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REMEDIAL ACTION PLAN FOR MCCOY ANNEX NTC ORLANDO FL

8/1/1998

HARDING LAWSON ASSOCIATES

REMEDIAL ACTION PLAN

BUILDING 7241, MCCOY ANNEX

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

Unit Identification Code: N65928

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August 1998

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, Harding Lawson Associates (formerly ABB Environmental Services, Inc.), hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No.: N62467-89-D-0317/137 are complete and accurate and comply with all requirements of this contract.

DATE: August 5, 1998

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(DFAR 252.227-7036)

FOREWORD

Subtitle I of the Hazardous and Solid Waste Amendments of 1984 to the Solid Waste Disposal Act of 1965 established a national regulatory program for managing underground storage tanks (USTs) containing hazardous materials, especially petroleum products. Hazardous wastes stored in USTs were already regulated under the Resource Conservation and Recovery Act of 1976. Subtitle I requires that the U.S. Environmental Protection Agency (USEPA) promulgate UST regulations. The program was designed to be administered by individual states, who were allowed to develop more stringent, but not less stringent, standards. Local governments were permitted to establish regulatory programs and standards that are more stringent, but not less stringent, than either State or Federal regulations. The USEPA UST regulations are found in the Code of Federal Regulations, Title 40, Part 280 (40 CFR 280) (*Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks*) and 40 CFR 281 (*Approval of State Underground Storage Tank Programs*). 40 CFR 280 was revised and published on September 23, 1988, and became effective December 22, 1988.

The Navy's UST program policy is to comply with all Federal, State, and local regulations pertaining to USTs. This report was prepared to satisfy the requirements of Chapter 62-770, Florida Administrative Code (*State Underground Petroleum Environmental Response*) regulations on petroleum contamination in Florida's environment as a result of spills or leaking tanks or pipelines.

Questions regarding this report at Naval Training Center, Orlando should be addressed to Mr. Nick Ugolini, Code 1843, at 803-820-5596.

EXECUTIVE SUMMARY

The purpose of this Remedial Action Plan (RAP) is to present a plan for remediation of petroleum contamination at Building 7241, Naval Training Center McCoy Annex, Orlando, Florida. The RAP presented herein is designed for implementation at the Building 7241 site and, when implemented, will result in a reduction of the level of petroleum-related contamination in the soil and groundwater in accordance with the requirements of Chapters 62-770 and 62-775, Florida Administrative Code.

This RAP sets forth a procedure of excavation and destruction of excessively contaminated soil at the site. The area to be excavated is associated with the existing free product. Free-product recovery is proposed through direct excavation. As model results indicate, containment of the existing groundwater contamination and contaminant degradation by natural attenuation are expected to occur, but a monitoring program will be implemented for assurance.

This RAP presents the rationale for the remedial actions to be implemented at the Building 7241 site. Implementation of remedial actions described in this RAP will include the following tasks:

- excavation of contaminated soil in the area surrounding monitoring well MW-1 to a depth approximately 8 feet below ground surface;
- disposal of the contaminated soil by off-site thermal treatment;
- product recovery in the excavated area, as necessary; and
- groundwater monitoring for natural attenuation.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AST	aboveground storage tank
BTEX	benzene, toluene, ethylbenzene, and xylenes
bls	below land surface
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
HLA	Harding Lawson Associates
mg/ℓ	milligrams per liter
NTC	Naval Training Center
OVA	organic vapor analyzer
ppm	parts per million
PWC	Public Works Center
RAP	Remedial Action Plan
SA	site assessment
SAR	site assessment report
SOUTHNAV-FACENGCOM	Southern Division Naval Facilities Engineering Command
TRPH	total recoverable petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOA	volatile organic aromatic
yd^3	cubic yard

1.0 INTRODUCTION

A Site Assessment Report (SAR) for Building 7241 at McCoy Annex, Naval Training Center (NTC), Orlando, Florida, was submitted by ABB Environmental Services, Inc. (ABB-ES) (presently Harding Lawson Associates [HLA]) (ABB-ES, 1998), in January 1998 to Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM). After approval of the SAR by Florida Department of Environmental Protection (FDEP), HLA was authorized by SOUTHNAVFACENGCOM to develop a Remedial Action Plan (RAP). This work is being performed under Contract Task Order No. 107 of the Comprehensive Long-Term Environmental Action, Navy contract.

1.1 PURPOSE. The purpose of the RAP is to present a plan for remediation of petroleum contamination at Building 7241. The RAP presented herein is designed for implementation at Building 7241 and, when implemented, will result in compliance with the requirements of Chapters 62-770 and 62-775, Florida Administrative Code (FAC).

1.2 SCOPE. This RAP presents the rationale for the remedial actions to be implemented at Building 7241. Implementation of remedial actions described in this RAP will include the following tasks:

- removing the source (contaminated soil along with free product);
- disposal of contaminated soil, groundwater, and free product; and
- natural attenuation and groundwater monitoring.

2.0 BACKGROUND

2.1 SITE DESCRIPTION. Building 7241 (former Youth Recreation Center) is located on Daetwyler Drive in the central part of the NTC, Orlando, McCoy Annex, in Orange County, Florida. Figure 2-1 shows the site location and a map of the surrounding area.

Building 7241 is a one-story building constructed of concrete block with a flat corrugated metal roof. It is currently vacant, but the building was formerly used as the Youth Recreation Center and contained a roller rink, game room, arts and crafts room, kitchen, and chapel. Prior to building construction in 1953, the area was undeveloped.

2.2 SITE HISTORY. Building 7241 is the former location of three petroleum storage tank systems, which had been operated at the property. The system at the north part of the building consisted of a 1,500-gallon underground storage tank (UST) that stored heating fuel. The system on the south side consisted of a 1,000-gallon UST that also stored heating fuel. In addition, at the southwest corner of the building, a 265-gallon aboveground storage tank (AST) stored heating fuel. All three tank systems were associated with the building's heating system. The former locations of the petroleum storage tank systems are shown on Figure 2-2, Site Plan.

The AST was removed on October 17, 1997; the 1,000-gallon UST was removed on November 8, 1997; and the 1,500-gallon UST was removed on November 12, 1997. All the tank removals were performed by the Navy Public Works Center (PWC) Pensacola. One temporary monitoring well was installed near the former location of the 1,500-gallon UST at the north side of the building. Another temporary monitoring well was at the southwest corner of the building near the former location of the 265-gallon AST. Laboratory analytical results showed no evidence of petroleum impact to groundwater at either location. In addition, soil samples were collected from each former tank location and screened with an organic vapor analyzer (OVA). Evidence of petroleum impact to soil was detected at the former location of the 1,000-gallon UST on the south side of the building. The Tank Closure Assessment Report (Navy PWC Pensacola, 1997) for Building 7241 contains a recommendation for the preparation of the SAR for the 1,000-gallon UST area.

2.3 SUMMARY OF SAR. A site assessment (SA) of Building 7241 was conducted and an SAR was submitted to the FDEP in January 1998 (ABB-ES, 1998). The FDEP reviewed the assessment and recommended submission of an RAP for Building 7241.

The following presents a summary of field investigations conducted during the SAR activities:

- Nine piezometers (PZ-1 through PZ-9) were installed to a depth of approximately 7 feet below land surface (bls) to assess the direction of shallow groundwater flow and delineate free-floating product at Building 7241.

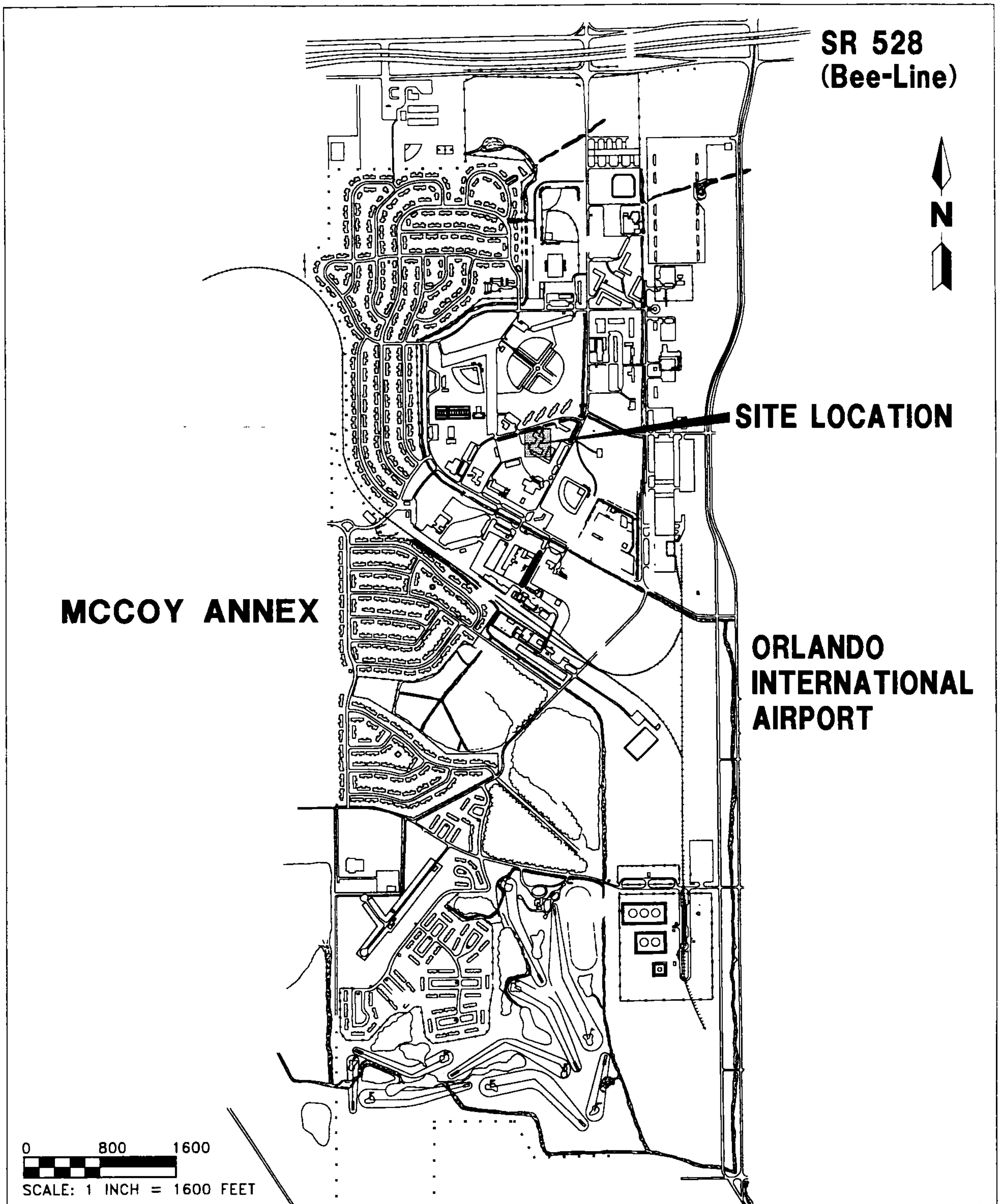

FIGURE 2-1
SITE LOCATION MAP

REMEDIAL ACTION PLAN
BUILDING 7241
MCCOY ANNEX

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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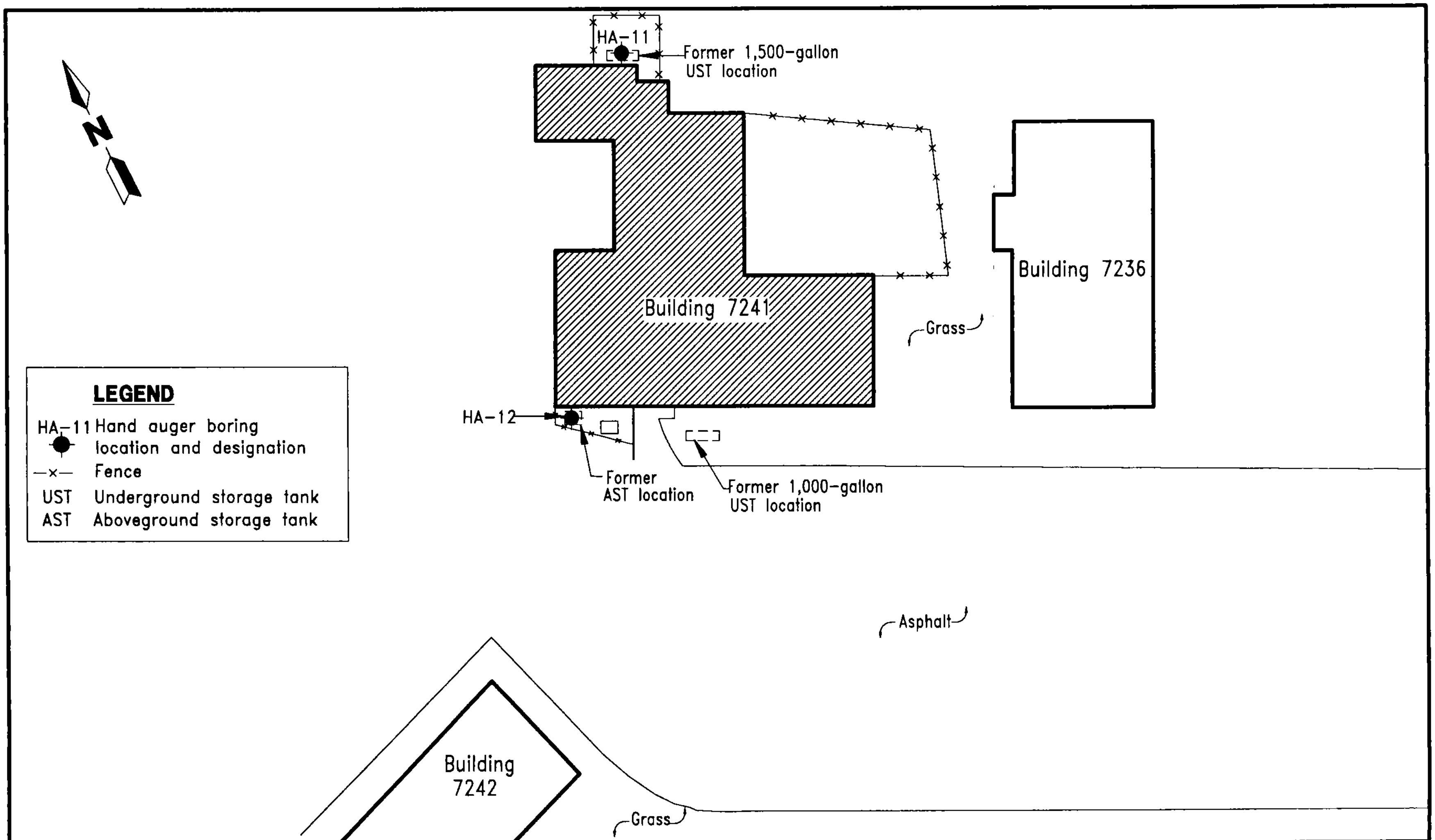

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FIGURE 2-2
SITE PLAN

REMEDIAL ACTION PLAN
BUILDING 7241
MCCOY ANNEX

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ORLANDO, FLORIDA

- Twelve soil borings were drilled, and soil samples were collected and analyzed for total volatile organic compounds using an OVA equipped with a flame ionization detector. In addition, three soil samples were collected and shipped to Savannah Laboratories and Environmental Services, Inc., to confirm petroleum impact to soil found with the OVA.

- Six monitoring wells were installed, and groundwater samples were collected and analyzed for constituents of the Kerosene Analytical Group. Groundwater samples collected from MW-1 indicted that dissolved petroleum hydrocarbon contamination exceeded Chapter 62-770, FAC, cleanup target levels.

The findings, conclusions, and recommendations of this SAR are summarized below.

2.3.1 SAR and Findings

Free Product

- Petroleum product measured 0.28 foot in thickness in monitoring well MW-1 on August 27, 1997.

