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Final

Work Plan for Pilot-Scale Testing of Free-Product Recovery and Aquifer Air Sparging at the Navy Fuel Farm Facility Naval Air Station Willow Grove Horsham Township, Pennsylvania

Contract No. N62472-92-D-1296
Contract Task Order No. 0009

Prepared for

Department of the Navy
Northern Division
Naval Facilities Engineering Command
Lester, Pennsylvania

Prepared by

EA Engineering, Science, and Technology
Newburgh, New York

November 1993 *296.0009*

EA Project No. 296.0009

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1. INTRODUCTION

1.1 SCOPE OF WORK

This pilot study Work Plan for the Navy Fuel Farm, Naval Air Station (NAS), Willow Grove, Horsham Township, Pennsylvania has been prepared for the Naval Facilities Engineering Command (NAVFAC) under the Base Realignment and Closure (BRAC) multi-year Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract (Contract No. N62472-92-D-1296), Contract Task Order (CTO) No. 0009, to provide guidance for the performance of a two-step pilot study of remedial technologies designed to reduce source contributions of hydrocarbons to site ground water. Under this CTO, EA Engineering, Science, and Technology will evaluate the effectiveness of both free-product recovery and shallow aquifer air sparging (AAS) as remedial technologies. This Work Plan has been developed based on the information and regulations contained in the following documents:

- Plan of Action for Site Inspection, NAS Willow Grove, Pennsylvania. February (EA 1988a).
- Draft Appendix B, Soil Vapor Contaminant Assessment at NAS Willow Grove. December (EA 1988b).
- Interim Report, Electromagnetic Survey, Soil Vapor Contaminant Assessment, and Revised Field Sampling Plan for Site Inspection Studies at NAS Willow Grove. March (EA 1989a).
- Draft Report, Environmental Test Boring Investigation at the Navy Fuel Farm, NAS Willow Grove, Horsham Township, Pennsylvania. June (EA 1989b)
- Final Report, Site Inspection Studies at NAS Willow Grove, Horsham Township, Pennsylvania. Volumes I and II. May (EA 1990)
- Final Interim Report on Investigations at the Navy Fuel Farm, NAS Willow Grove, November 1990 - July 1991. November (EA 1991).
- Final Report of Interim Site Investigations, Navy Fuel Farm - Willow Grove NAS. September (EA 1993).
- Commonwealth of Pennsylvania Department of Environmental Resources (PADER). Protective Levels and Criteria for the Excavation, Treatment, Cleanup and Disposal of Virgin Fuel Contaminated Soil. October (PADER 1991).

- Commonwealth of Pennsylvania Department of Environmental Resources, Ground Water Quality Protection Strategy. February (PADER 1992).

- Title 25 - Pennsylvania Code Chapter 245 Subchapter D, Storage Tanks; Corrective Action. August. Commonwealth of Pennsylvania, Environmental Quality Board (EQB 1993).

Based on the previous investigations, recommendations for the implementation of pilot scale remedial testing were presented (EA 1991), including: (1) installation of a pilot free-product recovery system on Well NFFW-2R and initiation of product recovery by pumping at Well NFFW-2R and/or Well NFFW-12; and (2), installation of a product skimmer pump or automated bailer on Well NFFW-6 to assess potential for continuous product yield without depressing the water table. Subsequent to these recommendations, and based on the need to address the presence of source hydrocarbons in the zone of water table fluctuations, Northern Division requested pilot testing of another technology, such as shallow AAS (in conjunction with soil vapor extraction [SVE]), which would also address residual hydrocarbons.

Pilot studies will be conducted in two phases, as outlined in the remainder of this Work Plan. The first phase will employ several iterations of free-product recovery (i.e., automated skimming, vacuum-enhanced pumping, and bailing) and is designed to assess the feasibility of free-product removal. Pilot testing of free-product recovery alternatives has been necessitated by the presence of free product at several locations within the Navy Fuel Farm facility. An adequate assessment of the transport mechanisms responsible for the migration and occurrence of free product within unconsolidated materials and underlying bedrock at the Navy Fuel Farm facility should be made prior to the implementation of the second phase of the Work Plan. Free-product recovery pilot tests will, therefore, be operated for at least three months in an effort to diminish the extent of free product, and to accumulate routine gauging data at the site.

During the initial free-product recovery phase of the study, much will be learned about the amount and distribution of non-aqueous phase liquid (NAPL) and adsorbed hydrocarbons as well as the extent to which NAPL is recoverable. This information will assist in evaluating candidate locations for testing a residual hydrocarbon recovery technology. EA and the Navy will evaluate this information prior to initiating the second phase of the study and decide whether to continue with or modify the plan discussed below.

SVE/AAS has been successfully applied in a wide variety of site settings. Potential limiting factors to this technology at the Navy Fuel Farm facility are the clay content of the soil and the presence of hydrocarbons in fractured bedrock. Nevertheless, this technology has potential for successful application at the Navy Fuel Farm facility, and is the likely technology to be tested.

The second phase of pilot testing at the site is planned to involve the utilization of the *in situ* technologies SVE and AAS. *In situ* AAS has been selected based on its potential to reduce source hydrocarbons within the zone of water table fluctuation, where a majority of hydrocarbons tend to be located. The proposed AAS system will be designed to reduce the extent of source hydrocarbons occurring as both free-product trapped beneath the water table and sorbed onto soil particles located in the phreatic zone. If left *in situ*, these hydrocarbons will serve as a continuing source of hydrocarbons to ground water. As opposed to other AAS systems designed to mitigate the dissolved-phase hydrocarbon component, AAS at the Navy Fuel Farm facility will be undertaken to evaluate its effectiveness in removing source hydrocarbons, after which natural attenuation processes will continue to improve ground-water quality.

This Work Plan forms the basis for constructing and testing the pilot systems and evaluating the effectiveness of these technologies. The results of the pilot studies will provide the criterion for design alterations, if appropriate, or the decision to investigate the utilization of other technologies. All results will prove useful, even negative ones, since they may provide criteria to eliminate these technologies from further consideration. The results of this study will be incorporated into an evaluation report of free-product recovery and SVE/AAS treatability at the Navy Fuel Farm facility. In the report, an evaluation of the success, failure, or limitations of technologies evaluated at the subject site will be made, along with results of performance evaluation audits and discussions of quality assurance.

1.2 OBJECTIVES

The primary objective of this project is to conduct remedial pilot studies and evaluate the effectiveness of each technology in reducing source hydrocarbons at the Navy Fuel Farm facility. An integral component to achieving this objective is the removal of free product. EA will install, operate, and maintain free-product recovery pilot systems at three site wells for a period of 9 months. From the point in time at which free-product has been sufficiently diminished within potential SVE/AAS pilot test locations, the mitigation of source hydrocarbons located in the phreatic zone via AAS may be evaluated. The SVE/AAS pilot study is proposed to run for a 6-month period.

1.3 FREE-PRODUCT RECOVERY

Once constructed and operating, the components of the free-product recovery system will be routinely monitored and sampled to evaluate the impact the remediation system has had on free product and ground water. In order to achieve the above, the following actions will be required:

- Institute a ground-water gauging program designed to assess the nature and extent of free-product and to evaluate the effectiveness of the vacuum-enhanced recovery system in drawing additional free product toward the recovery well.

- Implement a water sampling program to demonstrate treatment of aqueous effluent in sufficient levels prior to discharge.

- Perform routine air emissions monitoring on the vacuum-enhanced pumping system to gauge the performance of air treatment system.

- Prepare ground-water elevation contour maps from well gauging data prior to, during, and at the conclusion of the pilot study.

- Prepare interim and final reports summarizing the results of the pre-treatment, operations period, and post-treatment environmental conditions.

The pre-treatment, operations period, and post-treatment data will be incorporated into the final technology evaluation report. The results of the pre-treatment gauging data, in comparison with operational and post-treatment gauging data, and the volume of free-product recovered, will define the effectiveness of the free-product removal at the Navy Fuel Farm facility.

1.4 SOIL VAPOR EXTRACTION/AQUIFER AIR SPARGING

Once constructed and operating, the SVE/AAS system will be routinely monitored and sampled to evaluate the impact the remediation system has had on shallow soil and ground water. At completion of pilot study activities, soil vapor monitoring and ground water sampling and analysis will be performed at the same locations that pre-treatment samples were obtained. In order to achieve the above, the following actions will be required:

- Institute a soil vapor sampling program designed to assess the nature and extent of hydrocarbons in unsaturated-zone soil vapor.

- Implement a ground-water sampling program sufficient to evaluate the impact over time of the SVE/AAS system in reducing source hydrocarbons (via analysis of dissolved-phase hydrocarbons in site ground water).

- Prepare ground-water elevation contour maps from well gauging data prior to, during, and at the conclusion of the pilot study.

- Prepare interim and final reports summarizing the results of the pre-treatment, operations period, and post-treatment environmental conditions.

The results of the pre-treatment, operations period, and post-treatment analyses will be incorporated into the final technology evaluation report. The results of the pre-treatment analyses, in comparison with post-treatment analyses, will provide the basis for evaluating the effectiveness of the SVE/AAS pilot testing at the Navy Fuel Farm facility.

2. PROJECT DESCRIPTION

This Work Plan presents the technical procedures for performing a two-phase pilot study at the Navy Fuel Farm facility located at the NAS Willow Grove, Horsham Township, Pennsylvania (Figure 2-1). The Work Plan has been developed based upon a review of the data and information obtained from various sources, which are discussed in Section 1.1. The Navy Fuel Farm facility has been found to contain a source of petroleum hydrocarbons locally within soil, bedrock, and ground water.

Pilot remedial actions were recommended to initially focus on free-product removal (EA 1990, 1991). Initial screening of free-product recovery alternatives consisted of water table depression and free-product pumping, automated skimmer pump, automated bailer, and hand bailing. Field investigations (EA 1990, 1991, 1993) identified potential source areas for petroleum releases and approximations of dissolved-phase and free-phase hydrocarbon plumes. Preferred remedial methods for ground-water restoration were not identified by EA as the extent of free-phase and dissolved-phase hydrocarbons in soil and ground water was not completely interpreted during the field investigations.

Upon completion of the interim site investigation (EA 1993), Northern Division examined the need to develop a work plan to perform pilot study evaluations of several remedial alternatives. As discussed above, EA recommended the implementation of a pilot free-product recovery program. To address the source hydrocarbon component in the zone of shallow water table fluctuation at the Navy Fuel Farm facility, Northern Division intends to perform pilot air sparging tests to assess the effectiveness of this remedial approach. Through discussion, it was determined that a technical evaluation of AAS (in conjunction with SVE) would be made after completing the initial 3 months of pilot free-product recovery operations. It is understood that the results of this pilot study may serve as guidance in evaluating the potential of applying these technologies in full-scale across the remainder of the Navy Fuel Farm facility.

2.1 EXISTING CONDITIONS SURVEY

The Navy Fuel Farm facility is located along the north side of Privet Road and immediately south of the Pennsylvania Air National Guard (PAANG) portion of the Air Reserve Facility (ARF) at NAS Willow Grove (Figure 2-2). The Navy Fuel Farm facility and a portion of the adjoining property to the north, occupied by PAANG (Buildings 345 and 340), constitute the area requiring remedial efforts. The Navy Fuel Farm facility is bordered on all sides by NAS grounds. West of the subject site, across an access road, sits the aircraft parking apron off Runway 15. To the east, at the previous location of Building 157, sits the newly constructed Navy Fuel Farm facility, complete with a bermed enclosure containing the newly erected aboveground storage tanks. Abutting the Navy Fuel Farm facility to the north are ARF Buildings 330, 340, and 345. Several other base facilities exist within 1,000 ft of the site.

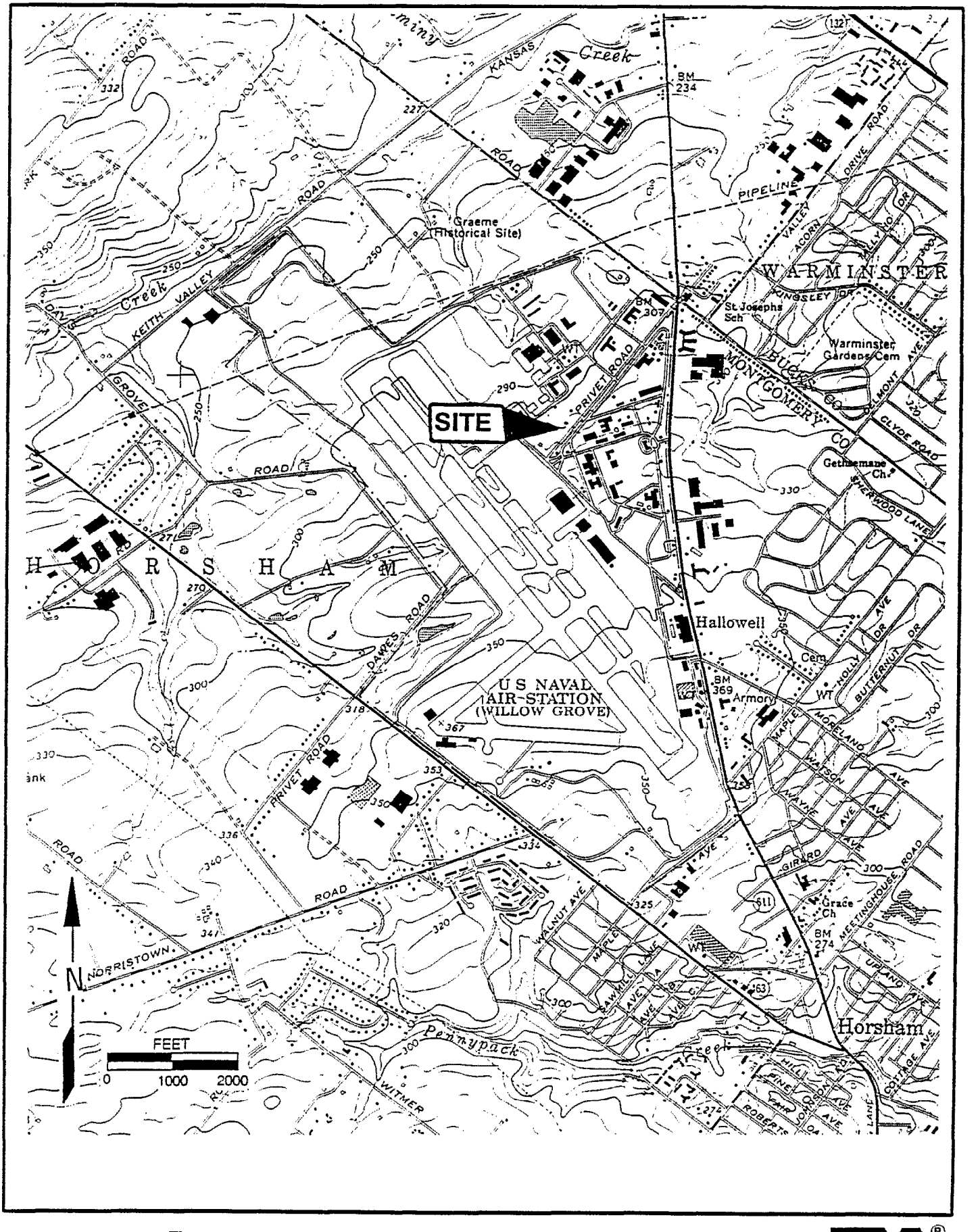

Figure 2-1. Site location map, Navy Fuel Farm facility, Naval Air Station, Willow Grove Grove, Pennsylvania.

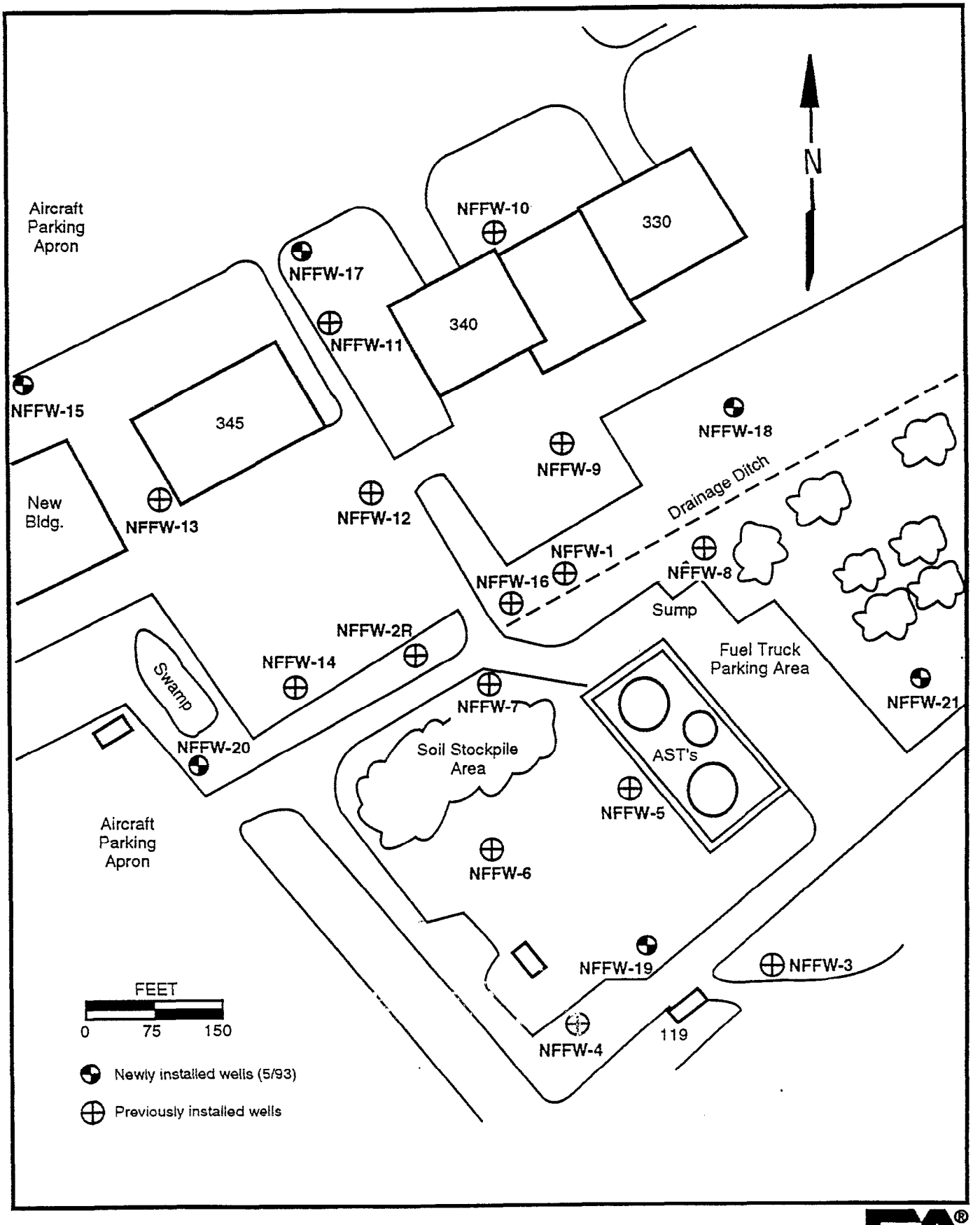

Figure 2-2. Site plan 1993, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

The Navy Fuel Farm facility is approximately 2 acres in area and consists of three aboveground storage tanks, associated aboveground piping, and building Nos. 119 and 81. Remaining Navy Fuel Farm facility grounds include a fuel truck parking area and a soil staging area. At present, the newly constructed facility remains inactive.

