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NAS PENSACOLA
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REMEDIAL ACTION PLAN FOR BUILDING 1932, NAVY EXCHANGE "TOUCH-N-GO" SERVICE STATION UST SITE 25 NAS PENSACOLA FL

4/1/2002

NAVFAC SOUTHERN

TETRA TECH NUS, INC.
7018 A.C. Skinner Parkway ■ Suite 250 ■ Jacksonville, FL 32256
(904) 281-0400 ■ FAX (904) 281-0070 ■ www.tetratech.com

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April 4, 2002

Project Number N4179

Ms. Tracie Vaught
Remedial Project Manager
Technical Review/Federal Facilities
Florida Department of Environmental Protection
2600 Blair Stone Road
Mail Station 4535
Tallahassee, Florida 32399-2400

Reference: CLEAN Contract Number N62467-94-D-0888
Contract Task Order (CTO) Number 0221

Subject: Final Remedial Action Plan
Building 1932
Naval Air Station Pensacola
Pensacola, Florida

Dear Ms. Vaught:

Tetra Tech NUS Inc. (TtNUS) is pleased to submit the Final Remedial Action Plan for Building 1932 at Naval Air Station (NAS) Pensacola in Pensacola, Florida for your review. This report has been prepared for the U.S. Navy Southern Division, Naval Facilities Engineering Command (SOUTHHNAVFACENGCOM) under CTO 0221, 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,

(For) Gerald Walker, P.G.
Project Manager

Enclosures

cc: Mr. B. Glover, SOUTHNAVEFACENGCOM (1 copy)
Mr. G. Campbell, NAS Pensacola (1 copy)
Ms. D. Wroblewski, TtNUS (cover letter only)
Mr. G. Roof, TtNUS (1 copy)
Mr. M. Perry, TtNUS (unbound copy)
✓Project Office File

Remedial Action Plan
for
Building 1932, Navy Exchange "Touch-n-Go" Service Station UST Site 000025

Naval Air Station Pensacola
Pensacola, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0221

April 2002

02JAX0077

REMEDIAL ACTION PLAN
FOR
BUILDING 1932, NAVY EXCHANGE
"TOUCH-N-GO" SERVICE STATION
UST SITE 000025

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

CONPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
Foster Plaza 7
661 Andersen Drive
Pittsburgh, Pennsylvania 15220-2745

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0221

APRIL 2002

PREPARED UNDER THE SUPERVISION OF:

GERALD WALKER
TASK ORDER MANAGER
TETRA TECH NUS, INC.
TALLAHASSEE, FLORIDA

APPROVED FOR SUBMITTAL BY:

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

The professional opinions rendered in this decision document identified as Remedial Action Plan for Building 1932, 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.

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

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ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
AST	Aboveground Storage Tank
bls	Below Land Surface
CAD	Computer Aided Design
CLEAN	Comprehensive Long-term Environmental Action Navy
cm/sec	centimeters per second
COCs	Contaminants of Concern
CSSPC	Coastal Systems Station Panama City
CTO	Contract Task Order
DE	Direct Exposure Limit
DPE	Dual-Phase Extraction
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FID	Flame Ionization Detector
FOTW	Federally Owned Treatment Works
ft	Feet (Foot)
ft^2	Square Feet
ft^3	Cubic Feet
GAC	Granular Activated Carbon
GAG	Gasoline Analytical Group
GCTLs	Groundwater Cleanup Target Levels
HOA	Hand-On-Auto
i	Hydraulic Gradient
K	Hydraulic Conductivity
KAG	Kerosene Analytical Group
LE	Leachability Limit
lbs	Pounds
lbs/day	Pounds per Day
µg/L	Micrograms per Liter
MDES	Mobile Dual Phase Extraction System
mg/kg	Milligrams per Kilogram
msl	Mean Sea Level
NAS	Naval Air Station
Navy	United States Navy
n_e	Effective Porosity

ACRONYMS (Continued)

NEMA	National Electrical Manufacturers Association
O&M	Operations & Maintenance
OVA	Organic Vapor Analyzer
ppm	Parts per Million
PVC	Polyvinyl Chloride
RAP	Remedial Action Plan
ROI	Radios of Influence
SAR	Site Assessment Report
SCTL	Soil Cleanup Target Level
SVE	Soil Vapor Extraction
TOC	Top of Casing
TRPH	Total Recoverable Petroleum Hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VAC	Voltage Alternating Current
VEE	Vapor Enhanced Extraction
VOCs	Volatile Organic Compounds
Vs	Seepage Velocity
yd^3	Cubic Yards

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (TtNUS) has completed a Remedial Action Plan (RAP) for Building 1932 Underground Storage Tank (UST) Site 000025 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) (TtNUS, 2001).
- Evaluated remedial alternatives for soil and free product at Building 1932.
- Prepared a RAP to provide a conceptual design for the remediation of soil and free product recovery and provide remedial equipment specifications.
- Specified a monitoring plan to track the remediation status of the site.
- Specified a system start-up and operation and maintenance (O&M) plan to operate the system.

This RAP identified a bioslurping system as the preferred remedial alternative to cleanup the site. Bioslurping technology remediates both soil contamination and free product recovery with a single system. The system was designed using information gathered from the SAR and from successful systems at similar locations. However, a treatability study is recommended to ensure an optimal final design. Based on a similar system and similar site conditions at Coastal Systems Station, Panama City (CSSPC), it is estimated that the system should remediate the site in four years. Results from the treatability study will more accurately determine the estimated time to cleanup. O&M requirements of the system will include maintaining the system in a proper operating mode, collecting samples from the vapor enhanced extraction (VEE) wells to verify that the system is operating as designed, and monitoring free product in monitoring wells.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

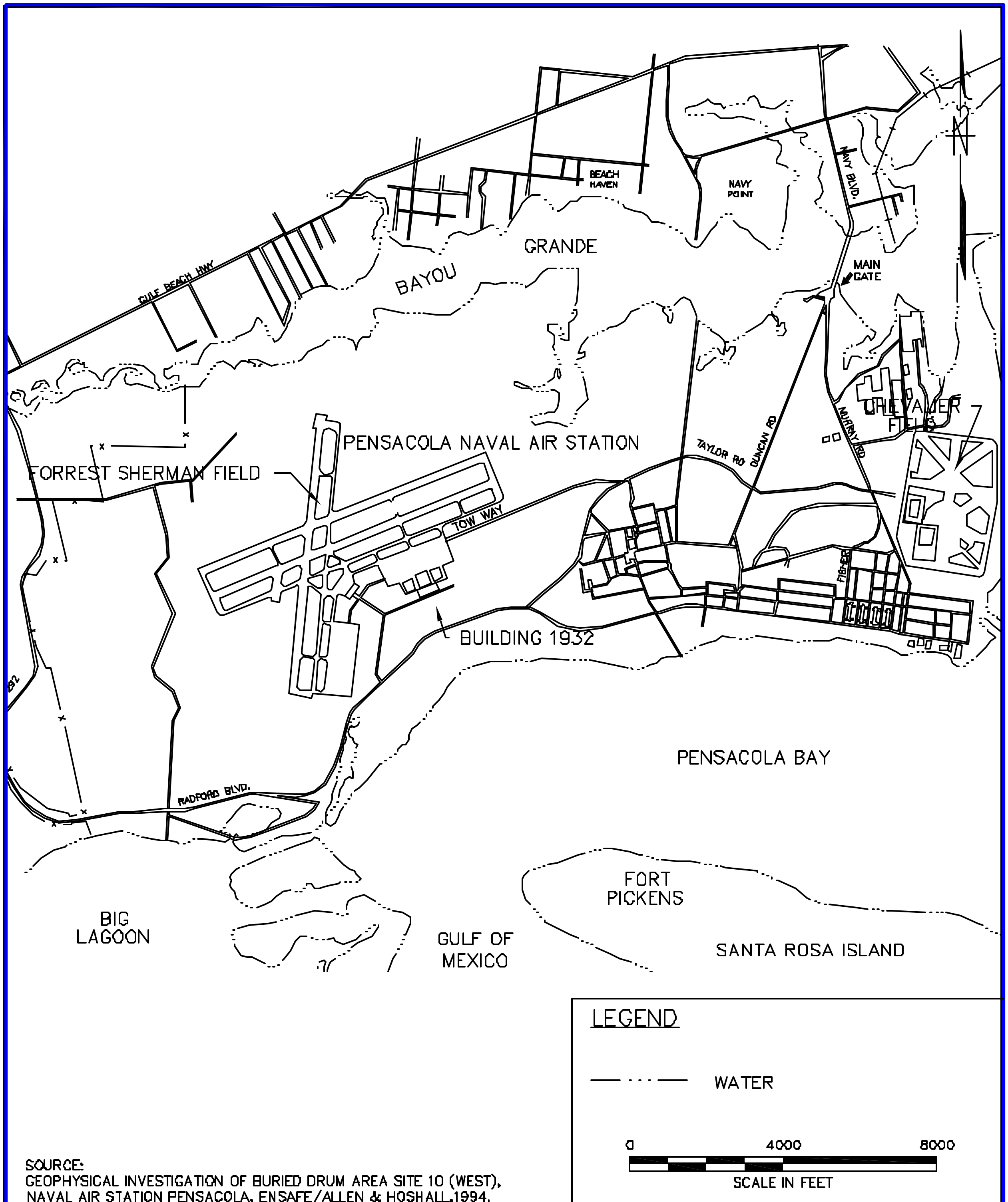
This RAP was prepared by TtNUS for the United States Navy (Navy) Southern Division Naval Facilities Engineering Command under Contract Task Order (CTO) 0221, for the Comprehensive Long-term Environmental Action Navy (CLEAN) III, Contract Number N62467-94-D-0888. The RAP was prepared to evaluate and recommend treatment options for the contaminated soil and free product present at Building 1932 at NAS Pensacola, Pensacola, Florida (Figure 1-1).

In 2001, TtNUS performed a site assessment and completed a SAR for Building 1932. The SAR recommended the preparation of a RAP to remove free product and remediate soil at the site. After free product removal and soil remediation, the SAR recommended that on-site groundwater be evaluated for natural attenuation.

The purpose of this RAP is to determine a remedial alternative to remediate soil and remove free product in accordance with the requirements of Chapter 62-770, FAC. This RAP evaluates applicable alternatives to protect human health and the environment, reduce contaminant concentrations within impacted soil, and retard further migration of contaminants to downgradient areas. This RAP also recommends a 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

Building 1932, UST Site 000025, is the current Navy Exchange “Touch N Go” Service Station facility located at Sherman Field, NAS Pensacola. NAS Pensacola is located in northwest Florida on the western side of Pensacola Bay, approximately 2 miles south of Pensacola, Florida, on Navy Boulevard. Building 1932 is located on the north side of San Carlos Road within the boundaries of Forrest Sherman Field. Building 1932, UST Site 000025 (Figure 1-2), consists of a single building and three canopy covered pump islands, and is currently used as a convenience store and gasoline station for Navy personnel. A former pump island is noted on Figure 1-2 to the south-southwest of the current dispensers. The concrete base and water lines are still present at this former pump island. The status of the former product lines is unknown. The site is covered with asphalt and concrete. Surface drainage generally flows to the south and is collected by storm sewer drains. The fuel islands are currently supplied fuels from aboveground storage tanks (ASTs) located approximately 85 feet (ft) south of the building. The ASTs supply diesel, unleaded, and super-unleaded fuel to the station via underground transportation lines.



SOURCE:
GEOPHYSICAL INVESTIGATION OF BURIED DRUM AREA SITE 10 (WEST), NAVAL AIR STATION PENSACOLA. ENSAFE/ALLEN & HOSHALL,1994.

DRAWN BY LLK / DATE 2/26/02		REGIONAL MAP REMEDIAL ACTION PLAN BUILDING 1932 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 4179
CHECKED BY / DATE			OWNER NO. 0000
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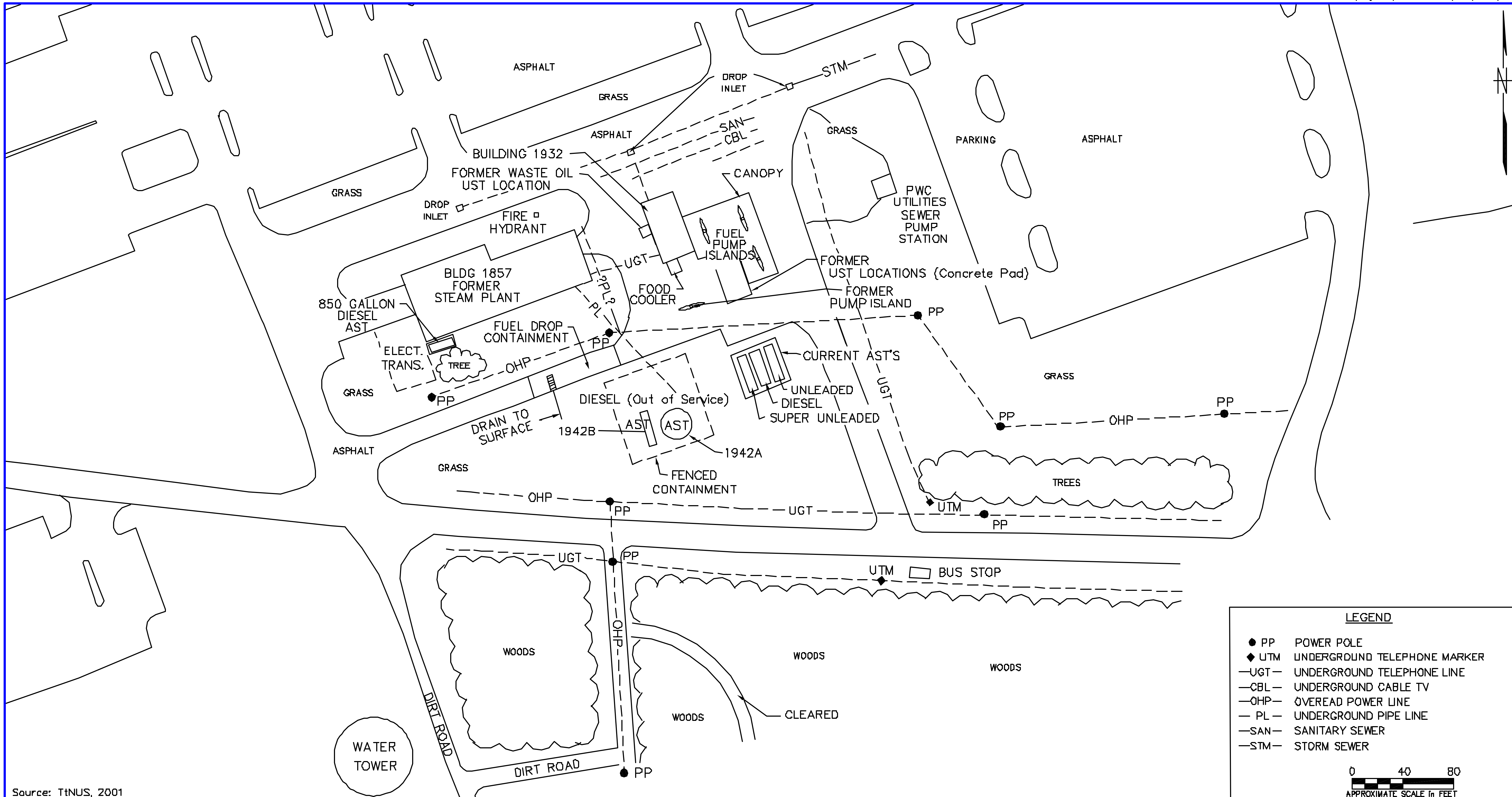

Source: TtNUS, 2001

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SITE PLAN
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 7749
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1.3 SITE HISTORY

According to the SAR, Building 1932 was constructed in 1959 and the original drawings indicated two vehicle service areas, one with a vehicle lift and the second with a floor drain (TtNUS, 2001). Former USTs located south of the fuel islands previously provided fuel for the service station. The current status of the former USTs is unknown. Whether the USTs were closed in place or closed by removal is unknown at this time. A concrete slab now covers the former USTs (or previous location of the USTs) and no fill ports are present. A 40-inch by 45-inch, 500-gallon capacity, steel used oil tank (UST Number 1932F) was located along the west wall of Building 1932 and received waste oil from service station activities. The waste oil UST was closed by removal in August 1994 and a release was reported based on discolored soil and corresponding organic vapor analyzer (OVA) response indicative of petroleum. Copies of the tank closure report and other historic data are provided in the SAR for the site (TtNUS, 2001)

After the release associated with the waste oil tank removal was reported (March 1995), a monitoring well was installed in the former tank hold location and a groundwater sample was collected. The sample was analyzed for volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method 8260 and base neutral acid extractables using USEPA Method 8270A. The groundwater sample was reported to contain 12 compounds at concentrations above method detection limits. Two of the compounds, naphthalene [79 micrograms per liter (μg/L)] and m,p-xylene (62 μg/L), were detected at concentrations exceeding the Florida Groundwater Cleanup Target Levels (GCTLs). Copies of the boring log and monitoring well construction diagram for this well (hereby designated as NASP-1932-MW-1) along with the laboratory data sheet are provided in the SAR for the site (TtNUS, 2001).

1.4 REPORT ORGANIZATION

This RAP 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	Provides information from the approved SAR and other investigations, and summarizes their findings and conclusions.

Section 3.0	RAP Goals	Establishes the soil treatment and free product recovery objectives for the remedial system/plan.
Section 4.0	Contaminant Distribution	Estimates the mass of free product and contaminants in the soil.
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 conceptual design of the preferred remedial alternatives.
Section 7.0	O&M and Monitoring	Establishes start-up and O&M procedures and provides a monitoring plan for the remediation system and sampling frequencies to evaluate the system's effectiveness.
Section 8.0	Remedial Action Plan Summary	Provides the FDEP summary checklist.
	References	Lists references used.

2.0 PREVIOUS INVESTIGATION FINDINGS AND CONCLUSIONS

The following is a summary of the data and information presented in the SAR (TtNUS, 2001).

2.1 LITHOLOGIC FINDINGS

The typical lithology at the site is yellowish brown to light brown to white, silty fine to medium grained sand. This lithology was encountered across the site from ground surface to depths of approximately 15 to 16 ft where a 1-ft thick peat layer was encountered. The tannic acid infusing the groundwater around the peat layers causes the sand to appear dark brown. A number of other borings encountered the dark brown tannic acid colored saturation prior to penetrating the peat. This tannic acid saturation generally occurred approximately 1 ft above the peat. Other than the peat layers, lithologies that would indicate potential confining layers were not encountered during the site assessment. Boring logs are contained within the SAR.

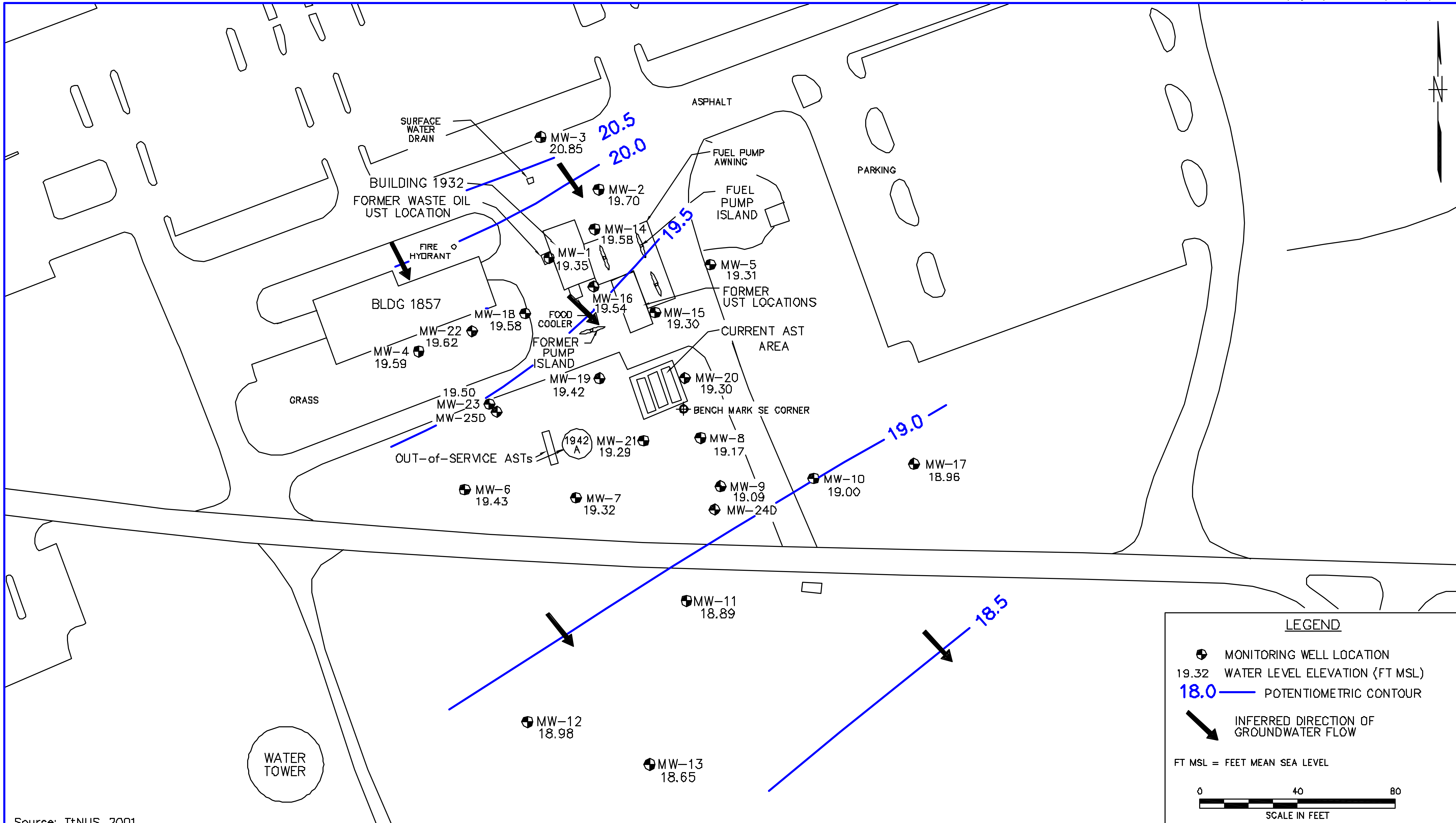
Regional lithology information is provided in the SAR (TtNUS, 2001). A copy of the fence diagram from the SAR is included in Appendix A.

2.2 GROUNDWATER AND AQUIFER CHARACTERISTICS

The depth to groundwater is approximately 10 to 13 ft below land surface (bls) at the site. Groundwater flow in the surficial aquifer is toward the south-southeast, away from Building 1932 toward Pensacola Bay (Figure 2-1). Table 2-1 presents the monitoring well construction data and groundwater elevations for November 8, 2000 and May 1, 2001. Figure 2-2 presents the groundwater potentiometric surface map from May 1, 2001.

The following aquifer parameter were estimated in the SAR (TtNUS, 2001).