Soil

- OVA analyzer headspace analyses of discrete soil samples collected from 12 soil borings on September 15 and October 24, 1997, indicate excessive petroleum contamination in soil samples collected from HA-3, HA-4, and HA-7 as defined by Chapter 62-770, FAC.

- Three composite soil samples were collected for laboratory analysis, including SS-1 (HA-4 from 2 to 4 feet bls); SS-2 (HA-7 from 2 to 4 feet bls); and SS-3 (HA-8 from 0 to 2 feet bls). Only SS-1 indicated the presence of several compounds at concentrations that exceed laboratory standard detection limits.

Groundwater

- Groundwater-level measurements conducted in August and September, 1997, indicate the groundwater flow direction at the site is generally from northwest towards southeast.

- Contaminants detected in groundwater samples collected on August 27, 1997, from MW-1, include benzene, ethylbenzene, xylenes, total recoverable petroleum hydrocarbons (TRPH), indeno(1,2,3-cd)pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene.

3.0 REMEDIAL ALTERNATIVES

3.1 CONTAMINANTS OF CONCERN. Contaminants of concern for Building 7241 are associated with a limited area of free product, soil contamination in the direct vicinity of free product, and groundwater contamination. Fingerprint analyses conducted on the free-phase product has indicated that the source of the contamination is the 1,000-gallon UST (ABB-ES, 1998). Therefore, the site contaminants of concern are those listed in Chapter 62-770, FAC, and presented in Table 3-1.

3.2 SOIL AND GROUNDWATER CLEANUP LEVELS. Standards and regulations regarding required remedial goals for soil and groundwater are contained in Chapter 62-770, FAC (September 1997) and should be applied following treatment by any method. Based on the available data and requirements in Chapter 62-770, FAC, the constituents of the Kerosene Analytical Group and mixed products analytical group are the basis for remedial actions. The target concentrations for each contaminant of concern are presented in Table 3-1. Soil target concentrations are based on a residential direct exposure scenario.

3.3 EXTENT OF CONTAMINATION. The area of contamination at Building 7241 includes the free-product plume, which consists of kerosene fuel, soil contaminated with Kerosene Analytical Group petroleum hydrocarbons, and groundwater contaminated with benzene, ethylbenzene, total xylenes, ethylene dibromide (EDB), indeno(1,2,3-cd)pyrene), and TRPH. The subsections below present a description on the extent of contamination in each of the areas.

3.3.1 Free Product Free-phase petroleum product is the primary source of contamination for soil and groundwater. Figure 3-1 presents the graph for the observed values of free-product thickness and the groundwater elevations at MW-1 between August 1997 and November 1997. This graph indicates that the observed free-product thickness varies with the groundwater level at MW-1. Observed thickness of free product is generally decreasing with an increase in groundwater level and vice versa. Groundwater elevation data is summarized in Appendix A. Based on the free-product thickness measurements recorded on October 23, 1997, and presented on Figure 3-2, the volume of free product remaining in the subsurface is estimated at 78.2 gallons (ABB-ES, 1998).

3.3.2 Soil As per Chapter 62-770, FAC, excessive soil contamination has been defined as soil with OVA headspace measurements exceeding 50 parts per million (ppm). In accordance with this definition, samples from the area near HA-2/DW2, HA-3/MW1, HA-4/MW1 and HA-7/MW3 exceeded 50 ppm. Three composite soil samples were collected for laboratory analysis, including SS-1/HA-4, SS-2/HA-7, and SS-3/HA-8. The soil samples were analyzed using U.S. Environmental Protection Agency (USEPA) Methods 8020, 8100, and Florida-Petroleum Residual Organics. Laboratory analytical results for soil sample SS-1 indicate the presence of several compounds at concentrations that exceed laboratory standard detection limits.

It is believed that the reported soil contamination is the result of the presence of floating free product at MW-1 and the contaminated groundwater. Seasonal variations in the water table may have resulted in some smearing of the free product. These facts indicate that the contamination is closely related to the

Table 3-1
Contaminants of Concern and Target Concentrations

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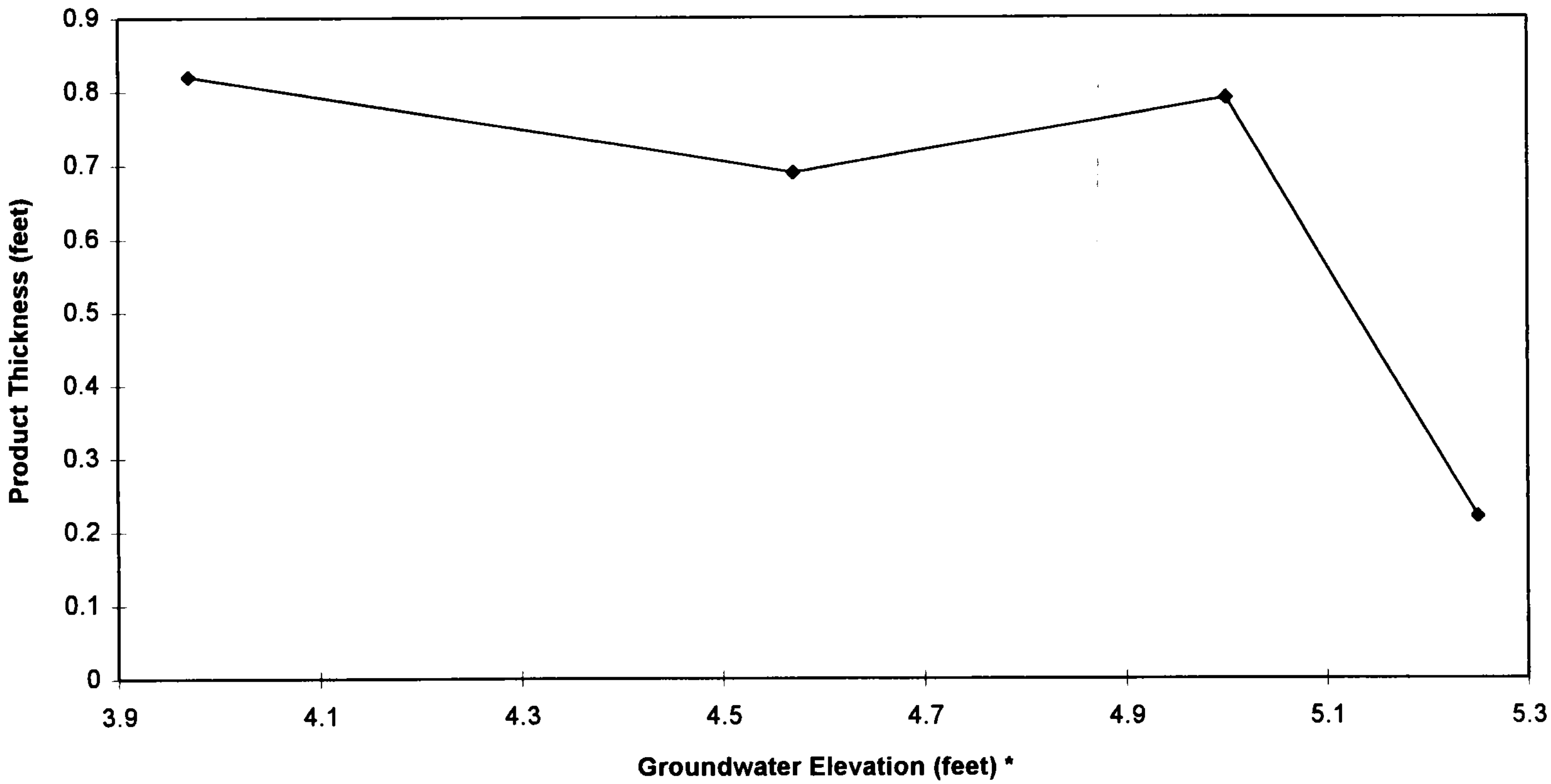
Parameter	Target Concentration	
	Soil (mg/kg)	Groundwater (ppb)
OVA reading for excessively contaminated soil	50 ppm	NA
Benzene	1.1	1
Toluene	300	40
Ethylbenzene	240	30
Total xylenes	290	20
1,2-Dibromoethane	NA	0.02
Acenaphthene	2,300	20
Acenaphthylene	1,100	210
Anthracene	19,000	2,100
Benzo(a)anthracene	1.4	0.2
Benzo(a)pyrene	0.1	0.2
Benzo(b)fluoranthene	1.4	0.2
Benzo(g,h,i)perylene	2,300	210
Benzo(k)fluoranthene	15	0.5
Chrysene	140	5
Dibenz(a,h)anthracene	0.1	0.2
Fluoranthene	2,800	280
Fluorene	2,100	280
Indeno(1,2,3-cd)pyrene	1.5	0.2
Naphthalene	1,000	20
Phenanthrene	1,900	210
Pyrene	2,200	210
1,2-Dichloroethane	0.6	3
Lead	500	15
Methyl tert-butyl ether	350	35
Total recoverable petroleum hydrocarbons	350	5 ppm

Notes: mg/kg = milligrams per kilogram.
ppb = parts per billion.
OVA = organic vapor analyzer.
NA = not applicable.
ppm = parts per million.



NOTES:
MW = monitoring well
* = relative to arbitrary datum

FIGURE 3-1
PRODUCT THICKNESS VERSUS WATER ELEVATION IN MW-1

REMEDIAL ACTION PLAN
BUILDING 7241
MCCOY ANNEX

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ORLANDO, FLORIDA

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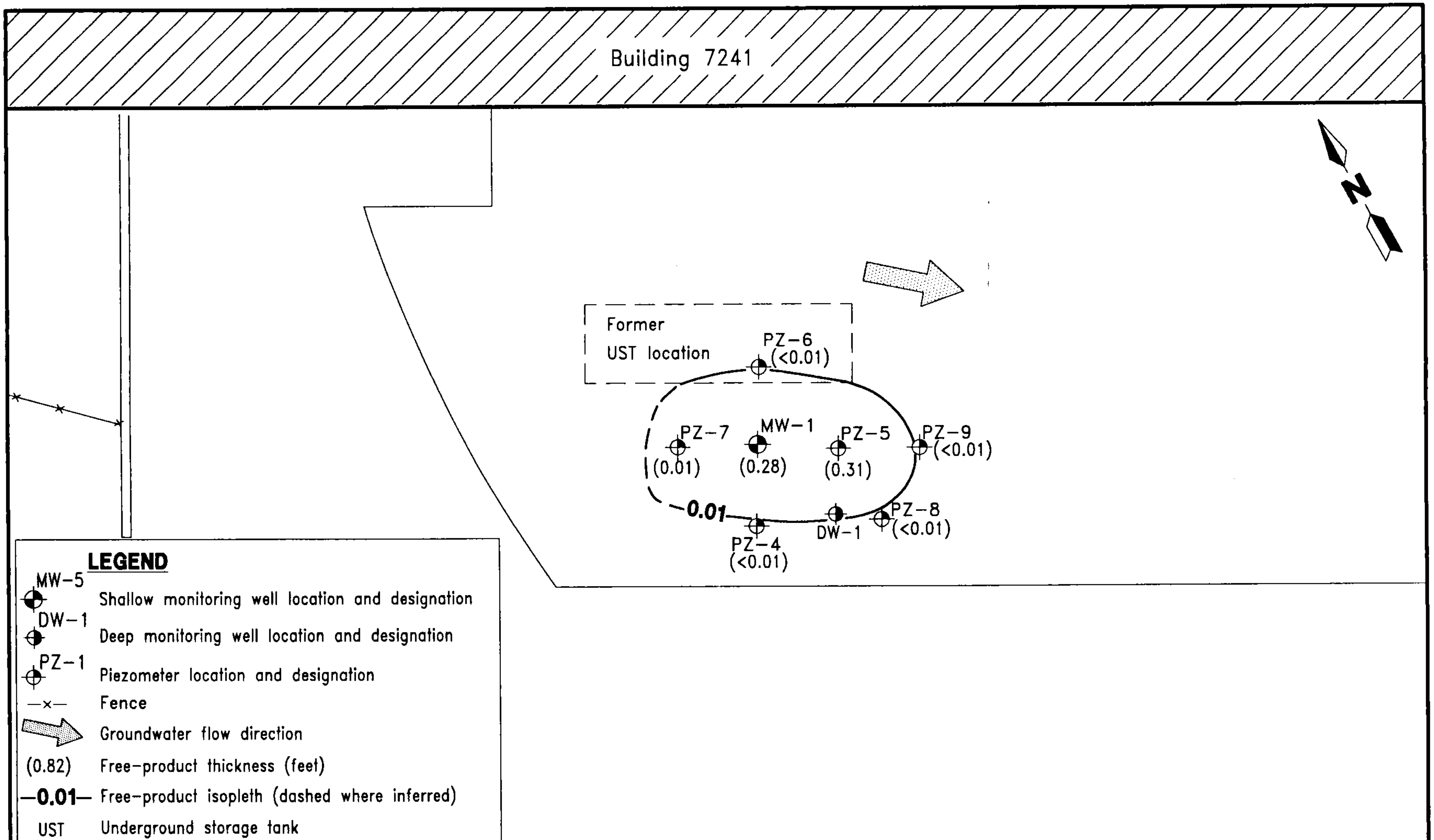

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FIGURE 3-2
FREE-PRODUCT DELINEATION MAP
OCTOBER 23, 1997

REMEDIAL ACTION PLAN
BUILDING 7241
MCCOY ANNEX

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

groundwater and does not represent excessive soil contamination. Therefore, soil contamination associated with SS-1/HA-4, SS-2/HA-7, and SS-3/HA-8 areas should be addressed as part of free-product removal and any groundwater remediation alternatives.

3.3.3 <u>Groundwater</u> Results of laboratory analysis for groundwater samples collected on August 27, 1997, are summarized in Appendix A. Based on target concentrations presented in Section 3.1, groundwater contamination is limited to the area of monitoring well MW-1. Laboratory analytical results for monitoring well MW-1 indicate the presence of several compounds at concentrations exceeding Chapter 62-770, FAC, Groundwater Cleanup Target Levels, including benzene, ethylbenzene, total xylenes, TRPH, indeno(1,2,3-cd)pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene and benzo(a)pyrene. The total hydrocarbon mass dissolved in groundwater is estimated to be 6.4×10^{-4} kilogram (ABB-ES, 1998).

3.4 SITE-SPECIFIC LIMITATIONS TO ALTERNATIVES. The site contamination is located beneath a grass area adjacent to an empty parking lot (see Figure 2-2). This is a nonactive area and, in general, any remedial construction or operation and maintenance activities could be considered.

3.5 REMEDIAL STRATEGY. A remedial action chosen for Building 7241 should be designed to address the area of free product and the associated soil and groundwater contamination.

Contamination associated with the soil is primarily confined to the former tank area and is due to the presence of free product. Therefore, any remedial technologies chosen for free-product removal and groundwater cleanup should also address the contamination associated with the soil. A separate treatment technology for soil is not warranted for this site.

3.6 REMEDIAL ALTERNATIVES SELECTION. When considering remedial options, exposure pathways and receptors should be identified. Once this is accomplished, the most cost-effective remedy can be selected and implemented to provide the necessary protection of human health and the environment while meeting the remedial action objectives. This phase of remedial planning becomes especially critical if natural attenuation is to be considered applicable.

3.6.1 <u>Technology Screening</u> The screening of technologies for free-product recovery, soil treatment, and groundwater treatment are provided in Tables 3-2, 3-3, and 3-4, respectively.

Some of the proven technologies, which have been field tested or implemented at similar sites, are discussed. Their application at Building 7241 is also considered.