The topography of the Navy Fuel Farm facility area is characterized as flat and gently sloping to the north-northwest. There is a slight downgrade at the north end of the facility which encourages runoff to flow northeast into the catchment basin or the adjacent ditch.

On and directly adjacent to the Navy Fuel Farm facility grounds exist several buried utilities, including water, electric, sewer, telephone, and product piping. Several storm sewer and sanitary sewer lines traverse the southern portion of Navy Fuel Farm facility grounds. A water main also extends across facility grounds. Updated utility drawings for the Navy Fuel Farm facility grounds have not been provided to EA. It is assumed that NAS personnel will provide these drawings to EA and mark the location of all utilities in the field prior to the commencement of excavations. A complete, updated assessment of the existing conditions will be made during the installation of the pilot system.

2.2 HISTORY OF FUEL STORAGE AND PRODUCT RELEASES AT THE NAVY FUEL FARM FACILITY

Information relating the site's history has been taken from EA (1993). From 1950 to 1991, two partially buried 210,000-gal JP-4/JP-5 aviation fuel tanks (Tank Nos. 115 and 116) were located at the site. A 500-gal underground waste oil tank and an underground diesel tank were also located at the southwestern corner of the site. The former locations of these tanks is provided in Figure 2-3.

In 1986, a spill occurred when Tank 115 was overfilled and fuel was released from the vent pipe onto the ground. The event was attributed to faulty gauges which registered less fuel than was actually present. During this same year, a utility trench was excavated along the western boundary of the site but work discontinued when free product was observed floating on the water within the trench. Subsequent observations have confirmed the continued presence of at least a sheen of free product in the trench. The area where the free product was discovered is immediately adjacent to a former drywell. The drywell accepted water which was periodically siphoned from the bottom of the fuel tanks.

In March 1989, JP-5 jet fuel was detected emanating from two patches of dead grass on the west side of Tank 115. Heavy rains flushed this fuel into the ditch on the north side of the site. Navy personnel responded with the placement of sorbent material in the ditch and adjacent to Tank 115. With this evidence of tank leakage, it was decided to empty and remove the two main fuel tanks (Tank Nos. 115 and 116). Removal of these tanks occurred in 1991. Also during this time, the waste oil and diesel underground storage tanks were removed. Inspection of the waste oil tank during removal revealed the tank was not intact as holes up to 1-in. in diameter were reported.

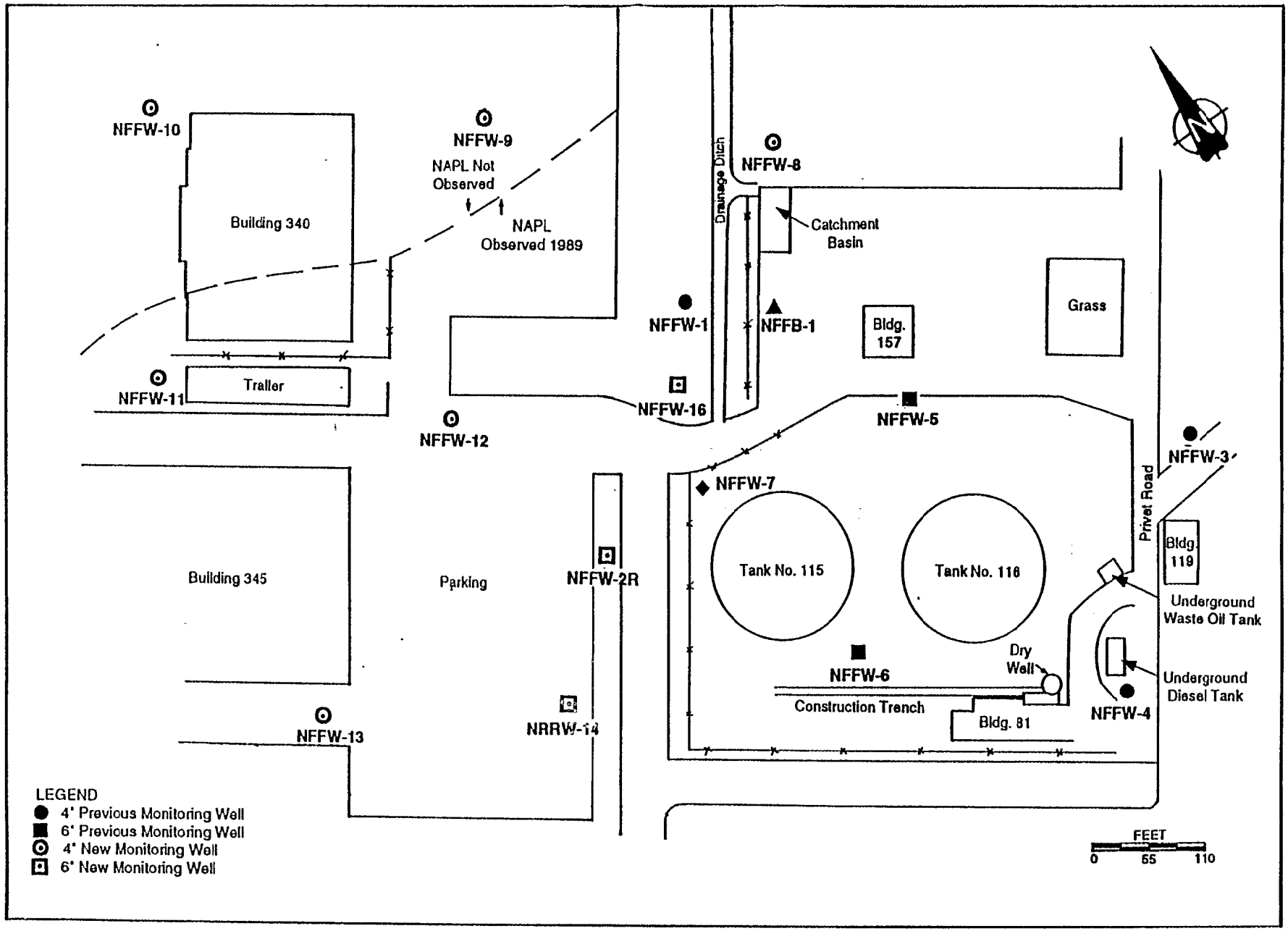

Figure 2-3. Site plan showing relevant site features, prior to 1991, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

Subsequent to the completion of removal activities, a new aboveground tank system was installed to the east of the former tank field location. In order to accommodate the newly constructed Navy Fuel Farm facility, Building No. 157 was removed. The new tank system at the Navy Fuel Farm consists of aboveground steel tanks set in a concrete berm. The Navy Fuel Farm facility is currently inactive. Figure 2-2 shows current site conditions.

2.3 GENERAL SITE CHARACTERISTICS

2.3.1 Site Geology

Site geology has been characterized based on the geologic logs of 40 soil borings installed by EA on and adjacent to the Navy Fuel Farm facility, 21 of which were completed as ground-water monitoring wells. Soil cover at the site varies in thickness from 6 to 21 ft. In general, soil depth increases from south to north, reflecting the dip of the underlying strata. The northeast edge of the site is underlain by soil types belonging to the Readington Silt Loam group; the remainder of the site is covered with fill material. The site-specific shallow stratigraphy is comprised primarily of silty clay and clayey silt with varying amounts of sand and little gravel. The high proportion of clay in the soil leads to reduced permeability and slow infiltration rates.

Unconsolidated materials at the site are underlain by the Middle Arkosic Member of the Late Triassic Stockton Formation. This member consists of interbedded red shale, siltstone, and gray-tan, medium-grained, Arkosic sandstone which was deposited as part of coalescing fluvial channel system. Red shale and siltstone are predominant along the south edge of the site, whereas the Arkosic sandstone underlies the remainder of the site.

Depth to competent bedrock may range from 6 ft in areas where soil was previously removed to competent sandstone bedrock during site construction activities to 20 ft in areas underlain by shale or siltstone. Relict bedding structure is often present as a zone several feet thick and overlying shale or siltstone units. Regional dip ranges from 5 to 15 degrees with strike to the north-northwest (Rima *et al.* 1962). Beds vary in thickness, often pinching out or grading into other facies, making interpretation of lithologic occurrence difficult.

Regionally, small displacement normal faults trending northeast-southwest are present throughout the unit. Two sets of vertical joints, roughly parallel and perpendicular to the strike direction, are well developed. A third set of joints, though not as well expressed as the first two, trends northwest-southeast (Rima *et al.* 1962).

2.3.2 Site Hydrology

The average depth to static ground water at the site on 21 June 1993 ranged from approximately 7 ft (Well NFFW-9) to 32 ft (Well NFFW-20) below grade. However, water levels fluctuate several feet due to seasonal influences. In most cases, ground water is observed within bedrock fractures or within the weathered zone immediately overlying

competent bedrock. Static water levels not only reflect the regional potentiometric surface but also the composite head resulting from the different water-yielding zones penetrated during drilling. For this reason, water levels may show marked differences in nearby wells depending on the number and size of fractures intercepted by each well.

Based upon several rounds of well gauging, movement of ground water at the Navy Fuel Farm facility is to the north, as shown in Figure 2-4. However, because flow is primarily through fractures within the bedrock or weathered bedrock, flow direction may be more related to fracture orientation rather than gradient. Ground-water flow through the Arkosic sandstone is more rapid than through the shale/siltstone as evidenced by more rapid recharge rates during well development and purging during sampling. This may be due to the greater size and density of the fractures present within the sandstone. Preferential movement through the sandstone results in greater yields of ground water parallel rather than perpendicular to bedding orientation, although local jointing and/or faulting may alter this trend.

Using the Neuman Method for unconfined aquifers, the average hydraulic conductivity, as derived from pumping test data at Wells NFFW-2R, NFFW-8, NFFW-12, NFFW-14, and NFFW-16 (EA 1991), was estimated at 4.05×10^{-5} cm/sec. The average ground-water velocity, as calculated by EA (1991) is estimated at 30 ft/year, assuming an effective porosity of 7 percent and a hydraulic gradient of 0.029 ft/ft. Aquifer tests conducted by EA (1991) have indicated that the wells are typically low yielding (0-2 gal per minute).

2.4 PETROLEUM HYDROCARBONS DETECTED AND INTERIM REMEDIAL OBJECTIVES

The pilot study described in this Work Plan is being conducted to evaluate the effectiveness of site remediation via source reduction at the Navy Fuel Farm facility. Source reduction includes the removal of free product and mitigation of hydrocarbons from source area soil, both above and below the shallow water table. Remediation of source area soil under this pilot study is scoped to be achieved in two phases, as described in Chapter 1.

Table 2-1 provides a summary of the petroleum hydrocarbons detected in ground water collected from wells at the Navy Fuel Farm facility. Table 2-2 provides a summary of maximum free-product thickness as observed in site wells during a recent investigation. Figure 2-5 provides an approximation of the aerial extent of free-product and dissolved-phase hydrocarbons at the subject site, based on recently collected well gauging data (EA 1993).

The goal of implementing interim remedial actions at this site is source reduction via free-phase product recovery and AAS/SVE. The objective of the pilot study detailed in this Work Plan is an evaluation of the effectiveness of free-phase product recovery and AAS/SVE. At completion of the pilot studies, the performance of these technologies will be reviewed against potential applicable or relevant and appropriate requirements for this site.

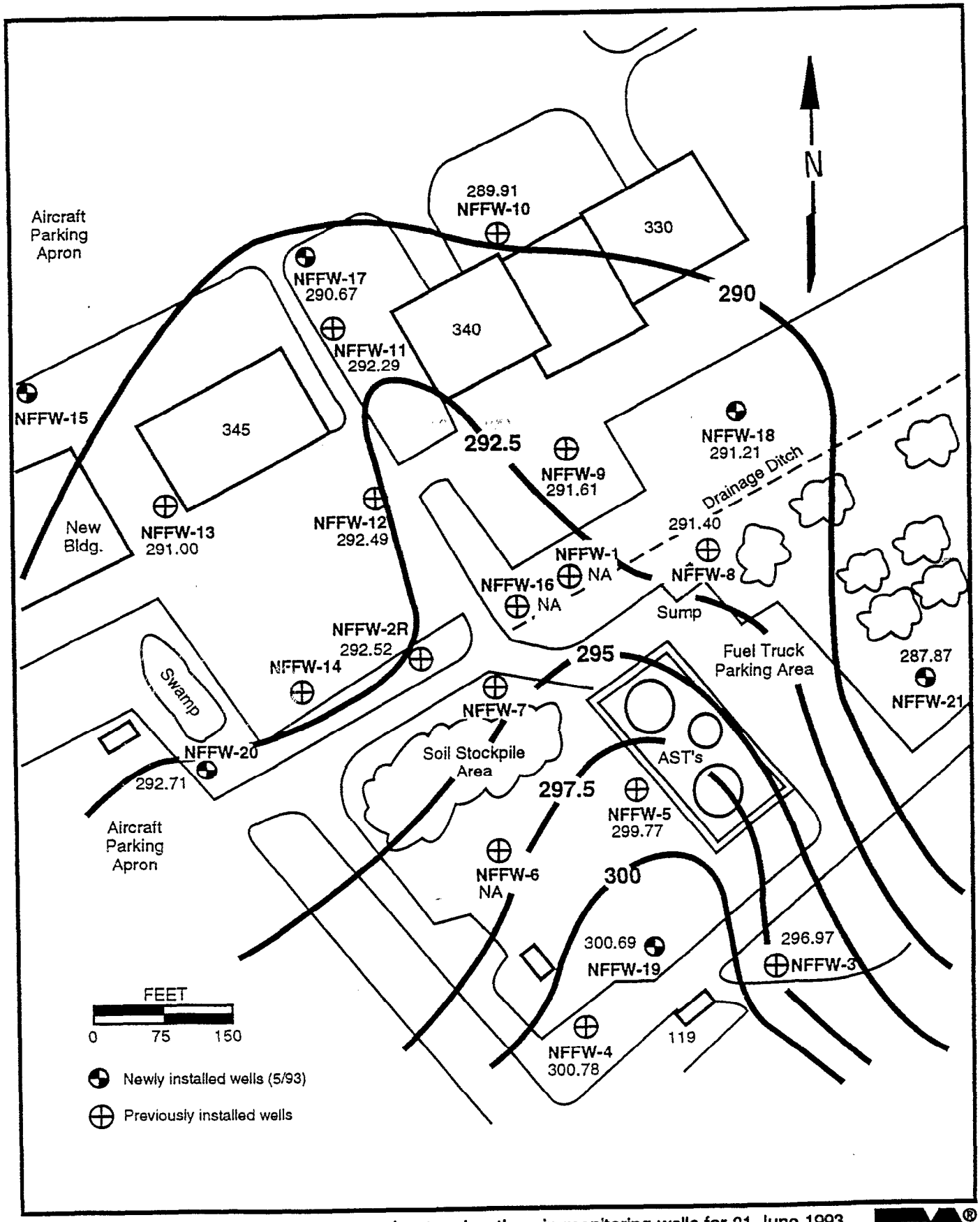

Figure 2-4. Site plan showing interpreted ground-water elevations in monitoring wells for 21 June 1993 gauging event, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

TABLE 2-1 SUMMARY OF ANALYTICAL RESULTS FOR GROUND-WATER SAMPLES TAKEN 10-21 JUNE 1993 AT THE NAVY FUEL FARM FACILITY, NAVAL AIR STATION, WILLOW GROVE, PENNSYLVANIA

Compound	NFFW-3	NFFW-4	NFFW-5	NFFW-5D	NFFW-8	NFFW-9	NFFW-10	NFFW-11
VOLATILE ORGANIC COMPOUNDS (μg/L)								
Acetone	---	---	---	77	59 B	---	14 B	---
Carbon Disulfide	---	---	14	12	---	---	---	---
Trichloroethene	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	5 J	---	---
Benzene	---	---	53	52	---	29	---	16
Toluene	---	---	---	---	---	---	---	---
Ethylbenzene	---	---	23	21	30	---	---	70
Total Xylenes	---	---	12	11	9 J	---	---	---
Total BTEX	---	---	88	84	39	29	---	86
TOTAL PETROLEUM HYDROCARBONS (μg/L)								
TPH (Gasoline)	1,600	---	1,600	1,700	8,800	1,300	360	8,300
TPH (JP-4)	---	---	---	---	3,200	---	---	40,000

NOTE: Wells NFFW-1, NFFW-2, NFFW-6, NFFW-7, NFFW-12, NFFW-13, NFFW-14, NFFW-16, and NFFW-19 not sampled due to presence of free-product in well.
Dashes (---) indicate not detected; refer to EA (1993) for complete results.
D = Duplicate sample; NA = Not analyzed; J = Estimated concentration; and B = Compound detected in associated method blank.

TABLE 2-1 (Continued)

Compound	NFFW-15	NFFW-17	NFFW-18	NFFW-19	NFFW-20	NFFW-21	Trip Blank	Trip Blank
VOLATILE ORGANIC COMPOUNDS (μg/L)								
Acetone	13 B	15 B	27 B	24 B	19 B	13 B	16 B	---
Carbon Disulfide	---	---	---	---	17	---	---	---
Trichloroethene	3 J	---	---	---	2 J	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---
Benzene	---	6 J	2 J	67	6 J	1 J	---	---
Toluene	---	---	1 J	17 J	2 J	1 J	---	---
Ethylbenzene	---	---	---	320	---	---	---	---
Total Xylenes	---	---	---	500	46	---	---	---
Total BTEX	---	6	3	904	54	2	---	---
TOTAL PETROLEUM HYDROCARBONS (μg/L)								
TPH (Gasoline)	---	530	6,800	6,900	5,900	---	NA	NA
TPH (JP-4)	---	8,400	---	3,600,000	1,600,000	---	NA	NA

TABLE 2-2 SUMMARY OF MAXIMUM FREE-PRODUCT THICKNESS OBSERVED DURING MAY-JUNE 1993 GAUGING PROGRAM AT NAVY FUEL FARM FACILITY, NAVAL AIR STATION, WILLOW GROVE, PENNSYLVANIA

Well Number	Maximum Free-Product Thickness (ft)
NFFW-1	0.02
NFFW-2R	0.27
NFFW-3	0.00
NFFW-4	0.00
NFFW-5	0.00
NFFW-6	1.20
NFFW-7	0.61
NFFW-8	0.00
NFFW-9	0.00
NFFW-10	0.00
NFFW-11	0.00
NFFW-12	0.01
NFFW-13	0.00[a]
NFFW-14	0.38
NFFW-15	0.00
NFFW-16	0.20
NFFW-17	0.00
NFFW-18	0.00
NFFW-19	2.00
NFFW-20	0.00[b]
NFFW-21	0.00

a. Free-product present in well during ground-water purging.
b. Green, translucent product detected in Well NFFW-20 after purging.