Hydraulic conductivity	K	=	185 ft per day or 6.526×10^{-2} centimeters per second (cm/sec)
Hydraulic gradient	i	=	0.00465 ft per foot
Seepage Velocity	Vs	=	1054.9 ft per year
Effective Porosity	n_e	=	0.30 (unitless)



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DRAWN BY LLK DATE 3/4/02
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COST/SCHED-AREA
SCALE AS NOTED

WATER LEVEL ELEVATIONS, SHALLOW ZONE
NOVEMBER 8, 2000
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179
APPROVED BY 0000 DATE
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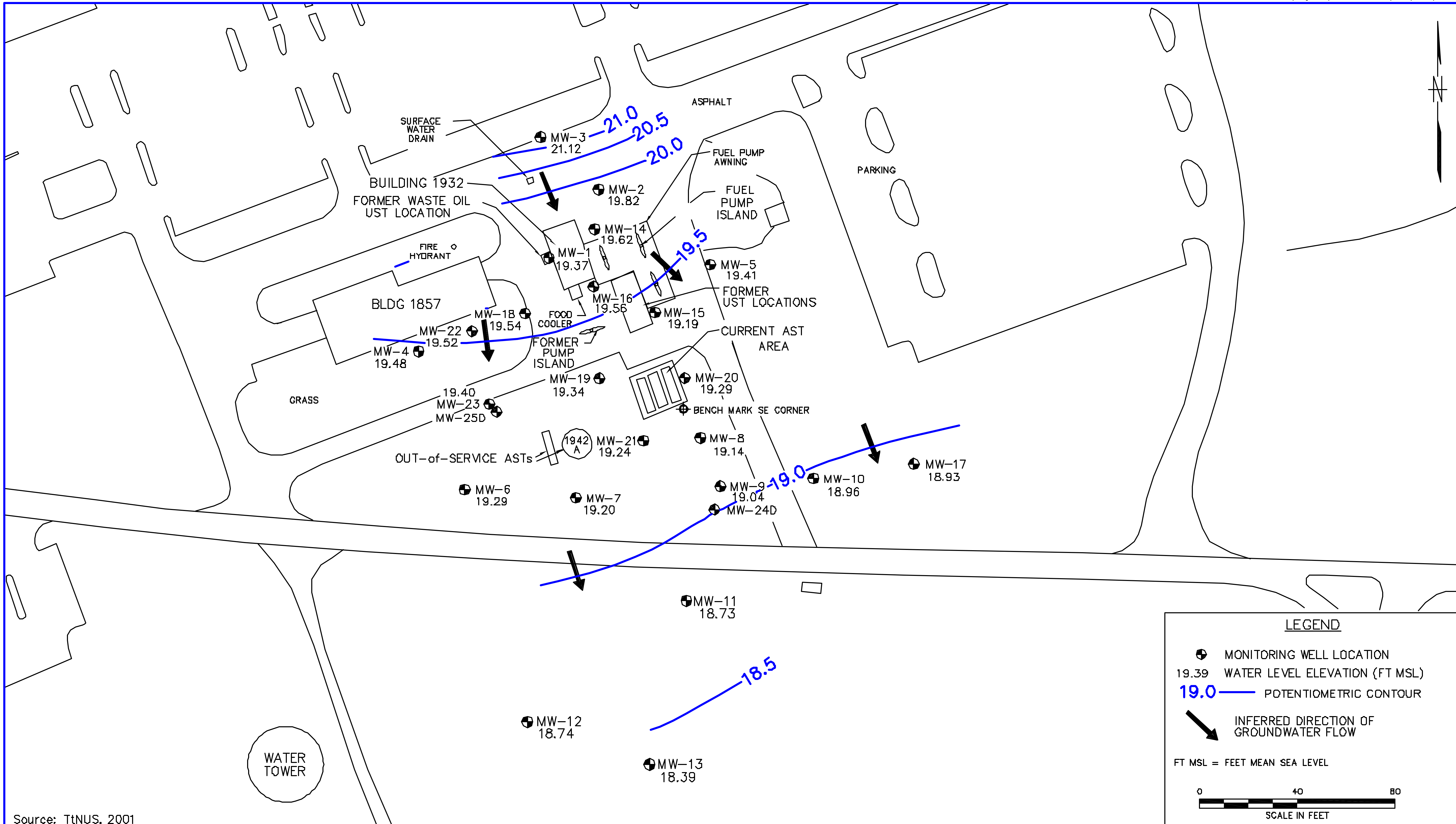
TABLE 2-1
Groundwater Elevation Summary

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Well ID	TOC Elevation (ft msl)	Depth of Well (ft)	Screened Interval (ft)	Depth to Water (ft)		Depth to Free Product (ft)		Free Product Thickness (ft)		Adj. Water Elevation (ft msl)	
				11/8/2000	5/1/2001	11/8/2000	5/1/2001	11/8/2000	5/1/2001	11/8/2000	5/1/2001
MW-1	31.055	16.34	5.85 - 15.85*	11.71	11.69	Trace	Sheen	<0.01		19.35	19.37
MW-2	31.070	15.50	5.0 - 15.0	11.37	11.25					19.70	19.82
MW-3	31.490	15.92	5.42 - 15.42	10.64	10.37					20.85	21.12
MW-4	31.600	16.08	5.58 - 15.58	12.01	12.12					19.59	19.48
MW-5	31.240	15.50	5.0 - 15.0	11.93	11.83					19.31	19.41
MW-6	29.810	16.05	5.55 - 15.55	10.38	10.52					19.43	19.29
MW-7	30.760	14.62	4.12 - 14.12	11.44	11.56					19.32	19.20
MW-8	31.250	15.54	5.04 - 15.04	12.41	12.11	12.00	Sheen	0.41		19.17	19.14
MW-9	30.070	15.60	5.10 - 15.10	10.98	11.03	Sheen				19.09	19.04
MW-10	31.090	15.95	5.45 - 15.45	12.09	12.13					19.00	18.96
MW-11	30.640	16.50	6.0 - 16.0	11.75	11.91					18.89	18.73
MW-12	29.210	15.85	5.35 - 15.35	10.23	10.47					18.98	18.74
MW-13	28.830	16.10	5.6 - 15.6	10.18	10.44					18.65	18.39
MW-14	31.400	15.85	5.35 - 15.35	11.82	11.78					19.58	19.62
MW-15	31.195	15.85	5.35 - 15.35	12.81	12.01	11.67	11.75	1.14	0.26	19.30	19.19
MW-16	31.250	15.81	5.31 - 15.31	11.71	11.69	Trace		<0.01		19.54	19.56
MW-17	30.150	15.78	5.28 - 15.28	11.19	11.22					18.96	18.93
MW-18	31.910	15.82	5.32 - 15.32	12.33	12.37	Sheen	Sheen			19.58	19.54
MW-19	31.480	16.00	5.50 - 15.50	12.06	12.14		12.13		0.01	19.42	19.34
MW-20	31.280	16.14	5.64 - 15.64	11.98	11.99	Trace		<0.01		19.30	19.29
MW-21	31.200	15.79	5.29 - 15.29	11.91	11.96	Trace		<0.01		19.29	19.24
MW-22	31.840	15.80	5.30 - 15.30	12.22	12.32	Trace		<0.01		19.62	19.52
MW-23	30.965	15.80	4.5 - 14.5	11.47	11.57					19.50	19.40
MW-24D	29.900	39.60	34.10 - 39.10	12.23	12.08					17.67	17.82
MW-25D	30.750	38.55	33.05 - 38.05	12.76	12.58					17.99	18.17

NOTES: Assumed benchmark of 33 feet above sea level at the SE corner of the current AST containment area.
* = Existing well installed by another consultant
Assumes Specfic Gravity of 0.8 for free product.
TOC (Top Of Casing) elevations surveyed 11/8/00
Bottom Point Cap Sump equals 0.5 foot
ft msl = feet above mean sea level



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY: LLK — DATE: 3/4/02
CHECKED BY — DATE
COST/SCHED-AREA
SCALE: AS NOTED

WATER LEVEL ELEVATIONS, SHALLOW ZONE
MAY 1, 2001
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179
APPROVED BY 0000 — DATE
APPROVED BY — DATE
DRAWING NO. FIGURE 2-2 — REV. 0

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 investigations and monitoring well installation described in the SAR (TtNUS, 2001).

During the SAR field activities performed in August and October 2000, the extent of soil contamination was determined by the installation of soil borings and OVA-Flame Ionization Detector (FID) screening of soil samples. Eleven soil borings (SB-1 through SB-11) were installed by direct push technology to the water table that occurred at approximately 14 to 15 ft bls. Results of the initial soil screening indicated that 5 of the 11 soil borings exhibited FID readings greater than 50 parts per million (ppm). Also, during the installation of the 24 monitoring wells, 18 FID samples were collected from the drilling cuttings of wells that were not adjacent to previous soil borings. Nine of the 18 well borings exhibited FID readings greater than 50 ppm. FID results from the soil screening are summarized in Table 2-2, and the soil boring location map is included as Figure 2-3.

In addition, Figures 2-4 through 2-6 present the 50-ppm isoconcentration lines for soil gas. Based on the diesel fuel and waste oil released at the site, 50-ppm soil gas is the criteria for "excessively contaminated" soil.

Seven confirmatory soil samples were collected for off-site laboratory analysis during the SAR field activities. Five of the samples (SB-1, SB-3, SB-5, SB-7, and SB-11) exhibited results that exceeded FDEP Leachability (LE) and/or Direct Exposure (DE) limits. Table 2-3 summarizes the analytical results from the confirmatory soil sample analysis and indicates FDEP Soil Cleanup Target Level (SCTL) exceedances. A soil analyte detection map is provided as Figure 2-7.

The results of the soil assessment indicate that there are petroleum-impacted soils at the site exceeding FDEP SCTLs. 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 2-6.

2.4 CONTAMINATED GROUNDWATER ASSESSMENT

The approved SAR for Building 1932 recommended that groundwater sampling of natural attenuation parameters should be conducted after free product recovery and soil remediation have been completed. Therefore, groundwater remediation will not be addressed in this RAP. Groundwater remediation will be

TABLE 2-2
Soil OVA Screening Results

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

SAMPLE					OVA SCREENING RESULTS		
Location Number	**Date Collected**	**Depth to Water (ft)**	**Sample Interval (ft bls)**	**Total Reading (ppm)**	**Carbon Filtered (ppm)**	**Net Reading (ppm)**	**Comments**
SB-1	8/5/2000		4-8	350	5	**345**	Adjacent to MW-1.
	8/5/2000	14.0	10-14	480	35	**445**	Free product at 13 ft bls. Analytical sample taken.
SB-2	8/5/2000		4-8	4	0	4	Adjacent to MW-18.
	8/5/2000		8-12	330	0	**330**	
	8/5/2000	14.0	12-14	255	2	**253**	Free product at 13-14 ft bls.
SB-3	8/5/2000		2-4	900	340	**560**	Adjacent to MW-14.
	8/5/2000		4-8	600	15	**585**	
	8/5/2000		8-12	900	130	**770**	
	8/5/2000	14.0	12-14	900	43	**857**	Analytical sample.
SB-4	8/5/2000		0-4	0	0	0	Adjacent to MW-2 .
	8/5/2000		4-8	0	0	0	
	8/5/2000	11.5	8-12	3	3	0	Analytical sample 8-12ft bls, TOC sample 12 -16 ft bls (peat at bottom)
SB-5	8/5/2000		0-4	0	0	0	
	8/5/2000		4-8	60	0	**60**	
	8/5/2000		8-12	270	5	**265**	Analytical sample 8-12 ft bls.
	8/5/2000	14.0	12-14	360	19	**341**	
SB-6	8/5/2000		0-4	0	0	0	
	8/5/2000		4-8	0	0	0	
	8/5/2000		8-12	1	0	1	Analytical sample 10-12 ft bls.
	8/5/2000	12.0	12-16	3	0	3	TOC sample 15 -16 ft bls (peat).
SB-7	8/5/2000		0-4	1550	1100	**450**	Adjacent to former dispenser island.
	8/5/2000		4-8	1050	0	**1050**	
	8/5/2000		8-12	1350	320	**1030**	
	8/5/2000	14.0	12-14	1200	280	**720**	
SB-8	8/6/2000		0-4	*	*	*	Adjacent to south of MW-18.
	8/6/2000		4-8	*	*	*	Strong petroleum odor.
	8/6/2000		8-12	*	*	*	
	8/6/2000	15.0	12-16	*	*	*	Free product at 14-15 feet bls.
SB-9	8/6/2000		0-4	*	*	*	Strong petroleum odor.
	8/6/2000		4-8	*	*	*	
	8/6/2000		8-12	*	*	*	
	8/6/2000	15.0	12-16	*	*	*	Free product at 14-15 feet bls.
SB-10	8/6/2000		0-4	*	*	*	Adjacent to MW-23 screened 10/10/00
	8/6/2000		4-8	*	*	*	
	8/6/2000		8-12	*	*	*	

TABLE 2-2 (Continued)
Soil OVA Screening Results

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

SAMPLE					OVA SCREENING RESULTS		
Location Number	**Date Collected**	**Depth to Water (ft)**	**Sample Interval (ft bls)**	**Total Reading (ppm)**	**Carbon Filtered (ppm)**	**Net Reading (ppm)**	**Comments**
SB-11	8/6/2000		0-4	*	*	*	Adjacent to MW-15 installed 10/8/00.
	8/6/2000		4-8	*	*	*	
	8/6/2000		8-12	*	*	*	
	8/6/2000	15.0	12-16	*	*	*	Analytical sample 12-15 ft bls. Free product at 14-15 ft bls.
MW-1	3/13/1995	9.5	0-17	NA	NA	NA	Installed by FGS, Inc. See adjacent SB-1.
MW-2	10/4/2000	11.5	NA	NA	NA	NA	See adjacent SB-4.
MW-3	10/4/2000		0-4	0	0	0	
	10/4/2000		4-8	0	0	0	
	10/4/2000	11.5	8-12	0	0	0	
MW-4	10/5/2000		0-4	0	0	0	
	10/5/2000		4-8	0	0	0	
	10/5/2000		8-12	0	0	0	
	10/5/2000	12.0	12-16	0	0	0	
MW-5	10/5/2000		0-4	0	0	0	
	10/5/2000		4-8	0	0	0	
	10/5/2000	12.0	8-12	0	0	0	
MW-6	10/5/2000		0-4	0	0	0	
	10/5/2000		4-8	0	0	0	
	10/5/2000	11.0	8-12	0	0	0	
MW-7	10/5/2000		0-4	0	0	0	
	10/5/2000		4-8	70	0	**70**	
	10/5/2000	11.0	8-12	170	0	**170**	
MW-8	10/5/2000		0-4	0	0	0	
	10/5/2000		4-8	16	0	16	
	10/5/2000	11.0	8-12	150	0	**150**	Free product
MW-9	10/6/2000		0-4	0	0	0	
	10/6/2000		4-8	3	0	3	
	10/6/2000	10.5	8-12	100	0	**100**	
MW-10	10/7/2000		0-4	0	0	0	
	10/7/2000		4-8	0	0	0	
	10/7/2000	11.5	8-12	0	0	0	
MW-11	10/7/2000		0-4	0	0	0	
	10/7/2000		4-8	0	0	0	
	10/7/2000	11.0	8-11	0	0	0	
	10/7/2000		12-16	165	0	**165**	Groundwater has strong diesel odor.

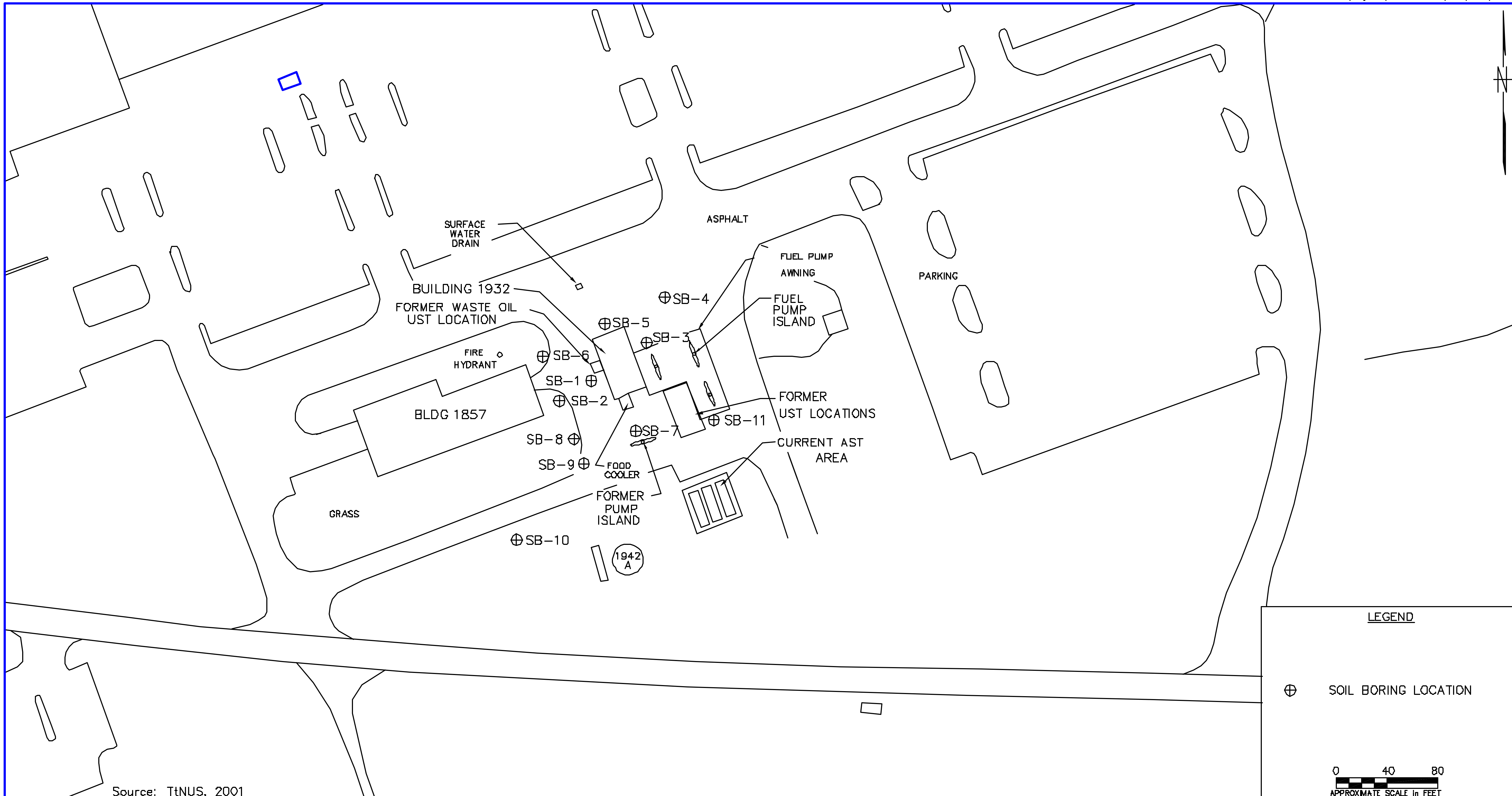
See notes at end of table.

TABLE 2-2 (Continued)
Soil OVA Screening Results

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

SAMPLE					OVA SCREENING RESULTS		
Location Number	**Date Collected**	**Depth to Water (ft)**	**Sample Interval (ft bls)**	**Total Reading (ppm)**	**Carbon Filtered (ppm)**	**Net Reading (ppm)**	**Comments**
MW-12	10/7/2000		0-4	0	0	0	
	10/7/2000		4-8	0	0	0	
	10/7/2000	10.5	8-12	0	0	0	
	10/7/2000		12-16	0	0	0	
MW-13	10/8/2000		0-4	0	0	0	
	10/8/2000		4-8	0	0	0	
	10/8/2000	10.0	8-12	0	0	0	
	10/8/2000		12-16	0	0	0	
MW-14	10/8/2000	12.0	NA	NA	NA	NA	See adjacent SB-3
MW-15	10/8/2000		0-4	1400	800	**600**	Adjacent to SB-11.
	10/8/2000		4-8	1000	100	**900**	
	10/8/2000	12.5	8-12	1200	150	**1050**	Free product
	10/8/2000		12-16	1600	1100	**500**	
MW-16	10/8/2000		0-4	95	0	**95**	
	10/8/2000		4-8	280	10	**270**	
	10/8/2000	11.0	8-12	800	150	**650**	
MW-17	10/9/2000		0-4	0	0	0	
	10/9/2000		4-8	0	0	0	
	10/9/2000	10.5	8-12	0	0	0	
	10/9/2000		12-16	0	0	0	
MW-18	10/9/2000	12.0	NA	NA	NA	NA	See adjacent SB-2 to the north.
MW-19	10/9/2000		0-4	20	5	15	
	10/9/2000		4-8	240	15	**225**	
	10/9/2000	11.0	8-12	410	170	**240**	
MW-20	10/9/2000		0-4	0	0	0	
	10/9/2000		4-8	60	0	**60**	
	10/9/2000	12.0	8-12	170	0	**170**	
MW-21	10/10/2000		0-4	0	0	0	
	10/10/2000		4-8	95	0	**95**	
	10/10/2000		8-10	160	0	**160**	
	10/10/2000	11.0	10-12	145	0	**145**	
MW-22	10/10/2000		0-4	0	0	0	
	10/10/2000		4-8	0	0	0	
	10/10/2000	11.0	8-12	60	0	**60**	
MW-23	10/10/2000	11.0	NA	NA	NA	NA	See adjacent SB-10.
MW-24D	10/11/2000	10.5	NA	NA	NA	NA	See adjacent MW-9.
MW-25D	10/18/2000	11.0	NA	NA	NA	NA	See adjacent SB-10.

Notes: * = Porta-FID gas out no readings available all borings hand augered to 4 ft bls for utilities



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SCALE AS NOTED

SOIL BORING LOCATIONS
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

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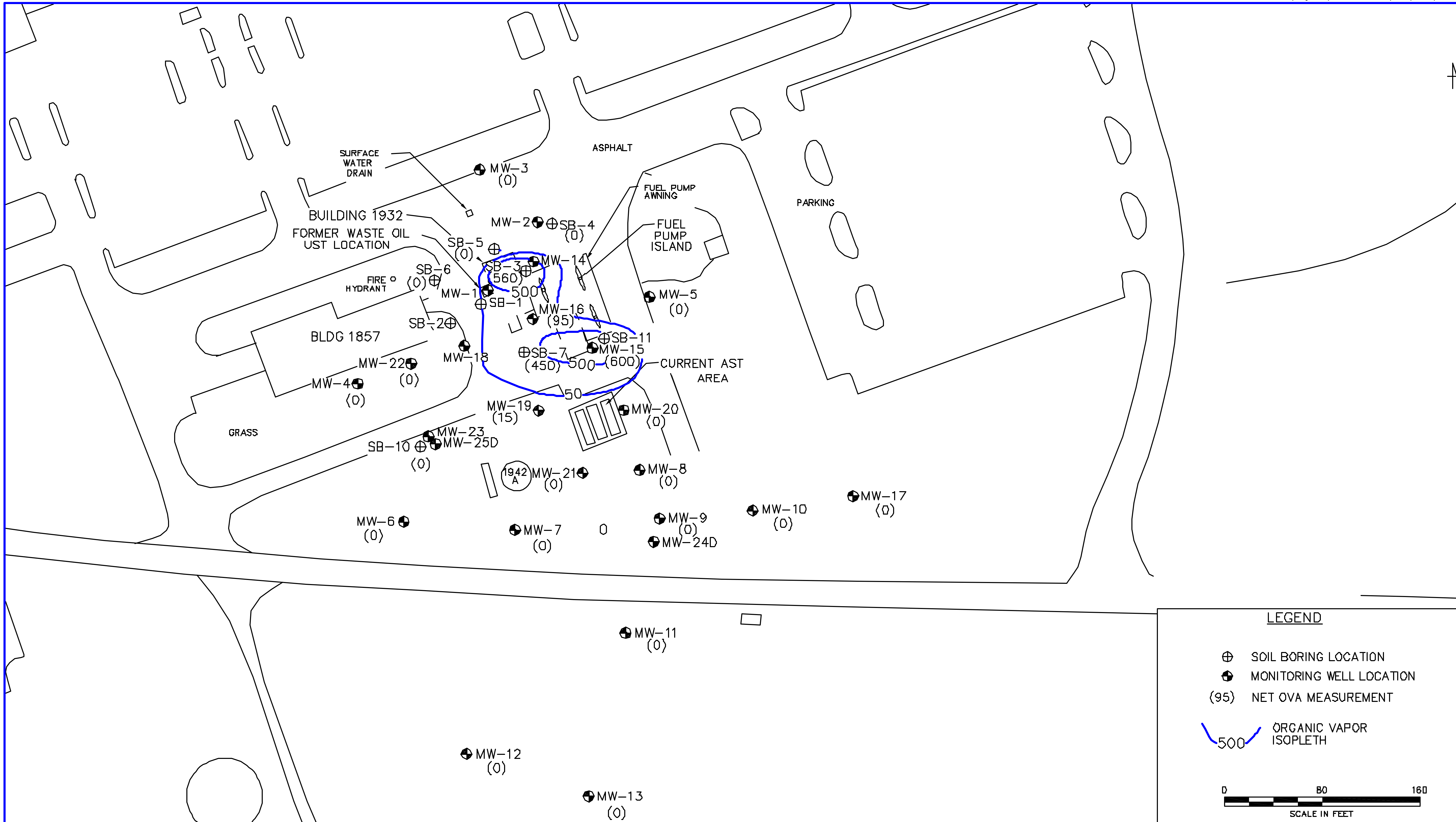
REV. 0



