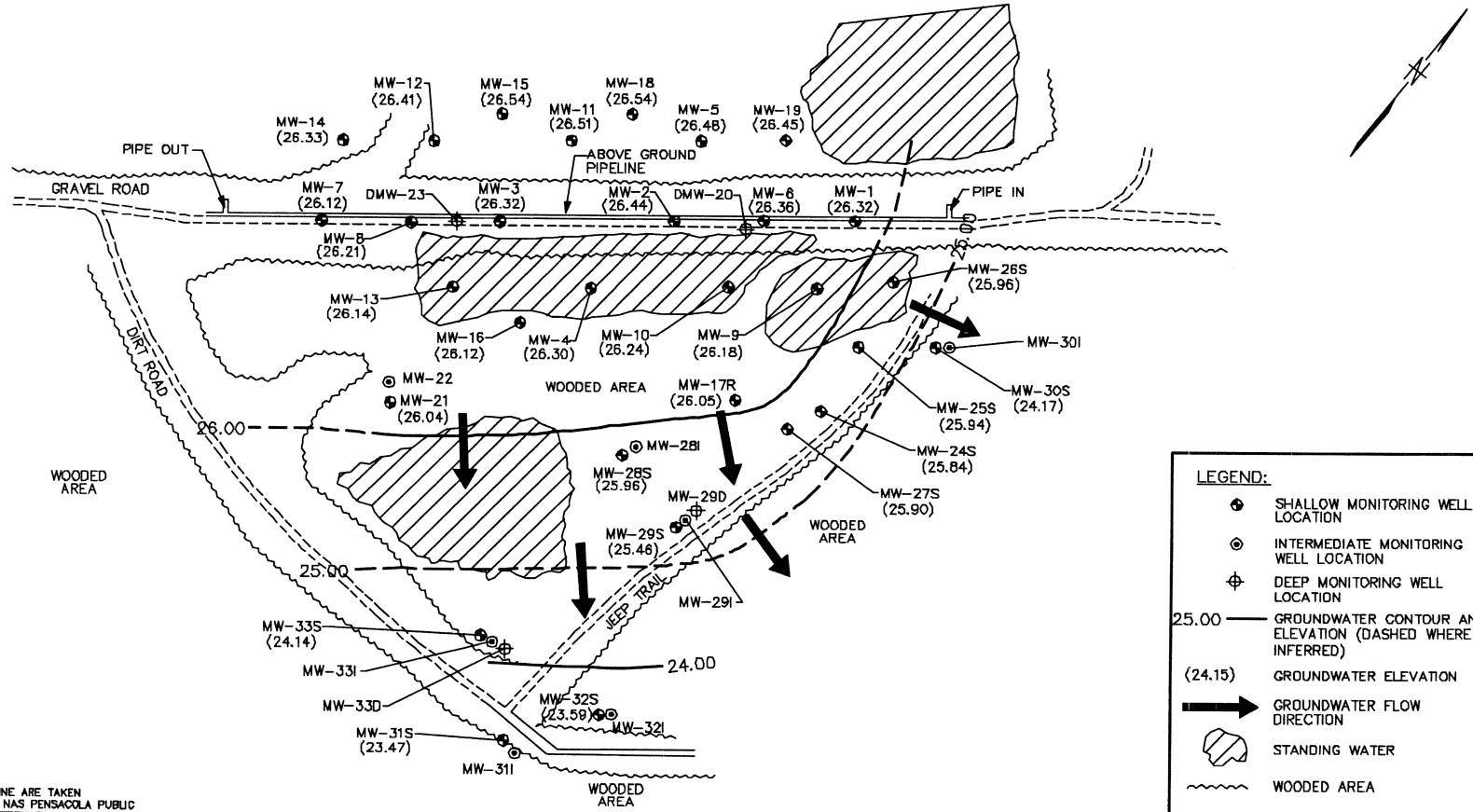
Table 2-2
Groundwater Level Data

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Well Number	Current Well Depth (ft)	Top of Casing Elevation (ft)	June 21, 2000		November 21, 2001		January 29, 2003	
			Depth to Water (ft btoc)	Groundwater Elevation (ft)	Depth to Water (ft btoc)	Groundwater Elevation (ft)	Depth to Water (ft btoc)	Groundwater Elevation (ft)
MW-1	11.42	29.39	6.18	23.21	6.69	22.70	3.07	26.32
MW-2	11.37	30.00	6.66	23.34	7.15	22.85	3.56	26.44
MW-3	11.71	30.38	7.02	23.36	7.52	22.86	4.06	26.32
MW-4	9.40	31.03	7.76	23.27	7.25	23.78	4.73	26.30
MW-5	7.66	31.02	7.64	23.38	8.14	22.88	4.54	26.48
MW-6	11.60	29.75	6.44	23.31	6.94	22.81	3.39	26.36
MW-7	12.45	30.18	6.84	23.34	7.36	22.82	4.06	26.12
MW-8	11.90	30.13	6.80	23.33	7.29	22.84	3.92	26.21
MW-9	8.15	31.13	8.04	23.09	8.54	22.59	4.95	26.18
MW-10	8.83	31.79	8.61	23.18	9.13	22.66	5.55	26.24
MW-11	9.37	31.00	7.60	23.40	8.16	22.84	4.49	26.51
MW-12	9.50	31.64	8.22	23.42	8.73	22.91	5.23	26.41
MW-13	7.91	30.56	7.32	23.24	7.81	22.75	4.42	26.14
MW-14	8.19	30.34	6.93	23.41	7.43	22.91	4.01	26.33
MW-15	7.39	30.49	7.00	23.49	7.49	23.00	3.95	26.54
MW-16	8.38	31.55	8.40	23.15	8.91	22.64	5.43	26.12
MW-17R	12.15	31.01	NA	NA	7.24	23.77	4.96	26.05
MW-18	7.24	31.05	7.31	23.74	8.82	22.23	4.51	26.54
MW-19	7.79	31.21	7.48	23.73	7.98	23.23	4.76	26.45
MW-20	23.75	29.73	10.09	19.64	10.59	19.14	8.25	21.48
MW-21	17.72	32.45	9.11	23.34	9.60	22.85	6.41	26.04
MW-22	28.57	32.44	11.66	20.78	12.18	20.26	8.71	23.73
DMW-23	39.59	30.36	10.98	19.38	11.46	18.90	8.85	21.51
MW-24S	14.92	32.35	NA	NA	8.64	23.71	6.51	25.84
MW-25S	14.56	31.55	NA	NA	7.75	23.80	5.61	25.94
MW-26S	15.33	31.27	NA	NA	7.47	23.80	5.31	25.96
MW-27S	14.54	31.69	NA	NA	8.00	23.69	5.79	25.90
MW-28S	14.86	31.44	NA	NA	7.71	23.73	5.48	25.96
MW-28I	27.75	31.15	NA	NA	10.45	20.70	9.73	21.42
MW-29S	15.79	31.87	NA	NA	NA	NA	6.41	25.46
MW-29I	27.73	31.77	NA	NA	NA	NA	9.56	22.21
MW-29D	41.00	31.83	NA	NA	NA	NA	10.32	21.51
MW-30S	15.40	30.29	NA	NA	NA	NA	6.12	24.17
MW-30I	24.02	30.10	NA	NA	NA	NA	9.80	20.30
MW-31S	14.75	33.33	NA	NA	NA	NA	9.86	23.47
MW-31I	27.65	33.21	NA	NA	NA	NA	11.32	21.89
MW-32S	15.20	34.39	NA	NA	NA	NA	10.80	23.59
MW-32I	27.85	34.77	NA	NA	NA	NA	10.62	24.15
MW-33S	14.85	31.70	NA	NA	NA	NA	7.56	24.14
MW-33I	28.06	31.93	NA	NA	NA	NA	10.06	21.87
MW-33D	41.75	31.84	NA	NA	NA	NA	10.08	21.76

Notes:
ft = feet
ft btoc = Feet below top of casing
NA = Denotes new wells which did not exist during specified field event.

ACAD: 2640GM11.dwg 08/20/03 MF PIT



LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- 25.00 — GROUNDWATER CONTOUR AND ELEVATION (DASHED WHERE INFERRED)
- (24.15) GROUNDWATER ELEVATION
- GROUNDWATER FLOW DIRECTION
- STANDING WATER
- WOODED AREA

0 150 300
APPROXIMATE SCALE IN FEET

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APPROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 8/11/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SHALLOW ZONE POTENTIOMETRIC SURFACE CONTOURS
JANUARY 29, 2003
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-1
REV. 0

FORM CADD NO. S3IV_3H.DWG - REV 0 - 1/20/99

2.3 CONTAMINATED SOIL ASSESSMENT

The vertical and horizontal extent of petroleum impacted soil in the vadose zone was assessed through soil vapor analysis performed during the soil boring investigation and monitoring well installation described in the SAR (NWPC, 1998) and SARA (TtNUS, 2001).

During the SAR field activities performed in January and February 1997, the extent of soil contamination was determined by the installation of soil borings and Organic Vapor Analyzer (OVA)-Flame Ionization Detector (FID) screening of soil samples (NWPC, 1998). Twenty soil samples (SB-1 through SB-20) were initially collected by hand auger at depths of 1 and 2 ft bls during the SAR field activities. Groundwater was encountered at approximately 2 to 3 ft bls. Results of the initial soil screening indicated that 8 of the 20 soil borings exhibited OVA-FID readings greater than 50 parts per million (ppm). As a result of these exceedances, NPWC advanced 10 additional soil borings (SB-21 through SB-30). OVA-FID results of the soil screening are summarized in Table 2-3 and copy of the soil boring location map is included in Appendix B.

In addition to the hand auger soil borings, soil samples were collected during the installation of monitoring wells MW-1 through MW-8 and DMW-20. Soil samples were collected from the soil borings at 1 and 2 ft bls. Soil samples were not collected from monitoring wells MW-9 through MW-19 because the water table was at ground surface. Copies of the soil boring locations map and the soil contamination distribution map from the SAR are included in Appendix B.

During the SARA field activities in May 2000, TtNUS collected additional soil samples for screening with a FID to confirm the previous results. Soil samples for headspace screening were collected from 54 soil boring locations (TtNUS, 2001) between the ground surface to the water table. A summary of the soil sample FID concentrations is provided in Table 2-4. Figure 2-2 shows the boring locations and corresponding FID concentrations (from the 2.0 ft sample interval) for all samples having detectable VOCs in the head space. In addition, Figure 2-2 shows the 50-ppm isoconcentration line.

Eight confirmatory soil samples plus one duplicate soil sample were collected for off-site laboratory analysis during the SARA field activities. Of the eight samples collected, three (NASP19HA0202, NASP19HA2603, and NASP19HA3302) were selected as high concentration samples, three (NASP19HA2003, NASP19HA3802, and NASP19HA4401) were collected as medium concentration samples, and two (NASP19HA0401 and NASP19HA5001) were collected as low concentration samples. Table 2-5 summarizes the analytical results from the confirmatory soil sample analysis and indicates

Table 2-3
Soil Vapor Measurements
Performed During Site Assessment by NPWC

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Soil Boring Number	Date of Measurement	Sample Depth (ft bls)	Headspace Readings[1] VOC Concentration (ppm)
SB-1	01/30/97	1	0
		2	0
SB-2	01/30/97	1	0
		2	0
SB-3	01/30/97	1	0
		2	0
SB-4	01/30/97	1	0
		2	0
SB-5	01/30/97	1	0
		2	0
SB-6	01/30/97	1	0
		2	0
SB-7	01/30/97	1	0
		2	0
SB-8	01/30/97	1	0
		2	0
SB-9	01/30/97	1	0
		2	0
SB-10	01/30/97	1	0
		2	0
SB-11	01/30/97	1	0
		2	>1000
SB-12	01/30/97	1	230
		2	405
SB-13	01/30/97	1	30
		2	0
SB-14	01/30/97	1	0
		2	>1000
SB-15	01/30/97	1	150
		2	750
SB-16	01/30/97	1	10
		2	110

See notes at end of table.

Table 2-3 (Continued)
Soil Vapor Measurements
Performed During Site Assessment by NPWC

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Soil Boring Number	Date of Measurement	Sample Depth (ft bls)	Headspace Readings[1] VOC Concentration (ppm)
SB-17	01/30/97	1	850
		2	0
SB-18	01/30/97	1	0
		2	950
SB-19	01/30/97	1	0
		2	0
SB-20	01/30/97	1	0
		2	0
SB-21	01/30/97	1	0
		2	0
SB-22	01/30/97	1	0
		2	0
SB-23	01/30/97	1	33
		2	0
SB-24	01/30/97	1	0
		2	0
SB-25	01/30/97	1	0
		2	0
SB-26	01/30/97	1	0
		2	0
SB-27	01/30/97	1	0
		2	0
SB-28	01/30/97	1	0
		2	0
SB-29	01/30/97	1	0
		2	0
SB-30	01/30/97	1	0
		2	0

See notes at end of table.

Table 2-3 (Continued)
Soil Vapor Measurements
Performed During Site Assessment by NPWC

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Soil Boring Number	Date of Measurement	Sample Depth (ft bls)	Headspace Readings[1] VOC Concentration (ppm)
MW-1	02/20/97	1	0
		2	0
MW-2	02/20/97	1	0
		2	0
MW-3	02/20/97	1	0
		2	0
MW-4	02/20/97	1	21
MW-5	02/20/97	1	0
MW-6	03/26/97	1	0
		2	0
MW-7	03/26/97	1	0
		2	0
MW-8	03/26/97	1	0
		2	0
MW-9	03/27/97	NS	NS
MW-10	03/27/97	NS	NS
MW-11	03/27/97	NS	NS
MW-12	03/27/97	NS	NS
MW-13	03/27/97	NS	NS
MW-14	04/08/97	NS	NS
MW-15	04/08/97	NS	NS
MW-16	04/08/97	NS	NS
MW-17	04/09/97	NS	NS
MW-18	04/09/97	NS	NS
MW-19	04/09/97	NS	NS
DMW-20	05/28/97	1	0

Notes:
bls = below land surface
ft = feet
NS = Not Sampled
ppm = Parts per Million Equivalent Methane
VOC = Volatile Organic Compounds

[1] SAR stated that an OVA headspace techniques were used (NPWC 1998). No information was provided as to whether filtered and unfiltered readings were taken.

Instrumentation had a maximum of 1000 ppm measurement limit.

Table 2-4
Soil Vapor Measurements
Performed by Tetra Tech NUS, Inc.

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Soil Boring Number	Date of Measurement	Sample Depth (ft bls)	Headspace Readings (ppm)		
			Total Organic Reading	Carbon Filtered Reading	Net Reading
HA01	05/08/00	1	40	0	40
		2	>5000	10	>4990
HA02	05/08/00	1	2400	12	2388
		2	>5000	30	>4970
HA03	05/08/00	1	62	0	62
		2	>5000	10	>4990
HA04	05/08/00	1	100	0	100
		2	3600	0	3600
		3	>5000	110	>4890
HA05	05/08/00	1	4875	0	4875
		2	>5000	0	>5000
		3	>5000	7	>4993
HA06	05/08/00	1	0	0	0
		2	3	1	2
		3	30	1	29
HA07	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA08	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA09	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA10	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA11	05/08/00	1	0	NF	NA
		2	0	NF	NA
HA12	05/08/00	2	2010	0	2010
		3	50	0	50
HA13	05/08/00	1	360	0	360
		2	>5000	24	>4976
		3	saturated	NF	NA
HA14	05/08/00	1	3400	0	3400
		2	>5000	0	>5000
		3	>5000	3	>4997

See notes at end of table.

Table 2-4 (Continued)
Soil Vapor Measurements
Performed by Tetra Tech NUS, Inc.

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Soil Boring Number	Date of Measurement	Sample Depth (ft bls)	Headspace Readings (ppm)		
			Total Organic Reading	Carbon Filtered Reading	Net Reading
HA15	05/08/00	1	2000	0	2000
		2	5000	5	4995
		3	>5000	17	>4983
HA16	05/08/00	1	3250	0	3250
		2	>5000	0	>5000
		3	saturated	NF	NA
HA17	05/08/00	1	0	NF	NA
		2	0	NF	NA
HA18	05/08/00	1	2	0	2
		2	195	0	195
HA19	05/08/00	1	0	NF	NA
		2	0	NF	NA
		2.5	0	NF	NA
HA20	05/08/00	1	0	NF	NA
		2	320	0	320
		3	1300	8	1292
HA21	05/08/00	1	1	0	1
		2	1	0	1
		3	0	NF	NA
HA22	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA23	05/08/00	2	0	NF	NA
		4	0	NF	NA
HA24	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA25	05/08/00	1	43	0	43
		2	>5000	0	>5000
		3	>5000	0	>5000
HA26	05/08/00	1	320	0	320
		2	4200	0	4200
		3	>5000	0	>5000
HA27	05/08/00	1	5	0	5
		2	0	NF	NA
		3	0	NF	NA
HA28	05/08/00	1	210	0	210
		2	>5000	0	>5000
		3	>5000	0	>5000

See notes at end of table.

Table 2-4 (Continued)
Soil Vapor Measurements
Performed by Tetra Tech NUS, Inc.

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Soil Boring Number	Date of Measurement	Sample Depth (ft bls)	Headspace Readings (ppm)		
			Total Organic Reading	Carbon Filtered Reading	Net Reading
HA29	05/08/00	1	430	0	430
		2	>5000	0	>5000
		3	>5000	0	>5000
HA30	05/08/00	1	60	0	60
		2	700	0	700
		3	>5000	0	>5000
HA31	05/08/00	1	320	1	319
		2	3200	0	3200
		3	>5000	20	>5000
HA32	05/08/00	1	1500	0	1500
		2	5000	0	5000
		3	>5000	8	>5000
HA33	05/08/00	1	3000	0	3000
		2	4800	0	4800
		3	saturated	NF	NA
HA34	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA35	05/08/00	1	0	NF	NA
		2	0	NF	NA
HA36	05/08/00	1	0	NF	NA
		2	0	NF	NA
HA37	05/08/00	1	3	0	3
		2	0	NF	NA
		3	0	NF	NA
HA38	05/08/00	1	17	0	17
		2	1500	0	1500
HA39	05/08/00	1	2	0	2
		2	1600	0	1600
		2.5	>5000	0	>5000
HA40	05/08/00	1	75	0	75
		2	>5000	0	>5000
		2.5	>5000	0	>5000
HA41	05/08/00	1	0	NF	NA
		2	0	NF	NA
		2.5	0	NF	NA
HA42	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA

See notes at end of table.

Table 2-4 (Continued)
Soil Vapor Measurements
Performed by Tetra Tech NUS, Inc.

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Soil Boring Number	Date of Measurement	Sample Depth (ft bls)	Headspace Readings (ppm)		
			Total Organic Reading	Carbon Filtered Reading	Net Reading
HA43	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA44	05/08/00	1	2600	0	2600
		2	1600	1	1599
HA45	05/08/00	1	11	0	11
		2	1900	0	1900
		3	>5000	0	>5000
HA46	05/08/00	1	43	0	43
		2	2900	0	2900
		3	5000	0	5000
HA47	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA48	05/08/00	1	0	NF	NA
		2	0	NF	NA
HA49	05/08/00	1	1	0	1
		2	0	NF	NA
HA50	05/08/00	1	90	1	89
		1.5	3900	12	3888
HA51	05/08/00	1	0	NF	NA
		2	0	NF	NA
		3	0	NF	NA
HA52	05/08/00	1	2	0	2
		2	2	0	2
		3	1	0	1
HA53	05/08/00	1	1	0	1
		2	3	0	3
		3	1	0	1
HA54	05/08/00	1	1	0	1
		2	0	NF	NA
		3	0	NF	NA

Notes:
bls = below land suface
ft = feet
NA = Not Available
NF = Not Filtered
ppm = Parts per Million Equivalent Methane

Maximum reading of equipment used was 5000 ppm

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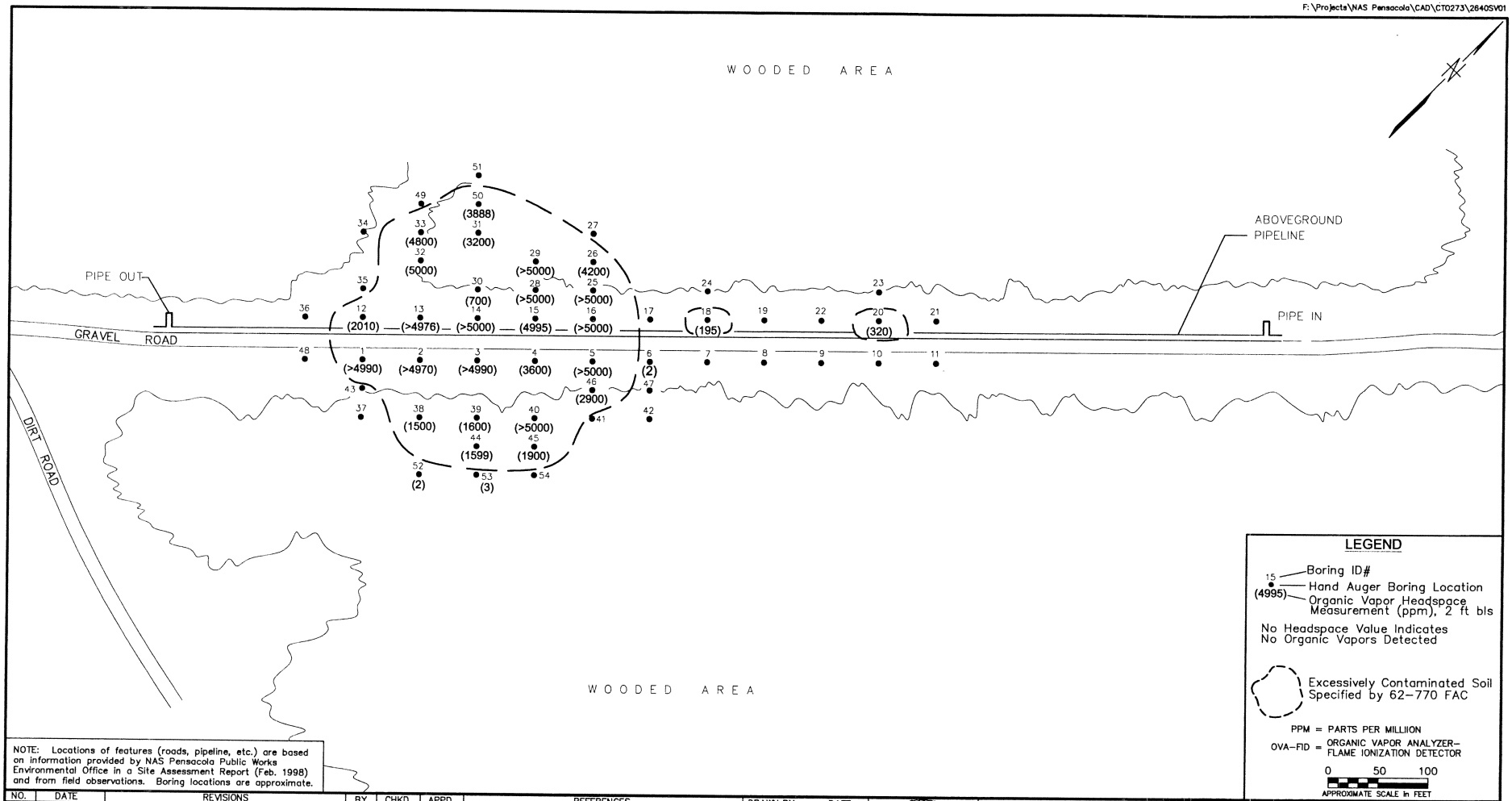


NOTE: Locations of features (roads, pipeline, etc.) are based on information provided by NAS Pensacola Public Works Environmental Office in a Site Assessment Report (Feb. 1998) and from field observations. Boring locations are approximate.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 8/05/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

AREAS OF EXCESSIVELY CONTAMINATED SOIL
DEFINED DURING SARA, MAY 2000
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-2
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

03JAX0187

CTO 0273

Table 2-5
Confirmatory Soil Sampling Analytical Results

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Compound	DE1[1]/DE2[2]/LE[3] (mg/kg)	Boring ID NASP19-								
		HA0202	HADO1	HA0401	HA2003	HA2603	HA3302	HA3802	HA4401	HA5001
		High	Duplicate	Low	Med.	High	High	Med.	Med.	Low
		05/08/00	05/08/00	05/08/00	05/08/00	05/08/00	05/08/00	05/08/00	05/08/00	05/08/00
VOCs (USEPA Method 8060B) (mg/kg)										
Benzene	1.1/1.6/	**1.85J**	**4.47**	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1100/8400/0.6	**12.4**	**22.4**	ND	ND	ND	0.125J	ND	ND	0.223J
Toluene	380/2600/0.5	**30.3**	**55.3**	ND	ND	ND	0.133J	0.0838J	ND	ND
Total Xylenes	5900/40000/0.2	**95.2**	**188**	ND	ND	ND	**7.46**	**0.276J**	ND	**0.712J**
1,1,2-Trichloroethane	1.3/1.8/0.03	ND	ND	ND	ND	ND	**0.583**	ND	ND	ND
PAHs (USEPA Method 8310) (mg/kg)										
1-Methylnapthalene	68/470/2.2	**3.13**	**4.08**	ND	ND	ND	ND	ND	ND	0.514
2-Methylnaphthalene	80/560/6.1	3.11	3.78	ND	ND	ND	ND	ND	ND	ND
Naphthalene	40/270/1.7	0.92	1.25	ND	ND	ND	ND	ND	ND	ND
FL-PRO (mg/kg)										
TRPH	340/2500/340	**2440**	**2800**	32.5	ND	**556**	**380**	**720**	**1100**	**4690**

Notes:
[1]DE1=Direct Exposure limit for residential area from Chapter 62-777, FAC
[2]DE2=Direct Exposure limit for industrial area from Chapter 62-777, FAC
USEPA = United States Environmental Protection Agency
J = Estimated Concentration
mg/kg = Milligrams per Kilogram
ND = Not Detected
[3]LE=Leachability for groundwater limit from Chapter 62-777, FAC

TRPH = Total Petroleum Hydrocarbons
FL-PRO = Florida-Petroleum Range Organics
PAH = Polynuclear Aromatic Hydrocarbons
BOLD = Exceedances of Soil Cleanup Target Levels

FDEP Soil Cleanup Target Level (SCTL) exceedances. A soil analyte detection map is provided as Figure 2-3.

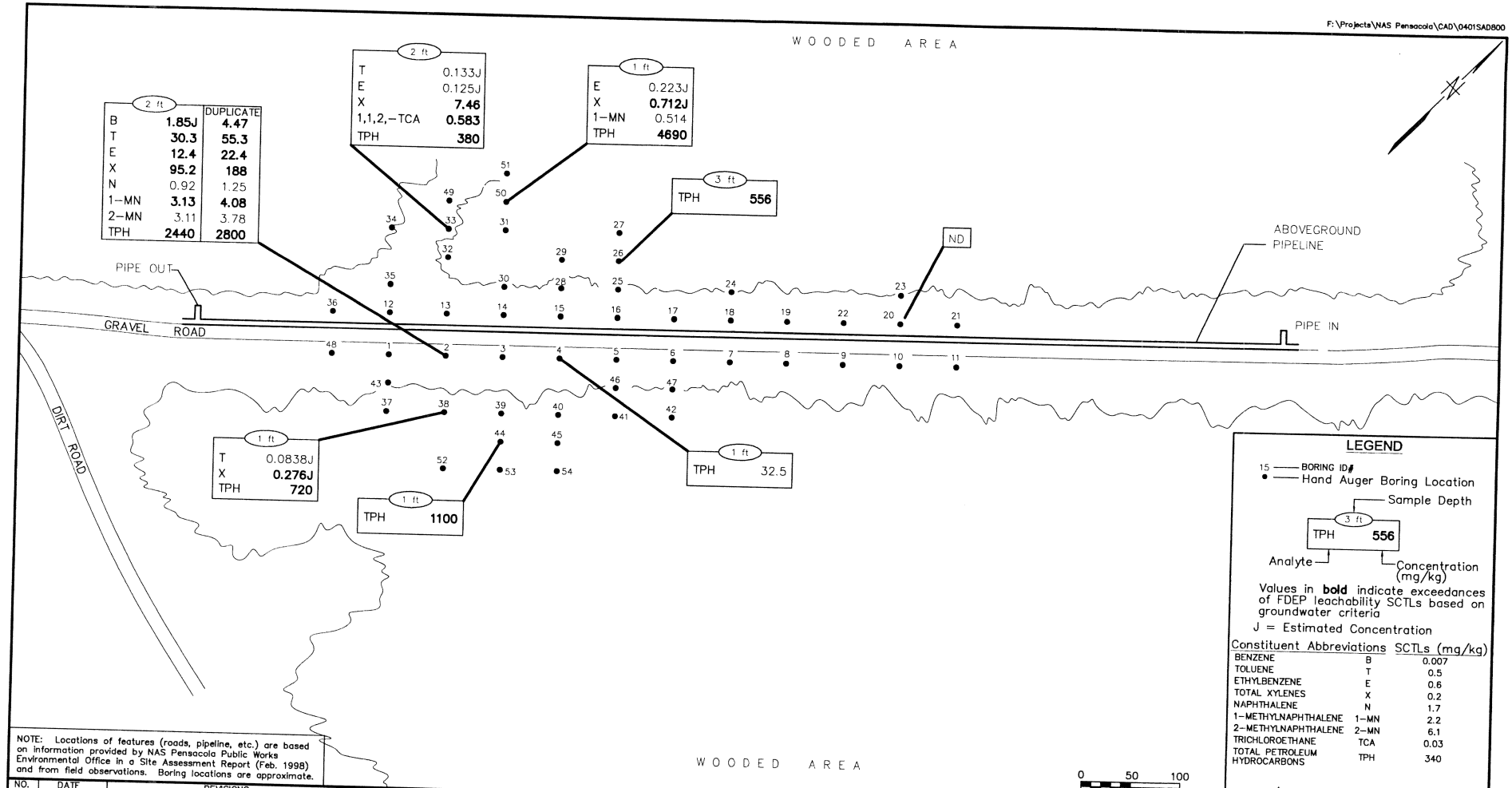
The results indicate that there are impacted soils at the site exceeding FDEP target levels. Based on soil screening data and the fixed-based lab results, the contaminants appear to be smeared throughout the soil in the vadose zone in the area depicted on Figure 2-2.