NOTE: Refer to EA (1993) for complete well gauging results.

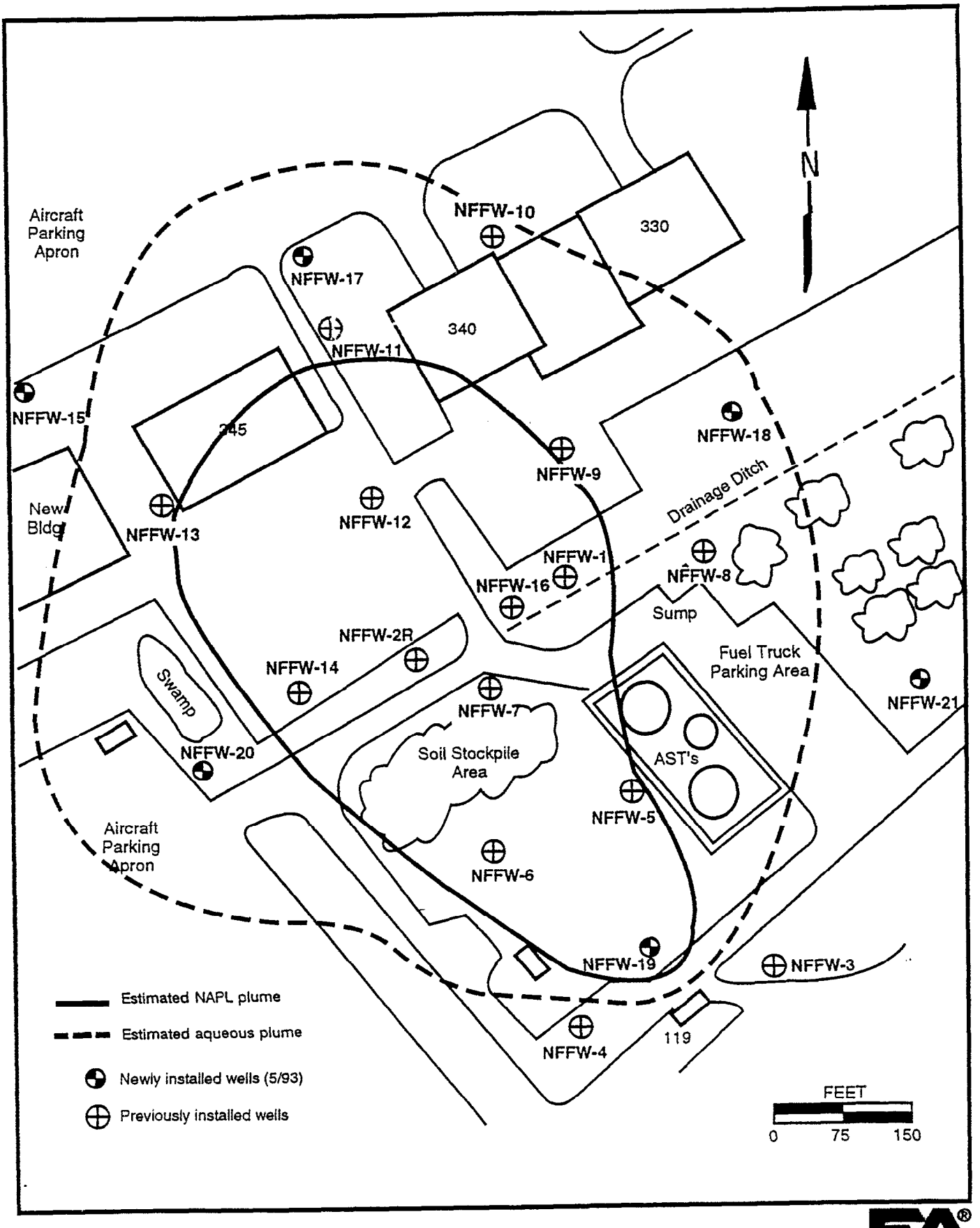

Figure 2-5. Interpreted hydrocarbon plume distribution, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

3. PROJECT ORGANIZATION

The overall project organization for CTO No. 0009 is presented in Figure 3-1. Ultimate project direction will be administered by the Northern Division. Field and project activities will be coordinated under the supervision of EA personnel. EA will direct the construction and field activities, including any subcontractors who may be working onsite. All analytical work will be provided by a laboratory under contract with EA.

3.1 KEY PERSONNEL

The pilot studies at the Navy Fuel Farm facility will involve several key organizations throughout its duration. Overall project direction is defined in Figure 3-1. Northern Division's Project Manager, Mr. James Colter, and Environmental Engineer, Mr. Paul Briegel, will be responsible for coordinating between subcontractor (EA) and regulatory agency personnel (PADER) in order to implement this Work Plan. Project coordination with NAS personnel will be the responsibility of Mr. Paul Greco of the Environmental Engineering Division of Public Works. The installation, operations, and monitoring of the pilot plant will be undertaken by EA. The pilot study group will be led by the Program Manager, Dr. Charles Houlik, CPG, and supervised by the CTO Manager, Mr. Michael Battle. Mr. Daniel Snowden and Mr. Barnabus Chukwueke are PADER's Hydrogeologist and Air Pollution Control Engineer, respectively, for the pilot study. Mr. Snowden and Mr. Chukwueke will provide regulatory review of this Work Plan and the data produced as a result of this study.

The pilot study group will be divided into several subgroups, including safety and health, construction management, field services, technical management, and analytical services. Safety and Health plan development for the construction and system start-up phases of this study will be the responsibility of Mr. Kris Hoiem, Certified Industrial Hygienist. Construction management, including the trenching, drilling, plumbing, electrical, and resurfacing phases, will be the responsibility of Mr. John Carnright. Oversight of all aspects of the installation, operations, maintenance, monitoring, sampling, and reporting during the pilot studies will be provided by Mr. Michael Battle. Technical support on free-product recovery and SVE/AAS issues will be provided by Ms. Gloria McCleary, P.E. Engineering support will be provided by Mr. Carl Reitenbach. Resumes of key EA personnel involved in the performance of pilot study activities at the Navy Fuel Farm facility are presented in Appendix A of this Work Plan.

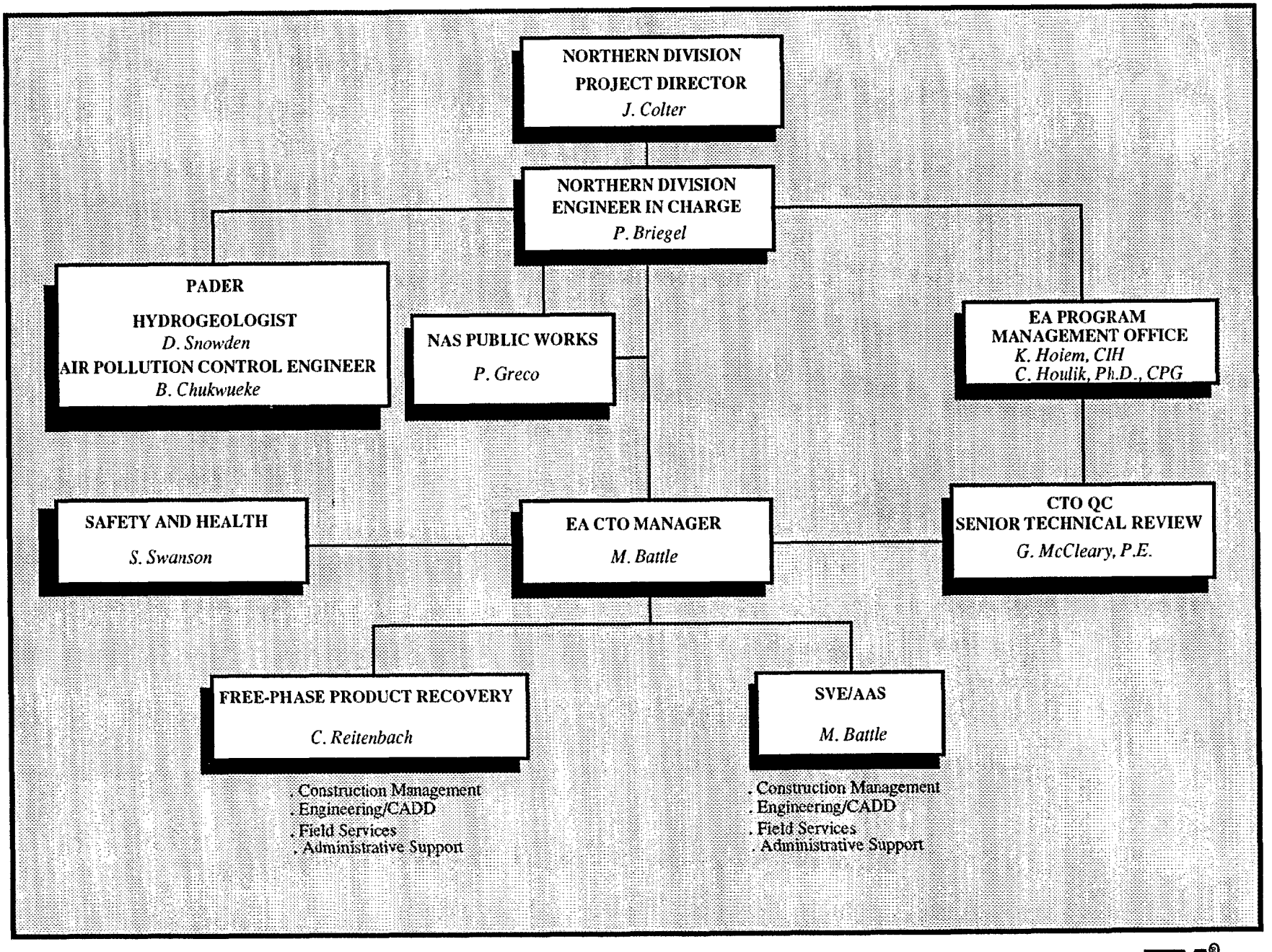

Figure 3-1. Project organization for pilot study activities at Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

4. FREE-PRODUCT RECOVERY PILOT STUDY

4.1 FREE-PRODUCT RECOVERY TECHNOLOGY SUMMARY

4.1.1 Objective

The primary objective of this field pilot study is to assess the feasibility of free-phase product recovery at the Naval Fuel Farm facility using vacuum-enhanced recovery and automated skimming technologies. Vacuum-enhanced pumping will be used to improve/facilitate product recovery. The Work Plan objectives also include characterization of the site conditions immediately prior to, during, and at the completion of the pilot system installation and operation.

4.1.2 Technology Description

Skimming of the free-phase product will be conducted in two wells (Wells NFFW-6 and NFFW-19) and vacuum-enhanced free-product recovery in one well (NFFW-2R). Free-product recovery employing vacuum enhancement and automated skimmers are proven technologies for the removal of free-phase product. Ground-water pumping during vacuum enhanced recovery maintains localized hydraulic control and initiates a "cone of depression" around the pumping well. A conceptual diagram illustrating the technology is shown in Figure 4-1.

Vacuum-enhanced recovery involves the application of a vacuum to the recovery well, which increases the hydraulic gradient toward the recovery well, thus increasing the ground-water pumping rate and the product recovery rate. Steady-state radial flow to a pumping well in an unconfined aquifer is given by the Thiem equation:

$$Q = k\pi \; [(h^2{}_2 - h^2{}_1)/\ln(r_2/r_1)]$$

where

Q	=	Flow (Length^3/Time)
k	=	Hydraulic conductivity (Length/Time)
π	=	3.14
h_1, h_2	=	Head (length at distances r_1 and r_2 (length) from the pumping well.

The term $(h^2{}_2-h^2{}_1)/\ln(r_2/r_1)$ includes the hydraulic gradient. Flow rate is directly proportional to the gradient.

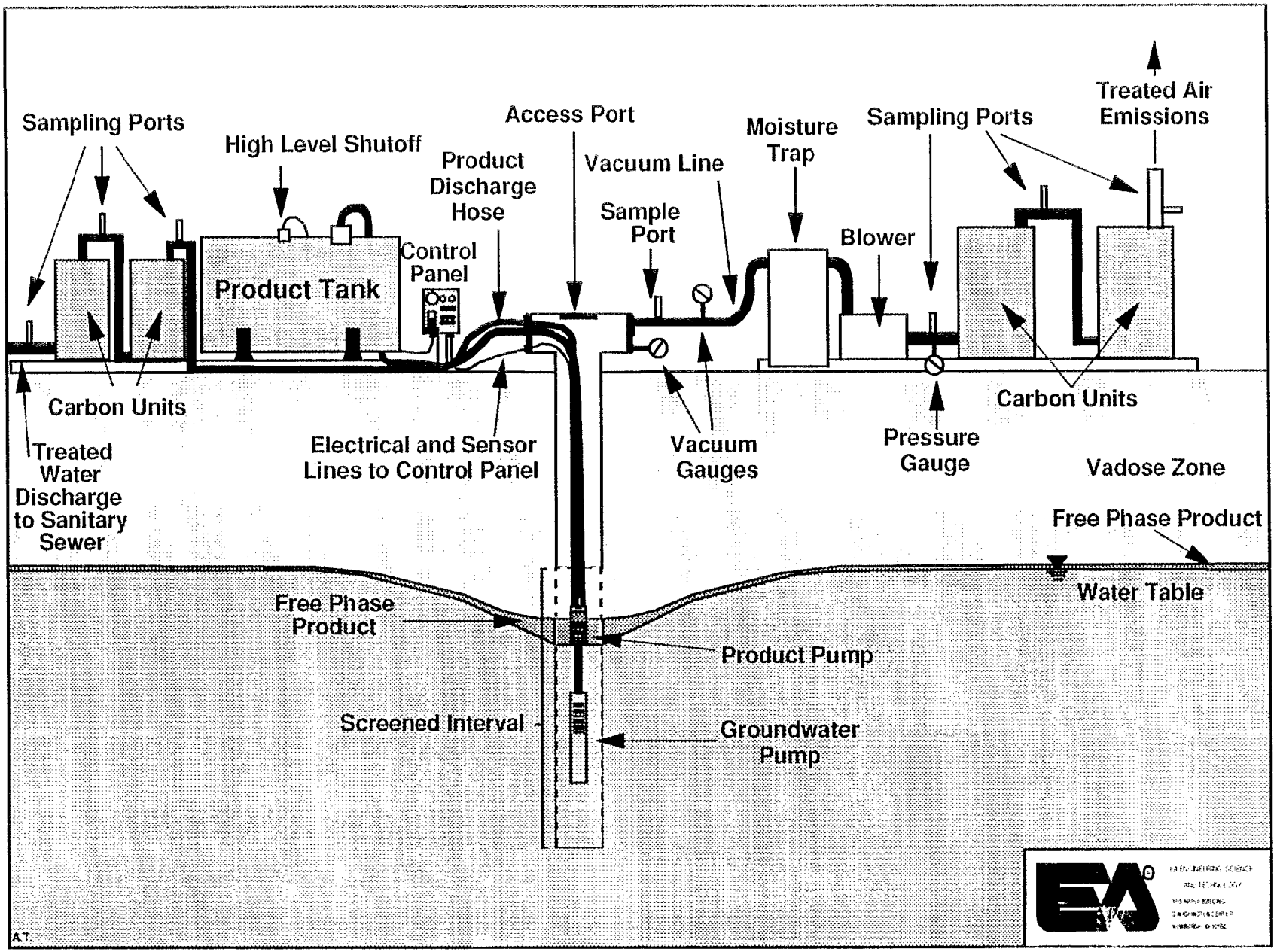

Figure 4-1. Schematic of vacuum-enhanced free-product recovery system to be installed at Well NFFW-2R, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

In simplest terms, the gradient is the change in head over a distance. Head has three components: elevation head, pressure head, and velocity head. When drawing down the water table in a typical recovery well, the change in elevation head is equal to the drawdown and the changes in pressure head and velocity head are assumed to be negligible. By applying a vacuum to the recovery well the change in pressure head is increased. This results in an increase in the gradient without an actual increase in the ground-water table depression. This increase in the change of head can be thought of in terms of an effective drawdown.

The effective drawdown is the actual drawdown as a result of ground-water pumping, plus the drawdown which would be necessary to equal the change in pressure head due to the vacuum being applied to the well. This concept is illustrated in Figure 4-2.

The increase in the effective drawdown results in a greater hydraulic gradient toward the pumping well and, therefore, a potentially higher ground-water pumping rate and free-product recovery rate. Due to the higher pumping rate, the travel time from the edge of the capture zone is decreased and subsequently project life is decreased. In addition, because the effective drawdown is increased without an increase in the actual drawdown, smearing of the aquifer with free-phase product is decreased. As a result, the amount of residual product is minimized and the potential for product recovery is maximized.

The effectiveness of free-product recovery is affected by aquifer permeability. Previous studies indicate that the ground water and free product at the site exists at or slightly above the soil/bedrock interface. The movement of free product and ground water is through fractures in the bedrock. Aquifer tests conducted by EA have indicated that the wells are typically low yielding (0-2 gpm) and the average hydraulic conductivity is 1×10^{-4} ft/min. The low permeability of the aquifer may limit the recovery effectiveness using ground-water pumping to recover free-phase product.

The operations and maintenance discussed in this chapter will provide data used to assess the effectiveness of vacuum enhanced free-product recovery.

The potential advantages of employing vacuum-enhanced free-product recovery are: (1) increased product recovery rates, (2) increased capture zone, (3) decreased project life, and (4) increased product recovery by minimization of the amount of residual (unrecoverable) product left in smear zone.

The potential disadvantages of employing vacuum-enhanced free-product recovery are: (1) increased ground-water pumping rates may increase water treatment costs, (2) air emissions may require treatment, and (3) additional capital costs associated with recovery equipment.