3.6.2 <u>Alternatives Selection</u> The remedial alternative selection process should be performed considering all contaminant zones (groundwater, soil, and free product) as one unit. The interaction of contaminants in one phase with contaminants in other phases should be considered. Removal of contaminants in

Table 3-2
Screening of Free-Product Recovery Technologies

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Technology/ Process	Collection			
	Advantages	Disadvantages	Screening Status	Comments
Interceptor trenches	• Requires a minimum of power input and maintenance by consolidating recovery pumps and appurtenances.	• The majority of the free- product contaminated area is within the underground storage tank area. • Passive recovery techniques typically take place over a long time frame. • Excavated soil and groundwater must be managed appropriately.	Eliminated	A longer free-product recovery time will be required for a passive recovery system.
Extraction wells with skimmer pumps	• Has been successfully implemented at other sites. • Groundwater recovered would require minimal treatment before going to the wastewater treatment facility.	• Requires multiple recovery pumps and associated appurtenances. • Effectiveness decreases in fine-grained soil. • Large power maintenance requirements are necessary for extraction of LNAPL.	Eliminated	Water table depressions may smear free product to greater depths.
Extraction wells with vacuum-enhanced recovery (Bioslurping)	• Groundwater recovered would require minimal treatment before going to the wastewater treatment facility. • Added benefit of bioventing in the vadose zone and increased dissolved oxygen in the shallow groundwater may be experienced. • Groundwater recovery can be minimized with appropriate operation. • No "smear zone" which is normally associated with free-product recovery wells.	• Operation and maintenance may be extensive to handle extreme groundwater fluctuations.	Eliminated	Technology is site specific and requires extensive operation and maintenance.
Large diameter sumps	• Product recovery sumps allow the use of product skimmers without groundwater recovery. • Operation and maintenance of an extensive well system is not necessary.	• A passive approach, complete product recovery may not be achieved within a desirable time frame.	Eliminated	A longer free-product recovery time will be required for a passive recovery system.

See notes at end of table.

Table 3-2 (Continued)
Screening of Free-Product Recovery Technologies

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Technology/ Process	Collection			
	Advantages	Disadvantages	Screening Status	Comments
Horizontal extraction wells	• Total number of pumps can be minimized with the aid of gravity flow. • Minimal site disturbance would be experienced.	• Large quantities of groundwater may be recovered during product recovery. • Installation below the capillary fringe is necessary to maintain gravity flow into the trench. • Excavated soil and groundwater must be managed appropriately.	Eliminated	Groundwater recovery will be maximized in an effort to draw in free product.
Manual Recovery	• Equipment requirements are minimal. • Capital costs are low compared to other technologies. • Uses existing wells.	• Costs for frequent mobilization of personnel and equipment are high.	Eliminated	Presently in use. Product recovery limited effectiveness.
Direct Excavation	• Provides complete removal of all free product and excessively contaminated soil. • Soil at the site is amenable to excavation beneath the groundwater table without immediate infiltration of contaminated groundwater. • Has been used successfully at other sites. • Fixed-price free-product removal alternative.	• Free product infiltrating into the excavation must be collected. • Controls and safety measures are required during excavation.	Retained	Technology offers a set time period for completion. Complete recovery of free product is almost ensured. The most excessively contaminated soil is removed for treatment as well.

Notes: ░ = indicates technology was eliminated.
LNAPL = light nonaqueous-phase liquid.

Table 3-3
Screening of Soil Remedial Technologies

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Orlando, Florida

Remedial Technology	Advantages	Disadvantages	Screening Status	Comments
No Action	• No cost would be incurred • Some contaminated soil is not contributing to groundwater contamination.	• Does not reduce exposure potential for human or environmental receptors. • Would not reduce mobility, toxicity, or volume of contaminants.	Retained	Potential threat to human health is low and contaminant migration is sufficiently delayed.
Soil Cover	• Reduces exposure potential for human receptors. • Easily implemented.	• Would not reduce toxicity or volume of contaminants. • Long-term liability associated with waste.	Eliminated	Sufficient threat is not apparent to warrant extensive actions.
Off-Site Landfill	• Widely used and easily implemented technology. • No wastes or treatment residuals remaining on site. • Contaminants may be relocated to a more stable, contained, lower-exposure potential environment. • Relatively little mobilization effort and cost. • Experienced excavation contractors available.	• Building foundation in the area make excavation difficult. • Would not reduce toxicity or volume of contaminants. • Limited landfill capacity nationwide. • Transportation and landfilling costs may be expensive. • Long-term liability associated with landfilled waste.	Retained	Choice will be dependent upon cost analysis.
On-Site Biotreatment	• No secondary wastes produced. • Contaminants may be relocated to a more stable, contained, lower-exposure potential environment. • No transportation of waste over public roads.	• Treatment area would have to be constructed. • Would not reduce toxicity or volume of contaminants. • Long-term monitoring and maintenance would be required. • Long-term liability associated with landfilled waste.	Eliminated	Cost is not likely to be competitive.
On-Site Incineration	• Destruction and removal efficiencies are greater than 99.99 percent, thus reducing volume of contaminants. • Technology is reliable and has been demonstrated for treating organics at full scale. • Widely used for treatment of organic wastes. • Mobile units are available.	• Building foundation make excavation difficult. • Soil volume to be treated is relatively small. Technology is not likely to be cost effective.	Eliminated	Cost is not likely to be competitive.

See notes at end of table.

Table 3-3 (Continued)
Screening of Soil Remedial Technologies

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Remedial Technology	Advantages	Disadvantages	Screening Status	Comments
Off-Site Incineration	• Destruction and removal efficiencies are greater than 99.99 percent, thus reducing volume of contaminants. • Technology is reliable and has been demonstrated for treating organics at full scale. • Widely used for treatment of organics wastes. • Experienced vendors are available.	• Building foundation make excavation difficult.	Retained	Choice will be dependent upon cost analysis.
Thermal Soil Aeration	• Technology has been demonstrated full scale for treating organics. • May not require an incinerator permit to operate. • Mobile units are available.	• Would not reduce toxicity, mobility, and volume of contaminants. • Secondary waste stream requires further treatment.	Eliminated	Does not offer benefits over other screened technologies.
Soil Washing	• Wide application to varied waste groups. • Mobile units are available.	• Difficulty in treating complex waste mixtures. • Potentially hazardous chemicals may be brought on site to be used in process. • Potential difficulty in removing washing solution from treated soil. • Limited effectiveness for treating soil with high humic content and high fine-grained clay fraction.	Eliminated	Does not offer benefits over other screened technologies.
Soil Vapor Extraction	• Reduces mobility, toxicity, and volume of contaminants if vapors are collected and treated. • Effective for extraction of VOCs from unsaturated zone. • Not subject to RCRA land disposal restrictions. • Extraction equipment is off-the-shelf and experienced vendors are readily available.	• Dispersion of vapors could result in localized concentrations of contaminants near well heads. • Extensive soil, air, and groundwater monitoring required, including soil borings. • Not effective for treating soil with a high moisture content.	Eliminated as primary treatment, may be necessary in coordination with biosparging for groundwater.	Capable of treating organic compounds. May be used with air sparging or bioventing. Large vapor contaminant concentrations from the product-saturated zone would require treatment.

See notes at end of table.

Table 3-3 (Continued)
Screening of Soil Remedial Technologies

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Remedial Technology	Advantages	Disadvantages	Screening Status	Comments
Soil Flushing	• Can be used in conjunction with groundwater treatment. • Effective for removal of organics from permeable soil. • Full-scale units are available.	• Difficulty in treating complex waste mixtures. • Limited effectiveness for treating soil with high humic content and high fine-grained clay fraction. • Transferring contaminant to groundwater will create more problems in contaminant recovery.	Eliminated	The number of pore volumes necessary would be excessive and an even distribution is difficult.
Bioventing	• Demonstrated at pilot scale for treating hydrocarbons in soil. • Reduces toxicity and volume of organics. • No secondary waste streams.	• Injected air may mobilize VOCs in the vadose zone. • Strict operating controls are required to maintain optimal biodegradation environment.	Eliminated	Capable of treating organics. May be used with soil vapor extraction. Free product present will continue to recontaminate any cleaned soil.

Notes: ░ = indicates technology was eliminated.
VOC = volatile organic compound.
RCRA = Resource Conservation and Recovery Act.

Table 3-4
Screening of Groundwater Remedial Technologies

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Remedial Technology	Advantages	Disadvantages	Screening Status	Comments
Natural Attenuation	• Disturbance to existing site operations is minimal. • The technology can be used in locations that are difficult to treat due to obstructions (i.e., under buildings, etc.)	• The technology is not suitable at sites where free product or impacted groundwater is present. • Natural attenuation may not be suitable if receptors could be affected by migration of contaminants. • Treatment times are normally longer than for active remedial measures.	Retained	Free product must be removed to implement this option.
Groundwater Monitoring	• Monitors short- and long-term effectiveness of remedial technologies when used during and after remediation.	• Would not reduce mobility, toxicity, or volume of contaminants when used alone.	Retained	Required component of any groundwater remediation.
Slurry Wall	• May reduce the mobility of contaminants present in groundwater. • Current construction methods are capable of going to a depth of 200 feet below ground surface.	• Containment would not reduce the toxicity or volume of contaminants in groundwater. • Would not reduce mobility of contaminants without capping the site. • Contaminants may well degrade slurry wall material.	Eliminated	Plume containment is not an issue because pore velocity indicates migration is sufficiently retarded. There are no downgradient receptors.
Groundwater Extraction Wells	• Some existing wells may be used.	• Wells must be strategically located so that cones of depression intersect and capture all contaminated groundwater.	Eliminated	More effective technologies have been proven.
Air Sparging	• Injected air may volatilize hydrocarbons. • Effective for VOCs when used in conjunction with soil vapor extraction. • Soil vapor extraction may not be necessary if low sparge rates are used.	• Extensive monitoring and operational adjustments may be required during start-up to attain proper dispersion rates. • Extensive soil, air, structural stability, and groundwater monitoring are required.	Eliminated	Biosparging is preferred because vapor recovery or vapor concentrations would be minimized.

See notes at end of table.

Table 3-4 (Continued)
Screening of Groundwater Remedial Technologies

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Remedial Technology	Advantages	Disadvantages	Screening Status	Comments
Biosparging	• Injected air stimulates biological degradation of contaminants *in situ*.	• Soil vapor extraction system may be required to recover vapors. • Extensive monitoring and operational adjustments may be required during start-up to attain proper dispersion rates. • Extensive soil, air, structural stability and groundwater monitoring required.	Retained May be applicable if natural attenuation is unsuccessful.	Low air flow rates may cause less structural instability in the subsurface soil than flow rates associated with air sparging.
Wastewater Treatment Facility Disposal	• May involve only pumping groundwater to treatment facility. • May only require the use of an oil-water separator.	• Treatability studies would be required to determine effect on treatment processes. • Approval required by operating agency.	Eliminated	Could be a viable disposal option for treated effluent. Groundwater recovery is not preferred.
Groundwater Reinjection	• Treated groundwater is reinjected for further treatment. • Accelerates groundwater cleanup.	• Infiltration of treated groundwater could affect the migration of contaminants. • Reinjection of water into the plume's path may have an adverse effect on the collection system. • Requires permitting.	Eliminated	Could be a viable disposal option for treated effluent. Groundwater recovery is not preferred.
Discharge to Surface Water	• Low capital cost.	• Effluent must meet discharge permit requirements. • Additional monitoring and reporting would be required. • NPDES Permit would be required.	Eliminated	No surface water body nearby.

Notes: [shading] = indicates technology was eliminated.
VOC = volatile organic compound.
NPDES = National Pollution Discharge Elimination System.

the form of soil vapor, groundwater, or free-phase product will have a positive effect on the other matrices not directly targeted.

3.6.2.1 **Free-Product Removal and Source Zone Reduction** Free-product removal will help expedite any soil and groundwater remedial alternatives. Residual product (product trapped in the interstitial pores of the soil) and free product make up virtually all of the total mass of contaminant. Residual or free-phase product can act as a continuing source to groundwater and soil contamination as fluctuations in groundwater occur.

Direct excavation and treatment of contaminated soil and free product is recommended. The depth to groundwater at the site at mean low water table is between 6.5 and 7.5 feet bls. Excavation to a depth of approximately 8 feet in the areas of known product contamination can effectively remove more than 99 percent of the source material. Remaining source material will consist of contaminants sorbed to saturated soil in equilibrium with the dissolved plume.

Off-site thermal treatment is considered to be the most economical option when considering the soil volume to be removed and treated. Therefore, this alternative is recommended as the soil treatment alternative.

3.6.2.2 **Groundwater Treatment** Based on experiences at other similar sites, the nature of the contaminants, and the natural attenuation data collected in June 1998, evidence exists supporting the feasibility of natural attenuation as a remedial alternative at this site. With the data collected to support natural attenuation and site-specific hydrogeologic parameters, the USEPA's BIOSCREEN Natural Attenuation Decision Support System was used to model contaminant fate and transport before and following source reduction. These results are presented in Chapter 5.0. Natural attenuation is the preferred remedy for this site.

4.0 SOIL EXCAVATION AND PRODUCT RECOVERY

The recommended remedial action for Building 7241 consists of source abatement through excavation of excessively contaminated soil in the area of known free-product contamination. Provisions should be taken for the proper handling and disposal of infiltrating groundwater and free product during the excavation. Following source removal, groundwater contaminant concentrations may remain above necessary action levels specified in Chapter 3.0 of this document, and remediation may be required.

The USEPA's BIOSCREEN was used to model natural attenuation processes at this site and to predict the natural reduction of contaminant concentrations. The assumptions and input values used for BIOSCREEN as well as an explanation of the BIOSCREEN scenarios screened are included in Chapter 5.0.

4.1 SOIL EXCAVATION AND TREATMENT. The area of excavation shown on Figure 4-1 is approximately 180 square feet. This is the area where free product has been observed. The soil is classified as fine-grained sand based on the Unified Soil Classification System.

Excavation and thermal treatment processes should be performed as outlined in Chapter 62-775, FAC. Excavation to a depth of 8 feet bls is proposed for the area shown. Based on a surface area of 180 square feet, an excavation depth of 8 feet and a swell factor of 12 percent, the total volume of soil to be excavated is conservatively estimated to be 60 cubic yards (yd^3) (approximately 84 tons).

4.1.1 Pretreatment Sampling The area of soil contamination corresponds with the suspected area of free-product contamination. Based on the volume of contaminated soil expected, one composite pretreatment sample must be analyzed, as described in Table 4-1, for volatile organic aromatics (VOAs), TRPH, and volatile organic halocarbons in accordance with Chapter 62-775.410, FAC. A total metals analysis must also be performed. The composite soil sample must be collected from at least four locations in the contaminated area and can be taken while performing the excavation.

4.1.2 Excavation Excavation will be conducted using standard earthmoving equipment. All operators will be certified by the Occupational Safety and Health Administration. OVA headspace analyses will be performed at set intervals during the excavation to monitor soil contaminant levels; however, visual inspection and knowledge of the apparent extent of free product will be used to delineate the area to be removed and treated. Excavation to a depth approximately 1 foot below the mean low groundwater table is necessary to implement free-product removal. Excavated soil should be loaded directly into trucks to facilitate immediate site removal and delivery to a permitted soil thermal treatment facility and to prevent spreading of the contaminated soil at the site. An updated listing of permitted thermal treatment facilities can be obtained from the FDEP.

