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Section : 02.05
Site 20903-5640 (White Oak)
Doc. #: 0001

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Engineering Evaluation/ Cost Analysis (EE/CA)

for

Site 46

Former
Naval Surface Warfare Center
White Oak, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0311

December 1998

TETRA TECH NUS, INC.

Section: 02.05
Site 20903-5640 (White Oak)
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ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) FOR SITE 46 FORMER NAVAL SURFACE WARFARE CENTER WHITE OAK, MARYLAND

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

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PREPARED BY:

Scott A. Nelt for
JEFFREY P. ORIENT, P.G.
PROJECT MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

APPROVED BY:

M. J. Bartmes for
JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
TETRA TECH NUS, INC.
KING OF PRUSSIA, PENNSYLVANIA

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ACRONYMS

µg/L	Microgram per Liter
AEHA	Army Environmental Hygiene Agency
ALC	Adelphi Laboratory Center
ARAR	Applicable or Relevant and Appropriate Requirement
AS	Air Sparging
AST	Aboveground Storage Tank
AWQC	Ambient Water Quality Criteria
B&R	Brown & Root
BCOE	Baltimore District, U.S. Army Corps of Engineers
BOD	Biological Oxygen Demand
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action Navy
COD	Chemical Oxygen Demand
COMAR	Code of Maryland
CTE	Central Tendency Exposure
CTO	Contract Task Order
DCE	Dichloroethene
DNAPL	Dense Nonaqueous Phase Liquid
EA	EA Engineering Science and Technology, Inc.
EBS	Environmental Baseline Survey
EE/CA	Engineering Evaluation/Cost Analysis
EFACHES	Engineering Field Activity - Chesapeake
GAC	Granular Activated Carbon
gpm	gallon per minute
GSA	General Services Administration
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IR	Installation Restoration
MCL	Maximum Contaminant Level
msl	mean sea level
NCP	National Oil and Hazardous Substances Contingency Plan
NSWC	Naval Surface Warfare Center

ORP	Oxidation Reduction Potential
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
SDWA	Safe Drinking Water Act
SI	Site Investigation
SVE	Soil Vapor Extraction
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TBC	To Be Considered
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TSDF	Treatment Storage and Disposal Facilities
USEPA	U. S. Environmental Protection Agency
USNR	United States Naval Reserve
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

Site 46 is located in the southeastern corner of NSWC White Oak. NSWC, White Oak was a Navy owned and operated facility for naval surface warfare research. The facility has been closed and the property was transferred to the GSA and U.S. Army. Through a series of investigations and studies of the site, TCE contamination has been identified in the groundwater and surface water.

As the lead agency, the Navy has determined that a non-time-critical removal action under CERCLA is appropriate for Site 46. This EE/CA has been prepared to develop, evaluate, and recommend an appropriate removal action to restore the groundwater within Site 46.

REMOVAL ACTION OBJECTIVES

The following objectives were selected for the removal action:

- The primary objective of any removal action undertaken within the study area is to prevent groundwater with contaminant levels in excess of MCLs from migrating off of Department of Defense property.

- The secondary objective is to prevent groundwater with contaminant levels in excess of MCLs from discharging to the adjacent streams.

- The tertiary objective is to restore groundwater within Site 46 by reducing TCE concentrations to less than 5 μg/L, the SDWA and State of Maryland MCL for TCE.

IDENTIFICATION, ANALYSIS, AND COMPARATIVE ANLAYSIS OF REMOVAL ACTION ALTERNATIVES FOR GROUNDWATER

A preliminary screening of groundwater technologies was conducted to eliminate process options not suited for use at Site 46. The technologies and process options retained from the preliminary screening were used to develop the following removal action alternatives:

- Alternative 1: No Action
- Alternative 2: Minimal Action, Natural Attenuation
- Alternative 3: Reactive Groundwater Treatment Wall

- Alternative 4a: Groundwater Treatment via Air Stripping, Surface Discharge – Site W Swale Treatment Unit
- Alternative 4b: Groundwater Treatment via Air Stripping, Surface Discharge – Isherwood Road Stream Treatment Unit
- Alternative 5: Air Sparging/Soil Vapor Extraction

Alternatives were evaluated based on the criteria of effectiveness, implementability, and cost. A comparative analysis was then conducted to evaluate these alternatives and select the most appropriate removal action. The present worth costs associated with these alternatives are as follows: Alternative 1 - no cost, Alternative 2 - $599,500, Alternative 3 - $973,100, Alternative 4a - $447,600, Alternative 4b - $735,800, and Alternative 5 - $886,700.

RECOMMENDED REMOVAL ACTION ALTERNATIVE

Based on the identification and comparative analysis of removal action alternatives, Alternative 4a was selected as the most appropriate removal action. It most effectively meets the removal action objective of groundwater restoration, complies with ARARs, and is easily implemented. Due to the use of the existing treatment unit at the Site W Swale, this alternative also minimizes the costs associated with the groundwater treatment component of the removal action.

1.0 INTRODUCTION

The Northern Division of Naval Facilities Engineering Command has issued Contract Task Order (CTO) 311 to Tetra Tech NUS (TtNUS), formerly Brown & Root (B&R) Environmental under Comprehensive Long-term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298. Under CTO 311, TtNUS is to perform an Engineering Evaluation/Cost Analysis (EE/CA) for the Site 46 area of the former Naval Surface Warfare Center (NSWC) White Oak. The purpose of the EE/CA is to recommend an approach to address contaminated groundwater at Site 46.

The work is part of the Navy's Installation Restoration (IR) Program, which is designed to identify contamination of Navy and Marine Corps facilities resulting from past operations and to institute corrective measures, as needed. CTO 311 is being administered by the Engineering Field Activity - Chesapeake (EFACHES).

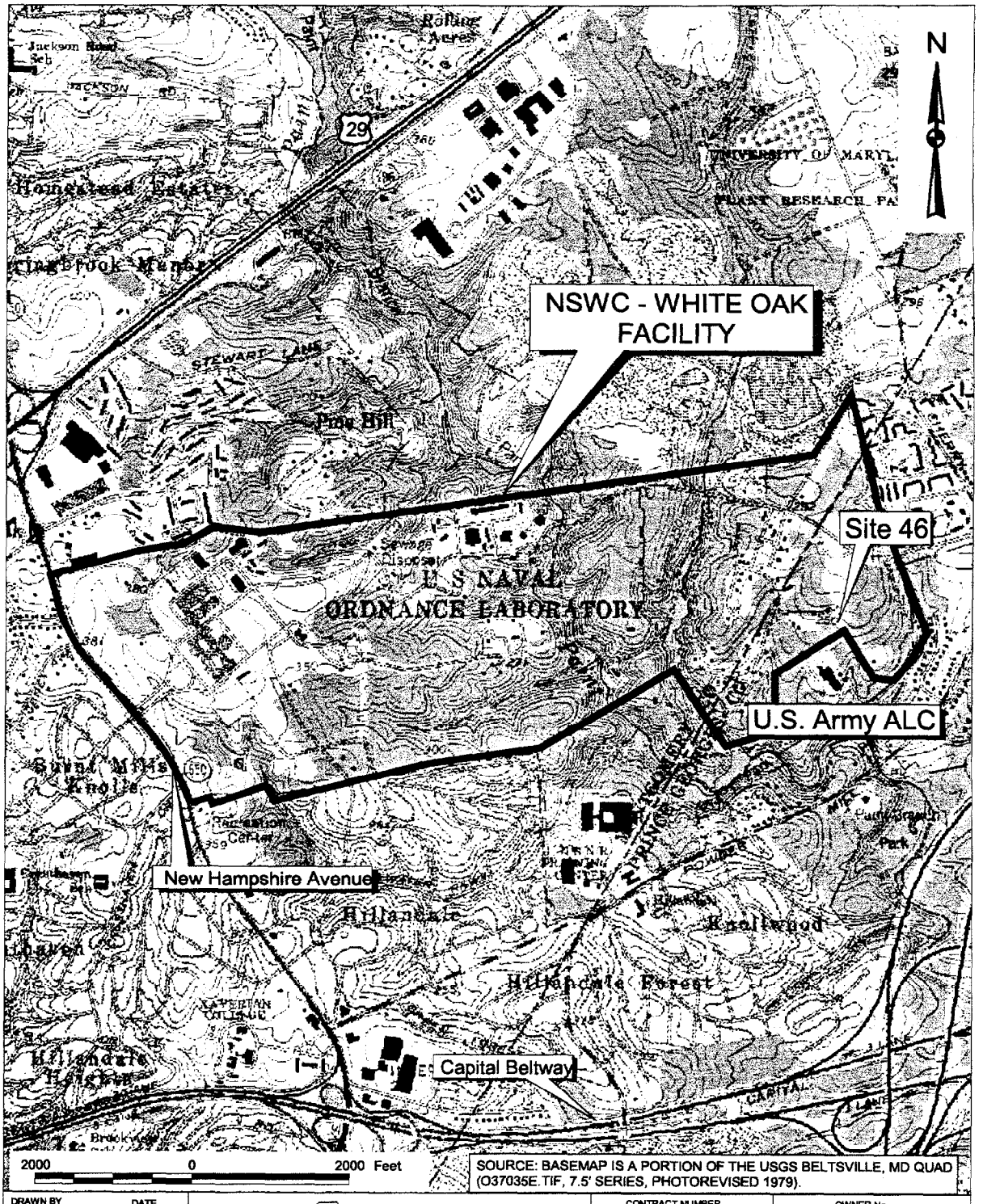
1.1 FACILITY DESCRIPTION

NSWC White Oak was a Navy owned and operated facility for naval surface warfare research. The facility is located approximately 5 miles north of Washington, D.C., off New Hampshire Avenue in White Oak, Maryland (see Figure 1-1). NSWC White Oak covers approximately 710 acres and is located in both Prince George's and Montgomery Counties. The facility lies in gently rolling terrain. NSWC White Oak lies entirely within the Paint Branch drainage basin.

NSWC White Oak has been closed and the property was transferred to the General Services Administration (GSA) and the U.S. Army. The former NSWC White Oak is bordered on the southeastern corner by the U.S. Army's Adelphi Laboratory Center (ALC) and the United States Naval Reserve (USNR) Training Center. Some of the land now occupied by the Army was once part of NSWC White Oak. Approximately 22 acres were transferred to the ALC in 1995, followed by a second transfer of approximately 48 acres in February 1998. Site 46 is being evaluated under this EE/CA and is located in the southeastern corner of the facility, adjacent to the ALC. Site 46 encompasses a substantial fraction of the acreage that was transferred. The Site 46 location is also shown on Figure 1-1.

1.2 SITE DESCRIPTION AND BACKGROUND

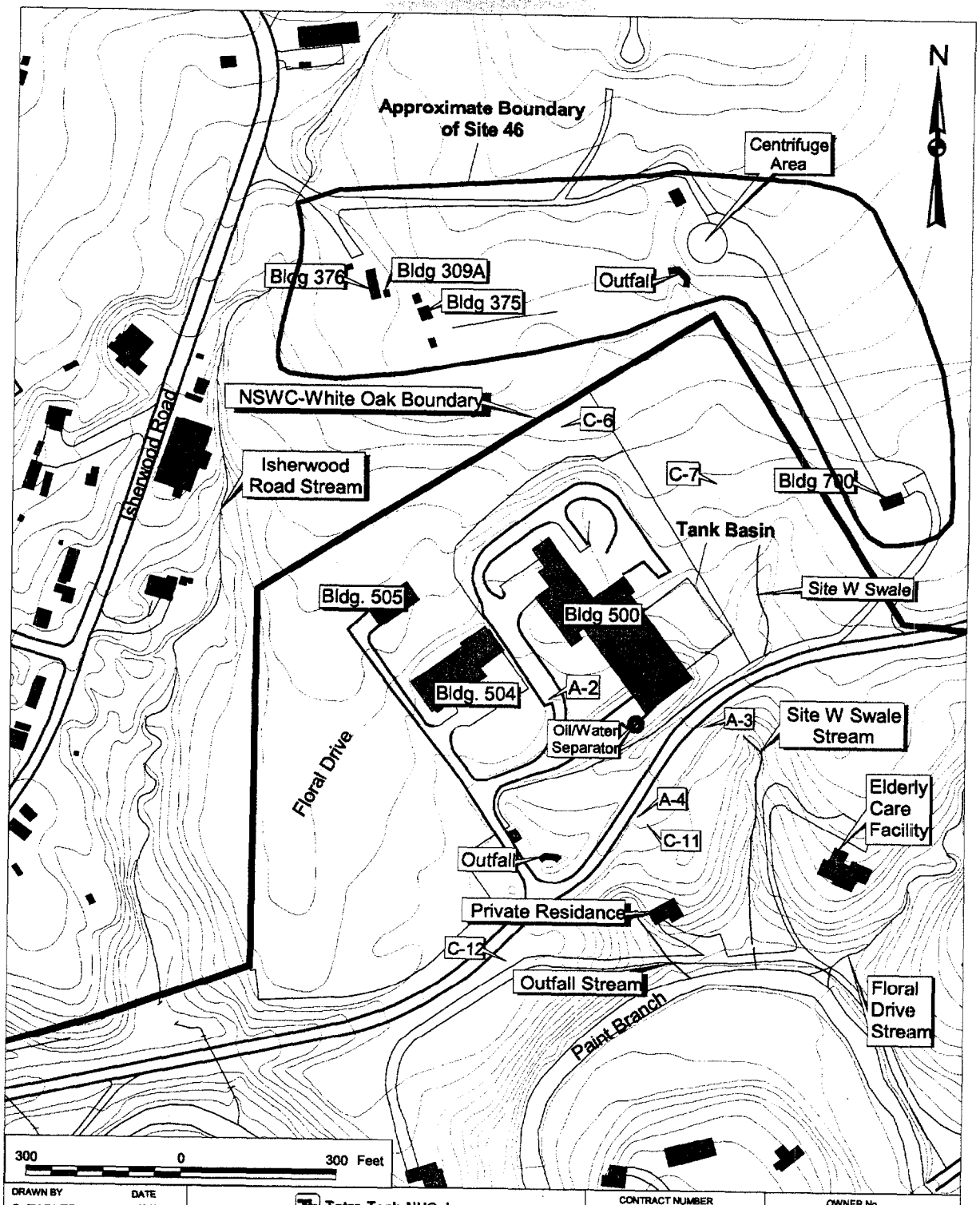
Structures associated with Site 46 include a centrifuge area, Building 700, and the area once occupied by Building 309. The primary ALC structure relative to the Site 46 investigation is Building 500. Site 46 and the Building 500 Area together comprise the study area for this EE/CA, as shown on Figure 1-2.



SOURCE: BASEMAP IS A PORTION OF THE USGS BELTSVILLE, MD QUAD (O37035E.TIF, 7.5' SERIES, PHOTOREVISED 1979).

DRAWN BY D. PERRY	DATE 4-FEB-98	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7855	OWNER No. 0300
CHECKED BY	DATE	FACILITY AND SITE LOCATION MAP SITE EE/CA NSWC - WHITE OAK, MARYLAND	APPROVED BY	DATE
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING No. FIGURE 1-1	REV 0

P:\GIS\WHITEOAK\74271000.APR 15-JUL-98 DNP LOCATION MAP LAYOUT 3



DRAWN BY S. TABLER	DATE 7/2/98	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7855 / OWNER No. 0300
CHECKED BY	DATE	STUDY AREA LAYOUT SITE 46 EE/CA NSWC, WHITE OAK, MARYLAND	APPROVED BY / DATE
COST/SCHEDULE-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING No. Figure 1-2 / REV 0

P:\GIS\WHITEOAK\78470800.APR 7/24/98 SMT STUDY AREA LAYOUT

The centrifuge basin is a concrete pit measuring approximately 100 feet in diameter and about 10 feet in depth and is lined with concrete and asphalt. The centrifuge itself is comprised of a large, center-mounted aircraft-type wing and various electrical and mechanical components. Surface runoff from the concrete/asphalt flows to a sump located within the centrifuge. Substances released within the centrifuge would likely be discharged through the sump to a nearby shallow drainage area (EFACHES, 1998b). This discharge outfall is located southwest of the centrifuge. Following operation of the centrifuge it was reportedly used for temporary drum storage.

Building 700 was once used as a storage area for Resource Conservation and Recovery Act (RCRA) hazardous waste, before transportation and disposal offsite. It has been clean closed and is no longer in use.

Building 309 was used as the Altitude Blast Chamber and Air Blast Field Laboratory and had a leach field associated with it. The structure was demolished in 1990-91, and Building 376 now stands in its place.

Building 500 was used by the U.S. Army for evaluating the performance of military equipment under simulated tactical nuclear strike conditions. Building 500 includes several ancillary structures to the west and a basin that once contained two aboveground storage tanks (AST) to the east. The Building 500 Area is bounded to the south by Floral Drive.

Storm sewers are located north, south, and west of Building 500. An underdrain beneath Building 500 and the tank basin collects groundwater and conveys it to the southern branch of the storm sewer system. The western branch of the storm sewer system collects surface water runoff and groundwater from north and west of Building 500.

Site 46 is bordered to the north and west by generally undeveloped land. The Della Whittaker Building, a U.S. Army office building, lies east of the Site 46 boundary. Three other sites that are being investigated under separate studies are adjacent to Site 46. Site 9 lies to the west and was used as an industrial wastewater disposal area. Site 7, an ordnance burn area, and Site 4, a chemical burial area, are located to the north.

Site 46 was identified as an IR Program site in 1996. The site investigations performed in 1997 and 1998 initially focused on the centrifuge and Building 700. The Building 309 Area was a secondary focus of Site 46 investigation efforts due to the presence of a drain field.

1.3 TOPOGRAPHY

Site 46 is located in the southeast corner of NSWC White Oak. The ground surface slopes moderately to the south and southeast, with a gradual southwestern slope in the western portion of the site. Ground surface elevations range from approximately 290 feet above mean sea level (msl) along the northern edge of the study area, to about 180 feet msl along the southern boundary (B&R Environmental, 1998b).

The land surface is a mixture of open fields, woodland, and developed areas. Paved areas and buildings are more prevalent in the southern portion of the study area. Open fields and woodlands are predominant elsewhere.

1.4 SURFACE WATER HYDROLOGY

Site 46 is located within an area generally bounded by two small, unnamed streams. One stream flows southward along Isherwood Road, between Site 9 and Site 46. This stream will be referred to as the Isherwood Road Stream. The second stream flows south and southwest along Floral Drive, and will be referred to as the Floral Drive Stream. Figure 1-2 presents the locations of these streams.

Two additional streams originate within the south-central portion of the study area, near Building 500. One stream originates just south of Floral Drive at a storm sewer outfall (Outfall Stream) and flows past a private residence. The other stream originates within the Site W Swale, located east of Building 500. This Site W Swale Stream flows south under Floral Drive and past an elderly care home.

All four of these streams discharge to Paint Branch, a 12-mile long tributary of the Anacostia River. The Floral Drive Stream is the largest of the four streams and has a much more extensive reach to the north, extending to near the northeast boundary of the former NSWC White Oak.

1.5 CLIMATE

Summers at NSWC White Oak are warm and humid, and winters are mild. Seasonal temperature variation is about 43 degrees F. The warmest weather occurs in July, with daily temperatures ranging from 69 degrees F to 88 degrees F. The coldest weather occurs in late January and early February, with daily temperatures ranging from 28 degrees F to 44 degrees F. The average annual precipitation is approximately 44 inches. Seasonal variation in precipitation is not pronounced, gradually fluctuating between a typical minimum of 3 inches in February to a typical maximum of 5 inches in August. Snowfall accumulations of more than 10 inches are rare, with the greatest snowfalls occurring in January and February.

The mean annual wind speed varies between 8 miles per hour in August and 11 miles per hour in March. The prevailing wind direction is from the south most of the year, except for northwesterly winds that occur during December, January, and March.

1.6 GEOLOGY

NSWC White Oak is located approximately 1 mile east of the Fall Line in the Coastal Plain physiographic province. The study area is underlain by a thin veneer of unconsolidated Coastal Plain deposits, which is underlain by saprolite (weathered bedrock) that grades into tightly folded, unweathered metamorphic bedrock described as either the Laurel Gneiss or Wissahickon Formation. The thickness of and/or depths to these three principal geologic units vary across the site, primarily as a function of the topography and to a lesser extent the location with respect to the Fall Line (B&R Environmental, 1998b).

1.6.1 Coastal Plain Deposits

Coastal Plain deposits belonging to the lower Cretaceous Patuxent Formation of the Potomac Group have been found across the study area. The Patuxent Formation is the basal unit of the Coastal Plain and directly overlies crystalline basement rock. These deposits consist of sand, silt, clay, and gravel that vary widely in the relative percentages of the various sediments and the degree of sorting within each depositional unit. Poorly sorted mixed sand and gravel deposits were most commonly encountered, with varying percentages of fines also present. Silty sands were the next most common type of deposit encountered. Thin, discrete deposits of silt and/or clay were occasionally encountered, as were thin, fine, well-sorted sand deposits. Near the base of the Coastal Plain deposits, a gravelly sand or sandy gravel was commonly observed. Pebbles, cobbles, and sands in this unit were almost entirely quartz.

The Coastal Plain deposits were found to be thickest in the north-central upland portion of the site, reaching a maximum observed thickness of approximately 55 feet. To the south, near the streams that border the study area, the thickness of the deposits decreases to only a few feet in places as a result of stream erosion.

1.6.2 Saprolite

Saprolite was encountered underlying the Coastal Plain deposits. Saprolite is a term used to describe the in-situ weathered bedrock zone that overlies competent, unweathered crystalline bedrock. Typically, the saprolite consists primarily of silt and clay sized particles. In places, relict bedding/schistocity was observed. In general, the saprolite is considerably more dense than the overlying sediments, based on

the relative resistance to drilling and sampling penetration. The upper surface of the saprolite is a subdued reflection of the site topography. The highest elevations of the upper surface correlate with topographic highs, while the areas where the top surface of the saprolite are lowest in elevation are near the streams. Conversely, the depth from ground surface to the top of the saprolite is greatest in the upland areas and most shallow in the areas of lower elevations near the streams. The observed thickness of the saprolite ranged from about 10 to 25 feet in borings that penetrated through to the underlying competent bedrock.

1.6.3 Bedrock

The unweathered crystalline bedrock (Laurel Gneiss of the Wissahickon Formation) underlies the saprolite. The contact between the saprolite and bedrock is gradational and is generally defined as the point where in-situ weathered crystalline material changes to competent bedrock. The bedrock is primarily gneiss, a metamorphic rock type that is generally hard and resistant to weathering and erosion. This description is consistent with the Laurel Gneiss, which is described as a quartz-mica gneiss, schist, and quartzite. In terms of hydrogeology, the bedrock functions as a fractured crystalline rock aquifer with low primary permeability but high secondary permeability, i.e., flow occurs within fractures, not the rock matrix. During recent investigations in the study area, bedrock was not encountered in any of the borings.

1.7 HYDROGEOLOGY

Groundwater is encountered within the study area in the Coastal Plain sediments, saprolite, and bedrock. The water table was typically encountered within the Coastal Plain sediments, at depths ranging from less than 4 feet to more than 47 feet below ground. Depths to the water table are greatest in the north-central upland area and most shallow in the low-lying areas adjacent to the streams. Based on field observations and testing, the Coastal Plain sediments, particularly the coarser grained sand and gravel deposits, transmit groundwater more readily than the saprolite or bedrock. Groundwater flow through the sediments and saprolite is primarily through intergranular pores, while groundwater in the bedrock migrates through fractures within the rock mass. Groundwater flow directions are a subdued reflection of the site topography, flowing from north-central upland areas south, east, and west toward the streams and other groundwater discharge points.

1.7.1 Groundwater Recharge/Discharge

Groundwater is recharged through precipitation infiltration. Groundwater discharge is to the streams located within and along the boundaries of the study area, and to man-made drains (the Building 500 underdrain system and storm sewers) located within the Building 500 Area.

At several locations, minor discrete wet zones were encountered immediately above finer-grained deposits located above the water table, indicating localized perched conditions. In addition, seepages were noted along several east to southeast-facing embankments. This suggests that some preferential groundwater movement may be occurring along the regional dip of the bedding of the Coastal Plain sediments to the southeast, and is also indicative of local perched groundwater conditions.

1.7.2 Groundwater Flow Directions

Shallow groundwater flow across the study area generally follows topography to the south and southeast. Figure 1-3 shows groundwater flow patterns in the unconsolidated deposits. The lateral flow gradient for the shallow groundwater is lowest in the north-central upland area, but becomes steeper as the groundwater reaches the southern and southeastern areas of the site.

In the south-central portion of the site, the underdrain system associated with Building 500 depresses the water table substantially and collects most shallow groundwater in the immediate vicinity of Building 500. Observations of flow in the storm sewer system under dry weather conditions also indicate that some shallow groundwater discharge to the storm sewers is occurring in the Building 500 vicinity. The storm sewer system ultimately discharges to the Outfall Stream.

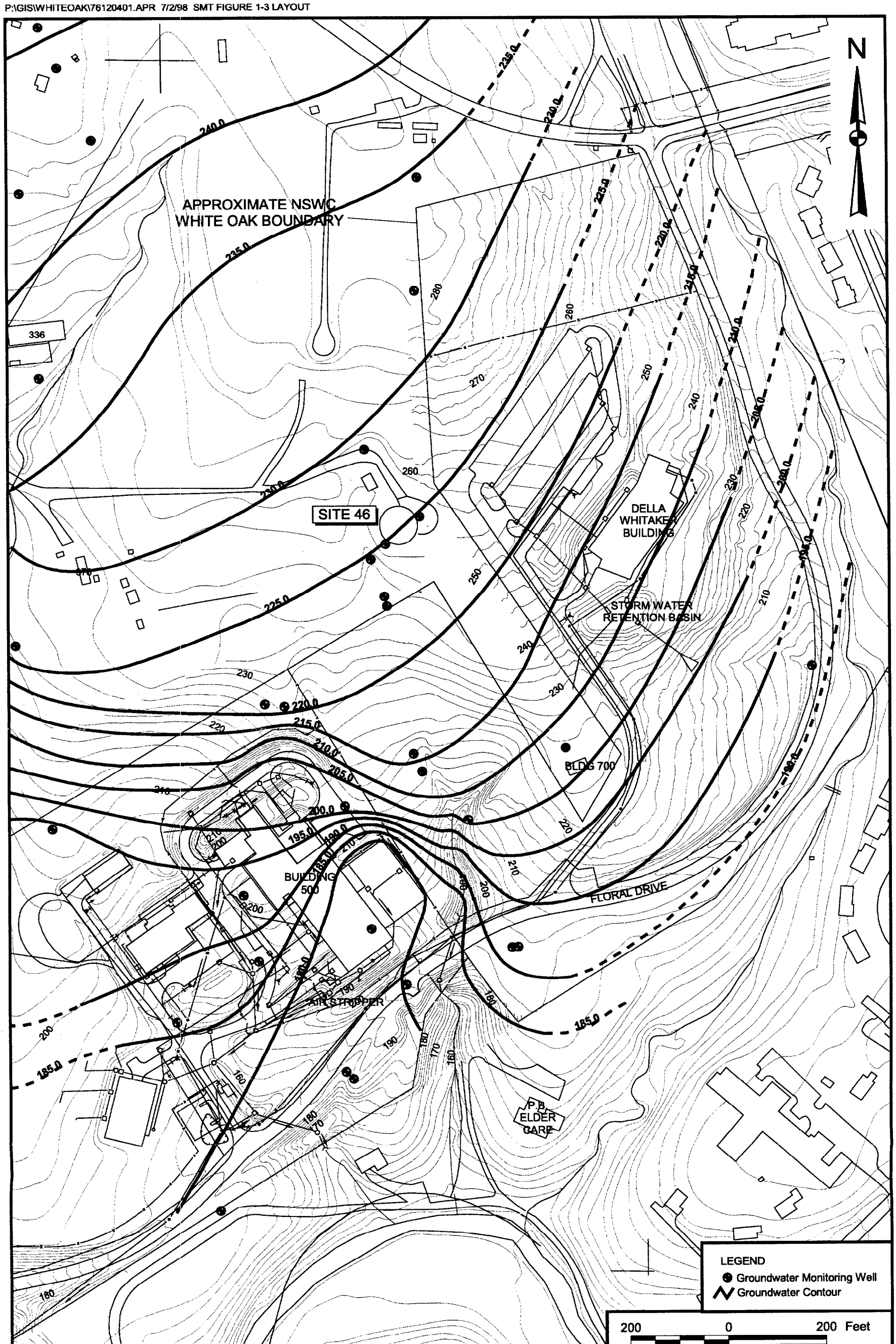
Another groundwater discharge point in the southern portion of the study area is the Site W Swale. The headwaters for this swale are located immediately east of the Building 500 Area. The Site W Swale flows southward under Floral Drive through a culvert, at which point it is considered the Site W Swale Stream. Groundwater from the western edge of the study area discharges to the Isherwood Road Stream. Groundwater within the eastern and southeastern portion of the study area flows to the southeast into the Floral Drive Stream.

The overall pattern of shallow groundwater movement across the study area indicates that the streams in the area act as the discharge points for site groundwater and can thus be considered hydrogeologic boundaries for the study area. It is not expected that shallow groundwater would bypass these discharge points and migrate beyond them, unless induced to do so by large-scale groundwater withdrawals across the streams (i.e., major pumping wells).

1.7.3 Hydraulic Characteristics

The hydraulic characteristics of the hydrogeologic units vary based on lithology. In general, the Coastal Plain deposits are more permeable than the saprolite and the bedrock and form the primary water-

P:\GIS\WHITEOAK\76120401.APR 7/2/98 SMT FIGURE 1-3 LAYOUT



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
S. TABLER	4/5/98		7855	0300
CHECKED BY	DATE	SHALLOW GROUNDWATER FLOW PATTERN	APPROVED BY SN	DATE 12/9
COST/SCHEDULE-AREA		SITE 46 EE/CA	APPROVED BY	DATE
SCALE AS NOTED		NSWC, WHITE OAK, MARYLAND	DRAWING NO. FIGURE 1-3	REV 0

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transmitting hydrogeologic unit encountered within the study area. Within the Coastal Plain deposits, the hydraulic characteristics vary considerably based on the makeup of the deposit, with the predominantly coarse-grained sand and gravel units being more permeable than the finer grained silt and clay units or poorly sorted sand-gravel-silt-clay mixtures.

The overall geometric mean hydraulic conductivity for the Coastal Plain deposits in the study area is 1.3 feet per day. This average hydraulic conductivity reflects the presence of significant percentages of fines (silt and clay) in most of the unconsolidated deposits encountered. The groundwater flow rate through the Coastal Plain deposits is approximately 0.4 feet per day.

Due to the overall fine-grained nature of the saprolite, the water-transmitting capability of this unit is significantly lower than that of the coarser grained Coastal Plain deposits. The saprolite has generally been observed to be dense and tight with a low water content.

1.8 PREVIOUS INVESTIGATIONS

Previous investigations within the study area have included the Army's Phase II Geohydrologic Study (Army Environmental Hygiene Agency [AEHA], 1994), the Aerial Photographic Analysis, NSWC, White Oak - Interim Report (Williams, 1996), the Army's Final Remedial Investigation (RI) Report for the Building 500 Area prepared by the Baltimore District Corps of Engineers (BCOE, 1998b), and the site visit and subsequent Site Investigation (SI) performed by B&R Environmental (1998b). There were some minor findings related to Site 46 and surrounding areas during the Environmental Baseline Survey (EBS) (EA Engineering Science and Technology [EA], 1996). In addition, the U.S. Environmental Protection Agency (USEPA) has conducted additional investigation in areas south of Site 46, the results of which have not been published as of the completion of this report.

1.8.1 Phase II Geohydrologic Study

The AEHA performed an investigation of the potential groundwater and surface water contamination from the Army's Building 500 and NSWC White Oak's Site 46 Areas (AEHA, 1994). Potential sources of contamination in the Building 500 Area included:

- Site 9 within the former NSWC White Oak
- Two 890,000-gallon ASTs that contained non-polychlorinated biphenyl (PCB) transformer oil and were located in the tank basin on the east side of Building 500
- Three underground storage tanks (USTs) located on the south sides of Buildings 504 and 505

- An oil/water separator located on the south side of Building 500
- Past spills of non-PCB transformer oil in Building 500

Study results indicated that drinking water standards were exceeded in groundwater by the metals thallium and nickel, and volatile organic compounds (VOCs) dichloromethane and trichloroethene (TCE). Low levels of total petroleum hydrocarbons (TPH) were detected in groundwater upgradient of Building 500. An upgradient source of thallium, dichloromethane, and petroleum hydrocarbons was suspected. The source of the TCE and nickel was unknown. Groundwater was determined to flow in a southwesterly direction in the Building 500 Area.

In addition to the groundwater contamination, explosive compounds (2,4,6-TNT and RDX) were detected in surface water and TPH was detected in sediment at a sample location within the Site W Swale. The location (SW-3) is a probable discharge point for groundwater and, based on topography, the location likely receives groundwater and surface water discharge from the former NSWC White Oak property. This sample location is shown on Figure 1-4.