2.4 CONTAMINATED GROUNDWATER ASSESSMENT

Groundwater samples were collected by NPWC during the SAR field investigation between February and May 1997 and September 1997. Groundwater samples were collected from monitoring wells MW-1 through MW-19 and the deep vertical extent monitoring well DMW-20 (NPWC, 1998). The groundwater samples were analyzed for VOCs, ethylene dibromide (EDB), PAHs, TRPH, and lead. A summary of the groundwater analytical results is provided in Table 2-6. The locations of the monitoring wells are shown on Figure 2-1.

On June 27, June 28, and July 7, 2000, TtNUS collected groundwater samples from 18 monitoring wells at Site 20 during the SARA field investigation (TtNUS, 2001). The monitoring wells sampled included wells MW-1, MW-2, MW-4, MW-6, MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-16, MW-18, MW-19, DMW-20, MW-21, MW-22, and DMW-23. Monitoring well MW-17 was dry at the time of the sampling event and, therefore, was not sampled. The groundwater samples were analyzed for VOCs, PAHs, and TRPH. The groundwater analytical results are summarized in Table 2-7. The analytical results indicate that samples from monitoring wells MW-2, MW-4, and MW-11 contain analytes with concentrations exceeding FDEP GCTLs for VOCs, PAHs, and TRPH. Groundwater samples from monitoring wells MW-6, MW-8, and DMW-23 contained VOCs at concentrations exceeding GCTLs. The analytes detected in the groundwater samples from the remaining monitoring wells were less than GCTLs. Figure 2-4 depicts groundwater detections with exceedances at the site noted in bold.

The FDEP technical review letter dated May 2, 2001 directed the Navy to install one additional well (MW-17R) to replace downgradient well MW-17 that was previously dry. Analysis of groundwater samples collected from MW-17R on August 25, 2001 indicated that additional monitoring wells would be required to further characterize the extent of groundwater contamination at the site. TtNUS installed and sampled six additional monitoring wells (MW-24S, MW-25S, MW-26S, MW-27S, MW-28S, and MW-28I) to further delineate the extent of contamination. Analytical results indicated that monitoring wells MW-17R, MW-25S, MW-28S, and MW-28I had VOC concentrations that exceeded FDEP GCTLs. No PAHs, TRPH, or lead were detected in exceedance of GCTLs. The groundwater analytical results are summarized in Table 2-8.



LEGEND

15 —— BORING ID#
• —— Hand Auger Boring Location

Sample Depth

3 ft
TPH 556

Analyte — Concentration (mg/kg)

Values in **bold** indicate exceedances of FDEP leachability SCTLs based on groundwater criteria

J = Estimated Concentration

Constituent Abbreviations		SCTLs (mg/kg)
BENZENE	B	0.007
TOLUENE	T	0.5
ETHYLBENZENE	E	0.6
TOTAL XYLENES	X	0.2
NAPHTHALENE	N	1.7
1-METHYLNAPHTHALENE	1-MN	2.2
2-METHYLNAPHTHALENE	2-MN	6.1
TRICHLOROETHANE	TCA	0.03
TOTAL PETROLEUM HYDROCARBONS	TPH	340

mg/kg = MILLIGRAMS PER KILOGRAM
SCTLs = Soil Cleanup Target Levels

NOTE: Locations of features (roads, pipeline, etc.) are based on information provided by NAS Pensacola Public Works Environmental Office in a Site Assessment Report (Feb. 1998) and from field observations. Boring locations are approximate.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 8/05/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SOIL ANALYTICAL RESULTS REPORTED BY FIXED-BASE LABORATORY
REMEDIAL ACTION PLAN
UST SITE NUMBER 0020/IR SITE 19
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-3 REV. 0

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98
03JAX0187

CTO 0273

Table 2-6
Analytical Results for Groundwater Samples
February and March 1997

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Compound	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10
	02/26/97	02/26/97	02/26/97	02/26/97	02/26/97	03/28/97	03/28/97	03/28/97	03/28/97	03/28/97
VOCs (USEPA Method 8021B) (µg/L)										
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	180	1200	17	ND	370	ND	1300	ND	ND
Toluene	ND	390	2400	240	ND	270	ND	3500	ND	ND
Ethylbenzene	ND	390	560	99	ND	630	3	450	ND	ND
Total Xylenes	ND	3070	4700	870	ND	5200	4	2000	ND	ND
Total BTEX	ND	4030	8860	1226	ND	6470	7	7250	ND	ND
USEPA 504.1 (µg/L)										
EDB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PAHs (USEPA Method 8310) (µg/L)										
Acenaphthene	ND	ND	ND	11	ND	ND	ND	ND	ND	ND
Flouranthene	ND	4	ND	ND	ND	ND	ND	ND	ND	ND
Flourene	ND	3	ND	4	ND	ND	ND	ND	ND	ND
Naphthalene	ND	81	93	53	ND	138	ND	ND	ND	ND
Phenanthrene	ND	5	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	3	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	ND	50	38	21	ND	95	ND	4	ND	ND
2-Methylnaphthalene	ND	74	52	47	ND	115	ND	12	ND	ND
Total Naphthalene	ND	220	183	136	ND	348	ND	16	ND	ND
FL-PRO (µg/L)										
TRPH	ND	18000	31000	35000	ND	150000	ND	12000	ND	ND
Metals Analysis (mg/L)										
Total Lead	ND	ND	ND	ND	0.004	ND	ND	0.011	ND	ND

See notes at end of table.

Table 2-6 (Continued)
Analytical Results for Groundwater Samples
February and March 1997

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Compound	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	DMW-20
	03/28/97	03/28/97	03/28/97	04/15/97	04/15/97	04/15/97	04/15/97	04/15/97	04/15/97	05/29/97
VOCs (USEPA Method 8021B) (µg/L)										
Bromodichloromethane	3	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	170	ND	ND	ND	ND	ND	ND	ND	ND	3
Toluene	2100	ND	2	ND	ND	ND	1	ND	ND	ND
Ethylbenzene	500	ND	ND	ND	ND	ND	ND	ND	ND	6
Total Xylenes	6700	ND	ND	ND	ND	ND	ND	ND	ND	60
Total BTEX	9473	ND	2	ND	ND	ND	1	ND	ND	69
USEPA 504.1 (µg/L)										
EDB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PAHs (USEPA Method 8310) (µg/L)										
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Flouranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Flourene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	94	ND	ND	ND	ND	ND	ND	ND	ND	2
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	96	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	75	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Naphthalene	265	ND	ND	ND	ND	ND	ND	ND	ND	2
FL-PRO (µg/L)										
TRPH	76000	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metals Analysis (mg/L)										
Total Lead	ND	0.007	0.004	ND	ND	ND	ND	ND	ND	ND

Notes:
BTEX = Benzene, Toluene, Ethylbenzene, Total Xylenes
ND = Analyte was not detected above instrument detection limits.
µg/L = Micrograms per Liter
EDB = Ethylene dibromide
TRPH = Total Recoverable Petroleum Hydrocarbons
mg/L = Milligrams per Liter

Table 2-7
Analytical Results for Groundwater Samples
June and July 2000

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Compound	Groundwater Cleanup Criteria[1]	MW-1	MW-2	MW-4	MW-6	MW-6 Dup	MW-7	MW-8	MW-9	MW-10	MW-11
		06/27/00	06/28/00	06/28/00	06/28/00	06/28/00	06/28/00	06/28/00	06/28/00	06/28/00	07/07/00
VOCs (USEPA Method 8021B) (µg/L)											
1,1-Dichloroethene	7	0.91J	ND	ND	ND	ND	ND	ND	ND	1.2	ND
Benzene	1	ND	**47.3**	**920**	**73.8**	**107E**	ND	**1200**	ND	ND	**352**
Ethylbenzene	30	ND	**393**	**1060**	**75.6**	**105E**	ND	**238**	ND	ND	**653**
Toluene	40	ND	**139**	**8540**	7.1	8.6	ND	**2880E**	ND	ND	**3440**
Total Xylenes	20	ND	**4300**	**8070**	**618**	**822E**	ND	**1110**	ND	ND	**5290**
PAHs (USEPA Method 8310) (µg/L)											
1-Methylnaphthalene	20	ND	6.6	**41.8**	ND	1.7J	ND	ND	ND	ND	**41.8**
2-Methylnaphthalene	20	ND	13.4	**51.7**	2.1	2.7	ND	ND	ND	ND	**55.6**
Naphthalene	20	ND	**32.7**	**122**	4.1	5.5	ND	3.9	ND	ND	**135**
FL-PRO (µg/L)											
TRPH	5000	ND	**6850**	**52200**	1880		ND	1340	ND	ND	**19500**

See notes at end of table.

Table 2-7 (Continued)
Analytical Results for Groundwater Samples
June and July 2000

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Compound	Groundwater Cleanup Criteria[1]	MW-11 Dup	MW-12	MW-13	MW-16	MW-18	MW-19	DMW-20	MW-21	MW-22	MW-23
		07/07/00	07/07/00	06/28/00	06/28/00	07/07/00	07/07/00	07/07/00	07/06/00	07/06/00	06/28/00
VOCs (USEPA Method 8021B) (µg/L)											
1,1-Dichloroethene	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.72J
Benzene	1	**508**	ND	ND	ND	ND	ND	ND	ND	1	0.61J
Ethylbenzene	30	**749**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	40	**5130**	ND	ND	ND	ND	ND	ND	ND	ND	0.63J
Total Xylenes	20	**6250**	ND	ND	ND	ND	ND	ND	ND	4.8	**53.8**
PAHs (USEPA Method 8310) (µg/L)											
1-Methylnaphthalene	20	**42.4**	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	20	**56.1**	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	20	**135**	ND	ND	ND	ND	ND	ND	ND	ND	ND
FL-PRO (µg/L)											
TRPH	5000	**21000**	ND	ND	ND	ND	ND	ND	499	328	316

Notes:
[1]Chapter 62-777, FAC
µg/L = micrograms per liter
J = estimated concentration
ND = Compound was not detected above instrument detection limits.
E = Exceeds Instrument Calibration

BOLD indicates an exceedance of limits.

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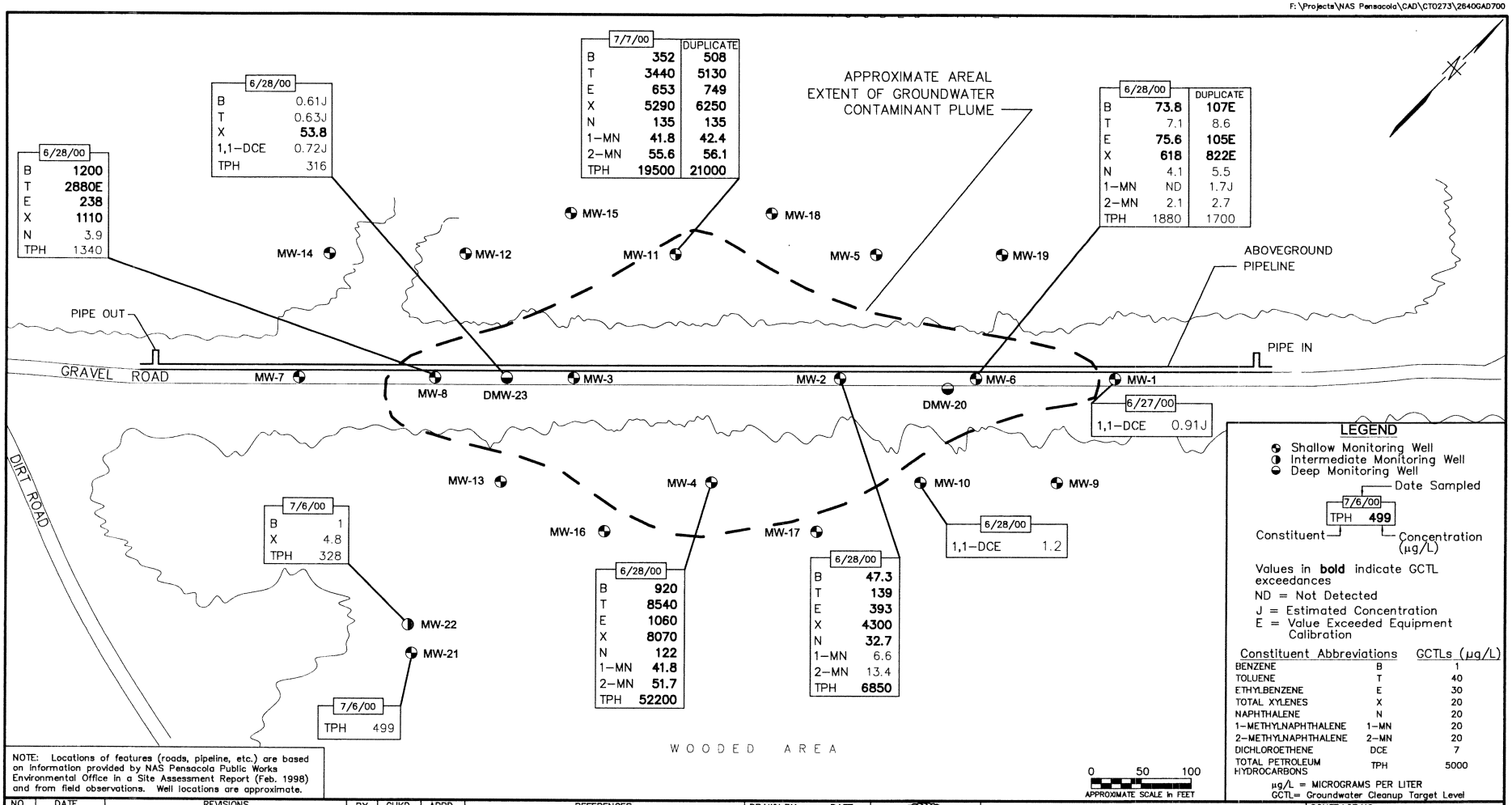

LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well

Date Sampled

7/6/00
TPH **499**

Constituent — Concentration (µg/L)

Values in **bold** indicate GCTL exceedances

ND = Not Detected

J = Estimated Concentration

E = Value Exceeded Equipment Calibration

Constituent Abbreviations		GCTLs (µg/L)
BENZENE	B	1
TOLUENE	T	40
ETHYLBENZENE	E	30
TOTAL XYLENES	X	20
NAPHTHALENE	N	20
1-METHYLNAPHTHALENE	1-MN	20
2-METHYLNAPHTHALENE	2-MN	20
DICHLOROETHENE	DCE	7
TOTAL PETROLEUM HYDROCARBONS	TPH	5000

µg/L = MICROGRAMS PER LITER
GCTL= Groundwater Cleanup Target Level

NOTE: Locations of features (roads, pipeline, etc.) are based on information provided by NAS Pensacola Public Works Environmental Office in a Site Assessment Report (Feb. 1998) and from field observations. Well locations are approximate.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 8/05/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GROUNDWATER ANALYTICAL DATA AND EXTENT OF CONTAMINANT PLUME
JUNE/JULY 2000
UST SITE NUMBER 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-4 REV. 0

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98

Table 2-8
Summary of Detected Contaminants in Groundwater

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida
Page 1 of 6

Sample No.	GCTL[1] (µg/L)	NASP-19-MW17	NASP-19-MW17-D	NASP19MW17R	NASP19MW17R-D	PEN-19-MW4	PEN-19-MW6
Sample Location		MW-17R	MW-17R	MW-17R	MW-17R	MW-4	MW-6
Collect Date		08/25/01	08/25/01	11/09/01	11/09/01	12/18/02	12/18/02
VOCs (USEPA Method SW-846 8260B) (µg/L)							
Benzene	1	**69.7 J**	**39.5 J**	**110**	**110**	**79**	**4.0**
Chloroform	5.7	NA	NA	ND	ND	ND	ND
Ethylbenzene	30	**50.2**	**51**	**130**	**120**	**360**	1.5
Methylene Chloride	5	NA	NA	**83**	**68**	ND	ND
Trichloroethene	3	NA	NA	ND	ND	ND	ND
Toluene	40	15.7	11.9	**74**	**75**	**2400**	ND
Xylenes, Total	20	**816**	**707**	**2740**	**2600**	**3500**	9.3
PAHs (USEPA Method SW-846 8310) (µg/L)							
1-Methylnaphthalene	20	8.69	8.43	7.8 J	ND	**20**	ND
2-Methylnaphthalene	20	10	9.41	10.2 J	ND	**32**	ND
Benzo(a)Pyrene	0.20	ND	0.137	ND	ND	ND	ND
Benzo(b)Fluoranthene	0.20	ND	0.158	ND	ND	ND	ND
Benzo(k)Fluoranthene	0.50	ND	0.158	ND	ND	ND	ND
Chrysene	4.80	ND	0.116	ND	ND	ND	ND
Fluorene	280	0.232	0.221	ND	ND	ND	ND
Naphthalene	20	17.2 J	17.1 J	17.2 J	ND	**59**	ND
TRPH (FL-PRO) (mg/L)	5	1.57 J	1.69 J	4.60	4.18	**20**	0.54 J
Metals (USEPA Method SW 846 6010 B) (µg/L)							
Lead	15	NA	NA	ND	ND	ND	ND

See notes at end of table.

Table 2-8
Summary of Detected Contaminants in Groundwater

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida
Page 2 of 6

Sample No.	GCTL[1] (µg/L)	PEN-19-MW8	PEN-19-MW11	PEN-19-MW22	PEN-19-MW22-D	PEN-19-MW24S	PEN-19-MW24S
Sample Location		MW-8	MW-11	MW-22	MW-22	MW-24S	MW-24S
Collect Date		12/18/02	12/18/02	12/19/02	12/19/02	11/09/01	12/18/02
VOCs (USEPA Method SW-846 8260B) (µg/L)							
Benzene	1	**190**	**430 J**	ND	ND	ND	ND
Chloroform	5.7	--	--	ND	ND	ND	ND
Ethylbenzene	30	25	**520**	ND	ND	ND	ND
Methylene Chloride	5	ND	ND	ND	ND	ND	ND
Trichloroethene	3	ND	ND	ND	ND	ND	ND
Toluene	40	**130**	**5800**	ND	ND	ND	ND
Xylenes, Total	20	**100**	**5500**	ND	ND	ND	ND
PAHs (USEPA Method SW-846 8310) (µg/L)							
1-Methylnaphthalene	20	ND	**22**	ND	ND	7.63	ND
2-Methylnaphthalene	20	ND	**31**	ND	ND	9.92	ND
Fluorene	280	ND	0.78 J	ND	ND	ND	ND
Naphthalene	20	ND	**58**	ND	ND	16 J	ND
TRPH (FL-PRO) (mg/L)	5	0.62 J	**26**	ND	ND	0.83	ND
Metals (USEPA Method SW-846 6010 B) (µg/L)							
Lead	15	10.7	ND	ND	ND	ND	ND

See notes at end of table.

Table 2-8
Summary of Detected Contaminants in Groundwater

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida
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Sample No.	GCTL[1] (µg/L)	PEN-19-MW25S	PEN-19-MW25S	PEN-19-MW26S	PEN-19-MW26S	PEN-19-MW27S	PEN-19-MW28I
Sample Location		MW-25S	MW-25S	MW-26S	MW-26S	MW-27S	MW-28I
Collect Date		11/09/01	12/18/02	11/09/01	12/18/02	11/09/01	11/09/01
VOCs (USEPA Method SW-846 8260B) (µg/L)							
Benzene	1	**19**	ND	ND	**2.7**	ND	**520**
Chloroform	5.7	ND	ND	ND	ND	ND	ND
Ethylbenzene	30	1.0	ND	ND	ND	ND	**82**
Methylene Chloride	5	ND	ND	ND	ND	ND	**60**
Trichloroethene	3	0.7 J	ND	0.99 J	ND	ND	**66**
Toluene	40	1.0	ND	ND	ND	ND	17 J
Xylenes, Total	20	**30.8**	ND	ND	ND	ND	**620**
PAHs (USEPA Method SW-846 8310) (µg/L)							
1-Methylnaphthalene	20	0.26 J	ND	ND	ND	0.105	1.59
2-Methylnaphthalene	20	ND	ND	ND	ND	0.126	2.6
Fluorene	280	ND	ND	ND	ND	ND	ND
Naphthalene	20	ND	ND	ND	ND	ND	4.68 J
TRPH (FL-PRO) (mg/L)	5	1.22	ND	0.929	ND	0.925	2.13
Metals (USEPA Method SW-846 6010 B) (µg/L)							
Lead	15	ND	ND	ND	ND	ND	ND

See notes at end of table.

Table 2-8
Summary of Detected Contaminants in Groundwater

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida
Page 4 of 6

Sample No.	GCTL[1] (µg/L)	PEN-19-MW28I	PEN-19-MW28S	PEN-19-MW28S	PEN-19-MW29S	PEN-19-MW29I	PEN-19-MW29D
Sample Location		MW-28I	MW-28S	MW-28S	MW-29S	MW-29I	MW-29D
Collect Date		12/18/02	11/09/01	12/18/02	12/17/02	12/17/02	12/17/02
VOCs (USEPA Method SW-846 8260B) (µg/L)							
Benzene	1	**590**	**120 J**	**1.1**	ND	**57**	ND
Chloroform	5.7	ND	ND	ND	ND	ND	ND
Ethylbenzene	30	**91**	0.53 J	ND	ND	17	ND
Methylene Chloride	5	ND	ND	ND	ND	ND	ND
Trichloroethene	3	ND	**4.7**	ND	ND	ND	ND
Toluene	40	ND	0.94 J	0.53 J	ND	1.8	ND
Xylenes, Total	20	**730**	17	ND	ND	**220**	1.6 J
PAHs (USEPA Method SW-846 8310) (µg/L)							
1-Methylnaphthalene	20	2.3	0.24	ND	ND	4.7	ND
2-Methylnaphthalene	20	3.0	0.3	ND	ND	6.6	ND
Fluorene	280	ND	ND	ND	ND	ND	ND
Naphthalene	20	9.6	0.126 J	ND	ND	7.6	ND
TRPH (FL-PRO) (mg/L)	5	2.4	1.21	0.47 J	ND	1.9	ND
Metals (USEPA Method SW-846 6010 B) (µg/L)							
Lead	15	ND	ND	ND	ND	ND	ND

See notes at end of table.

Table 2-8
Summary of Detected Contaminants in Groundwater

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida
Page 5 of 6

Sample No.	GCTL[1] (µg/L)	PEN-19-MW29D-D	PEN-19-MW30S	PEN-19-MW30I	PEN-19-MW31S	PEN-19-MW31I	PEN-19-MW32I
Sample Location		MW-29D	MW-30S	MW-30I	MW-31S	MW-31I	MW-32I
Collect Date		12/17/02	12/18/02	12/18/02	12/17/02	12/17/02	12/17/02
VOCs (USEPA Method SW-846 8260B) (µg/L)							
Benzene	1	ND	ND	ND	ND	ND	ND
Chloroform	5.7	ND	ND	ND	ND	ND	0.46 J
Ethylbenzene	30	ND	ND	ND	ND	ND	ND
Methylene Chloride	5	ND	ND	ND	ND	ND	ND
Trichloroethene	3	ND	ND	ND	ND	ND	ND
Toluene	40	ND	ND	ND	ND	ND	ND
Xylenes, Total	20	1.4 J	ND	ND	ND	ND	ND
PAHs (USEPA Method SW-846 8310) (µg/L)							
1-Methylnaphthalene	20	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	20	ND	ND	ND	ND	ND	ND
Fluorene	280	ND	ND	ND	ND	ND	ND
Naphthalene	20	ND	ND	ND	ND	ND	ND
TRPH (FL-PRO) (mg/L)	5	ND	0.57 J	ND	ND	ND	ND
Metals (USEPA Method SW-846 6010 B) (µg/L)							
Lead	15	ND	ND	ND	ND	ND	ND

See notes at end of table.

Table 2-8
Summary of Detected Contaminants in Groundwater

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida
Page 6 of 6

Sample No.	GCTL[1] (µg/L)	PEN-19-MW32S	PEN-19-MW33S	PEN-19-MW33I	PEN-19-MW33D	NASP19RB01-110901	PEN-19-RB121902
Sample Location		MW-32S	MW-33S	MW-33I	MW-33D		
Collect Date		12/17/02	12/17/02	12/17/02	12/17/02	11/09/01	12/18/02
VOCs (USEPA Method SW-846 8260B) (µg/L)							
Benzene	1	ND	**190**	**50**	ND	ND	ND
Chloroform	5.7	**7.1**	ND	ND	ND	ND	ND
Ethylbenzene	30	ND	12	0.51 J	ND	ND	ND
Methylene Chloride	5	ND	ND	ND	ND	1.6	ND
Trichloroethene	3	ND	ND	ND	ND	ND	ND
Toluene	40	ND	16	ND	ND	ND	ND
Xylenes, Total	20	ND	**130**	17	ND	ND	ND
PAHs (USEPA Method SW-846 8310) (µg/L)							
1-Methylnaphthalene	20	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	20	ND	ND	ND	ND	ND	ND
Fluorene	280	ND	ND	ND	ND	ND	ND
Naphthalene	20	ND	0.77 J	ND	ND	ND	ND
TRPH (FL-PRO) (mg/L)	5	ND	1.1 J	0.75 J	ND	0.879	ND
Metals (USEPA Method SW-846 6010 B) (µg/L)							
Lead	15	ND	ND	ND	8.8	ND	ND

Notes:
[1] Groundwater Cleanup Target Level as provided in Chapter 62-777, FAC.
Bold indicates an exceedance of limits
µg/L = micrograms per liter
J = Compound was detected at an estimated concentration
mg/L = milligrams per liter
FAC = Florida Administrative Code
FL-PRO = Florida Petroleum Range Organics

Monitoring well locations and shallow groundwater detections (GCTL exceedances in bold) are presented on Figure 2-5.

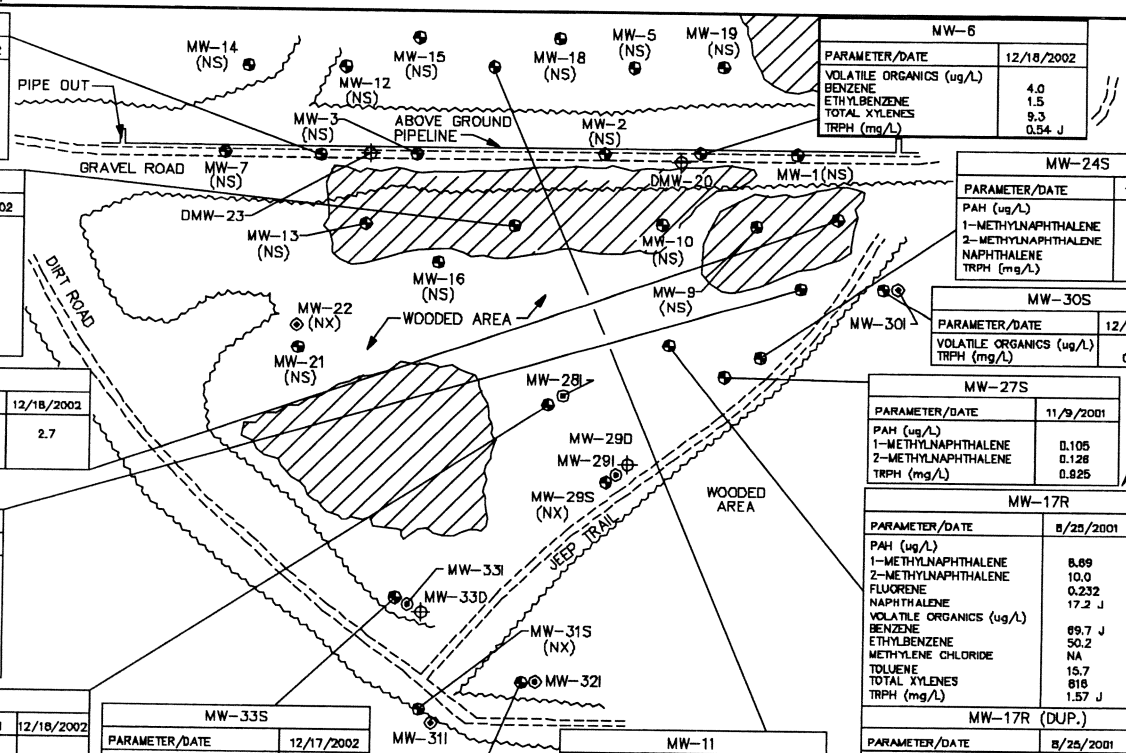
TtNUS performed a DPT site characterization in November 2002 to determine the horizontal and vertical extent of groundwater contamination. Groundwater samples were collected from 16 locations at depths of 10 ft, 25 ft, and 50 ft and sent to an on-site mobile laboratory for analysis. The mobile laboratory analytical results and DPT locations are presented on Figure 2-6. Twelve new monitoring wells (MW-29S, MW-29I, MW-29D, MW-30S, MW-30I, MW-31S, MW-31I, MW-32S, MW-32I, MW-33S, MW-33I, and MW-33D) were installed based on the mobile laboratory results for the DPT locations. The new monitoring well locations are depicted on Figure 2-5. Twenty-two monitoring wells (MW-4, MW-6, MW-8, MW-11, MW-22, MW-24S, MW-25S, MW-26S, MW-28S, MW-28I, MW-29S, MW-29I, MW-29D, MW-30S, MW-30I, MW-31S, MW-31I, MW-32S, MW-32I, MW-33S, MW-33I, and MW-33D) were sampled between December 17 and December 19, 2002. FDEP GCTL exceedances for VOCs, PAHs, and TRPH were detected in 12 of the 22 monitoring wells sampled at UST Site 20. Analytical data was summarized in Table 2-8. Monitoring well locations and shallow groundwater detections are presented on Figure 2-5. Intermediate and deep groundwater detections are presented on Figure 2-7. TtNUS summarized the results of the additional site characterization and monitoring well installation and sampling in their SARA II submitted to the FDEP on May 8, 2003.

2.5 FREE PRODUCT

Free product was not detected in the monitoring wells at Site 20 during field investigation activities. However, during the SARA field investigation on May 8, 2000, TtNUS personnel conducted a free product test of soil samples while advancing soil borings. The free product field screening method was used on four soil borings (HA02, HA04, HA15, and HA20) that exhibited a petroleum odor. The test was performed by placing approximately 4 ounces of soil in a clear 8-ounce soil jar, filling the jar with deionized water to approximately 0.5 inches above the top of the soil, and then adding a small amount (approximately 0.25 ounce) of Oil Red number 2 dye. After all the components were added, the jar was sealed, agitated vigorously for about 30 seconds, and then the components were allowed to settle.