Automated product skimming at Wells NFFW-6 and NFFW-19 will occur without the aid of water table depression or vacuum-enhancement due to the low transmissivities observed at

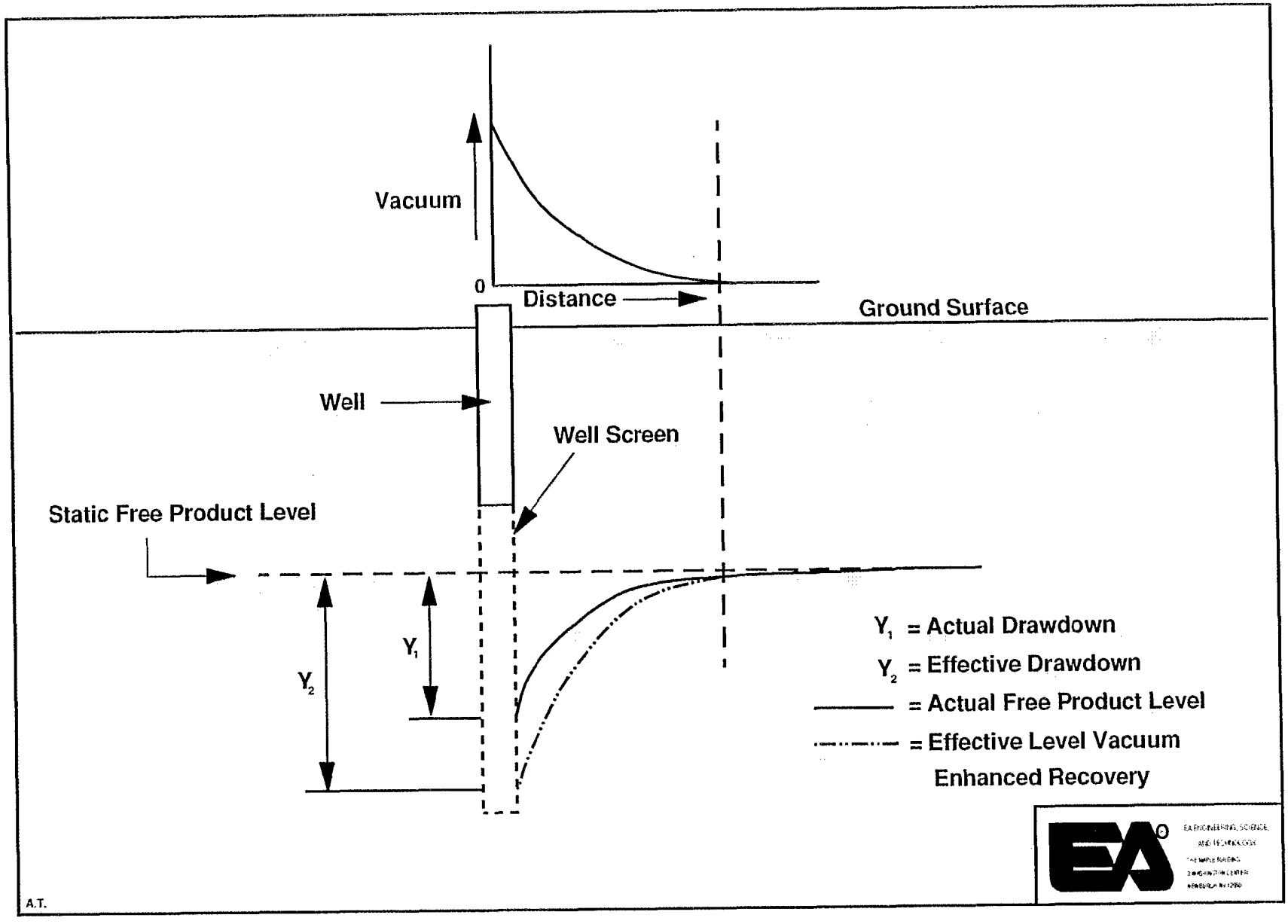

Figure 4-2. Illustration of actual and effective drawdown in a vacuum-enhanced recovery system.

these locations during prior pump tests and negligible yields anticipated. The focus of free-product recovery efforts at these locations is to evaluate whether automated skimming devices can sufficiently diminish free-product occurrence at these locations. Figure 4-3 provides a schematic of the skimming process.

4.2 FREE-PRODUCT RECOVERY SYSTEM INSTALLATIONS

A site plan of existing conditions as developed during previous site investigations is provided in Figure 4-4. The site plan lists the known permanent site features and monitoring well locations, including the wells to be used as recovery wells during this phase of the pilot study. Installation of the pilot plant equipment will be performed by EA. EA will use subcontractors for such activities as trenching, electrical, and concrete delivery/setting. All site work will be performed in accordance with the guidance provided in the Site Safety, Health, and Emergency Response Plan (Appendix B).

4.2.1 Free-Product Pilot Plant Location

The proposed location for the ground-water/free-product pilot plant is shown in Figure 4-4. Three existing monitoring wells will be used for the product recovery system. A vacuum enhanced free-product recovery system will be installed at Well NFFW-2R. Wells NFFW-6 and NFFW-19 will have automated product skimmers installed to remove free-product. Several important factors were considered when selecting the pilot plant site:

1. Previous studies (EA 1991) indicate that Well NFFW-2R has the most potential for use as a recovery well.

2. Free-product has been consistently observed in Wells NFFW-6 and NFFW-19.

3. Access to electric and other necessary utilities.

4. Location of treated effluent discharge point.

The final determination of the pilot plant location will be made in the field and coordinated with base personnel. This final siting will be based on verification of surface and subsurface site features, structures, and utilities that may preclude this original location. If a new siting is necessary, these same factors will be evaluated when selecting an alternate location.

4.2.2 Utility Locations

During the final siting process, NAS Public Works personnel will be contacted to obtain a complete set of utility drawings and to mark-out utility locations of the site. Also, if necessary, EA will contact the Pennsylvania utility hotline "Call Before You Dig," and will notify other relevant authorities before excavating/trenching.

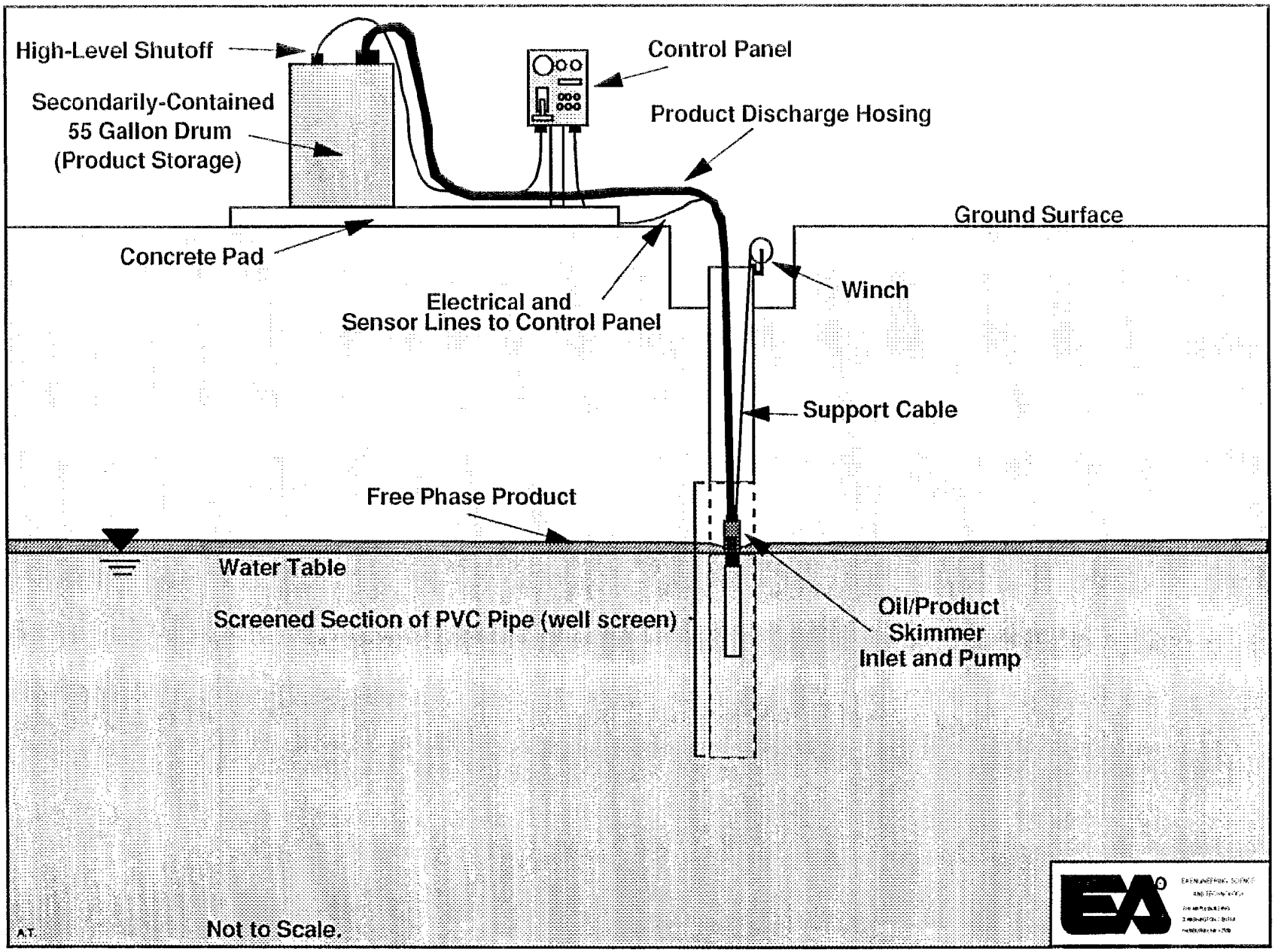

Figure 4-3. Schematic of automated product skimming system to be installed at Wells NFFW-6 and NFFW-19, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

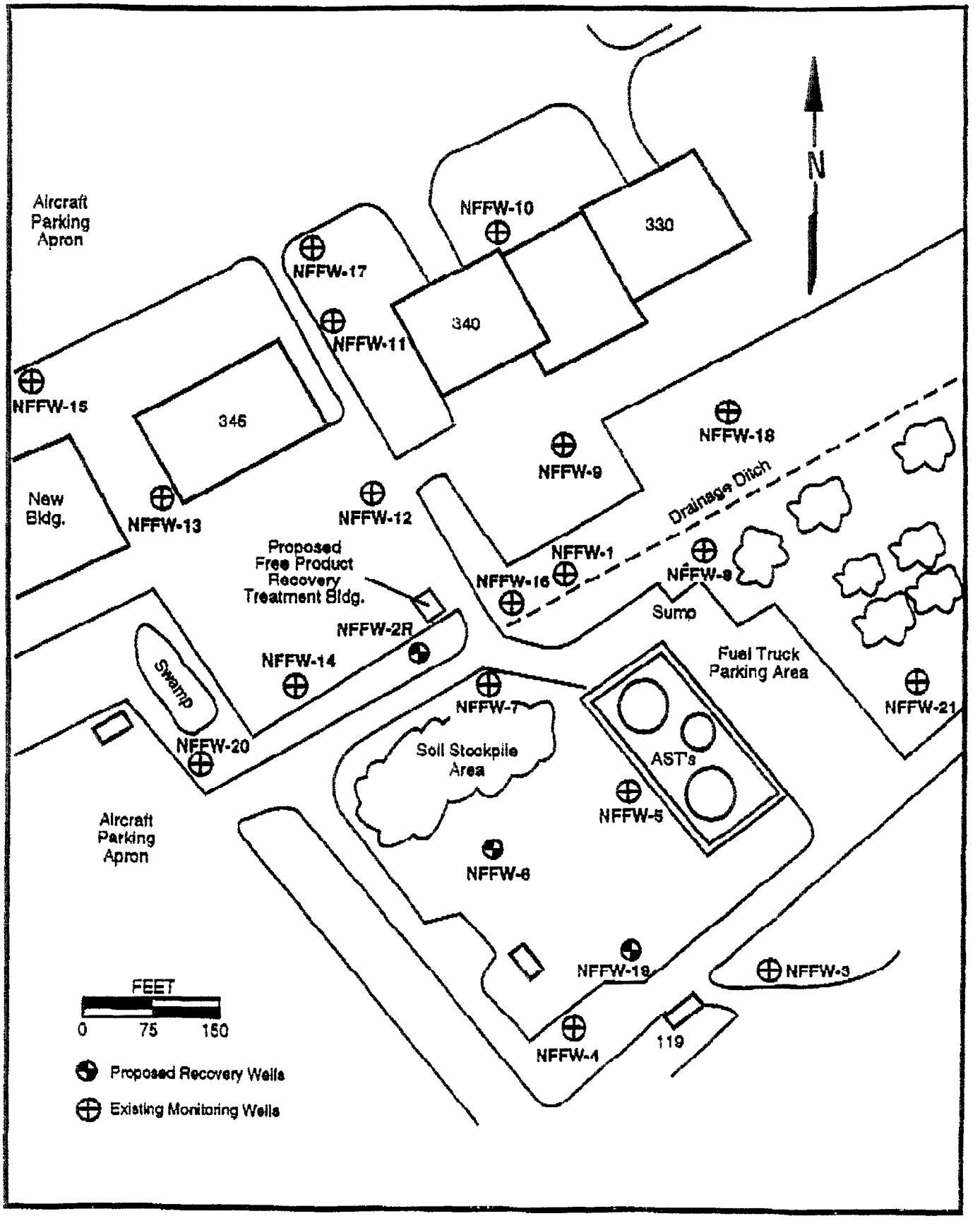

Figure 4-4. Site map showing proposed location of free-product recovery systems, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

4.2.3 Vacuum-Enhanced Free-Product Recovery System Installation

The vacuum-enhanced free-product recovery system consists of a vacuum pump, vapor phase treatment unit, ground-water treatment unit, and control panel located in a 10- × 8-ft pilot plant treatment building (shed). The treatment shed will also contain a moisture separator, vacuum pump, heater, lights, and associated controls. All electrical equipment and controls inside the treatment building shall be explosion proof. In addition, vapor-phase carbon treatment consisting of two 200-lb granulated activated carbon (GAC) units, in series, and aqueous-phase carbon treatment consisting of two 200-lb GAC units, in series, will be located in the building. Figure 4-1 provides a schematic diagram of the vacuum-enhanced free-product recovery system. The treatment shed will be located on the existing pavement adjacent to Well NFFW-2R and will be winterized to protect process equipment from freezing. A 500-gal double-walled product recovery tank will be located outside the shed. The tank will have a high level shut-off sensor to prevent overfills from occurring. All associated controls will be hard-wired to the control panel inside the treatment shed.

Dual-phase water table depression and free-product recovery pumps, including appropriate sensors, will be installed in Well NFFW-2R. The water table depression pump is expected to maintain a pumping rate of 2 gpm and discharge the GAC treated effluent directly to the sanitary sewer. For pilot system sizing, it is estimated that 10-20 gal of product will be recovered each day through vacuum-enhanced pumping operations. All pumps and sensors will be wired to the recovery system control panel in accordance with NEC requirements for temporary installations. EA anticipates that no trenching will be required to install the vacuum, ground-water, product, and electrical pipes/lines from the well to the treatment shed. Water discharge lines will be wrapped in heat traced tape and insulated for freeze protection. Any site restoration actions required in order to return the area to its original state and/or to match existing surfaces shall be performed.

4.2.4 Free-Product Recovery System (Automated Skimmer Pump) Installation

Free-product recovery systems utilizing automated free-product recovery skimmer pumps and sensors will be installed at Wells NFFW-6 and NFFW-19. Individual concrete pads, approximately 4 × 4 ft in size, will be poured adjacent to each of these wells. The pads will support the 55-gal product recovery drums and control panels installed at each well. The recovery drums will be equipped with secondary containment overpacks. For pilot system sizing, it is estimated that 1-2 gal of product will be recovered per day at each well through skimming operations. All pumps and sensors will be hard wired to the individual recovery system control panels. All process equipment shall be winterized to protect against freezing. Figure 4-3 provides a schematic of the automated skimming system. It is assumed that no trenching will be necessary for the installation of the free-product recovery systems. Any site restoration actions required in order to restore the area to its original state and/or to match existing surfaces shall be performed.

4.2.5 Electric Utility Installation

All electric control panels will be hard-wired to a local transformer by a licensed electrician under the supervision of EA. All electrical service work will be coordinated with NAS personnel. It is assumed that sufficient electrical capacity is available from existing sources at the Navy Fuel Farm facility. Electric is anticipated to be supplied to the treatment shed/pads by installation of overhead utility lines. The anticipated electrical requirements for this system are 100 amp, 240-volt, single-phase power.

4.2.6 Permitting

Since the Navy works in conjunction with PADER in implementing the proposed pilot remedial testing at the Navy Fuel Farm facility, remedial activities will not be exempt from the applicable administrative and permitting requirements. Therefore, prior to implementation of free-product recovery pilot testing, a supplement to this Work Plan will be furnished to secure PADER approval of the proposed remedial measures. The supplement will provide necessary detail on the locations, materials specifications, and methodologies to be employed during the construction of the pilot system. Necessary detail regarding the monitoring, sampling, operations, and maintenance of the free-product recovery systems is provided in other portions of the Work Plan.

4.2.6.1 Water Discharge Permit

It is assumed that the treated ground water will be discharged to the NAS Willow Grove sanitary sewer. Approval for this discharge will be obtained from NAS Public Works and PADER before the pilot system is operational. The water discharge is anticipated to be 2 gal per minute, or 2,880 gal per day.

4.2.6.2 Air Permits

The discharge of soil vapor containing elevated concentrations of volatile organic compounds (VOCs) by the vacuum-enhanced free-product recovery system requires approval by PADER's Bureau of Air Quality Control. The Bureau of Air Quality Control requires that an appropriately-sized air pollution abatement system be operated during pilot testing. The Bureau of Air Quality Control requires a "Request for Determination of Requirement for Plan Approval/Operating Permit Application," Form ER-AQ-17 be submitted. A copy of this form is provided in Appendix C. This permit is anticipated to take one month to process upon receipt by the State. EA will prepare and submit the application during the development of the pilot plant configuration.

4.2.6.3 Building and Construction Permits

Building and/or construction permits are not required for this installation of pilot remediation systems at NAS. The construction of a concrete pad, the erection of a temporary shed, and electrical connections to base transformers will require coordination with NAS Public Works and/or the office of Resident Officer in Charge of Construction. System schematics, site plans, and equipment specifications will be provided to appropriate NAS personnel to facilitate the field construction activities. In the event of conflicting schedules with other onsite construction projects, EA will take direction from Northern Division and the Resident Officer in Charge of Construction office.

4.3 FREE-PRODUCT RECOVERY SYSTEM FIELD OPERATIONS AND MONITORING

4.3.1 Purpose

The purpose of the field operations and monitoring is to continually evaluate the pilot study performance. Consistent monitoring also ensures that reliable, accurate data is being collected and allows periodic adjustments to the system to be made to maintain peak operating efficiency.

4.3.2 Schedule

As directed by Northern Division, free-product recovery pilot testing will be conducted for a 9-month period. During this time of testing and operation, various monitoring and operation and maintenance (O&M) duties need to be performed. During the first week of startup, the system will be monitored daily. The system will be monitored twice per week from the second through the fourth week and once per week from Weeks 5 to 13 (the tentative startup of the AAS/SVE pilot system). Beginning Week 14, and continuing to the termination of the pilot study in Week 39, the system will be monitored twice per month.

4.3.3 Monitoring and Operations and Maintenance

A description of the monitoring and sampling activities to be conducted during this study is provided below. The monitoring and O&M tasks include monitoring well and recovery well gauging; vapor and air emissions monitoring; recording system vacuum, pressure, and flow readings; product tank/drum gauging; water discharge monitoring and sampling; general system maintenance; GAC unit change-outs; and equipment cleaning and service.
A summary of the monitoring, sampling, and O&M to be conducted during the free-product recovery pilot study is presented in Tables 4-1 and 4-2.