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SCALE AS NOTED	

SOIL HEADSPACE SCREENING RESULTS
0-4 FEET BLS
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

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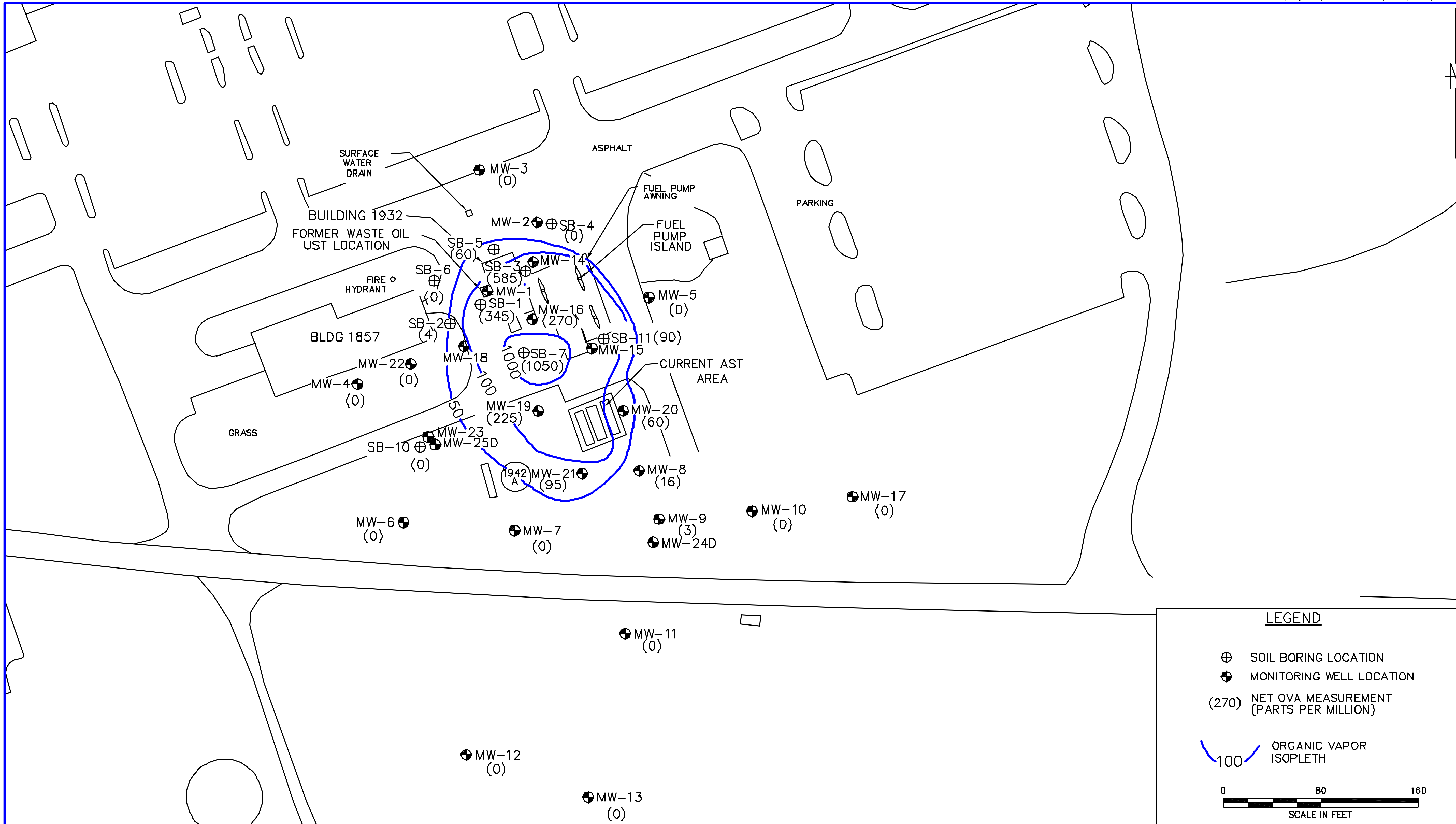

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SCALE AS NOTED

SOIL HEADSPACE SCREENING RESULTS
4-8 FEET BLS
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

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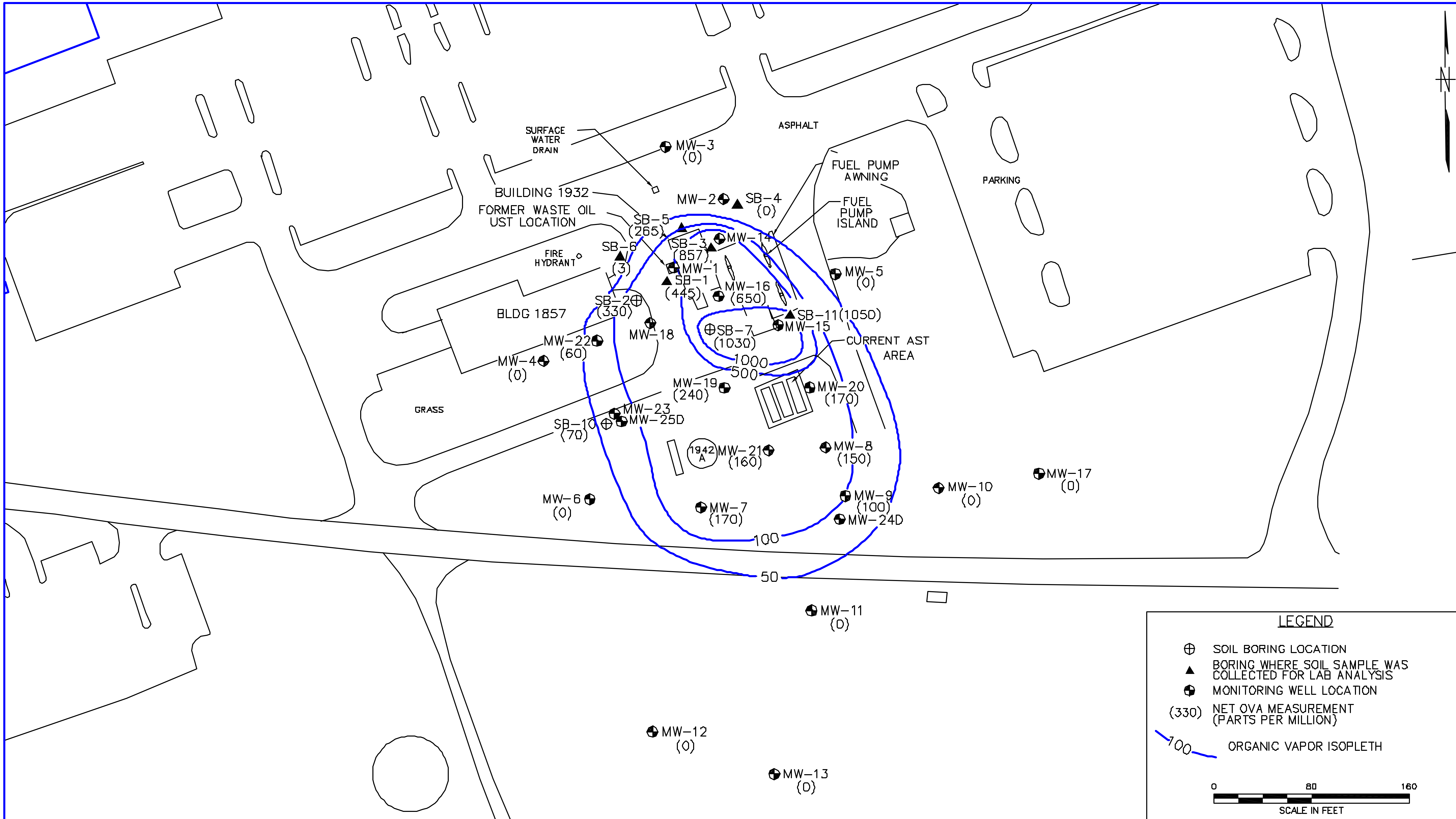

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CHECKED BY DATE
COST/SCHED-AREA
SCALE: AS NOTED

SOIL HEADSPACE SCREENING RESULTS
IMMEDIATELY ABOVE WATER TABLE
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-6
REV. 0

TABLE 2-3
Summary of Analytical Compounds Detected in Soil

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Number	DE1[1]/DE2[2]/LE[3] (mg/kg)	NASP1932 SB-1	NASP1932 DUP-1	NASP1932 SB-3	NASP1932 SB-4	NASP1932 SB-5
Sample Location		SB-1	SB-1 Duplicate	SB-3	SB-4	SB-5
Collect Date		8/8/2000	8/8/2000	8/8/2000	8/8/2000	8/8/2000
Sample Depth (bls)		10 - 14'	10 - 14'	12 - 14'	10 - 11.5'	8 - 12'
Volatile[4] (mg/kg)						
Ethylbenzene	1,100/8,400/0.6	**0.81**	--	**0.97**	--	--
Xylenes (total)	5,900/40,000/0.2	**1.1**	--	--	--	--
Methylene Chloride	16/23/0.02	--	--	--	--	--
Semi-Volatile [5](mg/kg)						
Phenol	900**/390,000/0.5	**0.82**[J]	--	--	--	--
1-Methylnaphthalene	68/470/2.2	**12**	0.24	**4.4**	--	**3**
2-Methylnaphthalene	80/560/6.1	**17**	0.34	**6.3**	--	4.2
Acenaphthene	1,900/18,000/2.1	1.8	0.045[J]	0.59	--	0.46
Anthracene	18,000/260,000/2,500	1	--	0.38[J]	--	0.45
Benzo(a)anthracene	1.4/5/3.2	--	--	--	--	--
Benzo(a)pyrene	0.1/0.5/8	--	--	--	--	--
Benzo(b)fluoranthene	1.4/4.8/10	--	--	--	--	--
Benzo(g,h,i)perylene	2,300/41,000/32,000	--	--	--	--	--
Benzo(k)fluoranthene	15/52/25	--	--	--	--	--
Chrysene	140/450/77	0.22[J]	0.013[J]	--	--	0.036[J]
Fluoranthene	2,900/48,000/1,200	0.28[J]	--	--	--	0.045[J]
Fluorene	2,200/28,000/160	2.9	0.059[J]	1.1	--	1.1
Indeno(1,2,3-cd)pyrene	1.5/5.3/28	--	--	--	--	--
Naphthalene	40/270/1.7	**4.7**	0.051[J]	1.4	--	0.43
Phenanthrene	2,000/30,000/250	4.2	0.055[J]	1.4	--	1.3
Pyrene	2,200/37,000/880	0.86	0.035[J]	0.21[J]	--	0.23
Total Petroleum Hydrocarbons [6](mg/kg)	340/2,500/340	**6,500**	**690**	**2,700**	--	**3,100**
Metals [7](mg/kg)						
Barium	110**/87,000/1,600	--	--	--	--	--
Chromium	210/420/38	--	1.6[J]	--	0.81	1.5[J]
Total Organic Carbon[8] (mg/kg)	NA/NA/NA	NA	NA	NA	46,900	NA

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
[3] LE= Leachability for groundwater limit from Chapter 62-777, FAC
[4] SW-846 8260B, [5] SW-846 8270C, [6] FL-PRO, [7] SW-846 6010B and 7471A, [8] USEPA 9060
[J] Indicates the presence of a chemical at an estimated concentration.
Bold indicates an exceedance of regulatory standards.
** Direct exposure value based on acute toxicity considerations.

TABLE 2-3 (Continued)
Summary of Analytical Compounds Detected in Soil

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Location	DE1[1]/DE2[2]/LE[3] (mg/kg)	SB-6	SB-7	SB-11
Collect Date		8/8/2000	8/8/2000	8/8/2000
Sample Depth (bls)		10 - 12'	10 - 14'	12 - 15'
Volatile[4] (mg/kg)				
Ethylbenzene	1,100/8,400/0.6	--	**1.2**	0.22
Xylenes (total)	5,900/40,000/0.2	--	**0.32[J]**	--
Methylene Chloride	16/23/0.02	--	--	--
Semivolatile [5](mg/kg)				
Phenol	900**/390,000/0.5	--	--	--
1-Methylnaphthalene	68/470/2.2	--	**14**	**54**
2-Methylnaphthalene	80/560/6.1	--	**19**	**78**
Acenaphthene	1,900/18,000/2.1	--	1.5	**4.9**
Anthracene	18,000/260,000/2,500	--	0.9	3
Benzo(a)anthracene	1.4/5/3.2	--	--	0.28[J]
Benzo(a)pyrene	0.1/0.5/8	--	--	**0.17[J]**
Benzo(b)fluoranthene	1.4/4.8/10	--	--	0.18[J]
Benzo(g,h,I)perylene	2,300/41,000/32,000	--	--	0.047[J]
Benzo(k)fluoranthene	15/52/25	--	--	0.13[J]
Chrysene	140/450/77	--	0.15[J]	0.37[J]
Fluoranthene	2,900/48,000/1,200	--	0.21[J]	1.1
Fluorene	2,200/28,000/160	--	2.8	10
Indeno(1,2,3-cd)pyrene	1.5/5.3/28	--	--	0.051[J]
Naphthalene	40/270/1.7	--	**4.7**	2.1
Phenanthrene	2,000/30,000/250	--	4.2	17
Pyrene	2,200/37,000/880	--	0.54[J]	2
Total Petroleum Hydrocarbons [6](mg/kg)	340/2,500/340	--	**4,700**	**14,000**
Metals [7](mg/kg)				
Barium	110**/87,000/1,600	NA	--	0.74[J]
Chromium	210/420/38	0.93[J]	--	0.82[J]
Total Organic Carbon[8] (mg/kg)	NA/NA/NA	244,000	NA	NA

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
[3] LE= Leachability for groundwater limit from Chapter 62-777, FAC
[4] SW-846 8260B, [5] SW-846 8270C, [6] FL-PRO, [7] SW-846 6010B and 7471A, [8] USEPA 9060
[J] Indicates the presence of a chemical at an estimated concentration.
Bold indicates an exceedance of regulatory standards.
** Direct exposure value based on acute toxicity considerations.

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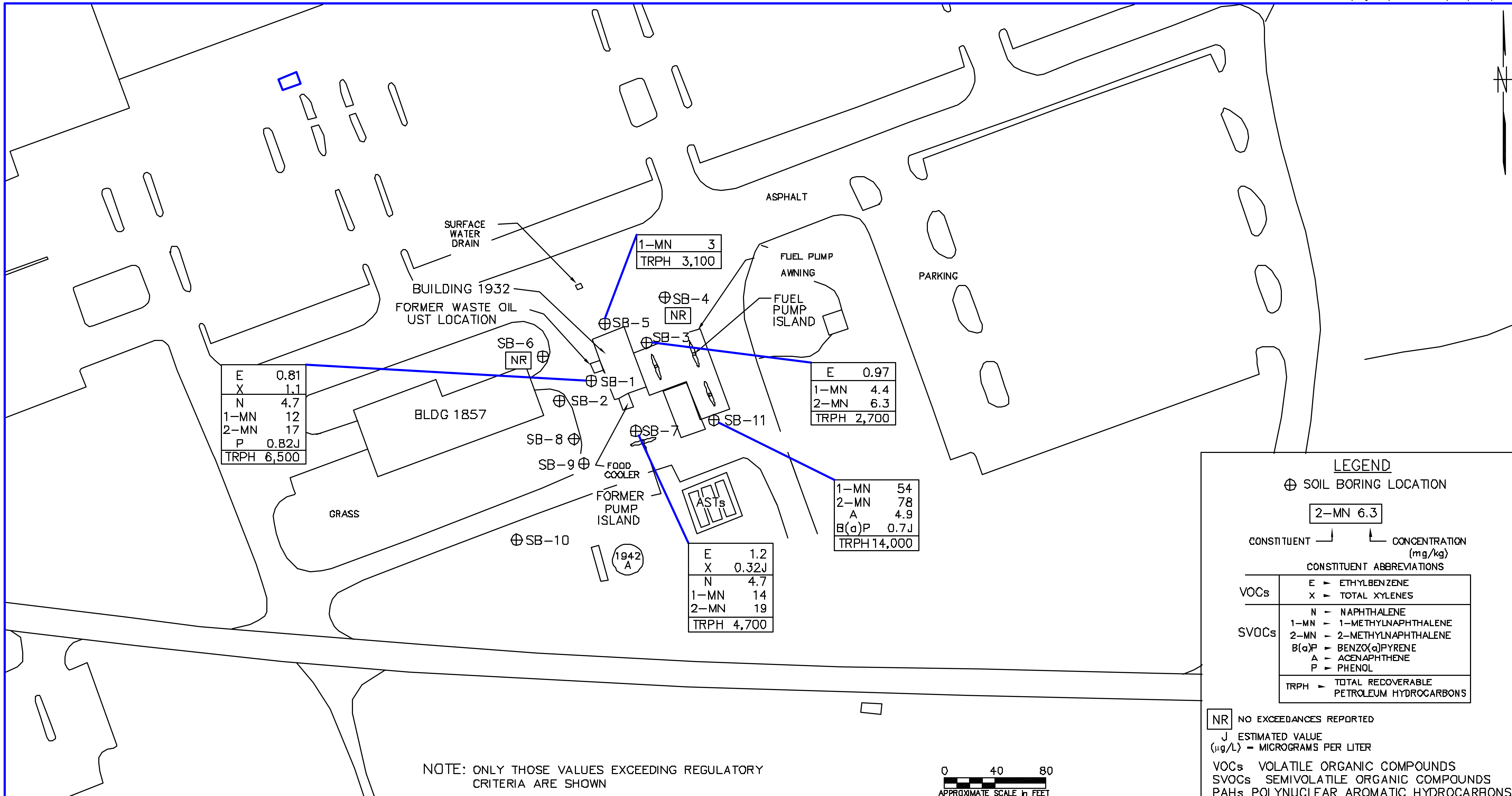

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SCALE AS NOTED

SOIL ANALYTICAL RESULTS
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179

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addressed after the source removal has been completed. Included below is a brief summary of groundwater findings from the SAR (TtNUS, 2001).

Based on the results of the groundwater assessment, concentrations of dissolved petroleum constituents appear to be migrating to the south-southeast at the site. Locations with exceedances of the FDEP GCTLs detected during the groundwater assessment included the areas immediately downgradient of the former dispenser island and former tank pit area. Laboratory analytical results indicated that benzene, ethylbenzene, total xylenes, 1,2-methylnaphthalene, naphthalene, and Total Recoverable Petroleum Hydrocarbons (TRPH) concentrations in 15 samples from the site exceeded the GCTLs. GCTL exceedances were not detected in the groundwater sample from the intermediate vertical extent well, NASP-1932-MW-25D. One GCTL exceedance for vinyl chloride was detected in the groundwater sample from the intermediate vertical extent well, NASP-1932-MW-24D. The SAR stated this exceedance was from an upgradient source, because it was not detected in any of the shallow wells.

The occurrence of the continuous peat layer, at approximately 16 ft bls, is believed to act as an aquitard. The peat layer also acts as a natural organic filter and appears to be limiting the vertical extent of contamination. The intermediate vertical extent wells (NASP-1932-MW-24D and NASP-1932-MW-25D), that were set with well screens considerably below the peat, were reported to contain no petroleum constituents above the GCTLs. Groundwater analytical results are shown on Table 2-4 and GCTL exceedances are depicted in Figure 2-8.

2.5 FREE PRODUCT

Free product thickness measurements were recorded from site monitoring wells during three gauging events, on August 5, 2000, November 8, 2000, and May 1, 2001. The initial measurement period in August 2000 included the only existing monitoring well, MW-1, installed during a previous investigation. The latter two events included all monitoring wells shown in Figure 2-8. Free product measurements ranged from a visible sheen to 1.14 ft in thickness. Four of the monitoring wells at the site contained a measurable thickness of free product and two more wells contained a visible sheen. During the initial measurement in August 2000, MW-1 was described to contain 0.98 ft of dark black free product. The water table was low due to drought conditions at that time. During the November 2000 monitoring well installation, the water table had risen approximately 2 ft and the free product layer was not detected in MW-1. TtNUS believes that there are two free product plumes, one waste oil and one diesel fuel, that have commingled (TtNUS, 2001). Monitoring well location MW-15 has historically exhibited the greatest recorded thickness of lighter colored diesel, free product. The detected thickness of free product diminished from 1.14 ft during the November 2000 event to 0.26 ft during the May 2001 event. The

TABLE 2-4
Summary of Detected Analytes in Groundwater

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Number	GCTL[1]	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7
Sample Location		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7
Collect Date		5/4/2001	5/6/2001	5/2/2001	5/4/2001	5/5/2001	5/5/2001	5/3/2001
Volatile[2] (μg/L)								
n-Butylbenzene	NA	--	--	--	--	--	--	--
Chloroform	5.7	--	--	--	--	--	--	--
Chloromethane	2.7	--	--	--	--	--	--	--
n-Propylbenzene	NA	4.6	--	--	--	--	--	--
1,3,5-Trimethylbenzene	10	2.5	--	--	--	--	--	**28**
trans-1,2-Dichloroethene	100	--	--	--	--	--	--	--
Trichloroethene	3.0	--	--	--	--	--	--	--
Vinyl Chloride	1.0	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	70	--	--	--	--	--	--	--
Isopropylbenzene	NA	2.8	--	--	--	0.87[J]	--	--
tert-Butylbenzene	NA	--	--	--	--	0.57[J]	--	--
sec-Butylbenzene	NA	1.9[J]	--	--	--	1.2[J]	--	--
Naphthalene	20	**34**	--	--	2.2	12	--	12
4-Isopropyltoluene	NA	1.6[J]	--	--	--	--	--	1.3[J]
1,2,4-Trimethylbenzene	10	**18**	--	--	2.1[J]	--	--	**17**
Benzene	1.0	--	--	--	--	--	--	--
Ethylbenzene	30	8.7	--	--	--	2.0	--	1.1
Toluene	40	--	--	--	--	--	--	0.55[J]
Xylenes	20	1.6[J]	--	--	--	--	--	**25**
Methyl tert-butyl ether	50	--	--	--	--	--	--	--
Methylene Chloride	5.0	--	--	--	--	--	--	--
Semivolatile[3] (μg/L)								
3,4-Methylphenol	4.0	--	**39[J]**	--	--	--	--	**6.9[J]**
2-Methylphenol	35	--	--	--	--	--	--	--
2-Methylnaphthalene	20	**29**	**39[J]**	--	--	--	--	13
4-Nitrophenol	56	--	16[J]	--	--	--	--	--
Benzo(k)fluoranthene	0.50	--	--	--	--	--	--	--
Dibenzofuran	28	--	--	--	--	--	--	--
Fluorene	280	--	--	--	--	--	--	4.8[J]
Naphthalene	20	--	**62**	--	--	--	--	--
Phenol	10	--	7.1[J]	--	--	--	--	--
Acenaphthene	20	3.6[J]	--	--	--	--	--	--
Phenanthrene	210	4.8[J]	--	--	--	--	--	--
2,4-Dimethylphenol	140	--	--	--	--	--	--	3.6[J]
Benzo(a)anthracene	0.20	--	--	--	--	--	--	**2.4[J]**
Butyl benzyl phthalate	140	--	--	--	--	--	--	3.1[J]
Chrysene	4.8	--	--	--	--	--	--	2.6[J]

See notes at end of table.

TABLE 2-4 (Continued)
Summary of Detected Analytes in Groundwater

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Number		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7
Sample Location	GCTL[1]	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7
Collect Date		5/4/2001	5/6/2001	5/2/2001	5/4/2001	5/5/2001	5/5/2001	5/3/2001
Polycyclic Aromatic Hydrocarbons[4] (µg/L)								
1-Methylnaphthalene	20	**25**	**35**	--	--	11	--	10
2-Methylnaphthalene	20	**27**	**40**	--	--	3.1[J]	--	11
Acenaphthene	20	4.3	6.6	--	--	3.9[J]	--	4.4
Fluoranthene	280	--	--	--	--	--	--	--
Fluorene	280	5.0	6.7	--	--	5.6[J]	--	4.0
Naphthalene	20	17	**64**	--	--	--	--	3.8
Phenanthrene	210	4.6	2.9[J]	--	--	--	--	2.5
Pyrene	210	--	--	--	--	--	--	0.76[J]
Total Residual Petroleum Hydrocarbons[5] (µg/L)	5,000	**6,600**	--	--	**10,000**	**6,100**	**10,000**	**8,500**
Metals[6] (µg/L)								
Arsenic	50	--	--	--	--	--	--	--
Cadmium	5.0	--	--	--	1.4[J]	--	--	--
Chromium	100	--	1.6[J]	--	--	1.6[J]	1.5[J]	1.2[J]
Lead	15	--	--	--	--	--	--	--

Sample Number		MW-8	MW-9	DUP-2	MW-10	MW-11	MW-12	MW-13
Sample Location	GCTL[1]	MW-8	MW-9	MW-9	MW-10	MW-11	MW-12	MW-13
Collect Date		5/5/2001	5/4/2001	5/4/2001	5/1/2001	5/4/2001	5/2/2001	5/2/2001
Volatile[2] (µg/L)								
n-Butylbenzene	NA	--	--	--	--	--	--	--
Chloroform	5.7	--	--	--	--	--	4.6	1.9
Chloromethane	2.7	--	--	--	--	--	0.71[J]	--
n-Propylbenzene	NA	5.9	6.2[J]	6.1[J]	--	--	--	--
1,3,5-Trimethylbenzene	10	**19**	**36**	**38**	--	**17**	--	--
trans-1,2-Dichloroethene	100	--	--	--	--	--	--	--
Trichloroethene	3.0	--	--	--	--	--	--	--
Vinyl Chloride	1.0	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	70	--	--	--	--	--	--	--
Isopropylbenzene	NA	4.5	4.2[J]	4.2[J]	--	0.64[J]	--	--
tert-Butylbenzene	NA	--	--	--	--	--	--	--
sec-Butylbenzene	NA	--	--	--	--	--	--	--
Naphthalene	20	**150**	**120**	**120**	3.0	**25**	--	--
4-Isopropyltoluene	NA	2.3[J]	2.8[J]	3.0[J]	--	1.1[J]	--	--
1,2,4-Trimethylbenzene	10	**14**	**80**	**82**	--	**13**	--	--
Benzene	1.0	**8.4**	**4.1[J]**	**3.9[J]**	--	--	--	--
Ethylbenzene	30	**56**	**32**	**32**	1.2	6.8	--	--

See notes at end of table.