The excavation should have sides sloped or shored in accordance with applicable standards to prevent unstable conditions during excavation that could pose hazards to personnel or surrounding structures and pavements. Storm water runon and runoff controls should be implemented to prevent off-site migration of sediment or contaminated storm water during site activities. Dust control should also be

Table 4-1
Pretreatment Soil Sampling and Analyses

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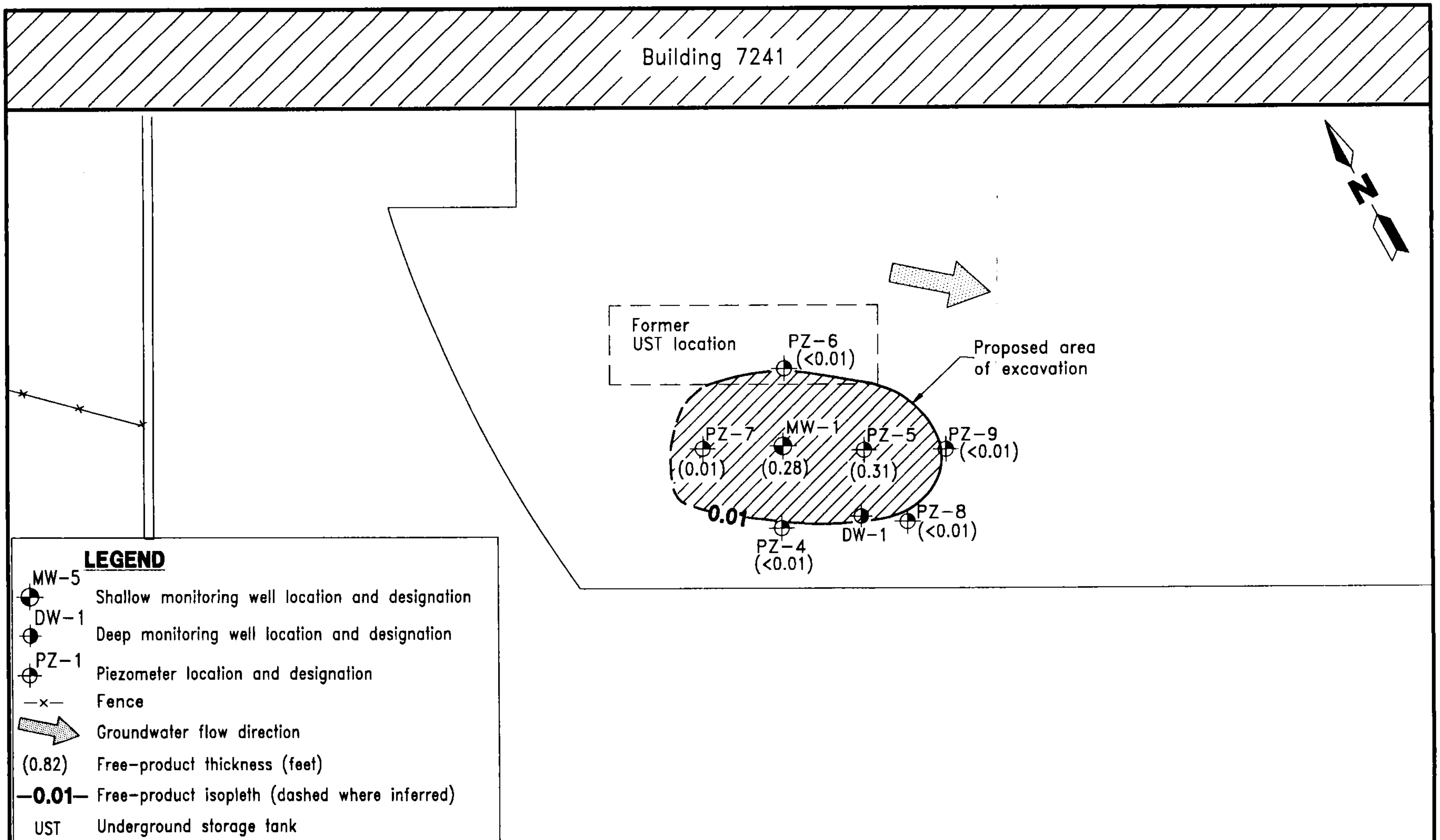
Contaminant	Test Method
Total Volatile Organic Aromatics	USEPA Methods 8020 or 8021
Total Recoverable Petroleum Hydrocarbons	Method FL-PRO
Naphthalene and the 15 Method-Listed PAHs	USEPA Methods 8100, 8250, 8270, or 8310
Metals	
Arsenic	USEPA Methods 7060, 7061, or 6010
Barium	USEPA Methods 7080, 7081, or 6010
Cadmium	USEPA Methods 7130, 7131, or 6010
Chromium	USEPA Methods 7190, 7191, or 6010
Lead	USEPA Methods 7421 or 6010
Mercury	USEPA Method 7471
Selenium	USEPA Methods 7740, 7741, or 6010
Silver	USEPA Methods 7760, 7761, or 6010

Source: Chapter 62-775.400(4) through 62-775-410(1)(e), Florida Administrative Code.

Notes: USEPA = U.S. Environmental Protection Agency.
FL-PRO = Florida-Petroleum Residual Organics.
PAH = polynuclear aromatic hydrocarbons.



0 5 10

SCALE: 1 INCH = 10 FEET

FIGURE 4-1
AREA OF PROPOSED EXCAVATION

REMEDIAL ACTION PLAN
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K:\02547\02547-15\SAR\02547576.DWG, VC-VC 07/23/98 08:14:21, AutoCAD R14 implemented to prevent fugitive emissions during excavation and soil handling. Benchmarks, existing structures, fences, sidewalks, utilities, and other cultural features shall be protected from excavation equipment. A professional survey to verify locations of site utilities was not conducted for this report; however, active or inactive subsurface obstructions are present. Obstructions may include pipelines for sanitary sewerage and underground electric lines. Feature locations shown on Figure 4-2 should be field verified prior to excavating.

4.2 FREE-PRODUCT REMOVAL. The approximate volume of product associated with the area to be excavated is 78.2 gallons (ABB-ES, 1998). This product exists in both free and residual forms. Excavation below the depth of the mean low water table will be required to capture product that is entrained in the capillary fringe. Excavations of this nature performed previously at adjacent site 7174 show the mobility of product to be minimal.

4.2.1 Infiltration into the Excavation Excavation to a depth below the groundwater table may cause infiltration of the surrounding groundwater into the open area. Past experience indicates that this is not a major concern; however, if free product is detected in recharging groundwater, recovery will be necessary. The volume of any infiltrating free product is unknown; however, because it would be originating from outside the expected area of free product, small quantities, if any, are expected. The groundwater and free-product recovery method will be chosen by the Response Action Contractor and to allow for some flexibility in this selection, only general requirements are specified here. Other options may be used with prior approval from FDEP.

Product sorbing materials will be used to recover small quantities of product that filtrate into the excavation. This material will be removed when saturated and drummed on site. These containers will be removed from the site by a licensed petroleum recycling agent.

A tanker truck with vacuum connections will be used to capture large quantities of free product, if necessary. A licensed petroleum recycling agent will remove and dispose of the free product and any groundwater captured incidentally.

If relatively high water table conditions exist at the time of excavation, the remediation contractor may, as an option, elect to dewater the work area prior to excavation. In this event, all recovered groundwater will be transported by a licensed petroleum recycling agent off site for disposal at a permitted facility.

4.2.2 Abandonment of Monitoring Wells The free-product areas are delineated by existing piezometers and monitoring wells MW-1 and DW-1. Monitoring wells within the area to be excavated should be abandoned (grouted and sealed) in accordance with Chapter 40C-3.517, FAC, prior to excavation. Well abandonment should be performed a minimum of 12 hours prior to the excavation. Proper permits will also be required.

4.3 SITE RESTORATION AND DEMOBILIZATION. Backfilling activities should commence and be completed at the end of each working day to minimize groundwater infiltration into the open area.

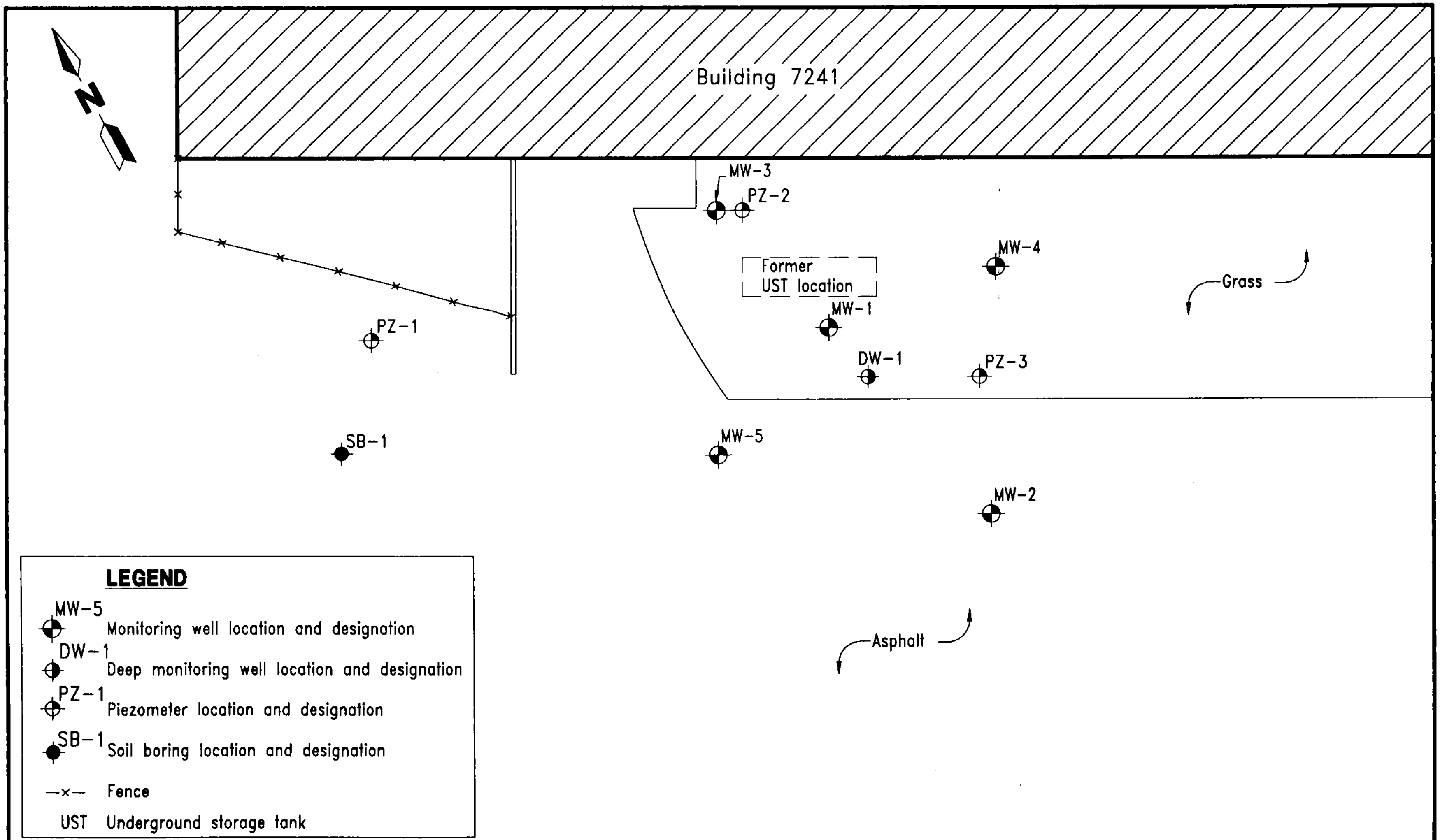

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FIGURE 4-2
SITE UTILITY MAP

REMEDIAL ACTION PLAN
BUILDING 7241
MCCOY ANNEX

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Backfill should be field compacted in place to surrounding conditions with earthmoving equipment tracks to a minimum of 85 percent Proctor (American Society for Testing and Materials D1557) or approved equivalent. Backfill material will be compacted in lifts of approximately 1 foot. Compactive effort will be no less than four passes of the earthmoving equipment. Approximately 60 yd^3 of backfill material will be needed.

The backfilled area will be raised grade to above surrounding elevations and the grade will be sloped from the center outward to a minimum slope of 50 horizontal to 1 vertical so that runoff will flow away from the backfilled area. The slope will be blended into level areas and the grade changes will be gradual. Certification that the backfill is free of petroleum hydrocarbon contamination is required from the backfill source prior to delivery.

During backfill operations, all lines and grades will be verified after all equipment and materials have been removed from the site and work is complete. Final review of project documentation as well as a site walkover will be conducted to ensure satisfactory completion of the project prior to leaving the site.

<u>4.4 FUTURE SITE ACTIVITIES</u>. No future plans are scheduled for this site after the source removal. The site and the whole McCoy area are still in the transfer phase to the city of Orlando.

5.0 GROUNDWATER GEOCHEMISTRY AND GROUNDWATER MODEL

The most important assumption when modeling natural attenuation is that biodegradation is occurring at the site. A strong indication of biodegradation is the presence of electron acceptors relative to the contamination at each sample location. At Building 7241, electron acceptor concentrations and other physical parameters such as pH and temperature were measured to evaluate if natural degradation is occurring. These data are provided in Table 5-1. An analysis of the data, as they pertain to each electron acceptor and microbial process, is provided in this section. The groundwater model is then discussed with results and recommendations.

Table 5-1
Natural Attenuation Monitoring, June 3, 1998

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Monitoring Parameters	Monitoring Wells CEF-811-		
	01	03	05
Ferrous iron (mg/ℓ)	3.3	1.28	0.01
Nitrate (mg/ℓ)	0.0	3.8	5.3
Sulfate (mg/ℓ)	0.0	3.8	28
Dissolved oxygen (mg/ℓ)	0.5	5.3	1.3
pH	6.13	6.29	6.36
Temperature (°C)	25	25	24
Conductivity (μmhos)	217	117	400

Notes: mg/ℓ = milligrams per liter.
°C = degrees Celsius.
μmhos = micromhos.

5.1 ELECTRON ACCEPTORS AND OTHER INDICATORS OF BIODEGRADATION.

Evidence exists for biodegradation when concentrations of electron acceptors, such as dissolved oxygen, nitrate, and sulfate, are depleted in the area of contamination. Other indicators of biodegradation are increased by-product concentrations, such as carbon dioxide and iron (II), in known areas of groundwater contamination. These indicators and other parameters are described in the subsections below.

5.1.1 Dissolved Oxygen A depleted concentration of dissolved oxygen in the source area is a strong indication of aerobic biodegradation. Field measurements indicate that dissolved oxygen at Building 7241 is relatively low, in the 0.5 milligrams per liter (mg/ℓ) range, in the contaminated area. The concentration for dissolved oxygen, based on measurements taken from wells outside of the contaminated zone, was 5.3 mg/ℓ.

5.1.2 Nitrate Concentrations of nitrate were measured in the field using a HACH test kit. A concentration of 0 mg/ℓ was measured at the source zone associated with monitoring well MW-1; nitrate measured at 5.3 mg/ℓ in the downgradient well MW-5 and measured at 3.8 mg/ℓ in the upgradient well MW-3. The use of nitrate in the denitrification process is not likely to be significant at Building 7241 due to the presence of dissolved oxygen. Nitrate cannot be used as an electron acceptor until the concentration of dissolved oxygen falls below about 0.5 mg/ℓ (Wiedemeier, 1995). At Building 7241, the lowest dissolved oxygen concentration within the plume was 0.50 mg/ℓ.

5.1.3 Iron II Under anaerobic conditions, iron III may be used as an electron acceptor. Although iron III available to microorganisms cannot be measured without knowing the degree of crystallinity, iron II, an end-product in the reaction, can be used as an indicator. Elevated levels of iron II corresponding to elevated levels of benzene, toluene, ethylbenzene, and xylenes (BTEX) indicate that biodegradation via iron III reduction is likely occurring. This is the case at Building 7241, where the highest iron II concentration of 73.3 mg/ℓ corresponds with the source well MW-1. The concentration of iron II was at 0.01 in the downgradient well MW-5 and the concentration of iron II was 1.28 mg/ℓ at the upgradient well, MW-3.

5.1.4 Sulfate Sulfate concentrations were measured using a HACH test kit. Sulfate was detected at 28 mg/ℓ in the downgradient well MW-5, at 3.8 mg/ℓ at the upgradient well MW-3, and was 0 mg/ℓ at the source well MW-1. This indicates sulfanogensis is occurring, but it is not likely to significantly contribute to biodegradation of the contaminants.

5.1.5 pH, Temperature, and Conductivity The average pH at Building 7241 is 6.3. This pH appears to indicate that microorganisms have adapted to site conditions. The temperature at Building 7241 is not subject to large fluctuations due to the mild climate in Florida and is not a limiting factor. Conductivity measurements were recorded during sampling to ensure that representative samples were obtained.