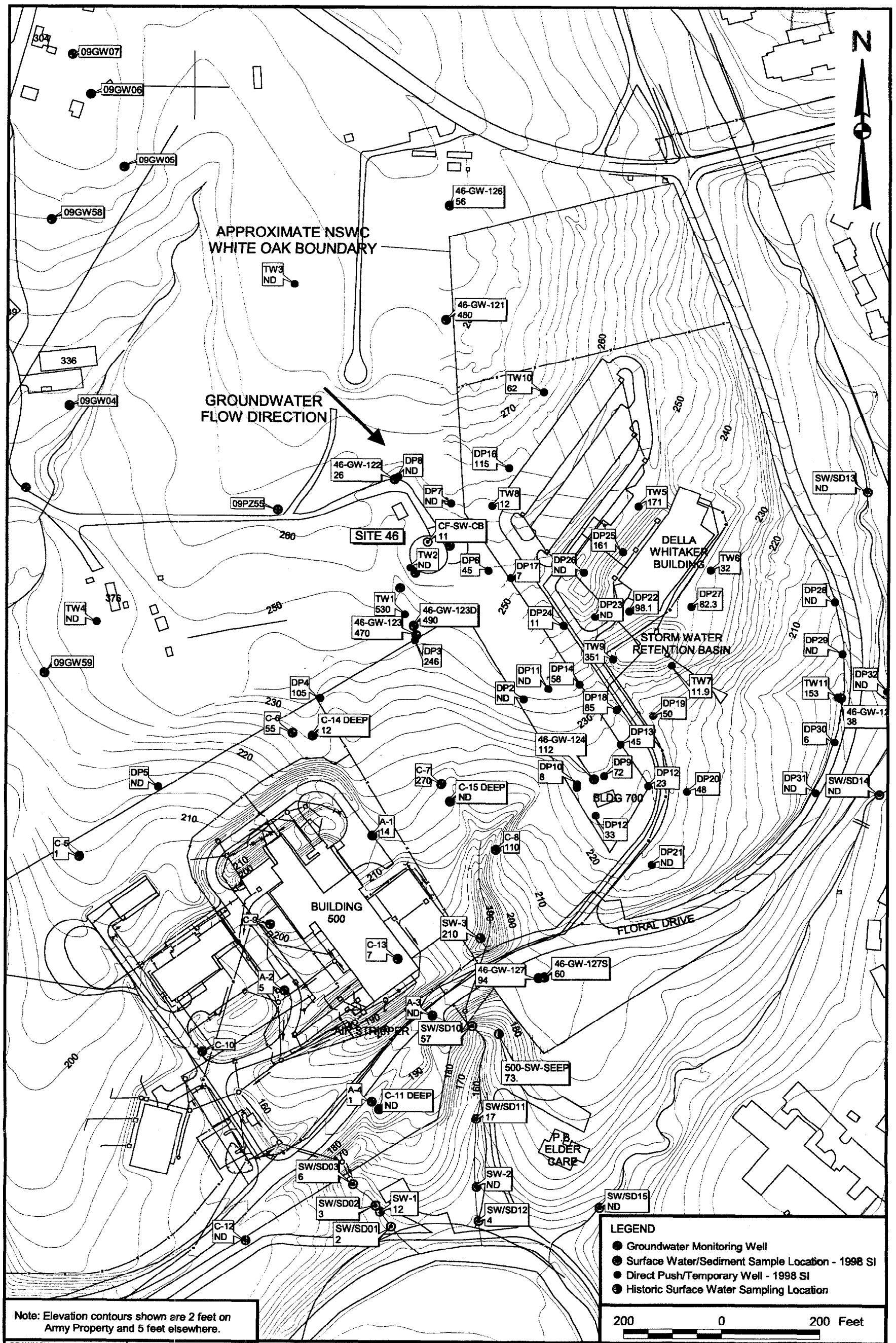
1.8.2 Aerial Photographic Analysis

The historic aerial photographic analysis (Williams, 1996) included a review of eight photographs spanning the time frame from 1944 to 1993. No indications of waste dumping/disposal were noted on the Navy property in the areas surrounding Building 500. The centrifuge area was consistently observed beginning in 1963 but was described as a wastewater treatment plant. Material storage was noted in the Building 700 Area in 1969, and timber harvesting activities were noted adjacent to the east side of the Building 500 Area. A road leading north and two buildings were observed in the Building 700 Area in the 1975 photo. In the 1989 photo, disturbed ground and a vertical tank were noted in the Building 700 Area.

1.8.3 Building 500 Area Final Remedial Investigation

An RI was performed by the BCOE in 1996 and 1997 to investigate groundwater contamination in the Building 500 Area of the ALC (BCOE, 1998). Groundwater samples were collected from 14 monitoring wells. Surface water and sediment samples were collected from the Site W Swale, the Site W Swale Stream, and the Outfall Stream. Surface water samples were also collected from the Building 500 floor drains. The groundwater, surface water, and sediment samples were analyzed for VOCs, Target Analyte List (TAL) metals, semivolatile organic compounds (SVOCs), pesticides and PCBs, and explosive compounds (BCOE, 1998).

P:\GIS\WHITEOAK\76120401.APR 7/15/98 SMT FIGURE 1-4 LAYOUT



Note: Elevation contours shown are 2 feet on Army Property and 5 feet elsewhere.

DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7855	OWNER NUMBER 0300
S. TABLER	4/5/98			
CHECKED BY	DATE	TCE DISTRIBUTION IN GROUNDWATER AND SURFACE WATER	APPROVED BY	DATE
COST/SCHEDULE-AREA		SITE 46 EE/CA	APPROVED BY	DATE
SCALE AS NOTED		NSWC, WHITE OAK, MARYLAND	DRAWING NO. FIGURE 1-4	REV 0

00076 B022

BCOE concluded that:

- Two surface water samples, one from the Outfall Stream (SW-1) and one from the Site W Swale (SW-3), contained VOCs. TCE was detected in these samples at concentrations above the USEPA maximum contaminant level (MCL) of 5 µg/L.

- TCE was detected in several groundwater monitoring wells above the MCL of 5 µg/L, at levels up to 160 µg/L.

- Trace levels of explosives (HMX and/or RDX) detected in three monitoring wells. MCLs for these explosive organic compounds have not been established.

The spatial distribution of TCE in the groundwater indicated that the source of the contamination is located upgradient of the Building 500 Area. TCE-contaminated groundwater appears to be intercepted by the subdrainage system associated with Building 500 and discharged into the storm sewer system. Additionally, TCE-contaminated groundwater appears to discharge into the Site W Swale. The well in which RDX was detected is adjacent to the ALC property boundary, suggesting that the explosives contamination is also from an upgradient source (BCOE, 1998).

1.8.3 Environmental Baseline Survey

The only information of note contained in the EBS report relative to Site 46 was a reference to the discovery of a 10-foot by 20-foot, shallow, water-filled pit containing trash and drums near Building 700 in 1991 (location not identified). According to the EBS, the pit contents were subsequently removed and the pit backfilled.

1.8.4 Site Visit

TtNUS personnel visited the study area on May 8, 1997 as part of the SI scoping process. Pertinent observations/findings of the site visit include:

- The Building 500 tank basin is a large concrete structure approximately 20 to 25 feet deep (the tanks have been removed). Runoff from the parking area located adjacent to the north-northwestern side of the tank basin is directed between it and the Site W Swale through a metal drain pipe that extends partly along the eastern side of the tank basin.

- The Building 500 underdrain system is a passive groundwater collection system that discharges to an oil-water separator located near the southern edge of Building 500. Flow from the drain system was estimated at 12 to 15 gallons per minute (gpm) in a shallow manhole located between the tank basin and the oil-water separator.

- Navy personnel consider the centrifuge area the most likely Navy source for the TCE contamination in the groundwater due to the presence of the sump and the occasional use of the centrifuge basin for drum storage.

- A sump is located below the centrifuge. Access is available through a metal lid in the floor of the structure. Water was observed in the sump approximately 3 feet below the floor of the centrifuge.

- The centrifuge sump is believed to discharge to an outfall located in a small gully adjacent to and southwest of the centrifuge. Two outfalls were suspected to be present in the gully; however, only one was found during the site visit and subsequent field work.

- According to Navy personnel, no releases were reported at Building 700. The building has been deactivated and cleaned.

1.8.5 Site 46 Investigation

TtNUS performed the SI in 1998 to determine if Site 46 is a source of the TCE-contaminated groundwater at Building 500. The objectives of the Site 46 investigation were to:

- Identify the source(s) of the TCE contamination around Building 500
- Characterize the identified source(s) within the Site 46 Area
- Determine the presence of any other constituents of concern in groundwater, soils, and surface water/sediment
- More fully characterize hydrogeologic conditions within the area
- Evaluate human health risks posed by contamination at the site

The SI resulted in detailed information regarding contaminant distributions and physical characteristics of the study area. Groundwater flow across the site is to the south and southeast, following site topography. The local streams and the underdrain/storm sewer system serve as hydrogeologic boundaries for the site and are points of groundwater discharge.

Groundwater is primarily impacted by TCE and almost all of the TCE is confined to the shallow groundwater. The pattern of TCE concentrations in groundwater suggests several sources for contamination, including the centrifuge area, the Della Whittaker Building Area, Site 4, and the Building 700 Area. The centrifuge area appears to be the primary source for the contamination encountered near Building 500. Data collected from the eastern part of the study area indicate that the Building 309 Area is not a source of TCE, as was once suspected.

1.8.6 Supplemental Centrifuge Investigation

An investigation of the centrifuge area was conducted during October and November 1998 to determine if the soils underlying the centrifuge are a continuing source for the groundwater contamination identified within Site 46. The investigation consisted of the collection of 47 soil gas, six subsurface soil, and four groundwater samples directly within or in proximity to the centrifuge.

The investigation did not identify significant levels of contamination within the subsurface soil beneath or near the centrifuge. As a result of this investigation, the centrifuge and its associated drain lines are not believed to be a continual source of groundwater contamination in this area. Elevated levels of TCE were detected in the groundwater samples at concentrations similar to that found during the SI. In addition benzene, toluene, ethylbenzene, and xylene were detected at elevated concentrations in an area previously occupied by an underground storage tank. A more detailed description of the investigation is provided in Appendix A.

1.9 NATURE AND EXTENT OF CONTAMINATION

The following summarizes the nature and extent of contamination in groundwater, soil, and surface water/sediment based on prior sampling events at Site 46. Sample locations referenced below are shown on Figure 1-4.

1.9.1 Groundwater

Groundwater analytical data (excluding data collected during the supplemental centrifuge investigation) and regulatory criteria and guidance are summarized in Table 1-1. TCE is the only VOC detected in groundwater at concentrations above its MCL across the site. VOCs related to gasoline were detected in an area northeast of the centrifuge. Other compounds frequently detected include 1,1,2,2-tetrachloroethane; chloroform; cis-1,2-dichloroethene (cis-1,2-DCE); and acetone. The detected concentrations of these compounds were generally low and did not exceed their respective MCLs.

TABLE 1-1

GROUNDWATER AND SURFACE WATER ANALYTICAL DATA AND REGULATORY CRITERIA AND GUIDANCE
SITE 46 EE/A
NSWC WHITE OAK, MARYLAND
PAGE 1 OF 2

Analyte	GROUNDWATER[1]						UNFILTERED SURFACE WATER[2]			REGULATORY CRITERIA AND GUIDANCE				
	Unfiltered Groundwater Data			Filtered Groundwater Data						USEPA Region III[4] Risk Based Concentrations Tap Water	USEPA Ambient Water Quality Criteria (AWQCs)[5]	MCL[6]	Background Concentrations[7]	
	Frequency of Detection[3]	Range of Detected Concentrations	Location of Maximum	Frequency of Detection[3]	Range of Detected Concentrations	Location of Maximum	Frequency of Detection	Range of Detected Concentrations	Location of Maximum				Groundwater (unfiltered)	Surface Water
VOLATILE ORGANICS (µg/L)														
1,1,1-Trichloroethane	10/46	0.1 J - 14	96ALCW14	NA	NA	NA	NA	NA	NA	54	1,030,000	200		
1,1,2,2-Tetrachloroethane	18/46	0.5 J - 22	46-GW-123d-D	NA	NA	NA	8/12	2-5.9	500-SW-SEEP	0.053	11			
1,1,2-Trichloroethane	1/46	0.8 J	46-GW-123d 46-GW-123d-D	NA	NA	NA	NA	NA	NA	0.19	42	5		
1,1-Dichloroethane	5/46	0.1 J - 2	AL-MW-C13-W-01	NA	NA	NA	NA	NA	NA	80				
1,1-Dichloroethene	7/46	0.1 J - 2	46-GW-121 46-GW-123	NA	NA	NA	1/12	0.3 J	500-SW-SEEP	0.044	18.5[12]	7		
1,2-Dichloroethane	6/46	0.2 J - 2	AL-C13-W-01	NA	NA	NA	1/12	0.3 J	500-SW-SEEP	0.12	99	5		
1,3-Dichlorobenzene				NA	NA	NA	1/12	0.1 J	500-SW-SEEP	1.4				
2-Butanone	3/37	2 J - 6	AL-C14-W-01	NA	NA	NA				190				
Acetone	8/43	4 - 23 J	46-GW-121	NA	NA	NA	1/12	20.6 L	500-SW-SEEP	370				
Bromodichloromethane	3/46	0.1 J - 1	AL-C6-W-01 AL-MW-C6-W-01-D	NA	NA	NA	1/12	0.1 J	CF-SW-CB	0.17		100/80		
Bromomethane	1/46	0.4 J	46-GW-123	NA	NA	NA	NA	NA	NA	0.85				
Carbon Disulfide	4/46	0.1 J - 0.9 J	46-GW-125	NA	NA	NA	NA	NA	NA	100				
cis-1,2-dichloroethene	26/46	1 - 53	46-GW-123	NA	NA	NA	5/12	0.5 J - 9.4	500-SW-SEEP	6.1		70		
Chlorobenzene	4/46	0.1 J - 0.5 J	46-GW-123d 46-GW-123d-D	NA	NA	NA	NA	NA	NA	3.5	21000	100		
Chloroform	18/46	0.3 J - 7	AL-C8-W-01	NA	NA	NA	2/12	0.5 J - 0.7 J	CF-SW-CB	0.15	470	100/80		
Chloromethane	3/46	0.5 J - 1.1 J	46-GW-123	NA	NA	NA	NA	NA	NA	1.5				
Methylene Chloride	5/46	1 - 2	AL-C12-W-01 AL-C14-W-01	NA	NA	NA	NA	NA	NA	4.1	1600	5		
Tetrachloroethene	5/46	0.1 J - 0.3 J	46-GW-123 46-GW-123d 46-GW-123d-D	NA	NA	NA	NA	NA	NA	1.1	8.85	5		
Toluene	7/46	0.1 J - 241	96ALCW14	NA	NA	NA	1/12	0.1 J	ARL-SW-13	75	200000	1000		
Trans-1,2-dichloroethene	5/46	0.1 J - 0.6 J	46-GW-123	NA	NA	NA	NA	NA	NA	12		100		
Trichloroethene	30/46	1 - 490	46-GW-123d	NA	NA	NA	8/12	2 - 73.8	500-SW-SEEP	1.6	81	5		
Vinyl Chloride	6/46	0.2 J - 1	AL-C13-W-01	NA	NA	NA	NA	NA	NA	0.019	525	2		
Xylenes, Total	2/35	0.2 J - 0.3 J	46-GW-125	NA	NA	NA	NA	NA	NA	1200		10000		
SEMIVOLATILE ORGANICS (µg/L)														
1,3-Dichlorobenzene	3/46	0.2 J	46-GW-121 46-GW-123 46-GW-123d 46-GW-123d-D	NA	NA	NA	NA	NA	NA	1.4	2600	600		
Bis(2-Ethylhexyl)phthalate	18/46	1 - 110	AL-C8-W-01 AL-C8-W-01	NA	NA	NA	1/9	2 J	CF-SW-CB	4.8	5.9	6		
Di-n-butyl phthalate	11/46	1 - 18	AL-C6-W-01 AL-C6-W-01	NA	NA	NA	NA	NA	NA	370	12000			
Phenanthrene	5/46	1 J - 3 J	46-GW-121	NA	NA	NA	NA	NA	NA	150[11]				
ENERGETICS (µg/L)														
2,4,6-Trinitrotoluene	4/45	0.4 J - 2.5	46-GW-126	NA	NA	NA	NA	NA	NA	2.2				
2-Amino-4,6-dinitrotoluene	4/45	0.4 J - 1.1	46-GW-126	NA	NA	NA	NA	NA	NA	0.22				
HMX	6/45	0.6 - 2.1	46-GW-126	NA	NA	NA	4/6	1.6-2.9	ARL-SW-13	180				
RDX	10/45	1 - 7.3	96ALCW05	NA	NA	NA	5/6	2.3-4.9	ARL-SW-13	0.61				
PESTICIDES/PCBs (µg/L)														
Alpha-BHC	NA	NA	NA	NA	NA	NA	1/9	0.004 J	IRBY-SW-3	0.011				
Gamma-Chlordane	NA	NA	NA	NA	NA	NA	1/9	0.002 J	500-SW-SEEP	0.19				

TABLE 1-1

GROUNDWATER AND SURFACE WATER ANALYTICAL DATA AND REGULATORY CRITERIA AND GUIDANCE
SITE 46 EE/A
NSWC WHITE OAK, MARYLAND
PAGE 2 OF 2

Analyte	GROUNDWATER[1]						UNFILTERED SURFACE WATER[2]			REGULATORY CRITERIA AND GUIDANCE				
	Unfiltered Groundwater Data			Filtered Groundwater Data						USEPA Region III[4] Risk Based Concentrations Tap Water	USEPA Ambient Water Quality Criteria (AWQCs)[5]	MCL[6]	Background Concentrations[7]	
	Frequency of Detection[3]	Range of Detected Concentrations	Location of Maximum	Frequency of Detection[3]	Range of Detected Concentrations	Location of Maximum	Frequency of Detection	Range of Detected Concentrations	Location of Maximum				Groundwater (unfiltered)	Surface Water
INORGANICS (µg/L)														
Aluminum	25/33	80 - 79100	46-GW-123	7/24	60 - 3100	96ALCW14F	2/9	109 - 225 K	500-SW-SEEP	3700		50 to 200 [10]	11800	75.9
Arsenic	8/33	1.2 K - 42.8	46-GW-123	NA	NA	NA	NA	NA	NA	0.045	0.14	50		
Barium	24/33	28.1 - 900	AL-MW-C14-W-01	14/24	30 - 1000	L-MW-C14-W-01	6/9	17.4 - 44.9	ARL-SW-13	260		2000	344	46.84
Beryllium	3/33	0.15 K - 2.1	46-GW-126	NA	NA	NA	NA	NA	NA	7.3		4	22.1	
Cadmium	7/33	0.5 K - 19	AL-MP-10-W-06	4/28	2.56 - 14	AL-MP-10-W-06	1/9	1.4 K	CF-SW-CB	1.8		5		
Calcium	31/33	2000 - 490000	AL-MW-C14-W-01	24/24	1800 - 370000	L-MW-C14-W-01	9/9	3200 K - 32900	CF-SW-CB				24500	22305
Chromium (total)	11/33	7.3 K - 298	46-GW-126	2/24	10	96ALCW14F AL-MW-C7-W-01F-D	NA	NA	NA	18 [8]		100	42.7	
Cobalt	8/33	3.3 - 41.4 K	46-GW-122	NA	NA	NA	1/9	0.93 K	500-SW-SEEP	220		NA	38.1	
Copper	9/33	11.8 - 148	46-GW-123	3/24	67 - 210	ALWA4F	1/9	9.1 K	CF-SW-CB	150		1300 [9]/1000 [10]	21.37	16.6
Cyanide	1/20	4.4	AL-MW-C8-W-01	NA	NA	NA	2/9	7.93-20.6	500-SW-SEEP	73	220000	200		
Iron	22/33	60 - 96700	46-GW-123	11/24	30 - 4300	96ALCWA1F	5/9	234 J - 474	IRBY-SW-3	1100		300 [10]	147000	1220
Lead	19/33	1.1 L - 51.4	46-GW-123	1/24	10	96ALCW05F	3/9	2.1 K - 3.7 K	500-SW-SEEP			15 [9]	13	2
Magnesium	32/33	340 - 77000	AL-MP-10-W-06	22/24	560 - 96000	AL-MP-10-W-06	9/9	4100 K - 8240	ARL-SW-13				26000	10200
Manganese	31/33	21 - 2100	AL-MP-10-W-06	20/24	27 - 2200	AL-MP-10-W-06	9/9	3 K - 77.4	IRBY-SW-3	73		50 [10]	7000	591
Mercury	7/33	0.268 - 2.5	46-GW-124	2/24	0.245 - 0.42	96ALCW06F	NA	NA	NA	1.1	0.15	2		0.1
Nickel	15/33	13.7 K - 121	46-GW-123 46-GW-126	5/24	30 - 72	AL-MP-10-W-06	5/9	8.4 - 27.2 K	CF-SW-CB	73	4600	100	177	30
Potassium	33/33	1000 - 310000	AL-MW-C14-W-01	23/24	850 - 350000	L-MW-C14-W-01	9/9	1490 - 24900	CF-SW-CB				25500	3617
Selenium	8/33	2.3 J - 52.6 K	46-GW-126	4/24	1.2 K - 2.2 J	L-MW-C14-W-01 AL-MW-C14-W-01F	2/9	2.9 K - 3.1 K	500-SW-SEEP	18		50	4.21	
Sodium	33/33	7100 - 140000	AL-MW-C14-W-01	24/24	6500 - 170000	L-MW-C14-W-01	9/9	10200 - 18300	ARL-SW-13				26217	20800
Vanadium	8/33	2.6 K - 250	46-GW-123	NA	NA	NA	NA	NA	NA	26			36.5	
Zinc	13/33	19.8 K - 230	96ALCW11	5/24	25 - 170	L-MW-C15-W-01	3/9	15.8 - 84.8	CF-SW-CB	1100		5000 [10]	257	36.6
PETROLEUM HYDROCARBONS (µg/L)														
Diesel Range Organics	2/13	1200 - 14000 K	AL-MW-C13-W-01	NA	NA	NA	NA	NA	NA					
Total Petroleum Hydrocarbons	4/8	1.2 - 2.84 L	46-GW-125	NA	NA	NA	1/2	829	CF-SW-CB					

NA - Not Analyzed.
– Not Applicable.
J = Estimated value.
K = Positive result is biased high as a result of quality control noncompliance.
L = Positive result biased low as a result of quality control noncompliance.
1 - Results include data from permanent groundwater monitoring well sampling during the Site Investigation (B&R Environmental, 1998b) and other historic sampling events.
2 - Results include data collected during the Site Investigation (B&R Environmental, 1998b).
3 - Duplicate samples were considered as one sample.
4 - USEPA, 1998.
5 - Ambient Water Quality Criteria protective of Human Health exposure through consumption of organisms.
6 - U.S. EPA Drinking Water Regulations and Health Advisories, October 1996.
7 - B&R Environmental, 1998a.
8 - Values for Hexavalent Chromium used.
9 - Action Level.
10 - Secondary MCL.
11 - Value for naphthalene used.
12 - State of Maryland value used (COMAR 08.02.03)+A21

Site 4 appears to be an upgradient source of TCE to at least the eastern portion of the study area. TCE was detected in Site 4 and Site 7 wells and in wells 46-GW-121 (480 µg/L) and 46-GW-126 (56 µg/L), which are located downgradient of Site 4 but are upgradient of other source areas associated with Site 46. The TCE concentrations of 161 and 171 µg/L detected in temporary points DP25 and TW5, located north of the Della Whittaker Building, also suggest potential migration from the Site 4 Area.

The centrifuge area was originally identified as a source area because groundwater samples collected from wells immediately upgradient of the centrifuge had only low levels of TCE (well 46-GW-122 - 26 µg/L), while wells directly downgradient of the outfall from the centrifuge have TCE levels that are more than one order of magnitude higher (well 46-GW-123 - 470 µg/L; well 46-GW-123D - 490 µg/L). The similarity in concentrations between wells 46-GW-123 and 46-GW-123D suggests that a dense nonaqueous phase liquid (DNAPL) is not present. In addition, the threshold concentration at which the presence of a DNAPL is suspected is generally considered to be 1 to 10 percent of the pure-phase solubility for the DNAPL chemical. For TCE, which has a solubility of 1,100 mg/L, the 1 percent threshold concentration would be 11 mg/L, approximately 20 times greater than the maximum concentration detected within the study area.

The TCE concentration in well 46-GW-124 (112 µg/L), north of Building 700, is higher than was observed in direct push samples collected immediately upgradient, suggesting a minor source in this area.

The high concentration of TCE (351 µg/L) detected in a sample from the temporary well located adjacent to the stormwater detention basin at the Della Whittaker Building (TW9) suggests a potential historic release of TCE in this area. Anecdotal information regarding activities associated with this building indicates that a few drums were found at one point in this general area and that an AST may have been located in this area previously.

The Building 500 Area is not currently considered a significant source based on the overall pattern of TCE levels in the central and southern portions of the study area. Contamination in these areas is likely attributable to source areas to the north.

Discharge of TCE-contaminated groundwater to the Building 500 underdrain system is evidenced by the detection of TCE in samples collected from the underdrain discharge. Results available for water samples from the storm sewers that drain the site north and west of Building 500 also indicate the presence of TCE in the discharge water, at concentrations of up to 305 µg/L (northernmost sample point). Observed flow in the sewers during dry weather conditions has been attributed to groundwater infiltration. Past sampling of Army wells in this area identified TCE in groundwater. However, wells south of Building 500 have

consistently had little or no TCE in them, indicating that the contaminated groundwater in the Building 500 Area is effectively being captured by the underdrain and storm sewer systems.

1.9.2 Soil

Six soil samples were collected during the SI from soil borings and direct push borings at depths where elevated photoionization detector (PID) readings suggested the possible presence of VOCs in soils. Sample locations are shown on Figure 1-4. None of the soil sample results indicated a significant source of contamination to groundwater at the locations where samples were collected.

Also during the SI, 10 soil gas sampling points were installed and soil gas levels measured. The purpose of the soil gas survey was to delineate the extent of vadose zone contamination, as indicated by the presence of VOCs in the soil. Soil gas survey points were selected to correspond with the locations exhibiting the highest groundwater contamination, based on analytical results from the first round of direct push sampling. Soil gas locations are shown on Figure 1-5.

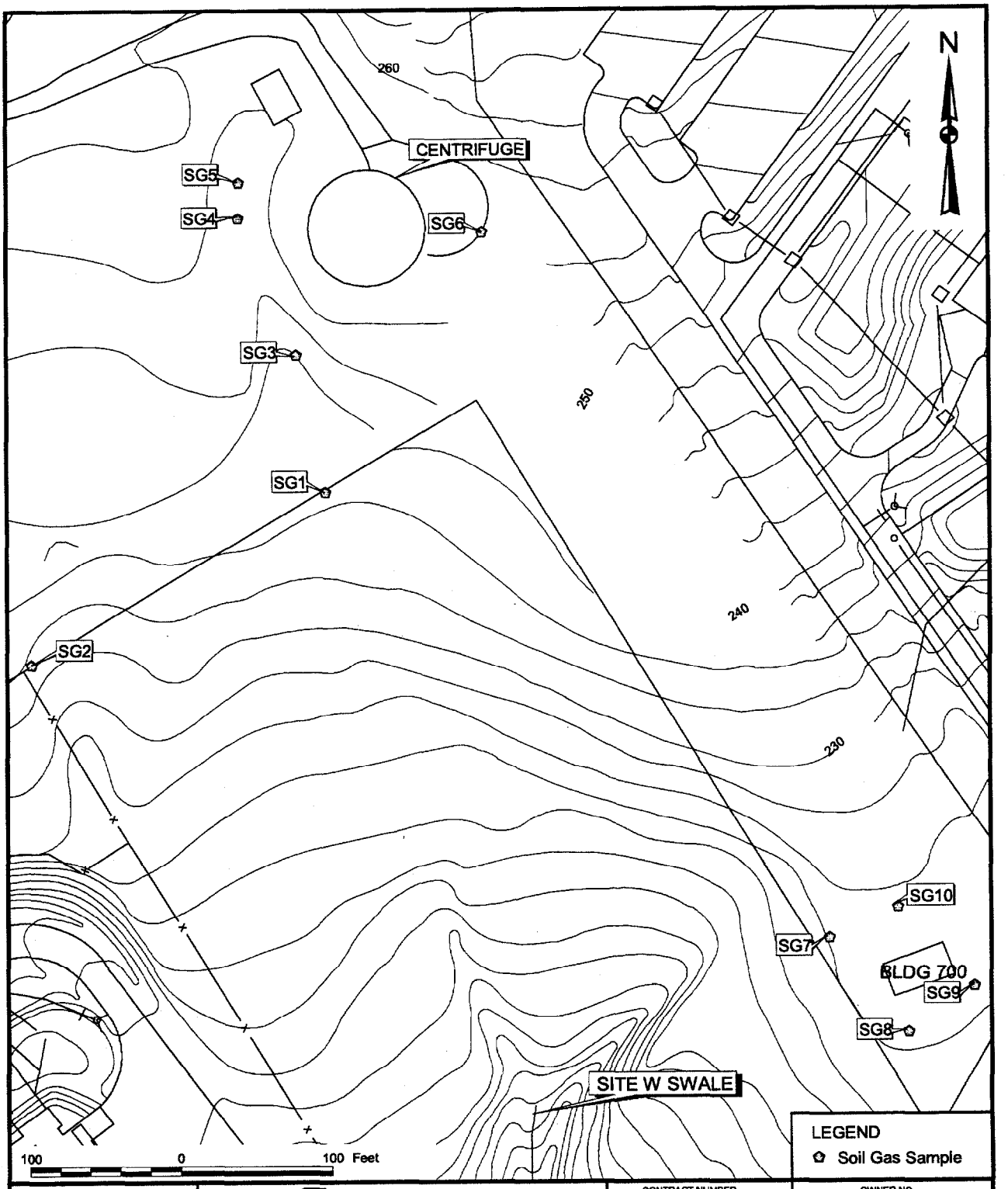
VOCs were detected at several of the soil gas survey points within and near the centrifuge; however contamination was not detected in soil samples collected from these same areas. VOCs were not detected at other soil gas survey points within Site 46.

1.9.3 Surface Water/Sediment

Surface water and sediment analytical data are summarized in Tables 1-1 and 1-2, respectively. Three surface water and sediment sample pairs were collected from each of the streams adjacent to the study area during the SI. Surface water samples were also collected from a seep located along the hillside of the Floral Drive Stream, and from a sump within the interior of the centrifuge structure.

The three surface water and sediment sample pairs collected from the Floral Drive Stream are shown on Figure 1-4. VOCs were not detected in any surface water samples, except for a trace (0.1 µg/L) detection of toluene. No SVOCs, pesticides, or PCBs were detected in the surface water samples. Trace (<5 µg/L) levels of two explosives, HMX and RDX, were detected in the surface water, as were a variety of inorganics. The pattern of detections and concentrations did not indicate any significant impacts due to releases of inorganics.

Sediment sample results from the Floral Drive Stream revealed the presence of low levels of a few VOCs in only the furthest upstream sample; however, TCE was not detected. A variety of SVOCs, primarily



DRAWN BY S. TABLER — DATE 4-MAY-98	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7855	OWNER NO. 0300
CHECKED BY — DATE —	SOIL GAS SURVEY LOCATIONS SITE 46 EE/CA NSWC, WHITE OAK, MARYLAND	APPROVED BY SW 12/9	DATE
COST/SCHEDULE-AREA		APPROVED BY —	DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 1-5	REV 0

P:\GIS\WHITEOAK\76120401.APR 15-JUL-98 DNP FIGURE 2-2 LAYOUT

TABLE 1-2

SEDIMENT ANALYTICAL RESULTS
SITE 46 EE/cA
NSWC WHITE OAK, MARYLAND
PAGE 1 OF 2

SEDIMENT ANALYTICAL RESULTS			
Analyte	Frequency of Detection	Range of Detected Concentrations	Location of Maximum
VOLATILES (µg/kg)			
1,1,2,2-TETRACHLOROETHANE	2/10	1 J - 2 J	IRB-SD-10
1,2-DICHLOROETHENE (TOTAL)	1/10	6 J	IRB-SD-10
2-HEXANONE	1/10	14	ARL-SD-13
4-METHYL-2-PENTANONE	1/10	8 J	ARL-SD-13
ACETONE	1/10	14 J	IRB-SD-10
TRICHLOROETHENE (TCE)	3/10	2J - 24	IRB-SD-10
SEMIVOLATILES (µg/kg)			
ACENAPHTHENE	3/7	46 J - 96 J	ARL-SD-14
ANTHRACENE	5/7	66 J - 320 J	ARL-SD-14
BENZO(A)ANTHRACENE	5/7	390 J - 2200	ARL-SD-14
BENZO(A)PYRENE	5/7	320 J - 2000	ARL-SD-14
BENZO(B)FLUORANTHENE	5/7	440 - 4000	ARL-SD-14
BENZO(G,H,I)PERYLENE	5/7	260 J - 1700	ARL-SD-14
BENZO(K)FLUORANTHENE	2/7	320 J - 410 J	IRBY-SD-3
BIS(2-ETHYLHEXYL)PHTHALATE	5/7	64 J - 280 J	ALD-SD-15
CARBAZOLE	5/7	58 J - 460	ARL-SD-14
CHRYSENE	5/7	480 - 2600	ARL-SD-14
DI-N-BUTYL PHTHALATE	1/7	320 J	IRBY-SD-3
DIBENZO(A,H)ANTHRACENE	1/7	200 J	IRBY-SD-3
DIBENZOFURAN	1/7	75 J	ARL-SD-14
FLUORANTHENE	5/7	900 - 5700	ARL-SD-14
FLUORENE	4/7	49 J - 140 J	ARL-SD-14
INDENO(1,2,3-CD)PYRENE	5/7	240 J - 1600	ARL-SD-14
PHENANTHRENE	5/7	450 - 2300	ARL-SD-14
PYRENE	5/7	920 - 4500	ARL-SD-14
PESTICIDES/PCBs (µg/kg)			
4,4'-DDD	2/7	0.62 J - 1.4 J	IRBY-SD-1
4,4'-DDE	2/7	13 J - 20 J	IRBY-SD-1
4,4'-DDT	2/7	5.9 J - 10 J	IRBY-SD-2
ALPHA-CHLORDANE	1/7	1.9 J	IRBY-SD-3
GAMMA-CHLORDANE	1/7	1.4 J	IRBY-SD-3
INORGANICS (mg/kg)			
ALUMINUM	7/7	909 - 3290	IRBY-SD-2
ARSENIC	3/7	1.4 - 1.5 L	IRBY-SD-3
BARIUM	7/7	10.7 - 38.9	ARL-SD-13
CALCIUM	7/7	196 - 23600	IRBY-SD-2
CHROMIUM	7/7	2.9 - 10.7	IRBY-SD-2
COBALT	6/7	1.4 - 4.5	IRBY-SD-2

TABLE 1-2

SEDIMENT ANALYTICAL RESULTS
SITE 46 EE/cA
NSWC WHITE OAK, MARYLAND
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SEDIMENT ANALYTICAL RESULTS			
Analyte	Frequency of Detection	Range of Detected Concentrations	Location of Maximum
COPPER	7/7	3.9 - 13.6 J	IRBY-SD-2
IRON	7/7	4020 - 9758	IRBY-SD-1
LEAD	7/7	2.7 - 12.3	ARL-SD-15
MAGNESIUM	7/7	407 - 3900	IRBY-SD-3
MANGANESE	7/7	82.7 - 267	ARL-SD-13
MERCURY	3/7	0.06 - 0.08	IRBY-SD-3
NICKEL	6/7	6.6 - 32.1 J	IRBY-SD-3
POTASSIUM	7/7	227 - 776 K	IRBY-SD-2
SELENIUM	1/7	3.3	ARL-SD-14
SODIUM	1/7	9.2	IRBY-SD-3
VANADIUM	7/7	3.8 - 45.7 J	IRBY-SD-3
ZINC	6/7	15.2 - 69.6 J	IRBY-SD-2

NOTES:

J = Estimated value.

K = Positive result is biased high as a result of quality control noncompliance.

L = Positive result biased low as a result of quality control noncompliance.

1 USEPA, 1998.

2 B&R Environmental, 1998a.

3 Values for naphthalene used.

4 USEPA Region III considers this an essential nutrient.

5 Values for hexavalent chromium used.

6 USEPA Region III.

7 Value is based on OSWER Soil Screening Level for residential land use (USEPA, 1994).

8 Values for chlordane used.

NOTE: Shaded sediment analytical results exceed one or more regulatory criteria and guidance values.

polynuclear aromatic hydrocarbons (PAHs), were detected but these types of compounds are commonly found in soils and sediments near roads. A variety of inorganics were also detected, which is typical for sediment samples. The pattern of detections and concentrations does not suggest any significant site-related impacts due to releases of inorganics to sediments. No pesticides, PCBs, or explosives were detected in sediment samples from this stream.