TABLE 4-1 SUMMARY OF THE TYPE AND FREQUENCY OF MONITORING, SAMPLING, AND MAINTENANCE TO BE PERFORMED AT THE VACUUM-ENHANCED RECOVERY SYSTEM DURING THE PILOT STUDY TO BE CONDUCTED AT THE NAVY FUEL FARM FACILITY, NAVAL AIR STATION, WILLOW GROVE, PENNSYLVANIA

Parameter	Type of Monitoring Measurement or Sampling	Location for Measurement or Sampling	Minimum Monitoring or Sampling Frequency
AIR MONITORING			
Vacuum Flow Rate	Pitot Tube or In-line Flowmeter	Vacuum blower	Daily during Week 1; twice per week during Weeks 2-4; once per week during Weeks 5-13; twice per month thereafter.
Vacuum	Magnehelic Gauge	Vacuum blower (suction side)	Daily during Week 1; twice per week during Weeks 2-4; once per week during Weeks 5-13; twice per month thereafter.
Differential Pressure	Magnehelic Gauge	Vacuum blower (pressure side)	Daily during Week 1; twice per week during Weeks 2-4; once per week during Weeks 5-13; twice per month thereafter.
VOC Loading	PID or FID with Tedlar Bag	Vacuum blower discharge (prior to GAC treatment)	Daily during Week 1; twice per week during Weeks 2-4; once per week during Weeks 5-13; twice per month thereafter.
VOC Emissions	PID or FID with Tedlar Bag	After GAC treatment	Daily during Week 1; twice per week during Weeks 2-4; once per week during Weeks 5-13; twice per month thereafter.
WATER MONITORING			
Monitoring Well Gauging	Oil Interface Probe	All monitoring wells	Immediately prior to startup; every 2 weeks during Weeks 1-4; monthly thereafter.
Monitoring Well Gauging	Oil Interface Probe	Wells 1, 2R, 6, 7, 12, 14, 16, 19	Daily during Week 1; twice per week during Weeks 2-4; once per week during Weeks 5-13; twice per month thereafter.
Water Discharge (GAC) Monitoring	Laboratory Sampling	Before, between, and after GAC treatment	Every other week during Weeks 1-8; monthly thereafter.
O&M MONITORING			
Product/Tank Gauging	Oil Interface Probe	Product tank/ drums at systems	Daily during Week 1; once per week during Weeks 2-8; twice per month thereafter.
Moisture Separator	System Maintenance	Moisture separator	Once per week during Weeks 1-8; twice per month thereafter.
Control Panel	System Maintenance	Circuit breakers	Once per week during Weeks 1-8; twice per month thereafter.
Equipment Cleaning & Service	System Maintenance	Entire system	Once per month.

TABLE 4-2 SUMMARY OF WATER SAMPLES TO BE COLLECTED FOR LABORATORY ANALYSIS DURING THE VACUUM-ENHANCED FREE-PRODUCT RECOVERY PILOT TEST, NAVY FUEL FARM FACILITY, NAVAL AIR STATION, WILLOW GROVE, PENNSYLVANIA

Sampling Location	Period of Activity	Total No. of Laboratory Samples	
		BTEX and Naphthalene (EPA 602/8020)	TPH as JP-4 (SW-846/8015)
Discharge Monitoring at GAC Units			
Influent (before GAC units)	Every other week for Weeks 1-8; monthly thereafter	12	12
Intermediate (after first GAC unit)	Every other week for Weeks 1-8; monthly thereafter	12	12
Effluent (after both GAC units)	Every other week for Weeks 1-8; monthly thereafter	12	12
Trip Blank	Every other week for Weeks 1-8; monthly thereafter	12	---
Total		48	36

4.3.3.1 Monitoring and Recovery Well Gauging

The purpose of obtaining water level and free-product level measurements is to monitor water table and free-product thickness fluctuations (i.e., seasonal) over time and to track the influence of the vacuum-enhanced free-product pumping system on the water table and free-product zone. Water level readings, in addition to floating product (if any), will be obtained at monitoring wells and recovery wells with the use of an oil/water interface probe graduated at 0.01-ft intervals. The probe and graduated tape will be decontaminated between measurements according to the protocol described in Section 4.3.5.2 of this Work Plan.

Ground-water and floating product levels will be collected from each of the site monitoring wells at least once before the initial system startup. After completing the initial background gauging of the 21 site wells during system startup, only those wells anticipated to be impacted by pumping will be gauged during every site visit. The eight wells that are expected to be influenced and will be gauged regularly during the first week are NFFW-1, NFFW-2R, NFFW-6, NFFW-7, NFFW-12, NFFW-14, NFFW-16, and NFFW-19. For the second through the fourth weeks, the monitoring frequency will be twice per week. For Weeks 5-13, site wells will be monitored once per week. After the AAS/SVE system is activated (presumably during Week 14), site wells will be monitored on a biweekly basis until termination of all pilot study activities at Week 39.

4.3.3.2 Water Discharge Monitoring

The purpose of water discharge monitoring is to confirm effluent treatment and evaluate when GAC units need to be replaced. Water samples prior to treatment will also be analyzed to collect ground-water quality for potential use in designing a permanent remediation system. Aqueous influent and effluent samples will be collected every other week for the first eight weeks and monthly thereafter. Samples will be collected at the influent (prior to GAC units), intermediate (between GAC units), and effluent ports (after GAC units) of the GAC treatment system. In-line sample taps will be installed in the system lines to accommodate sample collection. Samples will be analyzed for BTEX and naphthalene by U.S. Environmental Protection Agency (EPA) Method 602 and for TPH as JP-4 by Method SW-846/8015. One trip blank will also be analyzed for BTEX and naphthalene per sampling event. A total of 12 sampling events and 48 samples will be analyzed during this task. Sample results will be obtained on a standard 2-week turnaround time.

4.3.3.3 Air Emissions Monitoring

The purpose of monitoring the air emissions on the vacuum-enhanced free-product recovery system is to determine hydrocarbon loading (lb/day) and evaluate when GAC units need to be replaced. To gauge the performance of the vacuum system air treatment, routine vapor sampling will be conducted according to the schedule shown in Table 4-1. Total VOC concentrations will be monitored using a photoionization detector or flame ionization detector. Samples will be collected at the influent (prior to GAC units), intermediate

(between GAC units), and effluent ports (after GAC units) of the GAC treatment system. In-line sample ports will be installed in the system lines to accommodate sample collection. Breakthrough of vapor-phase carbon will be defined as when the volatile hydrocarbon concentration of the vapor at the intermediate port (after the first GAC unit) is 25 percent of the volatile hydrocarbon concentration in the untreated vapor. GAC units will be replaced when breakthrough occurs. No additional air quality sampling will be conducted. Vapor samples will be collected daily during the first week of system startup operations, twice per week during Weeks 2-4, once per week during Weeks 5-13, and twice per month thereafter to provide raw data on system performance. All vapor samples shall be collected according to the following procedure:

1. Attach one end of an unused piece of Tygon tubing to the hose barb on the end of the portable vacuum sampling pump and the other end to the in-line sample port.

2. Attach one end of an unused piece of Tygon tubing to the hose barb on the pressure port of the vacuum sample pump and the other end to the fill valve on a new, unused Tedlar air sample bag.

3. Close the fill valve on the air sample bag.

4. Turn on the pump and purge the pump and lines for approximately 2 minutes.

5. After the purge is complete, open the fill valve on the air sample bag, and allow the sample bag to fill. Once the bag has been inflated to approximately two-thirds of its full capacity (e.g., fully inflated), close the fill valve and the ball valve, and then remove the tubing from the fill valve.

6. While keeping the sample bag under pressure, open the fill valve and deflate the sample bag.

7. Reconnect the fill valve to the teflon tubing.

8. Allow the bag to fill twice, deflating the bag after each fill to purge the sample bag.

9. After repeating the sample purge procedure, fill the bag once again to collect the sample, making sure the fill valve is securely closed once the bag is filled.

10. The VOC measurements will be taken by inserting the tip of the photoionization detector/flame ionization detector into the tedlar bag fill tube and opening the fill valve.

11. The photoionization detector/flame ionization detector reading shall be allowed to stabilize, then the highest reading will be recorded. Prior to use, and at a minimum frequency of daily, the photoionization detector/flame ionization detector will be calibrated with a 100 parts per million isobutylene-in-air commercial gas standard, and used in accordance with the manufacturer's instructions.

4.3.3.4 Vacuum, Pressure, and Flow Measurements

Vacuum/pressure and flow measurements shall be recorded to determine the system operating status. During system start-up activities, vacuum/pressure and flow readings will be taken at frequent intervals on a daily basis until desired vacuum/pressure and flow rates are established. During the remainder of the field demonstration, vacuum, pressure, and flow readings will be taken during scheduled O&M visits. Magnehelic gauges will be used to obtain air pressure, vacuum, and flow data. An in-line flowmeter will be installed in the water discharge line to measure flow (in gpm). The gauges in service will provide the following ranges:

- Vacuum: 0-50 in. H_2O
- Pressure: 0-50 in. H_2O
- Air Flow Rate: 0-60 cfm
- Water Flow Rate: 0-10 gpm.

4.3.3.5 Product Recovery Tank Gauging

Product recovery tanks/drums shall be gauged to determine the level and volume of product and/or water in each. This data will be used to provide information on product recovery rates and efficiency. During startup activities (Week 1), the tanks shall be gauged at least on a daily basis. During the remainder of the field demonstration, readings will be recorded during each site visit. Product and water (if any) level readings will be obtained at the product recovery tank/drums with the use of an oil/water interface probe graduated at 0.01-ft intervals. The probe and graduated tape will be decontaminated between measurements according to the protocol described in Section 4.3.5.2 of this Work Plan. The readings will be taken by inserting the probe into a specific access port in the top of the tank and reading the tape at a pre-determined mark on the access port.

4.3.4 System Maintenance

During system operation, routine inspection of the process equipment is essential to maintain mechanical consistency. Each component of the system will be examined regularly and checked for wear or other problems. A discussion of the maintenance requirements for the major system components is provided below.

4.3.4.1 Moisture Separator Inspection

The moisture separator shall be checked during each site visit for leaks, freezing, rust, and loose or worn parts. In addition, the separator will be drained by opening the spigot at the bottom of the unit and draining any fluid into a 5-gal bucket. This fluid shall then be placed into a dedicated, labeled, 55-gal drum located adjacent to the treatment shed. The water will be cycled through a GAC unit and discharged along with the system effluent into the sanitary sewer.

4.3.4.2 Resetting/Replacement of Tripped Circuit Breakers/Fuses

The system electrical panel will be inspected during each site visit for tripped circuit breakers. If a circuit breaker is found to be tripped, the cause of the failure will be investigated. If no obvious problems are found, the part will be replaced. If the breaker continues to trip or blow after replacement, then the system will be shut down, the CTO Manager and base contact notified, and appropriate electrical servicing completed.

4.3.4.3 Replacement of GAC Units

Replacement of the aqueous and vapor phase GAC units at Well NFFW-2R shall occur when breakthrough on the lead GAC unit has been detected. The units will be replaced according to the following procedures.

Aqueous Phase Carbon Replacement

1. Raise the dual phase pumps to prevent oil pump intake from being submerged in water during GAC change-out.

2. Turn the entire vacuum enhanced pumping system off. The automated skimmer pumps are separate systems and should not be turned off.

3. Disconnect the water influent and effluent lines from the carbons by releasing the camlock fittings.

4. Remove the front or lead GAC unit.

5. Rotate the back or secondary polish GAC unit into the lead position.

6. Place the new GAC unit on-line as the secondary or polish unit.

7. Deploy the dual phase recovery pumps to the proper depth in the well.

8. Re-attach the camlock fittings and reactivate the vacuum enhanced pumping system power.

Vapor-Phase Carbon Replacement

1. Turn off the vacuum pump (water pumps do not need to be turned off).

2. Disconnect the vapor lines from the GAC units by releasing the camlock fittings.

3. Remove the front or lead GAC unit.

4. Rotate the back or secondary polish GAC unit into the lead position.

5. Place the new GAC unit on-line as secondary or polish unit.

6. Connect the vapor lines to the GAC units by attaching the camlock fittings.

7. Turn the vacuum pump on.

4.3.4.4 Cleaning of the Recovery Pumps and Probes/Sensors

The system pumps, sensors, and probes require periodic cleaning to ensure they will continue to operate at peak efficiency. Cleaning of the equipment will be performed according to the schedule shown in Table 4-1. Cleaning of the pumps and sensor probes shall be performed according to the following methods:

1. Raise the pumps out of the well.

2. Place absorbent pads under pump.

3. Inspect the sensors, probes, and oil intake for build-up of grit or debris which may inhibit proper operation.

4. Rinse sensors, probes, and oil intake filter with kerosene.

5. Deploy pumps to proper depth in the well.

4.3.5 Equipment Decontamination

Field personnel will decontaminate monitoring/sampling equipment in between stations after each measurement/sample is taken, and at the conclusion of daily activities to ensure cross-contamination between stations does not occur, and to eliminate the possibility of contaminants being carried offsite. Equipment cleaning will be undertaken in a manner that minimizes contamination of monitoring/sampling sites and monitoring wells. All VOC-based washwaters and waste products generated during cleaning operations will be placed into a dedicated, labeled 55-gal drum located on the treatment pad for this purpose. The water will be cycled through a GAC unit and discharged with the other system effluent into the sanitary sewer. All other wastes will be controlled as discussed in Section 4.3.6 of this Work Plan.

All ground-water monitoring/sampling equipment will be scrubbed with a wire brush to remove soil particles. Equipment that contacts free-product shall be wiped with absorbent cloth and then with reagent-grade methanol. Equipment that has not come in contact with free-product shall be wiped with a dry cloth. All equipment is to be washed in accordance with the rinse sequence described in detail below.

4.3.5.1 Decontamination of Sample Collection Equipment

The procedure for cleaning sample collection equipment is as follows:

1. Wash with warm potable water and laboratory-grade detergent (e.g., alkanox)
2. Rinse with de-ionized water
3. Rinse with methanol
4. Rinse with de-ionized water
5. Allow to air dry
6. Wrap sampling equipment in aluminum foil or plastic, as appropriate
7. Place in sealed plastic bag.

4.3.5.2 Decontamination of Field Measuring Equipment

The procedure for cleaning field measuring equipment is as follows:

1. Wash with potable water (from an approved source) and laboratory-grade detergent (e.g., alkanox)

2. Rinse with de-ionized water

3. Rinse with methanol

4. Rinse with de-ionized water

5. Allow to air dry.

Modifications to the above may be required for some field instruments. In such instances, the user should follow the procedures outlined in the vendor's equipment operations manual. Decontamination of sampling equipment will be kept to a minimum in the field, and wherever possible, dedicated or disposable sampling equipment will be used.

Personnel directly involved in equipment decontamination will wear protective clothing, as outlined in the Site Safety, Health, and Emergency Response Plan (Appendix B).

4.3.6 Waste Disposal

Wastes will be generated during the construction and operations phases of the free-product recovery pilot study. These wastes fall into the following categories.

4.3.6.1 Recovered Product

Free-product will be recovered through the vacuum-enhanced pumping and skimming processes. This liquid will be collected in the double-walled tank located at recovery Well NFFW-2R and the 55-gal drums located at Wells NFFW-6 and NFFW-19. Periodic measurements of the tank contents will signal when the tank(s) are becoming full. When recovery drums at Wells NFFW-6 and NFFW-19 reach capacity, the contents will either be transferred to the recovery tank adjacent to Well NFFW-2R or pumped out by a vacuum tanker and disposed of. When the recovery tank at Well NFFW-2R has reached capacity, the contents will be pumped out by a vacuum truck and disposed according to applicable federal, state, and local regulations. The product recovered in the tanks must be characterized to select the appropriate disposal option.

4.3.6.2 Granular Activated Carbon

GAC from both the aqueous and vapor phases of the recovery system will be replaced once it has become saturated with VOCs. The spent carbon will be replaced and transported offsite for regeneration by the supplier.

4.4 DATA ANALYSIS, INTERPRETATION, AND EVALUATION

4.4.1 Vacuum-Enhanced Free-Product Recovery

The performance of the vacuum enhanced pumping system will be evaluated by assessing the volume of product recovered, the rate of product recovery, and the change in the rate of product recovery with time.

4.4.2 Free-Product Automated Skimming

Free-product recovered as a result of automated skimming actions at Wells NFFW-6 and NFFW-19 will be analyzed and interpreted to evaluate the degree of product recovery achieved and draw qualitative conclusions regarding the efficacy of removal of free-productutilizing the skimmer technology. Operational data will be used to evaluate the volume of product recovered, the rate of product recovery, and any changes in the rate of product recovery.

4.4.3 Monitoring Results

4.4.3.1 Ground-Water Monitoring Well Measurements

Ground-water monitoring well gauging data will be used to assess changes in water table elevation and free-product thickness. Significant variations in pre- and post-operational free-product thickness may indicate the success/failure of the pilot program.

4.4.3.2 Product Recovered

Measurements of product recovered will be made by gauging tank/drum contents. These measurements will be directly converted to volumes of product recovered at each well. Product recovery totals will serve as the most significant indicator of hydrocarbon source reductions at the Navy Fuel Farm facility.

4.4.3.3 Area of Influence

Assessing the magnitude of the aerial influence of the vacuum-enhanced free-product recovery system will aid in determining the density of such wells required in a full-scale design. The area of influence of the vacuum enhanced free-product recovery system will be calculated using the recovery well and monitoring well gauging data and preparing a contour map of pre-operations (background) ground-water elevations and corresponding drawdown elevations during vacuum enhanced pumping.

4.4.3.4 Ground-Water Quality

Fluctuation or variation in ground-water quality at Well NFFW-2R may indicate changes in study zone characteristics. Ground-water quality will be assessed by examining the influent ground-water quality data collected at the aqueous-phase GAC treatment system throughout the study. Oftentimes, ground-water quality data collected at recovery wells may not provide an accurate indication of actual aquifer conditions due to the potential mixing of free product with ground water at the pump intake.

5. SOIL VAPOR EXTRACTION/AQUIFER AIR SPARGING PILOT STUDY

5.1 SOIL VAPOR EXTRACTION/AQUIFER AIR SPARGING TECHNOLOGY SUMMARY

5.1.1 Objective

The objective of this phase of the pilot study is to evaluate the effectiveness of SVE/AAS remediation technologies in reducing source concentrations of VOCs known to exist in the vadose and shallow saturated zones (i.e., the unconsolidated materials overlaying fractured bedrock). SVE/AAS pilot testing at the Navy Fuel Farm facility will only be implemented at which point free-product recovery operations have reduced light non-aqueous phase liquid (LNAPL) occurrence to less than approximately 0.5 in. in thickness across several potential technology testing areas. Therefore, at this juncture, SVE/AAS pilot testing will be discussed only as a potential remedial approach to the mitigation of source hydrocarbons present in the free, sorbed, and vapor phases in the vadose zone, and the free, sorbed, and dissolved phases in the phreatic zone. If additional environmental data becomes available which suggests these technologies are not suited to site conditions, the efficacy of performing the tests will be re-evaluated prior to implementing construction. The potential testing areas will include adjacent properties in evaluating potential soil vapor migration.