5.2 GROUNDWATER MODEL OVERVIEW AND DESCRIPTION. The BIOSCREEN computer model was used to model transport and degradation of hydrocarbons at Building 7241. The BIOSCREEN model was developed by the U.S. Air Force in August 1996 as a user-friendly model set in a Microsoft Excel spreadsheet environment. It is based on the Domenico analytical solute transport model.

The BIOSCREEN model used in this demonstration assumes that the limiting factors of biodegradation are the presence of indigenous hydrocarbon degrading bacteria and the presence of sufficient background electron acceptor concentrations. As shown in the preceding sections, evidence exists that aerobic degradation is occurring at Building 7241, and, to a lesser extent, anaerobic degradation may be occurring.

BIOSCREEN simulates advection, adsorption, dispersion, aerobic, and dominant anaerobic reactions through three model types. These three model types are

- solute transport without decay,
- solute transport with first-order decay, and
- solute transport with biodegradation (assuming an instantaneous biodegradation reaction).

For Building 7241, benzene and total VOA contamination can be modeled with all three model types.

5.3 MODEL LIMITATIONS. The BIOSCREEN model is effective for assessing the present contaminant conditions at Building 7241; however, limitations do exist. Modelers should consider these limitations when evaluating results.

BIOSCREEN considers the source area to be a total mass of contamination corresponding to the highest level of groundwater contamination distributed over a line source. Because postexcavation conditions are uncertain, engineering judgement and field observations will be necessary to completely predict the effectiveness of the remedial action.

Once the excavation is performed and the source area is removed, groundwater contaminant concentrations downgradient may remain above action limits. Modeling a plume in this configuration is not possible with BIOSCREEN. For this reason, the time to attenuate may be underestimated by the BIOSCREEN model following source removal. This situation may be counteracted by any volatilization of contaminants in the source zone and increased oxygenation of the source zone groundwater during the excavation.

5.4 GROUNDWATER MODEL DESIGN AND ASSUMPTIONS. In order to use the BIOSCREEN model to predict future contaminant transport and degradation, the model must be calibrated to match present site conditions. To do this an assumed plume origination date of 1994 is considered appropriate for model calibration. The UST was installed at Building 7241 in 1953. Undocumented spills may have occurred since that time, but based on the reported good condition of the tank upon removal, it is considered unlikely that the release is very old. A more recent release date is further supported by the observed condition of product recovered from the site and the limited extent of the dissolved contaminant plume.

Based on the existing data, groundwater contamination is restricted to the shallow zone of the surficial aquifer (i.e., the first 10 to 15 feet of the surficial aquifer). The lithology of the upper zone consists of a gray to brown, fine-grained sand. A conservative effective porosity of 0.35 was estimated. The use of BIOSCREEN, which is a two-dimensional model, is appropriate because the saturated interval is relatively homogeneous, and evidence of significant vertical migration of the groundwater contamination is not present.

The free product and free-product saturated soil contains approximately 99.9 percent of the contaminants in the source area. Free product acts as a continuing source to groundwater and soil contamination, because contaminants are most mobile in this zone. Because of this, and to accommodate model limitations, a negligible soluble contaminant mass load was presumed for modeling efforts following the removal of the free-product saturated soil.

Empirical data from similar sites show marked decreases in groundwater concentrations within 3 months following the excavation of free-product contaminated soil. Similar concentration reductions are expected at Building 7241. These reductions will be due to some volatilization and oxygenation of contaminants during excavation, and increased biological activity following site restoration. Recalibration of the BIOSCREEN model and verification of this and other assumptions will be performed following the excavation of the free-product saturated soil. An evaluation of the effectiveness of the BIOSCREEN model will also be made.

__5.4.1 Model Setup and Model Input__ Calibration of the BIOSCREEN model involved adjusting model inputs, which impacted contaminant transport and degradation rates. Assuming a 4-year plume lifetime starting in 1994, this procedure was continued until model results matched the present plume configuration.

Following this calibration, two scenarios were modeled. The first scenario considered a no action alternative to determine the maximum extent of contaminant transport and its effects. The second scenario considered source removal and natural attenuation. Model inputs for scenarios that modeled total BTEX are provided in Table 5-2.

__5.5 MODEL RESULTS__. Model results indicate that natural attenuation is feasible for groundwater remediation at Building 7241 following source removal. The BIOSCREEN model input and result screens are given in Appendix B.

__5.5.1 Calibration Model (Total BTEX Contamination)__ The calibration model indicates that first order decay is occurring at the site. Incorporating biodegradation using the Instantaneous Reaction model indicates virtually no plume migration, which appears to underestimate the current plume size. The first order decay is considered applicable for modeling the plume configuration under the existing (infinite source) scenario; however, the Instantaneous Reaction model appears applicable for more accurately modeling the extent of the contaminant plume following source removal.

__5.5.2 Fate and Transport: 25 and 50 Years__ Modeling a no action alternative, the plume source area was allowed to remain in place for 25 and 50 years from today. In both time frames considered, complete source reduction is not achieved regardless of which model type is used. A positive result of this model, which supports this natural attenuation alternative, is that the plume is not expected to migrate a significant distance beyond its present location.

__5.5.3 Groundwater BTEX Concentrations Following Source Removal__ Source removal is the key to the success of the natural attenuation process. This modeling scenario supports this. Assuming a negligible source material results in an immediate reduction of groundwater BTEX concentrations in the source zone using the Instantaneous Reaction model. A parallel reduction is expected downgradient of the plume.

__5.6 RECOMMENDATION AND TIME TO CLEAN UP__. Model results and an analysis of field data show that natural attenuation will be an effective remedy for Building 7241. The modeling effort displayed in this RAP was conducted in a conservative manner. However, due to modeling limitations and changing site conditions, the applicability of these model results could change.

Three months following source removal, site conditions should be reevaluated and the baseline of the most appropriate and up-to-date model should be set. At this time, concentrations in the dissolved plume are expected to have decreased from those documented in this report. Model results should be checked following subsequent monitoring events.

Table 5-2
BIOSCREEN Model Input Parameters

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Data Type	Parameter	Calibration Model Value	Fate and Transport Model Value	Source Removal and Natural Attenuation Value	Source of Data
Hydrogeology	· Hydraulic conductivity · Hydraulic gradient · Porosity	3.81×10^{-4} (cm/sec) 0.00127 (ft/ft) 0.35	3.81×10^{-4} (cm/sec) 0.00127 (ft/ft) 0.35	3.81×10^{-4} (cm/sec) 0.00127 (ft/ft) 0.35	· Slug tests · Calculated · Estimated
Dispersion	· Longitudinal dispersivity · Transverse dispersivity · Vertical dispersivity	1.0 (ft) 0.1 (ft) 0 (ft)	1.0 (ft) 0.1 (ft) 0 (ft)	1.0 (ft) 0.1 (ft) 0 (ft)	· Based on estimated plume length of 15 feet of Xu's dispersivity formula
Adsorption	· Retardation factor · Soil Bulk density, ρ_b · K_{oc} · f_{oc}	4.0 1.7 (kg/ℓ) 38 1.6×10^{-2}	4.0 1.7 (kg/ℓ) 38 1.6×10^{-2}	4.0 1.7 (kg/ℓ) 38 1.6×10^{-2}	· Calculated · Estimated · Literature · Estimated base on nearby sites
Biodegradation	Electron acceptor	O_2 / NO_3 / SO_4	O_2 / NO_3 / SO_4	O_2 / NO_3 / SO_4	· Based on field data collected June 1998
	Background conc. (mg/ℓ)	5.3 / 3.8 / 3.8	5.3 / 3.8 / 3.8	5.3 / 3.8 / 3.8	
	Minimum conc. (mg/ℓ)	- 0.5 / - 0 / - 0	- 0.5 / - 0 / - 0	- 0.5 / - 0 / - 0	
	Change in conc. (mg/ℓ)	4.8 / 3.8 / 3.8	4.8 / 3.8 / 3.8	4.8 / 3.8 / 3.8	
	Electron acceptor	FE / CH_4	FE / CH_4	FE / CH_4	
	Avg. conc. (mg/ℓ)	3.3 / --	3.3 / --	3.3 / --	
General	· Modeled area length · Modeled area width · Simulation time	10 15 4	10 15 25 and 50 (years from today)	10 15 1 week and 1 month	· Selected · Selected · Selected
Source Data	· Source thickness · Source concentration	10 (ft) 0.113 ppb	10 (ft) 0.113 ppb	10 (ft) 0.113 ppb	
Actual Data	· Distance from source (ft) · BTEX concentration in groundwater (mg/ℓ)	0 0.100	1 0.050	5 0.001	· Based on groundwater concentrations, August 1997

Notes: Use of data displayed above is shown in Appendix C.
Units selected in the table above were based on units input into the BIOSCREEN model.

cm/sec = centimeters per second.
ft/ft = feet per foot.
ft = feet.
kg/ℓ = kilograms per liter.
O_2 = oxygen.
NO_3 = nitrate.
SO_4 = sulfate.
mg/ℓ = milligrams per liter.
Fe = iron.
CH_4 = methane.
ppb = parts per billion.
BTEX = benzene, toluene, ethylbenzene, and xylenes.
conc. = concentration.
-- = no data.

BIOSCREEN model results indicate that contaminant target levels could be achieved as early as 1 month following source removal. For remedial planning purposes, a conservative cleanup time of 1 year is estimated. A more precise estimate may be possible when the model is updated following source removal. A long-term monitoring plan is provided in the next chapter.

6.0 LONG-TERM MONITORING PLAN

6.1 OVERVIEW. The monitoring program is designed to evaluate the performance, progress, and effectiveness of natural attenuation to reduce contaminants and retard their migration. The monitoring plan described in this chapter is designed to monitor plume migration over time, while verifying that intrinsic remediation is occurring.

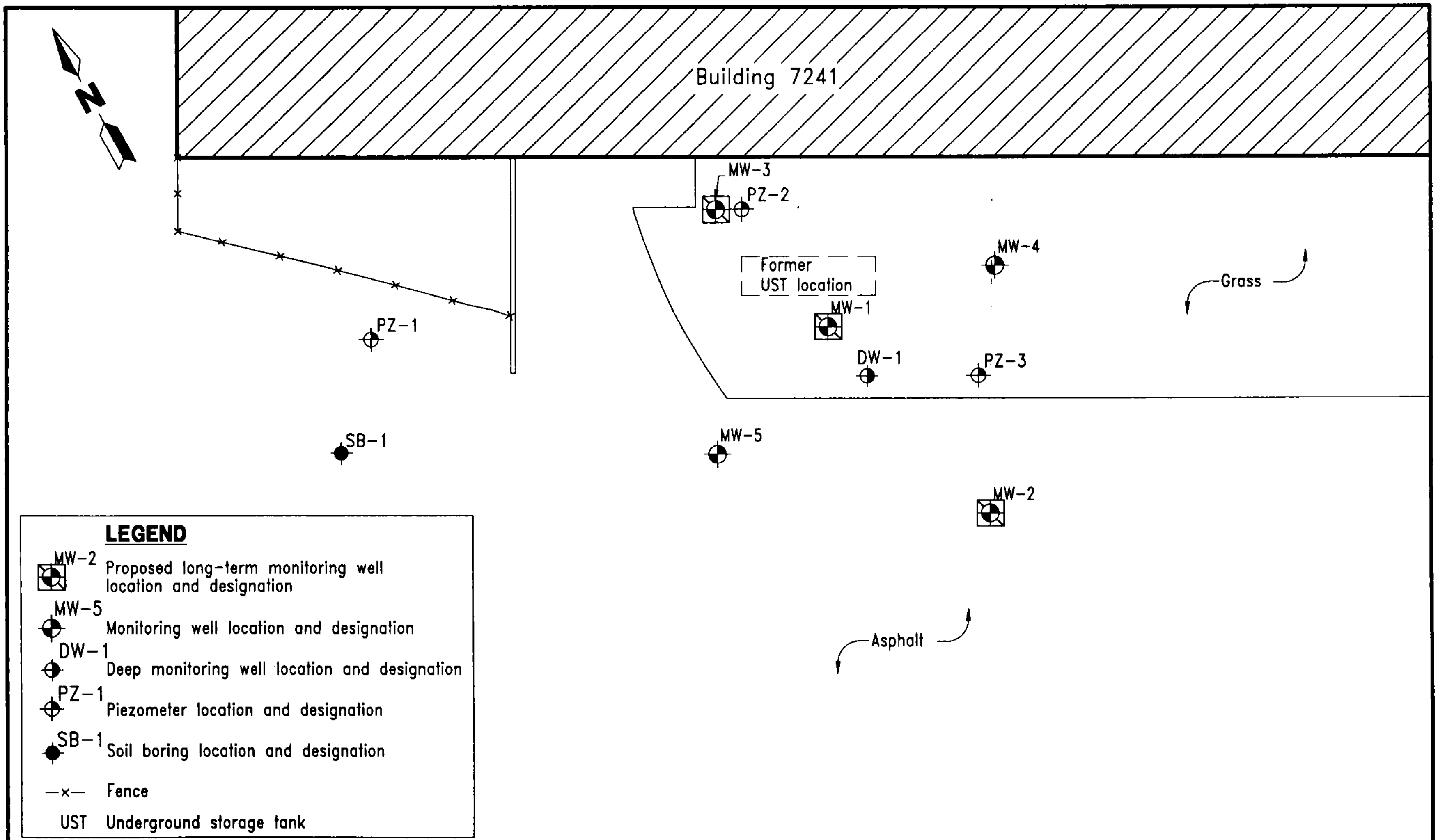
6.2 MONITORING WELL LOCATIONS. Long-term monitoring wells will be installed or are already in place upgradient, within, and immediately downgradient of the groundwater plume. Existing monitoring wells will be incorporated into this monitoring plan, when possible, to minimize well installation costs; however, it should be noted that one shallow well must be abandoned to complete the actions described in this RAP.

Three monitoring wells will be used as long-term monitoring wells to observe the degradation of the contaminants and plume retardation. The location of these wells is shown on Figure 6-1. Monitoring well MW-3 will be used to monitor upgradient site conditions. A shallow monitoring well, MW-1, will be reinstalled within the area of highest contaminant concentrations, near the former UST location. Monitoring well MW-2 will be used to monitor any downgradient contaminant migration.

6.3 MONITORING WELL INSTALLATION. All long-term monitoring wells will be screened in the shallow aquifer approximately 5 to 15 feet bls. Monitoring well installation and well development will comply with SOUTHNAVFACENGCOM's *Guidelines for Groundwater Monitoring Well Installation* and with USEPA's *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*. In addition, monitoring well installation will comply with Chapter 62-532, FAC.

6.4 GROUNDWATER SAMPLING. Sampling will be conducted quarterly for the first year and semiannually for additional years, if necessary, to verify that the contaminant mass and mobility are being effectively reduced. Water-level measurements will be collected during each sampling event. Samples will be collected from wells designated for long-term monitoring only and analyzed using the test methods shown in Table 6-1. Biodegradation parameters listed in Table 6-2 will be collected from all remaining shallow monitoring wells and analyzed on a yearly basis. These data will be used for continuing calibration of the groundwater model. If the data collected support the anticipated effectiveness of the remedial alternative at this site, monitoring frequency may be reduced to once per year, subject to FDEP approval. If the data collected at any time during the monitoring period indicate plume migration or a risk to human health, the sampling frequency will be adjusted accordingly and/or a contingency plan will be developed, approved by FDEP, and implemented.

6.5 REPORTING. Following each sampling event, groundwater models will be calibrated for improved forecasting. Within 60 days of each event, a report will be prepared and submitted to SOUTHNAVFACENGCOM. The report will include sampling and model results and recommendations for future actions.