During the completion of the SI, three surface water/sediment sample pairs were collected from the Outfall Stream, as shown on Figure 1-4. TCE was detected in all three surface water samples, but the concentrations decreased in the downstream direction from 6 to 2 µg/L. Trace levels of 1,1,2,2-trichloroethane (2 µg/L) were also detected. The only SVOCs, pesticides, or PCBs detected was alpha-BHC (a pesticide) at a concentration of 0.004 µg/L. VOCs were not detected in the sediment samples; however, low levels of a number of SVOCs and a few pesticides were detected. Inorganic results did not indicate any impacts to surface water or sediments.

During the SI, three surface water/sediment sample pairs were collected from the Site W Swale Stream, as shown on Figure 1-4. The three surface water samples had TCE concentrations ranging from 3.7 to 56.8 µg/L. As was found in samples from the Outfall Stream, TCE concentrations decreased in the downstream direction. Trace levels of a few other VOCs were detected (maximum 7.1 µg/L - cis-1,2-DCE). Sediment samples contained trace levels of TCE (maximum 24 µg/kg), as well as a few other VOCs at lower concentrations.

The Army had previously sampled the Site W Swale north of Floral Drive. Samples contained TCE at concentrations up to 210 µg/L and a few other VOCs at much lower concentrations (maximum 22 µg/L - cis-1,2-DCE). Trace levels of explosives (<2 µg/L) and a number of inorganics were also detected. Sediment results generally showed most of the same compounds but at lower concentrations. (AEHA, 1994)

A surface water sample collected by the Prince George's County Health Department in October 1997 from the seep south of Floral Drive near the Site W Swale Stream had a TCE concentration of 200 µg/L. TCE was detected at this location during the SI, but at a lower concentration (73.8 µg/L). Low levels of several other VOCs, trace levels of a pesticide, and one explosive were detected, but no SVOCs or PCBs were found. A variety of inorganics were detected. The pattern of detections and concentrations did not indicate any significant impacts due to releases of inorganics. Groundwater samples collected from wells 46-GW-127S and 46-GW-127 in the vicinity of the seep, had TCE concentrations of 60 and 94 µg/L, respectively.

The surface water sample from the centrifuge sump contained low levels of several VOCs, most notably TCE at 10.8 µg/L. Other VOCs were detected at concentrations of less than 3 µg/L. The low level detection of TCE indicates that TCE was released in this area in the past; however, the sump does not appear to be a significant continuing source at this time. One SVOC was detected at a trace level, along with a variety of inorganics. The pattern of detections and concentrations did not indicate any significant impacts due to releases of inorganics. No pesticides, PCBs, or explosives were detected. TPH was detected at a concentration of 829 µg/L.

The analytical data suggest that the VOC contamination present in surface water samples is due to migration of contaminated groundwater to surface water features within and bordering the study area. The groundwater contours indicate that groundwater flows toward the swale and other streams in the area. It appears that the surface water features act as hydrogeologic boundaries to shallow groundwater migration, and serve to contain the contaminated groundwater. This hydrogeologic boundary is formed by the Floral Drive Stream and seeps to the Site W Swale.

1.10 INTERIM MEASURES ASSESSMENT

In May 1998, TtNUS was asked by the Navy to evaluate the discharge of TCE-contaminated groundwater to the Site W Swale and Outfall Streams and recommend potentially appropriate interim response actions that could be rapidly implemented to mitigate these releases of contaminated groundwater. Two systems have been selected, recently been installed, and are now operational.

To address the water seeping into the underdrain and storm sewer system, an air stripper was installed to treat the water immediately upstream of the storm sewer system outfall. Contaminated water is pumped out of a manhole, treated by the stripper, and discharged to a downgradient location.

A subsurface groundwater collection trench was installed just north of Floral Drive. The trench originates at the Site W Swale and continues east along Floral Drive for approximately 400 feet. The collection trench conveys the contaminated groundwater to a central collection sump/pump station within the Site W Swale. Groundwater is pumped to the surface for treatment by an air stripper. Following treatment, the water is discharged to the culvert passing under Floral Drive.

Additional information is presented in the Interim Measures Assessment (B&R Environmental, 1998c).

1.11 REPORT ORGANIZATION

This section contains the introduction, presents the general site characteristics, and discusses the nature and extent of contamination at Site 46. Section 2.0 identifies removal action objectives, including a discussion of compliance with applicable or relevant and appropriate requirements (ARARs). Section 2.0 also presents a screening of available technologies and the selection of removal action alternatives. Section 3.0 presents a description and evaluation of each of the alternatives. Sections 4.0 and 5.0 present a comparative analysis of the alternatives and recommendations, respectively. Cost estimates for each alternative are provided in Appendix B. Preliminary conceptual design calculations are presented in Appendix C.

2.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES AND TECHNOLOGY SCREENING

Removal action objectives are developed to guide the removal action and ensure that the action complies with regulatory requirements. This section includes a streamlined risk assessment, an ARAR evaluation, removal action objective identification, available remedial technology preliminary screening, and representative process option selection.

2.1 STREAMLINED RISK ASSESSMENT

The streamlined risk assessment provides a general assessment of the risks posed by contaminants present in Site 46 groundwater, and of the potential for site groundwater to act as a source of contaminants to other media. A baseline risk assessment of chemical concentrations detected in groundwater and a qualitative ecological risk assessment were performed and presented in the Site 46 SI report (B&R Environmental, 1998b). Results of these assessments are summarized below.

2.1.1 Human Health Risk Assessment

Risk estimates for hypothetical future residential adult/child receptors were calculated and compared to target risk levels established by the USEPA. Data collected during the SI and data presented by the BCOE in the Final RI for the Building 500 Area (BCOE, 1998) were considered in the risk assessment.

The exposure assessment assumed that a hypothetical future on-site resident could be exposed to contaminants in groundwater via household use, i.e., ingestion, dermal, and inhalation routes of exposure, of the groundwater at some point in the future. However, the Site 46 Area is not currently available for residential development. Therefore, shallow groundwater underlying the study area is not currently used for domestic or industrial purposes. The hydrogeology of the site indicates that the shallow overburden aquifer discharges to surface water streams, preventing migration of contaminated groundwater to off-site areas where it could potentially be used as a drinking water source.

Risks were calculated for both reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios. The cancer risk estimates for both RME and CTE cases exceeded the USEPA target risk range of 1E-6 to 1E-4. The primary contributors to carcinogenic risk were arsenic; 1,1,2,2-tetrachloroethane; 1,1-dichloroethene; TCE; vinyl chloride; and bis(2-ethylhexyl)phthalate. Under all exposure scenarios evaluated, arsenic contributed between 68 and 73 percent of the total risk. TCE contributed from 10 to 12 percent of the total risk. All other contaminants contributed less than 10 percent. TCE and bis(2-ethylhexyl)phthalate were, however, the only primary contributors that were detected at

concentrations exceeding federal Safe Drinking Water Act (SDWA) MCLs. Arsenic levels were below the MCL for this compound. Evaluation of noncancer risk estimates also indicated that adverse noncarcinogenic health effects would be possible under the conditions established in the exposure assessment.

The results of the human health risk assessment indicated that the groundwater in the surficial aquifer underlying the study area would not be suitable as a domestic water supply because of the chemical concentrations detected in the groundwater.

TCE, bis(2-ethylhexyl) phthalate, aluminum, cadmium, chromium, iron, magnesium, manganese, mercury, nickel, and selenium were detected in groundwater samples at concentrations exceeding federal SDWA MCLs. However, many of the inorganics are within background concentrations. Noncarcinogenic risk assessment results indicate that adverse noncarcinogenic health effects may occur for both the adult and child residents under the RME scenario, primarily due to ingestion. Incremental lifetime cancer risks developed for receptors hypothetically using the groundwater as a domestic water supply are within the USEPA target risk range of 1E-6 to 1E-4. The primary cancer risk drivers are TCE, arsenic, and bis(2-ethylhexyl)phthalate. The uncertainty analysis suggests that the cancer risk estimated for arsenic, one of the primary contributors to risk, is probably overestimated (B&R Environmental, 1998b). The primary contaminant of concern in groundwater is TCE.

2.1.2 Ecological Risk Assessment

The qualitative ecological risk assessment compares the chemical concentrations detected in site groundwater, surface water, and sediment to available criteria and benchmarks set to protect aquatic biota. TCE was not detected in excess of screening criteria in either groundwater, surface water, or sediment.

Unfiltered groundwater results were compared to federal and state acute and chronic Ambient Water Quality Criteria (AWQC) for the protection of aquatic biota because groundwater discharges to surface water bodies in the study area. Only a few inorganics (cadmium, chromium, copper, lead, mercury, selenium, zinc, and iron) were detected at concentrations in excess of AWQCs. However, the only metals detected in filtered surface water samples in excess of AWQCs were lead and iron. This suggests that the metals concentrations noted in the unfitered groundwater samples may be due, in part, to turbidity and are not readily migrating and discharging to the surface water bodies. In addition, lead and iron were only detected in two of five and one of five unfiltered surface water samples, respectively. The maximum concentrations were reported from a location within the Site W Swale. It should be noted that results from the filtered surface water samples collected from this location contained lead at a level below the AWQC.

Sediment concentrations were compared to various toxicity benchmarks. Maximum concentrations of several SVOCs exceeded criteria, as well as cadmium, chromium, and mercury. However, these compounds are not expected to be related to site activities (B&R Environmental, 1998b).

2.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs are used to develop criteria by which removal action objectives and removal action technologies can be established. The term ARAR is defined in the National Oil and Hazardous Substances Contingency Plan (NCP) as follows:

- Applicable requirements are generally defined as cleanup standards, standards of control, or other substantive environmental protection requirements promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, or location. Only those state standards that are identified by a state in a timely manner and that are more stringent that federal requirements may be considered as applicable requirements.

- Relevant and appropriate requirements are defined as cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that are not directly "applicable" to a hazardous substance, pollutant, contaminant, remedial action, or location, but address situations sufficiently relevant to those encountered at the site that their use is appropriate. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be considered as relevant and appropriate requirements.

- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation.

Based on the manner in which they are applied during a removal action, ARARs are classified into three categories.

- Chemical-Specific. Chemical-specific ARARs were developed to provide health or risk-based concentration limits. These limits are specific for an individual chemical or group of chemicals. Often, these ARARs are used to determine the extent of site remediation. Chemical-specific ARARs may be concentration-based cleanup goals or may provide the basis for calculating such levels. In cases

where no chemical-specific ARAR exists, chemical advisories may be used to develop removal action objectives.

- Location-Specific. Location-specific ARARs are considered in view of natural or man-made site features. These ARARs are intended to limit activities within designated areas.

- Action-Specific. Action-specific ARARs pertain to the implementation of a given remedy. These ARARs control or restrict hazardous substance- or pollutant-related activities. These controls are considered when specific removal activities are planned for a site.

In addition to ARARs, other regulations and guidance may be classified as guidance "To Be Considered" (TBC). TBCs are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing removal actions or necessary for determining what is protective of human health and/or the environment. TBCs are also identified in this section to aid in evaluating the removal actions. Potential federal and state ARARs and TBCs are presented in Tables 2-1 and 2-2, respectively.

2.2.1 Contaminant-Specific ARARs

Data collected during the SI indicate that TCE is present at concentrations that exceed USEPA and Maryland MCLs and is the primary contaminant present in Site 46 groundwater. With the exception of inorganics, the only other compound that exceeded its MCL is bis(2-ethylhexyl)phthalate. Inorganics that exceed MCLs in unfiltered groundwater samples were aluminum, cadmium, iron, manganese, mercury, nickel, and selenium. Aluminum, cadmium, iron, and manganese concentrations in filtered groundwater samples still exceed MCLs. Aluminum, iron, and manganese are within background concentrations.

2.2.2 Action-Specific ARARs

Action-specific ARARs will be selected based on the specific removal actions proposed. Several action-specific ARARs are listed in Table 2-2. Activities that may be part of the potential removal action and subject to an ARAR include earth disturbance, air pollution, and well construction.

TABLE 2-1

FEDERAL ARARs AND TBCs
SITE 46 EE/CA
NSWC WHITE OAK, MARYLAND

ARAR/TBC	Type of ARAR	Requirement	Synopsis	Comments
Clean Air Act (CAA)	Chemical - Specific	Air emission limitations on selected parameters	Emission limitations related to attainment of National Ambient Air Quality Standards and Emission Standards for Hazardous Air Pollutants.	Potential removal actions may involve air emissions. However, emissions are not likely to be affected by CAA due to 1. Small quantities of pollutants emitted and/or 2. Source not included in a regulated category
Safe Drinking Water Act (SDWA)	Chemical - Specific	TCE 5 µg/L	Sets drinking water standards for public water supply.	Not currently applicable since site groundwater is not used as a public water supply. However, protection of groundwater for future potential drinking water use is an objective of the interim removal actions.

TABLE 2-2

STATE OF MARYLAND ARARs AND TBCs
SITE 46 EE/CA
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Citation (COMAR)	Title	Type of ARAR	Requirement Synopsis	Comments
26.02.03	Control of Noise Pollution	Action-Specific	Provides limits on the maximum allowable levels of noise at the site boundaries during site remediation work to protect the health, general welfare, and property of the people of the state.	Interim removal actions may involve use of heavy machinery.
26.04.01	Quality of Drinking Water in Maryland	Chemical-Specific	Provides for maximum contaminant levels (MCLs) of contaminants in drinking water.	Not directly applicable since groundwater is not used as a source of drinking water. However, protection of groundwater quality is one reason for interim removal action.
26.04.04	Well Construction	Action-Specific	Provides specifications for well construction and abandonment. Any wells installed, decommissioned, and/or abandoned in Maryland are subject to these requirements.	Interim removal actions may involve installation of wells.
26.05.01	Board of Well Drillers	Action-Specific	Provides licensing requirements for persons drilling and installing wells in the state. Assures that monitoring wells are installed by qualified well drillers.	Interim removal actions may involve installation of wells.

TABLE 2-2

STATE OF MARYLAND ARARs AND TBCs
SITE 46 EE/CA
NSWC WHITE OAK, MARYLAND
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Citation (COMAR)	Title	Type of ARAR	Requirement Synopsis	Comments
26.08.01 26.08.02 26.08.03 26.08.04	Water Pollution: General Water Quality Discharge Limitation Permits	Action-Specific	Protects and maintains the quality of surface water in the state. Establishes criteria and standards for discharge limitations and policy for antidegradation of waters of the state. Any contaminated groundwater entering the surface water must meet ambient water quality criteria. Discharge of treated groundwater must meet state NPDES limits.	Interim removal actions may discharge treated groundwater to surface water.
26.17.01 26.17.02	Erosion and Sediment Control Stormwater Management	Action-Specific Action-Specific	Any land-clearing, grading, or other earth disturbances require an erosion and sediment control plan. This plan must be approved before construction activities begin. Stormwater must be managed to prevent offsite sedimentation and maintain current site conditions. The primary goal is to maintain after development, as nearly as possible, the pre-development runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and local flooding.	Interim removal actions may involve significant earth disturbance.
26.13.01 26.13.02	Hazardous Waste Management System; General Identification and Listing of Hazardous Waste	Action-Specific Action-Specific	Provides criteria to identify toxicity characteristic hazardous waste and listed waste.	Interim removal actions may generate hazardous waste.

TABLE 2-2

STATE OF MARYLAND ARARs AND TBCs
SITE 46 EE/CA
NSWC WHITE OAK, MARYLAND
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Citation (COMAR)	Title	Type of ARAR	Requirement Synopsis	Comments
26.11	Air Quality	Action-Specific	Provides ambient air quality standards, general emissions standards, and restrictions for air emissions from construction activities, vents, and treatment technologies such as incinerators. Also includes nuisance and odor control. Construction activities may emit particulate matter into the ambient air. Remedial activities must follow regulations.	Interim removal actions may involve air emissions.
26.13.03	Standards Applicable to Generators of Hazardous Waste	Action-Specific	Establishes standards for generators of hazardous waste.	Interim removal actions may generate hazardous waste.
26.13.04	Standards Applicable to Transporters of Hazardous Waste	Action-Specific	Provides regulations for transporting hazardous waste. Any hazardous waste found during site remediation must be disposed of according to regulation. Any residues or by-products from treatment systems that are hazardous must be disposed of properly.	Interim removal actions may generate hazardous waste.

2.2.3 Location-Specific ARARs

The removal actions being evaluated may require significant disturbance of the site. Previous investigations have not identified wetlands or ecologically sensitive areas in the immediate vicinity of Site 46. The site is not located in a 100-year flood plain.

2.3 REMOVAL ACTION OBJECTIVES

As the lead agency, the Navy has determined that shallow groundwater is the medium to be considered under this removal action.

- The primary objective of any removal action undertaken within the study area is to prevent groundwater with contaminant levels in excess of MCLs from migrating off of Department of Defense property.

- The secondary objective is to prevent groundwater with contaminant levels in excess of MCLs from discharging to the adjacent streams.

- The tertiary objective is to restore groundwater within Site 46 by reducing TCE concentrations to less than 5 µg/L, the SDWA and State of Maryland MCL for TCE.

As discussed in Section 1.8.5, there appear to be several sources for the TCE contamination. The purpose of this EE/CA is to address groundwater associated with Site 46, and as such, the document focuses on the potential source areas within Site 46. Contamination in the vicinity of Building 700 is not being addressed as a potential source area because there were no releases during the building's history and the elevated TCE concentrations are upgradient of Building 700. Other potential source areas outside of Site 46 will be addressed by future investigations associated with other former NSWC White Oak sites and are outside the scope of this EE/CA.

2.4 STATUTORY LIMITS ON REMOVAL ACTIONS

The statutory limits for fund-financed removal actions are presented in Section 104(c)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). These limits are not applicable because the action at Site 46 is not financed by Superfund.

2.5 DETERMINATION OF REMOVAL ACTION SCHEDULE

The removal action at Site 46 was determined by the U.S. Navy to be a non-time-critical removal action because there is no imminent danger to life or health, a removal action needs to be implemented to prevent the spread of contamination, and a planning period of 6 months is available before implementation of the removal action. Implementation of the selected removal action could commence within 6 to 12 months of the finalization of this EE/CA.

2.6 PRELIMINARY SCREENING OF GROUNDWATER TECHNOLOGIES

Table 2-3 presents a preliminary screening of available technologies to address the groundwater contamination at Site 46.

2.7 REPRESENTATIVE TECHNOLOGIES AND PROCESS OPTIONS

The following technologies and process options have been retained from the preliminary screening:

- Institutional Controls
- Monitoring
- Natural Attentuation
- Extraction Wells
- Reactive Groundwater Treatment Wall
- Air Sparging/Soil Vapor Extraction
- Air Stripping
- Surface Water Discharge
- Activated Carbon Adsorption

Extraction wells are selected over collection trenches because they are expected to be more cost effective for this application. For groundwater treatment, air stripping is selected over steam stripping, activated carbon adsorption, and enhanced oxidation because it is expected to be more cost effective. Activated carbon adsorption has been selected for off-gas treatment over incineration/catalytic oxidation because it is expected to be more cost effective.

TABLE 2-3

SCREENING OF GROUNDWATER TECHNOLOGIES
SITE 46 EE/CA
NSWC WHITE OAK, MARYLAND
PAGE 1 OF 2

General Response Action	Technology Type	Process Options	Brief Description	Screening Comment
No Action	None	Not Applicable	No action is taken.	Retain as a baseline for comparison as required by the NCP.
Minimal Action	Institutional Controls	Fencing/Security/Posting of Notices/Deed Restrictions	Access/regulatory restrictions to prevent use of on-site groundwater or future down-gradient groundwater.	Potentially applicable. Retain for further consideration.
	Monitoring	Groundwater Sampling and Analysis	Monitoring wells for contaminants of concern in and around the site.	Potentially applicable. Retain for further consideration.
	Natural Attenuation	Chemical/Biological	Allowing naturally occurring chemical and microbial agents to degrade contaminants.	Potentially applicable. Retain for further consideration.
Containment	Subsurface Barriers	Grout Curtains/Slurry Walls/Sheet Piling	Use of physical barriers to minimize migration of contaminated groundwater.	Do not retain. Not effective in the long term.
		Hydraulic Barrier	Use of extraction wells or trenches to restrict horizontal migration of plume.	Do not retain. Not effective in the long term.
Removal	Wells/Trenches	Extraction Wells	Use of wells to remove contaminated groundwater from the saturated zone with pumps.	Potentially applicable. Retain for further consideration.
		Collection Trenches	Use of trenches backfilled with permeable material to collect and convey contaminated groundwater.	Potentially applicable. Retain for further consideration.
In-situ Treatment	Physical/ Chemical	Chemical Oxidation	Injection of oxidizing agents into the saturated zone to destroy organic contaminants.	Do not retain. Injection of aqueous oxidizing chemicals to ensure adequate dispersal throughout the plume would be difficult to implement.
		Reactive Groundwater Treatment Wall	Downgradient trenches backfilled with reactive media to remove organic contaminants from the groundwater.	Potentially applicable. Retain for further consideration.
	Biological	Biodegradation	Enhancement of natural aerobic and/or anaerobic processes by injecting nutrients and appropriate chemicals into the saturated zone.	Do not retain. Injection of aqueous nutrients and appropriate chemicals to ensure adequate dispersal throughout the plume would be difficult to implement.
	Physical/ Chemical	Air Sparging/Soil Vapor Extraction	Air-injection in saturated zone to volatilize and enhance aerobic biodegradation, with vapor extraction in the unsaturated zone to remove volatilized contaminants and off gases.	Potentially applicable. Transfer of VOCs to vapor phase is relatively quick. Impractical for application throughout the plume, may be suitable for use in a source area. Retain for further consideration.

TABLE 2-3

SCREENING OF GROUNDWATER TECHNOLOGIES
SITE 46 EE/CA
NSWC WHITE OAK, MARYLAND
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General Response Action	Technology Type	Process Options	Brief Description	Screening Comment
Ex-situ Treatment	Physical/ Chemical	Precipitation/Flocculation/ Clarification/Filtration Ion Exchange Reverse Osmosis	Use of one or more of these technologies to separate suspended solids and remove inorganics.	Do not retain. Not effective for treatment of primary contaminant, TCE.
		Air Stripping/Steam Stripping/ Activated Carbon Adsorption/ Enhanced Oxidation	Use of one or more technologies to transfer contaminants from the groundwater to another phase in a more concentrated form or to break down the contaminants into more innocuous forms.	Potentially applicable. Retain for further consideration.
Disposal	Surface Discharge	Local POTW	Discharge the extracted groundwater to a POTW with or without treatment.	Do not retain. A suitable POTW is not available.
		Surface Water	Discharge the extracted groundwater to one of the adjacent surface water bodies directly or through the storm sewer, following treatment.	Potentially applicable. Retain for further consideration.
	Subsurface Discharge	Re injection Infiltration Basins	Return the extracted groundwater to the aquifer using forced injection or passive percolation.	Do not retain. Subsurface discharge would only be advantageous if the source was well defined and injection of treated water could be used for flushing contaminants out of the source area.
Offgas Treatment	Physical	Activated Carbon Adsorption	Contaminated vapors pass through a bed of activated carbon. VOCs within the vapors are adsorbed onto the bed.	Potentially applicable. Retain for further consideration.
	Thermal/Chemical	Incineration/Catalytic Oxidation	VOCs are oxidized into relatively less toxic gasses.	Potentially applicable. Retain for further consideration.
	Biological Treatment	Biological Reactor	Microorganisms metabolize contaminants. VOCs are converted to cell mass, water vapor, and carbon dioxide.	Do not retain. Not effective for TCE.

3.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The removal action alternatives for groundwater at Site 46 are as follows:

- Alternative 1: No Action
- Alternative 2: Minimal Action, Natural Attenuation
- Alternative 3: Reactive Groundwater Treatment Wall
- Alternative 4a: Groundwater Treatment via Air Stripping, Surface Discharge – Site W Swale Treatment Unit
- Alternative 4b: Groundwater Treatment via Air Stripping, Surface Discharge Isherwood Road Stream Treatment Unit
- Alternative 5: Air Sparging/Soil Vapor Extraction

The following sections will describe these removal action alternatives, and evaluate each one based on effectiveness, implementability, and cost as outlined in Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA (USEPA, 1993).

The alternative evaluation assumes that the interim measures discussed in Section 1.10 will be in operation before the removal action is implemented. The secondary removal action objective, preventing discharge of contaminated groundwater to adjacent surface water bodies, will be met by the interim measures. Additionally, as discussed in Section 1.7.2, the adjacent streams are acting as a hydrogeologic boundary to shallow groundwater flow, preventing off-site migration of contaminated shallow groundwater and achieving the primary objective.

Therefore, the removal action alternatives presented here are evaluated based on how effectively each meets the third objective, groundwater restoration within Site 46.

3.1 ALTERNATIVE 1: NO ACTION

The no action alternative is evaluated to provide a comparative baseline against which other alternatives can be evaluated.

3.1.1 Description

Under this alternative, no removal action would be taken and the groundwater would be left as is, without implementing any containment, removal, treatment, or other mitigating actions.

3.1.2 Effectiveness

Alternative 1 does not provide an effective solution for groundwater restoration at Site 46. Although contaminants may be degrading naturally via dispersion, oxidation, etc., no mechanism can verify its effectiveness in meeting the removal action objective. Alternative 1 would not comply with ARARs.

3.1.3 Implementability

Under Alternative 1, no removal action would be taken; therefore, there would not be any difficulties or uncertainties associated with implementation.

3.1.4 Cost

There are no capital, operation, maintenance, or monitoring costs associated with this alternative.

3.2 ALTERNATIVE 2: MINIMAL ACTION, NATURAL ATTENUATION

Alternative 2 allows natural attenuation to restore groundwater.

3.2.1 Description

Under this alternative, TCE contamination in groundwater would be allowed to attenuate naturally and a natural attenuation study would be performed to evaluate the trend in concentrations over time. Chlorinated solvents, including TCE and its degradation products, have been known to undergo a variety of chemical and biological transformations under natural conditions within an aquifer. In addition to diffusion/dispersion, processes such as anaerobic (reductive) dehalogenation and aerobic oxidation could occur under the influence of microorganisms in the subsurface environment. The presence of microorganisms that are capable of either directly or indirectly using these toxic organic compounds to varying degrees may result in the formation of less toxic products. An adequate type and quantity of substrate, nutrients, temperature, pH, and other subsurface conditions, as well as the appropriate microbial population, are required for the biotic transformations to occur. Typically, naturally occurring microorganisms become acclimated over a period of several years to the presence of contaminants of concern. Therefore, acclimated microorganisms could be expected to be present at this site.

TCE can undergo both aerobic and anaerobic degradation; however, conditions necessary for aerobic biodegradation are not commonly encountered at sites where TCE contamination occurs. Under anaerobic conditions, TCE undergoes reductive dehalogenation to form dichloroethene (DCE), typically

cis-1,2-DCE, and vinyl chloride. These compounds require further degradation under either highly reducing or oxidizing conditions, the later being less likely to occur. The final degradation products under highly reducing conditions are the relatively less toxic ethene and ethane. However, if reducing conditions are not sufficiently high, vinyl chloride is a typical end product that resists further degradation. Under aerobic conditions, the final degradation products of vinyl chloride are carbon dioxide, hydrogen chloride, and water.

Groundwater samples would be collected semi-annually from 10 monitoring wells. Samples would be analyzed for Target Compound List (TCL) VOCs and natural attenuation parameters, including dissolved oxygen, dissolved organic carbon, pH, oxidation-reduction potential (ORP), dissolved methane, dissolved ethene, dissolved ethane, chlorides, nitrates, sulfates, sulfides, hydrogen, alkalinity, and dissolved iron. A site review would be conducted every 5 years as required under CERCLA.

The following are recommended data requirements for the design of this removal action alternative:

- Completion of a natural attenuation study in the contaminated areas to aid in determining if natural attenuation is actually occurring. The data currently available indicates the potential for natural attenuation, but are not conclusive.

3.2.2 Effectiveness

The mechanism of TCE degradation is predominantly via anaerobic cometabolism, in which the primary substrate for the microorganisms is a more easily degradable chemical such as phenol or methane, and the enzymes produced during primary metabolism cause the breakdown of TCE and DCE. Therefore, the presence of low levels of petroleum hydrocarbons (a source of primary substrate) in the source area well 46-GW-123 and in the centrifuge sump is expected to be beneficial for cometabolism of TCE and DCE to occur. As indicated by the presence of cis-1,2-DCE, TCE breakdown may be occurring in this location. The presence of trace levels of vinyl chloride indicates that degradation is either proceeding to completion or the degradation is not proceeding significantly beyond cis-1,2-DCE. However, indicator parameters of natural attenuation, as noted earlier, must be measured over several sampling rounds to verify whether TCE biogredation is proceeding to completion and thereby determine the effectiveness of this process.

3.2.3 Implementability

Procedures used for sampling groundwater are routine and laboratories are readily available to perform analysis for natural attenuation parameters.

3.2.4 Cost

The following costs are associated with Alternative 2:

Capital: $177,100
Operation & Maintenance: $0
Monitoring: $33,000 - $39,000/year
Present Worth: $599,500

The present worth cost assumes a 30-year duration. No major capital cost components are associated with this alternative.

3.3 ALTERNATIVE 3: REACTIVE GROUNDWATER TREATMENT WALL

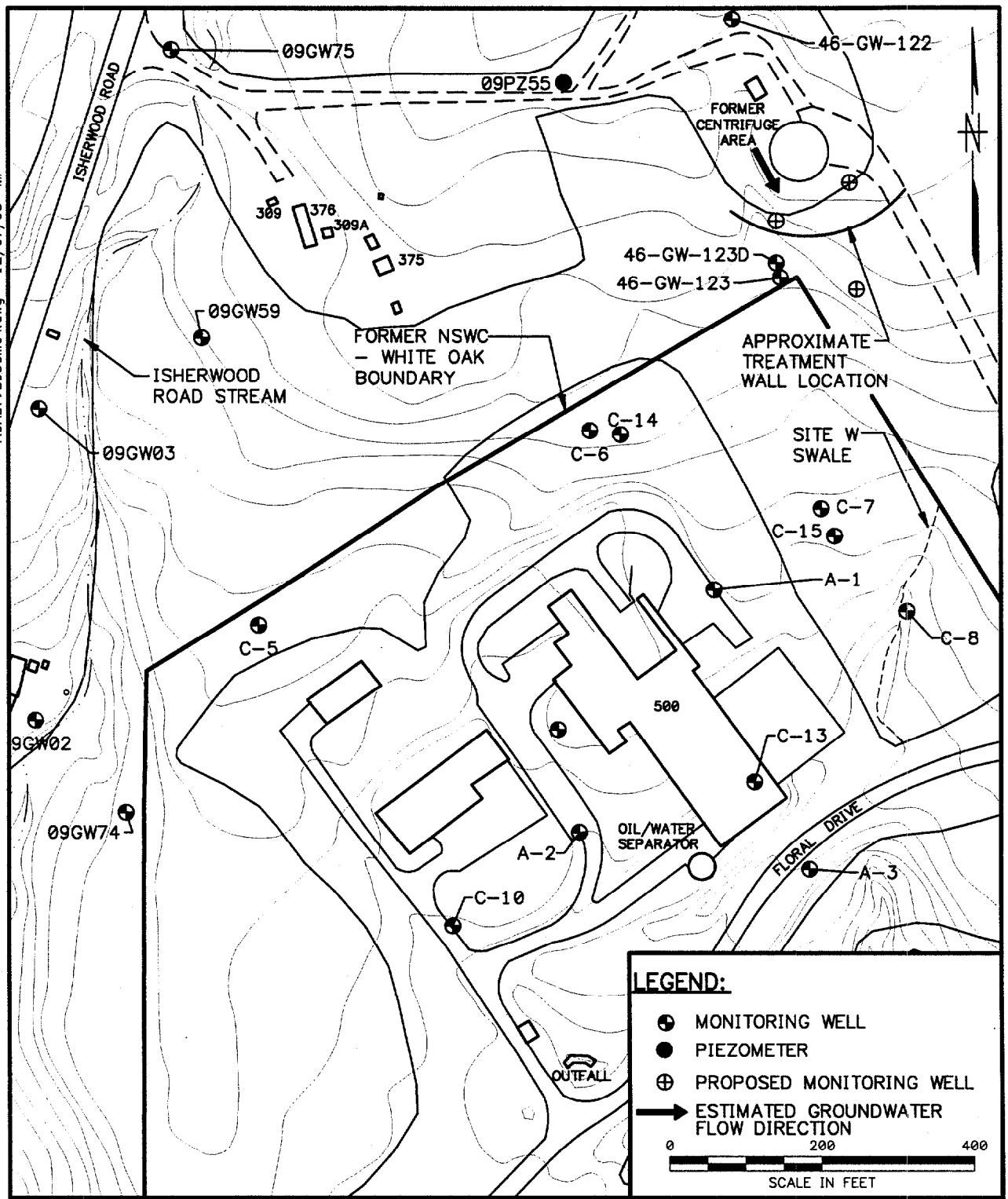
Alternative 3 provides for constructing a reactive groundwater treatment wall to restore groundwater.

3.3.1 Description

To treat contaminated groundwater in the area, a reactive groundwater treatment wall would be installed perpendicular to groundwater flow, in the approximate location shown on Figure 3-1. The location was selected so that the wall is near the apparent area of highest TCE contamination, based on available groundwater analytical data, and is also hydraulically downgradient of the centrifuge.

The reactive medium used is zero valent iron filings (Fe^0). As groundwater passes through the wall, TCE undergoes reductive dechlorination in which the Fe^0 donates electrons to reduce the TCE and becomes oxidized to ferrous iron (Fe^{2+}) or ferric iron (Fe^{3+}). The reactive wall must be designed to provide sufficient residence time for intermediate products, including cis-1,2-DCE and vinyl chloride, to fully degrade to ethene and ethane (USEPA, 1997).

The wall would be approximately 300 feet long and 40 feet deep, the depth to the confining layer. Iron filings would be placed between 40 and 25 feet below ground surface, the saturated thickness of the aquifer. The remainder of the wall would be backfilled with native soil. Based on site conditions, a 20-inch thick wall is necessary to achieve sufficient groundwater residence time to reduce TCE concentrations to below MCLs, and result in complete degradation of TCE to ethene and ethane. The thickness of the wall would need to be accurately determined during detailed design activities. Preliminary design calculations performed to determine the wall thickness are provided in Appendix C.



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CHECKED BY DATE	ALTERNATIVE 3: CONCEPTUAL LAYOUT SITE 46 EE/CA NSWC, WHITE OAK, MARYLAND	APPROVED BY SN	DATE 12/9
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 3-1	REV. 0

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Due to the proposed depth of the wall, the wall would be constructed by excavating a trench with a backhoe or clamshell and filling the trench with a biodegradable polymer slurry. The slurry would provide physical support to hold up the trench sides during wall construction. Iron fillings would be poured into the trench by a front end loader while the slurry is in place. The remainder of the wall would be completed with native soil. The slurry would biodegrade and be flushed out of the wall by groundwater flow leaving just the iron fillings. A 30-foot wide area would have to be cleared in order to facilitate wall installation. Soil that is excavated and replaced by the iron fillings would require proper handling and disposal.