TABLE 2-4 (Continued)
Summary of Detected Analytes in Groundwater

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Number	GCTL[1]	MW-8	MW-9	DUP-2	MW-10	MW-11	MW-12	MW-13
Sample Location		MW-8	MW-9	MW-9	MW-10	MW-11	MW-12	MW-13
Collect Date		5/5/2001	5/4/2001	5/4/2001	5/1/2001	5/4/2001	5/2/2001	5/2/2001
Volatile[2] (µg/L)								
Toluene	40	--	5.0	5.3	--	1.9	--	--
Xylenes	20	**26**	**120**	**120**	--	**52**	--	--
Methyl tert-butyl ether	50	11	--	--	--	--	--	--
Methylene Chloride	5.0	--	--	--	--	--	--	--
Semivolatile[3] (µg/L)								
3,4-Methylphenol	4.0	--	**83**[J]	**87**[J]	--	--	--	--
2-Methylphenol	35	--	12[J]	12[J]	--	--	--	--
2-Methylnaphthalene	20	--	**46**[J]	**45**[J]	--	--	--	--
4-Nitrophenol	56	--	--	--	--	--	--	--
Benzo(k)fluoranthene	0.50	--	--	--	--	--	--	--
Dibenzofuran	28	--	--	--	--	--	--	--
Fluorene	280	--	--	--	--	--	--	--
Naphthalene	20	--	**44**[J]	**48**[J]	--	--	--	--
Phenol	10	--	--	--	--	--	--	--
Acenaphthene	20	--	--	--	--	--	--	--
Phenanthrene	210	--	--	--	--	--	--	--
2,4-Dimethylphenol	140	--	--	--	--	--	--	--
Benzo(a)anthracene	0.20	--	--	--	--	--	--	--
Butyl benzyl phthalate	140	--	--	--	--	--	--	--
Chrysene	4.8	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons[4] (mg/L)								
1-Methylnaphthalene	20	--	**37**	**38**	1.0	6.7[J]	--	--
2-Methylnaphthalene	20	--	**49**	**49**	--	--	--	--
Acenaphthene	20	--	6.6[J]	6.6[J]	0.59[J]	4.7[J]	--	--
Fluoranthene	280	--	--	--	--	--	--	--
Fluorene	280	--	7.6[J]	7.2[J]	0.48[J]	3.1[J]	--	--
Naphthalene	20	--	**44**	**46**	--	7.7[J]	--	--
Phenanthrene	210	--	5.6[J]	5.2[J]	--	--	--	--
Pyrene	210	--	--	--	--	--	--	--
Total Residual Petroleum Hydrocarbons[5] (µg/L)	5,000	**16,000**	**30,000**	**33,000**	--	**8,200**	--	--
Metals[6] (µg/L)								
Arsenic	50	--	--	--	--	--	--	--
Cadmium	5.0	--	--	--	--	--	--	--
Chromium	100	2.8[J]	2.9[J]	2.8[J]	--	1.7[J]	--	--
Lead	15	7.1[J]	--	--	--	--	--	--

See notes at end of table.

TABLE 2-4 (Continued)
Summary of Detected Analytes in Groundwater

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Number	GCTL[1]	MW-14	MW-16	MW-17	MW-18	MW-20	DUP-3	MW-21
Sample Location		MW-14	MW-16	MW-17	MW-18	MW-20	MW-20	MW-21
Collect Date		5/3/2001	5/5/2001	5/1/2001	5/3/2001	5/6/2001	5/6/2001	5/3/2001
Volatile[2] (μg/L)								
n-Butylbenzene	NA	--	--	--	--	--	--	--
Chloroform	5.7	--	--	--	--	--	--	--
Chloromethane	2.7	--	--	--	--	--	--	--
n-Propylbenzene	NA	8.2	9.5	--	7.2	13	12	15
1,3,5-Trimethylbenzene	10	0.65[J]	--	--	**22**	3.7	4.1	**70**
trans-1,2-Dichloroethene	100	--	--	--	--	--	--	--
Trichloroethene	3.0	--	--	--	--	--	--	--
Vinyl Chloride	1.0	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	70	--	--	--	--	--	--	--
Isopropylbenzene	NA	4.9	5.7	--	--	8.4	7.6	9.5[J]
tert-Butylbenzene	NA	0.70[J]	0.64[J]	--	--	0.8[J]	0.69[J]	--
sec-Butylbenzene	NA	3.3[J]	3.4[J]	--	1.4[J]	3.7[J]	3.4[J]	--
Naphthalene	20	**99**	**110**	--	**110**	**190**	**210[J]**	**220**
4-Isopropyltoluene	NA	2.6[J]	6.8	--	2.2[J]	2.2[J]	2.0[J]	5.3[J]
1,2,4-Trimethylbenzene	10	**18**	**15**	--	**48**	2.9[J]	3.9[J]	**230**
Benzene	1.0	--	**1.0**	--	0.68[J]	**19**	**17**	--
Ethylbenzene	30	14	**30**	--	27	**55**	**51**	**69**
Toluene	40	--	--	--	2.2	--	--	--
Xylenes	20	0.73[J]	--	--	**49**	--	--	**320**
Methyl tert-butyl ether	50	--	--	--	--	13	12	--
Methylene Chloride	5.0	--	--	--	--	--	--	**9.8[J]**
Semivolatile[3] (μg/L)								
3,4-Methylphenol	4.0	--	--	--	**7.8[J]**	--	--	**36[J]**
2-Methylphenol	35	--	--	--	3.6[J]	--	--	13[J]
2-Methylnaphthalene	20	**71**	**87**	--	**66**	**160**	**160**	**120**
4-Nitrophenol	56	--	3.3[J]	--	--	--	--	--
Benzo(k)fluoranthene	0.50	--	**1.1[J]**	--	--	--	--	--
Dibenzofuran	28	--	5.7[J]	--	--	--	--	--
Fluorene	280	--	9.0[J]	--	--	--	--	--
Naphthalene	20	**47**	**52**	--	**64**	**130**	**120**	**100**
Phenol	10	--	--	--	--	--	--	**11[J]**
Acenaphthene	20	5.7[J]	6.0[J]	--	--	--	--	--
Phenanthrene	210	--	--	--	--	--	--	--
2,4-Dimethylphenol	140	--	--	--	2.3[J]	--	--	--
Benzo(a)anthracene	0.20	--	--	--	--	--	--	--
Butyl benzyl phthalate	140	--	--	--	--	--	--	--
Chrysene	4.8	--	--	--	--	--	--	--

See notes at end of table.

TABLE 2-4 (Continued)
Summary of Detected Analytes in Groundwater

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Number	GCTL[1]	MW-14	MW-16	MW-17	MW-18	MW-20	DUP-3	MW-21
Sample Location		MW-14	MW-16	MW-17	MW-18	MW-20	MW-20	MW-21
Collect Date		5/3/2001	5/5/2001	5/1/2001	5/3/2001	5/6/2001	5/6/2001	5/3/2001
Polycyclic Aromatic Hydrocarbons[4] (μg/L)								
1-Methylnaphthalene	20	**50**	**55**	--	**36**	**110**	**110**	**73**
2-Methylnaphthalene	20	**69**	**82**	--	**62**	**160**	**170**	**120**
Acenaphthene	20	6.5	6.4	--	3.6	9.8[J]	9.6[J]	6.1[J]
Fluoranthene	280	--	--	--	--	--	--	--
Fluorene	280	8.0	8.6	--	3.6	13	14	8.3[J]
Naphthalene	20	**49**	**53**	--	**61**	**130**	**130**	**110**
Phenanthrene	210	6.2	7.2	--	4.0	8.9[J]	9.0[J]	7.2[J]
Pyrene	210	0.30[J]	--	--	--	--	--	--
Total Residual Petroleum Hydrocarbons[5] (μg/L)	5,000	**17,000**	**5,400**	--	**36,000**	**26,000**	**29,000**	**39,000**
Metals[6] (μg/L)								
Arsenic	50	--	--	--	--	--	--	--
Cadmium	5.0	--	--	--	--	--	--	--
Chromium	100	1.3[J]	--	--	2.7[J]	2.5[J]	2.3[J]	4.0[J]
Lead	15	--	--	--	--	--	--	--

Sample Number	GCTL[1]	MW-22	DUP-1	MW-23	MW-24D	MW-25D
Sample Location		MW-22	MW-22	MW-23	MW-24D	MW-25D
Collect Date		5/2/2001	5/2/2001	5/2/2001	5/5/2001	5/2/2001
Volatile[2] (μg/L)						
n-Butylbenzene	NA	--	--	0.61[J]	--	--
Chloroform	5.7	--	--	--	--	--
Chloromethane	2.7	--	--	--	--	--
n-Propylbenzene	NA	--	--	--	--	--
1,3,5-Trimethylbenzene	10	--	--	**15**	--	--
trans-1,2-Dichloroethene	100	--	--	--	0.52[J]	--
Trichloroethene	3.0	--	--	--	2.3	--
Vinyl Chloride	1.0	--	--	--	**3.2**	--
cis-1,2-Dichloroethene	70	--	--	--	11	--
Isopropylbenzene	NA	--	--	--	--	--
tert-Butylbenzene	NA	--	--	--	--	--
sec-Butylbenzene	NA	--	--	--	--	--
Naphthalene	20	--	--	5.4	--	--
4-Isopropyltoluene	NA	--	--	0.62[J]	--	--
1,2,4-Trimethylbenzene	10	--	--	0.65[J]	--	--
Benzene	1.0	--	--	--	--	--
Ethylbenzene	30	--	--	--	--	--
Toluene	40	--	--	--	--	--
Xylenes	20	--	--	5.7	--	--

See notes at end of table.

TABLE 2-4 (Continued)
Summary of Detected Analytes in Groundwater

Remedial Action Plan
Building 1932, UST 000025
Naval Air Station Pensacola
Pensacola, Florida

Sample Number	GCTL[1]	MW-22	DUP-1	MW-23	MW-24D	MW-25D
Sample Location		MW-22	MW-22	MW-23	MW-24D	MW-25D
Collect Date		5/2/2001	5/2/2001	5/2/2001	5/5/2001	5/2/2001
Volatile[2] (µg/L)						
Methyl tert-butyl ether	50	--	--	--	--	--
Methylene Chloride	5.0	--	--	--	--	--
Semivolatile[3] (µg/L)						
3,4-Methylphenol	4.0	1.9[J]	--	--	--	--
2-Methylphenol	35	--	--	--	--	--
2-Methylnaphthalene	20	--	--	2.2[J]	--	--
4-Nitrophenol	56	--	--	--	--	--
Benzo(k)fluoranthene	0.50	--	--	--	--	--
Dibenzofuran	28	--	--	--	--	--
Fluorene	280	--	--	--	--	--
Naphthalene	20	--	--	--	--	--
Phenol	10	--	--	--	--	--
Acenaphthene	20	--	--	2.8[J]	--	--
Phenanthrene	210	--	--	--	--	--
2,4-Dimethylphenol	140	--	--	--	--	--
Benzo(a)anthracene	0.20	--	--	--	--	--
Butyl benzyl phthalate	140	--	--	--	--	--
Chrysene	4.8	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons[4] (µg/L)						
1-Methylnaphthalene	20	--	0.66[J]	6.5	--	--
2-Methylnaphthalene	20	--	0.72[J]	2.5	--	--
Acenaphthene	20	--	0.50[J]	3.8	--	--
Fluoranthene	280	--	--	0.30[J]	--	--
Fluorene	280	--	0.30[J]	3.1	--	--
Naphthalene	20	--	--	--	--	--
Phenanthrene	210	--	--	2.7	--	--
Pyrene	210	--	--	0.49[J]	--	--
Total Residual Petroleum Hydrocarbons[5] (µg/L)	5,000	**18,000**	**20,000**	**39,000**	--	--
Metals[6] (µg/L)						
Arsenic	50	--	--	--	--	14[J]
Cadmium	5.0	1.3[J]	--	--	--	--
Chromium	100	--	--	--	1.3[J]	--
Lead	15	--	--	--	--	--

Notes: **Bold** indicates an exceedance of regulatory limits.
[1] Groundwater Clean-up Target Level as provided in Chapter 62-777, FAC
[2] SW-846 8260B, [3] SW-846 8270C, [4] SW-846 8310, [5] FDEP FL-PRO, [6] SW-846 6010B
-- indicates analyte not detected. NA = not applicable.
[J] indicates the presence of a chemical at an estimated concentration.

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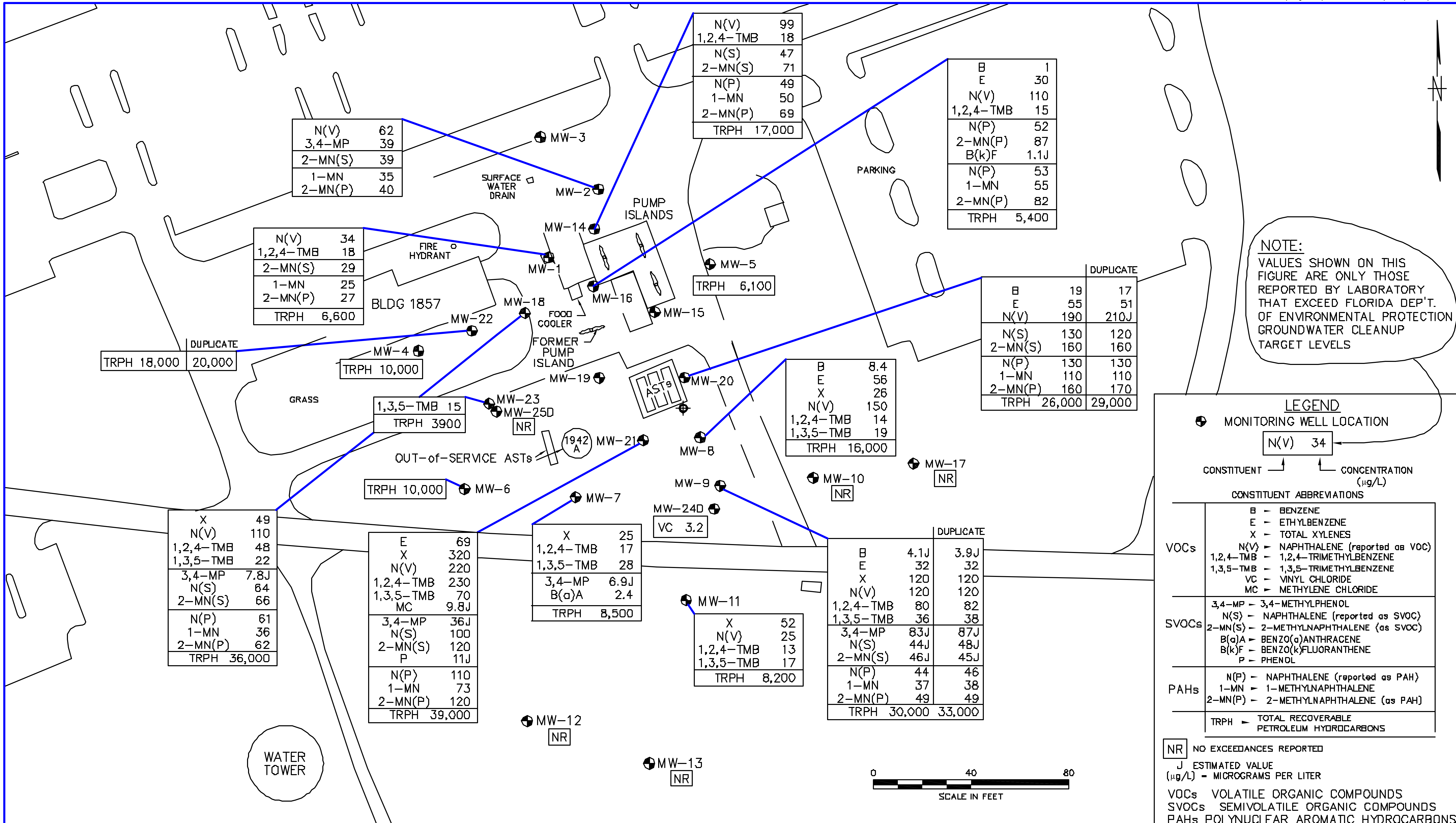


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 3/6/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GROUNDWATER ANALYTICAL RESULTS
MAY 2001
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-8
REV. 0

detected thickness of free product decreased in both plumes from the November and May events due to the rise in the water table. According to the SAR, free product from the waste oil plume has a relatively high viscosity, which causes it to become trapped in the soils. Figures 2-9 and 2-10 present the free product thickness measurements from the November 2000 and May 2001 measurement events, respectively.

2.6 SITE ASSESSMENT REPORT CONCLUSIONS AND RECOMMENDATIONS

The conclusions based on the data collected during the site assessment performed by TtNUS at the Building 1932, UST Site 000025, are summarized as follows:

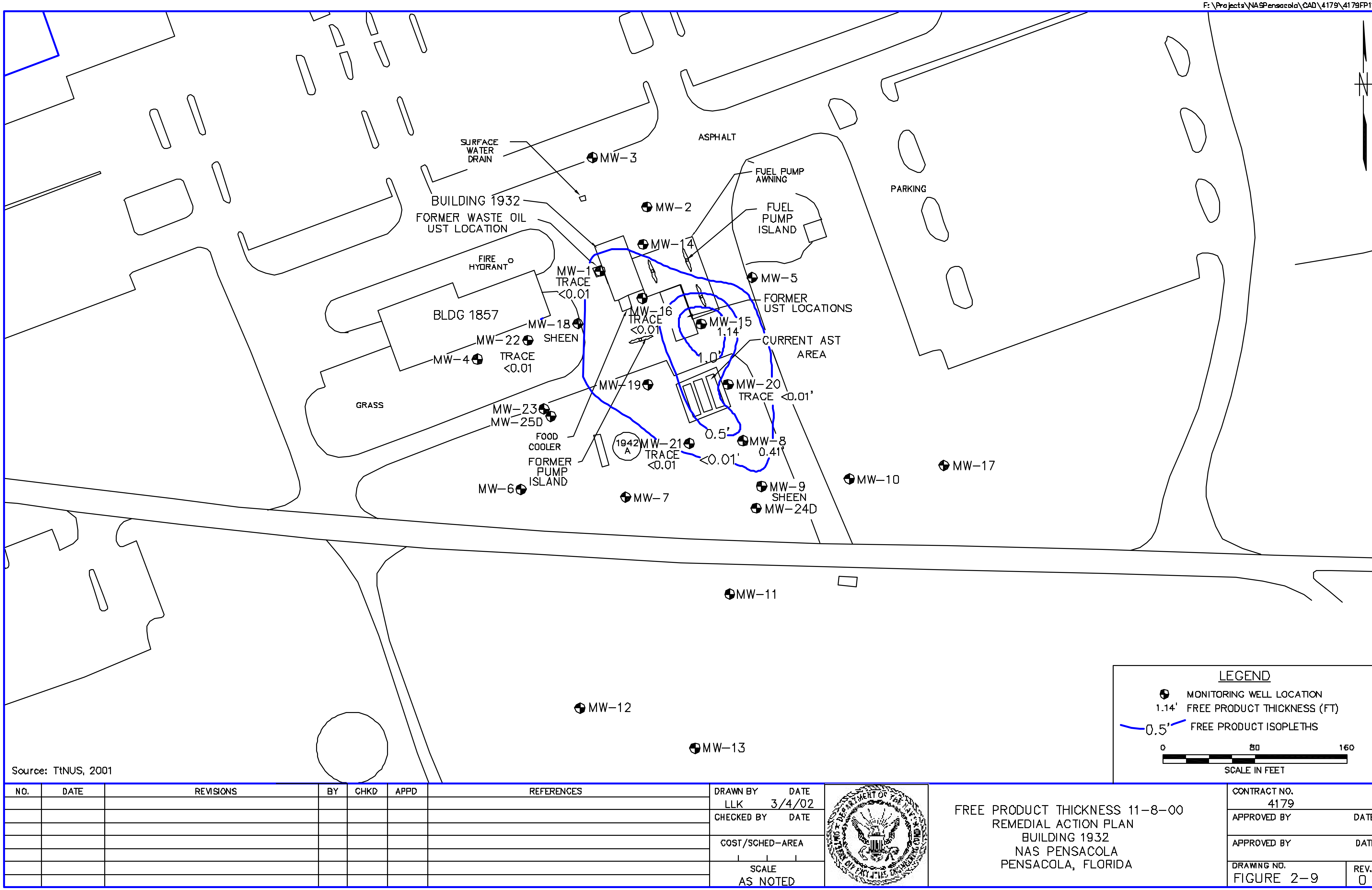
- Excessively contaminated soil at the site exceeded DE and/or LE SCTLs (Chapter 62-777, FAC). Soil contamination at the site is generally limited to the immediate vicinity of the former dispenser island south of the building and the former UST tank pit.

- Free-product accumulations within existing site monitoring wells ranged from a sheen to over 1.0 ft in thickness.

- Concentrations of dissolved petroleum contaminants of concern (COCs) in site groundwater exceeded GCTLs (Chapter 62-777, FAC).

Based upon the hydrogeological and chemical data presented in the SAR and the requirements of Chapter 62-770, FAC, TtNUS recommended that a RAP be completed and active remediation of the free-product and soils be addressed. Following active remediation, measurement of natural attenuation parameters of the on-site groundwater should be performed.

TtNUS recommended completion of a RAP and free product removal at the site should be initiated immediately and continued until an active recovery system is installed.