0 10 20

SCALE: 1 INCH = 20 FEET

K:\02547\02547-15\SAR\02547577.DWG, VC-VC 07/23/98 09:55:59, AutoCAD R14

FIGURE 6-1
PROPOSED LONG-TERM MONITORING WELL LOCATION PLAN

REMEDIAL ACTION PLAN
BUILDING 7241
MCCOY ANNEX

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

Table 6-1
Groundwater Sampling and Analysis for Contaminant Monitoring

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Analyte	Method[1]/ Reference	Data Use	Sample Volume, Sample Container, and Sample Preservation	Field or Fixed-Base Laboratory
Aromatic hydrocarbons	602; GC/MS	Method of analysis for BTEX.	Collect water samples in a 40 mℓ VOA vial; cool to 4°C; add hydrochloric acid to pH 2	Fixed
Semivolatile aromatic compounds	625; semivolatile extractables	Method of analysis for semivolatiles such as total naphthalenes.	Collect water samples in a 1 liter amber-tinted glass bottle; cool to 4°C.	Fixed

[1] Method refers to U.S. Environmental Protection Agency test methods.

Notes: GC/MS = gas chromatography and mass spectroscopy.
BTEX = benzene, toluene, ethylbenzene, and xylenes.
mℓ = milliliter.
VOA = volatile organic aromatic.
°C = degrees Celsius.

Table 6-2
Groundwater Sampling and Analysis for Biodegradation Monitoring[1]

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Analysis	Method[2]/ Reference	Data Use	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Temperature	170.1, Direct-reading thermometer	Well development; biological processes are temperature dependent.	Conduct *in situ*	Field
Dissolved oxygen	HACH Colorimeter	The oxygen concentration is a data input to most biological models; concentrations less than 1 mg/ℓ generally indicate an anaerobic pathway.	AccuVac Ampuls	Field
pH	150.1, Direct-reading meter	Biological processes are pH sensitive.	Collect 100 to 250 mℓ of water in a glass or plastic container, analyze immediately.	Field
Conductivity	120.1, Direct-reading meter	General water quality parameter used to verify that site samples are obtained from the same groundwater system.	Collect 100 to 250 mℓ of water in a glass or plastic container, analyze immediately.	Field
Alkalinity	HACH Colorimeter	General water quality parameter used to verify that site samples are obtained from the same groundwater system and to measure the buffering capacity of groundwater.	AccuVac Ampuls	Field
Ferrous Iron (Fe^{+2})	HACH Colorimeter	May indicate an anaerobic degradation process due to depletion of oxygen, nitrate, and manganese.	AccuVac Ampuls	Field
Nitrate (NO_3^{-1})	HACH Colorimeter	Substrate for microbial respiration if oxygen is depleted.	AccuVac Ampuls	Field
Sulfate (SO_4^{-2})	HACH Colorimeter	Substrate for anaerobic microbial respiration.	AccuVac Ampuls	Field

[1] Table adapted from the *Technical Protocol for Implementing the Intrinsic Remediation with Long-Term Monitoring Option for Natural Attenuation of Dissolved-Phase Fuel Contamination in Ground Water* (Wiedemeier, Todd H., 1995).
[2] Method refers to United States Environmental Protection Agency (USEPA) test methods.

Notes: HACH refers to the HACH Company catalog.

mg/ℓ = milligrams per liter.
mℓ = milliliter.
°C = degrees Celsius.

7.0 COST ESTIMATE

A cost estimate for the excavation and treatment of contaminated soil and ongoing monitoring of Building 7241 has been prepared. To facilitate the Navy's procurement procedures, the cost estimate is being submitted under a separate cover.

8.0 SCHEDULE

Excavation of up to 60 yd^3 of contaminated soil, included as phase one source removal of this RAP, can begin upon FDEP RAP approval. It is estimated that approximately 1 week would be necessary for site mobilization and site staging for phase one. Preparation of any permit applications should begin immediately upon notice to proceed from the Navy. The location of all underground utilities should also be determined and marked during this time period.

The remedial subcontractor should be an approved contractor for the thermal treatment of petroleum-contaminated soil and should meet all permit requirements. Well permits from the St. Johns River Water Management District for the abandonment and installation of shallow monitoring wells (to be installed in phase two) will be required prior to and following excavation and site restoration. This permitting process is expected to take approximately 1 week.

Mobilization and monitoring well installation is expected to be completed within 1 week following site restoration.

Following notice to proceed, including 1 month of procurement, approximately 2 months should be budgeted for implementation of remedial activities at Building 7241. site monitorings would subsequently occur on a quarterly basis.

9.0 PROFESSIONAL REVIEW CERTIFICATION

This RAP was prepared using standard engineering practices and designs. The plan for remediating this site is based on the information collected between November 1996 and June 1998, and engineering detailed in the text and appended to this report. If conditions are determined to exist differently than those described, the undersigned Professional Engineer should be notified to evaluate the effects of any additional information on the design described in this report.

This RAP was developed for Building 7241, McCoy Annex, Orlando, Florida, and should not be construed to apply to any other site.

HARDING LAWSON ASSOCIATES
2590 Executive Center Circle East
Tallahassee, Florida 32301

8/6/98

Michael K. Dunaway, P.E., P.G.
Professional Engineer
State of Florida License No.: 39451

Date: ____________________

REFERENCES

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Navy Public Works Center Pensacola. 1997. *Closure Assessment, Aboveground/ Underground Storage Tanks, Building 7241, Naval Training Center, McCoy Annex, Orlando, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (February).

Southern Division, Naval Facilities Engineering Command. 1989. Guidelines for Groundwater Monitoring Well Installation (March).

U.S. Environmental Protection Agency. 1989. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells.* EPA/600/4-89-034 (April).

Wiedemeier, T., J.T. Wilson, D.H. Kampbell, R.N. Miller, and J.E. Hansen. 1995. *Technical Protocol for Implementing Intrinsic Remediation With Long-Term Monitoring for Natural Attenuation of Dissolved-Phase Fuel Contamination in Ground Water, Volume I.* Prepared for Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks Air Force Base, San Antonio, Texas.

APPENDIX A

EXTENT OF CONTAMINATION

Table A-1
Groundwater Elevation Summary

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Well Number	Date	Depth to Product (ft btoc)	Depth to Water (ft btoc)	Product Thickness (feet)	Top-of-Casing* Elevation (feet)	Water-Level* Elevation (feet)
MW-1	08/13/97	--	NA	--	100.00	NA
	09/11/97	4.80	5.59	0.79		95.00
	10/02/97	5.26	5.95	0.69		94.57
	10/23/97	5.83	6.65	0.82		93.97
	11/10/97	4.70	4.92	0.22		95.25
MW-2	08/13/97	--	NA	--	99.64	NA
	09/11/97	--	4.61	--		95.03
	11/10/97	--	4.43	--		95.21
MW-3	08/13/97	--	NA	--	100.61	NA
	09/11/97	--	5.54	--		95.07
	11/10/97	--	5.33	--		95.28
MW-4	08/13/97	--	NA	--	99.77	NA
	09/11/97	--	4.74	--		95.03
	11/10/97	--	4.55	--		95.22
MW-5	08/13/97	--	NA	--	100.02	NA
	09/11/97	--	4.96	--		95.06
	11/10/97	--	4.75	--		95.27
DW-1	08/13/97	--	NA	--	100.10	NA
	09/11/97	--	5.35	--		94.75
	11/10/97	--	4.88	--		95.22
PZ-1	08/13/97	--	8.54	--	104.58	96.04
	09/11/97	--	9.42	--		95.16
	11/10/97	--	9.21	--		95.37
PZ-2	08/13/97	--	7.87	--	103.98	96.11
	09/11/97	--	8.81	--		95.17
	11/10/97	--	8.61	--		95.37
PZ-3	08/13/97	--	7.90	--	103.88	95.98
	09/11/97	--	8.82	--		95.06
	11/10/97	--	8.64	--		95.24
PZ-4	10/23/97	--	9.30	--	103.36	94.06
	10/02/97	--	8.71	--		94.65
	11/10/97	--	8.09	--		95.27
PZ-5	10/23/97	8.06	8.37	0.31	102.13	93.99
	10/02/97	7.50	7.67	0.17		94.59
	11/10/97	6.87	7.04	0.17		95.22

See notes at end of table.

Table A-1 (Continued)
Groundwater Elevation Summary

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Well Number	Date	Depth to Product (ft btoc)	Depth to Water (ft btoc)	Product Thickness (feet)	Top-of-Casing* Elevation (feet)	Water-Level* Elevation (feet)
PZ-6	10/23/97	8.40	8.40	<0.01	102.45	94.05
	10/02/97	--	7.83	--		94.62
	11/10/97	--	7.18	--		95.27
PZ-7	10/23/97	8.22	8.23	0.01	102.28	94.06
	10/02/97	7.64	7.65	0.01		94.64
	11/10/97	6.98	7.07	0.09		95.28
PZ-8	10/23/97	7.31	7.31	<0.01	101.36	94.05
	11/10/97	--	6.10	--		95.26
PZ-9	10/23/97	7.48	7.48	<0.01	101.50	94.02
	11/10/97	--	6.26	--		95.24

Water-level elevations (WLE) corrected for weight of free product (FP) (top of casing - depth to water + [FP thickness x 0.75]) = WLE

Notes: ft btoc = feet below top of casing.
* = referenced to arbitrary datum.
-- = not applicable.
NA = not available.
< = less than.

Table A-2
Summary of Groundwater Analytical Results

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Parameter	Chapter 62-770, FAC Target Cleanup Levels (µg/ℓ)	Monitoring Well/Sample Date									
		MW-1* 8/27/97	MW-2 8/27/97	MW-3 8/27/97	MW-4 9/11/97	MW-5 9/11/97	MW-5 10/16/97	DW-1 9/11/97	DW-1 10/16/97	RB-1 8/27/97	RB-2 9/11/97
Benzene	1	**21 B**	0.35 JB	0.10 JB	0.039 J	0.067 JP	NA	<0.50	NA	0.27 JB	0.065 J
Toluene	40	2.6 JPB	0.64 JB	0.26 JB	0.16 J	0.24 JP	NA	0.098 J	NA	1.8 B	0.26 J
Ethylbenzene	30	**42**	<0.75	0.042 J	0.067 J	0.11 JP	NA	<0.75	NA	0.24 J	0.059 J
Total xylenes	20	**48 B**	0.83 JB	0.233 JB	0.176 J	0.164 J	NA	0.048 J	NA	1.38 JB	0.232 J
1,3-Dichlorobenzene	NA	<7.5	<0.75	<0.75	<0.75	0.12 J	NA	<0.75	NA	<0.75	0.054 J
1,4-Dichlorobenzene	NA	<15	0.45 JB	0.52 JB	<1.5	<1.5	NA	<1.5	NA	0.56 JB	0.21 J
1,2-Dichlorobenzene	NA	<10	<1	<1	<1	0.097 JP	NA	<1	NA	<1	<1
Chlorobenzene	NA	<5	<0.50	<0.50	0.025 J	<0.50	NA	<0.50	NA	<0.50	0.075 J
MTBE	35	<50	<5	<5	<5	<5	NA	<5	NA	<5	0.27 J
1,2-Dibromoethane (EDB)	0.02	<0.0095	<0.0095	<0.0095	<0.010	**0.14 P**	<0.020	**0.32 P**	<0.020	<0.0095	<0.010
Total lead	15	<1	<1	1.6 B	4.8	<1.9	NA	2.9 B	NA	<1	<1.9
TRPH (mg/ℓ)	5	**14.95**	<0.10	<0.10	<0.10	0.4	NA	<0.10	NA	<0.10	<0.10
Naphthalene	20	6.0 J	<1	<1	<1	0.20 J	NA	<1	NA	<1	<1
Acenaphthene	20	2.0 J	<1	<1	<1	0.30 J	NA	<1	NA	<1	<1
Fluorene	280	7.0 J	0.20 J	<2	<2	4.0	NA	<2	NA	<2	<2
Pyrene	210	70	0.10 J	<0.50	<0.50	0.080 J	NA	0.080 J	NA	0.040 J	<0.50
Benzo(g,h,i)perylene	210	<1	0.010 J	<0.10	0.090 JB	<0.10	NA	0.090 JB	NA	<0.10	0.090 JB
Indeno(1,2,3-cd)pyrene	0.2	**0.30 JB**	0.020 JB	<0.10	<0.10	<0.10	NA	<0.10	NA	<0.10	<0.10
Acenaphthylene	210	0.50 J	<1	<1	<1	0.20 J	NA	<1	NA	<1	<1
Phenanthrene	210	14	<1	<1	<1	0.26 J	NA	<1	NA	<1	<1
Anthracene	2,100	12	<1	<1	<1	0.84 J	NA	<1	NA	<1	<1

See notes at end of table.

Table A-2 (Continued)
Summary of Groundwater Analytical Results

Remedial Action Plan
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Parameter	Chapter 62-770, FAC Target Cleanup Levels (µg/ℓ)	Monitoring Well/Sample Date									
		MW-1* 8/27/97	MW-2 8/27/97	MW-3 8/27/97	MW-4 9/11/97	MW-5 9/11/97	MW-5 10/16/97	DW-1 9/11/97	DW-1 10/16/97	RB-1 8/27/97	RB-2 9/11/97
Fluoranthene	280	5.7	0.085 J	<0.50	<0.50	<0.50	NA	<0.50	NA	0.039 J	<0.50
Benzo(a)anthracene	0.2	**1.9 J**	0.042 J	<0.20	<0.20	0.16 J	NA	<0.20	NA	0.015 J	<0.20
Chrysene	5	**6.7**	0.092 J	<0.50	<0.50	0.57	NA	0.037 J	NA	0.031 J	<0.50
Benzo(b)fluoranthene	0.2	**1.5 J**	0.036 J	<0.20	<0.20	0.10 J	NA	<0.20	NA	0.10 J	<0.20
Benzo(k)fluoranthene	0.5	**0.72 J**	0.020 J	<0.20	<0.20	0.010 J	NA	<0.20	NA	0.012 J	<0.20
Benzo(a)pyrene	0.2	**1.3 J**	0.053 J	<0.50	<0.50	<0.50	NA	<0.50	NA	0.022 J	<0.50
Dibenzo(a,h)anthracene	0.2	0.13 J	<0.20	<0.20	<0.20	<0.20	NA	<0.20	NA	<0.20	<0.20
1,2-Dichloroethane	3	<20	<2	<2	<2	<2	NA	<2	NA	<2	<2
Methylene chloride	NA	4.7 JB	0.24 JB	0.33 JB	1.7 JPB	2.2 PB	NA	1.4 JB	NA	0.38 JB	0.73 JB
Chloroform	NA	<20	<2	<2	<2	0.99 JPB	NA	1.4 JPB	NA	0.22 J	0.11 JB
Trichloroethene	NA	<20	<2	<2	<2	0.19 J	NA	<2	NA	<2	<2
1,2-Dichloropropane	NA	<20	<2	<2	<2	<2	NA	<2	NA	1.1 J	1.0 J
Bromodichloromethane	NA	<20	<2	<2	<2	0.079 JP	NA	0.19 J	NA	<2	<2
Tetrachloroethene	NA	<20	<2	<2	<2	<2	NA	<2	NA	0.11 J	0.14 J
Dichlorodifluoromethane	NA	<20	<2	<2	0.16 JP	<2	NA	0.35 JP	NA	<2	<2
Trichlorofluoromethane	NA	<20	<2	<2	0.25 JPB	0.25 JPB	NA	0.31 JPB	NA	<2	0.25 JB

See notes at end of table.

Table A-2 (Continued)
Summary of Groundwater Analytical Results

Site Assessment Report
Building 7241, McCoy Annex
Naval Training Center
Orlando, Florida

Notes: All concentrations in $\mu g/\ell$, unless otherwise noted.
Concentrations in bold represent values exceeding Chapter 62-770, FAC, Cleanup Target Levels.