The only long-term operation and maintenance requirement associated with this alternative is the need for periodic rejuvenation, typically every 7 to 10 years, of iron due to precipitates or biological activity on the upgradient aquifer/iron interface. Rejuvenation can be performed by agitating the upgradient side of the wall with a soil auger to restore the permeability of the filings.

Long-term monitoring would involve collecting groundwater samples from locations both upgradient and downgradient of the wall to monitor effectiveness. These locations include existing wells and new wells installed as shown on Figure 3-1. Two shallow monitoring wells would be installed upgradient of the wall. One well would be installed downgradient of the wall. Groundwater monitoring wells would be 2-inch diameter PVC. Sampling would be conducted quarterly. A site review would be conducted every 5 years, as required under CERCLA.

Monitoring wells are also typically installed on either end of a reactive wall to monitor groundwater flow and ensure that contaminated groundwater is not flowing around the wall. However, since there is known contamination originating from other areas upgradient of Site 46, if TCE contamination were found in wells located on either end of the wall, it might not be indicative of groundwater flow around the wall. Therefore, wells would not be installed at either end.

The following are recommended data requirements for the design of this removal action alternative:

- The lateral extent of the TCE contamination to better define dimensions of the treatment zone.
- Physical characteristics of the groundwater, including oil and grease, alkalinity, hardness, and total dissolved solids.
- Effects of the process on the inorganic chemistry of the groundwater. Specifically, the potential for mineral precipitation on the wall surface to occur that could reduce system effectiveness and life of the material.

3.3.2 Effectiveness

Alternative 3 complies with ARARs and would be capable of restoring groundwater and attaining the removal action objective. The alternative would be protective of public health and the community by reducing TCE concentrations to below its MCL. Because the shallow groundwater is not currently a source of drinking water, there is no immediate human health threat. This alternative would effectively meet the removal action objective until a more comprehensive remedial approach is identified to address upgradient areas of groundwater contamination.

Reactive groundwater treatment walls are an innovative technology, and their long-term effectiveness has not been thoroughly determined. There is limited field data concerning longevity of wall reactivity or loss of permeability due to fouling caused by other constituents in groundwater.

A thicker wall may be required to ensure complete degradation of TCE to ethene and ethane. Studies note a reduction in performance with distance traveled through the wall. The chemical reaction that occurs within the wall can cause pH to rise, which is suspected of reducing reaction rates and lowering effectiveness (Nyer, et al, 1996).

3.3.3 Implementability

The equipment necessary to install the reactive wall has been in use in the construction industry for quite some time, but its application to this technology is relatively recent. The biodegradable polymer slurry has been used in drilling water wells. The reactive wall technology is proprietary and a site license is required from an authorized vendor.

Installation of the wall may be impacted by the presence of subsurface barriers, including utilities. A utility clearance would have to be performed during the design phase so that adjustments in the wall location could be made to avoid interfering with underground utilities during installation. Wall installation would also require clearing dense trees and underbrush from a significant amount of land.

Reactive walls are passive systems that require no ongoing energy input. Maintenance requirements are limited to periodic rejuvenation of the upgradient iron/aquifer interface to remove buildup due to biological activity and/or metals precipitation.

Approximately 185 cubic yards of excess soil would require disposal. Since this soil would be removed from below the water table, it may be contaminated with TCE and require disposal as hazardous waste. However, Treatment, Storage, and Disposal Facilities (TSDF) capable of handling this material are readily

available. Compliance with site-specific health and safety procedures during excavation and wall installation would ensure that the exposure of workers to contaminants is minimized.

A minimum amount of investigation-derived waste (IDW), in the form of drill cuttings and development water, would also be generated under this alternative. Both media are potentially contaminated and may require special handling and disposal. However, TSDFs capable of handling this material are readily available.

3.3.4 Cost

The following costs are associated with Alternative 3:

Capital: $624,100
Operation & Maintenance: $50,000 (once every 10 years)
Monitoring: $24,000 to $30,000/year
Present Worth: $973,100

The present worth cost assumes a 30-year duration. Major capital cost components include iron filings and reactive wall installation. For the purpose of developing the capital cost estimate, residual soil generated during wall installation was assumed to be hazardous but acceptable for land disposal.

3.4 ALTERNATIVE 4: GROUNDWATER TREATMENT VIA AIR STRIPPING, SURFACE DISCHARGE

Alternatives 4a and 4b provide for restoring groundwater by extraction and surface treatment in an air stripper. The alternatives differ by the method of discharging the treated groundwater to the surface: 1) the Site W Swale, located south of the centrifuge location, and 2) the Isherwood Road Stream, located on the western edge of Site 46. Common components and alternative-specific details are provided below, as are discussions of effectiveness, implementability, and cost.

Groundwater would be extracted from the aquifer through a pumping well located immediately downgradient of the centrifuge area and treated by an air stripper. One, 6-inch diameter pumping well would be installed to 40 feet below ground surface with a 15-foot well screen. A submersible pump capable of achieving a 5 gpm pumping rate would be installed in the well. Extracted groundwater would be conveyed to the air stripper by 1-inch PVC pipe installed underground. The pipe would be installed inside a 3-inch corrugated plastic pipe to provide secondary containment in the event of a leak.

Air stripping is an aeration process in which VOCs are transferred from an aqueous phase to the gaseous phase. Air stripping is typically used for VOCs with a Henry's Law constant greater than or equal to 3.0 atmosphere-liters per mole (atm-L/mol). The Henry's Law constant for TCE is 8.92 atm-L/mol. Removal efficiencies of VOCs typically exceed 99 percent, depending on the operating parameters and the physical properties of the organic contaminants.

For this application, a porous tray type of air stripper would be used. In this system, water is allowed to flow by gravity from the top of the stripper through a series of trays. The water flows across each tray in a thin layer and comes into contact with numerous air bubbles that are formed by crosscurrent air flow through holes in the tray. The VOCs dissolved in the water are forced into the vapor phase and eventually exit the system at the top of the stripper. As the water flows from tray to tray, the dissolved concentration of VOCs decreases. Treated water is collected in a clearwell at the bottom of the stripper and discharged.

Factors affecting system performance include air-to-water flow ratio, number and size of trays, and operating temperature.

Groundwater samples would be collected quarterly from ten new and existing wells (including wells 46-GW-123 and 46-GW-123D). Samples would be analyzed for TCL VOCs. A site reveiw would be conducted every 5 years, as required under CERCLA.

3.4.1 Alternative 4a: Site W Swale Treatment Unit

Under this alternative, the groundwater would be pumped to the treatment unit that is being designed and installed at the Site W Swale as part of one of the interim measures discussed in Section 1.10. The estimated flow rate of 5 gpm from the source area pumping well would be combined with the estimated flow rate of 10 gpm from the interim measures groundwater collection trench, for a total flow rate of 15 gpm. The combined water streams would be filtered to remove suspended solids prior to treatment by the air stripper. The treated water would be gravity discharged to the culvert passing under Floral Drive and into the Site W Swale Stream.

The need for offgas treatment would be evaluated during the design of the interim measures system. The contribution of TCE from the source area to the off-gas emission is expected to be approximately 0.03 pounds per day. Preliminary conceptual design calculations are provided in Appendix C. This addition is not expected to trigger off-gas treatment requirements for the Site W Swale system, which is expected to be in compliance with exemption from State of Maryland regulations (COMAR 11.15.26.11).

Figure 3-2 shows the layout of the proposed extraction system and treatment plant. Figure 3-3 shows the conceptual design of the treatment system.

The following are recommended data requirements for the design of this removal action alternative:

- Pumping tests to verify groundwater extraction rate.
- Groundwater sampling to verify the TCE levels expected in the treatment system from both the Site 46 source area and Site W Swale area.
- Analysis of groundwater samples to determine oil and grease, total dissolved solids, iron and manganese (total and dissolved), calcium, magnesium, alkalinity, and hardness to evaluate need for pretreatment.

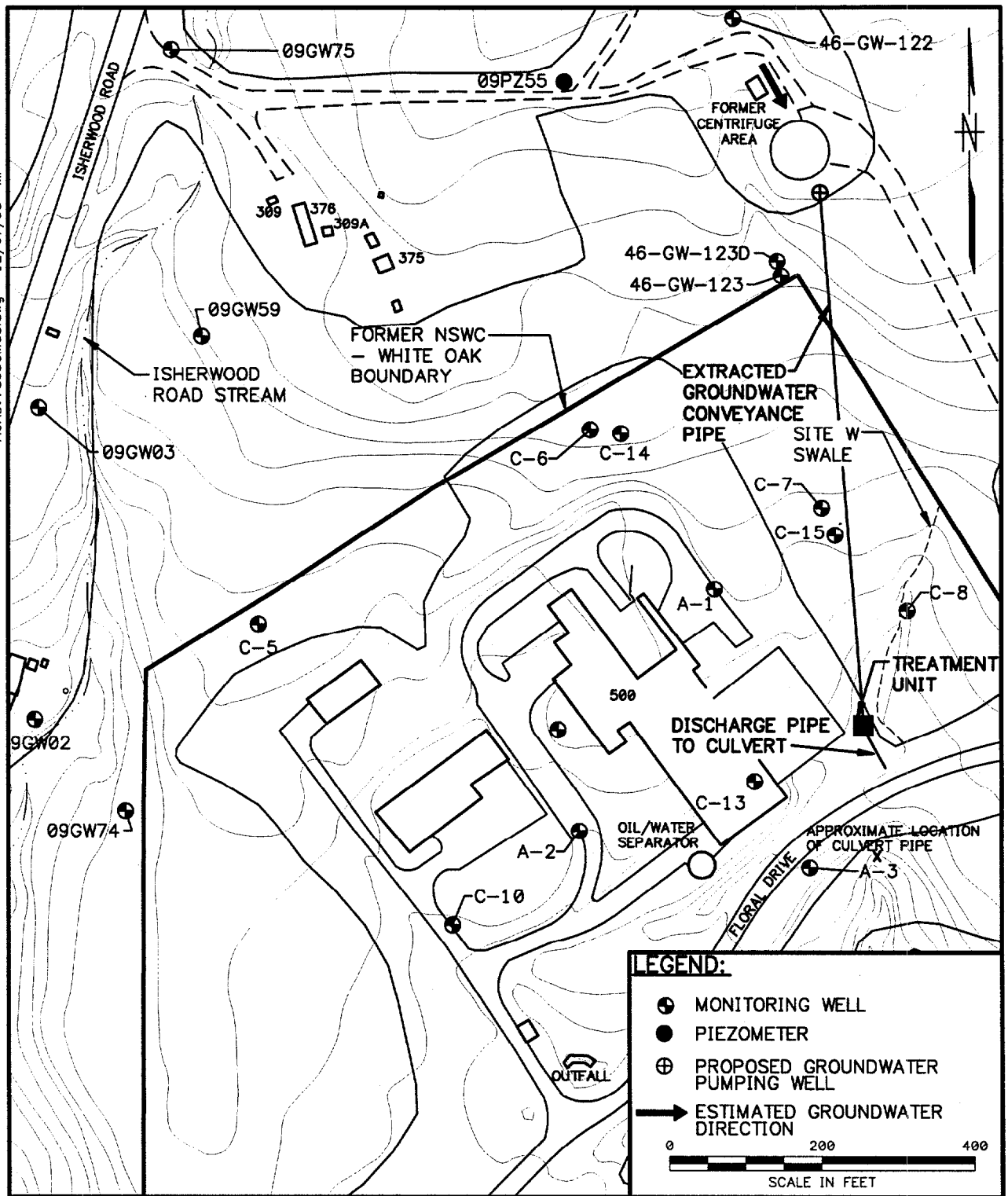
3.4.1.1 Effectiveness

This alternative would effectively reduce TCE concentrations in the source area and eventually achieve MCLs. There are no current shallow groundwater users, and therefore, no receptors are facing an imminent threat due to the contamination. By treating the source area groundwater, this alternative would minimize migration of TCE to downgradient areas and allow TCE concentrations to reduce via natural attenuation. This alternative would effectively meet the removal action objectives until a more comprehensive remedial approach is evaluated for addressing upgradient areas of groundwater contamination. This alternative would comply with ARARs, including surface water discharge standards.

3.4.1.2 Implementability

This alternative is implementable. Equipment and services necessary for system installation and operation are readily available. Selection of this alternative would necessitate that the design of the interim measures treatment system account for the added flow rates and TCE concentrations from the Site 46 source area.

Implementation of this alternative would also require verifying that the hydraulic capacity of the culvert beneath Floral Drive and the Site W Swale Stream would not be exceeded by the additional 5 gpm of flow, especially under storm flow conditions. If capacity is exceeded, this culvert may need to be replaced. Techniques to replace this culvert are readily available and have been in practice for many years in the construction industry. Replacement, however, may slightly increase the administrative difficulty depending on who has jurisdiction over Floral Drive and who would be permitted to perform the construction work, e.g., a Navy contractor versus a city crew or contractor. The system could be installed and operational within approximately 1 month.



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CHECKED BY DATE	ALTERNATIVE 4A: CONCEPTUAL LAYOUT SITE 46 EE/CA NSWC, WHITE OAK, MARYLAND	APPROVED BY SN	DATE 12/9
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 3-2	REV. 0

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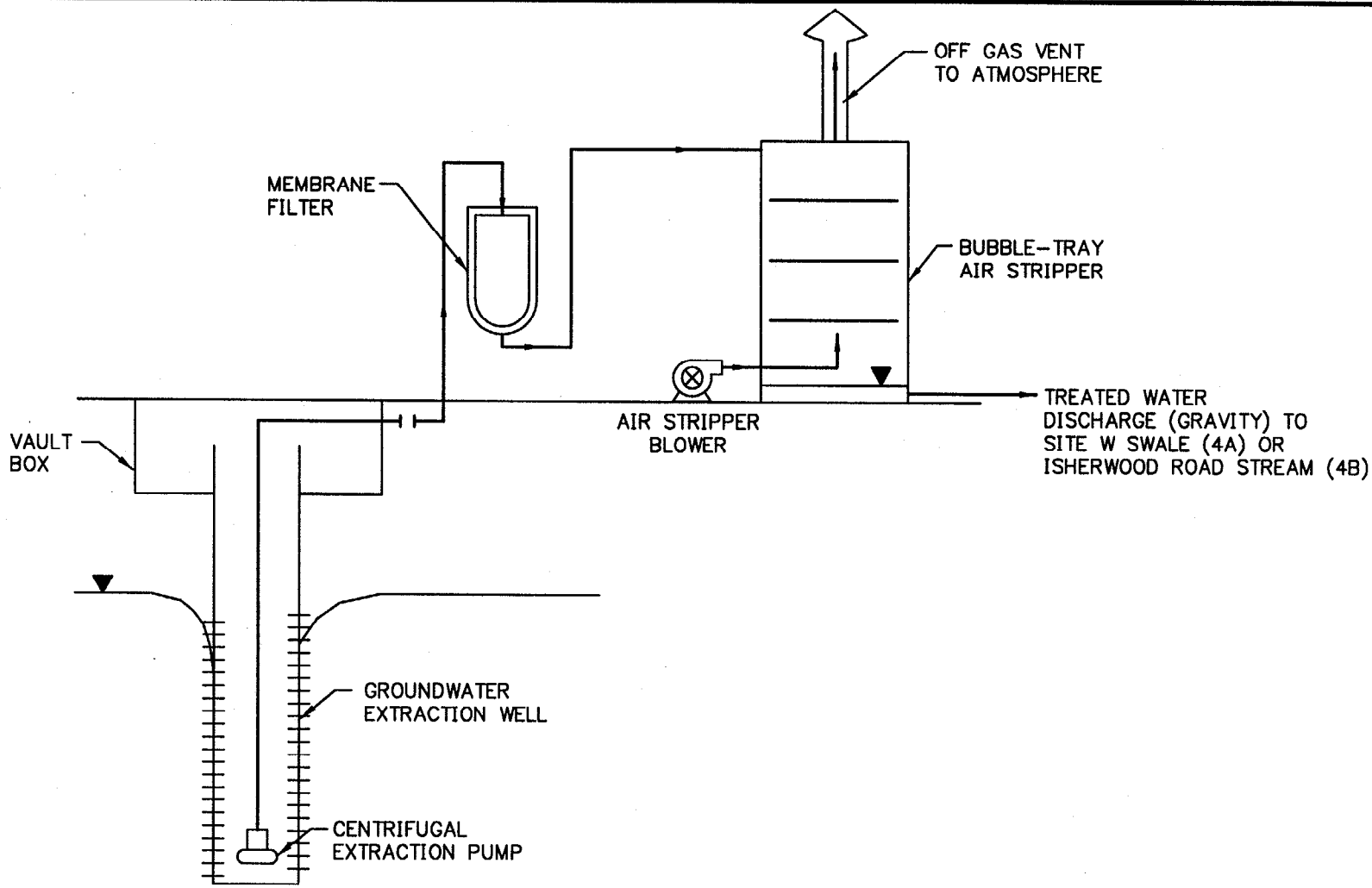

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CHECKED BY DATE	ALTERNATIVE 4: CONCEPTUAL DESIGN OF PUMP AND TREAT SYSTEM NSWC, WHITE OAK, MARYLAND	APPROVED BY SN	DATE 7-2-9
COST/SCHED-AREA		APPROVED BY	DATE
SCALE NOT TO SCALE		DRAWING NO. FIGURE 3-3	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

Typically, operation and maintenance requirements associated with tray type air strippers are minimal. The intense frothing action of the air-water contact scours the plates, which minimizes suspended solids, blockage and metal precipitate residue build up. Currently, only pretreatment by filtration is being proposed to minimize suspended solids blockage and remove a limited amount of oil and grease. However, depending on the concentration of certain dissolved constituents in groundwater, additional pretreatment including chemical addition may be required.

A minimum amount of IDW, in the form of drill cuttings and development water, would be generated under this alternative. Both media are potentially contaminated and may require special handling and disposal. However, TSDFs capable of handling this material are readily available.

3.4.1.3 Cost

The following costs are associated with Alternative 4a:

Capital: $124,000
Operation & Maintenance: $600 to $3,200/year
Monitoring: $24,000 to $30,000/year
Present Worth: $447,600

The present worth cost assumes a 30-year duration. Because extracted groundwater is treated by an existing air stripper unit, capital costs associated with this alternative are limited to installating a well, pump, and groundwater conveyance pipe, plus some minor electrical work to power the submersible pump.

3.4.2 Alternative 4b: Isherwood Road Stream Treatment Unit

Under this alternative, extracted groundwater would be pumped to a new aboveground treatment unit designed to treat groundwater solely from the Site 46 source area. The treatment unit would be installed adjacent to the Isherwood Road Stream, inside a prefabricated building placed on a concrete pad. Electricity would be brought to the building to operate the system and the building would be equipped with appropriate lighting and ventilation. Extracted groundwater would be pumped to the treatment unit and filtered to remove suspended solids. The treated water would be discharged by gravity to the Isherwood Road Stream.

Based on preliminary conceptual design calculations, the system would not require treatment of the offgas. The air stripper would emit approximately 0.03 pounds per day of total VOCs to the atmosphere, a

quantity that is exempt from State of Maryland regulations (COMAR 11.15.26.11). Preliminary conceptual design calculations are provided in Appendix C.

Figure 3-4 shows the layout of the proposed extraction system and treatment plant. The conceptual design of the treatment system is similar to the system proposed under Alternative 4a and illustrated on Figure 3-3.

The following are recommended data requirements for the design of this removal action alternative:

- Pumping tests to verify groundwater extraction rate.
- Groundwater sampling to verify the TCE levels expected in the treatment system from both the site 46 source area.
- Analysis of groundwater samples to determine oil and grease, total dissolved solids, iron and manganese (total and dissolved), calcium, magnesium, aqlkalinity, and hardness to evaluate need for pretreatment.

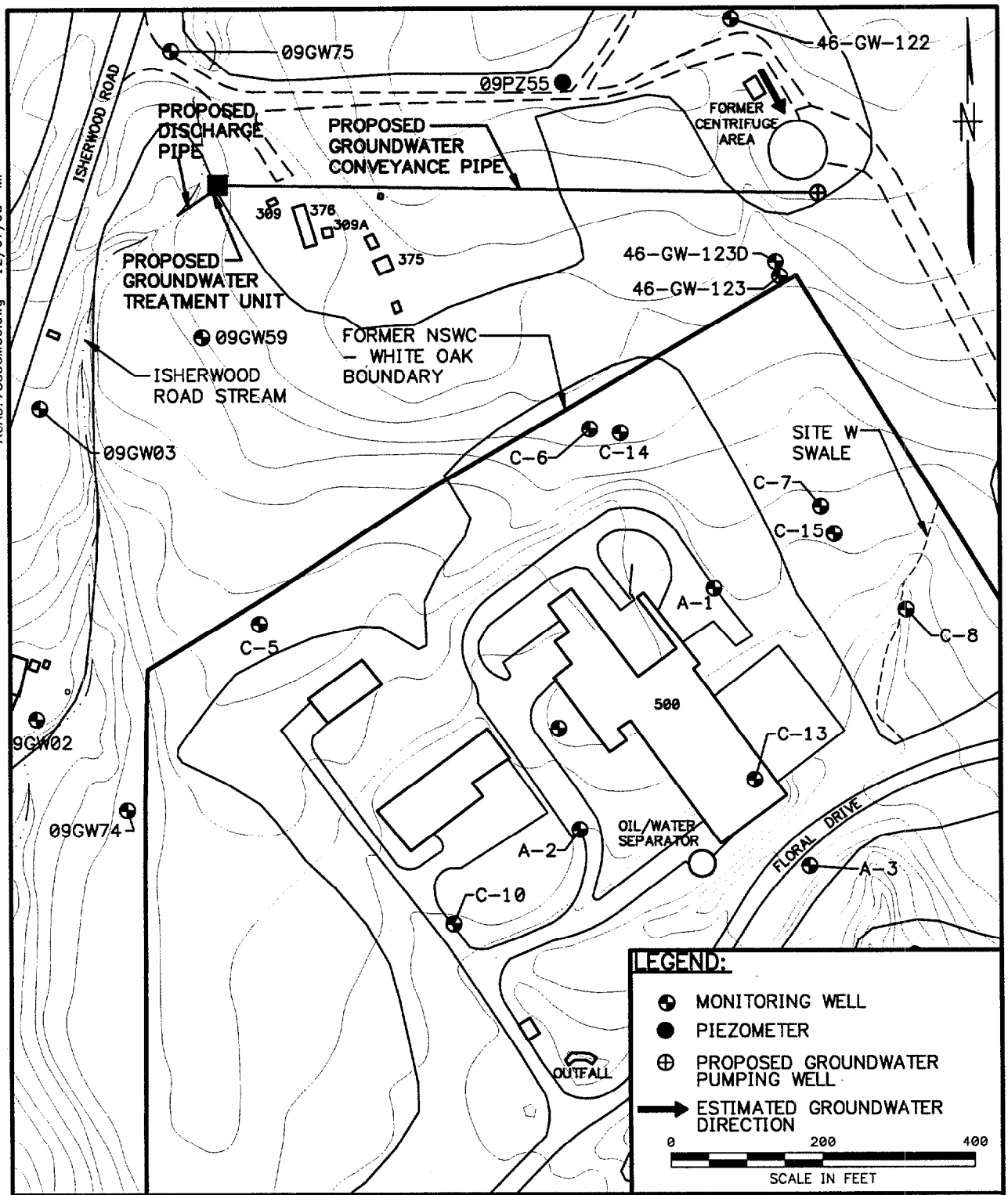
3.4.2.1 Effectiveness

This alternative would be effective in reducing TCE concentrations in the source area to eventually achieve MCLs. There are no current shallow groundwater users, and therefore, no receptors are facing an imminent threat due to the contamination. By treating the source area groundwater, this alternative would minimize migration of TCE to downgradient areas and allow TCE concentrations to reduce through natural attenuation. This alternative would effectively meet the removal action objective until a more comprehensive remedial approach is identified to address upgradient areas of groundwater contamination. This alternative would comply with ARARs, including surface water discharge standards.

3.4.2.2 Implementability

This alternative is implementable. Equipment and services necessary for system installation are readily available. The system could be installed and operational within approximately 1 month.

Typically, operation and maintenance requirements associated with tray type air strippers are minimal. The intense frothing action of the air-water contact scours the plates, which minimizes suspended solids blockage and metal precipitate and biological residue build up. Currently, only pretreatment by filtration is being proposed to minimize suspended solids blockage and remove a limited amount of oil and grease. However, depending on the concentration of certain dissolved constituents in groundwater, additional pretreatment including chemical addition may be required.



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CHECKED BY DATE	ALTERNATIVE 4B: CONCEPTUAL LAYOUT SITE 46 EE/CA NSWC, WHITE OAK, MARYLAND	APPROVED BY SN DATE 12/9	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 3-4	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

A minimum amount of IDW, in the form of drill cuttings and development water, would be generated under this alternative. Both media are potentially contaminated and may require special handling and disposal. However, TSDFs capable of handling this material are readily available.

3.4.2.3 Cost

The following costs are associated with Alternative 4b:

Capital: $180,700
Operation & Maintenance: $19,700/year
Monitoring: $24,000 to $30,000/year
Present Worth: $735,800

The present worth cost assumes a 30-year duration. Major capital cost components include well installation and treatment system equipment procurement and installation, including the treatment building and electrical components.

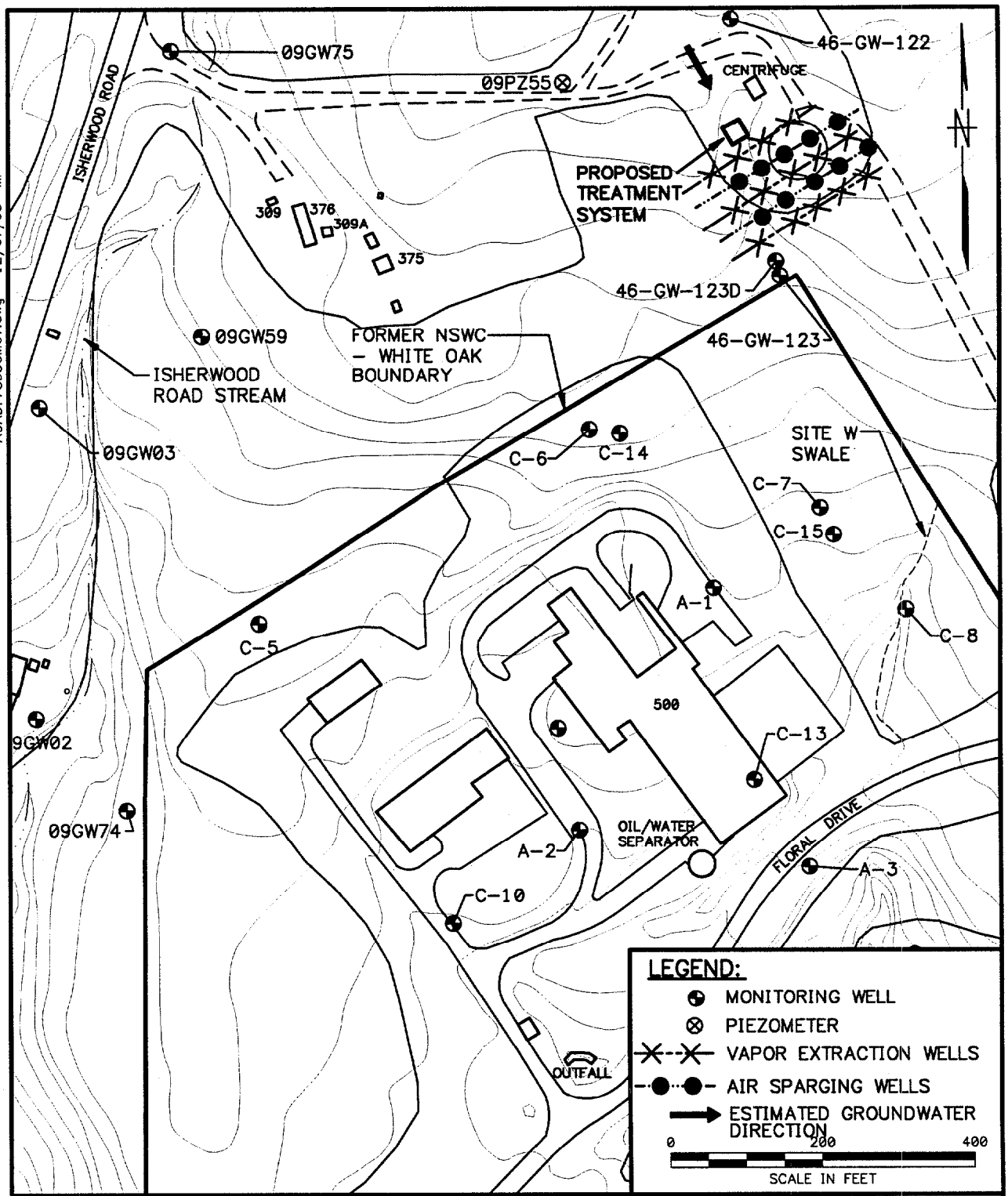
3.5 ALTERNATIVE 5: AIR SPARGING/SOIL VAPOR EXTRACTION

In this alternative, TCE in both groundwater and the source area soil would be addressed by an air sparging (AS)/soil vapor extraction (SVE) system.

3.5.1 Description

Primary components of the treatment system are air injection and vapor extraction wells, an air injection blower, a vapor extraction blower, heat exchangers, and a moisture separator. A granular activated carbon (GAC) unit could also be necessary for off-gas treatment. For purposes of the conceptual design presented here, it has been assumed that off-gas treatment would not be necessary. However, if this alternative is selected, the need for off-gas treatment would require further evaluation based on results of pilot-scale study during the design stage.

Injection and extraction wells would be installed in the source area groundwater, as shown on Figure 3-5. The proposed layout includes areas of high TCE concentrations in groundwater, based on analytical results. Existing groundwater monitoring wells would be used to monitor the effectiveness of the system.



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DRAWN BY DLT DATE 7/8/98	Tetra Tech NUS, Inc.	CONTRACT NO. 7855	OWNER NO. 0300
CHECKED BY DATE	ALTERNATIVE 5: CONCEPTUAL LAYOUT SITE 46 EE/CA NSWC, WHITE OAK, MARYLAND	APPROVED BY SN	DATE 12/4
COST/SCHED-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 3-5	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

AS/SVE is an in-situ process that removes VOCs from groundwater by distributing air as a separate phase through the aquifer, causing a transfer of the VOCs from the dissolved phase into the gas phase. The volatilized contaminants in the gas phase are then captured in the unsaturated (vadose) zone (along with other vadose zone VOCs) by the SVE system, and discharged to the atmosphere.

An air injection blower forces air through a series of equally spaced vertical wells that are screened in the aquifer. The air is forced through the screens into the groundwater, and is distributed as bubbles throughout the plume. The bubbles volatilize VOCs as they rise from the bottom of the saturated zone up towards the water table. The volatilized VOCs are then evacuated from the subsurface by vapor extraction wells that are screened within the vadose zone. VOCs already in the gaseous state are also extracted from the vadose zone. Extracted vapor passes through a moisture separator and in-line filter before entering the vacuum extraction blower. The vapor discharge from the blower is either treated or immediately discharged to the atmosphere.

At Site 46, air injection wells would be installed to a depth equivalent to the confining unit, or 40 feet below ground surface. Wells would be 2-inch diameter PVC and have 2-foot well screens. Vapor extraction wells would be installed to within 5 feet of the top of the water table, or 20 feet below ground surface, and have 5-foot well screens. Extraction wells installed within the footprint of the centrifuge would have 10-foot well screens to ensure capture of vapors from the entire vadose zone underlying the centrifuge. Extraction wells would also be constructed of 2-inch PVC. Wells would be equipped with valves and pressure regulators to allow manual adjustment of air flow at each well. A 60-foot well spacing, or a 30-foot radius of influence, has been assumed.

Based on previous experience with similar systems, the air injection blower is estimated to generate a 5 cubic feet per minute flow rate in each well and to operate at a pressure of approximately 7 pounds per square inch at each well head. The vapor extraction blower should extract vapor at 1.5 times the air injection rate to ensure complete capture of injected air. Typical vacuum would be 5 inches of mercury. Because water can damage the equipment, a moisture separator would be installed prior to the vacuum extraction blower to "knock out" water vapor in the extracted air stream. A moisture separation system would consist of one knock out drum with a capacity of approximately 50 gallons. The air injection blower would be configured to automatically shut down in the event of an extraction blower failure. Both blowers would be wired to automatically shut down in the event the moisture separator becomes full. A typical equipment building layout is shown on Figure 3-6.

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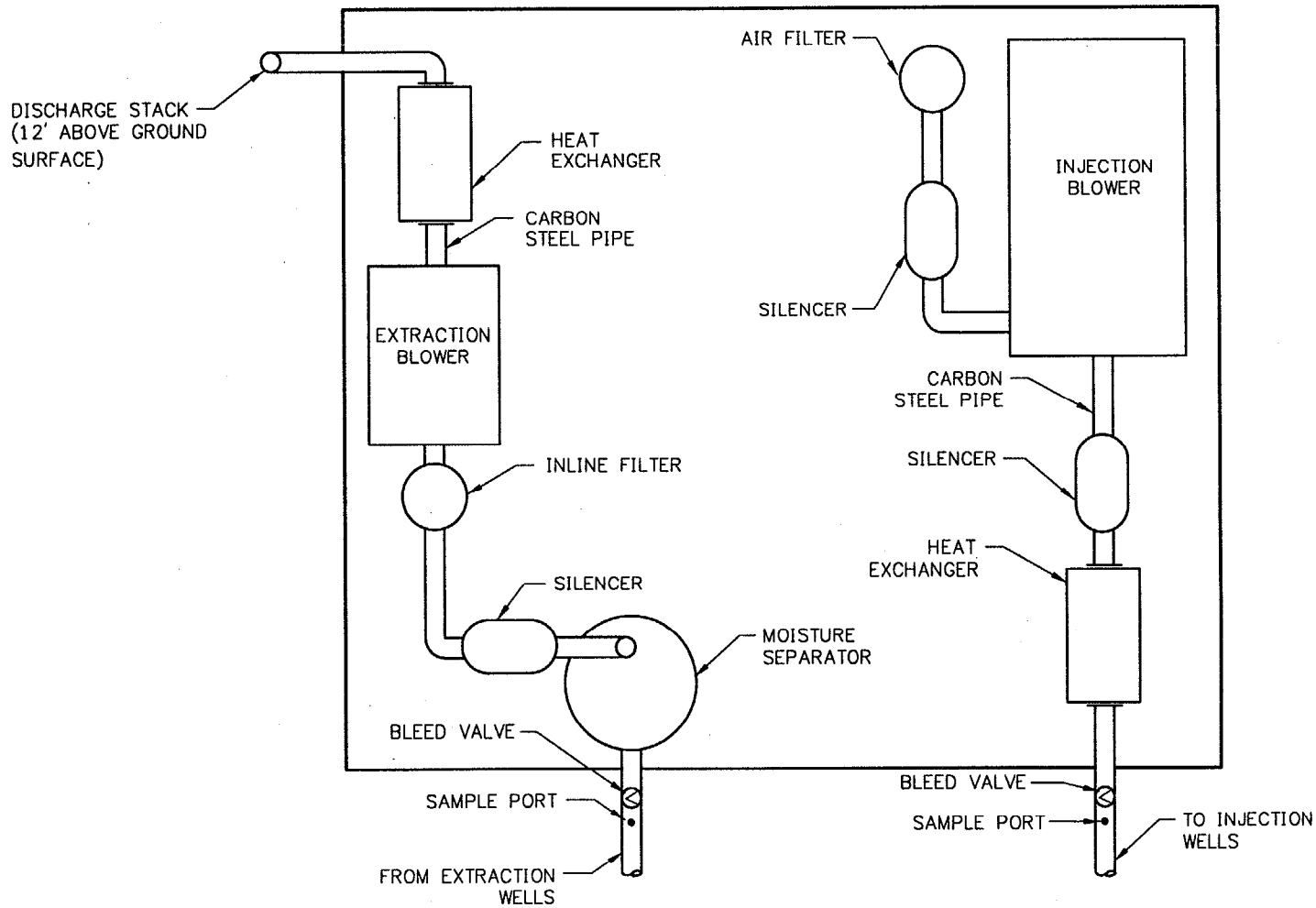

DRAWN BY DLT DATE 7/8/98	Tetra Tech NUS, Inc.	CONTRACT NO. 7855	OWNER NO. 0300
CHECKED BY DATE	ALTERNATIVE 5: AS/SVE SYSTEM TYPICAL EQUIPMENT BUILDING LAYOUT SITE 46 EE/CA NSWC, WHITE OAK, MARYLAND	APPROVED BY SN	DATE 12/4
COST/SCHED-AREA		APPROVED BY	DATE
SCALE NOT TO SCALE		DRAWING NO. FIGURE 3-6	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

The outlet of both blowers would be equipped with a heat exchanger to sufficiently reduce the discharge air temperature to prevent damage to the PVC transfer piping. System components would be installed inside a prefabricated equipment building placed on a concrete foundation.