5.1.2 Technology Description

5.1.2.1 Soil Vapor Extraction

SVE is a proven and well documented technology effective in the removal of vapor and sorbed-phase VOCs from the vadose zone. A conceptual diagram illustrating SVE technology is shown in Figure 5-1. VOCs are removed from the vadose zone as a negative pressure (vacuum) is exerted by a vacuum pump connected to a series of extraction wells or trenches. This results in the generation of soil vapor flow towards the extraction trench, while concurrently effecting an interphase transfer from the immiscible and water phases to the vapor phase, which is subsequently extracted (Marley *et al.* 1990). This interphase transfer is dependent upon many factors, the most important perhaps being the volatility of the compound. A compound's volatility is directly related to the degree to which it will partition into the vapor phase in the soil pores. The parameter that best describes a compound's volatility is its vapor pressure. It has been suggested that compounds with vapor pressures greater than 0.5-1.0 mm Hg at 20 C are amenable to removal by SVE (U.S. EPA 1991a; Hazardous Waste Consultant 1990, respectively).

Another important remedial process which occurs during SVE is *in situ* aerobic biodegradation. The pumping action of the SVE process provides a continuous soil air flow, which in turn supplies rate-limiting oxygen, enhancing aerobic biological degradation. For petroleum hydrocarbons, biodegradation has been reported to contribute as much as 55-85 percent of the removal rate (of jet fuel) during SVE (Miller *et al.* 1990). For

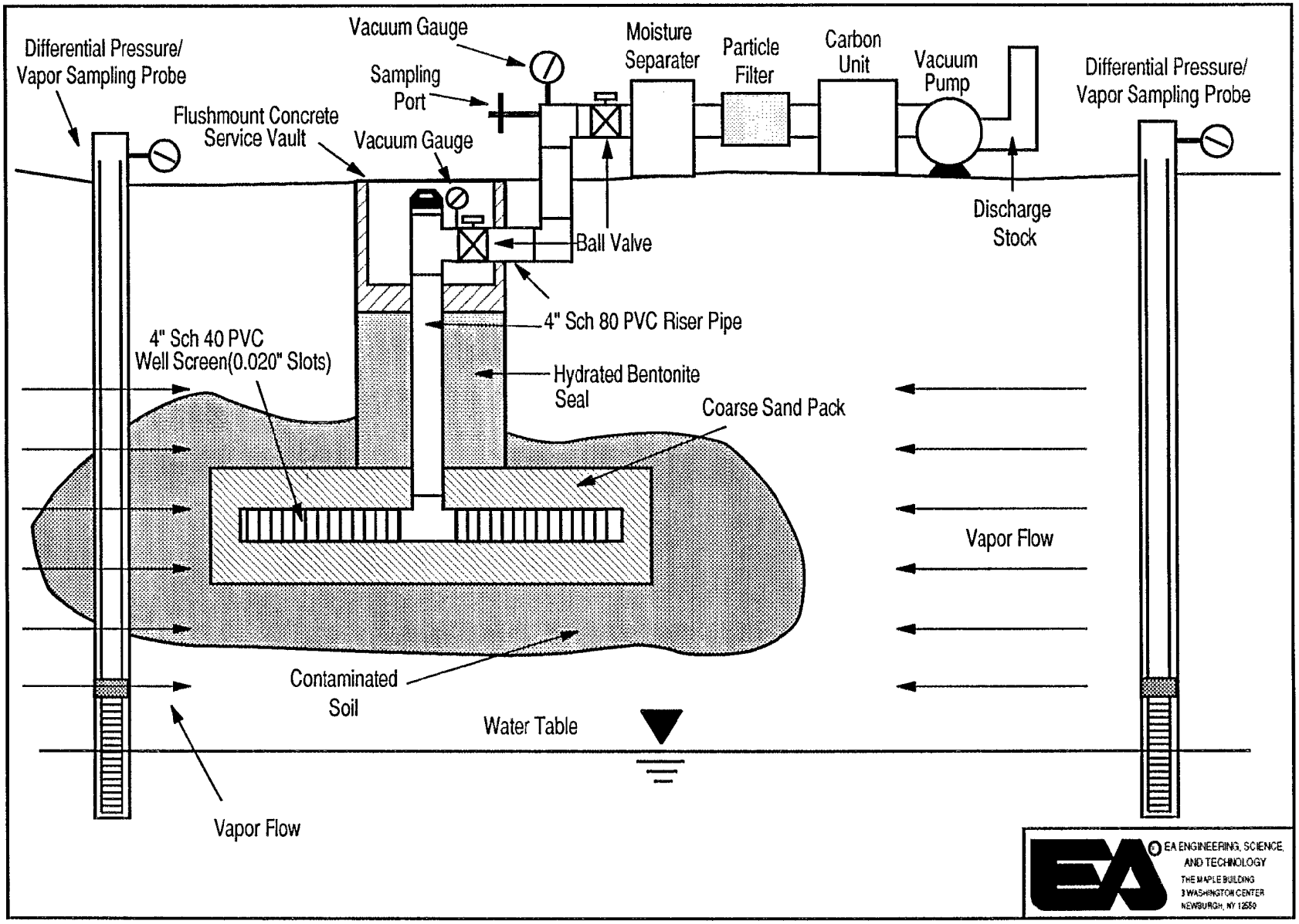

Figure 5-1. Construction schematic for a typical soil vapor extraction system in a shallow aquifer region.

purposes of this performance evaluation, biodegradation processes will be considered part of the overall SVE VOC mitigation process. The effectiveness of SVE is also a function of soil permeability. Soil permeability is a key parameter not only in determining if SVE is a feasible remedial option, but also for the SVE system design. If the air permeability of the site's soil is less than 10^{-10} cm^2, SVE may not be feasible (U.S. EPA 1991b). A soil that is not highly heterogeneous and possesses an air permeability of 10^{-6}-10^{-7} cm^2 or greater is believed to be adequate for SVE (U.S. EPA 1991b; Gudemann and Hiller 1988, respectively). The vadose soil permeability at the Navy Fuel Farm facility has not been determined during prior investigations. Based on soil descriptions, which show unsaturated zone soil consisting predominantly of clayey silt with trace very fine sand, and the calculated hydraulic conductivity of 4.05 x 10^{-5} cm/sec for underlying saturated soils and weathered/fractured bedrock, the applicability of SVE as a remedial approach in vadose zone soils is questionable. *In situ* testing will be conducted during system operations to characterize the permeability of site soils.

5.1.2.2 Aquifer Air Sparging

AAS is an emerging *in situ* technology involving the removal of VOCs from the saturated zone. This technology involves the selective injection of atmospheric air into the selected portion of the saturated zone to facilitate the mass transfer of volatile hydrocarbons from the free, sorbed, and dissolved phases to the vapor phase. AAS has been reported to have resulted in ground-water cleanup to the low ppb range (Ardito and Billings 1990; U.S. EPA 1992a,b; Harress Geotechnics, Inc. 1989; Looney *et al.* 1991; Marley 1991; Middleton and Hiller 1990). Preliminary results at one AAS site indicate *in situ* removal of benzene, toluene, ethylbenzene, and xylenes (BTEX) greater than 99.94 percent (Athens *et al.* 1993).

Similar to SVE, contaminant removal is achieved during AAS by a combination of volatilization and aerobic biodegradation. The degree to which each process contributes to contaminant removal will be site-specific; however, Billings *et al.* (1993) have stated that 50-85 percent of the total organic mass appears to be remediated by bioactivity.

Volatilization occurs during AAS as injected (sparged) air migrates horizontally and vertically through the saturated soil column. Contaminant mass transfer occurs as the dissolved and residual (sorbed or trapped free-product) phase VOCs existing within the saturated soil column are contacted with sparged air and partition into the vapor phase. As the sparged air (containing the "stripped" VOCs) displaces water existing within the saturated zone pore space, they are transported to the vadose zone, where they will be retrieved by the SVE system operating concurrently with the AAS system. Without SVE, the vapors introduced into the vadose zone via AAS may increase the magnitude and extent of vapor phase VOCs in the vadose zone, and may potentially migrate into nearby basements and utility conduits. Figures 5-2 and 5-3 conceptually depict the combined AAS and SVE remediation process.

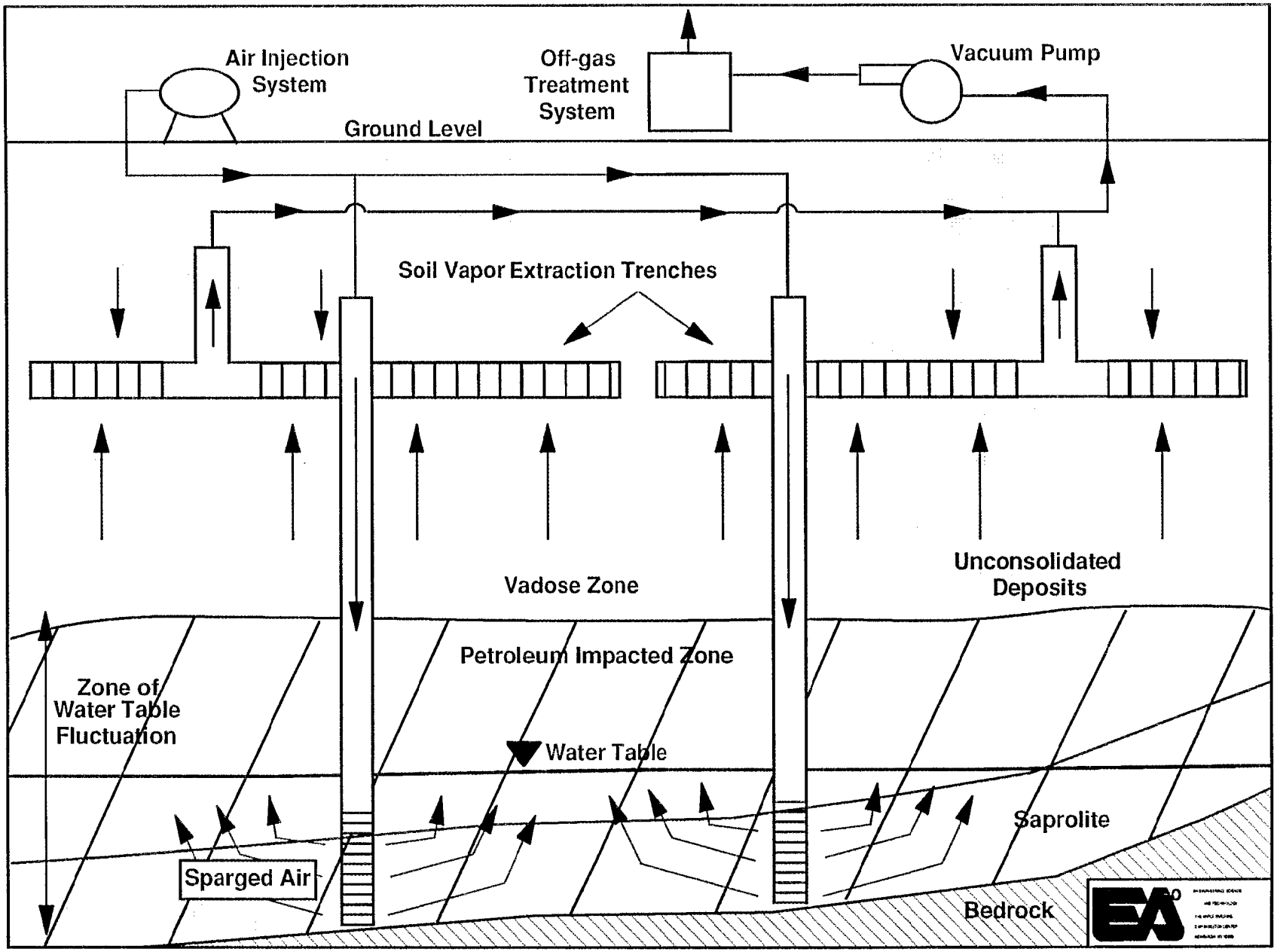

Figure 5-2. Construction schematic for a typical air sparging and soil vapor extraction system in a shallow aquifer region.

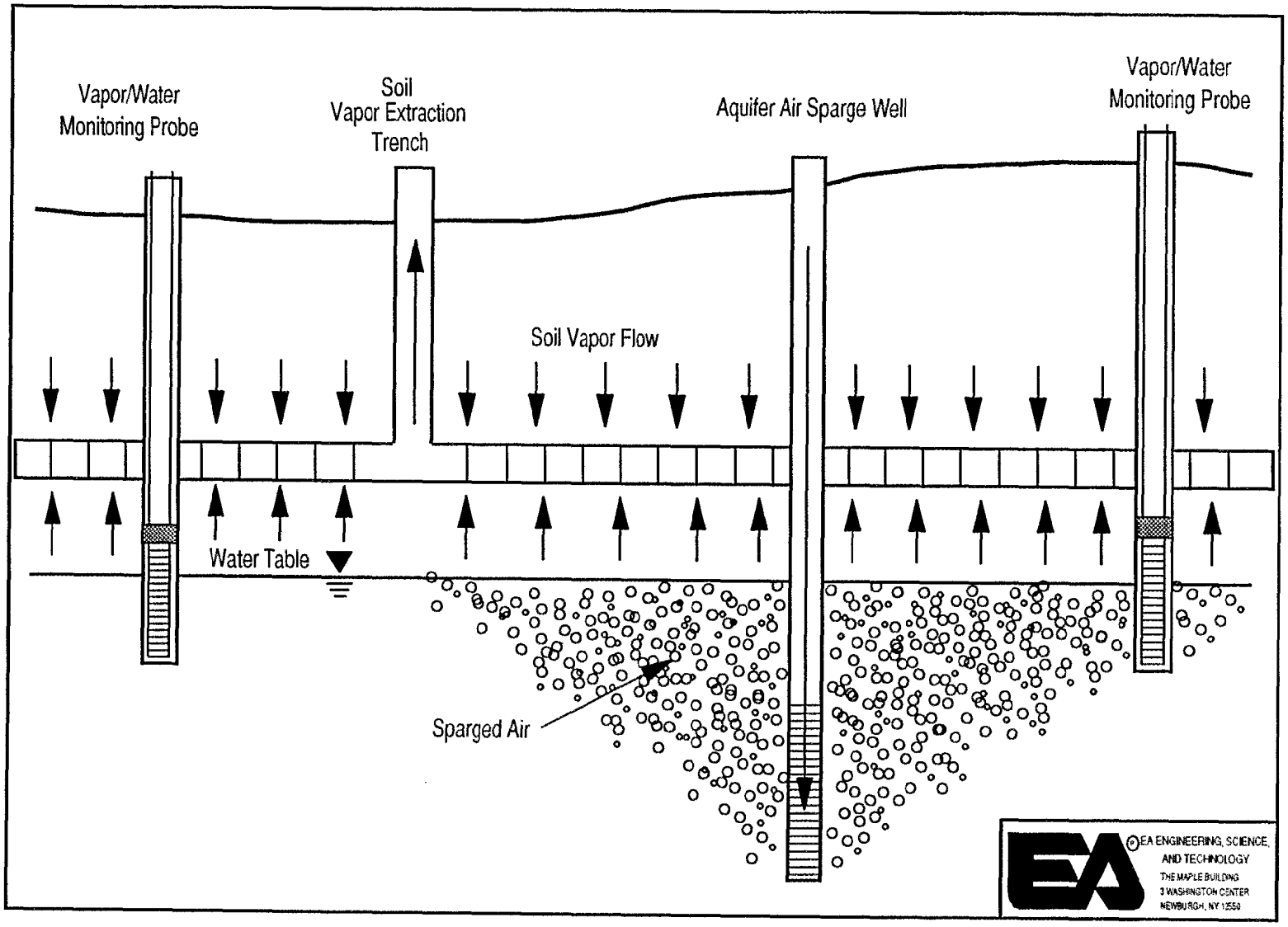

Figure 5-3. Soil vapor extraction/air sparging system.

The "strippability" of dissolved-phase VOCs is approximated by their Henry's Law constants (K_H) (Table 5-1). Henry's Law predicts the tendency of a compound to partition from the liquid to the vapor phase. A Henry's Law constant greater than 10^{-5} atm * m^3 * $mole^{-1}$ would indicate a compound that is "strippable" by AAS (Brown *et al.* 1991).

AAS has the potential to enhance the mitigation of organic compounds by aerobic biodegradation. Biodegradation is accomplished by supplying oxygen to the indigenous microbial population existing within the saturated zone. Biological degradation of organic compounds in the subsurface is known to be an oxygen-limited process (Borden *et al.* 1986). Successful biorestoration in aquifers is primarily dependent upon the effective transport of dissolved oxygen to the existing microbial population (Rainwater *et al.* 1989). Once the injected air diffuses into the aquifer during AAS, some of the oxygen becomes dissolved in solution. Dissolved oxygen is delivered to the aquifer as the oxygen-enriched ground water moves through the saturated zone. Hypothetically, the dissolved oxygen will be delivered (horizontally and vertically) at a rate equivalent to ground-water velocity. In reality, that rate will be attenuated by dilution and the rate at which dissolved oxygen is utilized by biodegradation and other processes. Concentrations of dissolved oxygen in contaminated aquifers are typically low (<1 mg/L) because biodegradation processes have consumed most of the naturally occurring oxygen in the aquifer. Injected atmospheric air under typical sparging temperature and pressure conditions in shallow ground water has an upper limit of oxygen solubility of 8-10 mg/L.

Similar to SVE, favorable soil conditions are prerequisite for successful AAS. Saturated soils that are not highly heterogeneous and possess a hydraulic conductivity (K) in the range of 10^{-3} cm/sec or greater are required to allow for sufficient air transport through the saturated zone (Danko 1991; Middleton and Hiller 1990). However, some successful AAS projects have been undertaken at sites where the hydraulic conductivities were in the range of 10^{-4} to 10^{-5} cm/sec (Athens *et al.* 1993; Brown *et al.* 1991; Cooley and Billings 1993). Previous investigations (EA 1991) have determined that hydraulic conductivity values in the shallow water table aquifer at the Navy Fuel Farm facility are generally at the lower end of this range (4.05×10^{-5} cm/sec).

Discontinuous silt or clay lense obstructions and/or preferential fracture flow may exist within the shallow water table and may thus restrict the effectiveness of AAS at this site. Prior drilling data for the Navy Fuel Farm facility support the existence of primary and conjugate fractures. Site characterizations will be made as a result of the implementation of this Work Plan to assess the impact of such obstructions. In the event a vertical confining material is encountered in the saturated zone, the efficacy of conducting AAS at that particular location will be re-evaluated.