F:\Projects\NASPensacola\CAD\4179\4179FP1100
N
SURFACE WATER DRAIN
MW-3
ASPHALT
FUEL PUMP AWNING
MW-2
BUILDING 1932
FORMER WASTE OIL UST LOCATION
FUEL PUMP ISLAND
PARKING
MW-14
FIRE HYDRANT
MW-1
TRACE
<0.01
MW-5
FORMER UST LOCATIONS
BLDG 1857
MW-16
TRACE
<0.01
MW-15
1.14'
MW-18
SHEEN
MW-22
CURRENT AST AREA
MW-4
TRACE
<0.01
1.0'
MW-19
MW-20
TRACE <0.01'
GRASS
MW-23
MW-25D
FOOD COOLER
0.5'
MW-8
0.41'
1942 A
MW-21
TRACE
<0.01
<0.01'
FORMER PUMP ISLAND
MW-17
MW-10
MW-6
MW-9
SHEEN
MW-7
MW-24D
MW-11
MW-12
MW-13
LEGEND
MONITORING WELL LOCATION
1.14' FREE PRODUCT THICKNESS (FT)
0.5' FREE PRODUCT ISOPLETHS
0
80
160
SCALE IN FEET
Source: TtNUS, 2001
NO.
DATE
REVISIONS
BY
CHKD
APPD
REFERENCES
DRAWN BY LLK
DATE 3/4/02
CHECKED BY
DATE
COST/SCHED-AREA
SCALE AS NOTED
FREE PRODUCT THICKNESS 11-8-00
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA
CONTRACT NO. 4179
APPROVED BY
DATE
APPROVED BY
DATE
DRAWING NO. FIGURE 2-9
REV. 0

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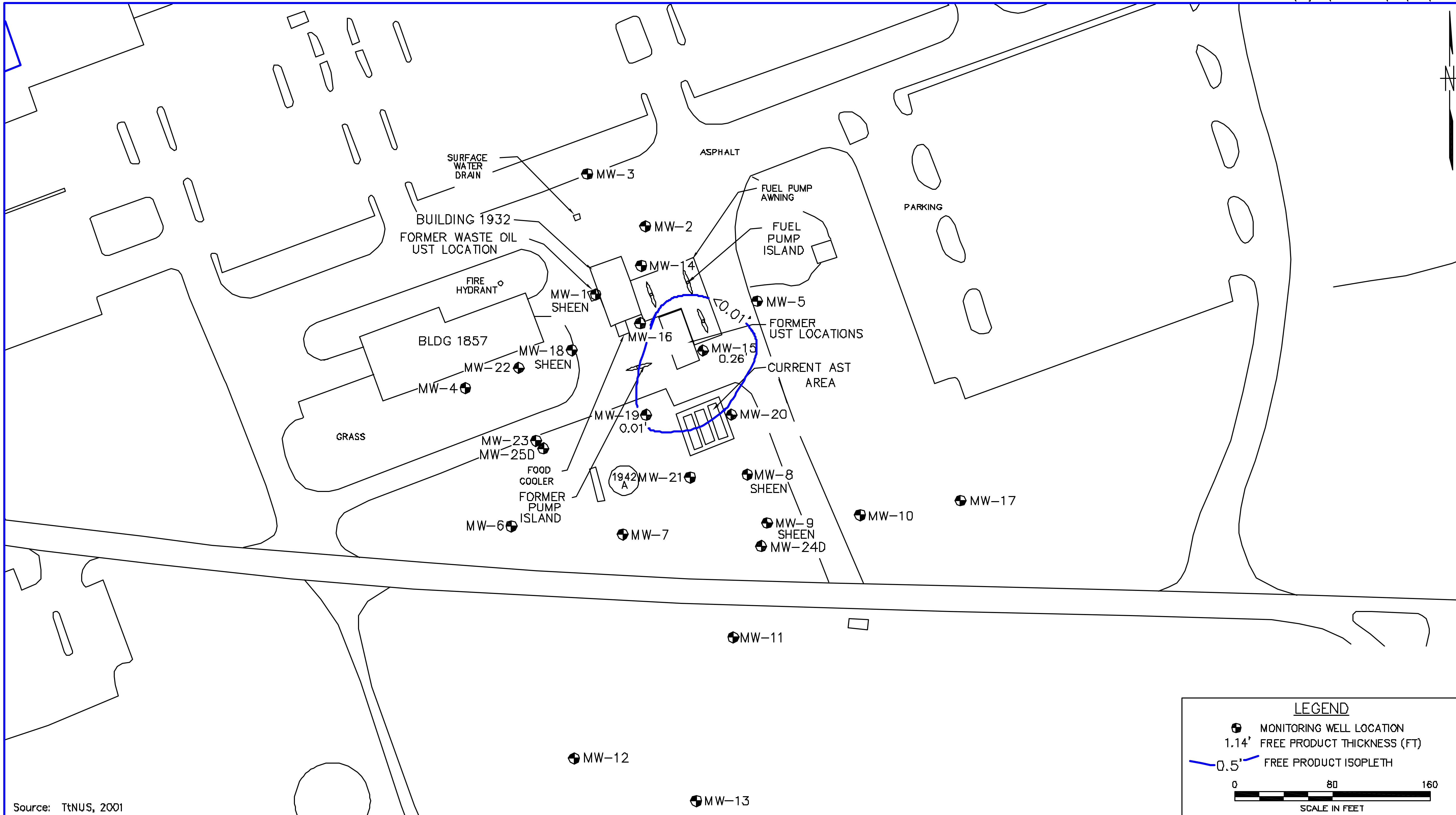


Source: TtNUS, 2001

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 3/5/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

FREE PRODUCT THICKNESS 5/01/01
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-10
REV. 0

3.0 REMEDIAL ACTION PLAN GOALS

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

- Remove the free product and remediate petroleum-impacted soil.
- Protect human health and the environment by reducing the concentrations of soil contamination and free-phase hydrocarbons detected at the site to target cleanup levels.

The goals and expected accomplishments of the RAP include:

- Identify a method to remediate or remove petroleum-impacted soil and remove free product.
- Select a remedial alternative that will result in a reduction of the leaching of hydrocarbon constituents to the groundwater matrix.
- Be protective of nearby water bodies.

The target cleanup concentrations for the soil at the subject site are based on analytes detected in the soil 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.

3.2 FREE PRODUCT TARGET LEVELS

Chapter 62-770, FAC, defines free product as petroleum or petroleum product in excess of 0.01 ft in thickness, measured at its thickest point, floating on surface water or groundwater. As a result of this definition, the remedial action goal for free product removal at Building 1932 will be to remove free product in excess of 0.01 ft.

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

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

Site-Specific COCs	Concentrations from Table II*
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
Benzo(a)pyrene	0.1 mg/kg
Acenaphthene	2.1 mg/kg
Phenol	0.5 mg/kg
TRPHs	340 mg/kg

NOTES:
* Concentration is the lower of the residential direct exposure SCTL or leachability SCTL based on groundwater criteria Table II, Chapter 62-777, FAC.
mg/kg = milligrams per kilogram

4.0 CONTAMINANT DISTRIBUTION

4.1 ESTIMATED MASS OF CONTAMINANTS IN SOIL

Net soil vapor readings in excess of 50 ppm were used to define "excessively contaminated soil" in accordance with Rule 62-770.200(2), FAC. For the site, the area of impacted soil was calculated by creating a 50-ppm line using a Computer Aided Design (CAD) program. CAD features an option that will calculate the area of an entity. This was used to find the area of each 4-ft interval. The three interval areas were calculated to be the following:

$Area_1$ (0-4 ft bls) = 10,300 square ft (ft^2)
$Area_2$ (4-8 ft bls) = 26,200 ft^2
$Area_3$ (8-12 ft bls) = 57,500 ft^2

The volume of each area was calculated by multiplying the area by the thickness (4 ft). The three volumes were added to calculate the total volume of contaminated soil. The volumes follow:

$Volume_1$ = 41,200 cubic ft (ft^3)
$Volume_2$ = 104,800 ft^3
$Volume_3$ = 230,000 ft^3
Total Volume = 376,000 ft^3

The mass of contaminants in vadose zone soil was calculated using the following equation:

$$\text{Mass} = \text{Volume ft}^3 \times \frac{1\,\text{yd}^3}{27\,\text{ft}^3} \times \frac{1.4\,\text{tons}}{1\,\text{yd}^3} \times 907\,\frac{\text{kg}}{\text{ton}} \times \text{avg.}\,\frac{\text{mg}}{\text{kg}}\,\text{TRPH} \times \left(1.0 \times 10^{-6}\right)\frac{\text{kg}}{\text{mg}} \times 2.204623\,\frac{\text{lb}}{\text{kg}}$$

where:

TRPH = arithmetic mean of TRPH concentrations.

The estimated mass of contaminants for the three combined areas was calculated to be approximately 172,663 pounds (lbs). Appendix B presents calculations for the estimated mass of impacted soil.

4.2 ESTIMATED MASS OF FREE PRODUCT

A determination of free product contaminant mass was completed for the site. The area of free product was calculated using the CAD method discussed above. Encompassing all wells that have been measured to contain free product during past events created the free product area. The determination was completed using the formula:

$$\text{Total free product mass} = A * T * n * Cf * Dfp$$

where:

- T = Average observed thickness (ft) = 0.5 ft
- A = Total area of plume (ft^2) = 23,300 ft^2
- n = Porosity = 0.30
- Cf = Correction factor for soil type (0.50 for sand)
- Dfp = Density of free product (49.12 lb/ft^3)

The area of the plume was used from the November 2000 event, assuming the total area of the free product plume more closely reflects conditions during the times of lower water table. An average thickness of 0.5 ft was chosen since the greatest observed thickness of diesel was 1.14 ft and 0.98 ft was the maximum observed thickness of waste oil. Since TtNUS believes the waste oil to be trapped in the soil, an overall average of thickness of 0.5 ft is assumed to be more representative of site conditions. Porosity of 30 percent represents the maximum range of porosity for a perfectly packed media of rounded grains. Variables for this calculation, other than area, were taken from the SAR (TtNUS, 2001). Based on the above assumptions the free product contaminant mass is estimated at 85,837 lbs.

5.0 REMEDIAL ALTERNATIVE TECHNOLOGY SCREENING

TtNUS conducted a screening of available technologies in order to determine a suitable remedial alternative for the subject site. Potential remedial technologies and process options for the soil and free product 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 SAR data, a total volume of approximately 14,000 cubic yards (yd^3) of soil exhibits hydrocarbon contamination as defined in Chapter 62-770, FAC. TtNUS has investigated alternate methods for the removal of hydrocarbons from the soils at the site. The following actions have been identified for remediation of impacted soil in this RAP:

- Excavation and disposal/treatment
- Bioventing
- Bioslurping (Dual-Phase Extraction)

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 Disposal/Treatment

This alternative consists of the physical removal and off-site treatment and/or disposal of impacted soils with hydrocarbon constituents exceeding the DE and/or LE SCTLs. To complete excavation of impacted soils, removal of soil from the surface to the depth of the water table (approximately 12 to 13 ft bls) over an area of approximately 57,500 ft^2 would be required. It would be necessary to excavate just below the water table (12 to 13 ft bls) and dewater with collection, treatment, and disposal of collected water and free product.

Removal operations can be accomplished with standard and specialized equipment. Following removal and immediate transportation or stockpiling of the impacted soil, samples collected from excavation sidewalls and bottom would be analyzed to confirm achievement of the RAP goals. The excavation would be backfilled with clean fill material and the site would be restored to its original condition. Any soil or other debris generated during excavation would be sampled, characterized, loaded, and transported to an off-site facility for treatment and/or disposal.

In order to complete the excavation and disposal of contaminated soil, certain site conditions must be considered that may affect operation of the remediation process and total cost of the project. For instance, when excavating near the building and gas station pumps, shoring would be necessary for support. Also, contaminated soil beneath the building and fuel pumps could not be excavated. An excavation of this scale would require the ceasing of operations at the gas station for an extended period of time. This may prove unacceptable to the Navy. In addition, while performing the excavation activities it would be necessary to prevent damage to underground utilities in the area and the fuel lines that supply the pump island. Soil that is unable to be removed may act as a continuing source of contamination to groundwater.

Estimated costs were based on the conceptual design (excluding shoring, station shutdown, hand excavation, etc.). The estimated cost for soil excavation, transportation, off-site treatment/disposal, and site restoration is presented in Table 5-1 and Appendix C, Table C1.

5.1.2 Bioventing

Bioventing is an in-situ remediation technology that uses indigenous microorganisms to biodegrade organic constituents adsorbed to soils in the unsaturated zone. Soils in the capillary fringe and the saturated zone are not affected. In bioventing, the activity of the indigenous bacteria is enhanced by inducing air (or oxygen) flow into the unsaturated zone (using extraction or injection wells) and, if necessary by adding nutrients (USEPA, 1995).

When extraction wells are used for bioventing, the process is similar to soil vapor extraction (SVE). However, while SVE removes constituents primarily through volatilization, bioventing systems promote biodegradation of constituents (generally by using lower airflow rates than for SVE). All aerobically biodegradable constituents can be treated by bioventing. In particular, bioventing has proven to be very effective in remediating releases of petroleum products including gasoline, jet fuels, kerosene, and diesel fuel. Bioventing is most often used at sites with mid-weight petroleum products (i.e., diesel fuel and jet fuel), because lighter products (i.e., gasoline) tend to volatilize readily and can be removed rapidly using SVE. Heavier products (e.g. fuel oils) generally take longer to biodegrade than the lighter products (USEPA, 1995).

Based on site characteristics (i.e., petroleum-impacted soil underneath the building) a bioventing system may require the installation of horizontal bioventing wells under Building 1932. These wells would be

TABLE 5-1
SOIL REMEDIAL ALTERNATIVES COST SUMMARY

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

Alternative	Capital Cost	Annual 0&M	Estimated Years of Operation	Present Worth Total Cost[1]
Excavation and Disposal	$1,440,000	$0	1	$1,440,000
Bioslurping	$137,000	$48,000	4	$339,000
Bioventing	$97,000	$35,000	7.5	$336,000

[1]Present Worth Total Cost also includes work plans and contingency cost not included in capital or annual 0&M costs.

used to remediate impacted soil that may exist underneath the building. As a result, a bioventing system with air extraction instead of air injection, would be installed to control any possible fugitive air emissions, which may seep into Building 1932. Fugitive air emissions may occur because although bioventing should result in the biodegradation of petroleum contaminants, some limited volatilization does occur (USEPA, 1993). Based on characteristics at similar sites a radius of 35 ft was assumed for costing purposes. Assuming a radius of influence (ROI) of 35 ft, 11 vertical bioventing wells and possibly 4 horizontal wells would be required to provide oxygen to the entire soil contaminant plume. Vertical wells are proposed at locations away from the building to reduce costs. The vertical and horizontal vent wells would be connected to a blower in a central compound by trenched polyvinyl chloride (PVC) line. The extracted air would require treatment by granular activated carbon (GAC) prior to release to the atmosphere to remove VOCs and comply with Chapter 62-770, FAC.

Based upon the soil hydrocarbon concentrations identified in the SAR, it is estimated that soil remediation may be achieved in approximately 7.5 years using bioventing. Estimating the time to clean up by bioventing is difficult to calculate unless a treatability study is performed, and the time to clean up provided herein may vary significantly from the actual cleanup time. The cleanup time calculations are presented in Appendix D. An estimated cost of bioventing implementation with 7.5 years of O&M is presented in Table 5-1 and Appendix C, Table C2.

5.1.3 Bioslurping (Dual-phase Extraction)

Bioslurping, also known as dual-phase extraction (DPE) or vacuum-enhanced extraction is an in-situ technology that uses pumps to remove combinations of contaminated groundwater, separate-phase petroleum products, and hydrocarbon vapor from the subsurface. Bioslurping systems can be effective in removing free-phase product from the subsurface, thereby reducing concentrations of petroleum hydrocarbons in both the saturated and unsaturated zones of the subsurface. Bioslurping systems are typically designed to maximize extraction rates for free product removal. However, the technology also stimulates biodegradation of petroleum constituents in the unsaturated zone by increasing the supply of oxygen (USEPA, 1995).

Bioslurping is a single-pump system that relies on high-velocity airflow to lift suspended liquid droplets upward by frictional drag through an extraction tube to land surface. The vacuum applied to the subsurface with DPE systems creates vapor-phase pressure gradients toward the vacuum well. These vapor-phase pressure gradients are also transmitted directly to the subsurface liquids present, and those liquids existing in a continuous phase will flow toward the vacuum well in response to the imposed gradients. The higher the applied vacuum, the larger the hydraulic gradients that can be achieved in both vapor and liquid phases and thus the greater the vapor and liquid recovery rates.

The water table depression that results from these high recovery rates serves both to hydraulically control groundwater migration and to increase the efficiency of vapor extraction. The remedial effectiveness of bioslurping within the zone of dewatering that commonly develops should be greater than that of air sparging due to the more uniform air flow developed using bioslurping (USEPA, 1995). Bioslurping can enhance biodegradation by substantially increasing the supply of oxygen to the vadose zone. The surface cover at Building 1932 consisting of asphalt, concrete, and Building 1932 itself, may prevent short-circuiting and help induce airflow to the petroleum impacted area.

The bioslurping system would consist of a draw tube located at the oil-water interface within the bioslurping well. The bioslurping well would be screened from the top of the impacted soil zone to approximately two feet into the groundwater table. A vacuum is initially applied to the draw tube to begin removal of free product and some groundwater. The draw tube and the well casing are manifolded to the same vacuum source. High vacuum is applied to the draw tube in order to lift the free product and/or water thus lowering the water table within the formation area of the recovery well. A vacuum applied to the inside of the well also results in a positive uplift on the water table thereby increasing the hydraulic gradients of the fluids within the well. The vacuum influence of the well increases the airflow into the well providing oxygen flow through the vadose and capillary fringe and stimulating biodegradation.

Assuming site conditions similar to Building 325 at CSSPC, 11 bioslurping wells would be required to remediate the soil and free product plumes. A treatability study would determine the exact number and locations of bioslurping points. The bioslurping wells would be connected by a line to a central compound with a vacuum pump, total fluids collection tank, vapor treatment, and an oil-water separator. The permeability of soil at Building 1932 would provide conditions conducive for airflow through the aquifer, but also would increase the amount of extracted water that would be necessary to treat. Therefore, it is recommended that to reduce costs the extracted groundwater be discharged to the Federally Owned Treatment Works (FOTW) after the groundwater has been partially treated thorough the oil-water separator.

Based on results from a similar system at CSSPC, the time to cleanup has been estimated to be four years. The system at CSSPC was effective in an area with similar lithology and contamination levels. To obtain a more accurate estimated time to cleanup and evaluate the systems actual potential for cleanup, a treatability study will be necessary. An estimated cost of bioslurping implementation with a treatability study and four years of O&M is presented in Table 5-1 and Appendix C, Table C3.

5.2 EVALUATION OF FREE PRODUCT RECOVERY ALTERNATIVES

Based on the calculations from Appendix B, a total volume of approximately 431 yd^3 of free product exists at Building 1932. TtNUS has investigated alternate methods for the removal of free-phase hydrocarbons from the soils at the site. The following actions have been identified for the removal of free product in this RAP:

- Skimming
- Groundwater depression
- Dewatering during soil excavation
- Bioslurping

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

5.2.1 Skimming

Skimming systems are typically used to collect free product with little or no recovery of water. In general this approach involves using skimming devices to remove product floating on the water table (USEPA, 1996).

Free product removal using skimming equipment is applicable in settings where long-term hydraulic control of the dissolved hydrocarbon plume is not required. The most common use of these systems is inclusion in an interim action where free product has entered open excavations. In general, skimming systems are applicable to settings in which the amount of free product is small and exists in permeable conduits such as utility bedding or buried underground structures. The hydraulic conductivity should be greater than ±10 centimeters per second to ensure a sufficient influx of free product to the skimmer. Skimmers may also be used in conjunction with other free product removal programs such as in monitoring and extraction wells used for water table depression methods (USEPA, 1996).

For long-term operations, skimmers are placed in wells and gravel-filled trenches with sumps. Recovery may be enhanced by the use of hydrophobic gravel packs in wells. Field studies have shown that gravel packs constructed from hydrophobic materials allow for free product to enter wells and sumps more rapidly. Recovery rates for long-term operations are generally very low.

The selection of skimming equipment is based primarily on the size of the recovery installation (well, trench) and expected rate of recovery of free product. Two types of skimming equipment are available.

Mechanical skimming equipment actively extracts free product from recovery initiation, whereas passive skimming equipment accumulates free product over time. Mechanical skimming systems rely on pumps (either surface mounted or within the well) or other motors to actively extract free product from the subsurface. Mechanical skimming systems are more often used where larger volumes of free product are present. Passive skimming systems do not actively pump free product; instead they slowly accumulate it over time. There are two basic forms of passive skimmers, filter canisters and absorbent socks.

Based on the high cost of installation of a mechanical system, including trenching and the number of skimmers necessary, a passive system has been chosen for evaluation. A passive system has lower capital costs and existing wells can be used.

To capture the free product plume, filter canisters would be placed in the wells where free product has been detected (monitoring wells MW-1, MW-8, MW-9, MW-15, MW-16, MW-18, MW-20, MW-21, and MW-22). To recover additional product, the wells would be hand bailed on a weekly interval when the skimmers are emptied and adjusted.

Based on the groundwater flow at the site, chemical characteristics of the contaminants, and comparison to similar systems at other locations, it is expected that the free product levels in the monitoring wells would persist for three to five years. However, this time calculation does not include desorption factors. Experience with passive skimming systems at sites with similar lithology and similar fuel oil contaminants indicate that adsorbed petroleum hydrocarbons within saturated zone soils continually leach into groundwater prolonging remedial time periods. This leaching process cannot be predicted accurately. Therefore, cost calculations were prepared using a more conservative remedial time period of seven years for the passive skimming system. An estimated cost for installation of a passive skimming system and four years of operation is presented in Table 5-2 and Appendix C, Table C4.

5.2.2 Groundwater Depression

This method of recovery creates a depression in the water table so that free product is directed toward pumping wells within the plume area. This system may help remove the free product potentially located under the building. Both free product and groundwater are extracted during recovery operations as the pump removes free product and water from the subsurface. The design of this system is constrained by the need to minimize drawdown of the water table because minimizing drawdown will reduce both the volume of co-produced water as well as the smearing of free product along the drawdown surface.

Product recovery systems using water table depressions are most applicable when hydraulic control of the hydrocarbon plume is necessary. These systems can operate in a wide range of permeability values

Table 5-2
Free Product Recovery Alternatives Cost Summary

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

ALTERNATIVE	CAPITAL COST	ANNUAL O&M	ESTIMATED YEARS OF OPERATION	O&M PRESENT WORTH	TOTAL PRESENT WORTH
Post-Excavation Dewatering	$11,000	$0	2 months	$0	$11,000
Skimming	$7,000	$25,000	8	$148,000	$155,000
Groundwater Depression	$59,000	$26,000	5	$107,000	$166,000

Note: See Appendix C for detailed cost estimates for the groundwater remediation alternatives.

and geologic media. Typically, free product recovery with water table depression is used in long-term operations of greater than one year (USEPA, 1996). The primary constraints on the design of this system include the need to minimize pumping rates and drawdowns but still provide hydraulic control of the free product.

To accomplish free product removal with groundwater depression, specialized pumps would be installed in wells MW-1, MW-8, MW-15, and MW-19. No additional wells would be installed. The free product and groundwater would be removed from these wells, the free product would be stored in drums on site, and the groundwater treated and discharged. Free product recovery using groundwater depression can generate large quantities of co-produced groundwater. Two options for the disposal of recovered groundwater include FOTW discharge or treatment and recharge to the water-bearing geologic formation. Because of the cost of treating contaminated groundwater, discharging it to the FOTW is preferred (provided the facility will accept discharges). Some pretreatment, such as phase separation, may be required before discharging to the sanitary sewer. Operational time to remediation using groundwater depression was estimated at 5 years. Experience with free product recovery systems indicates that adsorbed petroleum hydrocarbons within saturated zone soils continually leach into groundwater prolonging remedial time periods. This leaching process cannot be predicted accurately. An operational time of 5 years was used for cost purposes only, due to the uncertainties associated with free product removal. Actual removal times may vary significantly. The estimated costs for free product recovery with water table depression for 5 years of operation are presented in Table 5-2 and Appendix C, Table C5.

5.2.3 Dewatering During Soil Excavation

Free product may be recovered prior to and during excavation activities by dewatering, using trash pumps or conventional vacuum trucks. During excavation activities, free product and groundwater present in the excavation are removed by one of the above-mentioned methods. The removed product and water from dewatering activities will be treated at or disposed of at an off-site facility.

Free product dewatering is expected during soil excavation activities, and therefore the duration of the excavation phase of the project would determine the time limit for free product removal. Preliminary calculations indicate an estimated remedial time period of 30 days for excavation and disposal. An estimated cost for dewatering is included In Table 5-2, and as part of the Soil Excavation and On-site Treatment or Off-site Disposal Alternative presented in Appendix C, Table C6.

5.2.4 Bioslurping

Bioslurping systems addresses both soil remediation and free product recovery. The methods by which the proposed bioslurping system will recover free product are described in Section 5.1.3.

5.3 COST COMPARISON AND RATIONALE FOR SELECTION

A table comparing the estimated cost of remediation of soil and free product at the subject site using the combinations of the evaluated alternatives is provided in Table 5-3. Based on a review of the advantages, disadvantages, and costs, TtNUS recommends bioslurping.

The soil and free product remedial alternative, bioslurping, is recommended over other alternatives as it is a single system, has proven effective in similar situations, and is cost-effective. Excavation and dewatering has proven cost prohibitive and impracticable due to site restraints. Bioventing will require a separate system to recover free product and may require horizontal well installation under Building 1932. Also, the time to cleanup for a bioventing system would be directly connected to the effectiveness of the free product recovery, because the free product will act as a continuing source. Passive skimming has been eliminated as an alternative based on the intensive O&M, and it is generally ineffective for large free product plumes. The combination of a bioventing and groundwater depression would result in a need to install two separate sets of new wells at the site and the installation and O&M of two systems at the site. Based on this information bioslurping was chosen as the remedial alternative.

In order to effectively design and implement the bioslurping system, it will be necessary to conduct a treatability study. This study will assist in determining the optimum number of VEE wells to be installed. In addition, the treatability study will be used to determine a more accurate cleanup time.

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

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

COMBINED ALTERNATIVE	TOTAL PRESENT COST
Excavation and Disposal with Dewatering	$1,451,000
Bioslurping	$339,000
Bioventing and Groundwater Depression	$502,000
Bioventing and Skimming	$491,000

Note: See Appendix C for detailed cost estimates for the soil and free product remediation alternatives.

6.0 REMEDIAL SYSTEM DESIGN

The preferred remedial alternative presented in this RAP was selected based on it being a cost and time-effective method for treatment of hydrocarbons within the vadose zone and recovery of free product at the site. The potential remedial technologies and process options for free product recovery and soil remediation were identified and screened, and the results were presented in Section 5.0. The selected alternative is bioslurping, which addresses soil contamination and free product recovery.