A pilot-scale treatability study would be required to determine full-scale system design parameters, including flow rates, pressures, effective radii of influence for the extraction and injection wells, and the need for off-gas treatment.

Groundwater samples would be collected quarterly from 10 existing wells. Samples would be analyzed for TCL VOCs. Extracted vapor samples would also be collected to monitor removal effectiveness and verify compliance with air emissions standards. One sample would be collected quarterly. A site review would be conducted every 5 years, as required under CERCLA.

3.5.2 Effectiveness

This alternative complies with ARARs and would be capable of restoring groundwater. This alternative would effectively meet the removal action objective until a more comprehensive remedial approach is identified to address upgradient areas of groundwater contamination.

This technology is potentially very effective for removing TCE from Site 46 groundwater. This technology has been demonstrated to be successful in rapidly removing VOCs from the subsurface. However, removal of a quantity of VOCs sufficient to reduce concentrations to below MCLs is not likely. Of additional concern is the ability of the technology to uniformly to treat the entire saturated thickness of the aquifer.

This technology can be used to remove VOCs from both the saturated zone and the vadose zone, assuming there is adequate soil permeability to allow air flow. Typically, the permeability of the vadose zone and saturated zone are critical for successfully implementing this technology.

3.5.3 Implementability

Components of this technology (wells, blowers, vacuum pumps, etc.) are common in the remediation industry. Contractors and consultants are available to design, install, and operate the system. The operation would not be labor intensive and maintenance requirements would be limited to those of commonly used rotating equipment. Off-gas treatment, if necessary, would slightly increase system complexity.

Installation of wells would generate IDW in the form of soil cuttings and well development water. Both media are potentially contaminated and may require special handling and disposal. However, TSDFs capable of handling this material are readily available.

The majority of the piping would be installed underground to minimize the effects of weather on system operation. However, piping to wells installed within the centrifuge basin would be aboveground. Water vapor could condense in the pipes and freeze during the winter months, partially or completely blocking air flow and increasing system maintenance. Therefore, the addition of insulation around above ground pipes is proposed to minimize water vapor condensation and consequent freezing.

The time required to have a full-scale system operational is approximately 6 to 8 months. This includes pilot-scale system design, implementation, results evaluation, and then design and implementation of the full-scale system.

3.5.4 Cost

The following costs are associated with Alternative 5:

Capital: $234,400
Operation & Maintenance: $26,500/year
Monitoring: $25,000 to $31,000/year
Present Worth: $886,700

The present worth cost assumes a 30-year duration. Major capital cost components include well installation, IDW handling and disposal, and treatment system equipment procurement and installation.

4.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section compares the removal action alternatives identified in Section 3.0 as:

- Alternative 1: No Action
- Alternative 2: Minimal Action, Natural Attenuation
- Alternative 3: Reactive Groundwater Treatment Wall
- Alternative 4a: Groundwater Treatment via Air Stripping, Surface Discharge – Site W Swale Treatment Unit
- Alternative 4b: Groundwater Treatment via Air Stripping, Surface Discharge – Isherwood Road Stream Treatment Unit
- Alternative 5: Air Sparging/Soil Vapor Extraction

These alternatives will be compared to each other using the criteria identified in Section 3.0. The purpose of the comparative analysis is to identify the key advantages and disadvantages of each alternative relative to one another so tradeoffs that would affect remedy selection can be identified. The following discussion is summarized in Table 4-1.

4.1 EFFECTIVENESS

Alternative 1 would not be effective in restoring the groundwater and achieving the removal action objective. All of the action-oriented alternatives would be effective at restoring groundwater at Site 46; however, groundwater restoration would occur at different rates and many of the alternatives have uncertainties associated with their effectiveness because of the presence of other known and potential upgradient sources of TCE.

Alternative 2 would allow natural processes to degrade the TCE over time. However, the historic data available are insufficient to conclusively state that natural attenuation is occurring at Site 46 and is an effective means of restoring groundwater.

The reactive groundwater treatment wall proposed under Alternative 3 is capable of reducing TCE concentrations to below MCLs and achieving the removal action objective. However, further evaluation is necessary to verify the minimum wall thickness to completely degrade TCE to ethene and ethane. Incomplete degradation of TCE may result in increased concentrations of cis-1,2-DCE and vinyl chloride in groundwater.

TABLE 4-1

SUMMARY COMPARISON OF REMOVAL ACTION ALTERNATIVES
SITE 46 EE/CA
NSWC WHITE OAK, MARYLAND

No.	Alternative	Effectiveness	Implementability	Compliance with ARARs?	Offsite Treatment/ Disposal Required?
1	No Action	Low	High	No	No
2	Minimal Action, Natural Attenuation	Low	High	Yes	Yes
3	Reactive Groundwater Treatment Wall	Moderate	Moderate	Yes	Yes
4a	Groundwater Treatment via Air Stripping, Site W Swale Treatment Unit	High	High	Yes	Yes
4b	Groundwater Treatment via Air Stripping, Isherwood Road Stream Treatment Unit	High	High	Yes	Yes
5	Air Sparging/Soil Vapor Extraction	Moderate	Moderate	Yes	Yes

Air stripping is a proven method for removing volatile contamination from groundwater. Alternatives 4a and 4b would be equally effective at Site 46 and there are few uncertainties associated with their effectiveness.

The AS/SVE system proposed in Alternative 5 is capable of removing significant quantities of TCE from the groundwater; but may not reduce concentrations to below MCLs. A pilot-scale study is necessary to evaluate system effectiveness based on site conditions.

4.2 IMPLEMENTABILITY

Of the six alternatives, Alternative 1 is the most easily implemented because no removal action would be taken, so no difficulties or uncertainties are associated with implementation.

Alternatives 3, 4a, 4b, and 5 would generate IDW due to the installation of wells. Alternative 3 would generate approximately 278 cubic yards of potentially contaminated soil due to the replacement of soil with iron filings.

Of the groundwater restoration methodologies presented, Alternative 4a, groundwater extraction and treatment by the air stripper to be installed at the Site W Swale, is the most easily implemented. The use of an existing treatment unit reduces the work involved in implementing this alternative to installing a groundwater extraction well and conveyance piping.

Alternative 5 requires designing and implementating a pilot-scale treatability study to determine full-scale system operating parameters. This pilot-scale study slightly increases the complexity of the alternative and lengthens the amount of time involved until a full-scale system is operational. Implementation of Alternative 5 requires a significantly greater amount of time than the other alternatives, 6 to 8 months versus 1 to 2 months.

4.3 COST

The following summarizes the costs associated with each alternative:

Alternative	Capital	Operation & Maintenance (per year)	Monitoring (per year)	Present Worth
1	$0	$0	$0	$0
2	$177,100	$0	$33,000-$39,000	$599,500
3	$624,100	$50,000[1]	$24,000-$30,000	$973,100
4a	$124,000	$600-$3,200	$24,000-$30,000	$447,600
4b	$180,700	$19,700	$24,000-$30,000	$735,800
5	$234,400	$26,500	$25,000-$31,000	$886,700

1 Cost incurred once every 10 years.

5.0 RECOMMENDED REMOVAL ACTION

This section presents the recommended removal action alternative to restore contaminated groundwater at Site 46. For the purpose of meeting the requirements of the removal action, the alternative that offers the best balance of effectiveness and implementability in a cost effective manner is preferred.

Alternative 4a is the recommended removal action for Site 46. It most effectively meets the removal action objective of groundwater restoration, complies with ARARs, and does not have any significant implementability concerns. Alternative 4a offers the most effective method for restoring groundwater at Site 46.

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APPENDIX A

SUPPLEMENTAL CENTRIFUGE AREA INVESTIGATION

CENTRIFUGE AREA INVESTIGATION
October/November 1998

The centrifuge area investigation involved three major elements: soil gas surveys in the centrifuge and in the adjacent swales, the collection/analysis of soil samples, and the installation/sampling of three monitoring wells. The field effort is summarized in Table 1. These efforts are described below.

Soil Gas Survey

Centrifuge: The sample spacing pattern proposed in the work plan (a grid with 20 foot centers) was modified due to information provided in centrifuge construction drawings acquired after the work plan had been completed and on site conditions. The centrifuge consists of a depression, formed by a circular retaining wall (radius 40 feet). The centrifuge spindle is set on a concrete foundation (radius: 22.5 feet, thickness: 5 feet). The area between the edge of the spindle concrete foundation and the retaining wall is covered with asphalt and is sloped inward to a drainage swale formed in the asphalt immediately outside the concrete foundation. The drainage swale (radius 30 feet) carries all storm water to a drain located on the western side of the facility. Field investigators determined that it would be infeasible (and probably pointless) to drill the five-foot thick concrete. A "compass face" sampling pattern was established instead, with points collected from the lowlying swale area (where any past liquid releases would be expected to migrate to/accumulate) at the eight primary compass directions.

A jackhammer was used to penetrate the asphalt-covered drainage swale. Asphalt thickness ranged from 1 to 4 inches thick. Next, a 1-inch diameter steel rod was driven into the ground 12 to 24 inches. The rod was removed and plastic sheeting was placed over the hole. A photoionization detector (PID) with a 10.6 eV lamp probe tip was used to penetrate the plastic and was inserted into hole. The concentration of the VOCs was then measured.

Ten holes were holes were drilled. In addition to sample pattern circling the centrifuge, soil vapor samples were also taken from four separate cracks in the asphalt and beside the drain. Low level VOC readings were obtained from two of the sample points; 15.4 ppm at the northeast sample point and 2 ppm at the eastern sample point. Sample locations and results are shown on Figure 1.

Drainage Swales: Following the centrifuge investigation, the drainage swales surrounding the centrifuge were investigated. Three samples were collected from the swale east of the centrifuge (Swale 2); Swale point 2-1 had a VOC reading of 18.5 ppm. Swale points 2-2 and 2-3 were non-detect. Sample locations and results are shown on Figure 1.

The headwall area within the swale where the drain from the centrifuge floor discharges water (Swale 1) was also investigated. Soil vapor samples were obtained from soil gas

borings placed around the headwall until no further vapor readings were detected in an effort to determine the area of possible contamination. Soil gas locations were determined by gridding the area, using a 50-foot long rope and tape measure. The axis of the grid is roughly coincident with the centerline of the western swale.

A second headwall was located during the field effort. Because it is mostly covered with soil and leaves, the second headwall is not readily visible. The position of this headwall suggests that it is connected to the floordrain in one of the buildings, although this is unconfirmed. The location is shown on Figure 2.

An area of elevated soil gas readings centered around the two outfalls was identified in the survey. Table 2 summarizes the soil gas sampling results. Sample locations and results are also shown on Figure 2.

Soil Sampling

Soil samples were collected from several locations, based on the results of the soil gas survey. In the centrifuge, samples were collected from the two locations where soil gas VOCs had been detected. One soil sample was collected from the eastern soil gas sample point that had an elevated PID reading. Four samples were collected from the northeastern soil gas sampling point that had an elevated PID reading. Samples were collected using hand auger techniques; borings were advanced to the point where resistance was encountered (in both cases, tightly packed gravel prevented advancement of the boring). All samples collected from the borings had fractions measured for headspace VOCs. One sample collected from the northeastern boring (depth of 18-24 inches) of the centrifuge had headspace VOCs; all of the soil samples collected from this boring had a petroleum odor.

In addition to the samples described above, one sediment sample was collected from the centrifuge sump. Because of site access concerns, a garden hoe was attached to a pole and lowered to the bottom of the sump (about 10 feet below the bottom of the centrifuge). The sample was collected from the accumulated sediment scraped from the bottom of the sump with the hoe.

Two soil samples were collected outside of the centrifuge, from monitoring well borings. At well boring 46GW130, a soil sample was collected for analysis from a depth of 1.5 to 2.0 feet, based on elevated PID readings. At well 46GW132, elevated concentrations of VOCs (greater than 1000 ppm) were observed in the soil removed from the boring during the drilling of this well. As a result, a second soil boring was drilled immediately adjacent to the well and a soil sample was collected from the same depth interval where the highest PID readings were recorded in the monitoring well boring (46 GW 132 30.5-31.0).

There were only a few trace detections of VOCs in the soil samples. None of the results indicated that the soils are currently acting as a significant source of contamination to

groundwater. Table 3 lists the samples that were collected; Table 4 presents a summary of the analytical results (positive detections only).

Monitoring Well Installation

Three monitoring wells were installed as part of this effort. Although two of these wells (46 GW 131 and 46 GW 132) were originally planned as temporary wells, they were later converted to permanent wells with flush-mount surface completions. These wells are discussed below. Borings were advanced using hollow stem augers. All wells were constructed of 2" diameter PVC pipe with ten-foot long, 0.01-inch slot, PVC screens. Boring logs and well construction diagrams for these three wells are included in Attachment A.

One monitoring well (46 GW 130) was installed in the vicinity of the second headwall. This well was designed to assess contributions to groundwater contamination from a source or sources upgradient of the first head wall, but downgradient of the second headwall. As previously described, a soil sample was collected from a depth of 1.5-2.0 ft below grade, based on elevated PID readings. During the drilling of this well, "perched" water was observed above a small silt-clay lens; water was observed from 17.5 to 19.0 feet below grade. Field personnel collected a sample of this water and submitted the sample for analysis (46 GW 130P). After this sample was collected, drilling difficulties were encountered and the boring was abandoned. The drill rig offset seven feet south and the boring was redrilled to a depth of 26 feet, where refusal was again encountered. The well was set with a screened interval of 16 to 26 below grade.

Well 46 GW 131 was installed as a temporary well, but later completed as a permanent well. This well was located on the shoulder of the centrifuge between the centrifuge drain and the headwall, and was installed to assess contamination that might have originated from the drain.

Well 46 GW 132 was installed as a temporary well, but later completed as a permanent well. This well was located east of the centrifuge on the shoulder, and was installed to assess contamination on the east side of the centrifuge. As previously described, significant concentrations of VOCs (greater than 1000 ppm) were observed in the soil removed from the boring during the drilling of this well. As a result, a soil boring was located immediately adjacent to the well and a soil sample was collected (46 GW 132 30.5-31.0). Well locations are shown in Figure 1. Well construction details are summarized in Table 5.

After installation, the wells were developed and sampled. Samples were analyzed for volatile organics. Table 6 provides a summary of the analytical results (positive detections only).

As indicated in Table 6, all of the wells contained significant levels of VOCs, however the contaminants differed from well to well. In wells 46GW130 and 46GW131, chlorinated hydrocarbons were primarily found, with cis-1,2-dichloroethene (cis-1,2-

DCE) the primary contaminant detected in 46GW130 (344 ug/L) and trichloroethene (TCE) the primary contaminant found in 46GW131 (305 ug/L). Cis-1,2-DCE is a common breakdown product of the anaerobic degradation of TCE, thus it is possible that the two wells may be impacted by a common source despite the difference in chemical signatures. The perched water sample from 46GW130 had only a few trace-level detections. Well 46GW132 was primarily impacted by BTEX-type compounds, with toluene, benzene, and xylenes (437, 424, and 374 ug/L, respectively) all present at concentrations greater than 100 ug/L.

Figure 3 shows the approximate distribution of TCE in groundwater in the centrifuge area, using data from both this investigation and the earlier-completed site investigation. As is evident on the figure, the highest TCE detections are concentrated south and southwest of the centrifuge, in the vicinity of headwall No. 1 and the drain line. It should be noted that relatively high levels of BTEX compounds in well 46GW132 and cis-1,2-DCE in 46GW130 are not indicated on this figure, but should be considered in any remedial design effort.

Discussion

All sample results (positive detections only) are summarized in Tables 4 and 6. Attachment B contains the complete analytical results. Based on the soil gas survey and soil sampling results within the centrifuge, there does not appear to be a significant continuing source of contamination to groundwater in the soils beneath the centrifuge. PID readings were low to nondetect, and the soil samples collected had no significant contamination.

Some localized subsurface petroleum hydrocarbon contamination around the northeastern area of the centrifuge is indicated by the analytical results from well 46GW132 and the petroleum hydrocarbon odor noticed in the soil samples collected from the northeastern area of the centrifuge. This contamination is likely related to an underground fuel storage tank formerly located near the north-northeastern edge of the centrifuge. In general, groundwater samples collected during the Site 46 SI had trace to nondetect levels of BTEX compounds, suggesting that the centrifuge area BTEX contamination is localized.

West and southwest of the centrifuge, groundwater is impacted by chlorinated organics. The pattern of high-concentration detections of chlorinated organics in this area suggests that the centrifuge basin drain line and the outfalls located in the nearby swale are likely sources for this contamination, as the high-concentration detections in groundwater are primarily adjacent to and/or immediately downgradient of these features. Given that no wastes have been stored at the centrifuge for a number of years, the exposure of the drains/outfalls to precipitation has likely flushed most of any residual contamination from these structures, thus it does not appear that these drain lines/outfalls are continuing sources of contamination.

Table 1
Field Tasks Summary
Centrifuge Area Investigation

Task	Quantity	Purpose
Soil Gas Study	47 samples	Assess VOC contamination in soil around centrifuge and in the floor of the centrifuge
Soil Sampling	6 samples	Assess soil contamination in areas of observed VOC contamination
Monitoring Well Installation and Sampling	3 wells and 4 samples	Assess groundwater contamination at 3 locations

Table 2
Soil Gas Sampling Results
Centrifuge Area Investigation

Location			
Northing (feet)	Easting (feet)	Concentration (ppm by PID)	Comment
Swale 1			
7.5	-4.5	ND	
8	6.5	Not measured	46 GW 123
30	8	Not measured	46 GW 123D
35	-23.83	1.7	
62	-41	ND	
64.5	-15.92	45.4	
60	0	0.9	
70	34.83	ND	
77.67	1.25	ND	
92	1	ND	
94	14.83	ND	
83	26.13	55.2	
93	18.42	Not measured	Headwall1
96	15.92	Not measured	Headwall1
96	30.25	29.5	
103	0	112	
109	3.5	48.2	Headwall2
109	8.33	7.1	
96	18.67	17	
115	6.33	55.8	
121	12.25	20.1	
121	21.25	ND	
97	14.08	159	
132	6.25	14.1	
142	0	ND	
146	7.42	ND	
104	2.5	30.8	
100	-13.33	69.2	
100	-41.75	0.2	
116	-1	134	
130	-2	13.2	
133	-15.17	ND	
Swale 2			
0	0	18.5	SG 2-1
10	0	ND	SG 2-2
-10	0	ND	SG 2-3

Centrifuge	***(locations by compass face)***	
N	ND	
NNE	ND	
NE	15.4	Petroleum Odor
ENE	ND	

Location			
Northing (feet)	Easting (feet)	Concentration (ppm by PID)	Comment
E		2.0	Petroleum Odor
Crack #1		ND	
ESE		ND	
SE		ND	
Crack #2		ND	
S		ND	
Crack #3		ND	
S of Drain		ND	
N of Drain		ND	
W		ND	
Crack #4		ND	
NW		ND	

Notes:

1. Swale 1 locations are based a taped coordinate system, which originated at a fence south of the centrifuge and had as its axis the centerline of the swale. Monitoring wells and headwalls provide reference points.

2. Swale 2 locations are all on the axis of the swale. Sample 2-1 is located by a small foot bridge, east of monitoring well 46 GW 132.

3. Centrifuge samples are oriented on a compass face as described in the text.

4. Volatile organic compound concentrations were measured with a photoionization detector using a 10.6 eV lamp.

5. Measurements were collected during the period from October 26, 1998 to October 31, 1998.

6. ND-Not detected.

Table 3
Sample Summary
Centrifuge Area Investigation

Sample	Date Collected	Medium	Depth (ft below grade)	Rationale
46 GW 130P	110998	Water	17.5-19.0	Water Sample from perched zone
46 GW 130	111798	Water	16-26	Monitoring Well; MS/MSD
46 GW 999	111798	Water	16-26	Duplicate of 46 GW 130
46 GW 131	111798	Water	35-45	Monitoring Well
46 GW 132	111698	Water	35-45	Monitoring Well
East Centrifuge	102998	Soil	0-0.5	Elevated Soil Gas Detection
Centrifuge Sump	102998	Soil	Floor of Sump	Analysis of sump contaminants
Northeast Centrifuge	102998	Soil	0-0.5	Elevated Soil Gas Detection
Northeast Centrifuge	102998	Soil	0.5-1.0	Elevated Soil Gas Detection
Northeast Centrifuge	102998	Soil	1.0-1.5	Elevated Soil Gas Detection
Northeast Centrifuge	102998	Soil	1.5-2.0	Elevated Soil Gas Detection
46 GW 130	110998	Soil	1.5-2.0	Elevated Soil Gas Detection
46 GW 132	102998	Soil	30.5-31.0	Elevated PID reading during drilling

Table 4
Summary of Positive Soil Detections
Centrifuge Area Investigation

Sample No.	46GW130	46GW132	E Centrifuge	NE Centrifuge	NE Centrifuge	NE Centrifuge	NE Centrifuge	Centrifuge
Compounds, ug/kg		30.5 - 31 ft	0-0.5 ft	0-0.5 ft	0.5-1.0 ft	1.0-1.5 ft	1.5-2.0 ft	Sump
Methylene Chloride	13 B	13 B	6 JB					
Toluene	2 J							
Trichloroethene								2 J

ug/kg - Micrograms per kilogram

B - Compound found in blank also

E - Estimated result, concentration exceeded calibration range

J - Estimated concentration - below reporting limit

Table 5
Well Details
Centrifuge Area Investigation

Well	Date of Installation	Screened Interval (feet below grade)	Surface Completion
46 GW 130	November 12, 1998	16-26	Protective steel casing
46 GW 131	November 10, 1998	35-45	Flush Mount
46 GW 132	November 12, 1998	35-45	Flush Mount

Table 6
Summary of Positive Groundwater Detections
Centrifuge Area Investigation

Sample No.	46GW 130	46GW130P	46GW131	46GW999	46GW132
Compounds, ug/L				Dup of 46GW131	
1,1 Dichloroethene	1.5		1.4	1.1	
Methylene Chloride	0.4 JB	0.5 JB	0.6 JB	0.3 JB	
Trans-1,2-Dichloroethene	0.3 J		0.2 J	0.2 J	
Acetone		5.6	9.5		
Chloroform		0.8 JB		0.9 JB	0.3 JB
cis-1,2-Dichloroethene	343.9 EB		36.2 E	34.7 E	2.2
1,2-Dichloroethane			1.0 J	0.5 J	
1,1,1-Trichloroethane			0.3 J	0.3 J	
Benzene			0.1 J		424.3 E
Toluene	1.6		0.2 J		437 E
Ethylbenzene	0.2 J				97.1 E
Xylenes	1.2				374.3 E
Trichloroethene		0.4 J	304.6 EB	305.3 EB	28.5 EB
Vinyl Chloride				0.5 J	
1,1,2-Trichloroethane	0.8 J		0.7 J	0.6 J	
Tetrachloroethene	0.3 J		0.3 J	0.3 J	
Chlorobenzene			0.4 J		
1,1,2,2-Tetrachloroethane	17.2		15.2	13.3	0.8 J
1,3-Dichlorobenzene			0.2 J		
1,2-Dichlorobenzene				0.2 J	
1,2-Dibromoethane					10.6

ug/L - Micrograms per liter
B - Compound found in blank also
E - Estimated result, concentration exceeded calibration range
J - Estimated concentration - below reporting limit

FIGURE 1
SOIL GAS SURVEY RESULTS
CENTRIFUGE AREA

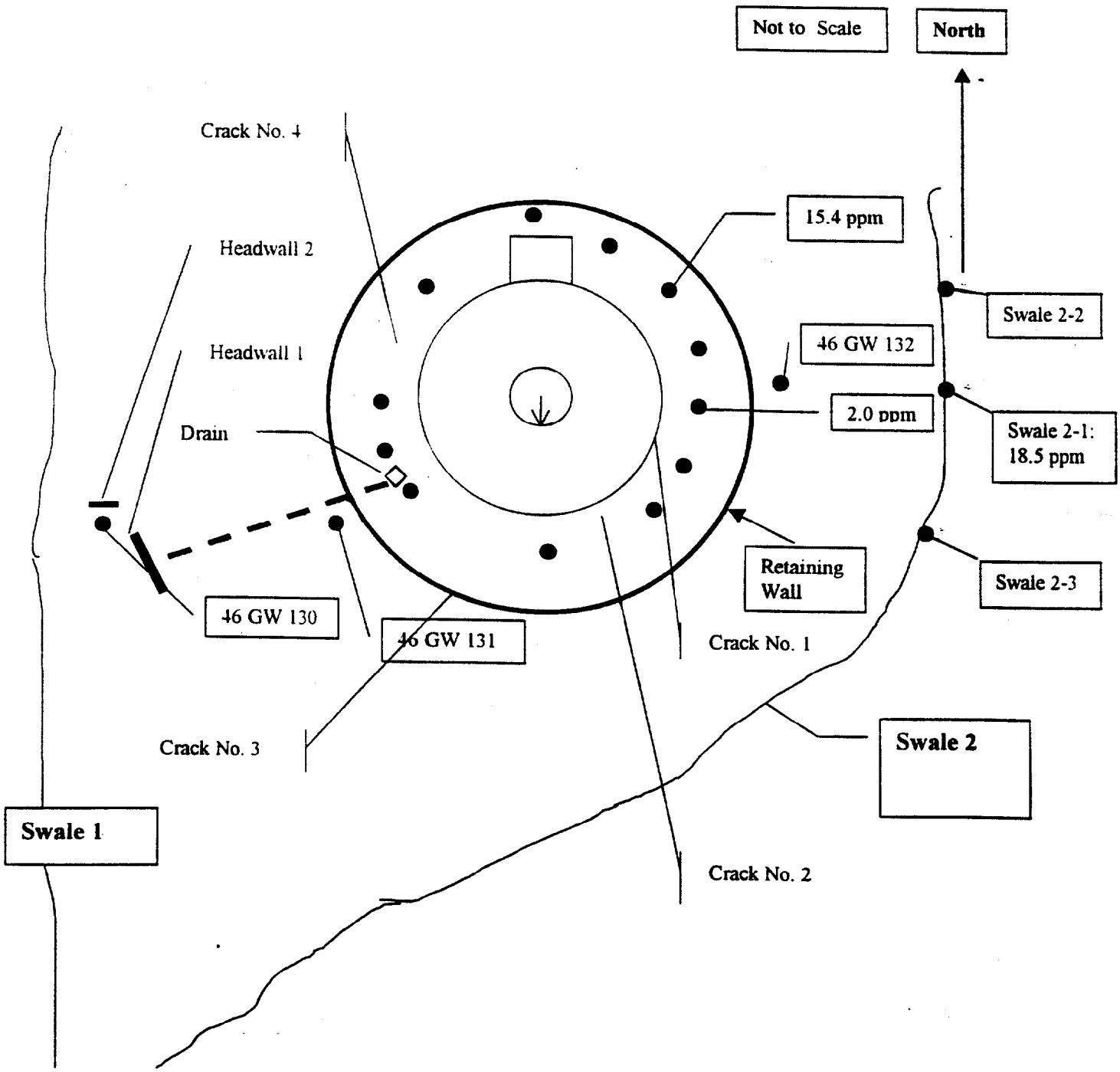
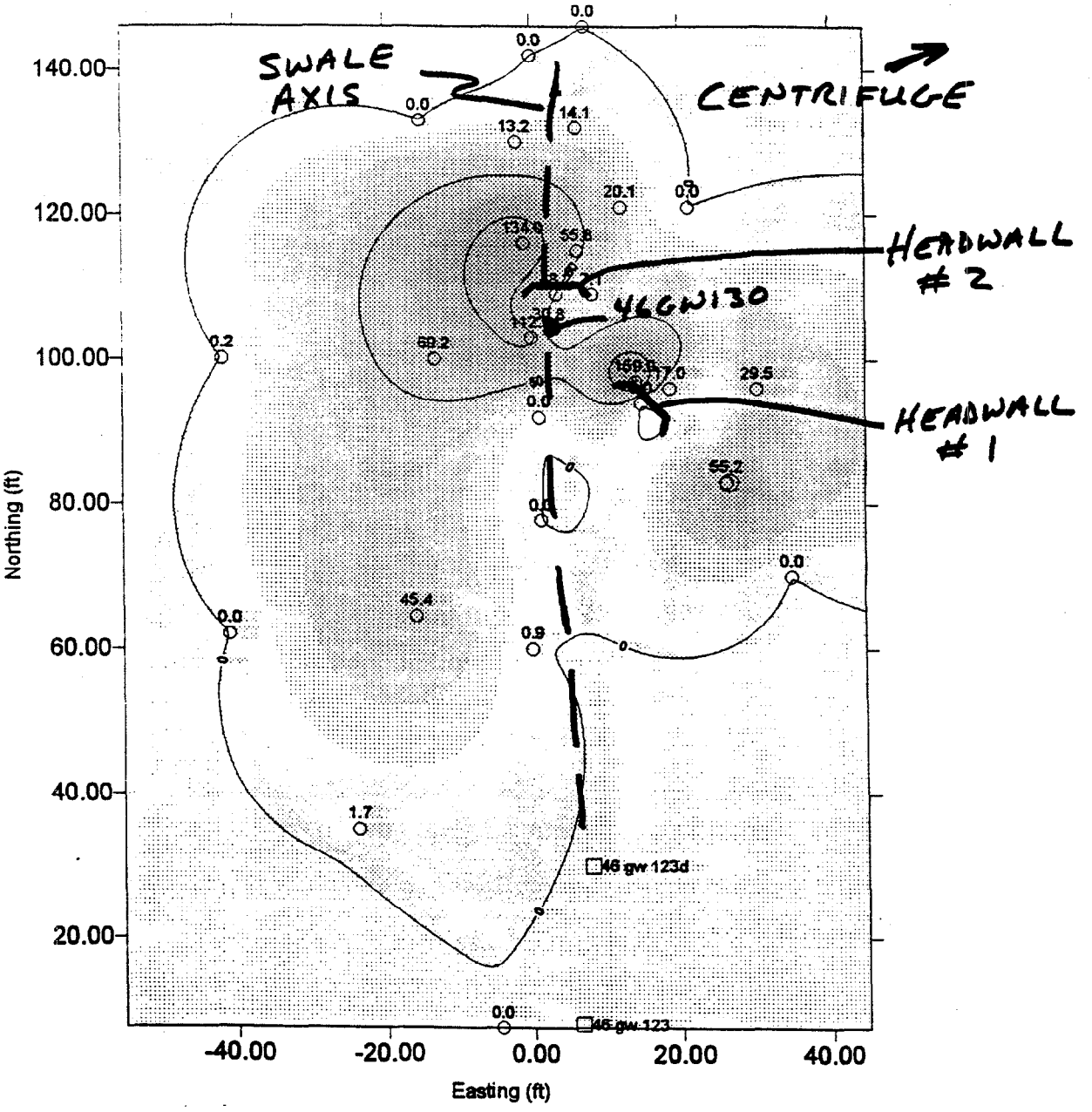
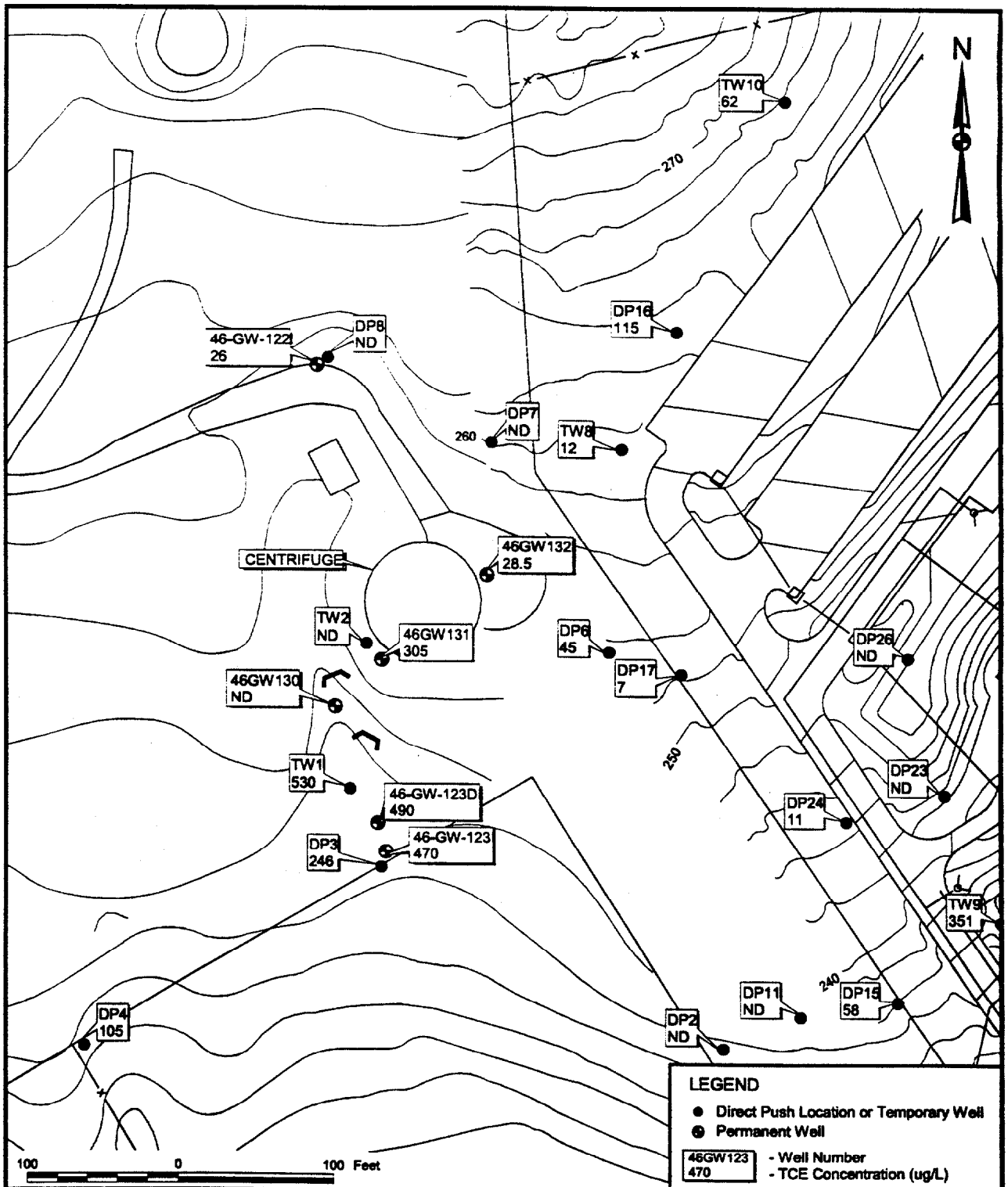