5.1.3 Preliminary Soil Vapor Extraction/Aquifer Air Sparging Technology Feasibility

Pertinent physio-chemical data related to assessing the feasibility of SVE/AAS are summarized in Table 5-1. Technologic feasibility is based upon known site conditions, as well as the chemical and physical properties of the hydrocarbons known to exist within the

TABLE 5-1 PHYSIO-CHEMICAL CHARACTERISTICS OF SELECTED COMPOUNDS OF CONCERN, NAVY FUEL FARM FACILITY, NAVAL AIR STATION, WILLOW GROVE, PENNSYLVANIA

Compound	Molecular Weight (g/mol)	Specific Gravity (at 20 C)	Henry's Law Constant at 25 C ($atm*m^3/mol$)	Vapor Pressure (mm Hg at 25 C)	Octanol/ Water Coefficient K_{ow}	Solubility (mg/L at 20 C)	MCL (mg/L)
Benzene	78.11	0.8765	5.55×10^{-3}	95	135	1,780	0.005
Toluene	92.14	0.8669	5.92×10^{-3}	28	490	515	1.0
Ethylbenzene	106.17	0.8670	8.04×10^{-3}	10	1,413	152	0.7
Xylenes	106.17	0.8610	4.18×10^{-3}	10	589	175	10
Naphthalene	128.17	1.162	4.83×10^{-4}	0.082	2,344	30	NA
2-Butanone (MEK)	72.11	0.8054	4.66×10^{-5}	100	2	275,000	NA
2-Methylnaphthalene	142.20	1.0058	4.99×10^{-4}	10[a]	7,244	26	NA

a. Measured at 105 C.

NOTE: NA = indicates not applicable; MCL = maximum contaminant level.

Physio-Chemical Data References:

U.S. EPA 1992c; Nyer et al. 1991; Verschueren 1983.

vadose and saturated zones. Soil conditions may or may not be favorable for the implementation of SVE and AAS, as previously discussed in Sections 5.1.2.1 and 5.1.2.2.

It must be recognized that the more complex, heavier-end fuel component, the polycyclic aromatic hydrocarbons (PAHs), are not considered extractable by either SVE or AAS and, hence, removal is not considered feasible by these technologies. It is projected that PAH mass reduction, if achievable, will occur through aerobic biodegradation processes. The mitigation of PAHs, therefore, will not be considered a driving factor in evaluating the performance of the pilot study.

The physio-chemical properties of VOCs observed within the vadose and/or uppermost saturated zones at the Navy Fuel Farm facility is provided in Table 5-1. Specific gravity and solubility are provided in this table to qualitatively assess the relative horizontal and vertical distribution in the vadose and saturated zones, as well as their potential mobility in the dissolved phase. Table 5-1 also provides the octanol/water partition coefficient for each target compound. The octanol/water partition coefficient (K_{ow}) is defined as the ratio of a compound's concentration in the octanol phase to its concentration in the aqueous phase of a two-phase system. Measured values of K_{ow} for organic compounds range from 10^{-3} to 10^{7}. Low K_{ow} values (< 10) are indicative of hydrophilic compounds and tend to have higher water solubilities. Compounds possessing high K_{ow} values ($> 10^{4}$) are considered very hydrophobic and thus tend to remain sorbed to soil. K_{ow} values are mainly used to relate to soil/sediment sorption. When combined with the organic content of the soil, K_{ow} values can be used to predict the amount of material sorbed onto the soil particles and the retardation factor for movement through the aquifer (Nyer et al. 1991).

5.2 SOIL VAPOR EXTRACTION/AQUIFER AIR SPARGING SYSTEM INSTALLATION

5.2.1 Site Plan

5.2.1.1 Utility Locations

A site plan with known permanent site features and monitoring well locations is provided as Figure 2-2. Incomplete information is currently available as to the locations of all underground utilities since the completion of Navy Fuel Farm facility construction activities. Utility locations will be assessed prior to the installation phases proposed in this Work Plan. Utility clearance will be secured from the Public Works Department at NAS Willow Grove. The locations of utilities will be noted and summarized in a site plan to be developed during pilot plant installation phase.

5.2.1.2 Soil Vapor Extraction Trench and Aquifer Air Sparging Well Layout

As previously discussed, the feasibility of implementing the SVE/AAS pilot test will be evaluated after pilot free-product recovery operations have commenced and free-product occurrence is further investigated and evaluated (as described in Chapter 4 of this Work

Plan). SVE/AAS will not be implemented in any area found to contain LNAPL thicknesses in excess of 0.03 ft over extended areas.

The location selected for testing will be a function of several criteria, including:

- Ability to secure site access from appropriate NAS Public Works and/or other governing body

- Favorable physio-chemical conditions. For example, analytical results which support testing in proposed area, such as those areas where free-product once existed, or where analytical results show elevated dissolved-phase hydrocarbons in ground water and elevated concentrations of vapor- and sorbed-phase hydrocarbons in the unsaturated zone

- Suitable access with respect to the locations of underground utilities, above-grade site features, and traffic.

Ideally, AAS wells will be placed in areas that are representative of the site's lithology and heterogeneity, and where moderate to significant contaminant concentrations exist in the vadose and saturated zones; while also conforming to the intended use of that particular location by NAS personnel.

The SVE/AAS performance evaluation may be conducted at several locations at the Navy Fuel Farm facility, including: (1) the parking lot used for staging of construction supplies south of Building 345, (2) the fuel truck parking area, and (3) west of the existing Navy Fuel Farm facility (location of the former Navy Fuel Farm storage tanks). These locations are depicted in Figure 5-4.

The AAS wells and SVE trenches will be contained in separate boreholes/trenches and selectively screened in the saturated and vadose zones, respectively. Existing ground-water monitoring wells within the test area will be used to monitor operating parameters associated with pilot plant operations.

5.2.1.3 Aquifer Air Sparging Well Network

A projected total of 24 AAS wells will be installed to conduct the SVE/AAS pilot study. The AAS wells will allow the introduction of atmospheric air into the saturated zone at low flows and pressures. The AAS wells are projected to be installed adjacent to the SVE trenches at intervals of approximately up to 40 ft (20-ft radial influence). The AAS wells will be located at various intervals from the SVE trenches, but will not be installed outside of the effective radius of capture of the SVE system.

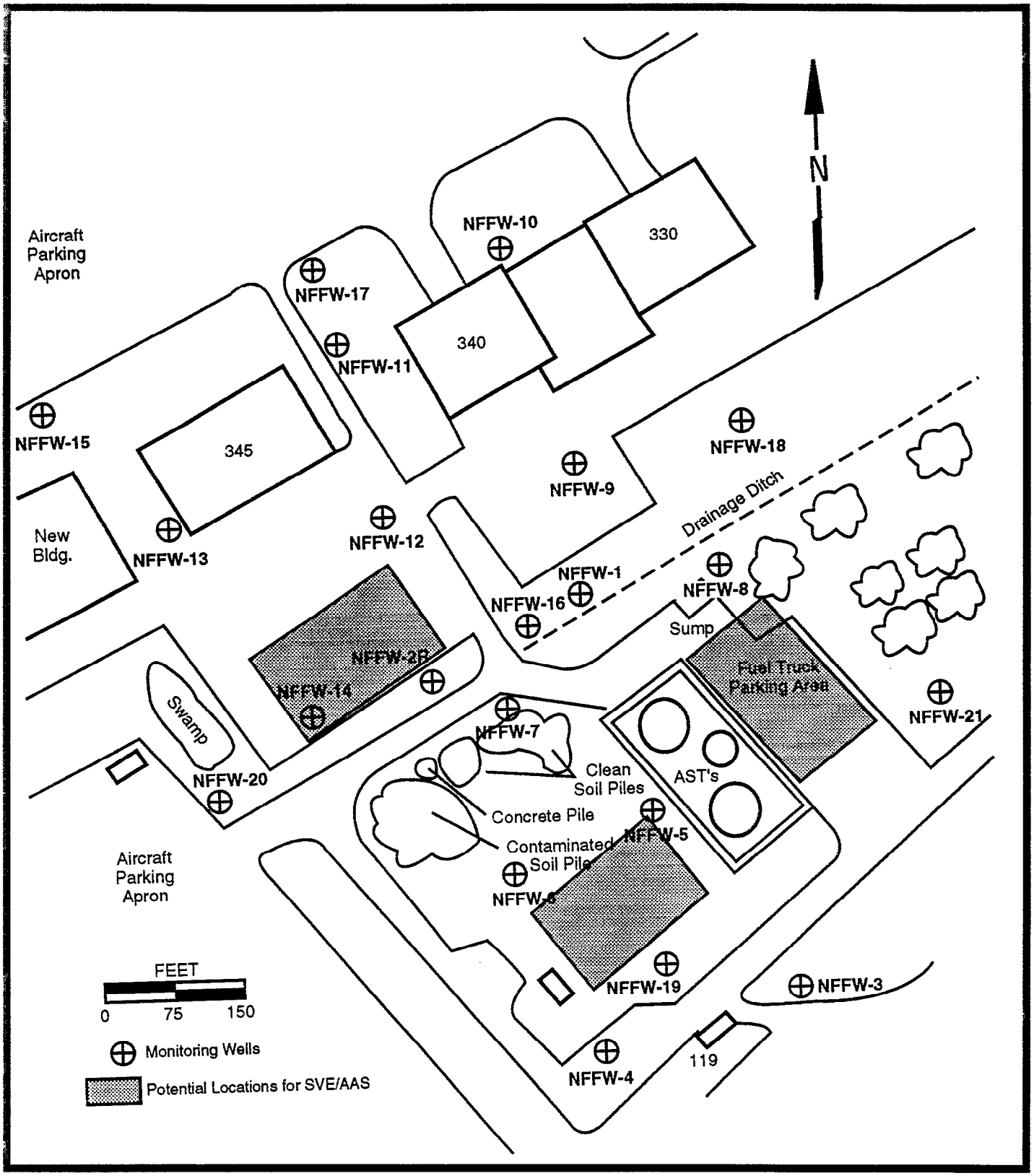

Figure 5-4. Site plan showing potential locations for SVE/AAS pilot testing, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

Each AAS well will be constructed of 2-in. Schedule 40 polyvinyl chloride (PVC) casing and screen and installed to depths ranging primarily from 6 to 13 ft below land surface (i.e., at the interface between underlying clayey silt or saprolite and competent bedrock). Each AAS well will contain up to 3 ft of wire wrap or equivalent high flow screen, the slot size being determined in the field but anticipated to consist of either 0.010- or 0.020-in. slot screen. The bottom of the screened interval will consist of a 1-ft section of solid casing with end plug, which will serve as a collection sump for precipitates. Sand pack will be installed from 6 in. below to 1 ft above the screened interval. A minimum 2-ft thickness of bentonite pellets will then be inserted above the sand pack interval. The remainder of the borehole will then be tremie-grouted to approximately 2 ft below surface grade. Figure 5-5 provides typical construction details for a shallow AAS well.

5.2.1.4 Soil Vapor Extraction Trench Network

SVE trenches are projected to be installed in 14 intervals, ranging in length from 15 to 40 ft. Based upon available site information, the anticipated effective radial influence of the vent trenches is approximately 20 ft. The SVE trenches will be situated no greater than 40 ft apart and will be located in such a manner as to fully intercept potential vapor migration toward adjacent subsurface structures, such as building basements and utility vaults.

Each SVE trench will consist of a series of individual intervals of 4-in. inner diameter (ID) Schedule 40 PVC high flow, slip coupling joint screen. Each SVE trench interval will be set to depths no greater than 4 ft below land surface, or approximately 2 ft above the high seasonal water table level. A suitable sand pack will be inserted from no less than 6 in. beneath to no greater than 1 ft atop the horizontal screen. A filter mesh will be installed atop the screened interval to prevent siltation/clogging. Typical SVE trench construction detail is provided in Figure 5-6.

5.2.2 Regulatory Approval of Soil Vapor Extraction/Aquifer Air Sparging Pilot Study

Since the Navy will work in conjunction with PADER in implementing the proposed pilot remedial testing at the Navy Fuel Farm facility, remedial activities will not be exempt from the applicable administrative and permitting requirements. Therefore, prior to implementation of SVE/AAS, a supplement to this Work Plan will be furnished to secure PADER approval of the proposed remedial measures. The supplement will provide detail on the locations, materials specifications, and methodologies to be employed during the construction of the SVE/AAS pilot system. Further, the supplement will provide detail on the monitoring, sampling, operations, and maintenance schedule for the SVE/AAS system, including number of samples and analyses required.

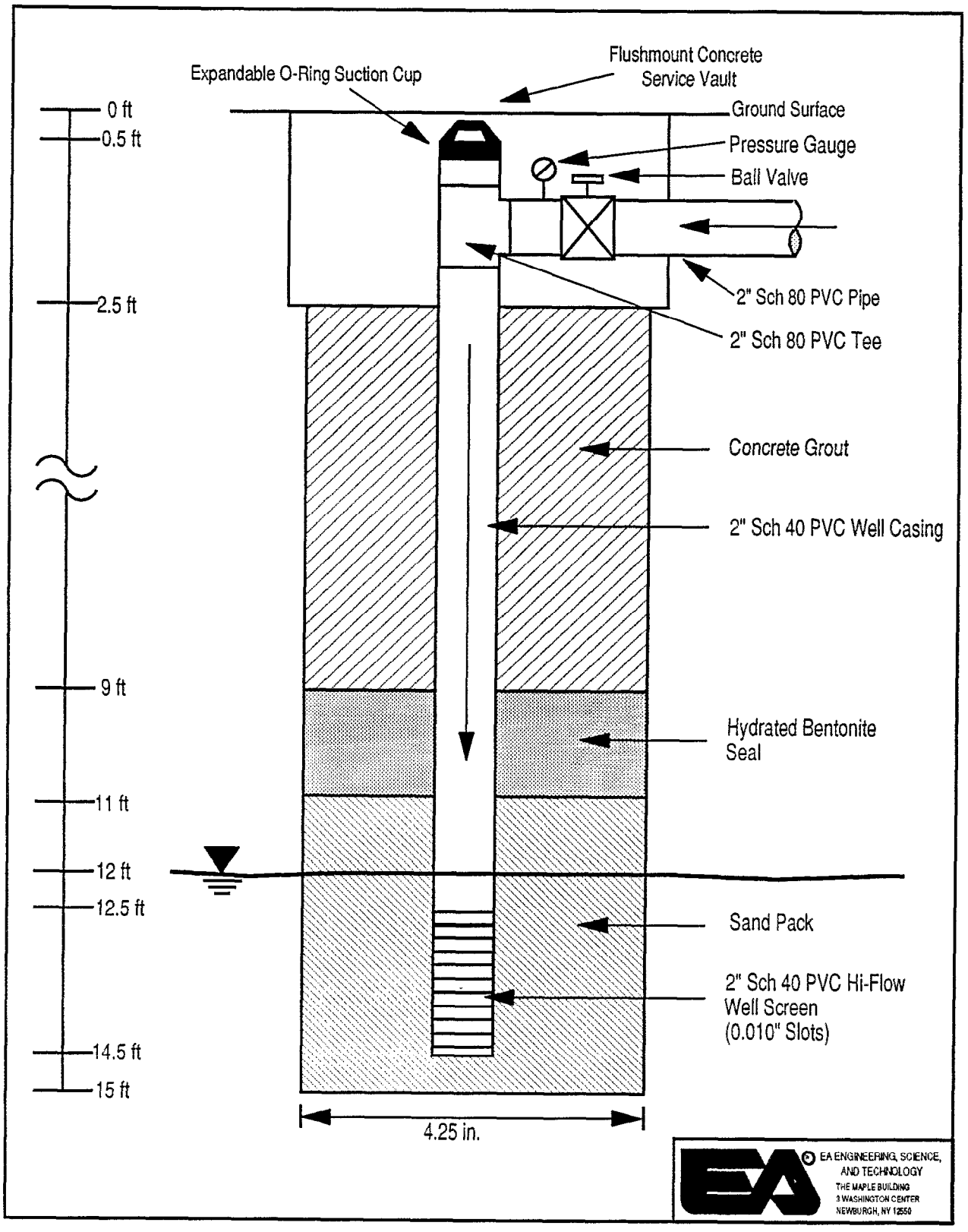

Figure 5-5. Typical well construction diagram of aquifer air sparging well.

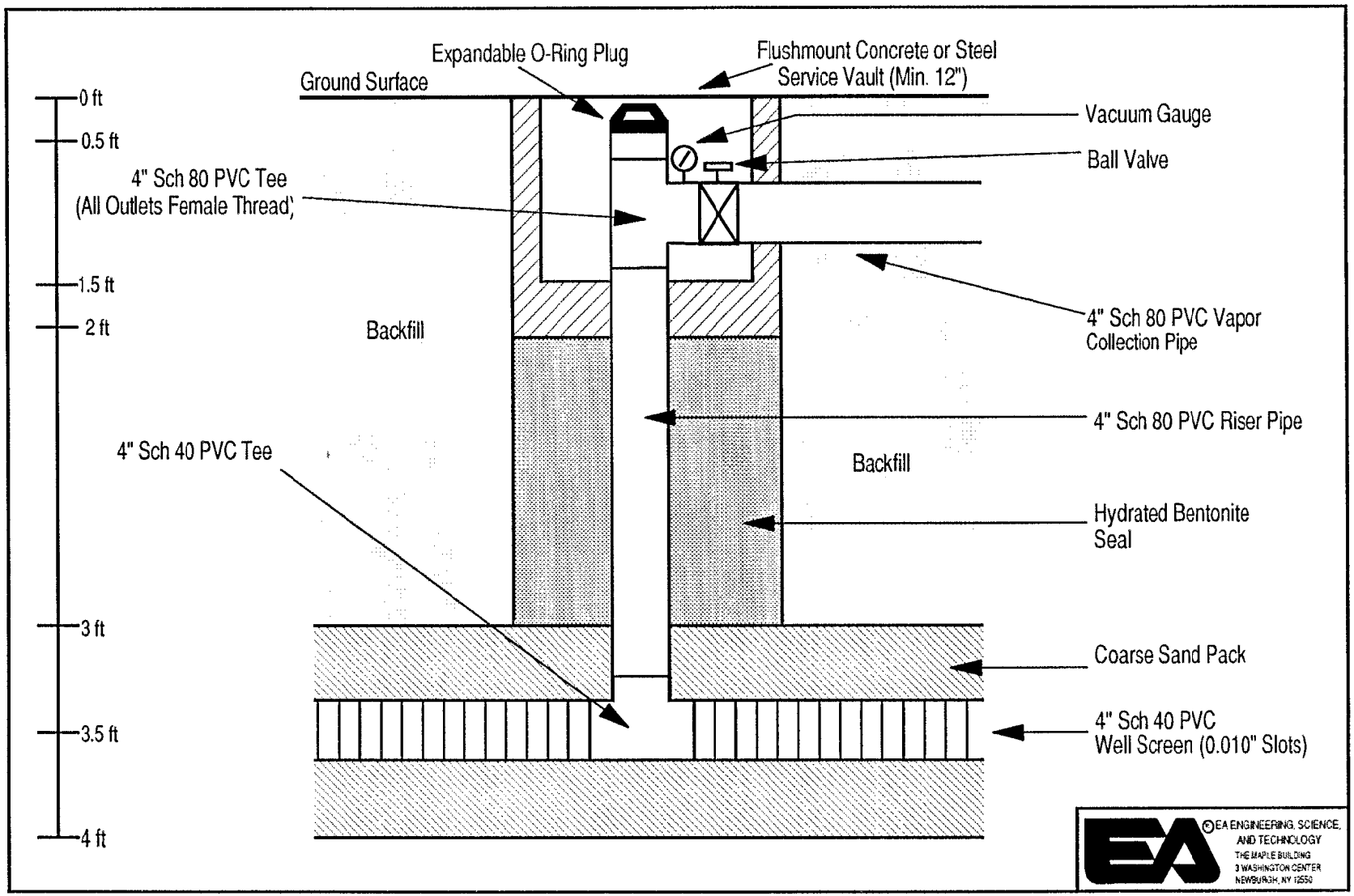

Figure 5-6. Construction diagram of typical soil vapor extraction trench.