6.1 BIOSLURPING SYSTEM DESIGN DETAILS

Major components of bioslurping include the following:

- Treatability study/Conceptual design
- VEE well installation
- Piping network
- Vacuum pump
- System equipment and controls
- Total fluids collection tank
- Oil-water separator

6.1.1 Treatability Study/Conceptual Design

Prior to system installation, a treatability study is recommended to optimize system design and efficiency. Mobile dual-phase extraction systems (MDES), also known as aggressive fluid vapor recovery systems, are a useful tool for treatability studies for bioslurping. The MDES vehicles are specially designed vacuum trucks, which perform DPE/bioslurping. Some specialty vendors of MDES provide site-specific data on vapor, free product, and groundwater extraction rates along with pressure transducers and water level indicators in surrounding monitoring wells. The water levels, pressure changes, and extraction rates provided during an MDES event can help determine ROI, effectiveness, and site specific criteria for the design of the vapor and groundwater treatment systems. An MDES event typically costs between $3,000 to $5,000 and some specialty vendors will provide the site-specific data, as described above, in a report.

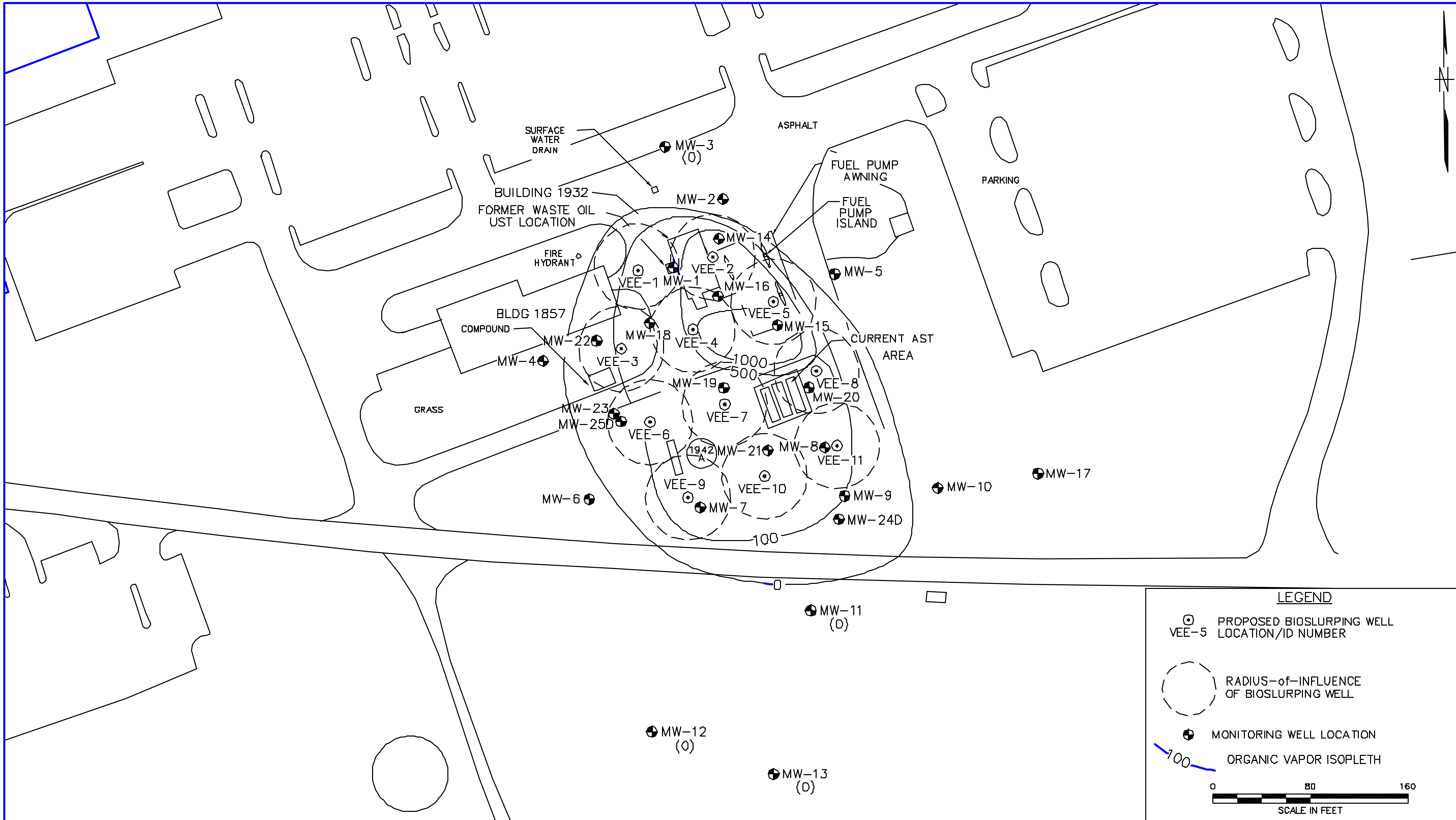
The conceptual design for this system consists of VEE wells, the piping from the wells to the bioslurping system, a holding tank and oil water separator for the extracted groundwater, and a vapor treatment system for the treatment and discharge of extracted vapors. The bioslurping system is a skid mounted system with two oil-sealed liquid ring vacuum pumps, close coupled to a explosion proof motor, and an oil reservoir tank with built-in baffles and coalescing filters for maximum air/oil separation and minimum oil emission. A vertical 120-gallon knockout tank and transfer pump is also connected to the bioslurping system. All components are piped and mounted on a steel baseplate. The two liquid ring vacuum pump systems are supplied with a 4-inch header for connection to the knockout package.

For preliminary (conceptual) design and costing purposes, the ROI is based on the hydraulic conductivity values estimated through slug tests conducted during the SAR (TtNUS, 2001), and intrinsic permeability associated with the system design for a similar system at Building 325 CSSPC (ABB-ES, 1996). The hydraulic conductivity at Building 1932 was estimated at 6.526 x 10^{-2} cm/sec. According to Applied Geology (Fetter, 1980), the hydraulic conductivity of 10^{-3} to 10^{-1} is associated with well-sorted sands and an associated intrinsic permeability (darcys) of 1 to 10 darcys. Therefore, to complete the conceptual design without a treatability study, it is estimated that the intrinsic permeability at Building 1932 is 1 to 10 darcys, which is assumed to be the same as Building 325, CSSPC. Based on the system at Building 325, a vacuum ROI was estimated at 35 ft. A more accurate ROI may be obtained through the treatability study.

An estimate of vacuum drawdown, vapor flow rate, and the number of VEE wells required was calculated based on the site-specific data presented above. Based on a comparison to similar conditions at CSSPC, it is estimated that Building 1932 requires 11 VEE wells, with a total flow rate of 550 cubic feet per minute and a total vacuum of 5 to 25 inches of mercury column. These VEE wells are also designed to extract free product and some groundwater. The proposed well placements are illustrated on Figure 6-1.

The treatability study should be used to calculate an actual ROI for free product recovery and vapor extraction. Hence, a more accurate number of wells may be determined. If an accurate ROI of free product recovery is not obtained and the wells are too close, the system may create excessive drawdown. Drawdown must be controlled to limit the free product from creating a smear zone. Transversely, if the ROI is too large the system will be ineffective in certain areas. In addition, optimization of well placement may decrease the total cost of the system.

In addition to determining the necessary ROI’s, the treatability study will more accurately determine potential air emissions from the vapor extraction portion of the system. A standard calculation was used to estimate the average daily emission rate at 24 lbs per day (lbs/day) of hydrocarbons, which is greater than the 13.7 lbs/day allowable by Chapter 62-770, FAC. A more accurate number will be determined by the treatability study to determine the size of the vapor treatment system.



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 3/4/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

PROPOSED BIOSLURPING WELL LOCATIONS
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 6-1
REV. 0

6.1.2 VEE Well Installation

The biosparging wells will be installed to a depth of approximately 15 ft bls or the top of the peat layer. Care will be taken not to drill through the peat layer (located at approximately 16 ft bls) as it is believed to represent an aquitard and this may cause cross-contamination to the lower aquifer. Hence, split spoon sampling should be performed beginning at 14 ft bls. The wells will be installed via a hollow stem auger drill rig. The well casing will be constructed of 4-inch diameter schedule 80 PVC pipe with, 4-inch diameter schedule 80, 0.020-inch slot PVC screen that covers both the free product layer and the vadose zone. This will ensure that both free product and soil vapors are extracted. Construction details for the VEE wells are detailed on Table 6-1.

The PVC well will be used to remove soil vapors by connecting it to a liquid ring pump system via 2-inch PVC piping. Free product will be extracted from the well using 1-inch clear, flexible PVC tubing. The drop tube will be inserted into the well through a three-way junction fitted to the top of the well casing. The construction details for the VEE wells are provided as Figure 6-2. The tube will be placed at the oil-water interface. A manifold will connect the drop tube and vapor extraction piping. The combination liquid and vapor piping will then be directed to the liquid ring pumping system (Figure 6-3).

6.1.3 System Equipment and Controls

The VEE wells are designed to extract free product, soil vapor, and some groundwater. Hence, the vacuum pump selected for this system should operate under dry (100 percent soil vapor), wet (100 percent fluids), and mixed flow situations. The vacuum pump(s) should also be capable of generating enough vacuum to extract soil vapor, free product, and groundwater from the VEE well and carry the total flow into the holding tank. Based on these requirements, it is recommended that two liquid ring pumps be used. Two liquid ring pumps similar those used at Building 325, CSSPC are recommended (Atlantic Fluidics Model A300 liquid ring pumps or equivalent). This liquid ring pump has a 20-horsepower motor and operates on 230 volt, 3-phase, alternating current, electrical power. This system is capable of extracting soil vapor, free product, and groundwater simultaneously. Design specifications and the quote are included in Appendix E. The actual pumps used for this system should be selected after performance of the treatability study.

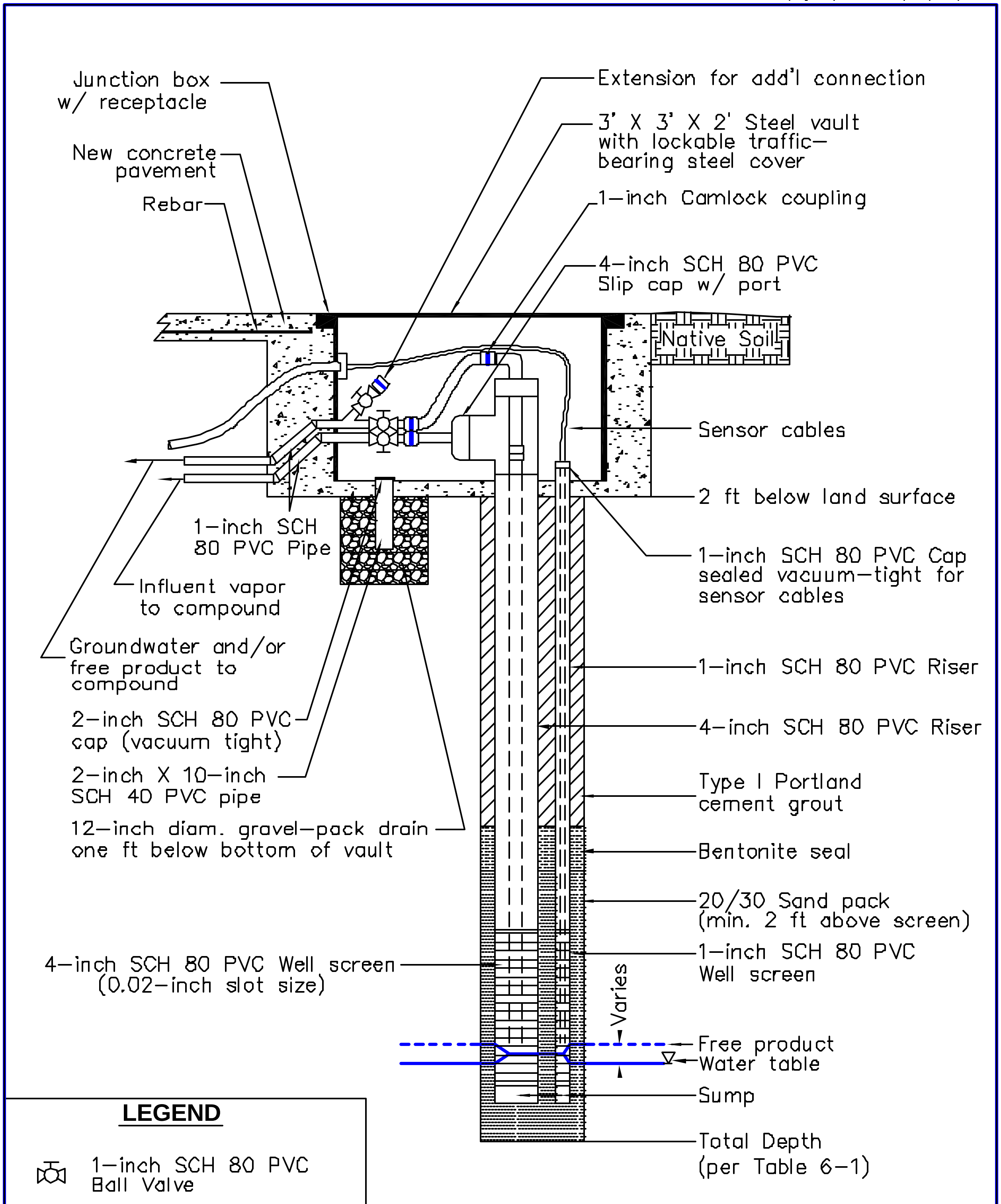
The liquid ring pump systems will be skid mounted and equipped with pressure and vacuum gauges, adjustable pressure relief valves, a flow meter, and a thermometer. The vacuum pumps will be explosion proof and will be operated by a control panel located on the skid.

Table 6-1
Construction Details of VEE Wells

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

VEE Well ID	Depth to Groundwater (ft bls)	Screen Interval (ft bls)	Nearest Monitoring Well
VEE-1	11.69	4-15	MW-1
VEE-2	11.78	4-15	MW-14
VEE-3	12.32	8-15	MW-22
VEE-4	11.69	4-15	MW-16
VEE-5	11.75	4-15	MW-15
VEE-6	11.57	8-15	MW-23
VEE-7	12.13	4-15	MW-19
VEE-8	11.99	4-15	MW-20
VEE-9	11.56	8-15	MW-7
VEE-10	11.96	8-15	MW-21
VEE-11	12.00	8-15	MW-8

Notes:
ID = indentification



DRAWN BY LLK / DATE 3/6/02		BIOSLURPING WELL CONSTRUCTION DETAILS REMEDIAL ACTION PLAN NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 4179
CHECKED BY / DATE			APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 6-2 / REV. 0

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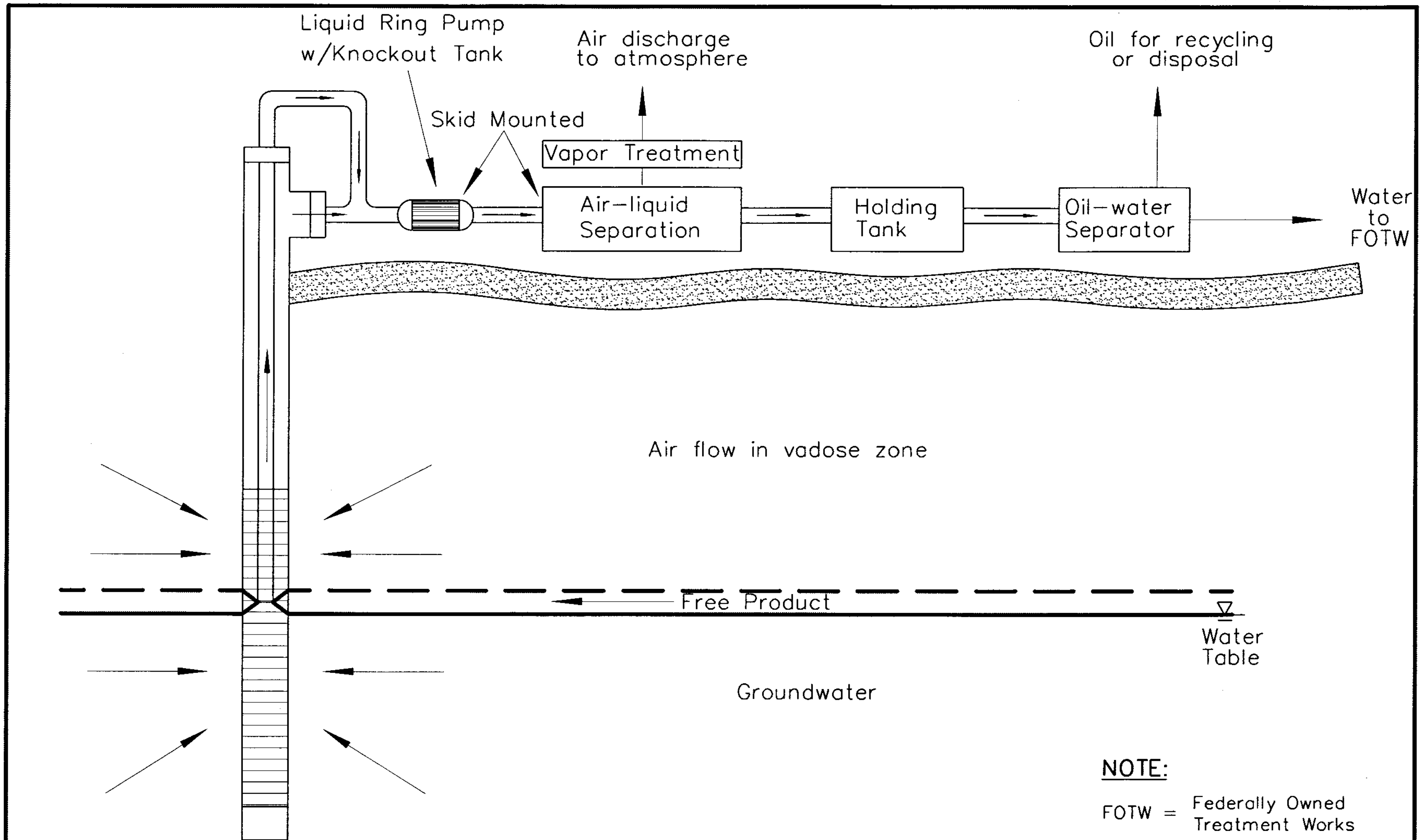


NOTE:

FOTW = Federally Owned Treatment Works

DRAWN BY LLK	DATE 3/5/02	BIOSLURPING EXTRACTION SYSTEM SCHEMATIC REMEDIAL ACTION PLAN BUILDING 1932 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 4179
CHECKED BY	DATE		APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 6–3 / REV. 0

The control panel will cause a shutdown of the pumps if any of the following occur:

- The liquid level in the seal reservoir of the liquid ring pump is at or below a low level sensor.
- The thermometer on the pump reads temperatures at or higher than those set by the pump manufacturer.
- The liquid level in the total fluids holding tank is at or above a high level sensor.
- The liquid level in the temporary fluids tank is at or above a high level sensor.
- In case of a shut off, the system will be serviced and the pumps manually restarted.

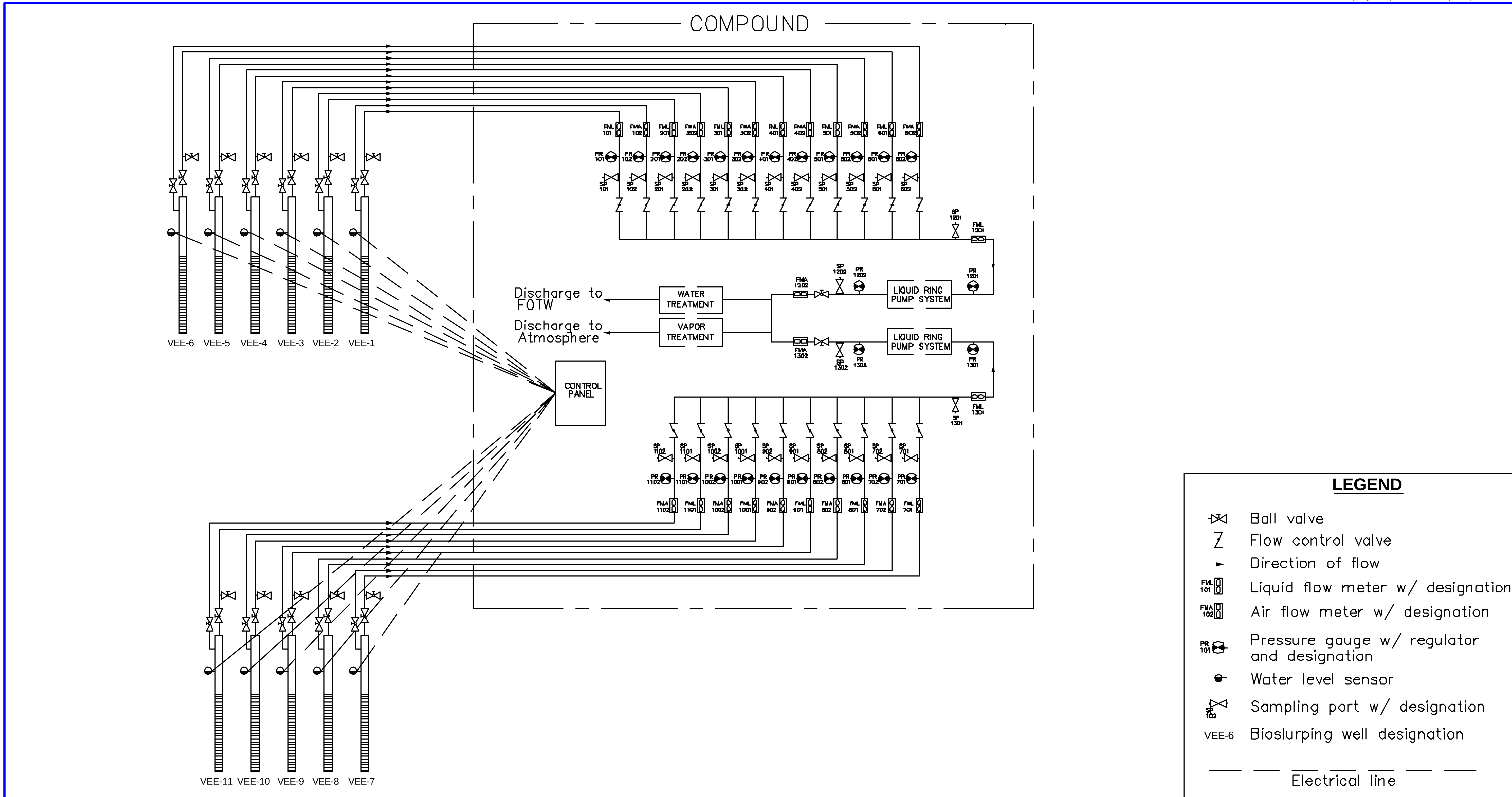
Figure 6-4 includes the piping and instrumentation diagram for the VEE system. Each VEE well will have two independent supply lines (liquid and vapor) that are manifolded at the compound. Appropriate sampling ports, flow control valves, and flow meters will be installed on each vacuum supply line to facilitate selective operation of the VEE wells. A totalizer flow meter and totalizer sampling port will be installed after the manifold to monitor the overall efficiency of the soil vapor extraction and free product recovery process.

The vacuum source attached to the drop tube will be designed to provide a third source of vacuum to facilitate supply of vacuum to any of the monitoring wells for free product recovery (see Figure 6-2). Installing these features on the well head would facilitate utilizing any of the existing monitoring wells as a free product recovery well, thus improving the overall efficiency of the VEE system.

The pipes from each VEE well will be designed to carry soil vapor, free product, and groundwater. The pipes from the VEE wells to the manifold will be of 1-inch diameter Schedule 80 PVC. The main supply line (manifold) connecting the VEE pipes to the liquid ring pump will be of 4-inch diameter Schedule 80 PVC.

Fluids recovered from the VEE wells will be discharged to the temporary liquid holding tank of the liquid ring pump system. This fluid is then discharged into a 1,000-gallon polyethylene observation tank, which is connected to the oil-water separation system. Mixed groundwater and free product are temporarily stored in the polyethylene tank to make a visual estimation of composition of fluids. The temporary holding tank will have a liquid high level sensor to prevent overfilling. The entire system and treatment compound will be securely retained within a 6-foot tall chain link fence with a minimum 10-ft long lockable gate for access.

The temporary holding tank will then discharge to the oil-water separator for the removal of free product from groundwater. The oil-water separator will have a liquid high sensor to prevent overfill. The selection of the oil-water separator should be performed after the treatability study to assure adequate sizing. Free



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 3/5/02
CHECKED BY DATE
COST/SCHED–AREA
SCALE NOT TO SCALE

VEE WELL PIPING AND INSTRUMENTATION DIAGRAM
REMEDIAL ACTION PLAN
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 4179
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 6–4 REV. 0

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98 product will be collected and disposed of per the requirements of Chapter 62-770, FAC. The water generated in the oil-water separator will be discharged to the FOTW. If this is not possible, an on-site water treatment system will likely be required.