During the process, petroleum product present in the soil is dyed red by the Oil Red, becoming easily visible. An approximately 1/8-inch layer of product developed in the jars containing soil from borings HA02, HA04, and HA15. Sample HA20 produced only a few small-floating globules of red fluid. This test indicates the presence of some free product in the soil at Site 20 (TtNUS, 2001).

ACAD:2640CT06.dwg 08/03/03 MF PIT



MW-8	
PARAMETER/DATE	12/18/2002
VOLATILE ORGANICS (ug/L)	
BENZENE	190
ETHYLBENZENE	25
TOLUENE	130
TOTAL XYLENES	100
TRPH (mg/L)	0.62 J
INORGANICS (ug/L)	
LEAD	10.7

MW-4	
PARAMETER/DATE	12/18/2002
PAH (ug/L)	
1-METHYLNAPHTHALENE	20
2-METHYLNAPHTHALENE	32
NAPHTHALENE	59
VOLATILE ORGANICS (ug/L)	
BENZENE	79
ETHYLBENZENE	380
TOLUENE	2400
TOTAL XYLENES	3500
TRPH (mg/L)	20

MW-26S		
PARAMETER/DATE	11/9/2001	12/18/2002
VOLATILE ORGANICS (ug/L)		
BENZENE		2.7
TRICHLOROETHENE	0.89 J	
TRPH (mg/L)	0.929	

MW-25S	
PARAMETER/DATE	11/9/2001
PAH (ug/L)	
1-METHYLNAPHTHALENE	0.28 J
VOLATILE ORGANICS (ug/L)	
BENZENE	19
ETHYLBENZENE	1.0
TOLUENE	1.0
TOTAL XYLENES	30.8
TRICHLOROETHENE	0.7 J
TRPH (mg/L)	1.22

MW-28S		
PARAMETER/DATE	11/9/2001	12/18/2002
PAH (ug/L)		
1-METHYLNAPHTHALENE	0.24	
2-METHYLNAPHTHALENE	0.3	
NAPHTHALENE	0.126 J	
VOLATILE ORGANICS (ug/L)		
BENZENE	120 J	1.1
ETHYLBENZENE	0.53 J	
TOLUENE	0.94 J	0.53 J
TOTAL XYLENES	17	
TRICHLOROETHENE	4.7	
TRPH (mg/L)	1.21	0.47 J

MW-33S	
PARAMETER/DATE	12/17/2002
PAH (ug/L)	
NAPHTHALENE	0.77 J
VOLATILE ORGANICS (ug/L)	
BENZENE	190
ETHYLBENZENE	12
TOLUENE	16
TOTAL XYLENES	130
TRPH (mg/L)	1.1 J

MW-32S	
PARAMETER/DATE	12/17/2002
VOLATILE ORGANICS (ug/L)	
CHLOROFORM	7.1

MW-11	
PARAMETER/DATE	12/18/2002
PAH (ug/L)	
1-METHYLNAPHTHALENE	22
2-METHYLNAPHTHALENE	31
FLUORENE	0.78 J
NAPHTHALENE	58
VOLATILE ORGANICS (ug/L)	
BENZENE	430 J
ETHYLBENZENE	520
TOLUENE	5800
TOTAL XYLENES	5500
TRPH (mg/L)	26

MW-6	
PARAMETER/DATE	12/18/2002
VOLATILE ORGANICS (ug/L)	
BENZENE	4.0
ETHYLBENZENE	1.5
TOTAL XYLENES	9.3
TRPH (mg/L)	0.54 J

MW-24S	
PARAMETER/DATE	11/9/2001
PAH (ug/L)	
1-METHYLNAPHTHALENE	7.83
2-METHYLNAPHTHALENE	9.92
NAPHTHALENE	16 J
TRPH (mg/L)	0.83

MW-30S	
PARAMETER/DATE	12/17/2002
VOLATILE ORGANICS (ug/L)	
TRPH (mg/L)	0.57 J

MW-27S	
PARAMETER/DATE	11/9/2001
PAH (ug/L)	
1-METHYLNAPHTHALENE	0.105
2-METHYLNAPHTHALENE	0.126
TRPH (mg/L)	0.825

MW-17R		
PARAMETER/DATE	8/25/2001	11/9/2001
PAH (ug/L)		
1-METHYLNAPHTHALENE	8.69	7.8 J
2-METHYLNAPHTHALENE	10.0	10.2 J
FLUORENE	0.232	
NAPHTHALENE	17.2 J	17.2 J
VOLATILE ORGANICS (ug/L)		
BENZENE	69.7 J	110
ETHYLBENZENE	50.2	130
METHYLENE CHLORIDE	NA	83
TOLUENE	15.7	74
TOTAL XYLENES	816	2740
TRPH (mg/L)	1.57 J	4.60

MW-17R (DUP.)		
PARAMETER/DATE	8/25/2001	11/9/2001
PAH (ug/L)		
1-METHYLNAPHTHALENE	8.43	
2-METHYLNAPHTHALENE	9.41	
BENZO(a)PYRENE	0.137	
BENZO(b)FLUORANTHENE	0.158	
BENZO(k)FLUORANTHENE	0.158	
CHRYSENE	0.116	
FLUORENE	0.221	
NAPHTHALENE	17.1 J	
VOLATILE ORGANICS (ug/L)		
BENZENE	39.5 J	110
ETHYLBENZENE	51.0	120
METHYLENE CHLORIDE	NA	68
TOLUENE	11.9	75
TOTAL XYLENES	707	2800
TRPH (mg/L)	1.69J	4.18

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APROXIMATE.

ANALYTICAL TARGET LEVELS		
ANALYTE	GCTL	NADC
1-METHYLNAPHTHALENE	20	200
2-METHYLNAPHTHALENE	20	200
BENZENE	1	100
BENZO(a)PYRENE	0.20	20
BENZO(b)FLUORANTHENE	0.20	20
BENZO(k)FLUORANTHENE	0.20	20
CHLOROFORM	5.7	NA
CHRYSENE	4.80	480
ETHYLBENZENE	30	300
FLUORENE	280	2800
LEAD	15	150
METHYLENE CHLORIDE	5	NA
NAPHTHALENE	20	200
PHENANTHRENE	210	2100
TOLUENE	40	400
TOTAL XYLENES	20	200
TRICHLORDETHENE	3	NA
TRPH	5	50

LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- (NX) NO EXCEEDANCES
- (NS) NOT SAMPLED
- GCTL GROUNDWATER CLEAN-UP TARGET LEVEL
- NADC NATURAL ATTENUATION DEFAULT CONCENTRATION
- J ESTIMATED
- mg/L MILLIGRAMS PER LITER
- NA NOT ANALYZED
- ug/L MICROGRAMS PER LITER
- STANDING WATER
- WOODED AREA

NOTES:

1. BLANK SPACE INDICATES NON-DETECTS.
2. BOLD INDICATES AN EXCEEDANCE OF OF GCTLS.

0 150 300
APPROXIMATE SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

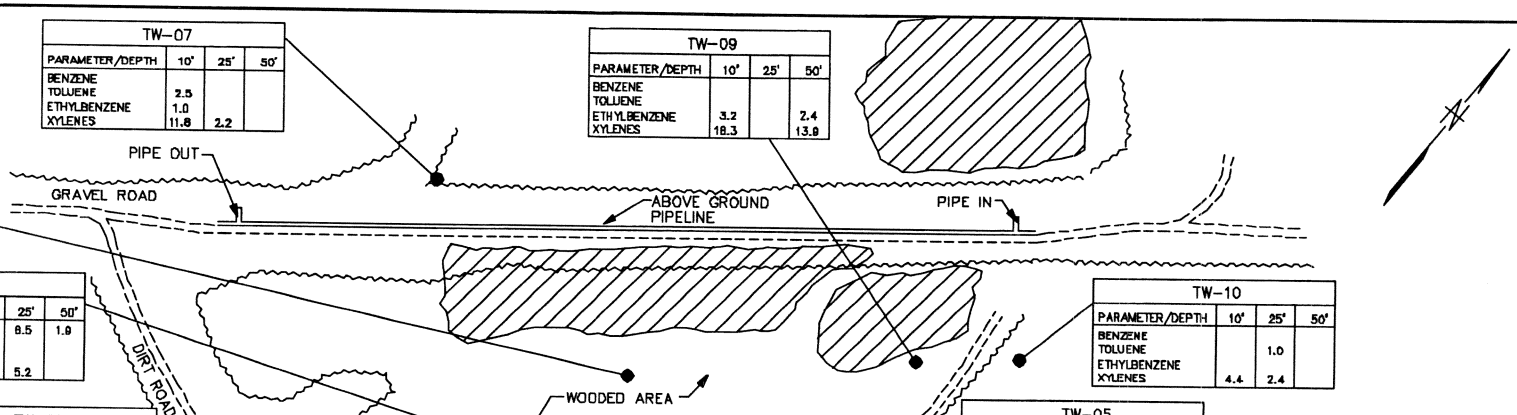
DRAWN BY HJB DATE 8/11/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

DETECTED CONCENTRATIONS IN SHALLOW MONITORING WELL SAMPLES
AUGUST 25, 2001 – DECEMBER 19, 2002
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-5
REV. 0

FORM CADD NO. SDIV_3HL.DWG - REV 0 - 1/20/99

ACAD: 2640GT04.dwg 09/03/03 MF PIT



TW-07			
PARAMETER/DEPTH	10'	25'	50'
BENZENE			
TOLUENE	2.5		
ETHYLBENZENE	1.0		
XYLENES	11.8	2.2	

TW-09			
PARAMETER/DEPTH	10'	25'	50'
BENZENE			
TOLUENE			
ETHYLBENZENE	3.2		2.4
XYLENES	18.3		13.9

TW-11			
PARAMETER/DEPTH	10'	25'	50'
BENZENE	1300	43	8.6
TOLUENE	8500	670	42.3
ETHYLBENZENE	990	68	7.6
XYLENES	7900	690	65.1

TW-02			
PARAMETER/DEPTH	10'	25'	50'
BENZENE		8.5	1.9
TOLUENE			
ETHYLBENZENE			
XYLENES		5.2	

TW-10			
PARAMETER/DEPTH	10'	25'	50'
BENZENE			
TOLUENE		1.0	
ETHYLBENZENE			
XYLENES	4.4	2.4	

TW-08			
PARAMETER/DEPTH	10'	25'	50'
BENZENE	28	200	
TOLUENE	1.0	4.0	1.3
ETHYLBENZENE	1.8	1.7	1.7
XYLENES	23.5	19.7	14.3

TW-05			
PARAMETER/DEPTH	10'	25'	50'
BENZENE		1.3	2.2
TOLUENE			
ETHYLBENZENE			
XYLENES		8.8	13.7

TW-13			
PARAMETER/DEPTH	10'	25'	50'
BENZENE	510	670	95.8
TOLUENE	3.7	1.4	6.5
ETHYLBENZENE			8.0
XYLENES	1010	70.9	72.4

TW-03			
PARAMETER/DEPTH	10'	25'	50'
BENZENE	2.8	5.8	4.2
TOLUENE			
ETHYLBENZENE			
XYLENES		6.7	9.5

TW-14			
PARAMETER/DEPTH	10'	25'	50'
BENZENE		16.7	
TOLUENE			
ETHYLBENZENE			
XYLENES	1.9	2.2	

TW-01			
PARAMETER/DEPTH	10'	25'	50'
BENZENE	590		12.5
TOLUENE	290		
ETHYLBENZENE	370		
XYLENES	3700	4.1	51.5

FLORIDA GCTLS	
ANALYTE	GCTL
BENZENE	1
TOLUENE	30
ETHYLBENZENE	40
TOTAL XYLENES	20

TW-04			
PARAMETER/DEPTH	10'	25'	50'
BENZENE	3.4	1.7	
TOLUENE		1.7	
ETHYLBENZENE			
XYLENES		21.8	1.6

TW-16			
PARAMETER/DEPTH	10'	25'	50'
BENZENE			
TOLUENE			
ETHYLBENZENE			
XYLENES			1.8

TW-12			
PARAMETER/DEPTH	10'	25'	50'
BENZENE		3.9	
TOLUENE	4.2		3.9
ETHYLBENZENE			1.1
XYLENES	4.8		8.8

TW-15			
PARAMETER/DEPTH	10'	25'	50'
BENZENE		183	
TOLUENE			
ETHYLBENZENE			
XYLENES			

TW-06			
PARAMETER/DEPTH	10'	25'	50'
BENZENE			NA
TOLUENE			NA
ETHYLBENZENE			NA
XYLENES			NA

LEGEND:

- ● TEMPORARY GROUNDWATER SAMPLE LOCATION
- GCTL GROUNDWATER CLEAN-UP TARGET LEVEL
- NA NOT ANALYZED
- STANDING WATER
- WOODED AREA

NOTES:

1. ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/L).
2. BOLD INDICATES AN EXCEEDANCE OF GCTLs.
3. BLANK SPACE INDICATES NON-DETECTS.

0 150 300
APPROXIMATE SCALE IN FEET

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 8/11/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

DETECTED CONCENTRATIONS IN DPT GROUNDWATER SAMPLES
NOVEMBER 5 – NOVEMBER 14, 2002
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-6 REV. 0

FORM CADD NO. SBIV_B1.DWG - REV 0 - 1/20/98

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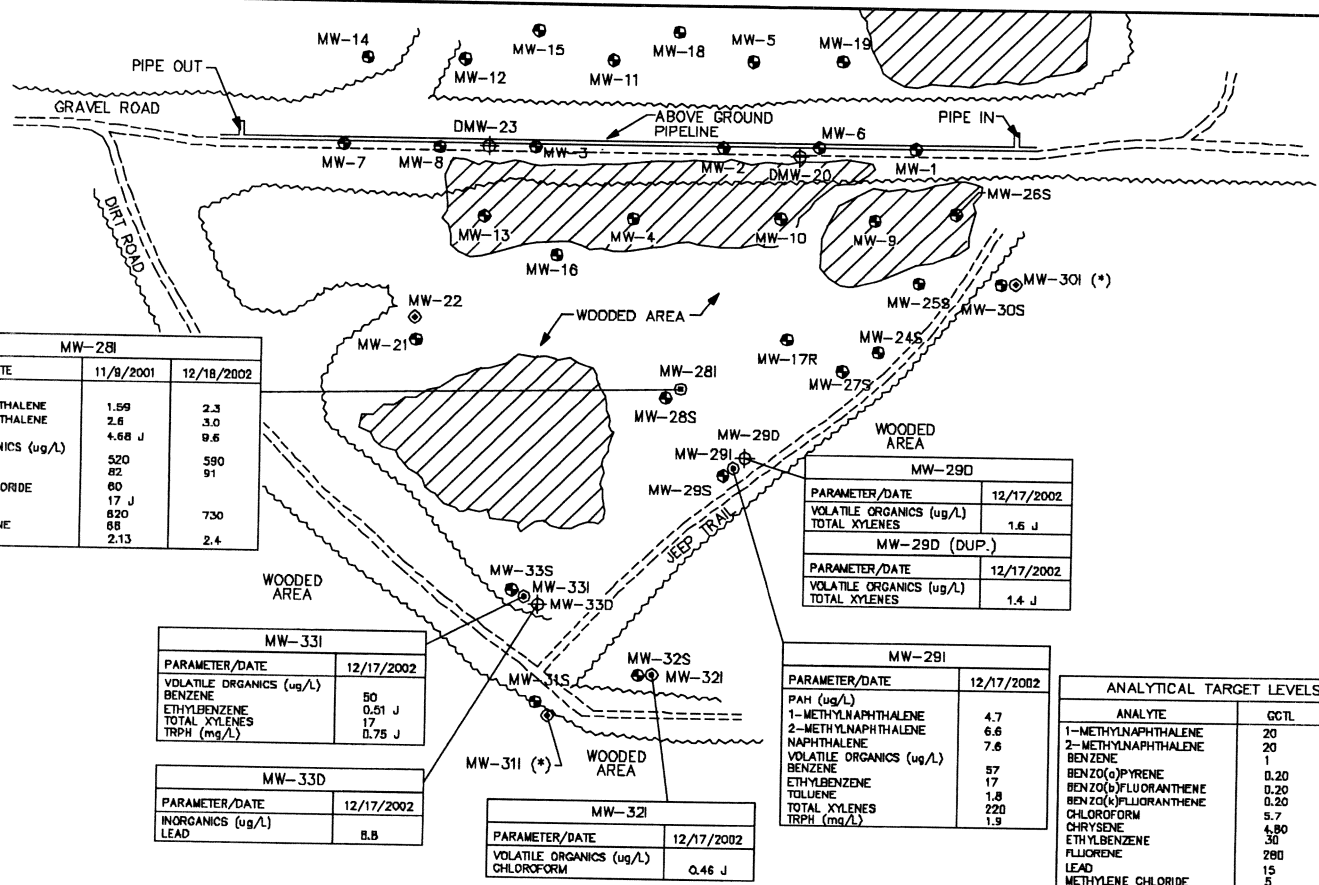
CTO 0273

ACAD: 2640GT05.dwg 08/03/03 MF PIT



MW-281		
PARAMETER/DATE	11/9/2001	12/18/2002
PAH (ug/L)		
1-METHYLNAPHTHALENE	1.59	2.3
2-METHYLNAPHTHALENE	2.6	3.0
NAPHTHALENE	4.68 J	9.6
VOLATILE ORGANICS (ug/L)		
BENZENE	520	590
ETHYLBENZENE	82	91
METHYLENE CHLORIDE	60	
TOLUENE	17 J	
TOTAL XYLENES	620	730
TRICHLOROETHENE	68	
TRPH (mg/L)	2.13	2.4

MW-29D	
PARAMETER/DATE	12/17/2002
VOLATILE ORGANICS (ug/L)	
TOTAL XYLENES	1.6 J

MW-29D (DUP.)	
PARAMETER/DATE	12/17/2002
VOLATILE ORGANICS (ug/L)	
TOTAL XYLENES	1.4 J

MW-331	
PARAMETER/DATE	12/17/2002
VOLATILE ORGANICS (ug/L)	
BENZENE	50
ETHYLBENZENE	0.51 J
TOTAL XYLENES	17
TRPH (mg/L)	0.75 J

MW-33D	
PARAMETER/DATE	12/17/2002
INORGANICS (ug/L)	
LEAD	8.8

MW-321	
PARAMETER/DATE	12/17/2002
VOLATILE ORGANICS (ug/L)	
CHLOROFORM	0.46 J

MW-291	
PARAMETER/DATE	12/17/2002
PAH (ug/L)	
1-METHYLNAPHTHALENE	4.7
2-METHYLNAPHTHALENE	6.6
NAPHTHALENE	7.6
VOLATILE ORGANICS (ug/L)	
BENZENE	57
ETHYLBENZENE	17
TOLUENE	1.8
TOTAL XYLENES	220
TRPH (mg/L)	1.9

ANALYTICAL TARGET LEVELS		
ANALYTE	GCTL	NADC
1-METHYLNAPHTHALENE	20	200
2-METHYLNAPHTHALENE	20	200
BENZENE	1	100
BENZO(a)PYRENE	0.20	20
BENZO(b)FLUORANTHENE	0.20	20
BENZO(k)FLUORANTHENE	0.20	20
CHLOROFORM	5.7	NA
CHRYSENE	4.80	480
ETHYLBENZENE	30	300
FLUORENE	280	2800
LEAD	15	150
METHYLENE CHLORIDE	5	NA
NAPHTHALENE	20	200
PHENANTHRENE	210	2100
TOLUENE	40	400
TOTAL XYLENES	20	200
TRICHLOROETHENE	3	NA
TRPH	5	50

LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- GCTL — GROUNDWATER CLEAN-UP TARGET LEVEL
- NADC — NATURAL ATTENUATION DEFAULT CONCENTRATION
- J — ESTIMATED
- mg/kg — MILLIGRAMS PER LITER
- NA — NOT ANALYZED
- µg/L — MICROGRAMS PER LITER
- STANDING WATER
- WOODED AREA
- (*) — NO COMPOUNDS WERE DETECTED ABOVE REPORTING LIMIT

NOTES:

1. BOLD INDICATES AN EXCEEDANCE OF GCTLs.
2. BLANK SPACE INDICATES NON-DETECTS.

0 150 300
APPROXIMATE SCALE IN FEET

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 8/11/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

DETECTED CONCENTRATIONS IN MONITORING WELLS
AUGUST 25, 2001 – DECEMBER 19, 2002
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-7
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

03JAX0187

CTO 0273

2.6 SAR ADDENDUM II CONCLUSIONS AND RECOMMENDATIONS

Soil screening identified 26 of 54 locations exhibiting OVA FID reading exceeding 50 ppm, which is the FDEP definition for excessively contaminated soil. Five VOCs (1,1,2-trichlorethane, benzene, ethylbenzene, toluene, and total xylenes), three PAHs (naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene), and TRPH were detected in confirmation samples at concentrations exceeding Florida Soil Cleanup Target Levels (TtNUS, 2001).

No free-phase petroleum hydrocarbons were detected in any of the monitoring wells. However, a field screening method to identify free product in soils was conducted and identified free product in three of four soil samples tested. GCTL exceedances for PAH compounds and TRPH were limited to permanent monitoring wells MW-4 and MW-11. These wells also had elevated concentrations of BTEX compounds which exceeded their respective GCTLs. BTEX compounds (benzene, ethylbenzene, and total xylenes) were detected in permanent monitoring wells MW-6, MW-8, MW-17R, MW-25S, MW-28S, MW-28I, MW-29I, MW-33S, and MW-33I with one or more analytes at concentrations exceeding their respective GCTLs. The BTEX plumes are shown on Figures 2-8 thru 2-11, respectively. The plume boundaries are the respective GCTLs for each contaminant with the NADSC also being shown. On December 17, 2002, MW-32S was sampled and chloroform was detected at a concentration exceeding its GCTL.

The analytical results indicate that multiple VOCs, PAHs, and TRPH exceeded GCTLs. Analytical results also indicate that BTEX compounds are present at concentrations exceeding NADSCs. Therefore, based on the results of the SAR, SARA, and SARA II for UST Site 20, TtNUS recommended resuming preparation of a RAP.

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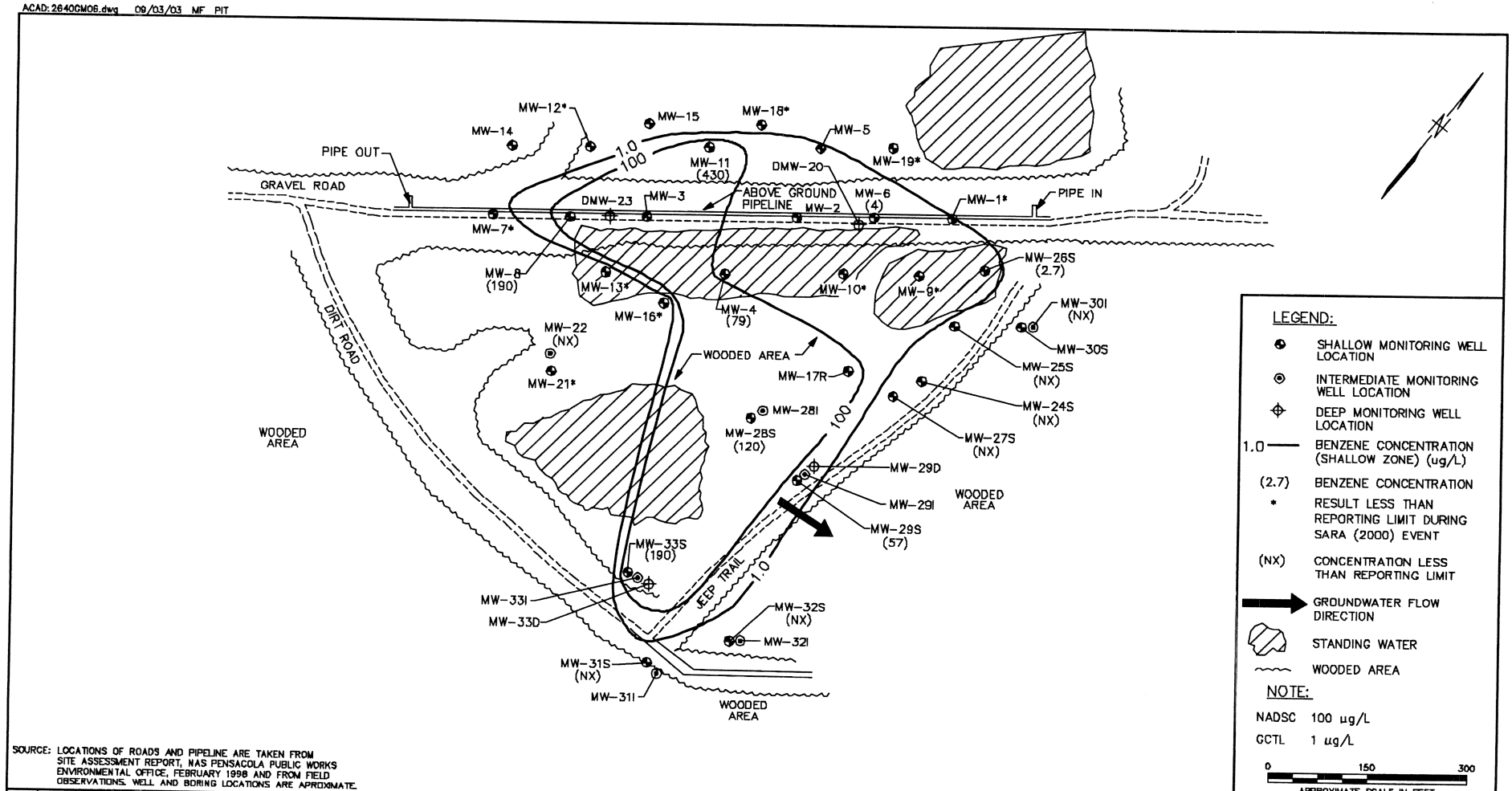


SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY MF DATE 8/5/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

BENZENE CONCENTRATIONS AND EXTENT OF GROUNDWATER PLUME
NOV/DEC 2002
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

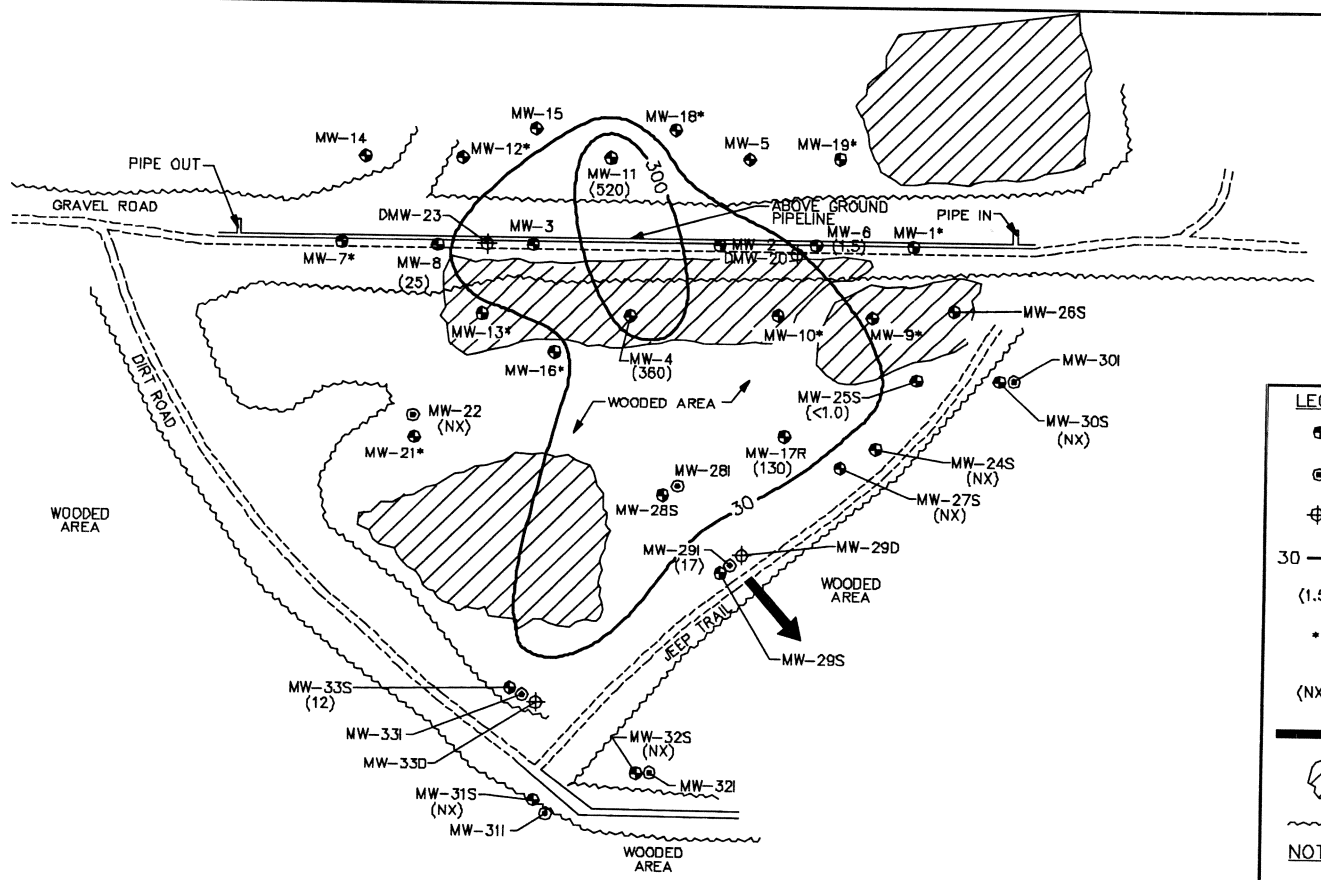
CONTRACT NO. 2640
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-8
REV. 0

FORM CADD NO. SBIV_IH.DWG - REV 0 - 1/20/98

03JAX0187

CTO 0273

ACAD: 2640GM08.dwg 09/03/03 NF PIT



LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- 30 — ETHYLBENZENE ISOCONTOUR SHALLOW ZONE
- (1.5) ETHYLBENZENE CONCENTRATION (ug/L)
- * RESULT LESS THAN REPORTING LIMIT DURING SARA (2000) EVENT
- (NX) CONCENTRATION LESS THAN REPORTING LIMIT
- GROUNDWATER FLOW DIRECTION
- STANDING WATER
- WOODED AREA

NOTES:

NADSC = 300 ug/L
GCTL = 30 ug/L

0 150 300
APPROXIMATE SCALE IN FEET

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 8/5/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

ETHYLBENZENE CONCENTRATIONS AND EXTENT OF GROUNDWATER PLUME
NOV/DEC 2002
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
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DRAWING NO. FIGURE 2-9
REV. 0

FORM CADD NO. SDIV_IH.DWG - REV 0 - 1/20/98

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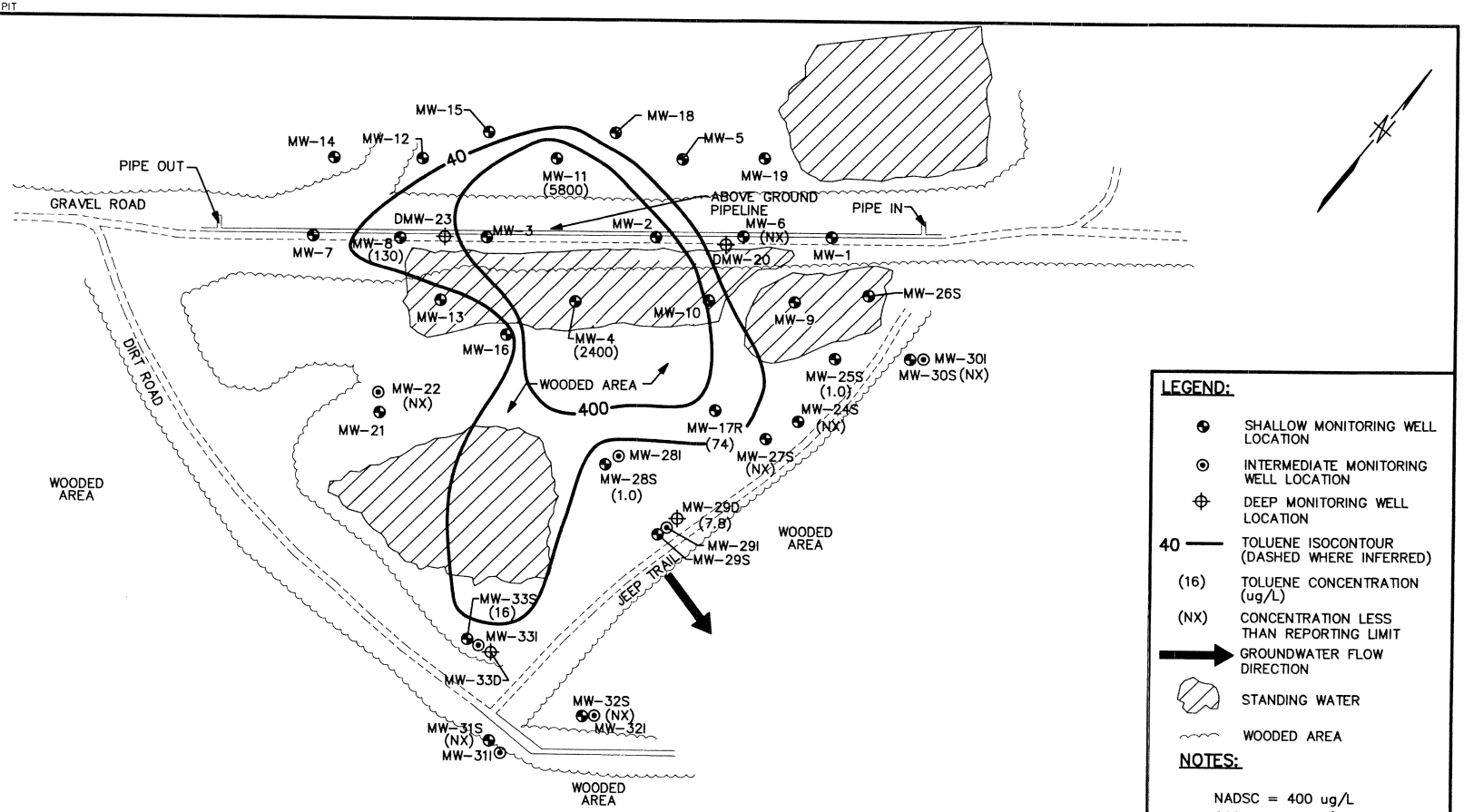

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APPROXIMATE.

LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- 40 — TOLUENE ISOCONTOUR (DASHED WHERE INFERRED)
- (16) TOLUENE CONCENTRATION (ug/L)
- (NX) CONCENTRATION LESS THAN REPORTING LIMIT
- GROUNDWATER FLOW DIRECTION
- STANDING WATER
- WOODED AREA

NOTES:

NADSC = 400 ug/L
GCTL = 40 ug/L

0 150 300
APPROXIMATE SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 8/5/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

TOLUENE CONCENTRATIONS AND EXTENT OF GROUNDWATER PLUME
NOV/DEC 2002
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
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DRAWING NO. FIGURE 2-10
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

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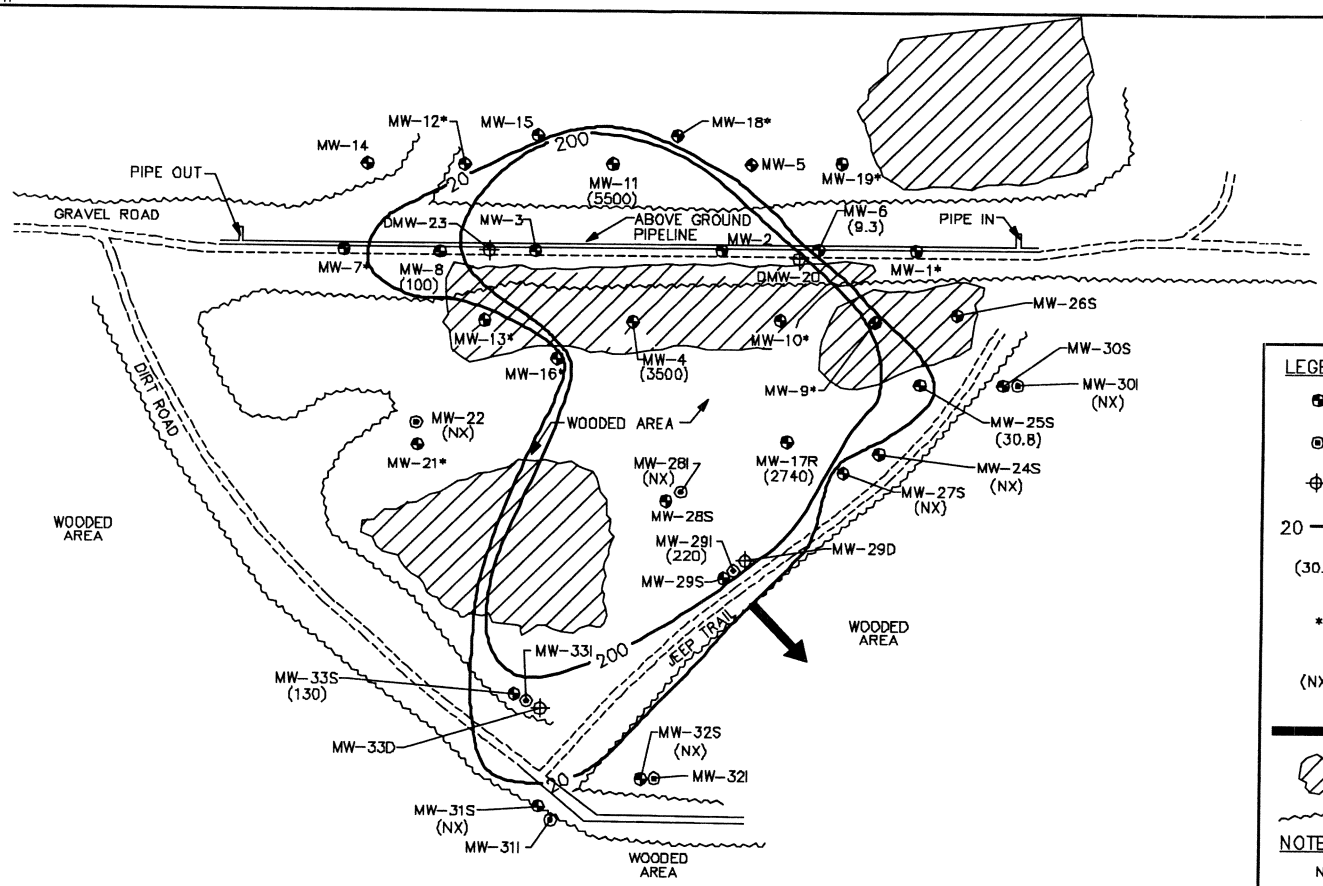

LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- 20 — TOTAL XYLENE ISOCONTOUR (SHALLOW ZONE)
- (30.8) TOTAL XYLENES CONCENTRATIONS (ug/L)
- * RESULT LESS THAN REPORTING LIMIT DURING SARA (2000) EVENT
- (NX) CONCENTRATION LESS THAN REPORTING LIMIT
- GROUNDWATER FLOW DIRECTION
- STANDING WATER
- WOODED AREA

NOTES:

NADSC = 200 ug/L
GCTL = 20 ug/L

0 150 300
APPROXIMATE SCALE IN FEET

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APPROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 8/5/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

TOTAL XYLENE CONCENTRATIONS AND EXTENT OF GROUNDWATER PLUME
NOV/DEC 2002
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
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DRAWING NO. FIGURE 2-11 REV. 0

FORM CADD NO. SBIV_3H.DWG - REV 0 - 1/20/99

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3.0 REMEDIAL ACTION PLAN GOALS

The objective of this RAP is to present a technology relevant and cost-effective to:

- Reduce the petroleum-impacted soil and groundwater at the site.
- Limit plume migration at the site.
- Protect human health and the environment by reducing the concentrations of hydrocarbons detected at the site to target cleanup levels.

The goals and expected accomplishments of the RAP include:

- Identify methods to treat petroleum-impacted soil and groundwater.
- Evaluate the above methods for each media and select remedial alternatives that will result in a reduction of COCs in each media.
- Provide a conceptual design for the selected technologies that can be used during any future final design and implementation phases of the site remediation.

The target cleanup concentrations for the soil and groundwater at the subject site are based on analytes detected in the soil and groundwater in exceedance of Chapter 62-777, FAC. The following subsections list the target levels for the site-specific COCs.

3.1 SOIL TARGET LEVELS

Based on the selected SCTLs listed in Table II of Chapter 62-777, FAC, Table 3-1 presents the soil remediation goals for the site-specific COCs. Site-specific soil COCs were defined as any constituent exceeding residential or leachability criteria for FDEP SCTLs.

3.2 GROUNDWATER TARGET LEVELS

Based on the GCTLs listed in Table V of Chapter 62-777, FAC, Table 3-2 presents the groundwater remediation goals for the site-specific COCs. Site-specific groundwater COCs were defined as any constituent detected in excess of FDEP GCTLs.

Table 3-1
Chemicals of Concern and Associated Soil Cleanup Target Levels

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Site-Specific COCs	Concentrations from Table II*
Benzene	0.007 mg/kg
Toluene	0.5 mg/kg
Ethylbenzene	0.6 mg/kg
Total Xylenes	0.2 mg/kg
Naphthalene	1.7 mg/kg
1-Methylnaphthalene	2.2 mg/kg
2-Methylnaphthalene	6.1 mg/kg
1,1,2-Trichloroethane	0.03 mg/kg
TRPHs	340 mg/kg

* Concentration is the lower of the residential direct exposure or leachability based on groundwater criteria Table II, Chapter 62-777, FAC.

Table 3-2
Chemicals of Concern and Associated Groundwater Cleanup Target Levels

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Site-Specific COCs	Concentrations from Table I
Benzene	1 µg/L
Chloroform	5.7 µg/L
Ethylbenzene	30 µg/L
Toluene	40 µg/L
Total Xylenes	20 µg/L
Methylene Chloride	5 µg/L
Naphthalene	20 µg/L
1-Methylnaphthalene	20 µg/L
2-Methylnaphthalene	20 µg/L
Trichloroethene	3 µg/L
TRPHs	5000 µg/L

* Concentrations from GCTLs Table I, 62-777, FAC.

3.3 SITE RESTRICTIONS AND DATA LIMITATIONS AFFECTING REMEDIAL ALTERNATIVES

Site 20 is an aboveground section of dual pipeline, running between the fuel farm and the tank truck loading facility at Forrest Sherman Field. Parallel to the pipeline is an unpaved road that is built up approximately three ft above the surrounding area. The aboveground section of the pipeline rests on supports along the northwest side of the road. The pipeline can not be altered or removed from service during remedial activities, and road access is necessary during remedial activities. The area on either side of the road at Site 20 is densely forested and may require clearing prior to commencement of remedial activity. The water table at Site 20 is shallow (0 to 3 ft bls) thus restricting the available remedial alternatives for contaminated soil.

Several data limitations that are important to this remedial design were not available. Contamination was detected at the maximum depth sampled (50 ft bls) during the SARA II. Therefore, 60 ft bls was assumed to be the maximum depth of contamination for this remedial design. Control for the western and northern edges of the plume were obtained from groundwater data collected during the 2000 SARA. Therefore, it was assumed the groundwater data collected in 2000 was representative of current conditions in those wells and used in the plume delineation maps.

4.0 CONTAMINANT DISTRIBUTION

4.1 ESTIMATED MASS OF CONTAMINANTS IN SOIL

Soil contamination was defined within the "smear zone" from land surface to the water table (at an average depth of 3 ft bls) and using OVA-FID data as depicted on Figure 2-2. The smear zone contamination averages approximately 3 ft thick and covers an estimated surface area (including all three areas of "excessively contaminated soil") of approximately 48,000 square ft (ft^2), yielding a total volume of approximately 5,333 cubic yards (yd^3) of contaminated soil. The average TRPH concentration from the fixed-based laboratory analysis of the seven soil samples taken (did not include the duplicate sample or the non-detect sample in the average calculation) is 1,417 mg/kg. Based on this information, an order of magnitude estimate for the quantity of adsorbed hydrocarbons in the soil is 19,200 pounds (lbs). Figure 2-2 defines the area where "excessively contaminated" soil was defined in the site assessment documents. Table C-1 in Appendix C presents calculations for the estimated mass of impacted soil.

The estimated quantities of soil contamination are approximate and based on an aerial extent established using OVA-FID measurements. Since soil clean up is often based on achieving SCTLs, the aerial extent may change based on the soil characterization activities performed during the remediation activities.

4.2 ESTIMATED MASS OF CONTAMINANTS IN GROUNDWATER

Groundwater analytical data collected from DPT sampling points during the SARA II indicated that COC concentrations exceeding GCTLs were present from the water table to a depth of 50 ft bls (maximum depth sampled). Contamination is presumed to exist below 50 ft bls because 6 of the 16 DPT samples had exceedances of GCTLs at 50 ft bls, which was the maximum depth DPT was able to penetrate. Therefore, it will be assumed that the contamination plume continues to 60 ft bls (an estimated 57 ft thick) and covers an approximate area of 310,000 ft^2, yielding a total volume of 33 million gallons of contaminated groundwater. By calculating average mass of soluble contaminants using average TRPH concentrations, the total mass of hydrocarbons absorbed and dissolved in the saturated zone was calculated to be 44,601 lbs. Figure 4-1 depicts the assumed area of groundwater contamination plume. Table C-2 in Appendix C presents calculations for the estimated mass of groundwater contamination.

The extent (horizontal and vertical) of groundwater contamination is not completely defined. The DPT samples at 50 ft bls exceed GCTLs in some locations and the downgradient end of the plume is not completely defined. In addition, TtNUS assumed the horizontal extent of contamination was uniform vertically throughout the aquifer. Therefore, the quantifications presented here may vary significantly from the actual conditions at the site.

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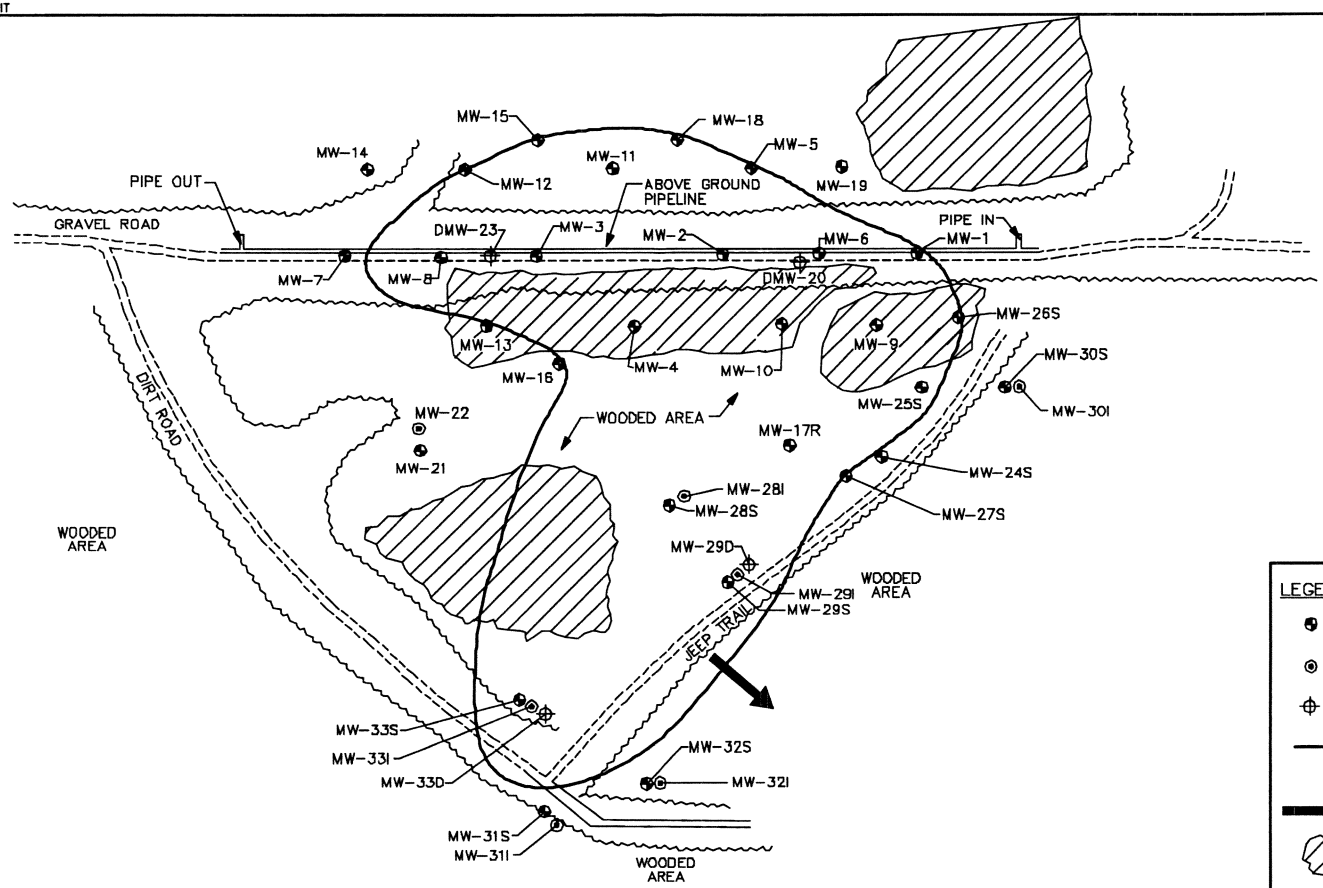

LEGEND:

- SHALLOW MONITORING WELL LOCATION
- INTERMEDIATE MONITORING WELL LOCATION
- DEEP MONITORING WELL LOCATION
- EXTENT OF BTEX & PAH CONTAMINATION ABOVE FDEP (µg/L)
- GROUNDWATER FLOW DIRECTION
- STANDING WATER
- WOODED AREA

0 150 300
APPROXIMATE SCALE IN FEET

SOURCE: LOCATIONS OF ROADS AND PIPELINE ARE TAKEN FROM SITE ASSESSMENT REPORT, NAS PENSACOLA PUBLIC WORKS ENVIRONMENTAL OFFICE, FEBRUARY 1998 AND FROM FIELD OBSERVATIONS. WELL AND BORING LOCATIONS ARE APROXIMATE.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 8/11/03
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

EXTENT OF CONTAMINATION ABOVE FDEP GCTLs
UST SITE 0020/IR SITE 19
REMEDIAL ACTION PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
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FORM CADD NO. SSIV_B4.DWG - REV 0 - 1/20/99

5.0 REMEDIAL ALTERNATIVE TECHNOLOGY SCREENING

TtNUS conducted a screening of available technologies to determine an appropriate remedial alternative for the subject site. Potential remedial technologies and process options for the soil and groundwater remediation have been identified and evaluated based on their ability to meet clean-up objectives (effectiveness), applicability based on site conditions, feasibility of implementation, reliability, anticipated duration, and cost.

5.1 EVALUATION OF SOIL TREATMENT ALTERNATIVES

Based on the previous assessment data, a total volume of approximately 5,333 yd^3 of soil exhibits hydrocarbon contamination as defined in Chapter 62-770, FAC. TtNUS has evaluated alternate methods for the treatment of the soils. The following actions have been identified for remediation of soil and evaluated in this RAP:

- Soil excavation and on-site treatment
- Soil excavation and off-site treatment/disposal
- Soil Vapor Extraction (SVE)

The following sections briefly discuss each of these soil remedial actions with respect to their suitability for implementation at this site.

5.1.1 Excavation and On-site Treatment

This alternative consists of the physical removal and on-site treatment of soils impacted with hydrocarbon constituents exceeding the target cleanup levels. To complete excavation of impacted soils, removal of approximately 48,000 ft^2 area of surface soil to the depth of 1 ft into the water table (3 ft bls was used for costing) is proposed.

The soil contamination is not defined well enough to facilitate a soil removal to residential SCTLs. Therefore, in conjunction with the remedial action, additional soil sampling with laboratory analysis will be necessary. TtNUS recommends delineating the soil contamination prior to mobilizing the excavation equipment to the field. This will facilitate less delays waiting on laboratory results.

The pipeline at the site is supported above the ground and is operational, transporting fuel to the airfield. As such, an engineer experienced in shoring design should be consulted during the final design to make

sure the structural stability of the pipeline is not compromised during soil excavation. Care must be taken not to damage the pipeline during excavation.

Soil removal operations can be accomplished using standard equipment. Mobile treatment equipment will be used to treat the excavated soil. After the soil is removed and treated, and analytical results indicated the contamination has been removed, the excavation will be backfilled with the treated soil and the site restored to its original condition. For the purposes of this RAP, soil treatment will consist of Low Temperature Thermal Desorption (LTTD). In addition, water collected during dewatering will be contained, sampled, and treated or disposed of in accordance with regulatory guidelines.

The primary advantage of excavation and on-site treatment is the complete removal and treatment of impacted soils on site. The excavation can be backfilled with the treated and clean soil within weeks. At no point are impacted soils physically removed from the site, thus eliminating the potential for dispersion of hydrocarbon constituents to unaffected soil or groundwater during the remedial process. Other advantages include that the COCs are destroyed and no longer pose a risk, and the soil is not land filled off-site creating a new potential liability.

The primary disadvantage of excavation is that it is often more costly than the other technologies.

It is estimated that it would take six months for the planning, mobilization, excavation, and treatment of soil at Site 20. The estimated costs for soil excavation, on-site treatment, and site restoration are presented in Table 5-1 and Appendix D, Table D1.

5.1.2 Excavation and Off-Site Treatment/Disposal

This alternative consists of the physical removal and off-site treatment/disposal of impacted soils with hydrocarbon constituents exceeding the target cleanup levels. The excavation activities associated with this alternative would be the same as detailed above in Section 5.1.1.

The excavated soil will be loaded onto trucks and hauled to an approved treatment or disposal facility. Typically the soil has been pre-characterized during the planning steps and no delays should occur. For the purposes of this RAP we contacted Waste Transportation and Disposal, Inc. (WTDI) for a cost estimate. WTDI stated they would transport the soil off-site and dispose of the contaminated soil at a federally licensed facility. Certificates of disposal would be provided for each waste stream manifest.

Table 5-1
Soil Remedial Alternatives Cost Summary

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

ALTERNATIVE	CAPITAL COST	ANNUAL O&M	ESTIMATED YEARS OF OPERATION	O&M PRESENT WORTH	TOTAL PRESENT WORTH
Soil Vapor Extraction	$314,000	$67,000	4	$201,000	$618,000
Excavation and On-site Treatment	$812,000	$0	1	$0	$816,000
Excavation and Disposal	$802,000	$0	1	$0	$715,000

Note: See Appendix D for detailed cost estimates for the soil remediation alternatives.

The excavation will be backfilled with clean fill material and the site restored to its original condition. In addition, water collected during dewatering will be containerized, sampled, and disposed in accordance with regulatory guidelines.

The primary advantage of excavation is the complete removal of contaminants from the site over a short duration. Off-site treatment is similar to on-site treatment in that it destroys the COCs. The less desirable attribute of removing the waste from the site is the risk associated with the transportation of the material, which is typically minimal. Disposal is often considered less desirable than treatment since the risk associated with the soil remains. Cost is typically the other consideration in selecting between on-site or off-site treatment or off-site disposal.

It is estimated that it would take six months for the planning, mobilization, excavation, and disposal at Site 20. The estimated costs for soil excavation, transportation, off-site treatment/disposal, and site restoration are presented in Table 5-1 and Appendix D, Table D2.

5.1.3 SVE

SVE involves the introduction of a pressure gradient across the soil matrix to extract hydrocarbon vapors and enhance volatilization of adsorbed hydrocarbons. A typical SVE system consists of vapor extraction wells, a vacuum blower, associated piping and safety controls. During SVE operation, a vacuum is applied to extraction wells situated within the vadose zone. As air is forced through the soil pores, soil gas is typically displaced and is drawn to the extraction wells and subsequently aboveground via piping for treatment. Extracted vapors are typically treated with an air-phase treatment unit (e.g., activated carbon) prior to discharge to the atmosphere. As the process continues, adsorbed- and dissolved-phase hydrocarbons remaining in the vadose zone are gradually stripped from the soil matrix. In addition, volatilization of contaminants on the surface of the water table is enhanced. The SVE system can be designed and constructed using explosion-proof equipment.

The SVE system promotes oxygen recharge, which also stimulates existing biological activity in the soil and enhanced aerobic biodegradation. The indigenous soil microbes, present at virtually all hydrocarbon release sites, tend to multiply rapidly in the presence of oxygen, which increases hydrocarbon digestion, and results in an accelerated remediation process.

SVE is not typically used at sites with groundwater tables located less than 3 ft bls. Special considerations must be taken for sites with a groundwater table located less than 10 ft bls because groundwater upwelling can occur within wells under vacuum pressures, potentially occluding screens and reducing or eliminating vacuum-induced soil vapor flow. This potential problem is not encountered if

injection wells are used instead of extraction wells to induce flow; therefore, at Site 20, injection wells would be used instead of extraction wells.

If a cleanup level of lower than 0.1 ppm is required for any individual constituent or a reduction in TRPH greater than 95 percent is required to reach the cleanup level for TRPH, either a pilot study should be conducted to demonstrate the ability of SVE to achieve these reductions at the site or another technology should be considered (USEPA, 1995). Therefore, at Site 20, a pilot study would be necessary if the SVE alternative is chosen. Additionally, horizontal air injection wells will be required for the site, as opposed to vertical extraction wells that are typically installed with SVE systems.

It is estimated that soil remediation may be achieved in approximately 1.9 years provided the system was large enough to apply enough pressure differential to the entire area (calculations are presented in Appendix E). However, since there are many uncertainties and the system would likely not be able to affect the entire area, TtNUS assumed four years for costing purposes. An estimated cost of SVE implementation with four years of O&M is presented in Table 5-1 and Appendix D, Table D3.

SVE was not selected based on the shallow water table. It is estimated that groundwater will be between 0 and 3 ft bls during remediation.

5.2 EVALUATION OF GROUNDWATER TREATMENT ALTERNATIVES

The dissolved hydrocarbon plume encompasses a surface area of approximately 310,000 ft^2, extending vertically approximately 57 ft below the static water table. An estimated volume of 33 million gallons of groundwater exhibits dissolved hydrocarbon concentrations in excess of FDEP GCTLs (calculations are presented in Appendix C).

The following actions have been identified for remediation of groundwater and will be evaluated in this RAP:

- Natural attenuation
- Groundwater pump-and-treat
- Air sparging
- PHOSter II™ technology
- Chemical oxidation

The first two alternatives were evaluated qualitatively and eliminated for reasons discussed below. Therefore, the cost evaluation was not performed for these. The remaining three options were more thoroughly evaluated including a present worth analysis for remediation costs.

The following sections briefly discuss each of these alternatives with respect to their suitability for implementation at this site.

5.2.1 Natural Attenuation

Natural attenuation, also known as passive bioremediation, intrinsic bioremediation, or intrinsic remediation, is a passive remedial approach that depends upon natural processes to reduce the potential impact of petroleum hydrocarbon releases either by preventing constituents from being transported to sensitive receptors or by reducing constituent concentrations to less harmful levels. The processes involved in natural attenuation include aerobic and anaerobic biodegradation, dispersion, volatilization, and adsorption. Petroleum hydrocarbon constituents are generally biodegradable, regardless of their molecular weight, as long as indigenous microorganisms have an adequate supply of nutrients and toxic substances do not inhibit biological activity. For heavier petroleum hydrocarbons, which are less volatile and less soluble than many lighter components, biodegradation will exceed volatilization as the primary removal mechanism, even though degradation is generally slower for heavier molecular weight constituents than for lighter ones.

Under the appropriate site conditions, natural attenuation can reduce the potential impact of petroleum hydrocarbon releases by preventing constituents from being transported to sensitive receptors or by reducing constituent concentrations to less harmful levels. Natural attenuation may also be an acceptable option for sites that have been subject to active remediation and which have substantially reduced concentrations of contaminants. However, natural attenuation alone is not an appropriate option at this site because COC levels exceed the NADSCs in Chapter 62-777, FAC. Therefore, it will not be further evaluated in this RAP.

5.2.2 Groundwater Pump-and-Treat

Hydrocarbon-impacted groundwater may be recovered using a conventional pump and treat technique from one or more recovery wells. For this site, we recommend using an aeration treatment system to strip and remove hydrocarbon constituents from the recovered groundwater. Aeration units are typically capable of a 99 percent removal rate of aromatic petroleum hydrocarbons. An aeration system is normally followed by off-gas polishing with vapor phase carbon, or other technology to ensure emissions do not exceed air quality standards. Also, the treated water is polished by passing through a liquid phase treatment system (e.g., granular activated carbon) prior to discharge.