FIGURE 2
SOIL GAS SURVEY RESULTS
SWALE AREA



Soil Gas Concentration (ppm)
[Contour Interval = 5 ppm, Min = (20), Max=130]



DRAWN BY: S. TABLER — DATE: 12/1/99	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 7855	OWNER NO.: —
CHECKED BY: JPO — DATE: —	TCE DISTRIBUTIONS CENTRIFUGE AREA - SITE 46 NSWC, WHITE OAK, MARYLAND	APPROVED BY: — DATE: —	
COST/SCHEDULE-AREA		APPROVED BY: — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 3	REV: 0

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ATTACHMENT A
BORING LOGS/WELL CONSTRUCTION DIAGRAMS

NUS CORPORATION
A Halliburton Company

PROJECT NSWC - WHITE OAK, MD - CENTRIFUGE
PROJECT NO. 7855.0204 BORING 46GW130
ELEVATION TBA DATE 11 OCT 94
FIELD GEOLOGIST KEN COTTRELL

SAMPLE NO. TYPE & DEPTH (ft)	BLOWS/SIX INCHES OR RQD (%)	SAMPLE RECOVERY/ SAMPLE LENGTH (ft)	MATERIAL MOISTURE & WATER DEPTH (ft)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS PID RESPONSE ON SPOON (PPM)
0.0	5/8	1.0/2.0	DRY	MED DENSE	BROWN	FINE TO MED SAND SOME SILT	SM	10-80
	10/8			MED DENSE			↓	
2.0	20/45	1.5/2.0		VERY DENSE		FINE TO COARSE SAND SOME	SW	0
	44/39			↓		GRAVEL		
4.0	10/24	1.7/2.0		DENSE				0
	40/50			VERY DENSE				
6.0	5/24	1.8/2.0		MED DENSE				0
	37/39			VERY DENSE				
8.0	14/35	1.7/2.0			TAN			0
	33/45							
10.0	21/33	1.7/2.0			RED-			0
	46/42				BROWN			
12.0	25/40	1.8/2.0						0
	43/45							
14.0	16/32	1.5/2.0			TAN			0
	30/32		↓	↓				
16.0	20/27	1.5/2.0	WET	DENSE			↓	0
	21/19			↓		GRAVELLY SAND, WITH SOME COBBLES	SW	
18.0	10/18	1.0/2.0		MED DENSE				0
	18/15				GRAY-		↓	
20.0	7/13	1.3/2.0			WHITE	CLAYEY SILT	ML	0
	13/13			↓				
22.0	30/50	1.0/2.0		VERY DENSE				0
	50/X				RED	CLAYEY SILT, SOME SAND		
24.0	50X/X	0.5/2.0	↓	↓		COBBLES	↓	0

REMARKS

BORING 46GW13

*SEE LEGEND ON BACK

PAGE 1 OF 1

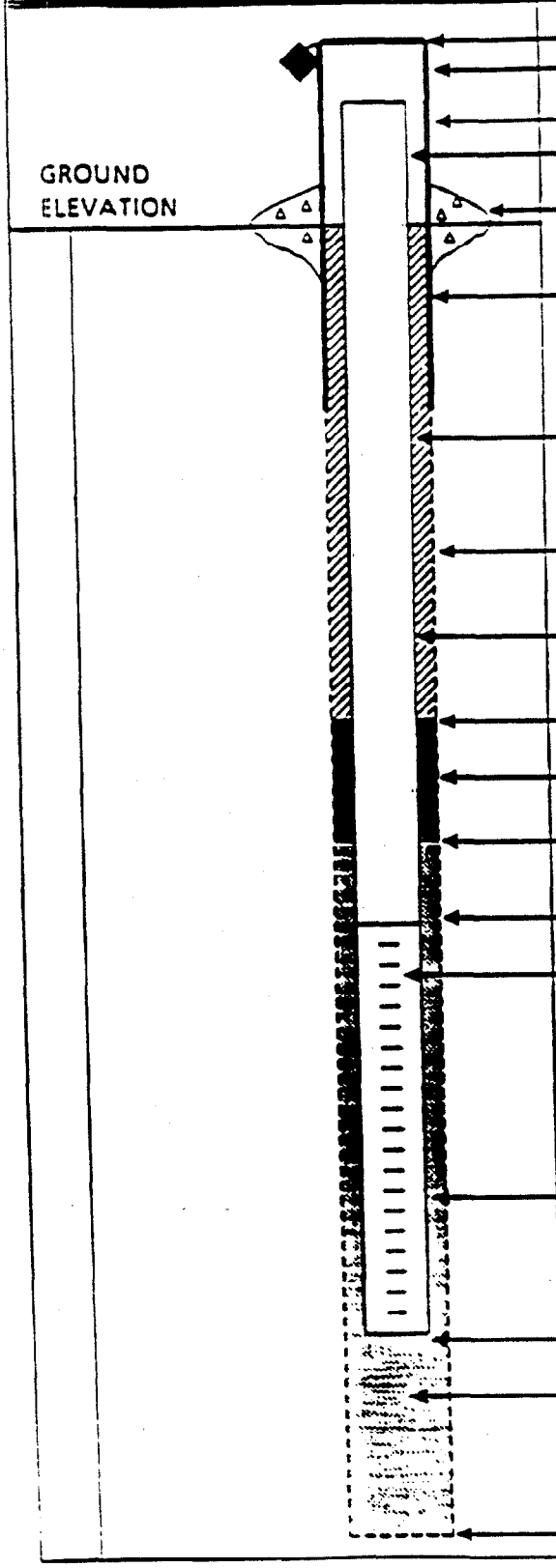
BORING NO.: 46GW13

OVERBURDEN
MONITORING WELL SHEET

PROJECT: WHITE OAK
PROJECT NO.: 7855.0204
ELEVATION: TBD
FIELD GEOLOGIST: KEN COTTRELL

LOCATION: CENTRIFUGE
BORING: 46GW13
DATE: 11/12/98

DRILLER: HARDIN HUBER
DRILLING METHOD: HSA
DEVELOPMENT METHOD: BAILING



ELEVATION OF TOP OF SURFACE CASING:
ELEVATION OF TOP OF RISER PIPE:
STICK - UP TOP OF SURFACE CASING
STICK - UP RISER PIPE: 2.9'
TYPE OF SURFACE SEAL: Concrete
I.D. OF SURFACE CASING: 6"
TYPE OF SURFACE CASING: Steel Stickup
RISER PIPE I.D.
TYPE OF RISER PIPE: PVC
BOREHOLE DIAMETER: 6 1/4"
TYPE OF BACKFILL: Cement/Bentonite Grout
ELEVATION / DEPTH TOP OF SEAL: 12
TYPE OF SEAL: Bentonite Pellets
DEPTH TOP OF SAND PACK: 14'
ELEVATION / DEPTH TOP OF SCREEN: 16
TYPE OF SCREEN: PVC
SLOT SIZE x LENGTH: 0.010" x 10'
I.D. OF SCREEN: 2"
TYPE OF SAND PACK: #1 Millersville
ELEVATION / DEPTH BOTTOM OF SCREEN: 12
ELEVATION / DEPTH BOTTOM OF SAND PACK: 1
TYPE OF BACKFILL BELOW OBSERVATION WELL:
ELEVATION / DEPTH OF HOLE: 1

NUS CORPORATION
A Halliburton Company

PROJECT NSWC - WHITE OAK, MD - CENTRIFUGE
PROJECT NO. 7855.0204 BORING 46GW131
ELEVATION TBA DATE 11/10/98
FIELD GEOLOGIST KEN COTTRELL

SAMPLE NO., TYPE & DEPTH (in)	BLOWS/SIX INCHES OR RQD(%)	SAMPLE RECOVERY/ SAMPLE LENGTH (in)	MATERIAL MOISTURE & WATER DEPTH (ft)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS PID RESP. ON SAMPLE (PPM)
0.0	10/20	1.5/2.0	DRY	MED DENSE	BROWN	SILTY FINE TO MED SAND, SOME	SM	0.0PPM
	20/14					GRAVEL & COBBLES		
2.0	10/12	1.2/2.0		MED DENSE	RED-			0.0
	14/18				BROWN			
4.0	11/12	1.5/2.0		MED DENSE				0.0
	13/10				BROWN	CLAYEY FINE TO COARSE SAND,	SC	
6.0	9/10	0.4/2.0		MED DENSE		SOME GRAVEL		0.0
	8/9							
8.0	4/3	1.0/2.0		LOOSE	GRAY-	SILTY FINE TO MED SAND	SM	0.0
	3/5				BROWN	SOME COBBLES		
10.0	4/2	0.7/2.0		LOOSE				0.0
	2/4							
12.0	2/2	1.8/2.0		LOOSE				0.0
	2/8							
14.0	6/8	1.2/2.0		MED DENSE	RED-	FINE TO COARSE SAND SOME GRAVEL	SW	0.0
	4/8				BROWN			
16.0	19/21	1.7/2.0		MED DENSE	RED-	FINE TO COARSE SAND SOME COBBLES		0.0
	42/50				BROWN			
18.0	18/21	1.7/2.0		DENSE				0.0
	24/9				RED-BR	SILTY FINE TO MED SAND	SM	
20.0	8/9	1.7/2.0		MED DENSE	WHITE-GRAY	RED MOTTLED SILTY FINE SAND,		0.0
	12/15				TO TAN	TRACE CLAYS		
22.0	14/19	1.5/2.0		DENSE	RED BROWN	QUARTZ COBBLES; FINE SAND,		0.0
	16/16				TO TAN BROWN	SOME SILT	SP	
24.0	7/10	1.8/2.0		MED DENSE	TAN AND	FINE SAND, SOME SILT,		0.0

REMARKS

BORING 46GW131

*SEE LEGEND ON BACK

NUS CORPORATION
A Halliburton Company

PROJECT NSWC - WHITE OAK, MD - CENTRIFUGE
PROJECT NO. 7855.0204 BORING 46GW131
ELEVATION TBA DATE
FIELD GEOLOGIST KEN COTTRELL

SAMPLE NO., TYPE & DEPTH (in)	BLOWS/SIX INCHES OR RQD(%)	SAMPLE RECOVERY/ SAMPLE LENGTH (in)	MATERIAL MOISTURE & WATER DEPTH (ft)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS PID RESP. ON SPOON (PPM)
	12/16		DRY	MED DENSE	WHITE GRAY	RED MOTTLED FINE SAND	SP	
26.0	9/15	1.8/2.0			TAN TO	FINE SAND		0.0
	11/17				LIGHT GRAY	TRACE SILT		
28.0	21/27	1.3/2.0		VERY DENSE	BROWN	COBBLES, SOME SANDS	GW	0.8
	32/26				TO WHITE			
30.0	20/50	0/2.0						0.0
	X/X							
32.0	8/25	1.0/2.0	MOIST	MED DENSE	TAN-	FINE SAND, SOME COBBLES	SP	0.0
	28/42			VERY DENSE	BROWN			
34.0	10/16	1.0/2.0		MED DENSE				0.0
	30/50			VERY DENSE				
36.0	9/11	1.5/2.0		MED DENSE	LT GRAY	RED MOTTLED FINE SAND,	SP	0.0
	13/19			DENSE	TO WHITE	TRACE SILT, COBBLES		
38.0	5/6	1.8/2.0	WET ▼	LOOSE -	WHITE			0.0
	8/30			MED. DENSE	TO RED BROWN	FINE TO COARSE SAND, SOME COBBLES	SP	
40.0	22/50X	0.5/2.0		DENSE	RED	RED COBBLES, SOME SANDS	GW	11.3
	X/X			VERY DENSE				
42.0	50X/X							Ø.Ø
	X/X							
44.0								

REMARKS

BORING 46GW131

*SEE LEGEND ON BACK

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Ken

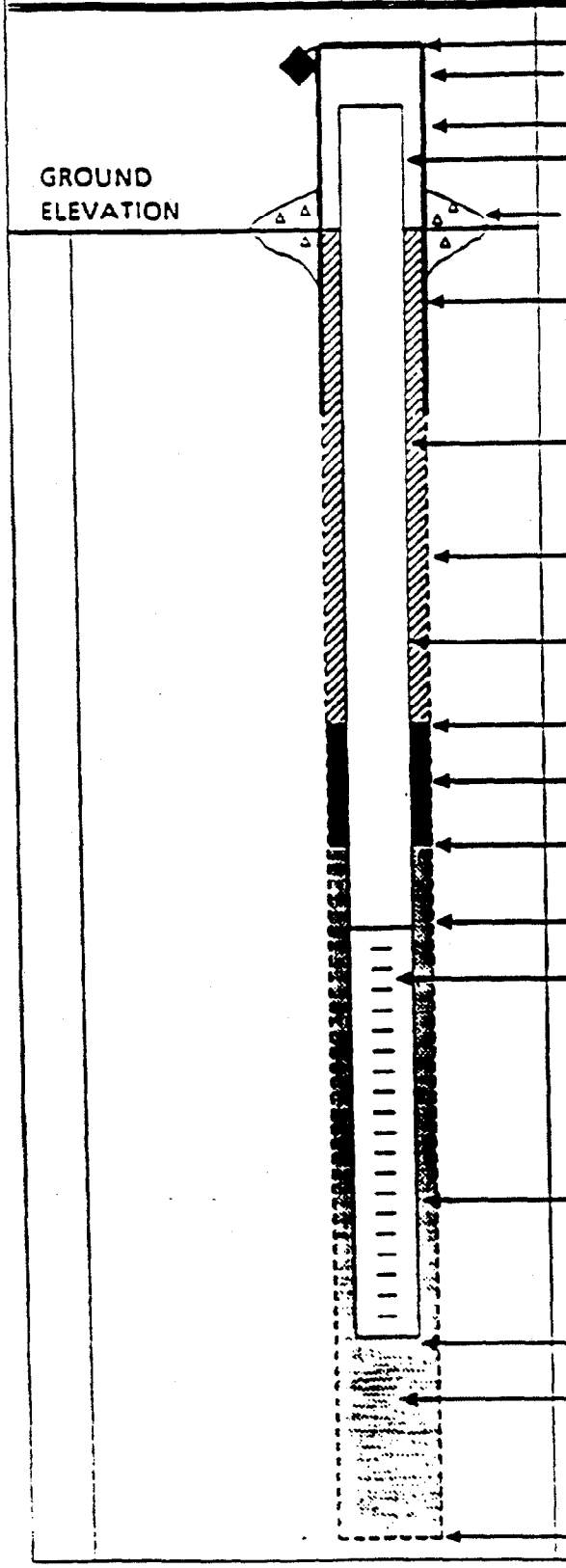
BORING NO.: 46GW13

OVERBURDEN
MONITORING WELL SHEET

PROJECT WHITE OAK
PROJECT NO. 7855.0204
ELEVATION TBA
FIELD GEOLOGIST KEN COTTRELL

LOCATION CENTRIFUGE
BORING 46GW13~~01~~
DATE 111094-111194 ~~EA~~

DRILLER HARDIN HUDSON
DRILLING METHOD HSA
DEVELOPMENT METHOD BAILING



ELEVATION OF TOP OF SURFACE CASING :
ELEVATION OF TOP OF RISER PIPE:
STICK - UP TOP OF SURFACE CASING
STICK - UP RISER PIPE : 0.0
TYPE OF SURFACE SEAL: Concrete
I.D. OF SURFACE CASING: 6"
TYPE OF SURFACE CASING: Flush Mount ~~Steel Stickup~~
RISER PIPE I.D. 2"
TYPE OF RISER PIPE: PVC
BOREHOLE DIAMETER: 6 1/4"
TYPE OF BACKFILL: Cement/Bentonite Grout
ELEVATION / DEPTH TOP OF SEAL: 128
TYPE OF SEAL: Bentonite Pellets
DEPTH TOP OF SAND PACK: 30.5'
ELEVATION / DEPTH TOP OF SCREEN: 13~~4~~
TYPE OF SCREEN: PVC
SLOT SIZE x LENGTH: 0.010" x 10'
I.D. OF SCREEN: 2"
TYPE OF SAND PACK: #1 Millersville
ELEVATION / DEPTH BOTTOM OF SCREEN: 14
ELEVATION / DEPTH BOTTOM OF SAND PACK:
TYPE OF BACKFILL BELOW OBSERVATION WELL:
ELEVATION / DEPTH OF HOLE 1

NUS CORPORATION
A Halliburton Company

PROJECT NSWCDL White Oak - Cantilever
PROJECT NO. 7855-0204 BORING 46GW132
ELEVATION TBD DATE 11/6/98
FIELD GEOLOGIST Cottrell

SAMPLE NO. TYPE & DEPTH (in)	BLOWS/SIX INCHES OR RQD (%)	SAMPLE RECOVERY/ SAMPLE LENGTH (in)	MATERIAL MOISTURE & WATER DEPTH (ft)	MATERIAL DESCRIPTION* SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS OR ROCK BRKENENESS	REMARKS PID (ppm)
19	11/19	22/24	Dry	MED Dense	TAN BROWN	Silty Fine sand w/ gravel +	SW	90 ppm
20	16/15					cobbles		
21	9/11	18/24		MED Dense	TAN Brown	Silty Fine-Med sand	SM	40-136 ppm
22	11/16							
23	6/7	22/24		Med Dense	TAN Brown	Silty Fine sand w/ gravel cobbles	SW	10-107 ppm
24	10/12					and a white clay matrix		
25	7/9	NA Mo		Med Dense	TAN Brown	Similar with more Clay at	SW	50-110 ppm
26	10/12					26.7 to 27.0		
27	9/10	20/24		Med Dense	TAN BROWN	Similar; 2" White Clay at 28.0'	SW CL	10-110 ppm
28	13/13					Quartz Cobble, TAN Brown Fine sand 28.5-29	GP SP	
29	10/20	22/24		Med Dense	Rust Brown	Fine to Med Sand	SP	Up to 100 ppm
30	32/28					Gravel in White Clay Matrix	GP	400 ppm
31	12/22	20/24		Med Dense	Rust Brown	Fine Sand	SP	200 ppm
32	50					Cobbles and white clay/sand/gravel	GW	20 ppm
						End of Boring at 33'		
						Below Grade		

REMARKS Elevated PID readings were noted during installation of well 46GW132. This boring was offset five feet horizontally to collect samples of contaminated material

BORING 46GW132

*SEE LEGEND ON BACK

PAGE 1 OF 1

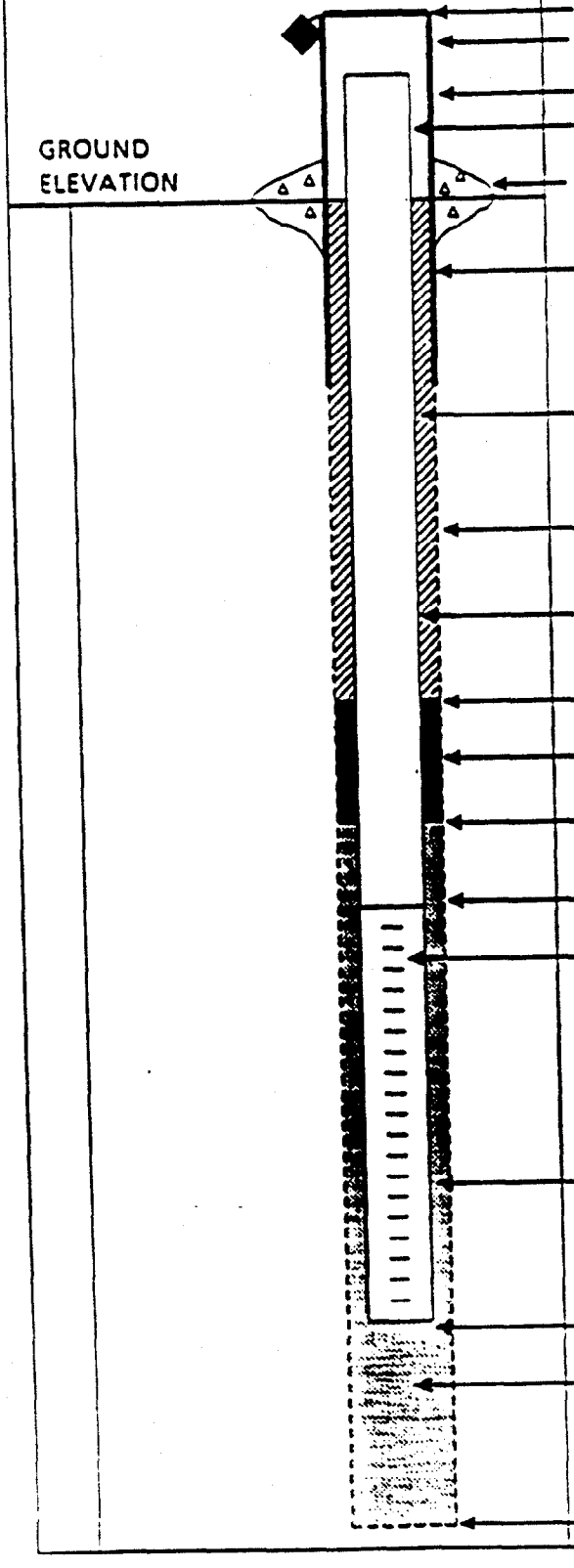
BORING NO.: 46GW132

OVERBURDEN
MONITORING WELL SHEET

PROJECT WHITE OAK
PROJECT NO. 7855.0204
ELEVATION TBA
FIELD GEOLOGIST KEN COTTRELL

LOCATION CENTRIFUGE
BORING 46GW132
DATE 111298

DRILLER HARDIN HUE
DRILLING METHOD HSA
DEVELOPMENT METHOD BAILING



ELEVATION OF TOP OF SURFACE CASING :
ELEVATION OF TOP OF RISER PIPE:
STICK - UP TOP OF SURFACE CASING
STICK - UP RISER PIPE : 0.0
TYPE OF SURFACE SEAL: Concrete
I.D. OF SURFACE CASING: 6"
TYPE OF SURFACE CASING Flush mount
RISER PIPE I.D. 2"
TYPE OF RISER PIPE: PVC
BOREHOLE DIAMETER: 6 1/4"
TYPE OF BACKFILL: Cement Bentonite
ELEVATION / DEPTH TOP OF SEAL: 128.5
TYPE OF SEAL: Bentonite Pellets
DEPTH TOP OF SAND PACK: 31.5'
ELEVATION / DEPTH TOP OF SCREEN: 135
TYPE OF SCREEN: PVC
SLOT SIZE x LENGTH: 0.010" X 10'
I.D. OF SCREEN: 2"
TYPE OF SAND PACK: #1 Millersville
ELEVATION / DEPTH BOTTOM OF SCREEN: 145
ELEVATION / DEPTH BOTTOM OF SAND PACK:
TYPE OF BACKFILL BELOW OBSERVATION WELL:
ELEVATION / DEPTH OF HOLE /

ATTACHMENT B
ANALYTICAL RESULTS

Project: CTO 284 NSWC WHITEOAK TCE

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9811087-02A
Client ID: 46GW130
Collected: 11/09/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/19/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	10	
Bromomethane	BQL	10	
Vinyl chloride	BQL	10	
Chloroethane	BQL	10	
Methylene chloride	13	10	B
Acetone	BQL	10	
Carbon Disulfide	BQL	10	
1,1-Dichloroethene	BQL	10	
1,1-Dichloroethane	BQL	10	
cis-1,2-Dichloroethene	BQL	10	
trans-1,2-Dichloroethene	BQL	10	
Chloroform	BQL	10	
1,2-Dichloroethane	BQL	10	
2-Butanone	BQL	10	
1,1,1-Trichloroethane	BQL	10	
Carbon tetrachloride	BQL	10	
Bromodichloromethane	BQL	10	
1,2-Dichloropropane	BQL	10	
cis-1,3-Dichloropropene	BQL	10	
Trichloroethene	BQL	10	
Benzene	BQL	10	
Dibromochloromethane	BQL	10	
trans-1,3-Dichloropropene	BQL	10	
1,1,2-Trichloroethane	BQL	10	
Bromoform	BQL	10	
4-Methyl-2-pentanone	BQL	10	
2-Hexanone	BQL	10	
Tetrachloroethene	BQL	10	
1,1,2,2-Tetrachloroethane	BQL	10	
Toluene	2	10	J
Chlorobenzene	BQL	10	
Ethylbenzene	BQL	10	
Styrene	BQL	10	
Xylene (total)	BQL	10	

Project: CTO-311 NSWC WHITEOAK TCE

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9811163-01A
Client ID: 46GW132 30.5-31.0
Collected: 11/16/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/19/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	10	
Bromomethane	BQL	10	
Vinyl chloride	BQL	10	
Chloroethane	BQL	10	
Methylene chloride	13	10	B
Acetone	BQL	10	
Carbon Disulfide	BQL	10	
1,1-Dichloroethene	BQL	10	
1,1-Dichloroethane	BQL	10	
cis-1,2-Dichloroethene	BQL	10	
trans-1,2-Dichloroethene	BQL	10	
Chloroform	BQL	10	
1,2-Dichloroethane	BQL	10	
2-Butanone	BQL	10	
1,1,1-Trichloroethane	BQL	10	
Carbon tetrachloride	BQL	10	
Bromodichloromethane	BQL	10	
1,2-Dichloropropane	BQL	10	
cis-1,3-Dichloropropene	BQL	10	
Trichloroethene	BQL	10	
Benzene	BQL	10	
Dibromochloromethane	BQL	10	
trans-1,3-Dichloropropene	BQL	10	
1,1,2-Trichloroethane	BQL	10	
Bromoform	BQL	10	
4-Methyl-2-pentanone	BQL	10	
2-Hexanone	BQL	10	
Tetrachloroethene	BQL	10	
1,1,2,2-Tetrachloroethane	BQL	10	
Toluene	BQL	10	
Chlorobenzene	BQL	10	
Ethylbenzene	BQL	10	
Styrene	BQL	10	
Xylene (total)	BQL	10	

Project: CTO 311 NSWC WHITEOAK

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9810228-01A
Client ID: 0-6 EAST CENTRIFUGE
Collected: 10/29/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/06/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	11	
Bromomethane	BQL	11	
Vinyl chloride	BQL	11	
Chloroethane	BQL	11	
Methylene chloride	6	11	J
Acetone	BQL	11	
Carbon Disulfide	BQL	11	
1,1-Dichloroethene	BQL	11	
1,1-Dichloroethane	BQL	11	
cis-1,2-Dichloroethene	BQL	11	
trans-1,2-Dichloroethene	BQL	11	
Chloroform	BQL	11	
1,2-Dichloroethane	BQL	11	
2-Butanone	BQL	11	
1,1,1-Trichloroethane	BQL	11	
Carbon tetrachloride	BQL	11	
Bromodichloromethane	BQL	11	
1,2-Dichloropropane	BQL	11	
cis-1,3-Dichloropropene	BQL	11	
Trichloroethene	BQL	11	
Benzene	BQL	11	
Dibromochloromethane	BQL	11	
trans-1,3-Dichloropropene	BQL	11	
1,1,2-Trichloroethane	BQL	11	
Bromoform	BQL	11	
4-Methyl-2-pentanone	BQL	11	
2-Hexanone	BQL	11	
Tetrachloroethene	BQL	11	
1,1,2,2-Tetrachloroethane	BQL	11	
Toluene	BQL	11	
Chlorobenzene	BQL	11	
Ethylbenzene	BQL	11	
Styrene	BQL	11	
Xylene (total)	BQL	11	

Project: CTO 311 NSWC WHITEOAK

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9810228-03A
Client ID: O-6 NE CENTRIFUGE
Collected: 10/29/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/06/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	11	
Bromomethane	BQL	11	
Vinyl chloride	BQL	11	
Chloroethane	BQL	11	
Methylene chloride	BQL	11	
Acetone	BQL	11	
Carbon Disulfide	BQL	11	
1,1-Dichloroethene	BQL	11	
1,1-Dichloroethane	BQL	11	
cis-1,2-Dichloroethene	BQL	11	
trans-1,2-Dichloroethene	BQL	11	
Chloroform	BQL	11	
1,2-Dichloroethane	BQL	11	
2-Butanone	BQL	11	
1,1,1-Trichloroethane	BQL	11	
Carbon tetrachloride	BQL	11	
Bromodichloromethane	BQL	11	
1,2-Dichloropropane	BQL	11	
cis-1,3-Dichloropropene	BQL	11	
Trichloroethene	BQL	11	
Benzene	BQL	11	
Dibromochloromethane	BQL	11	
trans-1,3-Dichloropropene	BQL	11	
1,1,2-Trichloroethane	BQL	11	
Bromoform	BQL	11	
4-Methyl-2-pentanone	BQL	11	
2-Hexanone	BQL	11	
Tetrachloroethene	BQL	11	
1,1,2,2-Tetrachloroethane	BQL	11	
Toluene	BQL	11	
Chlorobenzene	BQL	11	
Ethylbenzene	BQL	11	
Styrene	BQL	11	
Xylene (total)	BQL	11	

Project: CTO 311 NSWC WHITEOAK

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9810228-04A
Client ID: 6-12 NE CENTRIFUGE
Collected: 10/29/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/06/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	11	
Bromomethane	BQL	11	
Vinyl chloride	BQL	11	
Chloroethane	BQL	11	
Methylene chloride	BQL	11	
Acetone	BQL	11	
Carbon Disulfide	BQL	11	
1,1-Dichloroethene	BQL	11	
1,1-Dichloroethane	BQL	11	
cis-1,2-Dichloroethene	BQL	11	
trans-1,2-Dichloroethene	BQL	11	
Chloroform	BQL	11	
1,2-Dichloroethane	BQL	11	
2-Butanone	BQL	11	
1,1,1-Trichloroethane	BQL	11	
Carbon tetrachloride	BQL	11	
Bromodichloromethane	BQL	11	
1,2-Dichloropropane	BQL	11	
cis-1,3-Dichloropropene	BQL	11	
Trichloroethene	BQL	11	
Benzene	BQL	11	
Dibromochloromethane	BQL	11	
trans-1,3-Dichloropropene	BQL	11	
1,1,2-Trichloroethane	BQL	11	
Bromoform	BQL	11	
4-Methyl-2-pentanone	BQL	11	
2-Hexanone	BQL	11	
Tetrachloroethene	BQL	11	
1,1,2,2-Tetrachloroethane	BQL	11	
Toluene	BQL	11	
Chlorobenzene	BQL	11	
Ethylbenzene	BQL	11	
Styrene	BQL	11	
Xylene (total)	BQL	11	

Project: CTO 311 NSWC WHITEOAK

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9810228-05A
Client ID: 12-18 NE CENTRIFUGE
Collected: 10/29/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/06/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	11	
Bromomethane	BQL	11	
Vinyl chloride	BQL	11	
Chloroethane	BQL	11	
Methylene chloride	BQL	11	
Acetone	BQL	11	
Carbon Disulfide	BQL	11	
1,1-Dichloroethene	BQL	11	
1,1-Dichloroethane	BQL	11	
cis-1,2-Dichloroethene	BQL	11	
trans-1,2-Dichloroethene	BQL	11	
Chloroform	BQL	11	
1,2-Dichloroethane	BQL	11	
2-Butanone	BQL	11	
1,1,1-Trichloroethane	BQL	11	
Carbon tetrachloride	BQL	11	
Bromodichloromethane	BQL	11	
1,2-Dichloropropane	BQL	11	
cis-1,3-Dichloropropene	BQL	11	
Trichloroethene	BQL	11	
Benzene	BQL	11	
Dibromochloromethane	BQL	11	
trans-1,3-Dichloropropene	BQL	11	
1,1,2-Trichloroethane	BQL	11	
Bromoform	BQL	11	
4-Methyl-2-pentanone	BQL	11	
2-Hexanone	BQL	11	
Tetrachloroethene	BQL	11	
1,1,2,2-Tetrachloroethane	BQL	11	
Toluene	BQL	11	
Chlorobenzene	BQL	11	
Ethylbenzene	BQL	11	
Styrene	BQL	11	
Xylene (total)	BQL	11	

Project: CTO 311 NSWC WHITEOAK

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9810228-06A
Client ID: 18-24 NE CENTRIFUGE
Collected: 10/29/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/04/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	11	
Bromomethane	BQL	11	
Vinyl chloride	BQL	11	
Chloroethane	BQL	11	
Methylene chloride	5	11	J
Acetone	BQL	11	
Carbon Disulfide	BQL	11	
1,1-Dichloroethene	BQL	11	
1,1-Dichloroethane	BQL	11	
cis-1,2-Dichloroethene	BQL	11	
trans-1,2-Dichloroethene	BQL	11	
Chloroform	BQL	11	
1,2-Dichloroethane	BQL	11	
2-Butanone	BQL	11	
1,1,1-Trichloroethane	BQL	11	
Carbon tetrachloride	BQL	11	
Bromodichloromethane	BQL	11	
1,2-Dichloropropane	BQL	11	
cis-1,3-Dichloropropene	BQL	11	
Trichloroethene	BQL	11	
Benzene	BQL	11	
Dibromochloromethane	BQL	11	
trans-1,3-Dichloropropene	BQL	11	
1,1,2-Trichloroethane	BQL	11	
Bromoform	BQL	11	
4-Methyl-2-pentanone	BQL	11	
2-Hexanone	BQL	11	
Tetrachloroethene	BQL	11	
1,1,2,2-Tetrachloroethane	BQL	11	
Toluene	BQL	11	
Chlorobenzene	BQL	11	
Ethylbenzene	BQL	11	
Styrene	BQL	11	
Xylene (total)	BQL	11	