6.2 OFF-GAS TREATMENT

Soil vapor recovered from the vadose zone may also need to be treated. If the system extracts more than 13.7 lbs/day of hydrocarbon vapors, it must be treated per Chapter 62-770, FAC. The exhaust vapor will be treated using GAC filters. Soil vapors are discharged from the liquid ring pump to an unrestricted exhaust tower, also known as a centrifugal scrubber. Vapors at the effluent port of the centrifugal scrubber will be treated before atmospheric discharge using two 2,000-lb GAC vessels that will remove the volatile organic hydrocarbon compounds. After the first 30 days of operation, the amount of hydrocarbon exhaust will be remeasured. If the emissions are below action levels, the use of the GAC filters can be discontinued.

6.3 ELECTRICAL AND CONTROLS

6.3.1 Control Panel

Based on the current operations at the site, it is assumed that electrical power is available to the area, and a power drop will be installed to provide electrical power to the bioslurping system. This may require a power pole installed adjacent to the system, pending a recommendation by the Navy on utility connection. There will be a power drop provided for the bioslurping system with a 240-volt, two-pole, 100-amp breaker in a weatherproof box. A telephone service connection box is also recommended although not required.

There will be a single field-mounted control panel for the bioslurping system. There will be a single "ON" switch with additional subsystem control switches and individual Hand-On-Auto (HOA) switches for individual motors. When in “ON” position, all devices which are equipped with HOA switches will operate when their switch is in the “HAND” position and will be enabled when their switch is in the “AUTO” position.

The control panel will be designed and fabricated to receive three-phase, 240-voltage alternating current (VAC) as well as 120 VAC and 240 VAC single-phase power from a breaker panel. Individual power sources (circuit breakers) for each load will be provided in the power panel, to be wired directly to the individual motor starters. The control panel will be designed to properly operate system electrical equipment. The control panel will contain all relays, motor starters, terminal blocks, transformers, and other components necessary for operation of the electrical equipment. The panel will be pre-wired and fabricated in accordance with the National Electric Code and will utilize readily available electrical components.

The control panel will contain motor starters with thermal overload and overcurrent protection, automatic reset, HOA switches, and on/off control logic for the liquid ring pump. The panel will also contain all relays, terminal blocks, and other components necessary for automatic operation of the bioslurping system. All alarm circuits will be equipped with indicator lights at the control panel to serve as "first out annunciators" when alarm conditions occur.

The electrical control panel will be located outside, therefore a National Electrical Manufacturers Association (NEMA) 4 external flange mounted enclosure surrounding a NEMA 1 enclosure that is complete with externally-mounted pump hour meters, HOA pump switches, reset button, and high liquid level indicator lights will be required. The NEMA 4 enclosure will have a locking cover for controlled access.

6.3.2 Bioslurping System Controls/Operation

The control panel will control the on/off operation of the liquid ring pump, air/water separator pump and associated control valves, high pressure and high temperature cut-out switches on pumps, and liquid level (high-high level) shut off switches installed in the air-water separator and the holding tank.

The bioslurping main control and operation components are listed below:

- Pump motor starters with thermal overload, overcurrent protection, and loss of three-phase protection, automatic reset, external hour meter, and HOA switches.

- One air-water separator/condensate pump motor starter with thermal overload, overcurrent protection, HOA switch, and on/off control logic.

- Moisture separator high-high level sensor and controls will deactivate the liquid ring pump in the event of an abnormally high liquid level condition in the separator.

- Holding tank high-high level sensor and controls will deactivate the liquid ring pump in the event of an abnormally high liquid level condition in the tank.

- Condensate pump will start upon the activation of sensor level high and operate until sensor level low is deactivated.

- A solenoid-operated valve (control valve) will be interlocked with the condensate pump for open/closed operation. This interlock will be by auxiliary contact with the motor starter or across motor winding. This valve will open on air/water separator high level and close when the low level switch de-actuates.

- High temperature sensor(s) [located on the discharge of the liquid ring pump(s)] and controls will deactivate the pump in the event of an abnormally high temperature condition at the pump.

- High-pressure sensor(s) [located at the discharge of the liquid ring pump(s)] and controls will deactivate the pump in the event a high-pressure condition is detected downstream of the pump.

7.0 OPERATIONS & MAINTENANCE 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 BIOSLURPING SYSTEM START-UP

Following the treatability study, final design, 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-25D) of water levels and dissolved oxygen measurements will be collected. Also, prior to start-up, the bioslurping wells in the area will be surveyed in reference to elevation to establish a baseline top of casing elevation for each remedial well.

7.2 DOCUMENTATION

A bioslurping operation manual and maintenance plan will be provided at the time of system installation and start-up. The plan will provide all necessary information for the proper O&M of the system and maintenance of the product monitoring and recovery plan. The plan will include at a minimum the following:

- System start-up instructions.
- System shutdown instructions.
- Electrical controls and wiring diagram.
- System "as-built" drawings.
- Equipment manufacturers' product operation manuals for each piece of equipment.
- Equipment warranty and guarantee information.
- Equipment service and repair vendor information.
- System troubleshooting guide.
- Equipment and system maintenance schedule and checklist.
- Material safety data sheets for materials used or being stored.
- Monitoring schedule, including sample frequency, sampling locations, required analyses, parameters for field measurements, vapor monitoring requirements, and vacuum measurement requirements.
- Instructions for maintaining a site activity log.

The operation manual and maintenance plan will be assembled and bound in a manner suitable for use in the field.

7.3 MONITORING FREE PRODUCT RECOVERY

Free product thickness and depth to groundwater will be measured in the monitoring wells on a weekly basis for the first three months and monthly for the remainder of the year in order to establish the presence and extent of free product at the site. Free product and groundwater recovery will be continued until no recoverable free product is identified in any of the monitoring wells for three consecutive quarters.

7.4 MONITORING SOIL REMEDIATION PROGRESS

On a weekly basis for the first three months and a monthly basis for the remainder of the first year of operation, vapor extraction emissions will be monitored for volatile organic hydrocarbons using a FID. Vapor monitoring will be performed on the soil vapor airstream before treatment and following carbon treatment, so that GAC filters can be changed before system breakthrough. The monitoring plan for the remaining term of the remediation will be based on an evaluation of the first three months of data collected on the operation of the system.

The air emissions after controls (after GAC treatment) will be monitored to meet the requirements of Chapter 62-770, FAC. Samples will be collected in a tedlar bag and analyzed by USEPA Method TO 14 to determine total VOC concentrations in the discharge.

The monitoring data will be used to determine if the objectives of the RAP and standards of the design criteria are being met. The remedial system will 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 remedial system will be based on the site-specific monitoring data.

7.5 SYSTEM O&M

The proposed remedial system is designed to operate 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 following O&M items are scheduled to be performed weekly for the first month and monthly thereafter:

- Ensure that drop tubes in all wells are located at the oil-water interface.
- 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.

7.6 STATUS REPORTS

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

- Startup date.
- Recent free-phase 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 future monitoring and operations of the system.

7.7 GROUNDWATER MONITORING

Although this remedial system does not address dissolved-phase groundwater contamination treatment, groundwater monitoring is recommended to track dissolved plume migration, and to collect data to serve as a basis for the future selection of a remedial alternative for groundwater. It is recommended that groundwater monitoring be conducted on a semi-annual basis during system operations. It is recommended that the following monitoring wells be sampled: MW-1, 3, 4, 5, 6, 7, 10, 11, 13, 20, and 21. The monitoring wells will be sampled for the Gasoline Analytical Group (GAG) and Kerosene Analytical Group (KAG) as specified in Chapter 62-770, FAC. The groundwater analytical results should be included in the periodic status reports.

7.8 SYSTEM DEACTIVATION

The following criteria must be met for the active remediation to be deemed complete and prior to deactivation of the bioslurping system:

- Soil effluent vapor samples contain no detectable constituents.
- Free product thickness less than 0.01 or extent practicable.

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

- Deactivate the liquid ring pump and allow it to cool down.
- De-energize the control panel via the service disconnect.
- Piping and recovery wells will remain on site until after the post-closure monitoring verifies that the site has been properly remediated, at which point they will be removed from the site as directed by the Navy.

Following system deactivation, a full round of sampling for COCs and groundwater natural attenuation parameters will be conducted to evaluate the need for a groundwater remedial action. A second RAP for the site shall be prepared to address the contaminated groundwater if it exists. If no contaminated groundwater exists, then 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.

8.0 REMEDIAL ACTION PLAN SUMMARY

The Remedial Action Plan Summary checklist is included in Appendix F.

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FDEP (Florida Department of Environmental Protection), 1997. Florida Administrative Code, Petroleum Contamination Site Cleanup Site Criteria, Chapter 62-770. September.

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TtNUS (Tetra Tech NUS, Inc.), 2001. *Site Assessment Report for Building 1932, Navy Exchange "Touch-n-Go" Service Station UST Site 000025*, Naval Air Station Pensacola, Pensacola, Florida.

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USEPA, 1996. *How to Effectively Recover Free Product at Leaking Underground Storage Tank Sites,* USEPA 510-R-96-001. September.

USEPA, 1995. *How to Evaluate Alternative Cleanup Technologies For Underground Storage Tank Sites, A Guide For Corrective Action Plan Reviewers*, USEPA 510-B-95-007. May.

APPENDIX A

SAR FIGURES

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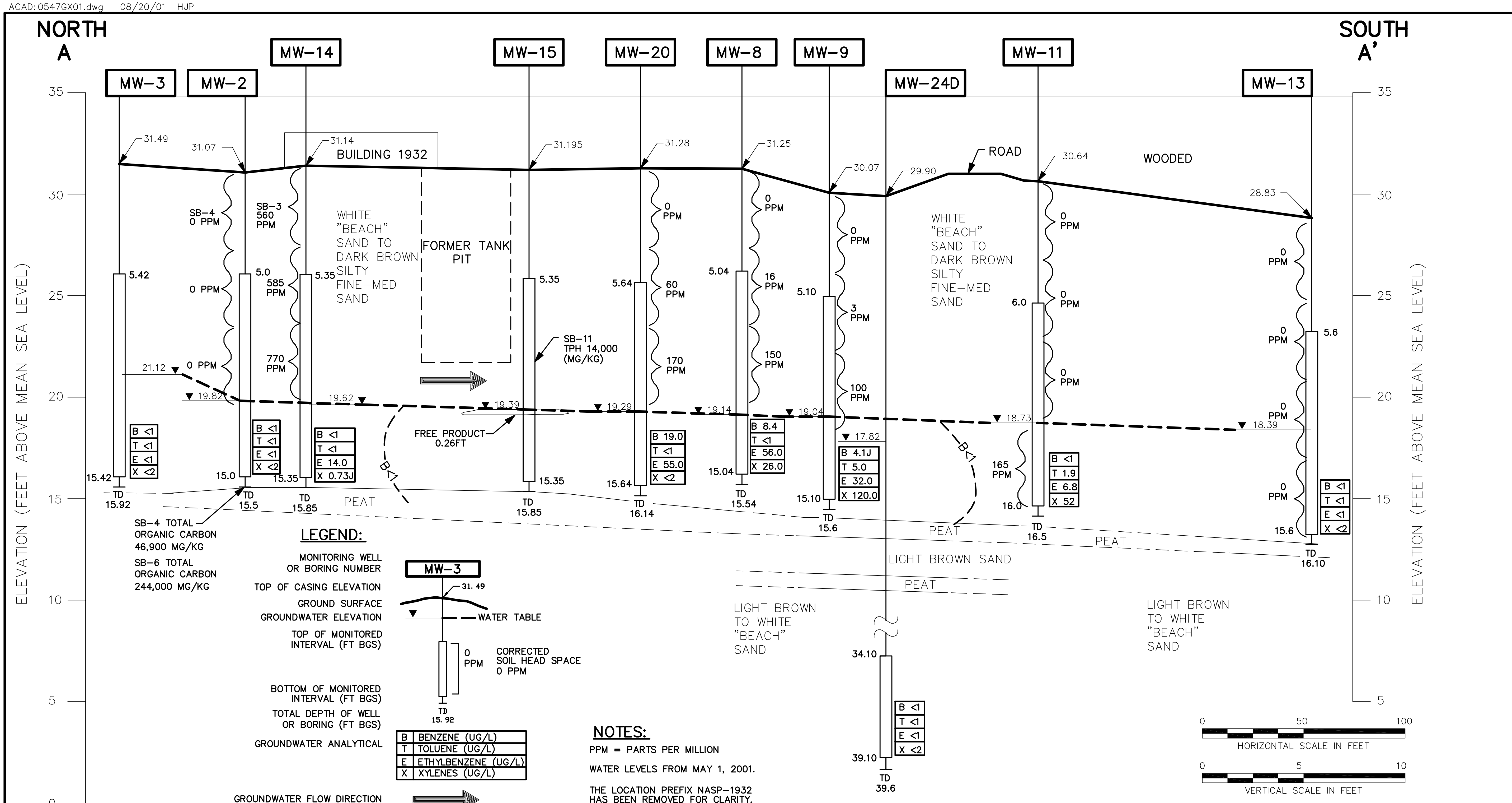


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 8/3/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION A-A'
SITE ASSESSMENT REPORT
BUILDING 1932
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 0547
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 3-1
REV. 0

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

APPENDIX B

CONTAMINANT MASS CALCULATIONS

TABLE B1
CONTAMINATED MASS CALCULATIONS

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

Soil

Average TRPH Concentration[1]				4429	mg/kg
Area of 0-4' contamination[2]		10300	ft^2		
Area of 4-8' contamination[2]		26200	ft^2		
Area of 8-12' contamination[2]		57500	ft^2		
Depth of each area		4	ft		
Volume of area 0-4' zone		41200	ft^3		
Volume of area 4-8' zone		104800	ft^3		
Volume of area 8-12' zone		230000	ft^3		
Total Volume of Soil Contamination		376000	ft^3		
		13925.93	yd^3		
Mass of Contaminated Soil[3]	V*1.4 ton/yd^3 907 kg/ton	19496.3	ton	17683141	kg
Mass of Contamination	TRPH*Mass Soil	172663.1	lbs	78318.63	kg

Free Product

Area of free product	23300	ft^2
Thickness	0.5	ft
Volume	11650	ft3
	431.48	yd3
porosity[4]	0.3	
Correction factor[4]	0.5	for sand
Density of free product[4]	49.12	lb/ft3
Mass of free product	85837.2	lbs

Notes:
[1] Calculated using SAR soil anlytical results
[2] Calculated using the 50 ppm isocontour line on CAD
[3] From "Pocket Ref" 1994
[4] From conclusions made in SAR (TtNUS, 2001)

APPENDIX C

REMEDIAL ALTERNATIVE COST ESTIMATES

Table C-1
Excavation and Disposal Cost

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

Estimator: RLM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)	
DIRECT COSTS	
Site Preparation and Mobilization	$11,000
Planning Documents	$32,000
Field Sampling & Oversight	$26,000
Excavation Activities	$70,000
Offsite Disposal of Soil	$918,000
Site Restoration and Demobilization	$235,000
Summary Data Report	$17,000
Costs for Excavation and Offsite Disposal	$1,309,000
Indirect Costs	
Contingency (@10%)	$131,000
TOTAL COSTS FOR EXCAVATION AND OFFSITE DISPOSAL	**$1,440,000**

Table C-1 (Continued)
Excavation and Disposal Cost

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation and Mobilization				
Silt fencing/signs/misc. materials	1	ls	$5,000	$5,000
Decontamination pad	1	ls	$1,000	$1,000
Pressure washer (assume base will provide decon water)	60	day	$20	$1,200
Pick-up truck	4	wk	$400	$1,600
General site mob/demob (4 laborers, 1 foreman)	5	ea	$400	$2,000
Total For Site Preparation and Mobilization				**$10,800**
Site Sampling & Oversight				
Planning Documents (HASP, WP)				
Professional Engineer	40	hrs	$90	$3,600
Jr. Level Engineer	200	hrs	$45	$9,000
Sr. Scientist	80	hrs	$90	$7,200
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				**$31,500**
Field Sampling & Oversight				
Jr. Level Geologist	400	hrs	$35	$14,000
ODCs	1	ls	$5,000	$5,000
Volatile Organics, Method 8260, assume 15, 3 QC	18	ea	$105	$1,890
PAH, Method 8310, assume 15, 3 QC	18	ea	$145	$2,610
TRPH (FL-PRO) assume 15 samples, 3 QC	18	ea	$135	$2,430
Total for Field Sampling & Oversight				**$25,930**
Excavation				
Excavation of Soil				
Trackhoe operator labor included in costs				
2.5 CY, Track Loader (2 units)	400	hrs	$125	$50,000
Four laborers	800	hrs	$25	$20,000
Subtotal for Excavation				**$70,000**
Offsite Disposal of Soil				
Transportation, and disposal of contaminated soil to a Subtitle D Facility	19496	ton	$47	$916,312
Characterization Sampling, 24 hr TAT (RCRA 8 metals, VOCs 8260, TRPH FL-PRO)	4	ea	$510	$2,040
Cost derived from quote from Andy Adams of Waste Transportation & Disposal Services (1-800-901-0081) cost quoted was $46.50/ton with treatment at an offsite soil burner.				
Subtotal for Offsite Disposal of Soil:				**$918,352**
Site Restoration and Demobilization				
	Quantity	Unit	Unit Cost	Total Cost
Common fill for backfill (load and haul) includes spreading and compaction	13,926	yd^3	$8	$111,408

Table C-1 (Continued)
Excavation and Disposal Cost

Hydroseeding	1	acre	$400	$400
Asphalt	5500	yd^2	$22	$121,000
Concrete curb,	150	linear	$2	$263
Demobilization of Equipment	2	ls	$1,000	$2,000
Subtotal Site Restoration and Demob:				**$235,071**

Summary Data Report

Summary Data Report				
Jr. Level Engineer	160	hrs	$45	$7,200
Senior Scientist	20	hrs	$80	$1,600
Mid-level Engineer	80	hrs	$60	$4,800
Word Processor	40	hrs	$35	$1,400
CADD	40	hrs	$40	$1,600
ODCs	1	ls	$500	$500
Total for Summary Data Report				**$17,100**

Table C-2
Bioventing Cost Alternative

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

Estimator: RLM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)		
DIRECT COSTS		
Site Preparation		$27,000
Piping and Equipment		$35,000
Total Installation labor		$19,000
TOTAL DIRECT COST		**$81,000**
INDIRECT COSTS		
Engineering and Design (20%)		$16,000
TOTAL INDIRECT COST		**$16,000**
Total Capital Costs (Direct + Indirect)		**$97,000**
OPERATIONS AND MAINTENANCE		
Administrative O&M		
Work Plan (WP) for Monitoring Activities		$9,000
4 Quarterly Site Activities Reports		$24,000
Total Administrative O&M, annual		**$24,000**
Present worth of O&M (7%, 7.5 yrs)	($136,445)	$136,000
Present worth O&M + SAP		**$145,000**
Treatment System O&M		
System Maintenance		$9,000
Utilities		$2,000
Total Treatment System O&M, Annual		**$11,000**
Present Worth of Treatment System O&M (7%, 7.5 yrs)	($62,537)	$63,000
Present Worth O&M (Administrative + Treatment System O&M)		**$208,000**
Assumption - System will run for seven and a half years.		
Total Capital and O&M Cost		$305,000
Contingency (10%)		$31,000
TOTAL COST		**$336,000**

Table C-2 (Continued)
Bioventing Cost Alternative

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation				
Storage trailer	1	mo	$106	$106
Treatment system concrete pad	1200	ft^2	$3	$3,600
Fencing, 30'x40'	140	ft	$13	$1,820
Gates for access to treatment system fence	1	ea	$726	$726
Utility connection for treatment system				
Including electric poles, cable, transformer, phone line for telemetry	1	ls	$15,000	$15,000
Pressure washer and water tank	1	mo	$504	$504
ODCs(Plastic sheeting, drums, pumps, hoses, supplies,etc.)	1	ls	$2,000	$2,000
Labor				
2 laborers, 4 days, 10 hrs/day	80	hr	$19	$1,520
1 foreman, 4 days, 10 hrs/day	40	hr	$35	$1,400
Total Site Preparation				**$26,676**
Note: 11 vertical bioventing wells estimated based on 35 foot radius of influence.				
Biovent System				
Piping and Equipment				
One 140 CFM, 7.5 HP, Extraction Blower System	1	ea	$3,179	$3,179
2" Dia. PVC @ 16' Depth, Vertical pipe vent installed	176	ft	$34	$5,945
System plumbing (piping, elbows, etc.)	1	ls	$4,000	$4,000
System control panel	1	ea	$3,000	$3,000
Misc construction materials	1	ls	$5,000	$5,000
Trenching (4' deep x 1' wide x 1000')	4000	cy	$1	$4,440
Site restoration (paving, hydroseeding, etc.)	1	ls	$5,000	$5,000
Remedial well survey (survey of new well locations)	1	ls	$2,000	$2,000
System start-up	1	ls	$2,000	$2,000
Knock-out tank	1	ls	$73	$73
GAC 100 CFM, 200lb Fill	1	drum	$710	$710
Total Piping and Equipment				**$35,347**
Labor for system connection & Start-up				
3 Laborers, 2 weeks @ 50 hrs/wk	300	hrs	$30	$9,000
1 Jr. Level Engineer, 2 weeks @ 50 hrs/wk	100	hrs	$45	$4,500
1 Sr. Engineer, 20 hours per week	40	hrs	$90	$3,600
1 Electrician, 1 week @ 50 hrs/wk	50	hrs	$35	$1,750
Total Labor:				**$18,850**
TOTAL DIRECT COSTS				**$80,873**

Table C-2 (Continued)
Bioventing 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 Engineer	80	hrs	$45	$3,600
Senior Engineer	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				**$8,825**

REPORTING	Quantity	Unit	Unit Cost	Total Cost
Site Activities Report (quarterly)				
1 Jr. Level Engineer	40	hrs	$45	$1,800
1 Senior Engineer	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**

Note: Costs for As Built Drawings are included in the CADD time.