Pump and treat for treatment of organics is fast becoming a technology of the past. It typically requires much longer than anticipated due to preferential flow paths and non-uniform extraction. In addition, it is

typically not desirable to the Navy. The order of magnitude estimates for a plume of this nature are $2.5 million, therefore, we will not evaluate this technology further.

5.2.3 Air Sparging

Air sparging can be used to remediate groundwater with petroleum hydrocarbons. The technology involves injecting air under pressure into the contaminated aquifer thereby increasing the mass transfer of the dissolved contaminants into the air bubbles followed by upward migration of the volatilized contaminants to the vadose zone. The injection of air into the contaminated zone will also stimulate biodegradation of less volatile petroleum constituents through oxygen recharge, and this technology is often referred to as biosparging. The primary difference between air sparging and biosparging is the flow rate of air injected into the aquifer.

This technology has proven effective in remediating groundwater contaminated with petroleum hydrocarbons. The advantage to air sparging over other active remediation technologies is that O&M is typically less expensive. Also, discharge requirements are less stringent than technologies such as pump and treat. It should be noted that air sparging systems generally use an integrated SVE system in order to recover VOCs removed from the contaminated aquifer. However, for the cost comparison presented below, this technology was evaluated separately, since vapor extraction would likely be ineffective due to the shallow water table at the site.

Preliminary calculations indicate a remedial time period of 9.5 years using air sparging technology to attain the FDEP GCTLs (calculations are presented in Appendix E). Therefore, for the RAP we used 10 years. An estimated cost for air sparging implementation with 11 years of O&M is presented in Table 5-2 and Appendix D, Table D4.

Air sparging is a proven technology for reducing BTEX and TRPH levels in groundwater and can be an economical approach to in-situ groundwater remediation. However, air sparging is not the preferred remedial alternative based on its higher cost and longer remediation time than the PHOSter II™ technology.

5.2.4 PHOSter II™ Technology Bioremediation

PHOSter II™ technology is an innovative technology of bioremediation where there is a controlled addition of phosphorus vapor along with air. The air and nutrients are injected through wells similar to air sparging wells. This stimulates the growth of natural microorganisms that feed on the organic compound contamination. As opposed to conventional bioremediation, which uses liquid phosphorus, PHOSter II™

Table 5-2
Groundwater Remedial Alternatives Cost Summary

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

ALTERNATIVE	CAPITAL COST	ANNUAL O&M	ESTIMATED YEARS OF OPERATION	O&M PRESENT WORTH	TOTAL PRESENT WORTH
Air Sparging	$449,000	$123,000	12*	$967,000	$1,558,000
PHOSter II™ Method	$563,000	$195,000	3*	$257,000	$1,232,000

* Indicates that last year is post-remedial monitoring.

**Indicates contractor O&M not included in present worth costs (costs included in Annual O&M).
Note: See Appendix D for detailed cost estimates for the groundwater remediation alternatives.

technology uses phosphorus vapor. This allows for a wider area of influence for the injection points and more control over the reactions involved. PHOSter II™ provides steady stimulation to allow development of a healthy, active microorganism population for rapid cleanup.

Under the appropriate site conditions, PHOSter II™ technology bioremediation can reduce the potential impact of petroleum hydrocarbon releases by preventing constituents from being transported to sensitive receptors or by reducing constituent concentrations to cleanup levels. It was estimated by the PHOSter II™ technology vendor that it would require approximately one year to achieve groundwater remediation to the target cleanup levels if soil from the unsaturated zone is excavated, or two years to achieve target cleanup levels if an in-situ soil treatment alternative is selected. An estimated cost for the implementation of bioremediation with two years of O&M is presented in Table 5-2 and Appendix D, Table D5.

5.2.5 Chemical Oxidation

In-situ chemical oxidation requires the injection of proprietary liquid chemical formulations into the contaminated portion of the aquifer. Two reactive compounds commonly used for in-situ oxidation of organic contaminants have been identified:

- Fenton's reagent
- Potassium permanganate

In Fenton's reagent, hydrogen peroxide reacts with ferrous iron to produce the hydroxyl radical, a powerful oxidizer. The hydroxyl radical progressively reacts with organic compounds to produce carbon dioxide and water. If potassium permanganate is used instead of Fenton's reagent, then the potassium permanganate ion rather than hydrogen peroxide is used as the reagent. When the potassium permanganate oxidizes a chlorinated organic compound, it produces carbon dioxide, manganese dioxide, and chloride ions. The reaction may result in a temporary exceedance of the secondary groundwater standards for color, total dissolved solids, manganese, pH, and chloride. Treatability testing is typically required to verify the effectiveness of in-situ chemical oxidation.

Multiple injection wells would be installed throughout the contaminant plume from which the chemical oxidation compounds would be injected. The amount of injected compound and the number of injection wells would be determined by a treatability study. Chemical oxidation would be effective in destroying the petroleum contaminants at the site.

One of the design issues or disadvantages of chemical oxidation for this site is the exothermic reaction that may create an unsafe environment near the below ground portions of the pipeline. Also, the cost of

chemical oxidation is typically higher than similar remediation technologies when treating an area as large as Site 20. An order of magnitude conceptual estimate for this site is $4 million based on a comparison to a site at NAS Jacksonville where the aerial extent was approximately 60,000 ft^2 and the depth was 35 ft. This site is approximately 5 times as large and the contaminant is deeper. In addition, the COC concentrations at this site are significantly higher. Therefore, this alternative will not be evaluated further.

5.3 COST COMPARISON AND RATIONAL FOR SELECTION

A table comparing the estimated cost of remediation of soil and groundwater at the subject site using the combinations of the evaluated alternatives is provided in Table 5-3. Table 5-4 presents a comparison of the advantages and disadvantages of each technology and comments on the applicability of each. Based on a review of the advantages, disadvantages, and costs, TtNUS recommends the excavation and off-site disposal for the soil and PHOSter II™ technology bioremediation system for groundwater at this site.

The soil remedial alternative, excavation and off-site disposal, is recommended over in-situ methods due to the shallow water table present at the site. The shallow water table, which averages between 0 and 3 ft bls, presents uncertainty for the effective remediation of the soil by in-situ methods. Additionally, with the shallow water table present at the site, in-situ soil remedial technologies such as bioventing and soil vapor extraction have a reduced radius of influence, therefore increasing the number of wells and the size of the remedial system required.

Disposal of soil is recommended over on-site soil treatment because the impacted soil will be immediately removed from the site. Clean backfill will be brought to the site and the excavation filled immediately. Groundwater remediation efforts can commence immediately following this. Therefore, TtNUS recommends excavation and off-site disposal for the soil.

PHOSter II™ technology is recommended as the selected remedial alternative for the groundwater at Site 20. Natural attenuation and groundwater pump-and-treat are not appropriate for the site as reported earlier. Although, chemical oxidation is effective, the higher costs associated with this alternative eliminate it from further consideration. Air sparging is not recommend due to the higher costs compared to PHOSter II™ technology and the prolonged remediation time. Therefore, PHOSter II™ technology was selected over other groundwater remedial alternatives based on it being cost-effective and having the shortest remedial time alternative for the site.

It is expected to require approximately six months for planning, site mobilization, excavation, and off-site disposal for remediation of the soil. Information provided by the PHOSter II™ vendor states that with the excavation and treatment of soil, it will require approximately one to two years to remediate the groundwater.

Table 5-3
Cost Comparison for Combined
Soil and Groundwater Remedial Alternatives

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

COMBINED ALTERNATIVE	TOTAL PRESENT COST
Air Sparging and SVE	$2,176,000
PHOSter II™ Method and SVE	$1,850,000
Air Sparging and Excavation and On-site Treatment	$2,374,000
PHOSter Method and Excavation and On-site Treatment	$2,048,000
Air Sparging and Excavation and Off-site Disposal	$2,273,000
PHOSter II™ Method and Excavation and Off-site Disposal	$1,947,000

Note: See Appendix D for detailed cost estimates for the soil and groundwater remediation alternatives.

Natural attenuation and groundwater treatment were evaluated qualitatively and eliminated from the evaluation process.

Table 5-4
Remedial Alternative Feasibility Comparison

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Media	Technology	Advantages	Disadvantages	Screening Comment
Soil	Excavation and On-site Treatment	Source removal, short remediation time (weeks), and can re-use soil as clean backfill.	Disturbance of site, permitting requirements and higher price than SVE and off-site disposal.	Eliminate – Higher cost than off-site disposal.
	Excavation and Off-site Treatment/Disposal	Source removal and short remediation time (weeks).	Transportation of contaminated soil off premises. Potential liability if not treated.	Retain – Lowest cost compared to alternatives and quickest completion time.
	SVE	Relatively low cost, readily available equipment and less risk of damaging aboveground pipeline.	Need for pilot study, shallow water table, and the soil contamination continues to leach to groundwater.	Eliminate – Due to shallow water table, uncertain effectiveness and costs higher than typical.
Water	Natural Attenuation	Relatively low cost.	Uncertain effectiveness, concentrations above GCTLs and release date was estimated around 1958.	Eliminate – Concentrations greater than FDEP NADSCs.
	Groundwater Pump and Treat	Easily implementable.	Asymptotic behavior may not reach GCTLs, need for pilot study, long remediation time, high cost, and often ineffective.	Eliminate – Often ineffective in reducing contamination to GCTLs, long remediation time and high costs.
	Air Sparging (AS)	Relatively low cost. Proven technology for eliminating VOCs.	Relative long remediation time and maintenance requirements.	Eliminate – Longer remediation time and higher cost than PHOSter II™.
	PHOSter II™ Technology	Shorter remediation time than AS, and effective on high TRPH	Requires source removal for soil. New and less proven technology.	Retain – Low overall cost, shorter treatment time compared to AS.
	Chemical Oxidation	Moderate cost, highly effective, short remediation time, proven technology.	Requires source removal for soil and need for pilot study. Less appropriate for large plumes due to cost	Eliminate – Higher costs than PHOSter II™.

6.0 REMEDIAL SYSTEM DESIGN

The preferred remedial alternatives presented in this RAP were selected based on being the most time-effective method for treatment of hydrocarbons within the vadose zone, and a time and cost effective treatment of hydrocarbons within the saturated zone at the site. The potential remedial technologies and process options for soil and groundwater remediation were identified and screened, and the results were presented in Section 5.0. The selected alternative for soil is excavation and on-site treatment and the selected groundwater alternative is PHOSter II™ technology.

6.1 EXCAVATION AND OFF-SITE DISPOSAL DESIGN DETAILS

Major components of soil excavation and on-site treatment include the following:

- Site preparation (pre-excavation activities)
- Excavation
- Off-site soil disposal at subtitle D landfill
- Backfill and compaction
- Site restoration and/or grading

Figure 6-1 presents the planned boundaries of the excavation area. Soil from the ground surface to 1 ft below the water table within the boundary marked should be excavated and considered petroleum impacted soil. The water table was located at an average depth of 3 ft bls when the original soil samples were collected at this site. Based on the soil plume boundary and an average thickness 3 ft bls, the estimated volume of soil to be disposed is 5,444 yd^3 (see Appendix D).

6.1.1 Site Preparation (Pre-Excavation Activities)

Prior to excavation activities, the limits of excavation should be staked in the field. The designated areas should be flagged and boundaries established by florescent yellow caution tape to define the exclusion zone.

Prior to beginning any excavation activities or any intrusive work, an excavation permit checking for subsurface structures, utility lines, and other potential interferences should be obtained. A professional survey to verify locations of site utilities was not conducted prior to this RAP. However, active or inactive subsurface obstructions may include electric lines, telecommunication lines, piping for sewer, gas distribution, etc.

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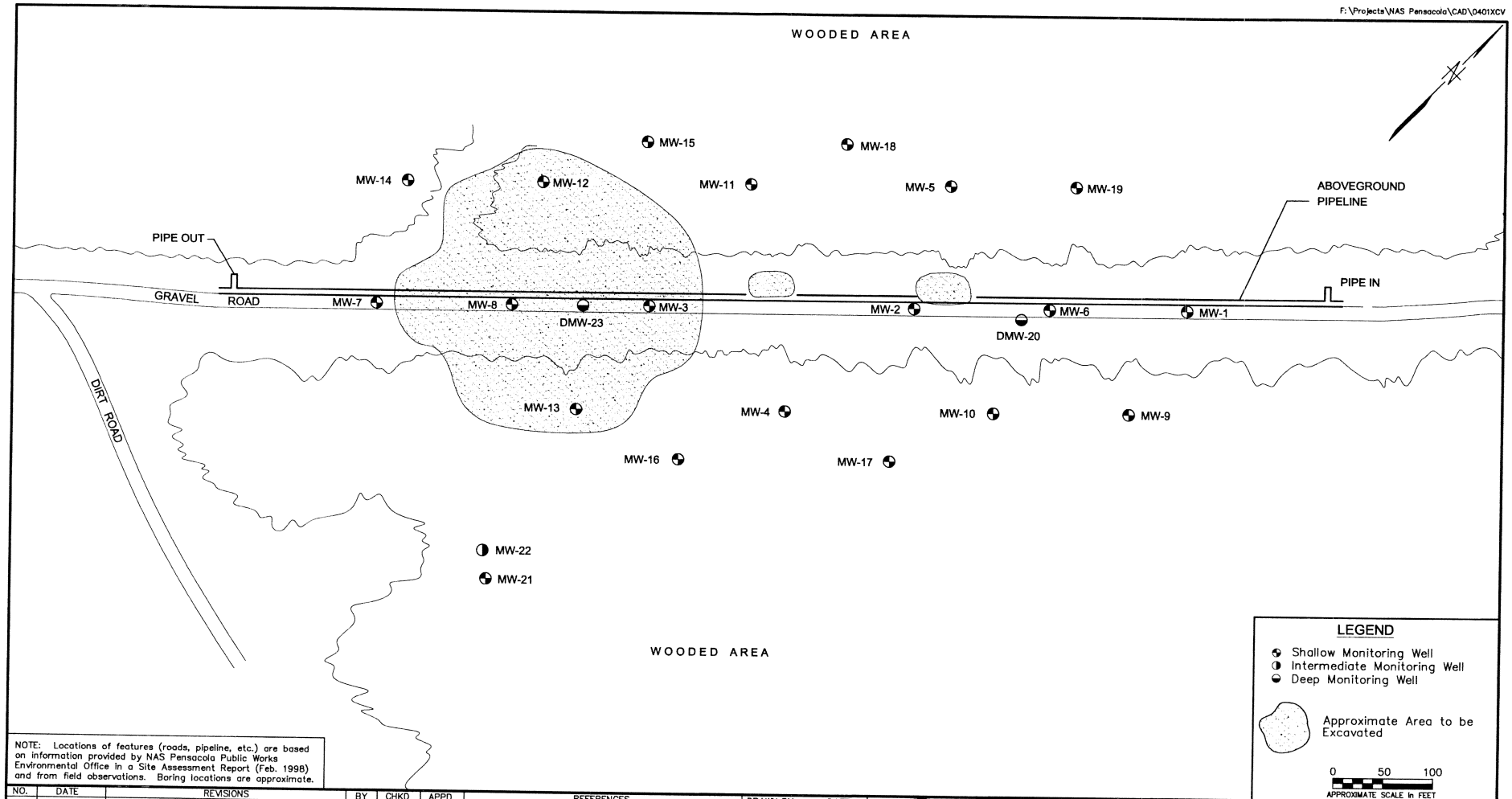

LEGEND

- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Approximate Area to be Excavated

0 50 100
APPROXIMATE SCALE in FEET

NOTE: Locations of features (roads, pipeline, etc.) are based on information provided by NAS Pensacola Public Works Environmental Office in a Site Assessment Report (Feb. 1998) and from field observations. Boring locations are approximate.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 8/28/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

PROPOSED EXCAVATION AREA
UST SITE 20/IR SITE 19
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 2640
APPROVED BY DATE
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REV. 0

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Monitoring wells within the limits of the excavation will be removed during excavation activities. The following wells will likely be abandoned: MW-3, MW-8, MW-12, MW-13, and DMW-23. Monitoring wells MW-7, MW-14, and MW-15 are adjacent to the excavation and may also require removal.

Prior to excavation activities, the heavy brush and trees should be cleared as required. Brush and trees should be cut and chipped on-site and the chipped material will be used as backfill. The soil should be grubbed to remove tree stumps, roots, and other large debris. A chain-link fence will be installed around the Site 20 excavation perimeter to protect the public. The fence will remain on site after the excavation to protect the groundwater remediation system.

The fuel line crossing the excavation area cannot be diverted, removed, or impacted during excavation activities. The fuel line is active and services the nearby air field. Excavation in close proximity to the fuel line may compromise the structural integrity of the pipeline supports. Therefore, vinyl sheet piles are anticipated around the fuel line supports for protection. The specific shoring required shall be included in the excavation design. Following the reinforcement of the soil underneath the pipeline, the clearing of the trees and brush, and the excavation activities including abandonment of monitoring wells may commence. The final shoring design for the fuel line should be performed by an engineer experienced in excavation and shoring.

The contractor shall prepare all required planning documents, such as an erosion and sediment control plan, Health and Safety Plan, Removal Action Plan, and Soil Treatment Plan, and also obtain all necessary permits.

6.1.2 Soil Excavation

This RAP assumes that the soil will be pre-characterized via sampling and laboratory analysis to establish the horizontal limits of the contamination.

Soil excavation should be within the area shown on by Figure 6-1. Soil excavated to 1 foot below the water table in the depicted area should be handled as petroleum contaminated soil. It should be noted that the depth of excavation may change pending the actual depth to the water table at the time of remedial activities. Additional excavation will be required to provide the appropriate slope as required by the Occupational Safety and Health Administration (OSHA) where shoring is not present. Excavation will be conducted using standard earth-moving equipment. All operators will be certified to be in compliance with 29 Code of Federal Regulations 1910.120 health and safety requirements. If free product is encountered during excavation activities, it will be recovered to the extent practical by using high vacuum suction, product-absorbing socks, or over excavation, as required.

The excavation will be completed to a depth of 1 ft below the water table. Therefore, dewatering will likely be required. The excavation plan should include dewatering and containment of the captured water. For this RAP, we assumed the captured water would be pumped into a frac tank and collected by a vacuum pump truck daily. The captured water would then be transported off-site for treatment and disposal at a permitted facility.

During excavation activities, the removed soil will be either stockpiled or immediately loaded into trucks for transport off-site.

The excavation should have sides sloped or be shored in accordance with applicable standards to prevent unstable conditions during excavation that could pose hazards to personnel. Stormwater run-on and run-off controls should be implemented to prevent migration of sediment or contaminated storm water during site activities.

The limits of excavation shown on Figure 6-1 are representative of the estimated footprint of the soil contaminant plume based on OVA headspace readings from the SAR and SARA. The soil in the excavation area is described as silty sand and the sides of the excavation should naturally slope. Excavations will be cut back and sloped to allow for safe entry into the excavation in accordance with OSHA regulations. Open excavations will be protected with suitable barriers such as temporary fences. The tops of the excavation will be provided with a berm of clean soil to minimize the amount of run-on that can enter the excavation.

Free product floating on the groundwater table at the bottom of the excavation will be removed. Collected water, free product, and materials will be disposed of off-site in accordance with local and state requirements.

During the temporary stockpiling of contaminated soil, if this occurs, the stockpile will be provided with erosion and sedimentation control such as silt fences or hay bails. Captured sediment from the contaminated soil stockpiles must be treated. Contaminated soil and treated soil stockpiles will be placed on an impermeable surface or liner with a minimum 20-mil thickness. Stockpiles will be graded to promote flow toward the excavation. Water and free product seeping out of stockpiles of contaminated soil must be captured for treatment or disposal. Stockpile locations selected by the contractor are subject to review and approval.

The excavation will be determined complete when confirmatory soil sample analytical results are below the concentrations listed in Table 3-1. For the purposes of this RAP, we have assumed the water level to

be at an approximate depth of 2 ft bls, which would result in excavation to 3 ft bls (1 ft below water table). Thus the total volume excavation of soil is estimated to be 5,444 yd^3. Based on the actual water table at the time of excavation, this volume may vary.

6.1.3 Off-Site Disposal

The selected soil treatment alternative for the site is off-site disposal. Impacted soils will be loaded onto trucks and transported to subtitle D landfill for disposal. A Certificate of Disposal will be provided for each waste stream per manifest.

6.1.4 Site Restoration

Clean backfill will be hauled to the site and stockpiled until excavation has advanced sufficiently to allow for placement of clean backfill. Fill will not be returned if it interferes with excavation activities. Backfill of excavated areas may be performed simultaneously with excavation if desirable. All water from the excavation during soil replacement will be removed as necessary to accommodate compaction. Backfill material will be placed in 12-inch lifts and compacted to 90 percent standard Proctor density, as required. The road will be restored to original site conditions. If excavation and backfill operations are performed simultaneously, a separation distance will be maintained between the toe of the slope for excavation and the toe of the slope for backfill to prevent or minimize cross-contamination by direct contact with free product or excessively contaminated soil. After all disturbed areas of excavation have been successfully backfilled, the site will be graded to drain. The excavation should be graded to match surrounding elevations, and the grade sloped from the center outward so that runoff will flow away from the backfilled area. The slope will be blended into the surrounding areas, and the grade changes will be gradual. If necessary, prior to backfilling an appropriate amount of 1½ to 2-inch diameter crushed stone will be provided as a bottom layer in order to stabilize saturated material resulting from groundwater encroachment into the open excavation.

Following completion of the compaction, groundwater monitoring wells that were abandoned or destroyed during remedial activities will be replaced as determined necessary to complete the groundwater monitoring associated with the groundwater remediation effort which is described in the following sections.

A final survey will be performed to identify the limits of excavation, final grading elevations, and new monitoring well locations and elevations. An as-built site plan will be prepared for the excavation project area. A completion report consistent with the requirements of Chapter 62-770.300, FAC will be provided summarizing volumes removed, disposed, replaced, site activities, and confirmatory soil sampling results.

6.2 PHOSter II™ DESIGN DETAILS

Once soil excavation at Site 20 is complete, the installation of the PHOSter II™ system shall proceed. PHOSter II™ technology includes the injection of nutrients in vapor phase with air into the aquifer. PHOSter II™ is a patented technology and portions of the PHOSter II™ remedial system are proprietary information of the vendor.

The conceptual design of the proposed PHOSter II™ system was developed by EGEO based on information provided by TtNUS and remedial systems at other sites. In particular, the design parameters for the PHOSter II™ system were provided by the PHOSter II™ vendor. The design parameters provided herein are strictly for the conceptual design. For the PHOSter II™ system, a field pilot study may be necessary to verify specific site design characteristics. For preliminary design purposes, EGEO assumed the radius of influence at the site to be 35 ft and the flow rate 5 actual cubic ft per minute (acfm).

The proposed PHOSter II™ injection point locations are presented on Figure 6-2. Process and Instrumentation Diagrams for the PHOSter II™ system and treatment compound were not provided by EGEO for this document. The PHOSter II™ vendor, EGEO Services, will provide the treatment system design prior to system construction. The following subsections provide the design rational and outline the components for the remedial system.

6.2.1 PHOSter II™ System

As shown in Figure 2-4, the dissolved hydrocarbon plume encompasses an area of approximately 310,000 ft^2. Figure 2-6 indicates that the groundwater contamination extends to a minimum depth of 50 ft (maximum depth sampled during SARA II) below the water table. For a degree of safety, 60 ft was chosen as the maximum depth of contamination. However, the vertical extent of groundwater contamination was not defined during the previous investigations. Therefore, additional site characterization may be beneficial to the final design. Based on the plume area and the estimated 35 ft radius of influence, EGEO proposed 84 air sparging wells for PHOSter II™ injection to remediate the groundwater underlying the subject site. The locations of the proposed PHOSter II™ wells are presented on Figure 6-2.

The PHOSter II™ vendor will supply the injection system (i.e., blower and equipment) and labor for connecting the system to the injection points, installation of the injection wells, and installation of a power source at Site 20 to run the remediation system.

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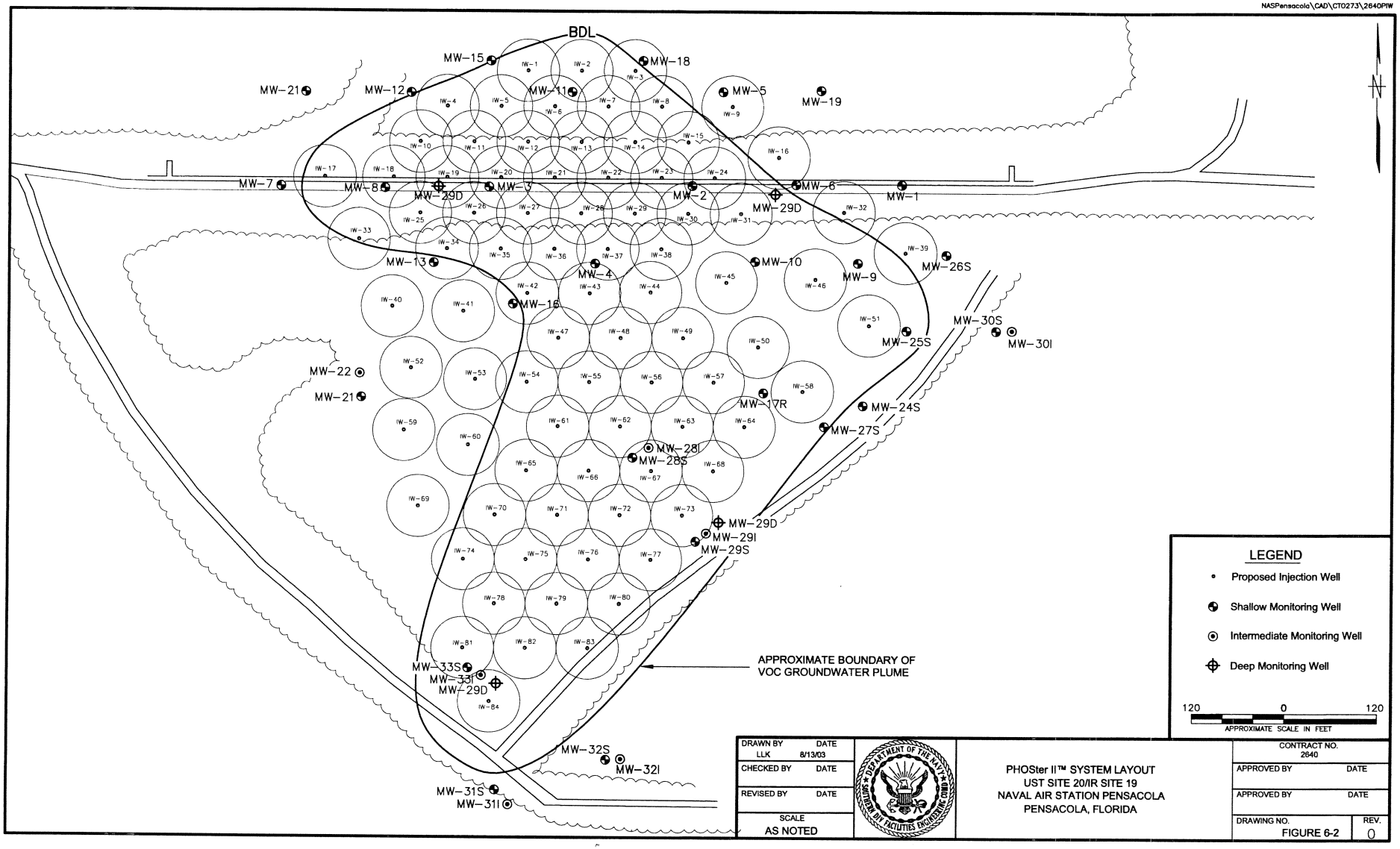

DRAWN BY LLK	DATE 8/13/03	PHOSter II™ SYSTEM LAYOUT UST SITE 20/IR SITE 19 NAVAL AIR STATION PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 2640
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6.2.2 PHOSter II™ Components

The remediation system equipment will consist of a 25 horsepower (HP) air compressor, air dryer, 200 gallon air receiver tank, 5 HP jockey air compressor, associated piping, valves and fittings. The air delivery system will be mounted on an open trailer and covered at the site. The nutrient delivery system and controls will be housed in a 15 ft x 8 ft lockable trailer.

6.3 PHOSter II™ CONSTRUCTION DETAILS

The proposed layout for the PHOSter II™ wells and location of the equipment area is presented on Figure 6-2. The well system design for the subject site consists of 84 PHOSter II™ wells. The PHOSter II™ treatment system will be contained in a mobile trailer.

6.3.1 PHOSter II™ Component Construction

The injection wells will consist of 1-inch High Density Polyethylene (HDPE) with flush threaded joints installed through the GeoProbe drive rod. The PHOSter II™ injection wells will be installed to a depth of 60 ft with the bottom 2 ft (58 to 60 ft bls) screened with a maximum HDPE slot of 0.015-inch. Wells will be installed with a 20/30 sand pack around the screen with 1 ft of bentonite above the sand pack. The remaining borehole will be filled with cement grout. A 1-ft by 1-ft by 1-ft, flush-mounted steel well box with lid will be placed over the top of each injection well. The lid will be supplied with an opening for the connection of the ½-inch diameter ethylene propylene diene monomer (EPDM) 200 PSI Rubber Manufacturers Association (RMA) Class C hoses, which the PHOSter II™ vendor will connect to the injection wells. All injection wells will be fully developed. The PHOSter II™ injection well details are shown on Figure 6-3.

The pressurized air will be supplied to the wells through piping from the blower within the secure equipment area. The blower will be connected to the air sparging wells. The PHOSter II™ injection piping will be placed aboveground, except where it crosses the road. Piping under the existing ground surface will be buried a minimum of 24 inches below grade. The piping conduit for road crossings will be installed during the backfill operations of the soil excavation. Above-grade service pipe will be ½-inch diameter EPDM 200 PSI RMA Class C hose. Below-grade service pipe will be ½-inch diameter linear low density polyethylene tube 100 PSI working pressure. All pipe sections, joints, couplings, and connections will be checked for tightness prior to trench backfilling. The PHOSter II™ vendor will provide all equipment and services necessary for connecting the injection wells to the treatment system. Trench details for the underground piping are shown on Figure 6-4. Aboveground piping will be used because Site 20 will be fenced in and provide easier maintenance for the system piping than if it was buried.