Project: CTO 311 NSWC WHITEOAK

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9810228-02A
Client ID: CENTRIFUGE SUMP
Collected: 10/29/98
Dilution: 1

Matrix: SOIL
Method: OLM03.2_V
Units: ug/Kg

Analyst: JJB
Analyzed: 11/06/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	13	
Bromomethane	BQL	13	
Vinyl chloride	BQL	13	
Chloroethane	BQL	13	
Methylene chloride	BQL	13	
Acetone	BQL	13	
Carbon Disulfide	BQL	13	
1,1-Dichloroethene	BQL	13	
1,1-Dichloroethane	BQL	13	
cis-1,2-Dichloroethene	BQL	13	
trans-1,2-Dichloroethene	BQL	13	
Chloroform	BQL	13	
1,2-Dichloroethane	BQL	13	
2-Butanone	BQL	13	
1,1,1-Trichloroethane	BQL	13	
Carbon tetrachloride	BQL	13	
Bromodichloromethane	BQL	13	
1,2-Dichloropropane	BQL	13	
cis-1,3-Dichloropropene	BQL	13	
Trichloroethene	2	13	J
Benzene	BQL	13	
Dibromochloromethane	BQL	13	
trans-1,3-Dichloropropene	BQL	13	
1,1,2-Trichloroethane	BQL	13	
Bromoform	BQL	13	
4-Methyl-2-pentanone	BQL	13	
2-Hexanone	BQL	13	
Tetrachloroethene	BQL	13	
1,1,2,2-Tetrachloroethane	BQL	13	
Toluene	BQL	13	
Chlorobenzene	BQL	13	
Ethylbenzene	BQL	13	
Styrene	BQL	13	
Xylene (total)	BQL	13	

Project: CTO-311 NSWC WHITEOAK TCE

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9811184-01A
Client ID: 46GW130
Collected: 11/17/98
Dilution: 1

Matrix: WATER
Method: OLC2.0
Units: ug/L

Analyst: WF
Analyzed: 11/20/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	1.0	
Vinyl chloride	BQL	1.0	
Bromomethane	BQL	1.0	
Chloroethane	BQL	1.0	
1,1-Dichloroethene	1.5	1.0	
Methylene chloride	0.4	2.0	JB
trans-1,2-Dichloroethene	0.3	1.0	J
1,1-Dichloroethane	BQL	1.0	
Acetone	BQL	5.0	
Carbon Disulfide	BQL	1.0	
cis-1,2-Dichloroethene	343.9	1.0	EB
Bromochloromethane	BQL	1.0	
Chloroform	BQL	1.0	
2-Butanone	BQL	5.0	
1,2-Dichloroethane	BQL	1.0	
1,1,1-Trichloroethane	BQL	1.0	
Carbon tetrachloride	BQL	1.0	
Benzene	BQL	1.0	
Trichloroethene	BQL	1.0	
1,2-Dichloropropane	BQL	1.0	
Bromodichloromethane	BQL	1.0	
cis-1,3-Dichloropropene	BQL	1.0	
Toluene	1.6	1.0	
trans-1,3-Dichloropropene	BQL	1.0	
1,1,2-Trichloroethane	0.8	1.0	J
Tetrachloroethene	0.3	1.0	J
Dibromochloromethane	BQL	1.0	
Chlorobenzene	BQL	1.0	
Ethylbenzene	0.2	1.0	J
Xylene (total)	1.2	1.0	
Styrene	BQL	1.0	
1,1,2,2-Tetrachloroethane	17.2	1.0	
1,2-Dibromoethane	BQL	1.0	
4-Methyl-2-pentanone	BQL	5.0	
2-Hexanone	BQL	5.0	
Bromoform	BQL	1.0	
1,3-Dichlorobenzene	BQL	1.0	
1,4-Dichlorobenzene	BQL	1.0	
1,2-Dichlorobenzene	BQL	1.0	
1,2-Dibromo-3-chloropropane	BQL	1.0	
1,2,4-Trichlorobenzene	BQL	1.0	

Project: CTO 284 NSWC WHITEOAK TCE

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9811087-01A
Client ID: 46GW130P
Collected: 11/09/98
Dilution: 1

Matrix: WATER
Method: OLC2.0
Units: ug/L

Analyst: WF
Analyzed: 11/16/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	1.0	
Vinyl chloride	BQL	1.0	
Bromomethane	BQL	1.0	
Chloroethane	BQL	1.0	
1,1-Dichloroethene	BQL	1.0	
Methylene chloride	0.5	2.0	JB
trans-1,2-Dichloroethene	BQL	1.0	
1,1-Dichloroethane	BQL	1.0	
Acetone	5.6	5.0	
Carbon Disulfide	BQL	1.0	
cis-1,2-Dichloroethene	BQL	1.0	
Bromochloromethane	BQL	1.0	
Chloroform	0.8	1.0	JB
2-Butanone	BQL	5.0	
1,2-Dichloroethane	BQL	1.0	
1,1,1-Trichloroethane	BQL	1.0	
Carbon tetrachloride	BQL	1.0	
Benzene	BQL	1.0	
Trichloroethene	0.4	1.0	J
1,2-Dichloropropane	BQL	1.0	
Bromodichloromethane	BQL	1.0	
cis-1,3-Dichloropropene	BQL	1.0	
Toluene	BQL	1.0	
trans-1,3-Dichloropropene	BQL	1.0	
1,1,2-Trichloroethane	BQL	1.0	
Tetrachloroethene	BQL	1.0	
Dibromochloromethane	BQL	1.0	
Chlorobenzene	BQL	1.0	
Ethylbenzene	BQL	1.0	
Xylene (total)	BQL	1.0	
Styrene	BQL	1.0	
1,1,2,2-Tetrachloroethane	BQL	1.0	
1,2-Dibromoethane	BQL	1.0	
4-Methyl-2-pentanone	BQL	5.0	
2-Hexanone	BQL	5.0	
Bromoform	BQL	1.0	
1,3-Dichlorobenzene	BQL	1.0	
1,4-Dichlorobenzene	BQL	1.0	
1,2-Dichlorobenzene	BQL	1.0	
1,2-Dibromo-3-chloropropane	BQL	1.0	
1,2,4-Trichlorobenzene	BQL	1.0	

Project: CTO-311 NSWC WHITEOAK TCE

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9811184-05A
Client ID: 46GW131
Collected: 11/17/98
Dilution: 1

Matrix: WATER
Method: OLC2.0
Units: ug/L

Analyst: WF
Analyzed: 11/20/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	1.0	
Vinyl chloride	BQL	1.0	
Bromomethane	BQL	1.0	
Chloroethane	BQL	1.0	
1,1-Dichloroethene	1.4	1.0	
Methylene chloride	0.6	2.0	JB
trans-1,2-Dichloroethene	0.2	1.0	J
1,1-Dichloroethane	BQL	1.0	
Acetone	9.5	5.0	
Carbon Disulfide	BQL	1.0	
cis-1,2-Dichloroethene	36.2	1.0	E
Bromochloromethane	BQL	1.0	
Chloroform	BQL	1.0	
2-Butanone	BQL	5.0	
1,2-Dichloroethane	1.0	1.0	J
1,1,1-Trichloroethane	0.3	1.0	J
Carbon tetrachloride	BQL	1.0	
Benzene	0.1	1.0	J
Trichloroethene	304.6	1.0	EB
1,2-Dichloropropane	BQL	1.0	
Bromodichloromethane	BQL	1.0	
cis-1,3-Dichloropropene	BQL	1.0	
Toluene	0.2	1.0	J
trans-1,3-Dichloropropene	BQL	1.0	
1,1,2-Trichloroethane	0.7	1.0	J
Tetrachloroethene	0.3	1.0	J
Dibromochloromethane	BQL	1.0	
Chlorobenzene	0.4	1.0	J
Ethylbenzene	BQL	1.0	
Xylene (total)	BQL	1.0	
Styrene	BQL	1.0	
1,1,2,2-Tetrachloroethane	15.2	1.0	
1,2-Dibromoethane	BQL	1.0	
4-Methyl-2-pentanone	BQL	5.0	
2-Hexanone	BQL	5.0	
Bromoform	BQL	1.0	
1,3-Dichlorobenzene	0.2	1.0	J
1,4-Dichlorobenzene	BQL	1.0	
1,2-Dichlorobenzene	BQL	1.0	
1,2-Dibromo-3-chloropropane	BQL	1.0	
1,2,4-Trichlorobenzene	BQL	1.0	

Project: CTO-311 NSWC WHITEOAK TCE

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9811184-04A
Client ID: 46GW999
Collected: 11/17/98
Dilution: 1

Matrix: WATER
Method: OLC2.0
Units: ug/L

Analyst: WF
Analyzed: 11/20/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	1.0	
Vinyl chloride	0.5	1.0	J
Bromomethane	BQL	1.0	
Chloroethane	BQL	1.0	
1,1-Dichloroethene	1.1	1.0	
Methylene chloride	0.3	2.0	JB
trans-1,2-Dichloroethene	0.2	1.0	J
1,1-Dichloroethane	BQL	1.0	
Acetone	BQL	5.0	
Carbon Disulfide	BQL	1.0	
cis-1,2-Dichloroethene	34.7	1.0	E
Bromochloromethane	BQL	1.0	
Chloroform	0.9	1.0	JB
2-Butanone	BQL	5.0	
1,2-Dichloroethane	0.5	1.0	J
1,1,1-Trichloroethane	0.3	1.0	J
Carbon tetrachloride	BQL	1.0	
Benzene	BQL	1.0	
Trichloroethene	305.3	1.0	EB
1,2-Dichloropropane	BQL	1.0	
Bromodichloromethane	BQL	1.0	
cis-1,3-Dichloropropene	BQL	1.0	
Toluene	BQL	1.0	
trans-1,3-Dichloropropene	BQL	1.0	
1,1,2-Trichloroethane	0.6	1.0	J
Tetrachloroethene	0.3	1.0	J
Dibromochloromethane	BQL	1.0	
Chlorobenzene	BQL	1.0	
Ethylbenzene	BQL	1.0	
Xylene (total)	BQL	1.0	
Styrene	BQL	1.0	
1,1,2,2-Tetrachloroethane	13.3	1.0	
1,2-Dibromoethane	BQL	1.0	
4-Methyl-2-pentanone	BQL	5.0	
2-Hexanone	BQL	5.0	
Bromoform	BQL	1.0	
1,3-Dichlorobenzene	BQL	1.0	
1,4-Dichlorobenzene	BQL	1.0	
1,2-Dichlorobenzene	0.2	1.0	J
1,2-Dibromo-3-chloropropane	BQL	1.0	
1,2,4-Trichlorobenzene	BQL	1.0	

Project: CTO-311 NSWC WHITEOAK TCE

GPL LABORATORIES, LLLP
ORGANIC ANALYSIS RESULTS

GP ID: 9811163-02A
Client ID: 46GW132
Collected: 11/16/98
Dilution: 1

Matrix: WATER
Method: OLC2.0
Units: ug/L

Analyst: WF
Analyzed: 11/20/98
Prepared:

VOLATILE TARGET COMPOUNDS

Parameter	Result	Rep.Lim.	Qualifier
Chloromethane	BQL	1.0	
Vinyl chloride	BQL	1.0	
Bromomethane	BQL	1.0	
Chloroethane	BQL	1.0	
1,1-Dichloroethene	BQL	1.0	
Methylene chloride	BQL	2.0	
trans-1,2-Dichloroethene	BQL	1.0	
1,1-Dichloroethane	BQL	1.0	
Acetone	BQL	5.0	
Carbon Disulfide	BQL	1.0	
cis-1,2-Dichloroethene	2.2	1.0	
Bromochloromethane	BQL	1.0	
Chloroform	0.3	1.0	JB
2-Butanone	BQL	5.0	
1,2-Dichloroethane	BQL	1.0	
1,1,1-Trichloroethane	BQL	1.0	
Carbon tetrachloride	BQL	1.0	
Benzene	424.3	1.0	E
Trichloroethene	28.5	1.0	EB
1,2-Dichloropropane	BQL	1.0	
Bromodichloromethane	BQL	1.0	
cis-1,3-Dichloropropene	BQL	1.0	
Toluene	437.0	1.0	E
trans-1,3-Dichloropropene	BQL	1.0	
1,1,2-Trichloroethane	BQL	1.0	
Tetrachloroethene	BQL	1.0	
Dibromochloromethane	BQL	1.0	
Chlorobenzene	BQL	1.0	
Ethylbenzene	97.1	1.0	E
Xylene (total)	374.3	1.0	E
Styrene	BQL	1.0	
1,1,2,2-Tetrachloroethane	0.8	1.0	J
1,2-Dibromoethane	10.6	1.0	
4-Methyl-2-pentanone	BQL	5.0	
2-Hexanone	BQL	5.0	
Bromoform	BQL	1.0	
1,3-Dichlorobenzene	BQL	1.0	
1,4-Dichlorobenzene	BQL	1.0	
1,2-Dichlorobenzene	BQL	1.0	
1,2-Dibromo-3-chloropropane	BQL	1.0	
1,2,4-Trichlorobenzene	BQL	1.0	

APPENDIX B

COST ESTIMATES

NAVAL SURFACE WARFARE CENTER - WHITE OAK
Maryland
Site 46 - Engineering Evaluation/Cost Analysis

Cost Estimate Assumptions

The following underlying assumptions apply to all cost estimates prepared for the above referenced site. Alternative specific assumptions are also provided, as necessary.

The prices used in the cost estimates are from one of the following sources:

ECHOS Environmental Restoration Unit Cost Book 1998
Means Site Work and Landscape Cost Data, 17th Edition, 1998
Past experience with similar technologies/processes

Power is available within close proximity (less than 100 feet) to the proposed locations for treatment system components.

All field work would be performed in a standard construction uniform. No level of safety is required, except where noted below.

Monitoring of system performance would entail sampling and analysis of groundwater and would require one technician for 1 day.

Reviews of site conditions would be performed every 5 years, as required under CERCLA.

Systems were assumed to operate and require monthly maintenance for 30 years.

It was assumed that the contractor would staff a project with 3 people from the company. Per diem would be paid for the first 2 weeks (14 days) of the project duration. All other field crew members (equipment operator, laborers, etc.) would be hired locally.

Alternative No. 2 - Minimal Action, Natural Attenuation

Existing and new groundwater monitoring wells will be used for monitoring natural attenuation in the aquifer. Ten samples would be collected twice per year and analyzed for TCL VOCs and natural attenuation parameters.

Investigation derived waste and well development water were assumed hazardous for disposal.

Alternative No. 3 - Reactive Groundwater Treatment Wall

Project duration was estimated at 1 month.

The following quantity assumptions were made:

Depth to water table:	25 feet
Depth to confining layer:	40 feet
Wall height:	40 feet
Wall length:	300 feet
Wall thickness:	20 inches
Volume of iron filings (1) :	7500 cubic feet (600 tons- bulk density of iron 0.08 ton/cubic foot)

Excess excavated soil: 278 cubic yards (equal to iron volume)

Since the excess soil would be from below that water table, it was assumed hazardous for disposal purposes. It would be loaded and hauled to a RCRA Subtitle C landfill.

Three additional monitoring wells would be installed to monitor effectiveness of the reactive wall. Ten samples would be collected quarterly and analyzed for TCL VOCs.

The wall would require rejuvenation once every 10 years. This is the only operation and maintenance requirement for the alternative.

Alternative 4a - Groundwater Treatment via Air Stripping - Site W Swale Treatment Unit

Project duration was estimated at 1 month.

Design flow rate for the treatment system is 5 gpm.

Extracted groundwater would be pumped to the existing treatment system at the Site W swale. Groundwater conveyance pipe would be 1-inch PVC inside 3-inch corrugated plastic pipe, to provide secondary containment.

It was assumed that the pump would have to be replaced once every 5 years. The only other operation and maintenance cost was electricity for the pump.

Existing groundwater monitoring wells are sufficient for monitoring system effectiveness. Ten samples would be collected quarterly and analyzed for TCL VOCs.

Alternative 4b - Groundwater Treatment via Air Stripping - Isherwood Road Stream Treatment Unit

Project duration was estimated at 1 month.

Design flow rate for the treatment system is 5 gpm.

Extracted groundwater would be pumped to a new treatment system installed adjacent to the Isherwood Road Stream. Groundwater conveyance pipe would be 1-inch PVC inside 3-inch corrugated plastic, to provide secondary containment.

System maintenance was calculated as 3% of system installation cost.

Existing groundwater monitoring wells are sufficient for monitoring system effectiveness. Ten samples would be collected quarterly and analyzed for TCL VOCs.

Alternative 5 - Air Sparging/Soil Vapor Extraction

Construction of the full-scale system was estimated at 2 months. This duration does not include the time for installation, operation, and evaluation of the pilot-scale study and the time required to design the full-scale system.

Installation of wells would be performed in Level D personal protective equipment (addition of tyvek coverall). No respiratory protection would be required. Labor costs were increased by 18% to account for decreases in efficiency due to the PPE.

Drill rig would be decontaminated at a decontamination pad available at the Parking Lot Landfill within the facility. A separate decontamination pad would not be constructed.

System maintenance was calculated as 3% of system installation cost.

Existing groundwater monitoring wells are sufficient for monitoring system effectiveness. Ten samples would be collected quarterly and analyzed for TCL VOCs. One sample of extracted soil vapor would be collected quarterly and also analyzed for TCL VOCs.

NAVAL SURFACE WARFARE CENTER - WHITE OAK
Silver Spring, Maryland
Site 46 - EE/CA
Summary Cost Data

Alternative	Costs			
	Capital	Sampling and Evaluation	Operation and Maintenance	Total Present Worth
2. Minimal Action, Natural Attenuation	$177,100	$33000 - $39000	$0	$599,500
3. Reactive Wall	$624,100	$24000 - $30000	$50,000 (1)	$973,100
4a. Air Stripping - Site W Swale	$124,000	$24000 - $30000	$600-$3200	$447,600
4b. Air Stripping - Isherwood	$180,700	$24000 - $30000	$19,700	$735,800
5. AS/SVE	$234,400	$25000 - $31000	$26,500	$886,700

(1) Once every 10 years

ALTERNATIVE 2

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 2 - Minimal Action, Natural Attenuation

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
1 MONITORING WELL INSTALLATION												
1.1 Install Monitoring Wells	240	vf	$40.00				$9,600	$0	$0	$0	$9,600	8 @ 30 feet
1.2 IDW Containerization	120	ea	$50.00				$6,000	$0	$0	$0	$6,000	labor, materials and eq
1.3 IDW Transportation and Disposal	120	ea	$100.00				$12,000	$0	$0	$0	$12,000	hazardous disposal
1.4 Well Development	8	hr	$250.00				$2,000	$0	$0	$0	$2,000	1 hr per well
1.5 Development Water Transportation and Disposal	2200	gal	$2.00				$4,400	$0	$0	$0	$4,400	hazardous disposal
1.6 Well Pads w/ Posts	8	ea	$750.00				$6,000	$0	$0	$0	$6,000	
2 NATURAL ATTENUATION STUDY												
2.1 Engineering Study	1	ls	$100,000				$100,000	$0	$0	$0	$100,000	
Subtotal Direct Costs less Subcontract								$0	$0	$0	$0	
Overhead on Labor Cost @ 30%									$0		$0	
G & A on Labor Cost @ 10%									$0		$0	
G & A on Material Cost @ 10%								$0			$0	
Total Direct Cost								$0	$0	$0	$0	
Indirects on Total Direct Labor Cost @ 75%									$0		$0	
Profit on Total Direct Cost @ 10%											$0	
Subtotal											$0	
Health & Safety Monitoring @ 3%											$0	
Total Field Cost											**$0**	
Subtotal Subcontractor Cost							$140,000				$140,000	
G & A on Subcontract Cost @ 10%							$14,000				$14,000	
Profit on Subcontractor Cost @ 5%											$7,000	
Subcontractor Cost											**$161,000**	
Contingency on Total Field and Subcontractor Costs @ 10%											**$16,100**	
Engineering on Total Field Cost @ 4%											**$0**	
TOTAL COST											**$177,100**	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 2 - Minimal Action, Natural Attenuation
Annual Monitoring Cost

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Sampling	$6,000		2 laborers for 1 day twice a year w/mob., per diem, shipping, IDW disposal, and supply costs.
Analysis/Water	$12,000		Sampling 10 existing wells, semi-annually. TCL VOCs and Natural Attenuation Parameters.
Annual Report	$15,000		
Site Review		$6,000	
TOTALS	$33,000	$6,000	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 2 - Minimal Action, Natural Attenuation
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$177,100		$177,100	1.000	$177,100
1		$33,000	$33,000	0.935	$30,855
2		$33,000	$33,000	0.873	$28,809
3		$33,000	$33,000	0.816	$26,928
4		$33,000	$33,000	0.763	$25,179
5		$39,000	$39,000	0.713	$27,807
6		$33,000	$33,000	0.666	$21,978
7		$33,000	$33,000	0.623	$20,559
8		$33,000	$33,000	0.582	$19,206
9		$33,000	$33,000	0.544	$17,952
10		$39,000	$39,000	0.508	$19,812
11		$33,000	$33,000	0.475	$15,675
12		$33,000	$33,000	0.444	$14,652
13		$33,000	$33,000	0.415	$13,695
14		$33,000	$33,000	0.388	$12,804
15		$39,000	$39,000	0.362	$14,118
16		$33,000	$33,000	0.339	$11,187
17		$33,000	$33,000	0.317	$10,461
18		$33,000	$33,000	0.296	$9,768
19		$33,000	$33,000	0.277	$9,141
20		$39,000	$39,000	0.258	$10,062
21		$33,000	$33,000	0.242	$7,986
22		$33,000	$33,000	0.226	$7,458
23		$33,000	$33,000	0.211	$6,963
24		$33,000	$33,000	0.197	$6,501
25		$39,000	$39,000	0.184	$7,176
26		$33,000	$33,000	0.172	$5,676
27		$33,000	$33,000	0.161	$5,313
28		$33,000	$33,000	0.150	$4,950
29		$33,000	$33,000	0.141	$4,653
30		$39,000	$39,000	0.131	$5,109
				TOTAL PRESENT WORTH	**$599,533**

ALTERNATIVE 3

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 3 - Reactive Groundwater Treatment Wall

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Mobilize/Demobilize Equipment	1	ls				$1,000.00	$0	$0	$0	$1,000	$1,000	backhoe, drill rig
1.2 Mobilize/Demobilize Personnel	6	ea			$500.00		$0	$0	$3,000	$0	$3,000	3 ppl, 2 ways
1.3 Per Diem	42	man-dy			$162.00		$0	$0	$6,804	$0	$6,804	2 wks - 14days each
1.4 Office Trailer	1	mo				$215.00	$0	$0	$0	$215	$215	
1.5 Storage Trailer	1	mo				$95.00	$0	$0	$0	$95	$95	
1.6 Decontamination Trailer	1	mo				$2,332.00	$0	$0	$0	$2,332	$2,332	
1.7 Utilities	1	mo		$500.00			$0	$500	$0	$0	$500	
1.8 Clear & Grub	0.5	ac			$3,613.00	$4,056.00	$0	$0	$1,807	$2,028	$3,835	
1.9 Site Survey	1	ac	$1,175.00				$1,175	$0	$0	$0	$1,175	
2 DECONTAMINATION												
2.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150	
2.2 Decontamination Services (man-weeks)	4	wk		$840.00			$0	$3,360	$0	$0	$3,360	
2.3 Decon Water Storage Tank, 6,000 gallon	1	mo				$641.30	$0	$0	$0	$641	$641	
2.4 Clean Water Storage Tank, 4,000 gallon	1	mo				$545.90	$0	$0	$0	$546	$546	
2.5 Decon Water Transportation & Disposal	500	gal	$0.85				$425	$0	$0	$0	$425	
2.6 PPE (10p * 5 days * 4 weeks)	200	day		$30.00			$0	$6,000	$0	$0	$6,000	
3 WALL INSTALLATION												
3.1 Compatibility Testing	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000	
3.2 Site License Fee	1	ls	$45,630.00				$45,630	$0	$0	$0	$45,630	15% of material/construction cost
3.3 Import Iron Filings	600	ton	$425.00				$255,000	$0	$0	$0	$255,000	
3.4 Excavation and installation of wall	12000	sf	$4.10				$49,200	$0	$0	$0	$49,200	300' long, 20" wide, 40' deep
3.5 Haul Waste Material from Wall Construction	7200	mi	$4.00				$28,800	$0	$0	$0	$28,800	18 cy/truck - 450 mile trip
3.6 Disposal of Waste Material at Hazardous Landfill	420	ton	$65.00				$27,300	$0	$0	$0	$27,300	1.5 tons/cy
4 MONITORING WELL INSTALLATION												
4.1 Install Monitoring Wells	90	vf	$40.00				$3,600	$0	$0	$0	$3,600	3 @ 30 feet
4.2 IDW Containerization	15	ea	$50.00				$750	$0	$0	$0	$750	labor, materials and equipment
4.3 IDW Transportation and Disposal	15	ea	$100.00				$1,500	$0	$0	$0	$1,500	hazardous disposal
4.4 Well Development	3	hr	$250.00				$750	$0	$0	$0	$750	1 hr per well
4.5 Development Water Transportation and Disposal	825	gal	$2.00				$1,650	$0	$0	$0	$1,650	hazardous disposal
4.6 Well Pads w/ Posts	3	ea	$750.00				$2,250	$0	$0	$0	$2,250	
5 SITE RESTORATION												
5.1 Purchase Topsoil, 6 in, Delivered	65	cy		$5.55			$0	$361	$0	$0	$361	
5.2 Spread Topsoil	65	cy			$0.51	$1.40	$0	$0	$33	$91	$124	
5.3 Revegetate	130	sy		$0.48	$1.40	$0.21	$0	$62	$182	$27	$272	equal to disturbed area
Subtotal Direct Costs less Subcontract								$16,083	$18,476	$7,676	$42,234	
Overhead on Labor Cost @ 30%									$5,543		$5,543	
G & A on Labor Cost @ 10%									$1,848		$1,848	
G & A on Material Cost @ 10%								$1,608			$1,608	
Total Direct Cost								$17,691	$25,866	$7,676	$51,233	
Indirects on Total Direct Labor Cost @ 75%									$19,399		$19,399	
Profit on Total Direct Cost @ 10%											$5,123	
Subtotal											$75,756	
Health & Safety Monitoring @ 3%											$2,273	
Total Field Cost											**$78,028**	
Subtotal Subcontractor Cost							$423,030				$423,030	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 3 - Reactive Groundwater Treatment Wall

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
G & A on Subcontract Cost @	10%						$42,303				$42,303	
Profit on Subcontractor Cost @	5%										$21,152	
Subcontractor Cost											**$486,485**	
Contingency on Total Field and Subcontractor Costs @	10%										**$56,451**	
Engineering on Total Field Cost @	4%										**$3,121**	
TOTAL COST											**$624,085**	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 3 - Reactive Groundwater Treatment Wall
Annual Operating and Maintenance Costs

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
1	Maintenance - Rejuvinate Reactive Wall Every 10 years	1	ls	$50,000	$50,000	
	Total Cost (every 10 years)				$50,000	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 3 - Reactive Groundwater Treatment Wall
Annual Monitoring Costs

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Sampling	$12,000		1 laborer for 2 days, four times a year w/mob., per diem, shipping, IDW disposal, and supply costs
Analysis/Water	$6,000		Sampling 10 wells quarterly. TCL VOC analysis.
Annual Report	$6,000		
Site Review		$6,000	
TOTALS	$24,000	$6,000	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 3 - Reactive Groundwater Treatment Wall
Present Worth Analysis

Year	Capital Cost	Operation & Maintenanc Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$624,085			$624,085	1.000	$624,085
1			$24,000	$24,000	0.935	$22,440
2			$24,000	$24,000	0.873	$20,952
3			$24,000	$24,000	0.816	$19,584
4			$24,000	$24,000	0.763	$18,312
5			$30,000	$30,000	0.713	$21,390
6			$24,000	$24,000	0.666	$15,984
7			$24,000	$24,000	0.623	$14,952
8			$24,000	$24,000	0.582	$13,968
9			$24,000	$24,000	0.544	$13,056
10		$50,000	$30,000	$80,000	0.508	$40,640
11			$24,000	$24,000	0.475	$11,400
12			$24,000	$24,000	0.444	$10,656
13			$24,000	$24,000	0.415	$9,960
14			$24,000	$24,000	0.388	$9,312
15			$30,000	$30,000	0.362	$10,860
16			$24,000	$24,000	0.339	$8,136
17			$24,000	$24,000	0.317	$7,608
18			$24,000	$24,000	0.296	$7,104
19			$24,000	$24,000	0.277	$6,648
20		$50,000	$30,000	$80,000	0.258	$20,640
21			$24,000	$24,000	0.242	$5,808
22			$24,000	$24,000	0.226	$5,424
23			$24,000	$24,000	0.211	$5,064
24			$24,000	$24,000	0.197	$4,728
25			$30,000	$30,000	0.184	$5,520
26			$24,000	$24,000	0.172	$4,128
27			$24,000	$24,000	0.161	$3,864
28			$24,000	$24,000	0.150	$3,600
29			$24,000	$24,000	0.141	$3,384
30			$30,000	$30,000	0.131	$3,930
					TOTAL PRESENT WORTH	**$973,137**

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: US NAVY	JOB NUMBER: 7855-0300
SUBJECT: WHITE OAK SITE 46 - ALT 3	
BASED ON:	DRAWING NUMBER:
BY: JBR 7/9/98	CHECKED BY: L. Shipley 7/15/98
APPROVED BY:	DATE:

CLEAR & GRUB - 30' WIDE FOR 200' LENGTH OF REACTIVE WALL

$(30')(300') = 9{,}000\ ft^2$

[0.21 ac.]

SAY A TOTAL OF 0.5 AC TO ACCOUNT FOR SOURCE REMOVAL CLEARING AND SMALL AREAS.

CONTAMINATED WASTE MATERIAL DISPOSAL

USE 1.5 TONS / CY

278 CY MATERIAL (FROM LORAINE SHIPLEY'S CALC)

$278\ CY\ (1.5\ TONS/CY) = 417$

SAY 420 TONS

REVEGETATE = DISTURBED AREA = 0.5 AC

$(0.5\ AC)\left(\frac{43560\ SF}{AC}\right)\left(\frac{SY}{9\ SF}\right) = 2{,}420\ SY$

= SY

ALTERNATIVE 4a

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4a - Groundwater Treatment via Air Stripping - Site W Swale Treatment Unit

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Mobilize/Demobilize Equipment	1	ls				$1,000.00	$0	$0	$0	$1,000	$1,000	backhoe, drill rig
1.2 Mobilize/Demobilize Personnel	6	ea			$500.00		$0	$0	$3,000	$0	$3,000	3 ppl, 2 ways
1.3 Per Diem	42	man-dy			$162.00		$0	$0	$6,804	$0	$6,804	2 wks - 14days each
1.4 Office Trailer	1	mo				$215.00	$0	$0	$0	$215	$215	
1.5 Storage Trailer	1	mo				$95.00	$0	$0	$0	$95	$95	
1.6 Decontamination Trailer	1	mo				$2,332.00	$0	$0	$0	$2,332	$2,332	
1.7 Utilities	1	mo		$500.00			$0	$500	$0	$0	$500	
1.8 Clear & Grub	0.75	ac			$3,613.00	$4,056.00	$0	$0	$2,710	$3,042	$5,752	
1.9 Site Survey	1	ac	$1,175.00				$1,175	$0	$0	$0	$1,175	
2 DECONTAMINATION												
2.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150	
2.2 Decontamination Services (man-weeks)	4	wk		$840.00			$0	$3,360	$0	$0	$3,360	
2.3 Decon Water Storage Tank, 6,000 gallon	1	mo				$641.30	$0	$0	$0	$641	$641	
2.4 Clean Water Storage Tank, 4,000 gallon	1	mo				$545.90	$0	$0	$0	$546	$546	
2.5 Decon Water Transportation & Disposal	500	gal	$0.85				$425	$0	$0	$0	$425	
2.6 PPE (4 p * 5 days * 4 weeks)	80	day		$30.00			$0	$2,400	$0	$0	$2,400	
3 GROUNDWATER EXTRACTION WELL INSTALLATION												
3.1 Install Extraction Well (40' in depth)	40	vf	$60.00				$2,400	$0	$0	$0	$2,400	15' screen
3.2 IDW Containerization	6	ea	$50.00				$300	$0	$0	$0	$300	labor, materials and equipment
3.3 IDW Transportation and Disposal	6	ea	$100.00				$600	$0	$0	$0	$600	hazardous disposal
3.4 Well Development	1	hr	$250.00				$250	$0	$0	$0	$250	
3.5 Development Water Transportation and Disposal	220	gal	$2.00				$440	$0	$0	$0	$440	hazardous disposal
3.6 Well Vault Box (2'x2'x2' w/ locking lid)	1	ea		$371.00	$265.00		$0	$371	$265	$0	$636	
4 DISCHARGE PIPING												
4.1 Trenching (2' wide by 3' deep)	700	lf			$1.97	$1.27	$0	$0	$1,379	$889	$2,268	incl. backfill, compaction and spoil dis
4.2 Pipe Bedding (2' wide)	700	lf		$0.58	$1.08	$0.27	$0	$406	$756	$189	$1,351	incl. gravel and compaction
4.3 1" PVC Pipe	700	lf		$0.93	$5.57	$0.32	$0	$651	$3,899	$224	$4,774	
4.4 3" Corrugated Plastic Pipe	700	lf		$0.40	$0.28		$0	$280	$196	$0	$476	1" PVC sleeved in 3" corrugated
4.5 Groundwater Pump	1	ea		$1,382.00	$328.80		$0	$1,382	$329	$0	$1,711	1-1/2 hp, 230V
4.6 Electric Connection for Pump	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000	
5 SITE RESTORATION												
5.1 Purchase Topsoil, 6 in, Delivered	25	cy		$5.55			$0	$139	$0	$0	$139	
5.2 Spread Topsoil w/ Backhoe	25	cy			$0.51	$1.40	$0	$0	$13	$35	$48	
5.3 Revegetate	150	sy		$0.48	$1.40	$0.21	$0	$72	$210	$32	$314	equal to disturbed area
Subtotal Direct Costs less Subcontract								$15,361	$26,210	$9,940	$51,511	
Overhead on Labor Cost @ 30%									$7,863		$7,863	
G & A on Labor Cost @ 10%									$2,621		$2,621	
G & A on Material Cost @ 10%								$1,536			$1,536	
Total Direct Cost								$16,897	$36,694	$9,940	$63,531	
Indirects on Total Direct Labor Cost @ 75%									$27,521		$27,521	
Profit on Total Direct Cost @ 10%											$6,353	
Subtotal											$97,405	
Health & Safety Monitoring @ 3%											$2,922	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4a - Groundwater Treatment via Air Stripping - Site W Swale Treatment Unit

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
Total Field Cost											**$100,327**	
Subtotal Subcontractor Cost							$7,590				$7,590	
G & A on Subcontract Cost @ 10%							$759				$759	
Profit on Subcontractor Cost @ 5%											$380	
Subcontractor Cost											**$8,729**	
Contingency on Total Field and Subcontractor Costs @ 10%											**$10,906**	
Engineering on Total Field Cost @ 4%											**$4,013**	
TOTAL COST											**$123,974**	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4a - Groundwater Treatment via Air Stripping - Site W Swale Treatment Unit
Annual Operating and Maintenance Costs