FAC = Florida Administrative Code.
$\mu g/\ell$ = micrograms per liter.
* = sample analyzed with dilution factor of 10.
B = analyte found in blank as well as in the sample.
J = estimated value.
P = difference between gas chromatograph and high-performance liquid chromatography columns is greater than 25 percent. Lower value reported.
NA = not available.
< = less than.
MTBE = methyl tert-butyl ether.
EDB = ethylene dibromide.
TRPH = total recoverable petroleum hydrocarbons (reported as Florida-Petroleum Residual Organics).
mg/ℓ = milligrams per liter.

APPENDIX B

BIOSCREEN MODEL PRINTOUTS

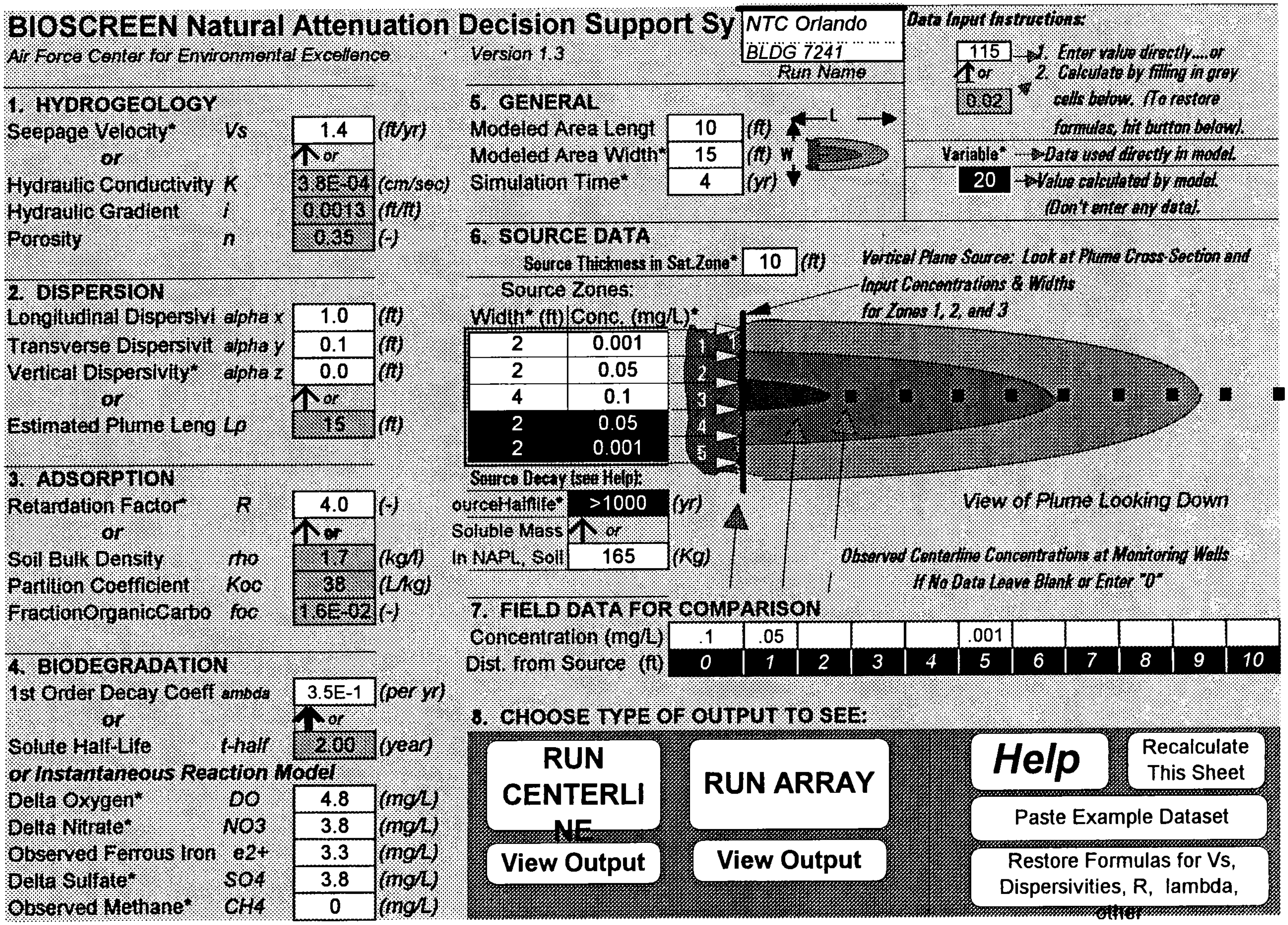
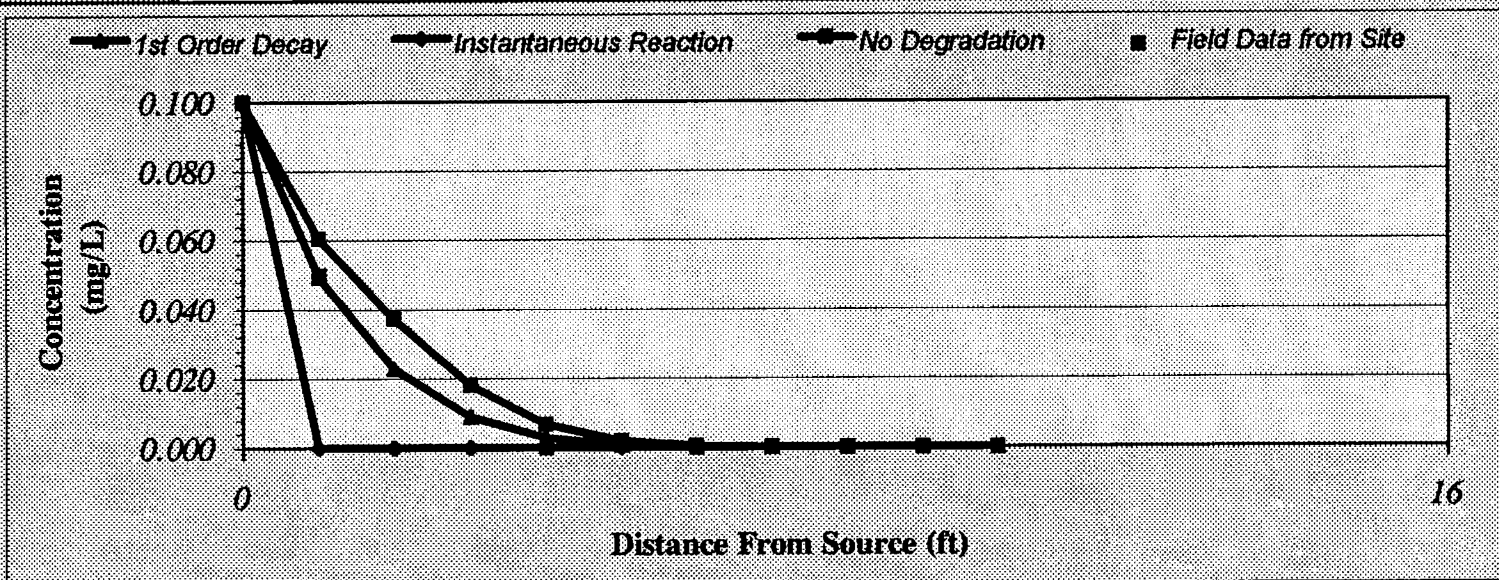


Figure 1A - BIOSCREEN Calibration Model Input Screen.

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	1	2	3	4	5	6	7	8	9	10
No Degradation	0.100	0.060	0.037	0.018	0.007	0.002	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.100	0.049	0.023	0.009	0.003	0.001	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	0.100	0.050				0.001					



Calculate Animation | Next Timestep | Prev Timestep

Time: 4 Years

Return to Input

Recalculate This Sheet

Figure 1B - BIOSCREEN Calibration Model Output.

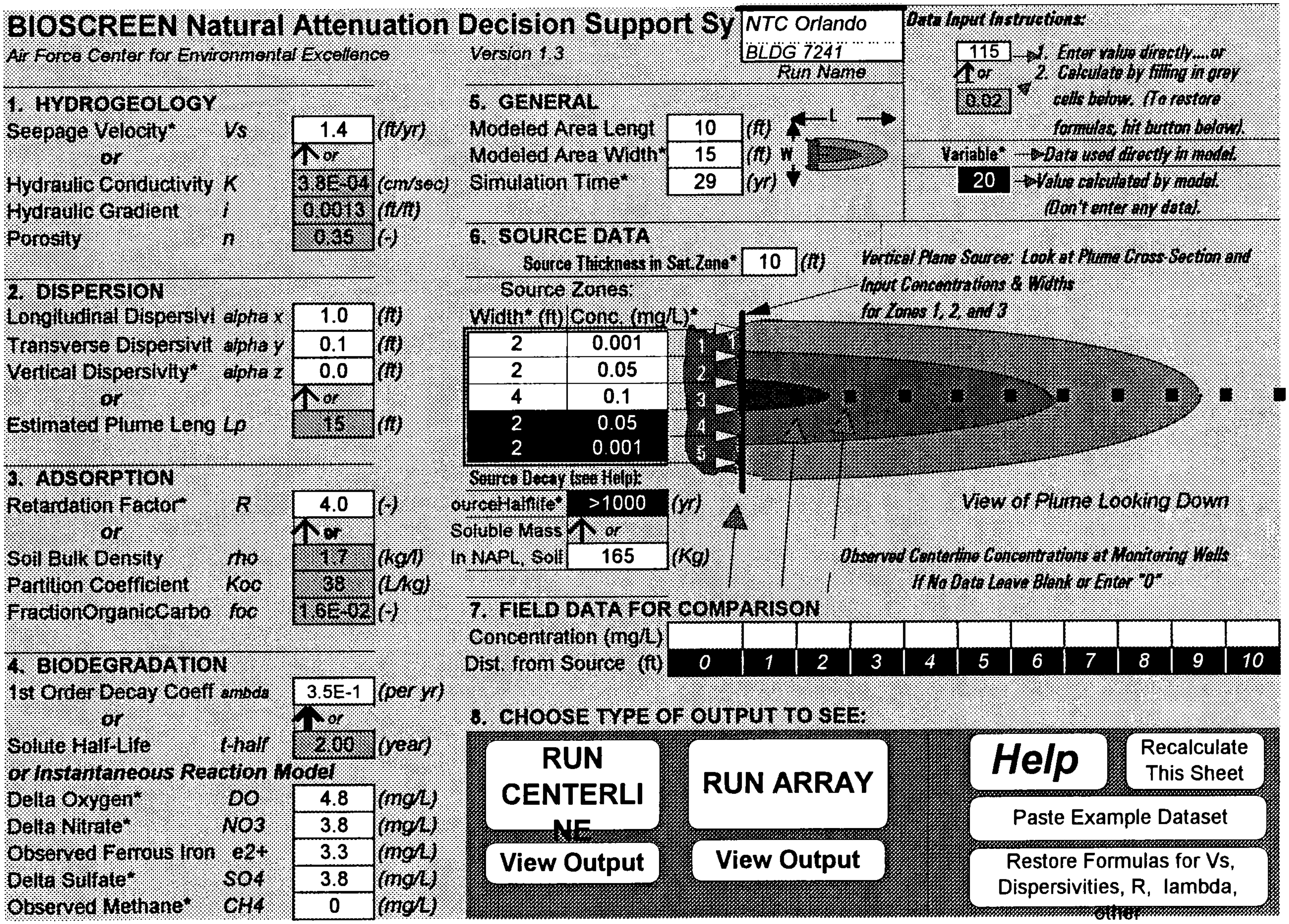
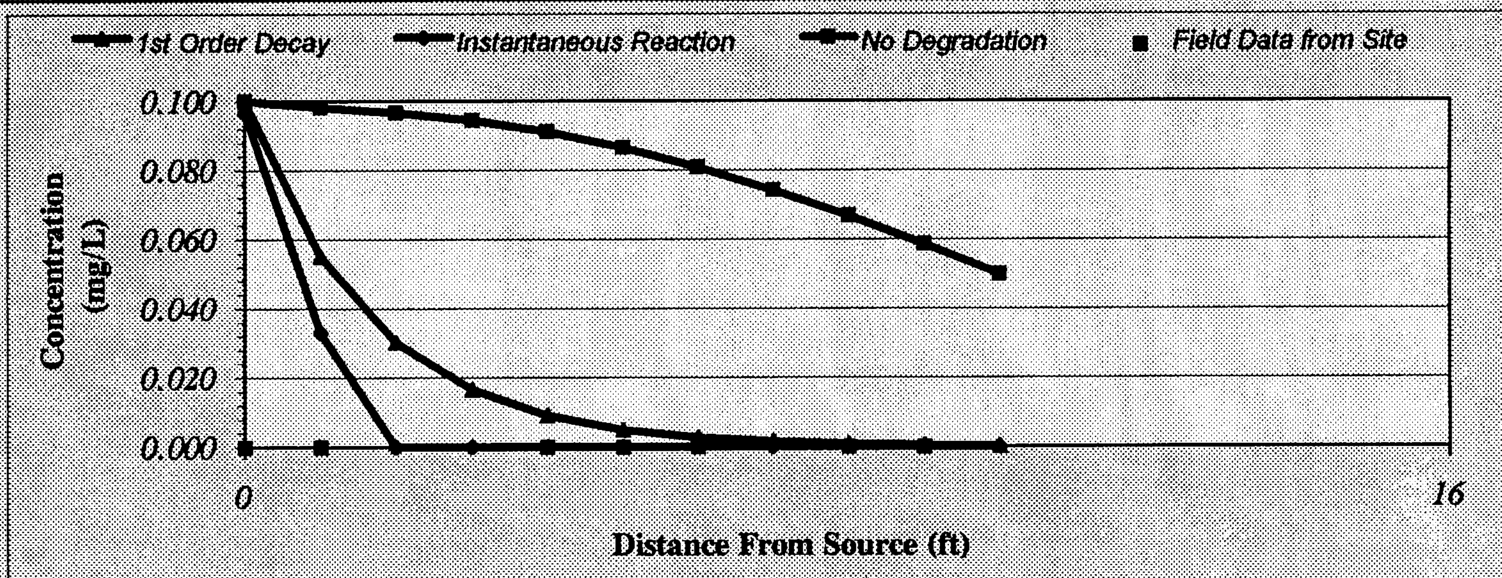


Figure 2A - BIOSCREEN No Action Model Input Screen.

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	1	2	3	4	5	6	7	8	9	10
No Degradation	0.100	0.098	0.097	0.094	0.091	0.086	0.081	0.074	0.067	0.058	0.050
1st Order Decay	0.100	0.055	0.030	0.016	0.009	0.005	0.003	0.001	0.001	0.000	0.000
Inst. Reaction	0.097	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Next Timestep
Calculate Animation
Prev Timestep

Time:
29 Years

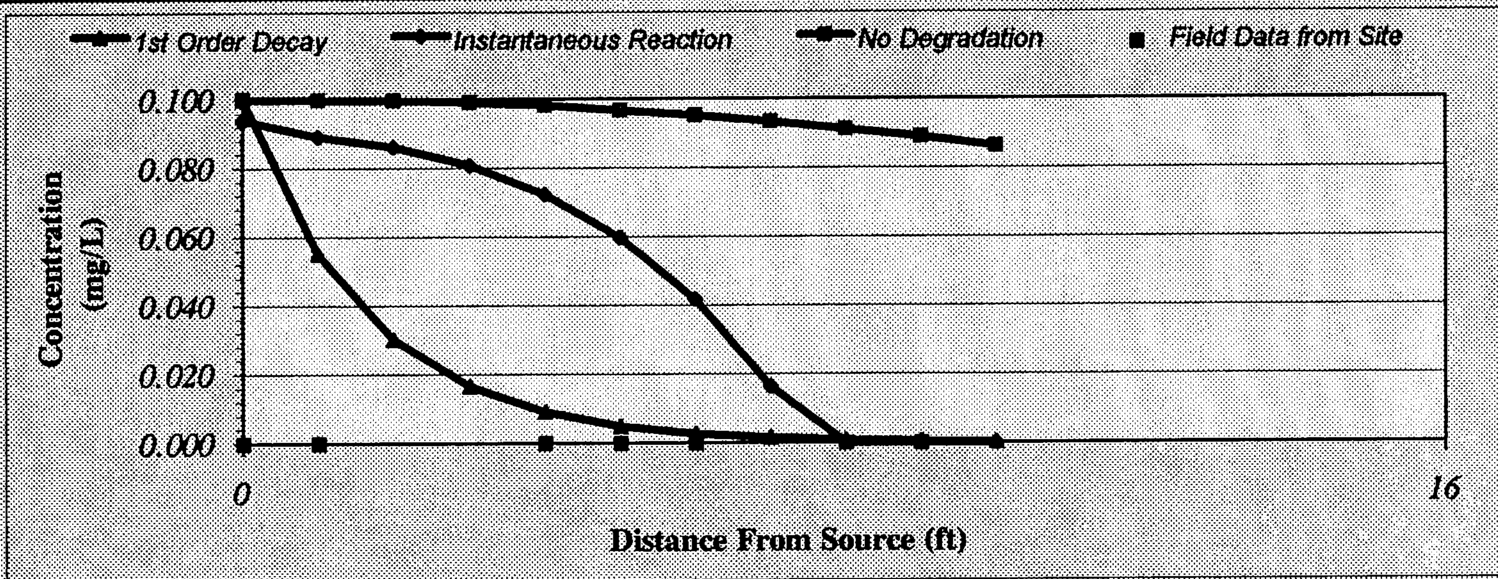
Return to Input

Recalculate This Sheet

Figure 2B - BIOSCREEN No Action Model Output - 25 years from present.