6.4 ELECTRICAL AND CONTROLS

Due to the remote location of the site, it will be necessary to bring power and telephone service to the site. A review of the site and site maps indicates that the nearest power source is located at the Sherman Tank Farm located approximately 1400 ft to the south. To provide power to the PHOSter II™ treatment system, a buried electrical service duct rated for 5 kilovolts (kV) will be installed to the site. One 45 kilovolt amperes (kVA) oil-filled, 3-phase, pad mounted transformer with a 480-volt secondary and a 480-volt panel as well as a 10 kVA dry-type transformer with 240-volt secondary and 250-volt panel will be installed at the site. The specific electrical and control system will be provided by the PHOSter vendor during the system final design and construction event.

cc: Greg Campbell, NAS Pensacola
Gerry Walker, Tetra Tech NUS, Inc., Tallahassee
Charlie Goddard, FDEP Northwest District

Reviewed by:

Timothy J. Bahr, P.G.
Professional Geologist Supervisor
Bureau of Waste Cleanup

5/2/01
Date

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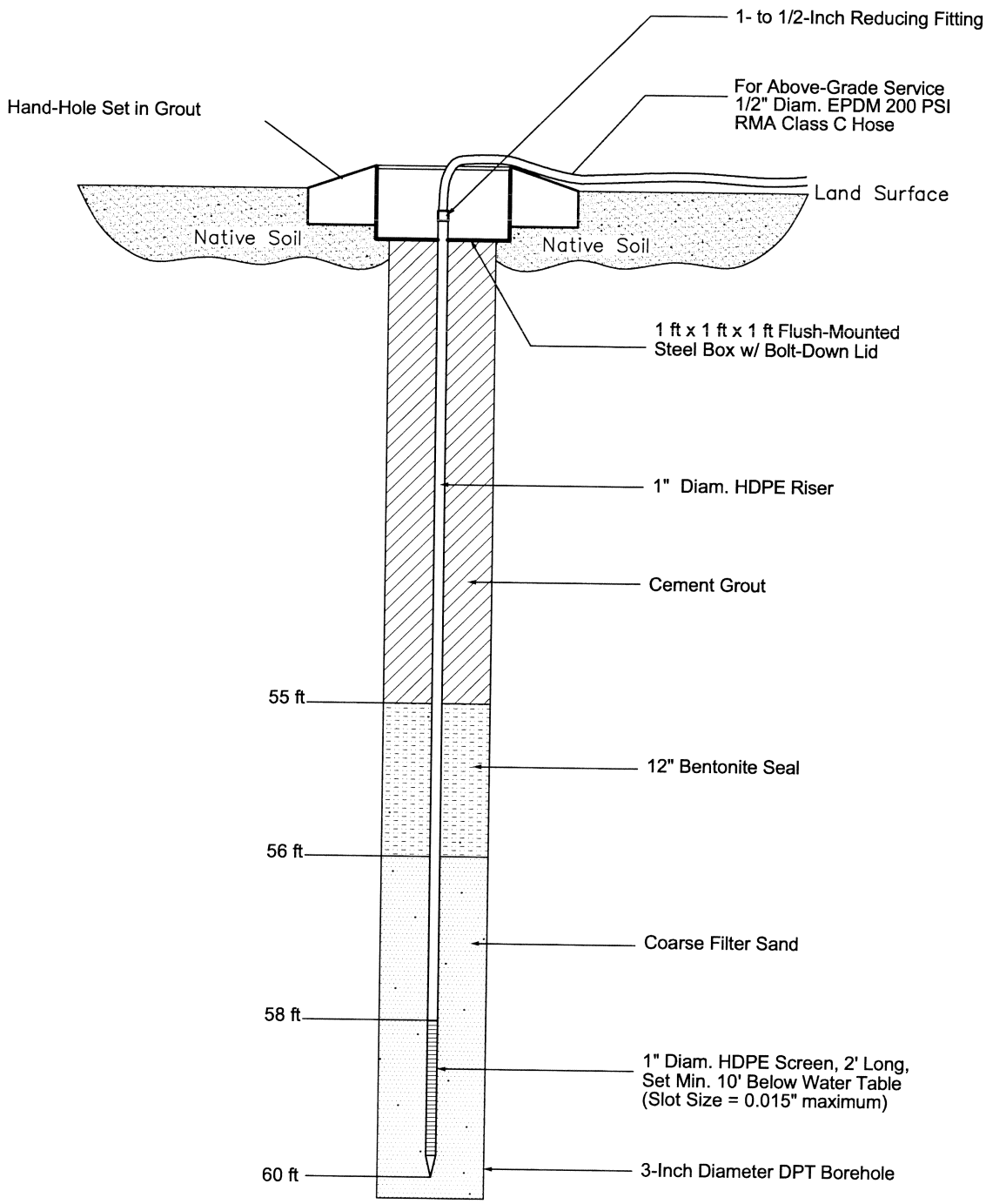

DRAWN BY LLK DATE 8/28/01	DEPARTMENT OF THE NAVY SOUTHERN DIV FACILITIES ENGINEERING COMD	TYPICAL INJECTION WELL (1 of 84) UST SITE 20/IR SITE 19 NAVAL AIR STATION PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 2640
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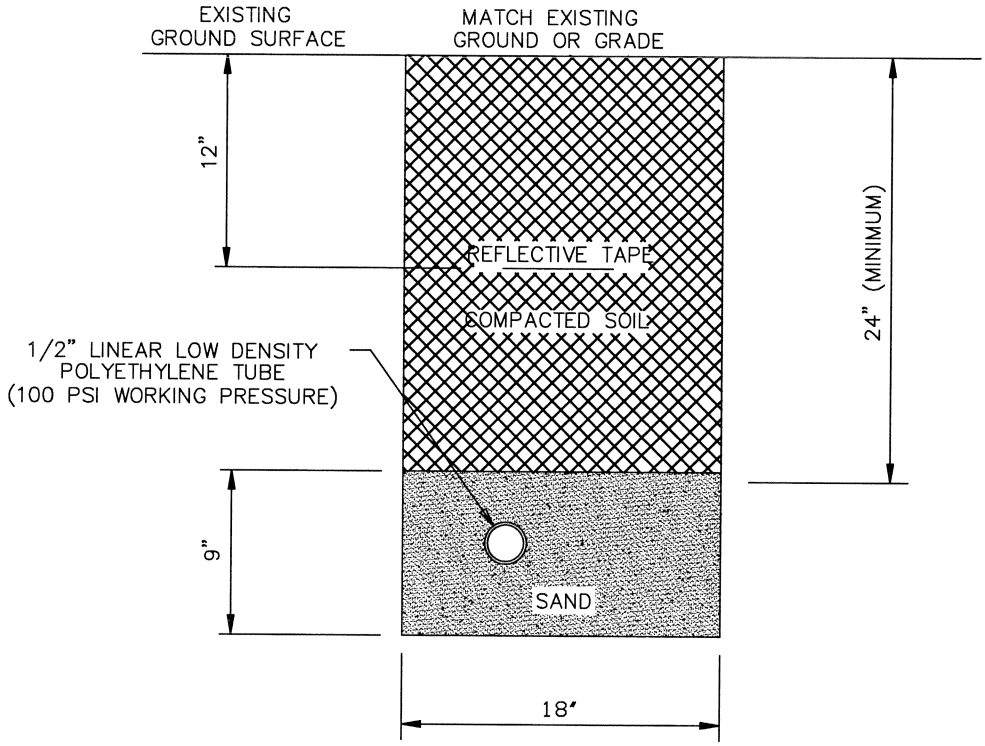

TYPICAL TRENCH DETAIL

DRAWN BY LLK DATE 8/28/01	DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD ★	TRENCH DETAIL UST SITE 20/IR SITE 19 REMEDIAL ACTION PLAN NAVAL AIR STATION PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 2640
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7.0 O&M AND MONITORING

The following sections establish procedures for the start-up of the system, O&M of the remediation equipment, monitoring of the operating parameters, and final system deactivation.

7.1 PHOSter II™ SYSTEM START-UP

Following installation, final inspection, and acceptance by the Navy, the system will be set for initial start-up. Approximately one week prior to start-up, a full round (MW-1 through MW-33) of water level mesurements, DO measurements, and groundwater samples will be collected. During this event, the PHOSter II™ injection wells and replacement wells in the area should also be surveyed in reference to elevation to establish a baseline top of casing elevation for each remedial well. Following collection of water levels, select monitoring wells shall be sampled and analyzed using USEPA Method 8310 for PAHs, USEPA Method 8021 for VOCs, FL-PRO for TRPH, USEPA Method 300 for nitrate, nitrite, and for orthophosphates. The initial round of measurements and groundwater analytical results will establish the baseline contaminant profiles and comparable monitoring parameters. System start-up shall commence approximately one week following the initial round of sampling.

7.2 DESIGNATION OF OBSERVATION WELLS

Based on the configuration of the dissolved hydrocarbon plume and the hydraulic gradient, the following monitor wells are proposed to monitor the effectiveness of the remedial system efforts at this site.

- MW-4, MW-6, MW-8, MW-11, MW-17R, MW-28I, MW-33S, MW-33I (monitoring wells in plume)
- DMW-23 and MW-29D (deep monitoring wells in plume)
- MW-32I (downgradient monitoring well)
- MW-34S and MW-34I (downgradient monitoring wells to be installed after soil excavation)
- MW-12 and MW-18 (up-gradient monitoring well)
- MW-21 and MW-7 (cross-gradient monitoring well)
- MW-1, MW-29S and MW-30S (cross-gradient monitoring well)

Groundwater samples shall be collected from these wells on a quarterly basis after the baseline sampling event. Samples shall be analyzed in the laboratory for VOCs, PAHs, TRPH, orthophosphates, nitrate, and nitrite. Field parameters (pH, conductivity, temperature, DO, and oxidation-reduction potential) will also be collected for each monitoring well during field sampling events.

7.3 MONITORING PLAN

A monitoring program is to be initiated upon approval of this RAP and subsequent installation and startup of the remediation system. The PHOSter II™ vendor will provide the O&M manual for the PHOSter II™ system. The monitoring plan will have the following three main objectives:

- To monitor the overall effectiveness of the remediation system in removing hydrocarbons from the groundwater.
- To verify that the contaminant plume is not migrating beyond the remediation area.
- To monitor the performance of the remedial equipment.

The proposed monitoring plan includes the following:

- Measurements of groundwater levels and DO in the monitoring wells to determine groundwater mounding and to verify the radius of influence measurements will be taken weekly for the first month, monthly for the next two months, and quarterly thereafter. Measurement will be performed using a water level indicator and a DO meter.

- Measurements of pressure flow rates will be performed weekly for the first month and monthly thereafter. Measurement will be performed using pressure gauges and flow meters mounted on the remediation system. A portable flow meter will also be used to check the airflow at the wells.

- Sampling and laboratory testing of groundwater from the selected monitoring wells to document remediation of the groundwater plume will be performed quarterly. The groundwater samples will be analyzed using USEPA Method 8310 for PAHs, USEPA Method 8021 for purgeable aromatics, FL-PRO for TRPH, nitrate, nitrite, and orthophosphate.

- The results of quarterly sampling will be reported every quarter in a status report (see Section 7.6).

Table 7-1 summarizes the proposed monitoring plan.

Table 7-1
Proposed Monitoring Plan

Remedial Action Plan
UST Site 20/IR Site 19
Naval Air Station Pensacola
Pensacola, Florida

Monitoring/Sample Location	Parameters	Review Frequency
System Manifolds*	Flow Rate Pressure	Weekly for the first month and monthly thereafter.
Monitoring Wells	Water Levels and DO	Weekly for the first month, monthly for the next two months, and quarterly thereafter.
Monitoring Wells	PAHs, VOCs, and TRPH (USEPA Methods 8310, 8021, and FL-PRO)	Quarterly
Remediation Well Heads*	Differential Pressure	Weekly for the first month, monthly for the next two months, and quarterly thereafter.

* Monitored by the PHOSter II™ Process Logic Controls System.

7.4 MONITORING REMEDIATION PROGRESS

The PHOSter II™ system will be re-evaluated after six months of sampling and testing and will be modified as necessary to maximize the effectiveness of the remediation system. By evaluating the following monitoring data, the overall effectiveness of the proposed remediation system and cleanup progress will be monitored:

- The trend of DO concentrations as the remedial system progresses.
- The trend of hydrocarbon concentrations in groundwater as the remedial system progresses.
- The trend of orthophosphates in groundwater as remediation occurs.

These monitoring data will be used to determine if the objectives of the RAP and standards of the design criteria are being met. The remediation system shall be modified if the monitoring data indicates that the cleanup goals cannot be met in the time frame as specified in the RAP. Modifications of the remediation system will be based on the site-specific monitoring data.

7.5 SYSTEM O&M

The proposed remediation system is designed to operate intermittently and automatically with minimal maintenance. Site visits for system inspection and maintenance will be performed by a trained and qualified technician and will be performed in conjunction with system monitoring to reduce costs. The PHOSter II™ vendor will provide guidance for the PHOSter II™ system O&M.

The following O&M items are scheduled to be performed weekly for the first month and monthly thereafter:

- Maintain good housekeeping measures for the entire remediation system compound, picking up trash and cutting weeds as necessary.
- Log all inspection activities and repairs performed.

An O&M manual will be provided with all equipment and systems acquired. The manual will have at a minimum sections covering the unloading, installation, set-up, operation instruction, and maintenance instruction for each component of the system.

7.6 STATUS REPORTS

During the implementation and operation of the remediation system described in this RAP, quarterly status reports will be submitted to Navy. The frequency of the reports is assumed to be quarterly for costing purposes. The reports will summarize all remedial activities and will contain at a minimum the following information:

- Startup date.
- Hydrocarbon constituent concentrations in groundwater as measured from monitoring wells, together with water table elevations.
- DO, carbon dioxide, orthophosphate, nitrate, and nitrite in the groundwater.
- Recent hydrocarbon plume and groundwater contour maps.
- A graph of cumulative mass degraded versus operation time.

- Summary of system operational data.

- Conclusions as to the effectiveness of the active remedial system, and recommendations on further monitoring and operations of the system.

7.7 SYSTEM DEACTIVATION

One of the following criteria must be met for active remediation to be deemed complete and prior to deactivation of the PHOSter II™ system:

- No Further Action criteria as defined in Chapter 62-770.680, FAC have been met.

- Natural attenuation criteria established in Chapter 62-770.690, FAC have been achieved.

- Concentrations of COCs in the designated monitoring wells have "leveled off" as defined in Chapter 62-770.700, FAC.

After the site meets one the above criteria, the system will be deactivated. The following steps will be followed during system deactivation:

- Deactivate the PHOSter II™ blower and allow to cool down.

- De-energize the control panel via the service disconnect.

- Remove PHOSter II™ system trailer. However, piping and injection wells will remain on site until after the post closure monitoring verifies that the site has been properly remediated, at which point it will be removed from the site as directed by the Navy.

TtNUS understands that it is the responsibility of the PHOSter II™ vendor to remove and deactivate the remediation system. Following system deactivation, a Post Active Remediation Monitoring Plan must be developed for the site and approved by the FDEP. The contents of this plan are included in Chapter 62-770.750, FAC. This monitoring will occur for a minimum of one year.

REFERENCES

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APPENDIX A

FDEP LETTER DATED MAY 2, 2001

Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

May 2, 2001

Mr. Byas Glover
Code 18410
Southern Division
Naval Facilities Engineering Command
Post Office Box 190010
North Charleston, South Carolina 29419-9010

RE: Site Assessment Report Addendum, Underground Storage Tank (UST) Site 19, Naval Air Station Pensacola, Florida, DEP Facility #179203973

Dear Mr. Glover:

I have completed the technical review of the Site Assessment Report Addendum for UST Site 19, NAS Pensacola dated April 10, 2001 (received April 10, 2001). The document is adequate to meet the contamination assessment requirements of Chapter 62-770, Florida Administrative Code (F.A.C.). Therefore, you must now submit a Remedial Action Plan (RAP) in accordance with Rule 62-770.700, F.A.C.

Since monitoring well MW-17 was dry during the last sampling event, I recommend that remedial activities include the installation and sampling of a deep monitoring well located adjacent to MW-17.

Please submit the RAP in accordance with the approved Management Action Plan for NAS Pensacola. If I can be of any further assistance with this matter, please contact me at (850) 921-9989.

Sincerely,

Joseph F. Fugitt

Joseph F. Fugitt, P.G.
Remedial Project Manager

cc: Greg Campbell, NAS Pensacola
Gerry Walker, Tetra Tech NUS, Inc., Tallahassee
Charlie Goddard, FDEP Northwest District

Reviewed by:

Timothy J. Bahr, P.G.
Professional Geologist Supervisor
Bureau of Waste Cleanup

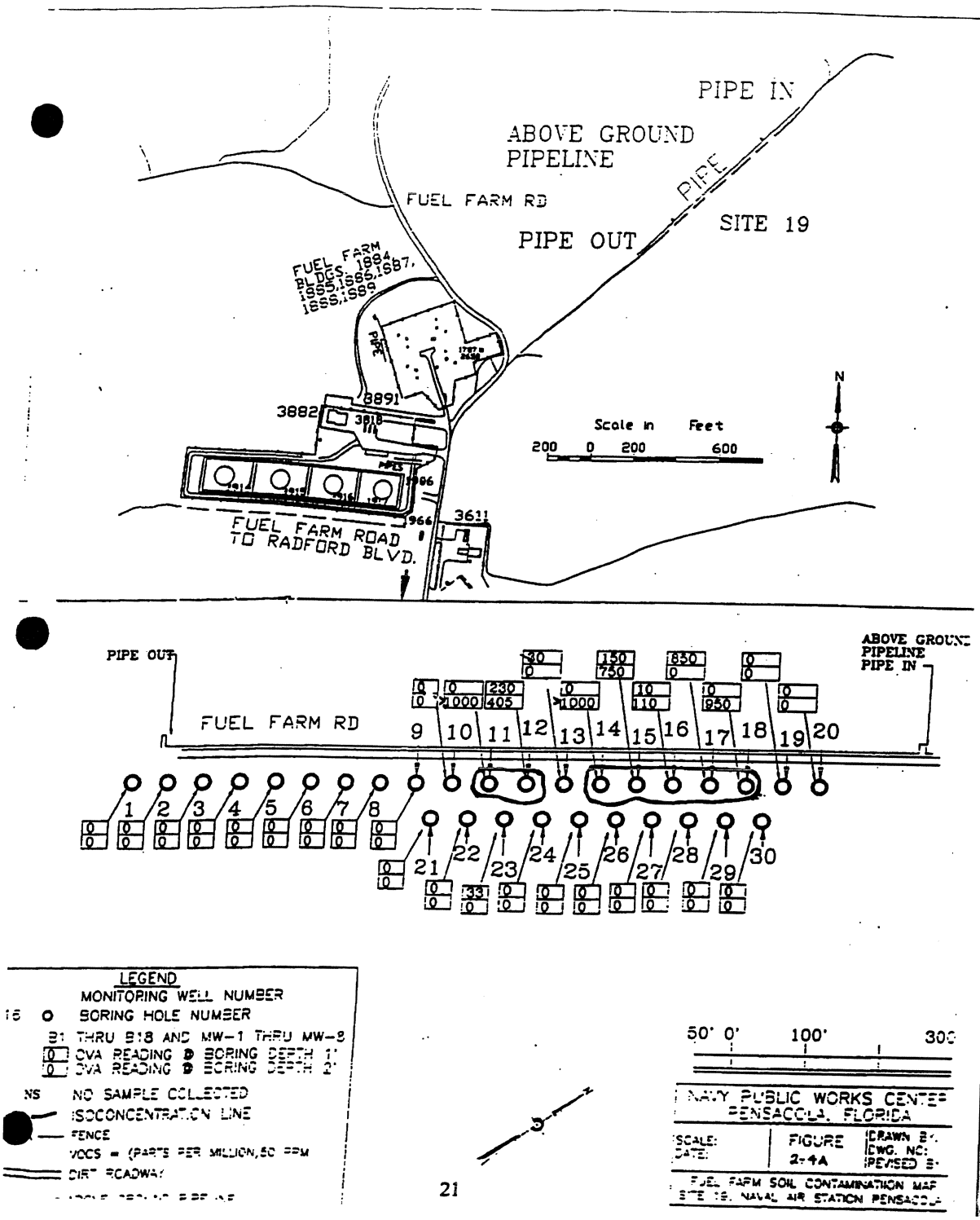
5/2/01
Date

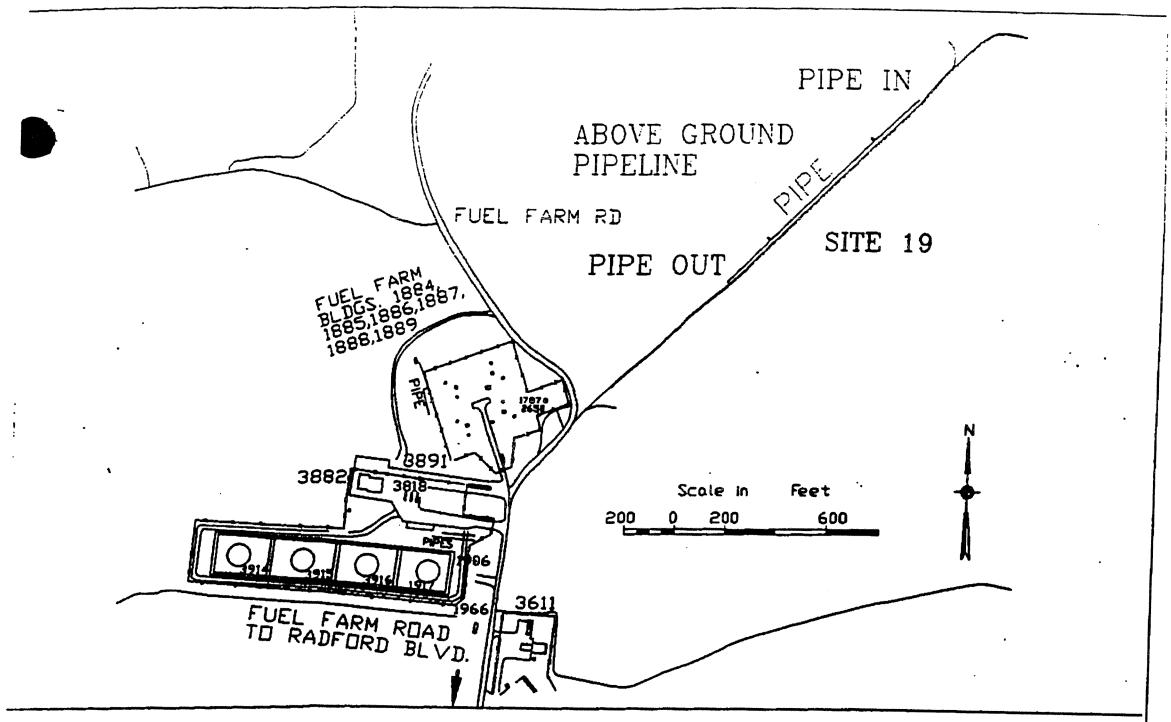
JJC ESN

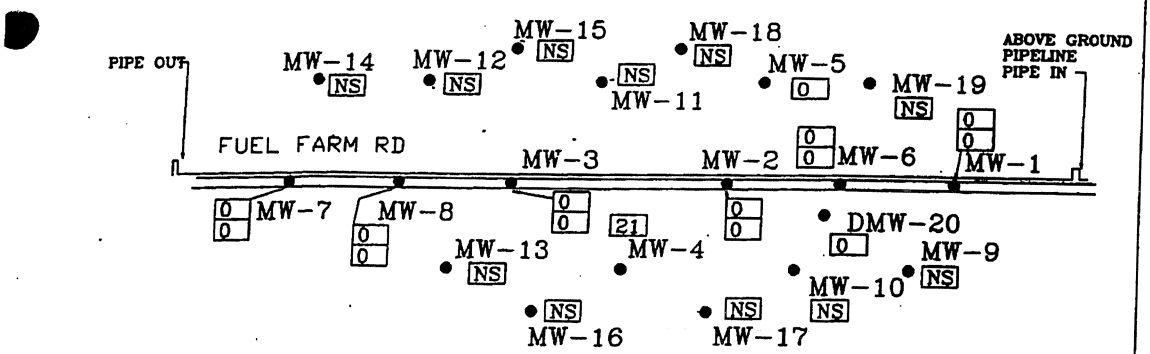
TIMOTHY J. BAHR
LICENSE
NO. 1209
STATE OF
FLORIDA
PROFESSIONAL GEOLOGIST

APPENDIX B

SAR BORING LOCATION FIGURES


PIPE IN
ABOVE GROUND PIPELINE
FUEL FARM RD
PIPE OUT
SITE 19
FUEL FARM BLDGS. 1884, 1885, 1887, 1895, 1896, 1898, 1899
3882
3618
8891
3611
Scale in Feet
200 0 200 600
N
FUEL FARM ROAD TO RADFORD BLVD.
PIPE OUT
ABOVE GROUND PIPELINE PIPE IN
FUEL FARM RD
9 10 11 12 13 14 15 16 17 18 19 20
1 2 3 4 5 6 7 8
21 22 23 24 25 26 27 28 29 30
LEGEND
MONITORING WELL NUMBER
O BORING HOLE NUMBER
B1 THRU B18 AND MW-1 THRU MW-8
OVA READING @ BORING DEPTH 1'
OVA READING @ BORING DEPTH 2'
NS NO SAMPLE COLLECTED
ISOCONCENTRATION LINE
FENCE
VOCS = (PARTS PER MILLION, 50 PPM
DIRT ROADWAY
50' 0' 100' 300
NAVY PUBLIC WORKS CENTER
PENSACOLA, FLORIDA
SCALE:
DATE:
FIGURE 2-4A
DRAWN BY:
DWG. NO:
REVISED BY:
FUEL FARM SOIL CONTAMINATION MAP
SITE 19, NAVAL AIR STATION PENSACOLA





LEGEND

MW-2 ● MONITORING WELL NUMBER

BORING HOLE NUMBER

B1 THRU B18 AND MW-1 THRU MW-8

0 OVA READING ● BORING DEPTH 1'

0 OVA READING ● BORING DEPTH 2'

NS NO SAMPLE COLLECTED

ISOCONCENTRATION LINE

X — FENCE

VOCS = (PARTS PER MILLION)50 PPM

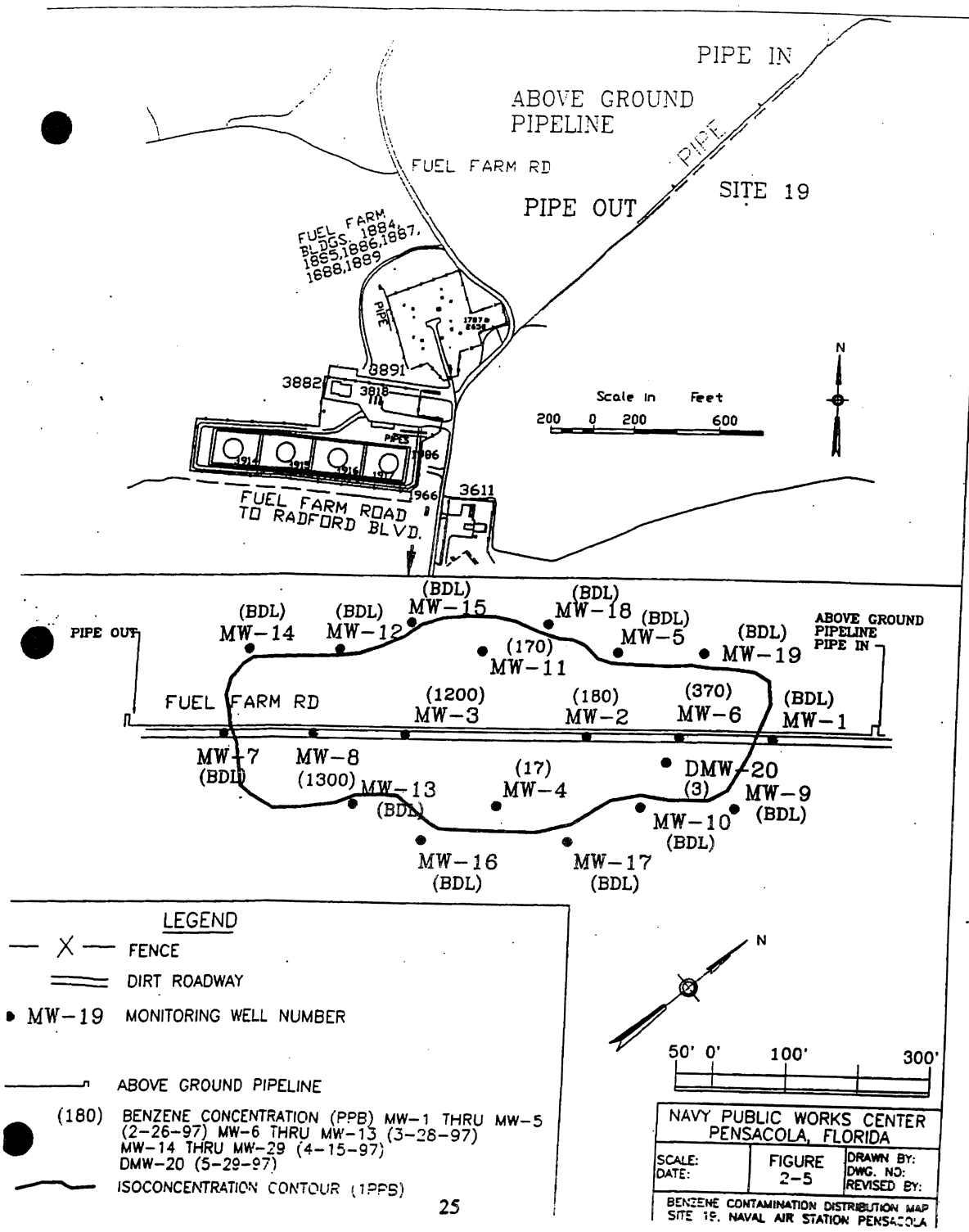
DIRT ROADWAY

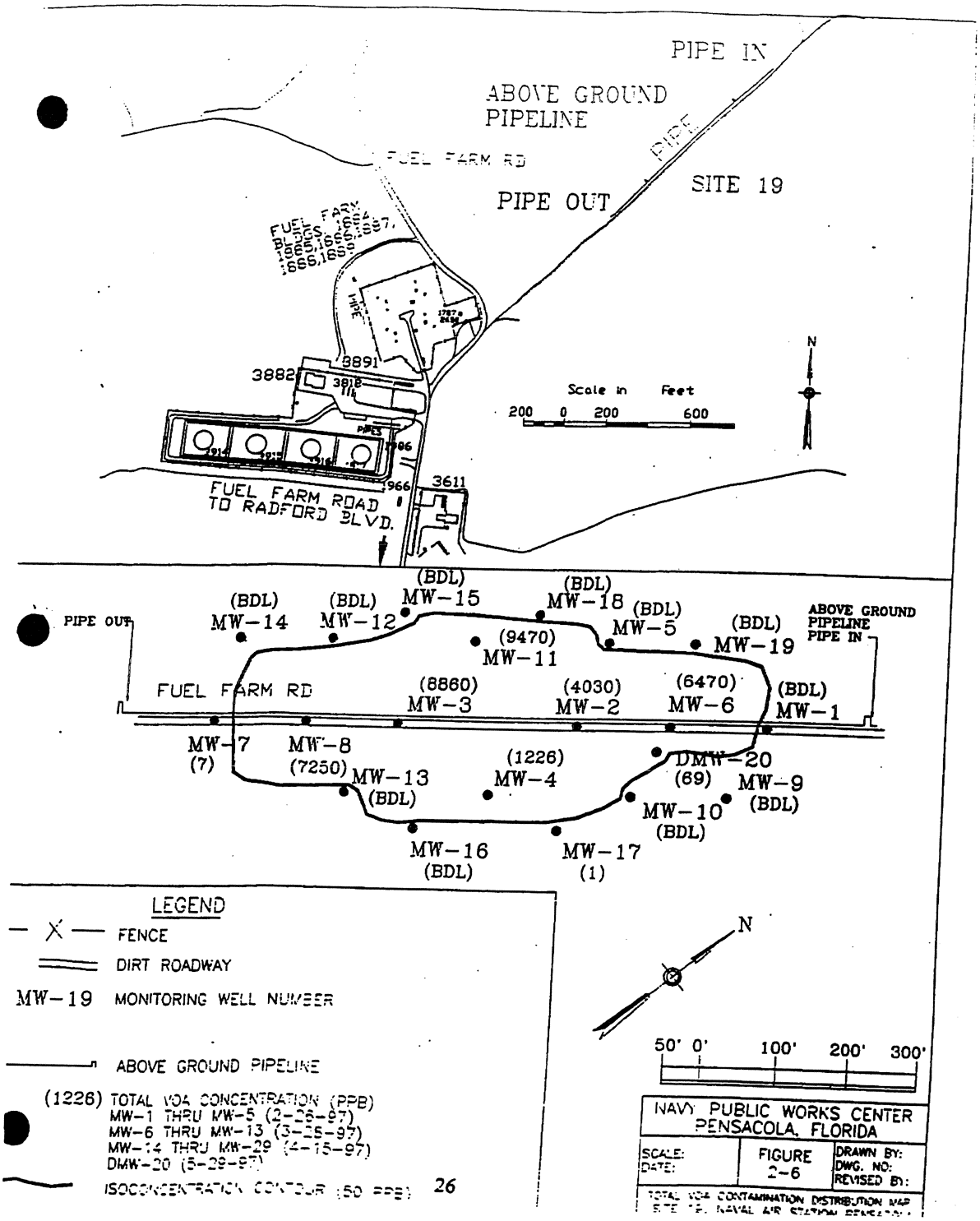
50' 0' 100' 300'