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
1	Energy - Electric	9800	Kw-hr	$0.06	$588	Note: Annual Cost - 24 hr/ day - 365 days/ year
	Total Annual Cost				$588	
1	Maintenance	1	ls	$1,711	$1,711	Replace pump every 5 years
2	Labor	8	hr	$35	$280	1 person for 8 hours every 5 years
	Additional Maintenance Cost Every 5 Years				$2,579	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4a - Groundwater Treatment via Air Stripping - Site W Swale Treatment Unit
Annual Monitoring Cost

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Sampling	$12,000		2 laborers, 1 day, four times a year w/mob., per diem, shipping, IDW disposal, and supply costs.
Analysis/Water	$6,000		Sampling 10 points quarterly - wells and treatment system effluent TCL VOC analysis.
Annual Report	$6,000		
Site Review		$6,000	
TOTALS	$24,000	$6,000	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4a - Groundwater Treatment via Air Stripping - Site W Swale Treatment Unit
Present Worth Analysis

Year	Capital Cost	Operation & Maintenanc Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$123,974			$123,974	1.000	$123,974
1		$588	$24,000	$24,588	0.935	$22,990
2		$588	$24,000	$24,588	0.873	$21,465
3		$588	$24,000	$24,588	0.816	$20,064
4		$588	$24,000	$24,588	0.763	$18,761
5		$3,167	$30,000	$33,167	0.713	$23,648
6		$588	$24,000	$24,588	0.666	$16,376
7		$588	$24,000	$24,588	0.623	$15,318
8		$588	$24,000	$24,588	0.582	$14,310
9		$588	$24,000	$24,588	0.544	$13,376
10		$3,167	$30,000	$33,167	0.508	$16,849
11		$588	$24,000	$24,588	0.475	$11,679
12		$588	$24,000	$24,588	0.444	$10,917
13		$588	$24,000	$24,588	0.415	$10,204
14		$588	$24,000	$24,588	0.388	$9,540
15		$3,167	$30,000	$33,167	0.362	$12,006
16		$588	$24,000	$24,588	0.339	$8,335
17		$588	$24,000	$24,588	0.317	$7,794
18		$588	$24,000	$24,588	0.296	$7,278
19		$588	$24,000	$24,588	0.277	$6,811
20		$3,167	$30,000	$33,167	0.258	$8,557
21		$588	$24,000	$24,588	0.242	$5,950
22		$588	$24,000	$24,588	0.226	$5,557
23		$588	$24,000	$24,588	0.211	$5,188
24		$588	$24,000	$24,588	0.197	$4,844
25		$3,167	$30,000	$33,167	0.184	$6,103
26		$588	$24,000	$24,588	0.172	$4,229
27		$588	$24,000	$24,588	0.161	$3,959
28		$588	$24,000	$24,588	0.150	$3,688
29		$588	$24,000	$24,588	0.141	$3,467
30		$3,167	$30,000	$33,167	0.131	$4,345
					TOTAL PRESENT WORTH	**$447,583**

CALCULATION WORKSHEET Order No. 19116 (01-01)

CLIENT: US NAVY	JOB NUMBER: 7855-0300
SUBJECT: WHITE OAK SITE 46 - ALT 4a	
BASED ON:	DRAWING NUMBER:
BY: JRR 7/9/98	CHECKED BY: L. Shipley 7/15/98
APPROVED BY:	DATE:

TRENCHING SYSTEM, INCL BACKFILL, COMPACTION — M98 A12.3-110-1320

2' WIDE, 3' DEEP

LF — L 1.97 — E 1.27

PIPE BEDDING, 2' WIDE — M98 A12.3-310-1460

LF — M 0.58 — L 1.08 — E 0.27

(ASSUMING 80-20 PROPORTION LAB-EQUIP)

1¼" PVC PIPE — E98-3326-0401

LF — M 0.93 — L 5.57 — E 0.32

3" CORRUGATED PLASTIC PIPE — M98-027-111-0030

LF — M 0.40 — L 0.28

CLEAR & GRUB

10' + 700' = 7,000 ft² [0.16 ac]

TOTAL = 0.25 + 0.16 ac

= 0.41

SAY 0.5 Ac + 0.25 - SOURCE REMOVAL COMPONENT

GROUNDWATER PUMP, 1½ hp, 230V, W/O CONTROLS — E98-3323-0701

EA — M 1,382 — L 328.80

RENEGETATE = DISTURBED AREA

= 1830 sy

$$0.75\ Ac \left(\frac{43{,}560\ sf}{Ac}\right)\left(\frac{1\ sy}{9\ sf}\right) = 3{,}630\ sy$$

CALCULATION WORKSHEET Order No. 19116 (01-01)

CLIENT: US NAVY	JOB NUMBER: 7855-0300
SUBJECT: WHITE OAK SITE 46 - ALT 4a	
BASED ON:	DRAWING NUMBER:
BY: JRR 7/10/98	CHECKED BY: L Shipley 7/15/98
APPROVED BY:	DATE:

PUMP ELECTRIC USAGE

HP x 746 = Watts

$\frac{1.5 hp \times 746}{1000} = 1.119$ kW

kW x 24 $\frac{hrs}{day}$ x 365 days/yr = kWh per year

1.119 kW x 24 x 365 = 9,802.44 kWh per year

ALTERNATIVE 4b

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4b - Groundwater Treatment via Air Stripping - Isherwood Road Stream Treatment Unit

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Mobilize/Demobilize Equipment	1	ls				$1,000.00	$0	$0	$0	$1,000	$1,000	backhoe, drill rig
1.2 Mobilize/Demobilize Personnel	6	ea			$500.00		$0	$0	$3,000	$0	$3,000	3 ppl, 2 ways
1.3 Per Diem	42	man-dy			$162.00		$0	$0	$6,804	$0	$6,804	2 wks - 14days each
1.4 Office Trailer	1	mo				$215.00	$0	$0	$0	$215	$215	
1.5 Storage Trailer	1	mo				$95.00	$0	$0	$0	$95	$95	
1.6 Decontamination Trailer	1	mo				$2,332.00	$0	$0	$0	$2,332	$2,332	
1.7 Utilities	1	mo		$500.00			$0	$500	$0	$0	$500	
1.8 Clear & Grub	0.85	ac			$3,613.00	$4,056.00	$0	$0	$3,071	$3,448	$6,519	
1.9 Site Survey	1	ac	$1,175.00				$1,175	$0	$0	$0	$1,175	
2 DECONTAMINATION												
2.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150	
2.2 Decontamination Services (man-weeks)	4	wk		$840.00			$0	$3,360	$0	$0	$3,360	
2.3 Decon Water Storage Tank, 6,000 gallon	1	mo				$641.30	$0	$0	$0	$641	$641	
2.4 Clean Water Storage Tank, 4,000 gallon	1	mo				$545.90	$0	$0	$0	$546	$546	
2.5 Decon Water Transportation & Disposal	500	gal	$0.85				$425	$0	$0	$0	$425	
2.6 PPE (4 p * 5 days * 4 weeks)	80	day		$30.00			$0	$2,400	$0	$0	$2,400	
3 GROUNDWATER EXTRACTION WELL INSTALLATION												
3.1 Install Extraction Well (40' in depth)	40	vf	$60.00				$2,400	$0	$0	$0	$2,400	15' screen
3.2 IDW Containerization	6	ea	$50.00				$300	$0	$0	$0	$300	labor, materials and equipment
3.3 IDW Transportation and Disposal	6	ea	$100.00				$600	$0	$0	$0	$600	hazardous disposal
3.4 Well Development	1	hr	$250.00				$250	$0	$0	$0	$250	
3.5 Development Water Transportation and Disposal	220	gal	$2.00				$440	$0	$0	$0	$440	hazardous disposal
3.6 Well Vault Box (2'x2'x2' w/ locking lid)	1	ea		$371.00	$265.00		$0	$371	$265	$0	$636	
4 DISCHARGE PIPING												
4.1 Trenching (2' wide by 3' deep)	800	lf			$1.97	$1.27	$0	$0	$1,576	$1,016	$2,592	incl. backfill, compaction and spoil dis
4.2 Pipe Bedding (2' wide)	800	lf		$0.58	$1.08	$0.27	$0	$464	$864	$216	$1,544	incl. gravel and compaction
4.3 1" PVC Pipe	800	lf		$0.93	$5.57	$0.32	$0	$744	$4,456	$256	$5,456	
4.4 3" Corrugated Plastic Pipe	800	lf		$0.40	$0.28		$0	$320	$224	$0	$544	1" PVC sleeved in 3" corrugated
4.5 Groundwater Pump	1	ea		$1,382.00	$328.80		$0	$1,382	$329	$0	$1,711	1-1/2 hp, 230V
5 INSTALL TREATMENT SYSTEM												
5.1 6" Concrete Slab on Grade, Reinforced	108	sf		$2.67	$3.05	$1.00	$0	$288	$329	$108	$726	
5.2 Treatment Building	1	ls		$3,900.00	$650.00		$0	$3,900	$650	$0	$4,550	
5.3 Shallow Tray Air Stripper	1	ea		$11,000.00	$3,800.00	$1,900.00	$0	$11,000	$3,800	$1,900	$16,700	5 gpm
5.4 Bag Filter	1	ea		$2,000.00	$300.00		$0	$2,000	$300	$0	$2,300	
5.5 PVC Pipe - 4" - Dischage	50	lf		$2.83	$2.82		$0	$142	$141	$0	$283	
5.6 Plumb system	1	ls		$1,000.00	$500.00		$0	$1,000	$500	$0	$1,500	
5.7 Pressure Gauges	1	ea		$175.00	$50.00		$0	$175	$50	$0	$225	
5.8 Rip Rap Discharge Protection	2	cy		$15.40	$6.70	$8.00	$0	$31	$13	$16	$60	
6 INSTALL ELECTRICAL												
6.1 Load Center, 3W, 120/240 V, Single Phase	1	ea	$380.00				$380	$0	$0	$0	$380	
6.2 Meter Center - 4 terminals, 100 Amp	1	ea	$147.00				$147	$0	$0	$0	$147	
6.3 Grounding	1	ea	$400.00				$400	$0	$0	$0	$400	
6.4 100 Amp Outdoor Disconnect Switch	1	ea	$1,525.00				$1,525	$0	$0	$0	$1,525	
6.5 3/4" PVC Coated Conduit	1	Clf	$91.50				$92	$0	$0	$0	$92	
6.6 Power Groundwater Pump	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000	1 electrician for 2 days + supplies
6.7 Connect Air Stripper	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000	1 electrician for 2 days
7 SITE RESTORATION												
7.1 Purchase Common Fill, Delivered	50	cy		$6.75			$0	$338	$0	$0	$338	
7.2 Spread Fill from Stockpile w/ Backhoe	50	cy			$0.51	$1.40	$0	$0	$26	$70	$96	
7.3 Purchase Topsoil, 6 in, Delivered	30	cy		$5.55			$0	$167	$0	$0	$167	
7.4 Spread Topsoil from Stockpile w/ Backhoe	30	cy			$0.51	$1.40	$0	$0	$15	$42	$57	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4b - Groundwater Treatment via Air Stripping - Isherwood Road Stream Treatment Unit

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
7.5 Revegetate	180	sy		$0.48	$1.40	$0.21	$0	$86	$252	$38	$376	equal to disturbed area
Subtotal Direct Costs less Subcontract								$34,467	$33,315	$12,639	$80,421	
Overhead on Labor Cost @ 30%									$9,995		$9,995	
G & A on Labor Cost @ 10%									$3,332		$3,332	
G & A on Material Cost @ 10%								$3,447			$3,447	
Total Direct Cost								$37,914	$46,642	$12,639	$97,194	
Indirects on Total Direct Labor Cost @ 75%									$34,981		$34,981	
Profit on Total Direct Cost @ 10%											$9,719	
Subtotal											$141,895	
Health & Safety Monitoring @ 3%											$4,257	
Total Field Cost											**$146,151**	
Subtotal Subcontractor Cost							$11,134				$11,134	
G & A on Subcontract Cost @ 10%							$1,113				$1,113	
Profit on Subcontractor Cost @ 5%											$557	
Subcontractor Cost											**$12,804**	
Contingency on Total Field and Subcontractor Costs @ 10%											**$15,895**	
Engineering on Total Field Cost @ 4%											**$5,846**	
TOTAL COST											**$180,697**	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4b - Groundwater Treatment via Air Stripping - Isherwood Road Stream Treatment Unit
Annual Operating and Maintenance Costs

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
1	Energy - Electric	16338	Kw-hr	$0.06	$980	Pump (1.5 hp), Blower (2 hp)
2	Maintenance	1	ls	$1,358	$1,358	3% of Capital Cost
3	Labor	12	day	$280	$3,360	1 visit per month
4	Mobilization/Demobilization/Per Diem	12	ea	$1,166.00	$13,992	1 visit per month
	Total Annual Cost				$19,690	

Note: Annual Cost - 24 hr/ day - 365 days/ year

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4b - Groundwater Treatment via Air Stripping - Isherwood Road Stream Treatment Unit
Annual Cost

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Sampling	$12,000		1 laborer, 2 days, four times a year w/mob., per diem, shipping, IDW disposal, and supply costs.
Analysis/Water	$6,000		Sampling 10 points quarterly - wells and treatment plant discharge. TCL VOC analysis.
Annual Report	$6,000		
Site Review		$6,000	
TOTALS	$24,000	$6,000	

NAVAL SURFACE WARFARE CENTER-WHITE OAK
Maryland
Site 46 EE/CA
Alternative 4b - Groundwater Treatment via Air Stripping - Isherwood Road Stream Treatment Unit
Present Worth Analysis

Year	Capital Cost	Operation & Maintenanc Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$180,697			$180,697	1.000	$180,697
1		$19,690	$24,000	$43,690	0.935	$40,850
2		$19,690	$24,000	$43,690	0.873	$38,142
3		$19,690	$24,000	$43,690	0.816	$35,651
4		$19,690	$24,000	$43,690	0.763	$33,336
5		$19,690	$30,000	$49,690	0.713	$35,429
6		$19,690	$24,000	$43,690	0.666	$29,098
7		$19,690	$24,000	$43,690	0.623	$27,219
8		$19,690	$24,000	$43,690	0.582	$25,428
9		$19,690	$24,000	$43,690	0.544	$23,768
10		$19,690	$30,000	$49,690	0.508	$25,243
11		$19,690	$24,000	$43,690	0.475	$20,753
12		$19,690	$24,000	$43,690	0.444	$19,399
13		$19,690	$24,000	$43,690	0.415	$18,131
14		$19,690	$24,000	$43,690	0.388	$16,952
15		$19,690	$30,000	$49,690	0.362	$17,988
16		$19,690	$24,000	$43,690	0.339	$14,811
17		$19,690	$24,000	$43,690	0.317	$13,850
18		$19,690	$24,000	$43,690	0.296	$12,932
19		$19,690	$24,000	$43,690	0.277	$12,102
20		$19,690	$30,000	$49,690	0.258	$12,820
21		$19,690	$24,000	$43,690	0.242	$10,573
22		$19,690	$24,000	$43,690	0.226	$9,874
23		$19,690	$24,000	$43,690	0.211	$9,219
24		$19,690	$24,000	$43,690	0.197	$8,607
25		$19,690	$30,000	$49,690	0.184	$9,143
26		$19,690	$24,000	$43,690	0.172	$7,515
27		$19,690	$24,000	$43,690	0.161	$7,034
28		$19,690	$24,000	$43,690	0.150	$6,554
29		$19,690	$24,000	$43,690	0.141	$6,160
30		$19,690	$30,000	$49,690	0.131	$6,509
					TOTAL PRESENT WORTH	**$735,786**

CALCULATION WORKSHEET Order No. 19116 (91-01)

CLIENT: US NAVY	JOB NUMBER: 7855-0300
SUBJECT: WHITE OAK SITE 46 - ALT 4B	
BASED ON:	DRAWING NUMBER:

BY	CHECKED BY	APPROVED BY	DATE
JRR 7/10/98	L. Shipley 7/15/98		

RIP-RAP - MACHINE PLACED FOR SLOPE PROTECTION M98-022-712-0100

CY M 15.40 L 6.70 E 8

ALTERNATIVE 5

NAVAL SURFACE WARFARE CENTER - WHITE OAK
Maryland
Site 46 EE/CA
Alternative 5 - Air Sparing/Soil Vapor Extraction

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
1 MOBILIZATION/DEMOBILIZATION												
1.1 Mobilize/Demobilize Equipment	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000	backhoe/ATV drill rig/trailer
1.2 Mobilize/Demobilize Personnel	6	ea			$500.00		$0	$0	$3,000	$0	$3,000	Site Sup, Job Foreman, Ge
1.3 Per Diem	42	man-dy			$162.00		$0	$0	$6,804	$0	$6,804	2 wks - 14 days each
1.4 Office Trailer	2	mo				$215.00	$0	$0	$0	$430	$430	
1.5 Storage Trailer	2	mo				$95.00	$0	$0	$0	$190	$190	
1.6 Utilities	2	mo		$500.00			$0	$1,000	$0	$0	$1,000	
1.7 Clear & Grub	0.37	ac			$3,613.00	$4,056.00	$0	$0	$1,337	$1,501	$2,838	
1.8 Site Survey	0.55	ac	$792.00				$436	$0	$0	$0	$436	
2 DECONTAMINATION												
2.1 Decon Water Storage Tank, 6,000 gallon	1	mo				$641.30	$0	$0	$0	$641	$641	
2.2 Clean Water Storage Tank, 4,000 gallon	1	mo				$545.90	$0	$0	$0	$546	$546	
2.3 Decon Water Transportation & Disposal	1000	gal	$0.85				$850	$0	$0	$0	$850	
2.4 PPE (3 p * 5 days * 4 weeks)	60	day		$30.00			$0	$1,800	$0	$0	$1,800	
3 WELL INSTALLATION												
3.1 Install Air Injection Wells - HSA	380	vf	$40.00				$15,200	$0	$0	$0	$15,200	
3.2 Install Vapor Extraction Wells - HSA	250	vf	$40.00				$10,000	$0	$0	$0	$10,000	
3.3 Drill through Centrifuge floor	5	ea	$122.00				$610	$0	$0	$0	$610	6" diam, 2' thick
3.4 Continuous Split Spoons	315	ea	$10.00				$3,150	$0	$0	$0	$3,150	
3.5 Well Development	10	hr	$250.00				$2,500	$0	$0	$0	$2,500	
3.6 Containerize IDW (Drill Cuttings and Development Wa	24	wells	$50.00				$1,200	$0	$0	$0	$1,200	
3.7 Collect Groundwater Samples from Injection Wells	10	wells		$15.00	$25.00		$0	$150	$250	$0	$400	
3.8 Analysis of Groundwater Samples - TCL VOCs	10	ea	$150.00				$1,500	$0	$0	$0	$1,500	as baseline condition
4 PILOT SCALE TREATABILITY STUDY												
4.1 Design, Install, and Test Pilot Scale AS/SVE System	1	ls	$5,000.00		$10,000.00	$10,000.00	$5,000	$0	$10,000	$10,000	$25,000	
5 TREATMENT SYSTEM INSTALLATION												
5.1 Trench Excavation, Backfill, Compaction	9	day			$220.40	$285.00	$0	$0	$1,984	$2,565	$4,549	100 lf per day
5.2 Import Gravel Bedding	34	cy	$4.70	$17.25			$160	$587	$0	$0	$746	
5.3 2" PVC Pipe	1200	lf		$0.65	$2.05		$0	$780	$2,460	$0	$3,240	
5.4 Misc PVC Fittings - Elbows, Couplers, etc.	1	ls		$1,000.00			$0	$1,000	$0	$0	$1,000	
5.5 Pipe Testing	1	ls			$500.00	$250.00	$0	$0	$500	$250	$750	
5.6 Vault Boxes (2'x2'x2' w/ Locking Covers)	19	ea		$371.00	$265.00		$0	$7,049	$5,035	$0	$12,084	
5.7 6" Concrete Slab on Grade, Reinforced	108	sf		$2.67	$3.05	$1.00	$0	$288	$329	$108	$726	9' x 12'
5.8 Treatment Building	1	ls		$3,900.00	$650.00		$0	$3,900	$650	$0	$4,550	9'x12' x 8' high
5.9 Air Sparging System	1	ea	$85.00	$5,665.00	$2,832.50		$85	$5,665	$2,833	$0	$8,583	50 cfm @ 8 psi, 7-1/2 hp
5.10 Vapor Extraction System	1	ea	$85.00	$7,570.00	$3,785.00		$85	$7,570	$3,785	$0	$11,440	80 cfm @ 6" Hg, 7-1/2 hp
5.11 2" PVC Pressure Regulator on each well	24	ea		$84.80	$29.10		$0	$2,035	$698	$0	$2,734	
5.12 2" Gate Valve on each well	24	ea		$415.52	$29.10		$0	$9,972	$698	$0	$10,671	
5.13 2" Steel Pipe and Misc Steel Fittings for Inside Equip	1	ls		$2,500.00	$1,000.00		$0	$2,500	$1,000	$0	$3,500	
6 INSTALL ELECTRIC												
6.1 Load Center, 3W, 120/240 V, Single Phase	1	ea	$380.00				$380	$0	$0	$0	$380	
6.2 Meter Center - 4 terminals, 100 Amp	1	ea	$147.00				$147	$0	$0	$0	$147	
6.3 Grounding	2	ea	$400.00				$800	$0	$0	$0	$800	
6.4 100 Amp Outdoor Disconnect Switch	1	ea	$1,525.00				$1,525	$0	$0	$0	$1,525	
6.5 3/4" PVC Coated Conduit	2	Clf	$91.50				$183	$0	$0	$0	$183	
6.6 Connect Blowers	1	ls	$2,000.00				$2,000	$0	$0	$0	$2,000	1 electrician for 4 days
7 SITE RESTORATION												
7.1 Revegetate	1791	sy		$0.48	$1.40	$0.21	$0	$860	$2,507	$376	$3,743	equal to disturbed area
7.2 Transportation and Disposal of IDW - Solids	9	drum	$65.00				$585	$0	$0	$0	$585	assumes hazardous
7.3 Transportation and Disposal of IDW - Liquids	187	gal	$2.00				$374	$0	$0	$0	$374	assumes hazardous

NAVAL SURFACE WARFARE CENTER - WHITE OAK
Maryland
Site 46 EE/CA
Alternative 5 - Air Sparing/Soil Vapor Extraction

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal	Comments
Subtotal Direct Costs less Subcontract								$42,356	$32,730	$13,299	$88,385	
Overhead on Labor Cost @ 30%									$9,819		$9,819	
G & A on Labor Cost @ 10%									$3,273		$3,273	
G & A on Material Cost @ 10%								$4,236			$4,236	
Total Direct Cost								$46,592	$45,822	$13,299	$105,713	
Indirects on Total Direct Labor Cost @ 75%									$34,366		$34,366	
Profit on Total Direct Cost @ 10%											$10,571	
Subtotal											$150,650	
Health & Safety Monitoring @ 3%											$4,519	
Total Field Cost											**$155,169**	
Subtotal Subcontractor Cost							$45,484				$45,484	
G & A on Subcontract Cost @ 10%							$4,548				$4,548	
Profit on Subcontractor Cost @ 5%											$2,274	
Subcontractor Cost											**$52,306**	
Contingency on Total Field and Subcontractor Costs @ 10%											**$20,748**	
Engineering on Total Field Cost @ 4%											**$6,207**	
TOTAL COST											**$234,430**	

NAVAL SURFACE WARFARE CENTER - WHITE OAK
Maryland
Site 46 EE/CA
Alternative 5 - Air Sparing/Soil Vapor Extraction
Annual Operating and Maintenance Costs

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
1	Energy - Electric	98025	Kw-hr	$0.06	$5,882	
2	Maintenance	1	ls	$2,088	$2,088	3% of Items 5 and 6 Total Cost on Capital Cost Page
3	Labor	12	day	$280	$3,360	1 visit per month
4	Mobilization/Demobilization/Per Diem	12	ea	$1,166.00	$13,992	1 visit per month
5	Dispose of Water from Moisture Separator	600	gal	$2.00	$1,200	Assumes 50 gallons/month - hazardous
	Total Annual Cost				$26,522	

Note: Annual Cost - 24 hr/ day - 365 days/ year

NAVAL SURFACE WARFARE CENTER - WHITE OAK
Maryland
Site 46 EE/CA
Alternative 5 - Air Sparing/Soil Vapor Extraction
Annual Monitoring Cost

Item	Item Cost Annually	Item Cost per 5 Years	Notes
Sampling	$12,000		1 Laborer, 2 days, four times per year, w/ mob/demob, per diem, shipping, IDW disposal, and supply costs
Analysis/Water	$6,000		TCL VOCs; 10 existing wells; quarterly sampling
Analysis/Air	$1,000		TCL VOCs; 1 sample per quarter
Annual Report	$6,000		
Site Review		$6,000	
TOTALS	$25,000	$6,000	

NAVAL SURFACE WARFARE CENTER - WHITE OAK
Maryland
Site 46 EE/CA
Alternative 5 - Air Sparing/Soil Vapor Extraction
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$234,430			$234,430	1.000	$234,430
1		$26,522	$25,000	$51,522	0.935	$48,173
2		$26,522	$25,000	$51,522	0.873	$44,978
3		$26,522	$25,000	$51,522	0.816	$42,042
4		$26,522	$25,000	$51,522	0.763	$39,311
5		$26,522	$31,000	$57,522	0.713	$41,013
6		$26,522	$25,000	$51,522	0.666	$34,313
7		$26,522	$25,000	$51,522	0.623	$32,098
8		$26,522	$25,000	$51,522	0.582	$29,986
9		$26,522	$25,000	$51,522	0.544	$28,028
10		$26,522	$31,000	$57,522	0.508	$29,221
11		$26,522	$25,000	$51,522	0.475	$24,473
12		$26,522	$25,000	$51,522	0.444	$22,876
13		$26,522	$25,000	$51,522	0.415	$21,382
14		$26,522	$25,000	$51,522	0.388	$19,990
15		$26,522	$31,000	$57,522	0.362	$20,823
16		$26,522	$25,000	$51,522	0.339	$17,466
17		$26,522	$25,000	$51,522	0.317	$16,332
18		$26,522	$25,000	$51,522	0.296	$15,250
19		$26,522	$25,000	$51,522	0.277	$14,272
20		$26,522	$31,000	$57,522	0.258	$14,841
21		$26,522	$25,000	$51,522	0.242	$12,468
22		$26,522	$25,000	$51,522	0.226	$11,644
23		$26,522	$25,000	$51,522	0.211	$10,871
24		$26,522	$25,000	$51,522	0.197	$10,150
25		$26,522	$31,000	$57,522	0.184	$10,584
26		$26,522	$25,000	$51,522	0.172	$8,862
27		$26,522	$25,000	$51,522	0.161	$8,295
28		$26,522	$25,000	$51,522	0.150	$7,728
29		$26,522	$25,000	$51,522	0.141	$7,265
30		$26,522	$31,000	$57,522	0.131	$7,535
					TOTAL PRESENT WORTH	**$886,699**

CALCULATION WORKSHEET Order No. 19116 (01-01)

CLIENT	JOB NUMBER
US Navy	7855-0300
SUBJECT: WHITE OAK - Site 46 - ALT 5	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
LMS	J. Rinelli 7/15/98		7/9/98

Cost Estimate Quantities & Assumptions

Mob/Demob

Site Survey (200' x 120') = 0.55 acres

Clear and Grub 0.55 acres (- centrifuge area) = .37a
$\pi 50^2 = 0.18ac$

Assume use of decon pad at Parking Lot Landfill for Drill Rig Decon.

Well Installation

Air Injection wells - 2" PVC - 10 ea
8 @ 40'
2 @ 30' (inside centrifuge) } 380 lf

Vapor Extraction wells - 2" PVC - 14 each
11 @ 20'
3 @ 10' } 250 lf

Continuous Split Spoons - 315 ea.

Vault Boxes w/ Locking Covers - 11 + 8 = 19

Pipe Installation - 2" PVC

Extraction - 600' + 100' (header)
Injection - 400' + 100' (header) } 1200 lf

Trench Excav 600 + 400 + 100 (both header pipes will run through same trench)
- aboveground runs (200') = 900 lf

CLIENT	JOB NUMBER
US Navy	7855-0300
SUBJECT: White Oak - Site 46 Alt 5	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
LMS	J. Ritchie 7/15/98		7/9/98

Trench Excav

900 lf @ 2.5' deep x 2' wide = 167 cy
Assume Production rate of
Import Stone Bedding 100 ft/day = 9 days

1900 x 2' x 6" = 341 cy

IDW

2" well, 4" Hole

Volume = 630 cf @ 4" diam
= 55.1 cf @ 7.5 gal/cf
= 413 gal @ 50 gal/drum
= 9 drums Soil cuttings

Volume = 3 purge volumes @ 380 cf (injection wells only)
@ 2" diam
= 24.8 cf @ 7.5 gal/cf
= 187 gal @ 50 gal/drum
= 4 drums development water

Electrical Costs assume that power is available at Building adjacent to centrifuge

CALCULATION WORKSHEET Order No. 19116 (01-01)

CLIENT	JOB NUMBER
US Navy	7855-0300
SUBJECT	
White Oak. Site 46. AIES	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
LMS	J. Ritchie 7/15/98		7/9/98

Electrical Consumption

Blower 7½ hp
Compressor 7½ hp } 15 hp

$15\,hp \times 746 \frac{watts}{hp} = 11{,}190\,watts = 11.19\,kW$

$11.19\,kW \times 24 \frac{hours}{day} \times 365 \frac{days}{year} = 98{,}025 \frac{kWhr}{year}$

APPENDIX C

PRELIMINARY CONCEPTUAL DESIGN CALCULATIONS

CALCULATION WORKSHEET Order No. 19116 (01-01)

CLIENT	JOB NUMBER
NSWC White Oak Site 46	7855-0300 CTO 311

SUBJECT: Conceptual Design - Alt #3 - Reactive Groundwater Treatment Wall

BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
L. Shipley	J. Ritzuiz 7/15/98		7/6/98

Purpose: To calculate the required thickness of a reactive treatment wall to achieve necessary groundwater residence time for contaminant reduction.

References: In Situ Treatment Technology
Evan K. Nyer, et al; Geraghty & Miller
Environmental Science and Engineering
Series, Lewis Publishers @ 1996.

Known Data:

Depth to Water Table: 25'
Depth to Confining Unit: 40'
Influent TCE Concentration: 530 ug/L
(analytical data, TW1)
Effluent TCE Concentration: 5 ug/L (MCL)
Groundwater Flow Rate: 0.4 ft/day

Calculate:

$$N_{1/2} = [\ln(C_{eff}/C_{inf})] / \ln(1/2)$$ [Nyer, p. 283]

where

$N_{1/2}$ = the number of half lives required
C_{eff} = the desired effluent concentration
C_{inf} = the influent concentration

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
NSWC White Oak Site 46	7855-0300 CTO 311

SUBJECT: Conceptual Design - Alt #3 - Reactive Groundwater Treat...

BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
L. Shipley	J. Ritchie 7/15/98		7/6/98

$N_{1/2} = [\ln(5/530)] / \ln(1/2)$

$N_{1/2} = 6.7$ half lives

the half life of TCE is 13.6 hours

$\therefore$ Residence Time $= (6.7)(13.6)$

$= 91.5$ hours

Groundwater flow rate $= 0.4$ ft/day

wall thickness $= 91.5 \text{ hours} \times \frac{1 \text{ day}}{24 \text{ hours}} \times 0.4 \frac{\text{ft}}{\text{day}}$

$= 1.525$ ft

Use wall thickness of 20"

ESTIMATION OF
OFF-GAS EMISSIONS
AIR STRIPPER SYSTEM

ESTIMATION OF OFF-GAS EMISSIONS:

Vapor-phase Concentrations

Procedure:

1. Obtain mass flow rate of VOC in air assuming 100 % removal from water
2. Ratio of molar flow rate of VOC to molar flow rate of air= vapor-phase conc (ppmv)
3. Based on vapor-phase VOC conc, estimate GAC adsorption capacity
4. Using VOC mass loading and adsorption capacities, estimate GAC usage

Water flow rate=	5.00	gpm
Mass flow rate of VOC =5 gpm x [C]x0.012 lb/day		
where [C]= VOC concentration in water		
Molar flow rate of VOC= mass flow rate/mol wt.		
Air flow rate=	60.00	cfm (assuming shallow-tray type air stripper)
Air density =	0.08	lb/ft^3
Mass flow rate of air=	4.67	lb/min
Molar flow rate of air=	0.16	lbmol/min

Air Conc of VOC= molar flow rate of VOC/molar flow rate of carrier air

Concentrations in air stream :

Parameter	Water Conc (ug/L)	Mol Wt (lb/lb mol)	Molar flow rat (lbmol/min)	Vapor Conc (ppmv)	Vapor Conc (mg/m^3)	TWA Limi (ppmv)	Maximum Emissions (lb/day)	
TCE	**500**	131.9	1.58E-07	**0.98**	5.63	**50**	**3.00E-02**	
1,2-DCE	**53**	96	2.30E-08	**0.14**	0.60	**200**	**3.18E-03**	
			Total Conc=	**0.98**		**TotalVOC**	**0.03**	**lb/day**

State of Maryland Exemption for Small Quantities of Toxic Air Pollutants= 0.5 lb/hr for all VOCs whose TLVs exceed 200 micrograms/m^3 (MD Subtitle 11, Chapter 15, Sec 26.11)
Also District of Columbia does not require emissions control if total discharge is less than 15 lb/day for photochemically reactive solvents (Title 20, Chapter 7)

Because regulatory limits are not exceeded, no off-gas treatment would be required.

Carbonair Environmental Systems
2731 Nevada Avenue North
New Hope, MN 55427-2864
612-544-2154 800-526-4999
Fax: 612-544-2151

07/08/98
14:36:24

----------STAT 15----------
VERSION 3.1

WATER FLOW RATE: 5.0 gpm
AIR FLOW RATE: 60.0 cfm
WATER TEMPERATURE: 55.0 F
AIR-TO-WATER RATIO: 90:1

Influent Conc. for TRICHLOROETHENE 500.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	82.53905	87.3048	4.5855	0.0248
2	96.86230	15.6885	5.3812	0.0291
3	99.43329	2.8335	5.5241	0.0298
4	99.89755	0.5122	5.5499	0.0300
5	99.98148	0.0926	5.5545	0.0300
6	99.99665	0.0167	5.5554	0.0300

Influent Conc. for TOTAL VOCs 500.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	82.53905	87.3048	4.5855	0.0248
2	96.86230	15.6885	5.3812	0.0291
3	99.43329	2.8335	5.5241	0.0298
4	99.89755	0.5122	5.5499	0.0300
5	99.98148	0.0926	5.5545	0.0300
6	99.99665	0.0167	5.5554	0.0300