TREATMENT SYSTEM O&M (annual)

System Maintenance

Labor				
Jr. Engineer, 4 hrs per month, system operating data, control	48	hr	$45	$2,160
Technician, 8 hrs per month	96	hr	$30	$2,880
Project Mgr, 2 hrs per month	24	hr	$100	$2,400
Electrician, 4 hours per year	4	hr	$60	$240
Misc. equip/supplies	1	yr	$500	$500
Air Sampling				
TO 14 Sampling, Tedlar Bag, 2 per quarter	8	each	$100	$800
Total System Maintenance (annual):				**$8,980**
Utilities				
Electricity	29200	kWh	$0.06	$1,752
Assume 10 kW*8 hr/day*365 day/yr = 29200 kWh/yr				
Total Utilities				**$1,752**
Total Treatment System O&M (Annual)				**$10,732**

Table C-3
Bioslurping Cost Alternative

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

Estimator: RLM
Checked By:

COST SUMMARY TABLE (costs rounded to nearest $1000)		
DIRECT COSTS		
Site Preparation		$27,000
Piping and Equipment		$60,000
Total Installation labor		$19,000
TOTAL DIRECT COST		**<u>$106,000</u>**
INDIRECT COSTS		
Engineering and Design (20%)		$21,000
Treatability Study		$10,000
TOTAL INDIRECT COST		**$31,000**
Total Capital Costs (Direct + Indirect)		**<u>$137,000</u>**
OPERATIONS AND MAINTENANCE		
Administrative O&M		
Work Plan (WP) for Monitoring Activities		$9,000
4 Quarterly Site Activities Reports		$24,000
Total Administrative O&M, annual		**<u>$24,000</u>**
Present worth of O&M (7%, 4 yrs)	($81,293)	$81,000
Present worth O&M + SAP		**<u>$90,000</u>**
<u>Treatment System O&M</u>		
System Maintenance		$8,000
Utilities		$16,000
Total Treatment System O&M, Annual		**<u>$24,000</u>**
Present Worth of Treatment System O&M (7%, 4 yrs)	($81,293)	$81,000
Present Worth O&M (Administrative + Treatment System O&M)		**$171,000**
Assumption - System will run for four years.		
Total Capital and O&M Cost		$308,000
Contingency (10%)		$31,000
<u>TOTAL COST</u>		**<u>$339,000</u>**

Table C-3 (Continued)
Bioslurping Cost Alternative

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Site Preparation				
Storage trailer	1	mo	$106	$106
Treatment system concrete pad	1200	ft^2	$3	$3,600
Fencing, 30'x40'	140	ft	$13	$1,820
Gates for access to treatment system fence	1	ea	$726	$726
Utility connection for treatment system				
Including electric poles, cable, transformer, phone line for telemetry	1	ls	$15,000	$15,000
Pressure washer and water tank	1	mo	$504	$504
ODCs(Plastic sheeting, drums, pumps, hoses, supplies,etc.)	1	ls	$2,000	$2,000
Labor				
2 laborers, 4 days, 10 hrs/day	80	hr	$19	$1,520
1 foreman, 4 days, 10 hrs/day	40	hr	$35	$1,400
Total Site Preparation				**$26,676**
Bioslurping System				
Piping and Equipment				
Skid mounted Liquid Ring Pump Sytem and Controls	1	ea	$29,740	$29,740
Polyethylene Skid Mounted Storage Tank	1	ea	$2,431	$2,431
4" Dia. PVC @ 16' Depth, Vertical pipe vent installed [1]	176	ft	$28	$4,928
System plumbing (piping, elbows, valves, etc.)	2	ls	$2,000	$4,000
Misc construction materials	1	ls	$5,000	$5,000
Trenching (4' deep x 1' wide x 1000')	4000	cy	$1	$4,440
Site restoration (paving, hydroseeding, etc.)	1	ls	$5,000	$5,000
Remedial well survey (survey of new well locations)	1	ls	$2,000	$2,000
System start-up	1	ls	$2,000	$2,000
Total Piping and Equipment				**$59,539**

Note: [1] 11 vertical bioslurping wells estimated based on 35 foot radius of influence

Labor for system connection & Start-up	Quantity	Unit	Unit Cost	Total Cost
3 Laborers, 2 weeks @ 50 hrs/wk	300	hrs	$30	$9,000
1 Jr. Level Engineer, 2 weeks @ 50 hrs/wk	100	hrs	$45	$4,500
1 Sr. Engineer, 20 hours per week	40	hrs	$90	$3,600
1 Electrician, 1 week @ 50 hrs/wk	50	hrs	$35	$1,750
Total Labor:				**$18,850**

Table C-3 (Continued)
Bioslurping Cost Alternative

TOTAL DIRECT COSTS **$105,065**

OPERATIONS AND MAINTENANCE

Administrative O&M

Work Plan for Monitoring and O&M Activities

Labor	Quantity	Unit	Unit Cost	Total Cost
Jr. Level Engineer	80	hrs	$45	$3,600
Senior Engineer	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				**$8,825**

REPORTING	Quantity	Unit	Unit Cost	Total Cost
Site Activities Report (quarterly)				
1 Jr. Level Engineer	40	hrs	$45	$1,800
1 Senior Engineer	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

Table C-3 (Continued)
Bioslurping Cost Alternative

Labor				
Jr. Engineer, 4 hrs per month, system operating data, control	48	hr	$45	$2,160
Technician, 8 hrs per month	96	hr	$30	$2,880
Project Mgr, 2 hrs per month	24	hr	$100	$2,400
Electrician, 4 hours per year	4	hr	$60	$240
Misc. equip/supplies	1	yr	$500	$500
Total System Maintenance (annual):				**$8,180**
Utilities				
Electricity	262800	kWh	$0.06	$15,768
Assume 30 kW*24 hr/day*365 day/yr = 262800 kWh/yr				
Total Utilities				**$15,768**
Total Treatment System O&M (Annual)				**$23,948**

Table C-4
Free Product by Passive Skimming Cost Summary

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Free Product Removal/Skimming System				
Skimmer, 1" Diameter, 47" L, 0.10 gal capacity	9	ea	$675	$6,075.00
Labor				
1 Technician, 2 days	16	hrs	$35	$560
1 Jr. Level Engineer, 1 day	8	hrs	$45	$360
Total				**$6,995**
TREATMENT SYSTEM O&M (annual)				
System Maintenance				
Labor:				
Technician, 24 hrs per month	288	hr	$30	$8,640
Sr. Engineer, 2 hours per month	24	hr	$90	$2,160
Project Mgr, 2 hrs per month	24	hr	$100	$2,400
Recovered Product Drum Disposal, 12 per year	12	ea	$197	$2,364
Total Annual System Maintenance				**$15,564**
Quarterly Status Reports				
1 Jr. Level Geologist 16 hrs	64		$45	$2,880
1 Senior Geologist 4 hrs	16		$80	$1,280
Technical Expert 2 hrs	8		$75	$600
Production:				
Word processing 8 hrs	32		$35	$1,120
Editor 2 hrs	8		$60	$480
Copying: 50 pgs x 25 copies	1250	page	$0.10	$125
Binding/shipping, 25 copies	25	ea	$20	$500
ODC's, Production Support (editing, copying, binders, etc.)	1	ls	$1,000	$1,000
CADD, 8 hrs/figure, 4 figures	32	hrs	$40	$1,280
Total Annual Quarterly Status Report Cost				**$9,265**
Total Annual O&M and Reporting Cost				**$24,829**
Total Present Worth of O&M and Reporting (8 yrs, 7%) Assume system will run for eight years.			($148,261.37)	**$148,000**
TOTAL PROJECT COST				**$155,000**

Table C-5
Free Product Recovery by Groundwater Depression Cost Summary

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Free Product Recovery with Water Table Depression				
Pneumatic Product Recovery Pump	3	ea	$3,800	$11,400.00
10 gpm Oil/Water Separator	1	ea	$6,418	$6,418
Oil/Water Separator Installation	1	ls	$984	$984
4,000 Polyethylene Aboveground Holding Tank	60	mo	$540	$32,400
Sewer Connection Fee	1	ea	$2,270	$2,270
Labor				
1 Technician, 1 week @ 50 hrs/wk	50	hrs	$35	$1,750
1 Jr. Level Engineer, 1 week @ 50 hrs/wk	50	hrs	$45	$2,250
1 Sr. Engineer, 16 hours	16	hrs	$90	$1,440
TOTAL				**$58,912**
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, 8 hours per year	8	hr	$35	$280
Misc. equip/supplies	1	yr	$500	$500
Total Annual O&M				**$19,740**
Quarterly Status Reports				
1 Jr. Level Geologist 16 hrs	64		$45	$2,880
1 Senior Geologist 4 hrs	16		$80	$1,280
Technical Expert 2 hrs	8		$75	$600
Production:				
Word processing 8 hrs	32		$35	$1,120
Editor 2 hrs	8		$60	$480
Total Annual Reporting				**$6,360**
Total Annual O&M and Reporting				**$26,100**
Present Worth of O&M and Reporting (7%, 5 yrs)			($107,015)	**$107,000**
Assume five years of system operation.				
TOTAL PROJECT COST				**$166,000**

Table C-6
Free Product Recovery During Excavation Cost Summary

DIRECT COSTS	Quantity	Unit	Unit Cost	Total Cost
Product Recovery Pump w/ controls & electric	2	mo	$216	$432.86
Poly Tank, 4000 gal	2	mo	$540	$1,080.00
Oily Water Removal, 2000 gal	4000	gal	$0.24	$960
TOTAL				**$2,473**
REPORTING, Site Activities Report/System Operation Report:				
1 Jr. Level Geologist	100	hrs	$45	$4,500
1 Senior Geologist	16	hrs	$80	$1,280
Technical Expert	6	hrs	$75	$450
Production:				
Word processing	12	hrs	$35	$420
Editor	8	hrs	$60	$480
CADD operator,	8	hrs	$40	$320
Reproduction: 100 pgs @ 20 copies	2000	pg	$0.10	$200
Shipping/binding: 20 reports	20	ea	$20	$400
Total Report/Modeling Cost:				**$8,050**
TOTAL PROJECT COST				**$10,523**

APPENDIX D

ESTIMATED REMEDIAL TIME CALCULATIONS

Table D-1
Bioventing Estimated Time to Clean-up Shallow Zone

Remedial Action Plan
Building 1932, UST Site 000025
Naval Air Station Pensacola
Pensacola, Florida

To determine M, mass of soil treated:

Assume flow rate at biovent extraction well =	8	cfm			
Assume flow rate at 11 biovent extraction wells =	88	cfm			
There are 480 minutes in 8 hours per day[1]	480	minutes/day			
Therefore the flow rate per day is =	42240	cf/day	or	1196.24	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 =	8870.40	cf/day	or	251.21	m^3/day

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

The density of oxygen at STP =	1.21	kg/m^3			
1 atm at 68F					
The volume was =	251.21	m^3/day			
The mass of oxygen for treatment =	303.96	kg/day	or	668.72	lbs/day
mass= density*volume					
Therefore: lbs per day oxygen/3.5 =	191.06	lbs of petroleum product degraded per day.			

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

lbs of petroleum degraded per day		191.06	lbs
lbs total of petroleum in soil		262288	petroleum is soil
lbs of petroleum degraded per day / days		1372.78	days
Multipy by 2 for factor of safety		2745.57	days
(due to varying site conditions)	or	**7.5**	**years**

APPENDIX E

DESIGN SPECIFICATIONS

TUTHILL Vacuum Systems | atlantic fluidics
21 South Street
South Norwalk, Connecticut USA 06854
Tel 203 853-7315 Fax 203 866-8218

March 6, 2002

Mr. Joe Ferranti
Tetra Tech NUS Inc
7018 A.C. Skinner Pkwy, Ste 250
Jacksonville, FL 32256

FAX# 904 281-~~0700~~ 0070

Re: Oil Sealed Soil Remediation Package

Dear Joe,

In response to our telephone conversation, we are pleased to offer our proposal as follows:

Duplex Oil Sealed Soil Remediation Package including two Model OSR-300 oil sealed packages, each featuring the Atlantic Fluidics Model A300 liquid ring vacuum pump in cast iron construction and viton seals, close coupled to 20 HP, 1160 RPM, 208-230/460/3/60 Class I, Group D explosion proof motor. The oil reservoir tank has built-in baffles and coalescing filters for maximum air/oil separation and minimum oil emission. The tank is fitted with an oil level gauge, low oil level switch and pressure gauge. The oil is cooled with an air-cooled heat exchanger with the fan driven by an extended shaft from the liquid ring pump motor. The oil return line to the pump includes a 3-way thermostatic valve, two temperature gauges, a solenoid valve and a flow control valve. The inlet to the pump includes a vacuum gauge, check valve and shut-off valve. All components are piped and mounted on a steel baseplate.

The knockout tank package includes a vertical, 120 gallon steel tank built to ASME standards and includes a full length sight tube, a multi-level switch assembly with four (4) floats, a vacuum relief valve, a vacuum gauge and a Ø5" cleanout access. The transfer pump is a Grundfos multi-staged centrifugal driven by ¾ HP, 3450 RPM, 208-230/460/360 Class I, Group D explosion proof motor rated for 25 gpm at 75 ft head. The pump discharge is fitted with a pressure gauge, gate valve and check valve. All components are piped an mounted on a steel baseplate.

The two OSR-300 packages will be supplied with a Ø4" header for connection to the knockout package. The system will ship in four components (2) OSR-300, (1) knockout package and (1) header for customer installation on site.

Price: $29,740.00

Shipment: 7-8 weeks upon receipt of order FOB: Norwalk, CT
Freight collect

Terms: Net 30 (subject to credit approval)

Very truly yours,

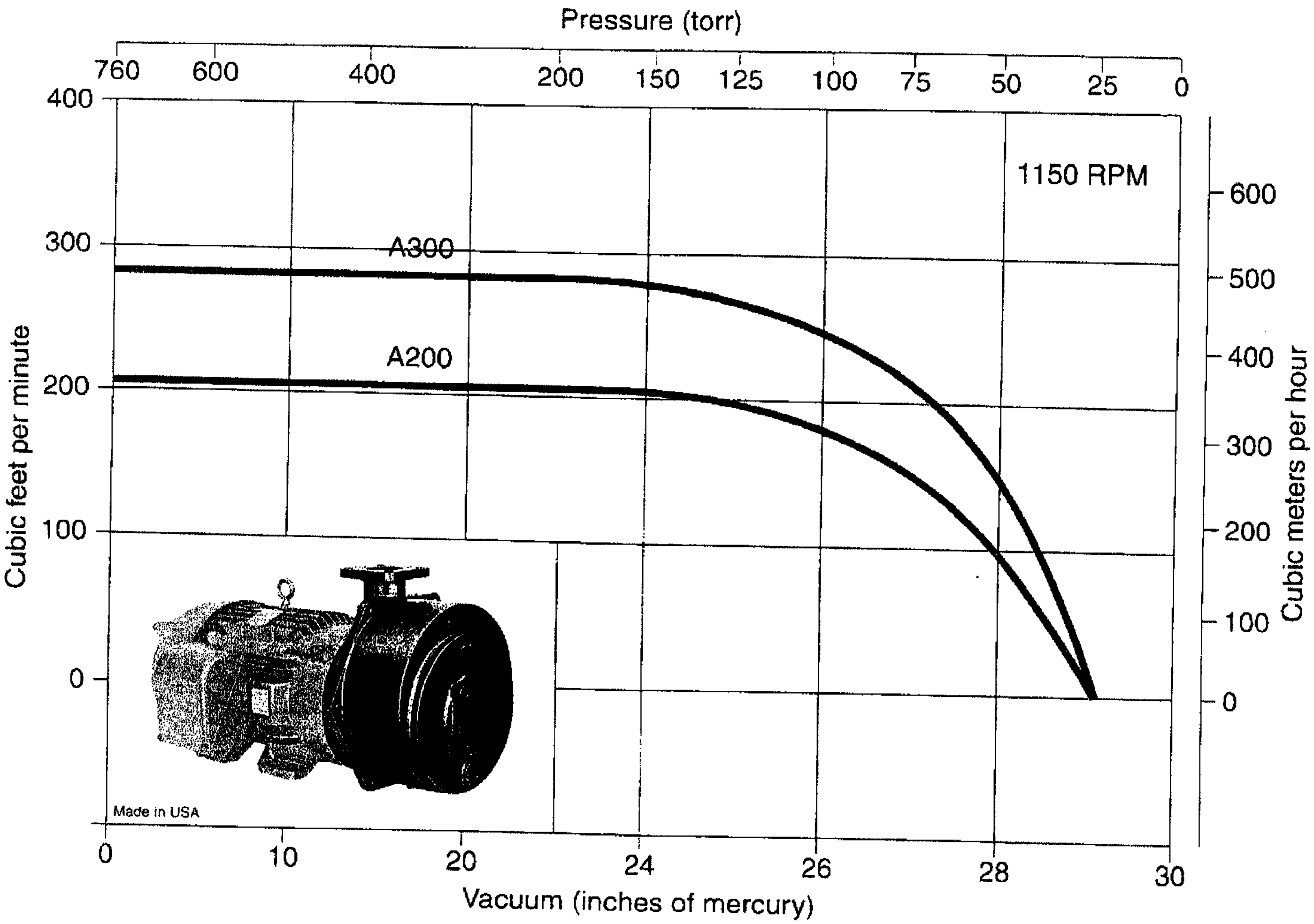
Karim Khidhayir
KK:le

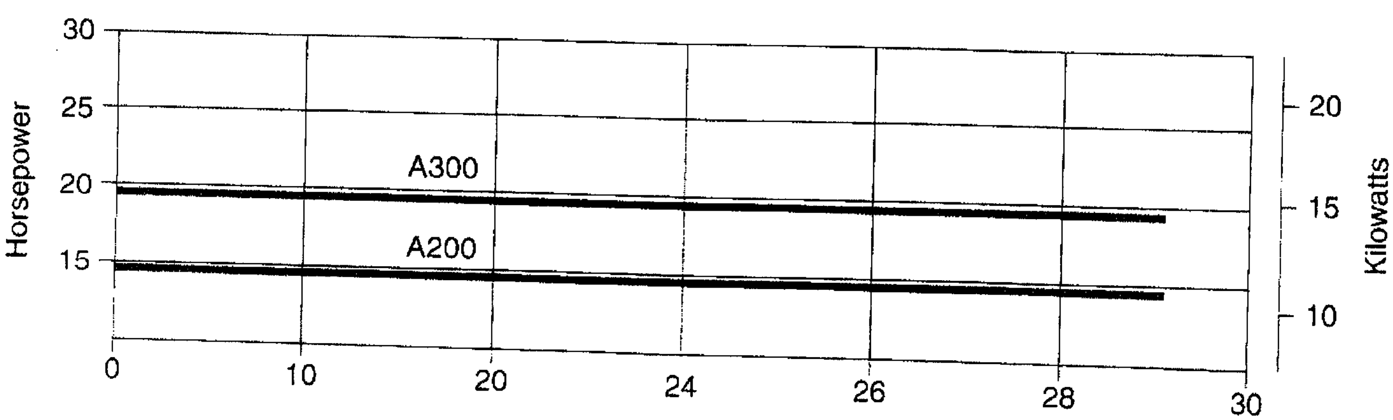
TERMS: NET 30 DAYS

SEE REVERSE SIDE FOR TERMS AND CONDITIONS

TUTHILL VACUUM SYSTEMS | atlantic fluidics

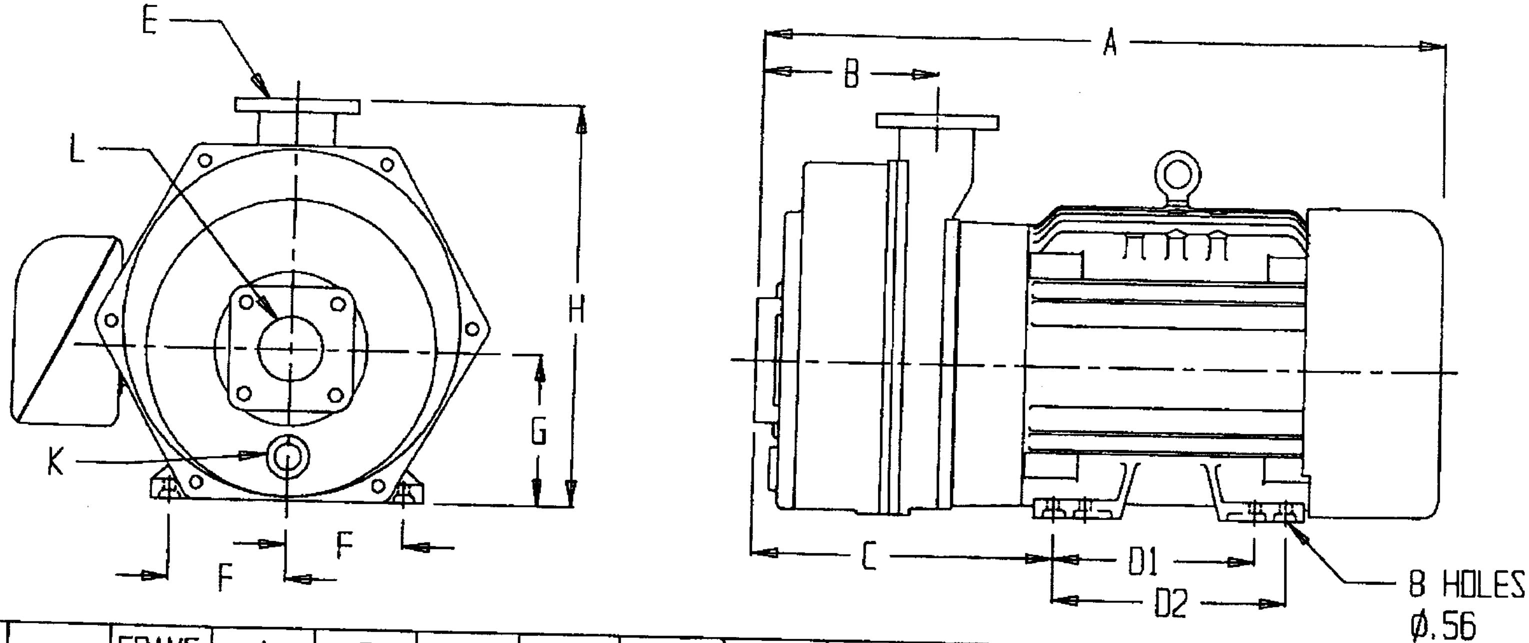
Dry air performance curves for Fluid-Vac® single stage vacuum pumps





21 South Street, South Norwalk, CT 06854 (203) 853-7315 Fax (203) 866-8218
www.atlanticfluidics.com

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
B	DIMENSIONS BROUGHT UP TO DATE	08/17/98	



MODEL	HP	FRAME (NEMA)	A (IN)	B (IN)	C (IN)	D1 (IN)	D2 (IN)	E (FL)	F (IN)	G (IN)	H (IN)	K (NPT)	L (FL)	WEIGHT (LBS)
A200	15	284TYZ	32.44	8.31	14.25	9.5	11.0	3	5.50	7.00	18.38	1	3	510
A300	20	284TYZ	33.82	9.69	15.63	9.5	11.0	3	5.50	7.00	18.38	1	3	550

NOTES:

1. MODEL A200 SHOWN
2. MOTORS ARE BALDOR (3∅, TEFC)
3. DIMS SUBJECT TO CHANGE WITHOUT NOTICE

TUTHILL Vacuum Systems

A200-A300 CLOSE COUPLED ASSEMBLY

DRAWN BY: KK	SIZE A	DATE 08/29/95	DWG NO. A998-A300-01 / REV B
APP. BY	SCALE NONE	CAD FILE NO. 998-043B	SHEET 1 OF 1

APPENDIX F

RAP SUMMARY CHECKLIST

FLORIDA

Remedial Action Plan Summary

DEP Form # 62-770.900(4)
Form Title: Remedial Action Plan Summary
Effective Date: September 23, 1997

Site Name BUILDING 1932, UST SITE 000025
Location NAVAL AIR STATION PENSACOLA
Media Contaminated: ☐ Groundwater ☒ Soil

FDEP Facility ID No. ________
Current Date 3/20/02
Date of Last GW Analysis 5/5/01

Type(s) of Product(s) Discharged:
☐ Gasoline Analytical Group
☒ Kerosene Analytical Group (Diesel)
- Estimated Petroleum Mass (lbs):
  - Groundwater ________
  - Saturated Zone Soil ________
  - Vadose Zone Soil 172,663
- Area of Plume 57,600 (ft^2)
- Thickness of Plume 12 (ft)

Groundwater Recovery and Specifications:
- No. of Recovery Wells ______
  ☐ Vertical ☐ Horizontal
- Design Flow Rate/Well ________ (gpm)
- Total Flow Rate ________ (gpm)
- Hydraulic Conductivity ________ (ft/day)
- Recovery Well Screen Interval ______ (ft)
- Depth to Groundwater ________ (ft)

Method of Groundwater Remediation:
☐ Pump-and-Treat
  ☐ Air Stripper
    ☐ Low Profile ☐ Packed Tower
  ☐ Diffused Aerator
  ☐ Activated Carbon
    ☐ Primary Treatment ☐ Polishing
☐ In Situ Air Sparging
- No. of Sparge Points ______
  ☐ Vertical ☐ Horizontal
- Pressure ________ (psi)
- Design Air Flow Rate/Well ________ (cfm)
- Total Air Flow Rate ________ (cfm)

☐ Biosparging
- No. of Sparge Points ______
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well ________ (cfm)

☐ Bioremediation
  ☐ In Situ ☐ Ex Situ
☐ Other ________

Method of Groundwater Disposal:
☐ Infiltration Gallery ☐ Sanitary Sewer
☐ Surface Discharge/NPDES ☐ Injection Well
☐ Other ________

Free Product Present: ☒ Yes ☐ No
- Estimated Volume 85,837 (gal)
- Maximum Thickness 1.14 (in)
- Method of Recovery (check all that apply):
  ☐ Manual Bailing ☐ Skimming Pump
  ☒ Other BIOSLURPING

Method of Soil Remediation:
☐ Excavation
  Volume to be Excavated ________ (yds^3)
  ☐ Thermal Treatment ☐ Land Farming On Site
  ☐ Landfill ☐ Bioremediation
  ☐ Other ________
☐ Vapor Extraction System (VES)
- No. of Venting Wells ______
  ☐ Vertical ☐ Horizontal
- VES - Applied Vacuum ________ (wg)
- Design Air Flow Rate ________ (cfm)
- Design Radius of Influence ________ (ft)
- Air Emissions Treatment
  ☐ Thermal Oxidizer ☐ Catalytic Converter
  ☐ Carbon ☐ Other ________

☐ Soil Bioventing
- No. of Venting Wells ______
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate ________ (cfm)

☐ In Situ Bioremediation
☒ Other BIOSLURPING

Natural Attenuation:
- Method of Evaluation
  ☐ Rule 62-770.690(1)(e), F.A.C.
  ☐ Rule 62-770.690(1)(f), F.A.C.

Estimated Time of Cleanup: 1460 (days)
- Method of Estimation
  ☐ Pore Volumes (no. of pore vols. = ______)
  ☐ Exponential Decay (Decay Rate) ____ (day^{-1})
  ☐ Groundwater Model
  ☒ Other COMPARISON TO SIMILAR SITE

Estimated Cost:
- Est. Capital Cost (incl. install.) $ 147,000
- Est. O & M Cost (per year) $ 48,000
- Est. Total Cleanup Cost $ 339,000