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	1	2	3	4	5	6	7	8	9	10
No Degradation	0.100	0.100	0.100	0.099	0.098	0.097	0.095	0.093	0.091	0.089	0.086
1st Order Decay	0.100	0.055	0.030	0.016	0.009	0.005	0.003	0.001	0.001	0.000	0.000
Inst. Reaction	0.094	0.089	0.086	0.081	0.072	0.060	0.042	0.016	0.000	0.000	0.000
Field Data from Site											



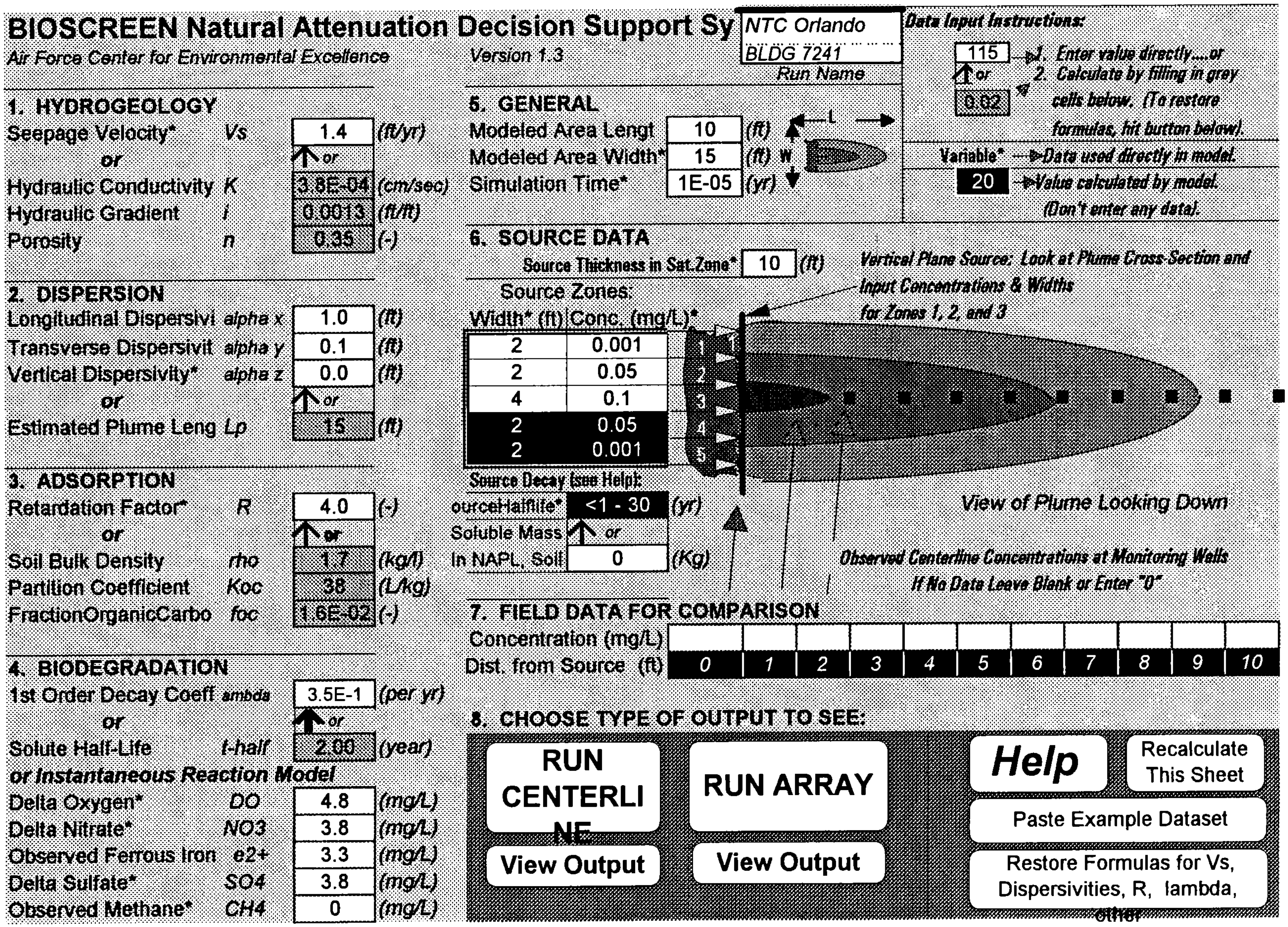
Calculate Animation Next Timestep Prev Timestep

Time: *54 Years*

Return to Input

Recalculate This Sheet

Figure 2C - BIOSCREEN No Action Model Output - 50 years from present.



Figur BIOSCREEN No Source Model Input Screen.

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft)

Distance from Source (ft)

↓	0	1	2	3	4	5	6	7	8	9	10
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Model to Display:

No Degradation Model

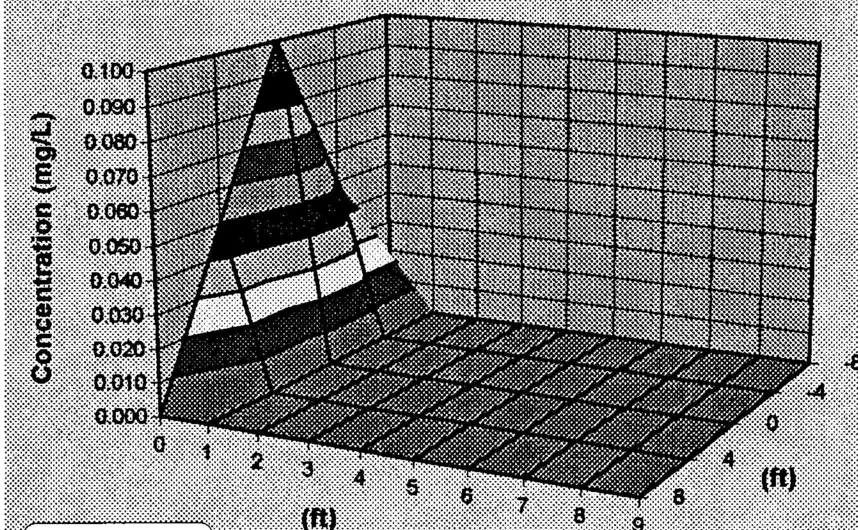
1st Order Decay Model

Instantaneous Reaction Model

Time: **0.00001 Years**

Target Level: **0.000** mg/L

Displayed Model: **Inst. Reaction**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation: an't Calc *(Kg)*

- Actual Plume Mass: an't Calc *(Kg)*

= Plume Mass Removed by Biodeg: - *(Kg)*

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
-	-	-	-	-	*(Kg)*

Original Mass in Source (Time = 0 Years): 0.0 *(Kg)*

Mass in Source Now (Time = 0.00001Years): 0.0 *(Kg)*

Current Volume of Groundwater in Plume: an't Calc *(ac-ft)*

Flowrate of Water Through Source Zone: an't Calc *(ac-ft/yr)*

Mass HELP

Recalculate

Figure 3B - No Source / Instantaneous Reaction Model Output - Immediately following source removal.

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) / *Distance from Source (ft)*	0	1	2	3	4	5	6	7	8	9	10
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Model to Display:

No Degradation Model

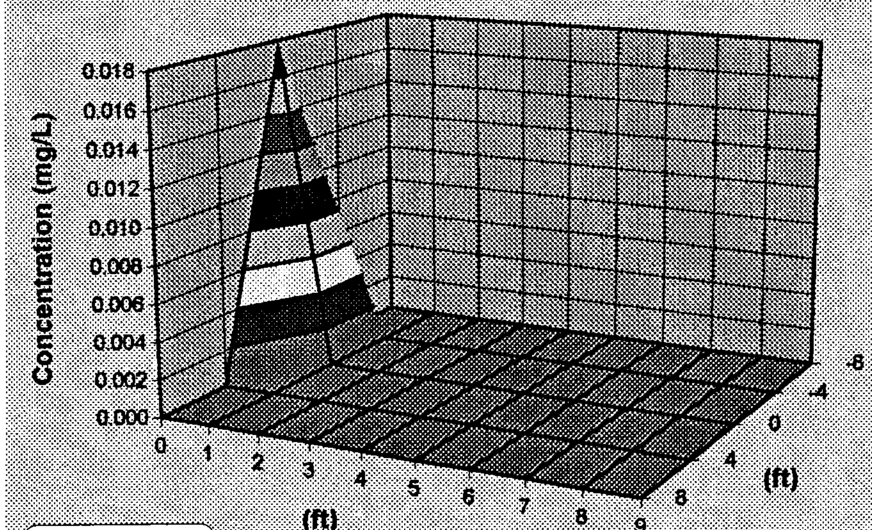
1st Order Decay Model

Instantaneous Reaction Model

Time: **0.01918 Years**

Target Level: **0.000** mg/L

Displayed Model: **Inst. Reaction**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation: an't Calc (Kg)

- Actual Plume Mass: an't Calc (Kg)

= Plume Mass Removed by Biodeg: - (Kg)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
-	-	-	-	-	(Kg)

Original Mass in Source (Time = 0 Years): 0.0 (Kg)

Mass in Source Now (Time = 0.01918Years): 0.0 (Kg)

Current Volume of Groundwater in Plume: an't Calc (ac-ft)

Flowrate of Water Through Source Zone: an't Calc (ac-ft/yr)

Mass HELP

Recalculat e

Figure . No Source / Instantaneous Reaction Model Output - 1 week following source removal.

DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) / *Distance from Source (ft)*

	0	1	2	3	4	5	6	7	8	9	10
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Model to Display:

No Degradation Model

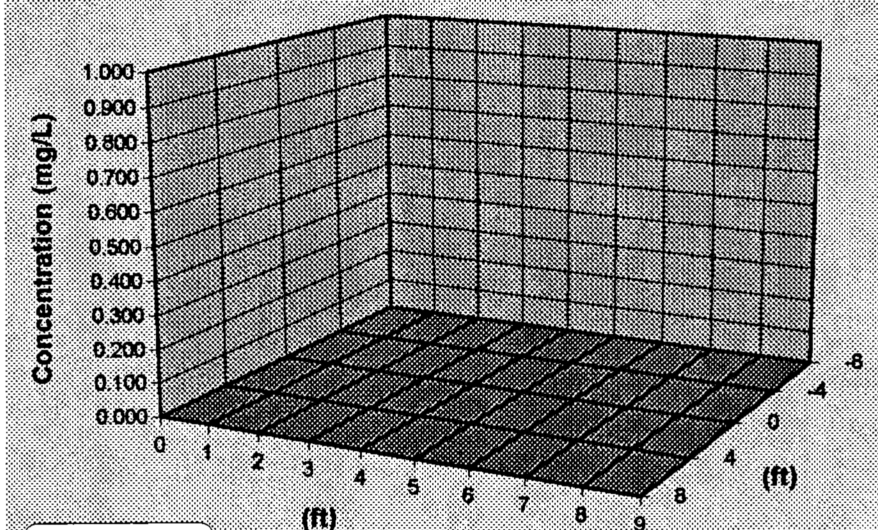
1st Order Decay Model

Instantaneous Reaction Model

Time: **0.0822 Years**

Target Level: **0.000** mg/L

Displayed Model: **Inst. Reaction**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	an't Calc	*(Kg)*
- Actual Plume Mass	an't Calc	*(Kg)*
= Plume Mass Removed by Biodeg	-	*(Kg)*

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
-	-	-	-	-	*(Kg)*

Original Mass In Source (Time = 0 Years)	0.0	*(Kg)*
Mass in Source Now (Time = 0.0822Years)	0.0	*(Kg)*
Current Volume of Groundwater in Plume	an't Calc	*(ac-ft)*
Flowrate of Water Through Source Zone	an't Calc	*(ac-ft/yr)*

Mass HELP

Recalculate

Figure 3D - No Source / Instantaneous Reaction Model Output - 1 month following source removal.

APPENDIX C

BASIS OF DESIGN

BASIS OF DESIGN
Remedial Action Plan
Building 7241, NTC Orlando, McCoy Annex

The purpose of this plan is to describe actions necessary to comply with the requirements of Chapter 62-770, Florida Administrative Code (FAC). The plan is based on a strategy of source abatement followed by remediation by natural attenuation. This strategy is implemented through the following steps.

- obtain necessary regulatory approvals
- abandon monitoring wells located in area of excavation
- excavate soil to a depth of 8 feet below land surface
- transport contaminated soil off site for thermal treatment
- remove and dispose any free product infiltrating into the excavation
- restore site to original grades
- re-install monitoring well(s) necessary for long-term monitoring
- begin site monitoring for first year
- update BIOSCREEN model based on new site conditions and data

Because of the limited area of free product contamination and the relatively low concentrations of dissolved contaminants in groundwater, it is anticipated that the source removal action will result in a reduction in the total mass of contaminants of more than 99 percent. The effectiveness of remediating the contaminated groundwater by natural attenuation will be greatly impacted by the success of the source abatement. Following the first post-excavation monitoring event, the effectiveness of natural attenuation should be re-evaluated using the BIOSCREEN model. The evaluation of the model results should be used to guide continued implementation of this plan. If contaminant concentrations remaining after source abatement are very low, a reduction in the monitoring requirements should be considered. If concentrations are significantly higher than predicted, additional remedial measures should be considered. Any variations from the approved plan must be accepted by the FDEP prior to implementation.

Harding Lawson Associates

August 10, 1998

Document No.:02530.091

Commanding Officer
Southern Division
Naval Facilities Engineering Command
Mr. Nick Ugolini, Code 1843
2155 Eagle Drive
N. Charleston, SC 29406

Subject: **Remedial Action Plan (RAP) for Building 7241**
McCoy Annex
NTC, Orlando, Florida
CTO 107, Contract No.: N62467-89-D-0317/107

Dear Mr. Ugolini

Enclosed is the Remedial Action Plan (RAP) for Building 7241, McCoy Annex, NTC Orlando, Florida. This RAP is submitted as The Final RAP.

Should you have any question regarding this letter, please contact the undersigned at (407) 895-8845.

Very Truly Yours,
ABB ENVIRONMENTAL SERVICES, INC.

John Kaiser
Installation Manager

Mirna Barq
Project Engineer

JPK/MB/lak

cc: Wayne Hansel, Code 18B7, Southern Division
Lt. Gary Whipple, NTC Orlando
Mark Zill, NTC Orlando
John Mitchell, FDEP
City of Orlando via Wayne Hansel
File Copy (2 enc)

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Engineering and
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