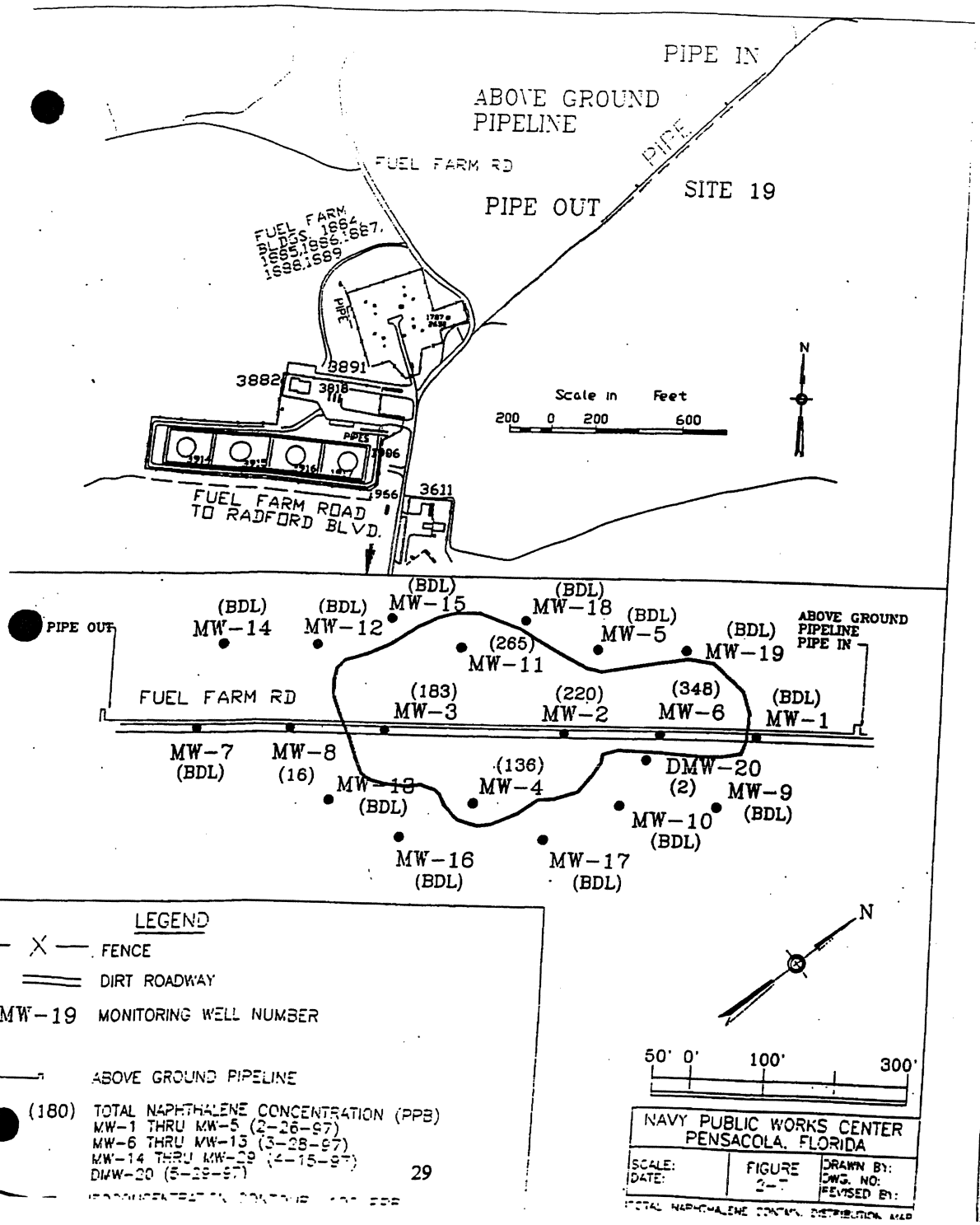
NAVY PUBLIC WORKS CENTER
PENSACOLA, FLORIDA

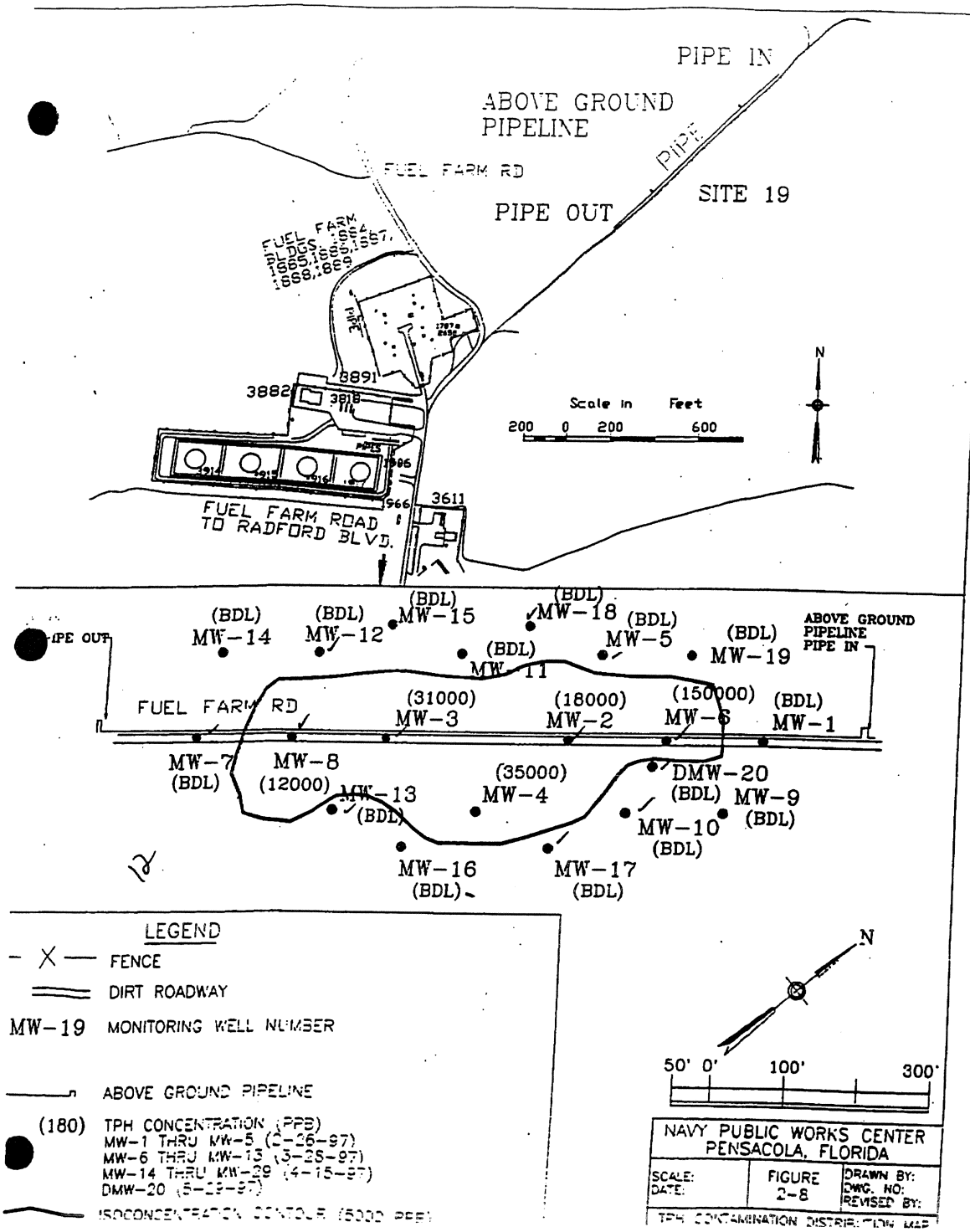
SCALE: DATE:	FIGURE 2-4B	DRAWN BY: DWG. NO: REVISED BY:

FUEL FARM SOIL CONTAMINATION MAP
SITE 19, NAVAL AIR STATION PENSACOLA


PIPE IN
ABOVE GROUND PIPELINE
PIPE
FUEL FARM RD
PIPE OUT
SITE 19
FUEL FARM BLDGS. 1884, 1885, 1886, 1887, 1888, 1889
PIPE
3882
3818
3891
PIPES
1914
1915
1916
1917
1966
3611
FUEL FARM ROAD TO RADFORD BLVD.
Scale in Feet
200 0 200 600
N
PIPE OUT
(BDL) MW-14
(BDL) MW-12
(BDL) MW-15
(BDL) MW-18
(BDL) MW-5
(BDL) MW-19
ABOVE GROUND PIPELINE PIPE IN
(170) MW-11
FUEL FARM RD
(1200) MW-3
(180) MW-2
(370) MW-6
(BDL) MW-1
MW-7 (BDL)
MW-8 (1300)
MW-13 (BDL)
(17) MW-4
DMW-20 (3)
MW-9 (BDL)
MW-10 (BDL)
MW-16 (BDL)
MW-17 (BDL)
LEGEND
FENCE
DIRT ROADWAY
MW-19 MONITORING WELL NUMBER
ABOVE GROUND PIPELINE
(180) BENZENE CONCENTRATION (PPB) MW-1 THRU MW-5 (2-26-97) MW-6 THRU MW-13 (3-28-97) MW-14 THRU MW-29 (4-15-97) DMW-20 (5-29-97)
ISOCONCENTRATION CONTOUR (1PPB)
N
50' 0' 100' 300'
NAVY PUBLIC WORKS CENTER
PENSACOLA, FLORIDA
SCALE:
DATE:
FIGURE 2-5
DRAWN BY:
DWG. NO:
REVISED BY:
BENZENE CONTAMINATION DISTRIBUTION MAP
SITE 19, NAVAL AIR STATION PENSACOLA


PIPE IN
ABOVE GROUND PIPELINE
FUEL FARM RD
PIPE OUT
SITE 19
3882
3891
3818
3611
966
FUEL FARM ROAD TO RADFORD BLVD.
Scale in Feet
200 0 200 600
N
PIPE OUT
(BDL) MW-14
(BDL) MW-12
(BDL) MW-15
(BDL) MW-18
(BDL) MW-5
(BDL) MW-19
ABOVE GROUND PIPELINE PIPE IN
(9470) MW-11
FUEL FARM RD
(8860) MW-3
(4030) MW-2
(6470) MW-6
(BDL) MW-1
MW-7 (7)
MW-8 (7250)
MW-13 (BDL)
(1226) MW-4
DMW-20 (69)
MW-9 (BDL)
MW-10 (BDL)
MW-16 (BDL)
MW-17 (1)
LEGEND
FENCE
DIRT ROADWAY
MW-19 MONITORING WELL NUMBER
ABOVE GROUND PIPELINE
(1226) TOTAL VOA CONCENTRATION (PPB)
MW-1 THRU MW-5 (2-26-97)
MW-6 THRU MW-13 (3-25-97)
MW-14 THRU MW-29 (4-15-97)
DMW-20 (5-29-97)
ISOCONCENTRATION CONTOUR (50 PPB)
N
50' 0' 100' 200' 300'
NAVY PUBLIC WORKS CENTER
PENSACOLA, FLORIDA
SCALE:
DATE:
FIGURE 2-6
DRAWN BY:
DWG. NO:
REVISED BY:
TOTAL VOA CONTAMINATION DISTRIBUTION MAP


PIPE IN
ABOVE GROUND PIPELINE
FUEL FARM RD
PIPE OUT
SITE 19
FUEL FARM BLDGS. 1664, 1665, 1666, 1667, 1668, 1669
PIPE
3882
3891
3818
PIPES
1906
1956
3611
FUEL FARM ROAD TO RADFORD BLVD.
Scale in Feet
200 0 200 600
N
PIPE OUT
(BDL) MW-14
(BDL) MW-12
(BDL) MW-15
(BDL) MW-18
(BDL) MW-5
(BDL) MW-19
ABOVE GROUND PIPELINE PIPE IN
(265) MW-11
FUEL FARM RD
(183) MW-3
(220) MW-2
(348) MW-6
(BDL) MW-1
MW-7 (BDL)
MW-8 (16)
MW-13 (BDL)
(136) MW-4
DMW-20 (2)
MW-9 (BDL)
MW-10 (BDL)
MW-16 (BDL)
MW-17 (BDL)
LEGEND
FENCE
DIRT ROADWAY
MW-19 MONITORING WELL NUMBER
ABOVE GROUND PIPELINE
(180) TOTAL NAPHTHALENE CONCENTRATION (PPB)
MW-1 THRU MW-5 (2-26-97)
MW-6 THRU MW-13 (3-28-97)
MW-14 THRU MW-29 (4-15-97)
DMW-20 (5-29-97)
N
50' 0' 100' 300'
NAVY PUBLIC WORKS CENTER
PENSACOLA, FLORIDA
SCALE:
DATE:
FIGURE
DRAWN BY:
DWG. NO:
REVISED BY:
TOTAL NAPHTHALENE CONTAM. DISTRIBUTION MAP


PIPE IN
ABOVE GROUND PIPELINE
FUEL FARM RD
PIPE OUT
SITE 19
FUEL FARM BLDGS
3882
3918
8891
3611
FUEL FARM ROAD TO RADFORD BLVD.
Scale in Feet
200 0 200 600
N
PIPE OUT
(BDL) MW-14
(BDL) MW-12
(BDL) MW-15
(BDL) MW-18
(BDL) MW-5
(BDL) MW-19
ABOVE GROUND PIPELINE PIPE IN
(BDL) MW-11
FUEL FARM RD
(31000) MW-3
(18000) MW-2
(150000) MW-6
(BDL) MW-1
MW-7 (BDL)
MW-8 (12000)
MW-13 (BDL)
(35000) MW-4
DMW-20 (BDL)
MW-9 (BDL)
MW-10 (BDL)
MW-16 (BDL)
MW-17 (BDL)
LEGEND
FENCE
DIRT ROADWAY
MW-19 MONITORING WELL NUMBER
ABOVE GROUND PIPELINE
(180) TPH CONCENTRATION (PPB)
MW-1 THRU MW-5 (2-26-97)
MW-6 THRU MW-13 (3-25-97)
MW-14 THRU MW-29 (4-15-97)
DMW-20 (5-29-97)
ISOCONCENTRATION CONTOUR (5000 PPB)
N
50' 0' 100' 300'
NAVY PUBLIC WORKS CENTER
PENSACOLA, FLORIDA
SCALE:
DATE:
FIGURE 2-8
DRAWN BY:
DWG. NO:
REVISED BY:
TPH CONTAMINATION DISTRIBUTION MAP

APPENDIX C

CONTAMINANT MASS CALCULATIONS

Table C1
Estimated Mass of Contaminants in Vadose Zone Soil Matrix

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

INPUT:

Estimated Impacted Area	48,000 ft^2	4459 m^2
Estimated Average Impacted Thickness	3 ft	1 m
Estimated Impacted Volume	144,000 ft^3	4078 m^3
Average TRPH Concentration		1,285 mg/kg

CALCULATIONS:

Estimated Mass of Impacted Unsaturated Soil	7,467 tons	6773760 kg
Estimated Mass of Hydrocarbons in Soil	**19151** lbs	8704 kg

NOTES:

TRPH - Total recoverable petroleum hydrocarbons
mg/kg - milligrams per kilogram
ft - feet
ft^2 - square feet
ft^3 - cubic feet
lbs - pounds
m - meter
m^2 - square meters
m^3 - cubic meters

Estimated area = Length (ft) x Width (ft) (assume area is rectangular) = 240 ft x 200 ft
Water levels vary from 0-3 ft (January 2003). Majority of area is at less than 1 ft.
From fixed laboratory analysis of soil samples from HA02, HA04, HA26, HA33, HA20, HA38, HA44, HA50. (See Tables 2-3 and 2-4 in the February 2001 SAR)
Estimated Mass of Impacted Unsaturated Soil = impacted volume (ft^3) x (1 yd^3/27 ft^3) x (1.4 tons/1 yd^3) x (907.2 kg/ton)
Estimated mass of hydrocarbons = hydrocarbon concentration (mg/kg) x mass of soil (kg)

Prepared By_____ Checked By_____
Date

Table C2
Estimated Mass of Dissolved and Adsorbed Contaminants in Saturated Zone

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

Mass of Soluble Contaminants Calculations

Well Number	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	BTEX (µg/L)	1-Methylnaphthalene (µg/L)	2-Methylnaphthalene (µg/L)	Naphthalene (µg/L)	TRPH (µg/L)	Impacted Thickness (feet)
MW-4	79.0	2400.0	360.0	3500.0	6339.0	20.0	32.0	59.0	20000	57
MW-6	4.0	--	1.5	9.3	14.8	--	2.1	4.1	540	57
MW-8	190.0	130.0	25.0	100.0	445.0	--	--	3.9	620	57
MW-11	430.0	5800.0	520.0	5500.0	12250.0	22.0	31.0	58.0	26000	57
MW-17R	110.0	74.0	130.0	2740.0	3054.0	7.8	10.2	17.2	4600	57
MW-26S	2.7	--	--	--	2.7	--	--	--	--	57
MW-28S	1.1	0.53	--	--	1.6	--	--	--	470	57
MW-28I	590.0	--	91.0	730.0	1411.0	2.30	3.00	9.60	2400	57
MW-29I	57.0	1.80	17.0	220.0	295.8	4.70	6.60	7.60	1900	57
MW-30S	--	--	--	--	--	--	--	--	570	57
MW-33S	190.0	16.0	12.0	130.0	348.0	--	--	--	770	57
MW-33I	50.0	--	0.51	17.0	67.5	--	--	--	750	57

Average Dissolved Contaminant Concentration (ug/l) =	**154.9**	**1203.2**	**128.6**	**1438.5**	**2925.1**	**11.4**	**14.2**	**22.8**	**5329.1**

Estimated GW Volume: 'Impacted Area x Impacted Thickness x Porosity = (310,000 ft^2)(57 ft)(0.25)(7.48 gal/ft^3) = **33,042,900 gallons**

Estimated Mass of Soluble Contaminants: M(dissolved)(lbs) = C(dissolved)(ug/L) x V(gw)(gal) x 3.7854(L/gal) x 2.205E-9(lb/ug)
where: M(dissolved) = mass of dissolved contaminants (lbs)
C(dissolved) = average dissolved contaminant concentration (mg/l)
V(gw) = volume of impacted groundwater (gal)

Estimated Mass of Soluble Contaminants (lbs)=

42.72	**331.81**	**35.45**	**396.70**	**806.68**	**3.13**	**3.90**	**6.28**	**1469.64**

Estimated Total Mass of Soluble Contaminants Based on TRPH Concentration = 1,469.6 lbs

TABLE C2 (Continued)

Mass of Adsorbed Contaminants Calculations

Concentration of Contaminants Adsorbed to Soil: C(soil) = C(dissolved) x Kd

where: C(soil) = contaminant concentration in soil (mg/kg)
C(dissolved) = average dissolved contaminant concentration (mg/L)
Kd = solid/liquid distribution coefficient (L/kg)

For organics: Kd = Koc x Foc

	Benzene	Toluene	Ethyl-Benzene	Xylene	BTEX	1-Methylnaphthalene	2-Methylnaphthalene	Naphthalene	TRPH (*)
Koc (l/kg):	38	135	1288	240	NA	1288	1288	1288	1288
Foc (kg/kg):	0.005	0.005	0.005	0.005	NA	0.005	0.005	0.005	0.005
Kd (l/kg) =	**0.19**	**0.68**	**6.44**	**1.20**	**NA**	**6.44**	**6.44**	**6.44**	**6.44**
C(dissolved) (mg/l):	0.155	1.203	0.129	1.438	NA	0.011	0.014	0.023	5.33
Kd (l/kg):	0.19	0.68	6.44	1.20	NA	6.44	6.44	6.44	6.44
C(soil) (mg/kg) =	**0.0294**	**0.8122**	**0.828**	**1.726**	**NA**	**0.073**	**0.091**	**0.147**	**34.32**

(*) - Based on Naphthalene value

Estimated Impacted Soil Mass: M(soil) = Impacted Area x Impacted Thickness x (1-n) = (310,000 ft^2)(57ft)(1-0.25)(1.0 yd^3/27 ft^3)(1.28 tons/yd^3)(907.2 kg/ton) = **5.70E+08** kg

Estimated Mass of Contaminants Adsorbed to Soil: M(adsorbed)(lbs) = C(soil)(mg/kg) x M(soil)(kg) x 2.205E-6 (lb/mg)

C(soil) (mg/kg):	0.02943	0.812153	0.828	1.726	NA	0.07	0.09	0.147	34.32
M(soil):	5.70E+08	5.70E+08	5.70E+08	5.70E+08	NA	5.70E+08	5.70E+08	5.70E+08	5.70E+08
M(adsorbed) (lbs) =	**36.986**	**1020.689**	**1040.49**	**2169.402**	**NA**	**91.943**	**114.524**	**184.30**	**43132**

Estimated Total Mass of Adsorbed Contaminants Based on TRPH Concentration = **43132** **lbs**

TOTAL ESTIMATED MASS OF HYDROCARBONS IN SATURATED ZONE (LBS) = ADSORBED MASS + DISSOLVED MASS = **44601** **lbs**

Prepared by: _____

Checked by: _____
Date

APPENDIX D

REMEDIAL ALTERNATIVE COST ESTIMATES

Table D-1
Excavation and On-site Treatment Cost

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

Estimator: CRM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)

DIRECT COSTS	
Site Preparation and Mobilization	$69,000
Planning Documents	$33,000
Field Sampling & Oversight	$22,000
Excavation Activities	$181,000
On-site Treatment of Soil	$358,000
Site Restoration and Demobilization	$7,000
Summary Data Report	$10,000
Costs for Excavation and Onsite Disposal	$680,000
Indirect Costs	
Contingency (@20%)	$136,000
TOTAL COSTS FOR EXCAVATION AND OFFSITE DISPOSAL	**$816,000**

Table D-1 (Continued)
Excavation and On-site Treatment Cost

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation and Mobilization				
Silt Fence	300	lf	$2	$606
Security fencing 6' chain-link	2520	lf	$7	$16,682
6' Swing Gate, 12' double	1	ls	$750	$750
Site signs	12	ea	$49	$589
Decontamination pad	1	ls	$1,000	$1,000
1800 PSI Steam Cleaner Rental (assume base will provide decon water)	1	mo	$1,050	$1,050
Site Clearing (heavy brush, light trees, clear, grub, grub, and haul)	7	ac	$5,186	$36,302
Pick-up truck	9	wk	$350	$3,150
Field Engineer (oversight for the entire field event, prep, excavation, demob, etc.)	9	wk	$920	$8,280
General site mobilization	1	ls	$1,000	$1,000
Total For Site Preparation and Mobilization				**$69,409**
Site Sampling & Oversight				
Planning Documents (HASP, WP)				
Professional Engineer	40	hrs	$126	$5,040
Jr. Level Engineer	200	hrs	$48	$9,600
Sr. Scientist	80	hrs	$80	$6,400
Word Processor	80	hrs	$35	$2,800
CADD	160	hrs	$40	$6,400
ODCs	5	ls	$500	$2,500
Total for Planning Documents				**$32,740**
Field Sampling & Oversight				
Jr. Level Geologist	200	hrs	$40	$8,000
ODCs	1	ls	$1,000	$1,000
Volatile Organics, Method 8260, assume 30, 5 QC	35	ea	$135	$4,725
PAHs, Method 8310, assume 30 samples, 3 QC	33	ea	$125	$4,125
TRPH (FLPRO) assume 30 samples, 3 QC	33	ea	$90	$2,970
Sampling equipment	1	ls	$1,000	$1,000
Total for Field Sampling & Oversight				**$21,820**
Excavation				
Excavation of Soil				
Pipeline Reinforcement (Quote from ACT)	4240	ft^2	$19	$80,306
Dewatering (Vacuum truck on site daily to emply frac tank)	1	ls	$10,000	$10,000
Excavate fuel impacted soil	5333	yd^3	$7.43	$39,624
Treated soil placement and compaction	5333	yd^3	$7.68	$40,957
Laborer (50 hrs/week, 8 weeks)	400	hr	$25	$10,000
Mobilization/demobilization	1	ls	$6,674	$6,674
Total for Excavation Activities				**$180,887**

Table D-1 (Continued)
Excavation and On-site Treatment Cost

	Quantity	Unit	Unit Cost	Total Cost
On-site Treatment of Soil				
Quote from WTDI for permiting, mo/demob, soil transport, and treatment				
On-site soil treatment costs	7467	ton	$48	$358,416
Total for On-site Disposal of Soil:				**$358,416**
Site Restoration and Demobilization				
Hydroseeding	1	acre	$518	$518
General demobilization of equipment	1	ls	$1,000	$1,000
Drill and install 7 - 2" PVC monitoring wells	145	ft	$35.89	$5,204
Subtotal Site Restoration and Demob:				**$6,722**
Assumption:				
No repair to current dirt road beyond backfill w/compaction was priced				
Summary Data Report				
Jr. Level Engineer	40	hrs	$48	$1,920
Senior Scientist	8	hrs	$80	$640
Mid-level Engineer	60	hrs	$80	$4,800
Word Processor	16	hrs	$35	$560
CADD	32	hrs	$40	$1,280
ODCs	1	ls	$500	$500
Total for Summary Data Report				**$9,700**

Table D-2
Excavation and Disposal Cost

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

Estimator: CRM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)

DIRECT COSTS	
Site Preparation and Mobilization	$68,000
Planning Documents	$33,000
Field Sampling & Oversight	$22,000
Excavation Activities	$135,000
Offsite Disposal of Soil	$276,000
Site Restoration and Demobilization	$52,000
Summary Data Report	$10,000
Costs for Excavation and Offsite Disposal	$596,000
Indirect Costs	
Contingency (@20%)	$119,000
TOTAL COSTS FOR EXCAVATION AND OFFSITE DISPOSAL	**$715,000**

Table D-2 (Continued)
Excavation and Disposal Cost

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation and Mobilization				
Silt Fence	300	lf	$2	$606
Security fencing 6' chain-link	2520	lf	$7	$16,682
6' Swing Gate, 12' double	1	ls	$750	$750
Site signs	12	ea	$49	$589
Decontamination pad	1	ls	$1,000	$1,000
1800 PSI Steam Cleaner Rental (assume base will provide decon water)	2	mo	$1,050	$2,100
Site Clearing (heavy brush, light trees, clear, grub, grub, and haul)	7	ac	$5,186	$36,302
Pick-up truck	8	wk	$350	$2,800
Field Engineer (oversight for the entire field event, prep, excavation, demob, etc.)	8	wk	$920	$7,360
General site mobilization	1	ls	$1,000	$1,000
Total For Site Preparation and Mobilization				**$68,189**
Site Sampling & Oversight				
Planning Documents (HASP, WP)				
Professional Engineer	40	hrs	$126	$5,040
Jr. Level Engineer	200	hrs	$48	$9,600
Sr. Scientist	80	hrs	$80	$6,400
Word Processor	80	hrs	$35	$2,800
CADD	160	hrs	$40	$6,400
ODCs	5	ls	$500	$2,500
Total for Workplan & Health & Safety Plan				**$32,740**
Field Sampling & Oversight				
Jr. Level Geologist	200	hrs	$40	$8,000
ODCs	1	ls	$1,000	$1,000
Volatile Organics, Method 8260, assume 30, 5 QC	35	ea	$135	$4,725
PAHs, Method 8310, assume 30 samples, 3 QC	33	ea	$125	$4,125
TRPH (FLPRO) assume 30 samples, 3 QC	33	ea	$90	$2,970
Sampling equipment	1	ls	$1,000	$1,000
Total for Field Sampling & Oversight				**$21,820**
Excavation				
Excavation of Soil				
Pipeline Reinforcement (Quote from ACT)	4240	ft^2	$19	$80,306
Dewatering (Assume vacuum truck on site for 10 days, collection, transport, and disposal of contaminated water)	1	ls	$10,000	$10,000
Excavate fuel impacted soil	5333	yd^3	$7.43	$39,624
Laborer (50 hrs/week, 4 weeks)	200	hr	$25	$5,000
Mobilization/demobilization	1	ls	$6,674	$4,000
Subtotal for Excavation				**$134,930**
Offsite Disposal of Soil				
Transportation, and disposal of contaminated soil to a Subtitle D Facility Cost derived from quote from Andy Adams of Waste Transportation & Disposal Inc. (1-800-901-0081) cost quoted with disposal at subtitle D landfill.	7467	ton	$37	$276,279
Subtotal for Offsite Disposal of Soil:				**$276,279**

Table D-2 (Continued)
Excavation and Disposal Cost

Site Restoration and Demobilization

	Quantity	Unit	Unit Cost	Total Cost
Common fill for backfill (load and haul) includes spreading and compaction	5,333	yd^3	$9	$45,437
Hydroseeding	1	acre	$518	$518
Demobilization of Equipment	1	ls	$1,000	$1,000
Drill and install 7 2" PVC monitoring wells	140	ft	$35.89	$5,025
Subtotal Site Restoration and Demob:				**$51,980**

Assumption:
No repair to current dirt road beyond backfill w/compaction was priced.

Summary Data Report

Summary Data Report				
Jr. Level Engineer	40	hrs	$48	$1,920
Senior Scientist	8	hrs	$80	$640
Mid-level Engineer	60	hrs	$80	$4,800
Word Processor	16	hrs	$35	$560
CADD	32	hrs	$40	$1,280
ODCs	1	ls	$500	$500
Total for Summary Data Report				**$9,700**

Table D-3
SVE Cost Alternative

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

Estimator: CRM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)

DIRECT COSTS		
Site Preparation		$83,000
Piping and Equipment		$140,000
Total Installation labor		$19,000
Treatability Study		$20,000
TOTAL DIRECT COST		**$262,000**
INDIRECT COSTS		
Engineering and Design (20%)		$52,000
TOTAL INDIRECT COST		**$52,000**
Total Capital Costs (Direct + Indirect)		**$314,000**
OPERATIONS AND MAINTENANCE		
Administrative O&M		
Work Plan (WP) for Monitoring Activities		$8,000
Reporting, Site Activities Report/System Operation Report		$23,000
Total Administrative O&M, annual		**$23,000**
Present worth of O&M (7%, 4 yrs)	($77,906)	$78,000
Present worth O&M + SAP		**$86,000**
Treatment System O&M		
System Maintenance		$33,000
Utilities		$11,000
Total Treatment System O&M, Annual		**$44,000**
Present Worth of Treatment System O&M (7%, 3 yrs)	($115,470)	$115,000
Present Worth O&M (Administrative + Treatment System O&M)		**$201,000**
Assumption - System will run for three years, plus one year of monitoring, for a total of four years.		
Total Capital and O&M Cost		$515,000
Contingency (20%)		$103,000
TOTAL COST		**$618,000**

Table D-3 (Continued)
SVE Cost Alternative

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation				
Storage trailer	3	mo	$500	$1,500
Trailer delivery, setup, removal	2	ea	$1,000	$2,000
Treatment system concrete pad	1	ls	$2,000	$2,000
Security fencing 6' chain-link	2520	lf	$7	$16,682
6' Swing Gate, 12' double	1	ls	$750	$750
Utility connection for treatment system				
Including electric poles, cable, transformer, phone line for telemetry	1	ls	$15,000	$15,000
Signs, temp fencing, barricades to seclude construction area	1	ls	$1,500	$1,500
Site Clearing (heavy brush, light trees, clear, grub, grub, and haul)	7	ac	$5,186	$36,302
Pressure washer and water tank	3	mo	$504	$1,512
Plastic sheeting, drums, pumps, hoses, supplies	1	ls	$2,000	$2,000
Pick-up truck	1	wk	$350	$350
Labor				
2 laborers, 4 days, 10 hrs/day	80	hr	$25	$2,000
1 field engineer, 5 days, 10 hrs/day (over-site)	50	hr	$25	$1,250
Total Site Preparation				**$82,846**

Note: 51 horizontal SVE wells estimated based on 15 foot radius of influence, and adjusted for overlap. The 15 foot radius of influence is based on site information, and a treatability study is recommended.

Biovent System				
Piping and Equipment				
Blower 5000 CFM, 8" Pressure, 20 HP, Blower System	1	ea	$39,134	$39,134
2" Dia. PVC @ 3' Depth, Horizontal pipe vent installed	2500	ft	$34	$84,450
Drill and install 2 2" PVC monitoring wells	45	ft	$35.89	$1,615
System plumbing	1	ls	$2,000	$2,000
System control panel	1	ea	$3,000	$3,000
Misc construction materials	1	ls	$5,000	$5,000
Site restoration	1	ls	$1,000	$1,000
Remedial well survey	1	ls	$2,000	$2,000
System start-up	1	ls	$2,000	$2,000
Total Piping and Equipment				**$140,199**
Labor for system connection & Start-up				
3 Laborers, 2 weeks @ 50 hrs/wk	300	hrs	$25	$7,500
1 Jr. Level Engineer, 2 weeks @ 50 hrs/wk (over-site)	100	hrs	$48	$4,800
1 Sr. Engineer, 16 hours	24	hrs	$112	$2,688
1 Electrician, 1 week @ 50 hrs/wk	50	hrs	$75	$3,750
Total Labor:				**$18,738**
Treatability Study	1	ls	$20,000	**$20,000**
TOTAL DIRECT COSTS				**$261,783**

Table D-3 (Continued)
SVE Cost Alternative

OPERATIONS AND MAINTENANCE

Administrative O&M

Work Plan for Monitoring and O&M Activities

Labor	Quantity	Unit	Unit Cost	Total Cost
Jr.-Level Geologist/Scientist	80	hrs	$40	$3,200
Senior Geologist	16	hrs	$80	$1,280
ODC's, Production Support (editing, copying, binders, etc.)	1	ls	$1,000	$1,000
Word Processor	16	hrs	$35	$560
CADD, 8 hrs/figure, 4 figures	32	hrs	$40	$1,280
Editor	8	hrs	$60	$480
Copying: 50 pgs x 25 copies	1250	page	$0.10	$125
Binding/shipping, 25 copies	25	ea	$20	$500
Total Work Plan				**$8,425**

Table D-3 (Continued)
SVE Cost Alternative

REPORTING	Quantity	Unit	Unit Cost	Total Cost
Site Activities Report				
1 Jr. Level Geologist	40	hrs	$40	$1,600
1 Senior Geologist	16	hrs	$80	$1,280
Production:				
Word processing	12	hrs	$35	$420
Technical Expert	6	hrs	$75	$450
Editor	8	hrs	$60	$480
CADD operator, 3 dwgs per report @ 8 hours per dwg	24	hrs	$40	$960
Reproduction: 100 pgs @ 20 copies	2000	pg	$0.10	$200
Shipping/binding: 20 reports	20	ea	$20	$400
Total Report Cost:				**$5,790**
TREATMENT SYSTEM O&M (annual)				
System Maintenance				
Labor				
Jr. Engineer, 16 hrs per month, system operating data, control	192	hr	$48	$9,216
Sr. Engineer, 2 hours per month	24	hr	$112	$2,688
Technician, 16 hrs per month	192	hr	$30	$5,760
Project Mgr, 2 hrs per month	24	hr	$126	$3,024
Electrician, 4 hours per year	4	hr	$60	$240
Misc. equip/supplies	12	mo	$500	$6,000
Air sparging maintenance	12	mo	$500	$6,000
Total System Maintenance (annual):				**$32,928**
Utilities				
Electricity	175200	kWh	$0.06	$10,512
Assume 20 kW*24 hr/day*365 day/yr = 175,200 kWh/yr				
Total Utilities				**$10,512**
Total Treatment System O&M (Annual)				**$43,440**

Table D-4
Air Sparging Cost Alternative

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

Estimator: CRM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)

DIRECT COSTS		
Site Preparation		$86,000
Air Sparge Well System Installation		$207,000
Piping and Equipment		$35,000
Total Installation labor		$26,000
Treatability Study		$20,000
TOTAL DIRECT COST		**$374,000**
INDIRECT COSTS		
Engineering and Design (20%)		$75,000
TOTAL INDIRECT COST		**$75,000**
Total Capital Costs (Direct + Indirect)		**$449,000**
OPERATIONS AND MAINTENANCE		
Administrative O&M		
Sampling and Analysis Plan (SAP) for Monitoring Activities		$9,000
Annual Groundwater Monitoring (4 quarters)		$57,000
Reporting, Site Activities Report/System Operation Report		$24,000
Total Administrative O&M, annual		**$81,000**
Present Worth of O&M (7%, 12 yrs)	($643,358)	$643,000
Present Worth O&M + SAP		**$652,000**
Treatment System O&M		
System Maintenance		$31,000
Utilities		$11,000
Total Treatment System O&M, annual		$42,000
Present Worth of Treatment System O&M (7%, 11 yrs)	($314,944)	$315,000
Present Worth O&M (Administrative + Treatment System O&M)		**$967,000**
Assumption - System will run for 10 years, plus one year of monitoring, for a total of 11 years.		
Total Capital and O&M Cost		$1,416,000
Contingency (10%)		$142,000
TOTAL COST		**$1,558,000**

Table D-4 (Continued)
Air Sparging Cost Alternative

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation				
Storage trailer	3	mo	$500	$1,500
Trailer delivery, setup, removal	2	ea	$1,000	$2,000
Treatment system concrete pad	1	ls	$2,000	$2,000
Security fencing 6' chain-link	2520	lf	$7	$16,682
Site Clearing (heavy brush, light trees, clear, grub, grub, and haul)	7	ac	$5,186	$36,302
6' Swing Gate, 12' double	2	ls	$750	$1,500
Utility connection for treatment system				
Including electric poles, cable, transformer, phone line for telemetry	1	ls	$15,000	$15,000
Signs, temp fencing, barricades to seclude construction area	1	ls	$1,500	$1,500
1800 PSI Steam Cleaner Rental (assume base will provide decon water)	1	mo	$1,050	$1,050
Plastic sheeting, drums, pumps, hoses, supplies	1	ls	$2,000	$2,000
Labor				
2 laborers, 5 days, 10 hrs/day	100	hr	$25	$2,500
1 foreman, 10 days, 10 hrs/day	100	hr	$35	$3,500
Total Site Preparation				**$85,534**

Note: 84 air sparging wells estimated based on 30 foot radius of influence, adjusted to 24 foot radius of influence for overlap. The 30 foot radius of influence is based on site information, and a treatability study will be required.

Air Sparge System				
Air sparge well installation				
Drill and install 84 - 2" PVC horizontal monitoring wells, 60 feet deep	5040	ft	$35.89	$180,886
Oversight, engineer or geologist	550	hrs	$48	$26,400
Total Injection well Installation Cost:				**$207,286**
Piping and Equipment				
Vacuum Blower and Appurtenances	1	ea	$9,000	$9,000
Vapor Phase Treatment System (carbon drum for first month of start-up)	1	ls	$1,500	$1,500
Piping and trenching	900	ft	$15	$13,500
System plumbing	1	ls	$2,000	$2,000
System control panel	1	ea	$3,000	$3,000
Misc construction materials	1	ls	$2,000	$2,000
Site restoration	1	ls	$1,000	$1,000
Remedial well survey	1	ls	$1,000	$1,000
System start-up	1	ls	$2,000	$2,000
Total Piping and Equipment				**$35,000**
Labor				
3 Laborers, 2 weeks @ 50 hrs/wk	450	hrs	$30	$13,500
1 Jr. Level Engineer, 2 weeks @ 50 hrs/wk	150	hrs	$45	$6,750
1 Sr. Engineer, 16 hours	24	hrs	$90	$2,160
1 Electrician, 1 week @ 50 hrs/wk	50	hrs	$75	$3,750
Total Labor:				**$26,160**

Table D-4 (Continued)
Air Sparging Cost Alternative

	Quantity	Unit	Unit Cost	Total Cost
Treatability Study	1	ls	$20,000	**$20,000**
TOTAL DIRECT COSTS				**$373,980**
OPERATIONS AND MAINTENANCE				
Administrative O&M				
SAP for Monitoring and O&M Activities				
Labor				
Jr.-Level Geologist/Scientist	80	hrs	$45	$3,600
Senior Geologist	16	hrs	$80	$1,280
ODC's, Production Support (editing, copying, binders, etc.)	1	ls	$1,000	$1,000
Word Processor	16	hrs	$35	$560
CADD, 8 hrs/figure, 4 figures	32	hrs	$40	$1,280
Editor	8	hrs	$60	$480
Copying: 50 pgs x 25 copies	1250	page	$0.10	$125
Binding/shipping, 25 copies	25	ea	$20	$500
Total SAP				**$8,825**
Quarterly Groundwater Monitoring				
Assumptions:				
Duration of alternative = 10 yrs				
Use of 19 existing wells				
Quarterly for all 10 years				
Labor: 1 Technician, 5 days per sampling event @10 hour days	50	hrs	$30	$1,500
1 Geologist, 5 days per sampling event @10 hour days	50		$45	$2,250
Car Rental: (one week)	1	wk	$350	$350
Total Labor:				**$4,100**
Lab:				
Volatile Organics, Method 8260, assume 20 wells, 4 QC	24	ea	$135	$3,240
PAHs, Method 8310, assume 20 wells, 2 QC	22	ea	$125	$2,750
TRPH (FLPRO) assume 20 wells, 2 QC	22	ea	$90	$1,980
Total Analysis:				**$7,970**

Table D-4 (Continued)
Air Sparging Cost Alternative

Expendables and Equipment Rental	Quantity	Unit	Unit Cost	Total Cost
Gloves (2 boxes per event)	2	box	$10	$20
Teflon tubing (400 feet per event)	400	ft	$2.00	$800
Silicon tubing (50 feet per event)	50	ft	$2.00	$100
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$250	$250
Rental of YSI 556 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	1	wk	$300	$300
Pumps for purging wells, 2 pumps,	1	wk	$75	$75
MiniRAE 2000 PID monitor	1	wk	$200	$200
First Aid kit	1	ls	$50	$50
Water level indicator	1	wk	$50	$50
Disposal of purge water, assume nonhaz., (drums)	2	ea	$150	$300
Total Expendables and Equipment Rental:				**$2,145**
Total Quarterly Costs for Groundwater Monitoring				**$14,215**
REPORTING				
Site Activities Report				
1 Jr. Level Geologist	40	hrs	$45	$1,800
1 Senior Geologist	16	hrs	$80	$1,280
Production:				
Word processing	12	hrs	$35	$420
Technical Expert	6	hrs	$75	$450
Editor	8	hrs	$60	$480
CADD operator, 3 dwgs per report @ 8 hours per dwg	24	hrs	$40	$960
Reproduction: 100 pgs @ 20 copies	2000	pg	$0.10	$200
Shipping/binding: 20 reports	20	ea	$20	$400
Total Report Cost:				**$5,990**
TREATMENT SYSTEM O&M (Annual)				
System Maintenance				
Labor				
Jr. Engineer, 16 hrs per month, system operating data, control	192	hr	$45	$8,640
Sr. Engineer, 2 hours per month	24	hr	$90	$2,160
Technician, 16 hrs per month	192	hr	$30	$5,760
Project Mgr, 2 hrs per month	24	hr	$100	$2,400
Electrician, 4 hours per year	4	hr	$60	$240
Misc. equip/supplies	12	mo	$500	$6,000
Air sparging maintenance	12	mo	$500	$6,000
Total System Maintenance (annual):				**$31,200**
Utilities				
Electricity	175200	kWh	$0.06	$10,512
Assume 20 kW*24 hr/day*365 day/yr = 175,200 kWh/yr				
Total Utilities				**$10,512**
Total Treatment System O&M (Annual)				**$41,712**

Table D-5
PHOSter Technology Cost Alternative

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

Estimator: CRM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)

DIRECT COSTS		
Site Preparation		$279,000
PHOSter Injection Well System Installation		$136,000
Piping and Equipment		$49,000
Total Installation labor		$5,000
TOTAL DIRECT COST		**$469,000**
INDIRECT COSTS		
Engineering and Design (20%)		$94,000
TOTAL INDIRECT COST		**$94,000**
Total Capital Costs (Direct + Indirect)		**$563,000**
OPERATIONS AND MAINTENANCE		
Total for Contractor O&M		**$300,000**
Administrative O&M		
Sampling and Analysis Plan (SAP) for Monitoring Activities		$8,000
Annual Groundwater Monitoring (4 quarters)		$72,000
Reporting, Site Activities Report/System Operation Report		$23,000
Total Administrative O&M, annual		**$95,000**
Present Worth of O&M (7%, 3 yrs)	($249,310)	$249,000
Present Worth O&M + SAP		**$257,000**
Treatment System O&M		
Utilities		$0
Total Treatment System O&M, annual		**$0**
Present Worth of Treatment System O&M (7%, 2 yrs)	$0	$0
Present Worth O&M (Administrative + Treatment System O&M)		**$257,000**
Assumption - System will run for two years, plus one year of monitoring, for a total of three years.		
Total Capital and O&M Cost		$1,120,000
Contingency (10%)		$112,000
TOTAL COST		**$1,232,000**

Table D-5 (Continued)
PHOSter Technology Cost Alternative

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation				
System Design and Fabrication[1]	1	ls	$135,000	$135,000
Contractor Mobilization & Start-Up [1]	1	ls	$40,000	$40,000
Contractor demobilization	1	ls	$20,000	$20,000
Utility connection for treatment system				
Including electric poles, cable, transformer, phone line for telemetry[1]	1	ls	$80,000	$80,000
Site signs	12	ea	$49	$589
Pick-up truck	1	wk	$350	$350
Labor				
1 field engineer, 7 days, 10 hrs/day	70	hrs	$48	$3,360
Total Site Preparation				**$279,299**
Note: [1] Cost from eGeo Quote dated 8-13-03				
PHOSter System				
PHOSter Injection Well Installation[1]	1	ls	$110,000	$110,000
Oversight, engineer or geologist (50 hrs/week, 4.5 weeks)	550	hrs	$48	$26,400
Total Injection Well Installation Cost:				**$136,400**
Piping and Equipment				
Injectors/Injection line installation[1]	1	ls	$45,000	$45,000
Site restoration	1	ls	$1,000	$1,000
Remedial well survey	3	days	$1,057	$3,171
Total Piping and Equipment				**$49,171**
Note: Most piping, equipment, and labor is included in the eGeo quote under System Design/Fabrication and Well Installation				
Labor				
1 Jr. Level Engineer, 2 weeks @ 50 hrs/wk	100	hrs	$48	$4,800
Total Labor:				**$4,800**
TOTAL DIRECT COSTS				**$190,371**

Table D-5 (Continued)
PHOSter Technology Cost Alternative

OPERATIONS AND MAINTENANCE	Quantity	Unit	Unit Cost	Total Cost
Contractor O&M				
Contractor System O&M (24 months)[1]	1	ls	$300,000	$300,000
Total for Contractor O&M				**$300,000**
Administrative O&M				
SAP for Monitoring and O&M Activities				
Labor				
Jr.-Level Geologist/Scientist	80	hrs	$40	$3,200
Senior Geologist	16	hrs	$80	$1,280
ODC's, Production Support (editing, copying, binders, etc.)	1	ls	$1,000	$1,000
Word Processor	16	hrs	$35	$560
CADD, 8 hrs/figure, 4 figures	32	hrs	$40	$1,280
Editor	8	hrs	$60	$480
Copying: 50 pgs x 25 copies	1250	page	$0.10	$125
Binding/shipping, 25 copies	25	ea	$20	$500
Total SAP				**$8,425**
Quarterly Groundwater Monitoring				
Assumptions				
Duration of alternative = 2 yrs				
Use of 20 existing wells				
Quarterly for three years				
Labor:				
2 Geologist/scientists, one 5-day week per sampling event @10 hour days	100	hrs	$75	$7,500
Car Rental: (one week per event)	1	wk	$350	$350
Total Labor:				**$7,850**
Lab:				
Volatile Organics, Method 8260, assume 20 wells, 4 QC	24	ea	$135	$3,240
PAHs, Method 8310, assume 20 wells, 2 QC	22	ea	$125	$2,750
TRPH (FLPRO) asume 20 wells, 2 QC	22	ea	$90	$1,980
Total Analysis:				**$7,970**

Table D-5 (Continued)
PHOSter Technology Cost Alternative

Expendables and Equipment Rental	Quantity	Unit	Unit Cost	Total Cost
Gloves (2 boxes per event)	2	box	$10	$20
Teflon tubing (400 feet per event)	400	ft	$2.00	$800
Silicon tubing (50 feet per event)	50	ft	$2.00	$100
Shipping and supplies (tape, bubble wrap, ice)	1	ls	$250	$250
Rental of YSI 556 meter for conductivity, Oxidation-Reduction Potential, pH, dissolved oxygen, turbidity, and temperature.	1	wk	$300	$300
Pumps for purging wells, 2 pumps,	1	wk	$75	$75
MiniRAE 2000 PID monitor	1	wk	$200	$200
First Aid kit	1	ls	$50	$50
Water level indicator	1	wk	$50	$50
Disposal of purge water, assume nonhaz., (drums)	2	ea	$150	$300
Total Expendables and Equipment Rental:				**$2,145**
Total Quarterly Costs for Groundwater Monitoring				**$17,965**
REPORTING				
Site Activities Report				
1 Jr. Level Geologist	40	hrs	$40	$1,600
1 Senior Geologist	16	hrs	$80	$1,280
Production				
Word processing	12	hrs	$35	$420
Technical Expert	6	hrs	$75	$450
Editor	8	hrs	$60	$480
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APPENDIX E

ESTIMATED REMEDIAL TIME CALCULATIONS

Table E-1
SVE Estimated Time to Clean-up

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

To determine M, mass of soil treated:

Assume flow rate at SVE injection well =	10	cfm			
There is 1440 minutes in a day	1440	minutes/day			
Therefore the flow rate per day is =	14400	cf/day	or	407.763	m^3/day

From guidance document USEPA, 1996
Approximately 3 to 3.5 pounds of oxygen are needed to degrade one pound of petroleum.

Oxygen portion in air =	0.21	percent			
The flow rate of oxygen per day =	3024	cf/day	or	85.63023	m^3/day

Density = mass/volume
Therefore,
mass = (density * volume)

The density of oxygen at STP = assume STP	1.309	kg/m^3			
The volume was =	85.63023	m^3/day			
The mass of oxygen for treatment = (For one injection point)	112.08997	kg/day	or	247.1	lbs/day

Therefore: 247.1/3.5 = 70.6 lbs of petroleum product degraded per day.

Approximately 3 to 3.5 pounds of oxygen are needed to degrade 1 pound of petroleum product.
3.5 is a conservative number.

If there are 27 injection wells located at the site,

lbs of petroleum degraded per day	70.6	lbs
lbs total of petroleum in soil	24190	petroleum is soil
lbs of petroleum degraded per day / days	342.63456	days
Double time due to effects expected =	685.26912	days
under ideal conditions. or	**1.9**	**years**

Table E2
Estimated Remedial Time
Air Sparging System

Remedial Action Plan
UST Site 19
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Pensacola, Florida

The following first order decay/rate equation may be used to estimate a conservative time for the contaminants of concern concentrations to be reduced below the remedial action objectives (RAO). This model calculates both the weighted average and maximum clean-up times as dictated by the initial concentrations.

$$C_{(t)} = C_{(o)} \times e^{-Bt}$$

Variables:

$C_{(t)}$ = Concentration at end of duration or RAO's (ug/L)
$C_{(o)}$max = Initial Maximum Concentration (ug/L)
$C_{(o)}$ave = Initial Weighted Average Concentration (ug/L) (from Table E3, Page 2)
e = base of the natural log (approximately 2.71828)
B = first order differential rate constant (see page 2 of 4)
t = duration (solving for)

Solving for t reduces to: $t = \ln(C_{(t)}/C_{(o)}) / -B$

Contaminant Type	C_o Max (ug/L)*	C_o Ave (ug/L)*	C_t (ug/L)*	t Max (years)	t Ave (years)
Benzene	1220.00	261.4	1.00	46.15	36.15
Ethylbenzene	1060.00	241.96	30.00	23.15	13.56
Total Xylenes	8070.00	1944.18	40.00	34.47	25.22
Naphthalenes	215.50	106.40	20.00	19.30	13.569
TRPH	52200.00	8205.00	5000.00	19.04	4.02

Prepared By:_____ Checked By:_____

Date

Table E2 (Continued)
Estimated Remedial Time
Air Sparging System

Remedial Action Plan
UST Site 19
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Calculations of Weighted Concentration Average

Maximum contaminant concentrations at the sparging wells may be estimated by calculating a weighted average of surrounding well contaminant concentrations under static conditions. The weighted average is based on the inverse of the distances from the nearest sparging well. In order to be conservative, TtNUS does not factor wells in which no detection of contaminants were received.

Weighted Average Concentrations are calculated using the following formula (25% factor of safety added):

$$C = \frac{(c1/d1 + c2/d2 + ... + cn/dn)}{(1/d1 + 1/d2 + ... + 1/dn)} \times 1.25$$

Variables:
C = Weighted Average Concentration
c# = monitoring well concentrations
d# = distance from nearest sparging well to monitoring well considered

Well Designation	MW-2	MW-4	MW-6	MW_8	MW-11	MW-23	
Distance to As (ft):	10	10	10	10	10	10	
Contaminant Type	Concentrations (ug/L)						Weighted Concentrations (ug/l)
Benzene	47.3	920	73.8	1220.0	352.0	0.6	544.5
Toluene	139	8540	7.1	2880.0	3440.0	0.6	3126.4
Ethylbenzene	393	1060	75.6	238.0	653.0	0.0	504.1
Total Xylenes	4300	8070	618	1110.0	5290.0	53.8	4050.4
MTBE	0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalenes	52.7	215.5	6.2	3.9	232.4	0.0	106.4
TRPH	6850	52200.0	1900.0	1300.0	19500.0	300.0	17093.8

Table E2 (Continued)
Estimated Remedial Time
Air Sparging System

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
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Calculation of Rate Constant B

The first order rate coefficient B can be calculated by the following equation: B = f x d x D/L x S/V x H/u x Q/Vs

Variables:

f = Fraction of plume sparged (unitless)	f =	1.0	assumed
d = Fraction of 24-hour day unit operates (unitless)	d =	1.0	assumed
D = Contaminant diffusion coefficient (cm^2/s)	D =	see below	
L = Diffusive distance around bubble (m)	L =	4.49E-03	see page 3
S/V = effective surface area to volume ration of a bubble (m^{-1})	S/V =	667.7	see page 3
H = Depth of screen below water table (m)	H =	18.0	see page 4
u = Bubble terminal Rise velocity (m/s)	u =	2.51E-01	see page 3
Q = Total air flow (m^3/s)	Q =	5.93E-02	see page 4
V_s = Volume of water in plume that contact bubbles (m^3)	V_s =	129234.8	see page 4

Contaminant Type	D	B (sec^{-1})	B (yr^{-1})
Benzene	1.00E-09	4.88E-09	1.54E-01
Toluene	1.00E-09	4.88E-09	1.54E-01
Ethylbenzene	1.00E-09	4.88E-09	1.54E-01
Total Xylenes	1.00E-09	4.88E-09	1.54E-01
Naphthalenes	8.00E-10	3.91E-09	1.23E-01
TRPH	8.00E-10	3.91E-09	1.23E-01

Table E2
Estimated Remedial Time
Air Sparging System

Remedial Action Plan
UST Site 19
Naval Air Station Pensacola
Pensacola, Florida

Calculations of Variables

Estimation of Contaminant Diffusion Coefficient

Volatiles =	1.00E-09	m^2/s
Semi-Volatiles =	8.00E-10	m^2/s

Calculate the diffusive distance around bubble (L)

This model assumes L = r.

Where r is equal to the effective radius of the bubble

$$r = 2 \times R \times \{6\sigma/[R^2 \times (P_w - P_a) \times g]\}^{1/3}$$

Given

R =	2.54E-04	m	(orifice diameter of the sparger or well screen slot)
σ =	0.0728	N/m	(air water surface tension)
Pw =	1000	kg/m^3	(density of water)
Pa =	1.29	kg/m^3	(density of air at 50F)
g =	9.8	m/s^2	(acceleration due to gravity)
well slot =	0.01	in	
L = r =	4.49E-03	m	

S/V is the effective surface area to volume ratio of a bubble

S/V = 3/r

r is calculated above, therefore

S/V = 667.7 m^{-1}

Table E2
Estimated Remedial Time
Air Sparging System

Remedial Action Plan
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Pensacola, Florida

Calculations of Variables

υ is the terminal rise velocity of a bubble.

$\upsilon = \{1.04 \times g \times r + (1.07 \times \sigma)/(r \times P_w)\}^{1/2}$

Where:

g =	9.8	m/s^2	(acceleration due to gravity)
r =	4,49E-03	m	(calculated above)
σ =	0.0728	N/m	(air water surface tension)
P_w =	1000	kg/m^3	(density of water)
υ =	0.251	m/s	

The height, H, is equal to the average total depth of the sparge well to the water table.

TD =	60	ft
DTW =	1	ft
H =	59	ft
H =	17.9832	m

The air flow rate is determined by the number of sparge wells and a correction for pressure caused by well depth.

Q = # wells x flow rate per well x adjustment for pressure

# wells =	35	unitless
flow/well =	10.00	SCFM
TD =	60.00	ft
DTW =	1.00	ft
ADJF =	0.35869565	unitless
Q =	125.543478	CFM
Q =	5.93E-02	m^3/s

Table E2
Estimated Remedial Time
Air Sparging System

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Naval Air Station Pensacola
Pensacola, Florida

Calculations of Variables

Volume of plume in sparged area is determined by following calculation

$$Vs = A \times h \times \eta$$

Where:

A =	309,600	ft^2	(estimated surface area of plume)
h =	59.00	ft	(height of contaminated groundwater)
η =	0.25	unitless	(porosity from the SAR)

V_s = 4566600 ft^3

V_s = 129234.8 m^3