5.3 DATA ANALYSIS AND INTERPRETATION

5.3.1 Performance Considerations

5.3.1.1 Vadose Zone Remediation

The degree of vadose zone remediation achieved during SVE pilot testing will be evaluated utilizing one data set. Statistically significant decreases will indicate the feasibility of having implemented SVE at the site.

The extent of hydrocarbon removal from the vadose zone can more reliably be quantified utilizing the content of hydrocarbons in the SVE system off-gas. The mass of hydrocarbons removed during SVE can be estimated using the following formula (modified after U.S. EPA 1989):

$$ER = Q * C * MW * 1.58\times10^{-7} * 24$$

where

ER = Emissions rate (lb/day)
C = VOC concentration in extracted soil vapor (ppm-v)
Q = SVE flow rate (cubic feet per minute)
MW = Molecular weight (average) of the hydrocarbons removed (lb/lb-mole).

The mass volume of VOCs can also be estimated by graphing VOC concentrations versus time and calculating the area beneath the resultant curve.

5.3.1.2 Phreatic Zone Remediation

Data will be analyzed and interpreted to evaluate the degree of source hydrocarbon reductions achieved as measured by ground-water remediation and vadose zone remediation and to draw qualitative conclusions regarding the potential enhancement of biodegradation via SVE/AAS. The degree to which the level of source hydrocarbons are remediated within the phreatic zone as achieved via SVE/AAS will be independently evaluated utilizing two separate data sets.

One method will relate to the ground-water analytical data obtained from the pre-operations monitoring and post-operations monitoring. The mass volume of organic compounds contained in the dissolved-phase plume can be estimated for each data set, and the difference between the two volumes (above a statistically meaningful threshold) will be assumed to be the degree of dissolved-phase hydrocarbons removal achieved during AAS operations.

The second method will relate concentrations of hydrocarbons in the SVE system off-gas prior to and during active AAS. The degree of hydrocarbon removal from the saturated zone achieved during SVE only and combined SVE/AAS operations can be approximated by the typical relationship depicted in Figure 5-7. The AAS system will only be activated once the concentrations of hydrocarbons in the SVE off-gas reach a predictable (preferably asymptotic) slope. The increase in hydrocarbon concentrations above the "SVE-only" concentration detected in the SVE off-gas will be assumed to be directly attributable to removal via AAS. The quantification of hydrocarbon removal can be accomplished using the emission rate formula discussed in Section 5.3.1.1.

5.3.1.3 Biodegradation Potential

It is not the intent of the SVE/AAS operations to quantify the degree to which aerobic biodegradation contributes to *in situ* VOC removal during SVE/AAS operations. However, qualitative conclusions may be drawn at the completion of the pilot study as to whether these technologies have induced conditions (i.e., the introduction of oxygen into saturated or vadose zone soils) favorable for aerobic biodegradation to occur.

5.3.1.4 Potential Dissolved Phase Plume Migration

Although not well documented in the literature, the potential exists for accelerated plume migration via over-pressurization of an AAS system (Figure 5-8). The degree of dissolved-phase plume migration will be qualitatively evaluated by reviewing the ground-water analytical and water level data collected prior to and during SVE/AAS operations. Statistically significant increases in either dissolved-phase VOC concentrations or water levels in monitoring wells downgradient or near the periphery of the dissolved-phase plume may suggest that accelerated movement of the dissolved-phase plume may have occurred during the demonstration.

5.3.2 Data Interpretation: Aquifer Air Sparging

5.3.2.1 Injection Pressure

Aquifer resistance pressure is defined as the pressure that is required to achieve a steady and sustainable air flow into the saturated zone. Aquifer resistance pressure typically is equal, or nominally exceeds, the pressure required to displace the standing water column (i.e., hydrostatic pressure) in the AAS well. The pressure expected to be utilized as the AAS system design pressure will be nominally above the aquifer resistance pressure. Excessive pressures above this threshold may potentially result in "streaming," a hypothetical acceleration in horizontal plume migration, or "short-circuiting" through preferential flow pathways. EA will provide interpretation of measured injection pressures and pertinent field observations as they relate to system performance.

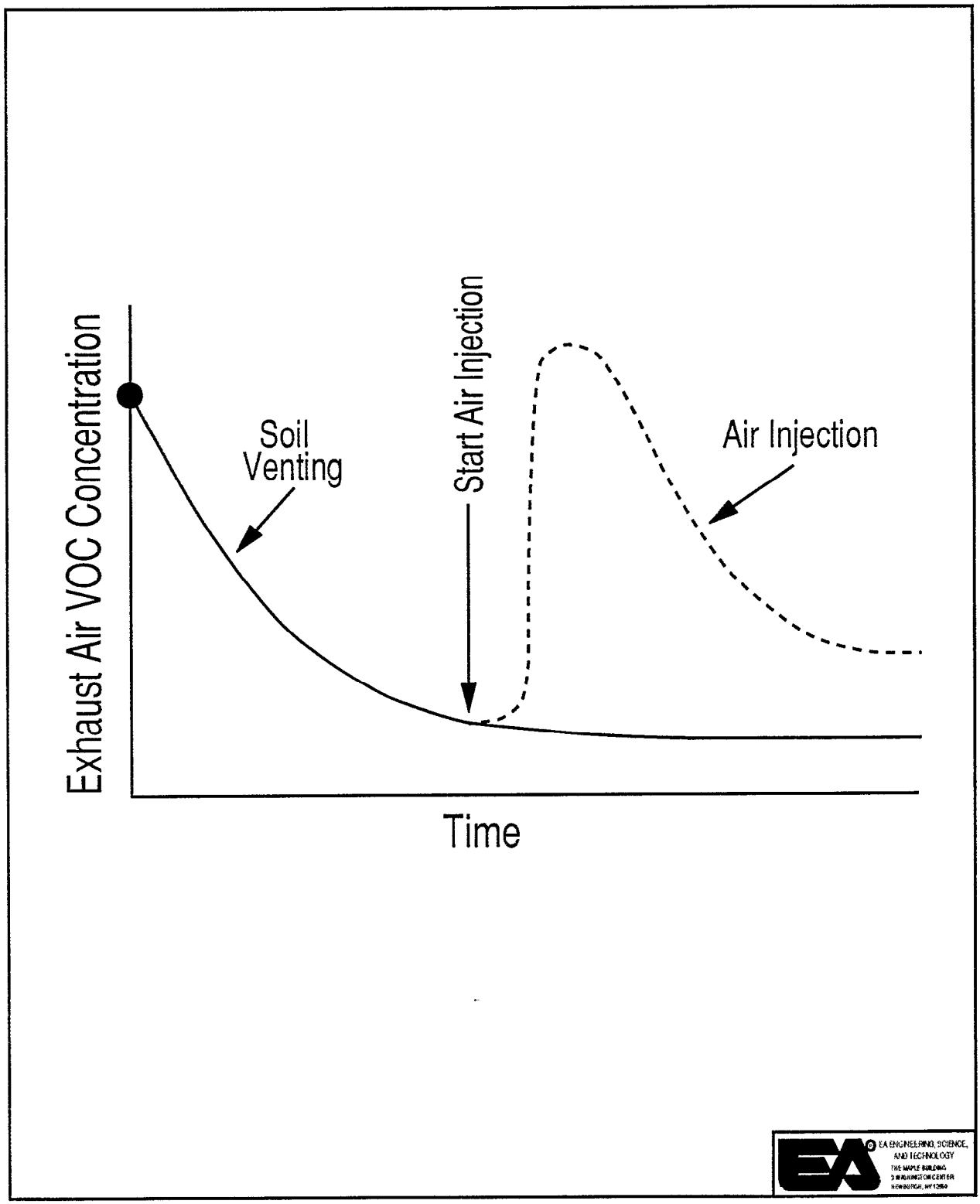

Figure 5-7. Typical variation of exhaust air VOCs with time in an in situ groundwater aeration system (Middleton and Hiller 1990).

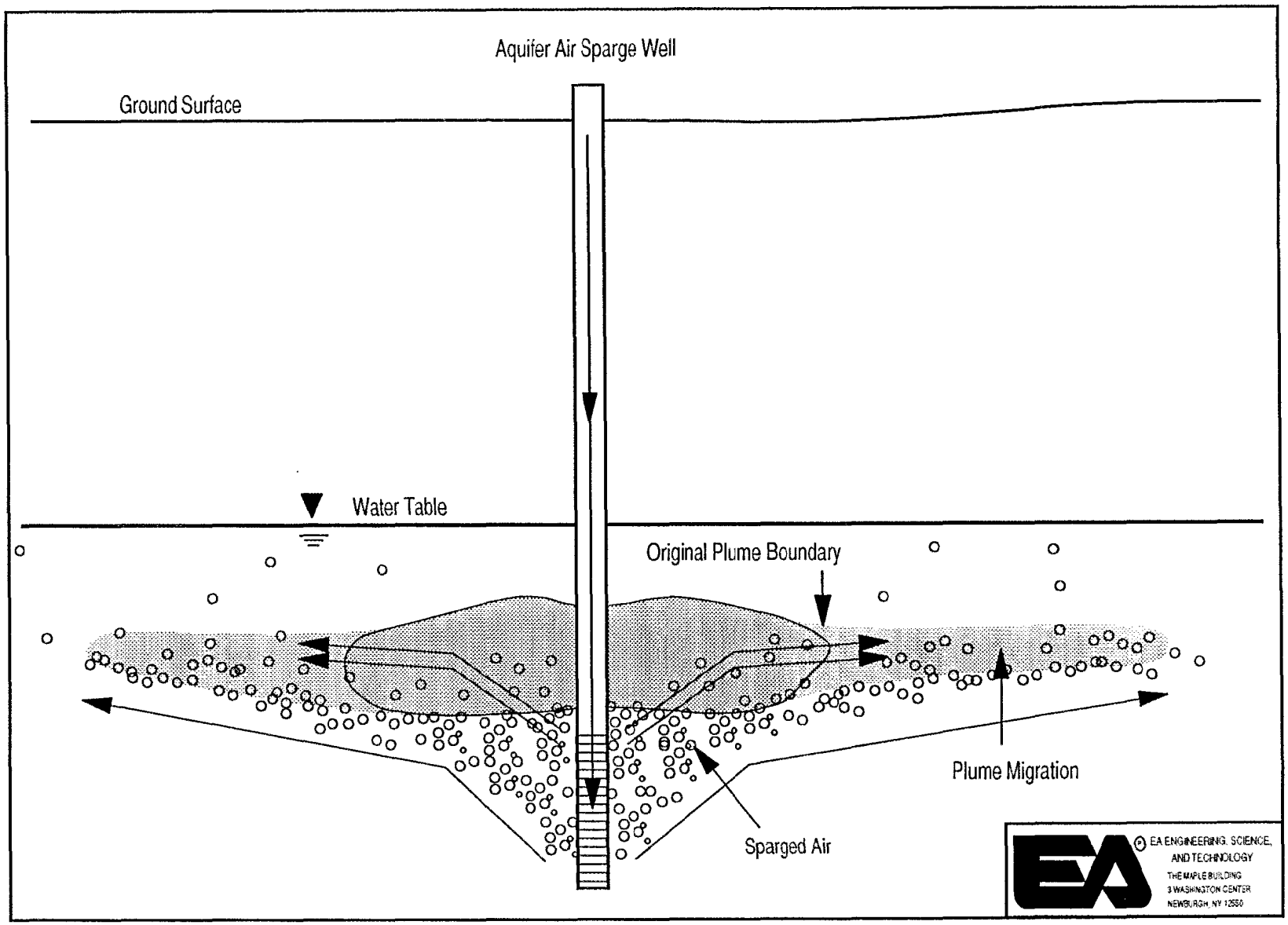

Figure 5-8. Potential disadvantage of air sparging: plume migration by overpressurization.

5.3.2.2 Injection Flow Rate

The total injection flow rate of the designed AAS system should be no greater than 50 percent of the total vapor extraction rate of the SVE system. Also, this injection flow rate should correspond, at a minimum, with an *in situ* air/water ratio of 30:1. The highly soluble compounds, such as MTBE, will likely require much higher air/water ratios. The *in situ* air/water ratio of an AAS system may be approximated by the following equation:

$$AAS\ air/water\ ratio = (D_p V_t^{-1} Q)/(n_e V_p)$$

where

D_p = The horizontal distance (in the direction of ground-water flow) from the upgradient edge of the dissolved-phase plume to the downgradient edge of the dissolved-phase plume (ft)
V_t = Ground-water flow velocity (ft/min)
Q = AAS injection flow rate (ft^3/min)
n_e = Effective porosity of soils (dimensionless)
V_p = Volume of the dissolved-phase plume (ft^3).

Calculation of injection flow rate may also be used to qualitatively assess the loading rate of VOCs from the saturated zone.

5.3.2.3 Area of Influence

The area of influence of AAS wells and systems has been reported in U.S. EPA (1992a) to range from 5 to 177 ft radially. The area of influence induced at each AAS well will be determined by reviewing four data sets obtained during the field demonstration: differential pressures, VOC measurements in monitoring points, dissolved oxygen, and initial water level fluctuation. Whereas some practitioners have reported a correlation in these data sets (Brown *et al.* 1991), EA's experience with AAS suggests that a stronger correlation existing between differential pressures and increases in VOC concentrations in the vadose zone may be more effective in predicting areas under AAS influence.

Nonetheless, three of the four data sets will be reduced, contoured, and represented graphically for correlation as follows (water level data excluded due to potential interference by seasonal fluctuations):

- Differential Pressures—For the field demonstration data corresponding to the expected design injection pressure, graph differential pressures observed in the shallow monitoring points (y-axis) versus distance (x-axis). The differential pressure corresponding to the radial zone of AAS influence is site-specific and has been reported to range from

0.01 to 1.0 in. of H_2O (Brown *et al.* 1991; Leonard and Brown 1992, respectively). Contour maps of the horizontal distribution of differential pressures, as available, will also be constructed.

- VOC Measurements—Graph the increase in recorded VOC measurements (as a percentage of ambient VOC measurements) along the y-axis versus its respective distance from the AAS well along the x-axis. Evaluate these data in the horizontal and vertical dimensions. Correlate this data to graphs previously generated for differential pressures.

- Dissolved Oxygen—Monitoring concentrations of dissolved oxygen before and during the system operations is another means of calculating effective zone of AAS influence. Plot increases in dissolved oxygen in the ground-water monitoring wells (as a percentage) on the y-axis versus distance from the AAS well (x-axis). Look for correlations between the resultant graph and the other graphs prepared for VOCs and differential pressures.

5.3.2.4 Aquifer Air Sparging Well Efficiency

The potential exists for biological fouling in the AAS wells. This condition can potentially occur as the result of high iron or manganese concentrations in the saturated zone. Fouling can be inferred by a gradual increase in injection pressures during AAS. The existence of bio-fouling during AAS operations is not known to have been documented in the literature. Iron and manganese concentrations as high as 317 and 4 ppm, respectively, have been reported in ground water at one site where EA has performed AAS with no indication of diminished efficiency (Athens *et al.* 1993).

5.3.3 Data Interpretation: Soil Vapor Extraction

5.3.3.1 Vacuum Gradient

Isopleths of SVE system vacuum (negative pressure) will be generated displaying contours of differential pressures across the site at all varied operating vacuum flow rates conducted during SVE-only operations. This information will be utilized to evaluate the effects of AAS upon SVE operation, as well as potentially identifying areas containing low permeability anomalies. Using a specified differential pressure threshold, it can also be used to display the area of SVE influence from each SVE trench.

5.3.3.2 Soil Permeability Tests

Tabulated data from SVE operations will include the following: applied vacuum at trench head, SVE flow rate, vacuum distribution, and VOC blower influent concentrations. Pressure changes will be plotted as a function of time. The soil permeability to air flow may

be calculated from the slope and intercept of the data obtained from the above plots per the methodologies recommended by the U.S. EPA (1991b) and utilizing the HyperVentilate™ software program (U.S. EPA 1992d).

Dynamic Method

The dynamic method for determining soil permeability to air requires that soil vapor be extracted (or injected) at a constant rate from a single venting point (Hinchee *et al.* 1992). Pressure differentials are then monitored throughout the vicinity anticipated to be within the radial influence of the extraction system. The equation yielding air permeability is:

$$k = \frac{Qu}{4A\pi m}$$

where

- k = Soil gas permeability (cm^2)
- Q = Volumetric flow rate from the vent point (cm^3/s)
- u = Viscosity of air (1.8×10^{-4} g/cm-s at 18 C)
- A = Slope of straight line plot of P' versus ln t (g/cm-s). P' = "Gauge" pressure measured at distance "r" from the vent well at time "t" ($g/cm\text{-}s^2$)
- r = Radial distance from monitoring point to vent well (cm)
- m = Stratum thickness, generally the vent well screened interval (or length).

The dynamic method may produce solutions that are known to be somewhat unreliable in certain circumstances, such as at sites with moderate to permeable soils or when shallow SVE points (< 10 ft) and high water table are encountered (Hinchee *et al.* 1992). As an alternate to the above one-dimensional equation, the steady state-method may be used.

Steady-State Method

In situations where the dynamic method is inappropriate, the steady-state method may be used. The formula is as follows:

$$k = \frac{Q\ u\ ln(R_w/R_l)}{H\ \pi\ P_w\ [1-(P_{atm}/P_w)^2]}$$

where

k = Soil gas permeability (cm^2)
Q = Volumetric flow rate from the vent point (cm^3/s)
u = Viscosity of air (1.8×10^{-4} g/cm-s at 18 C)
R_w = Radius of the venting trench (cm)
R_I = Maximum radius of venting influence at steady-state (cm)
H = Depth (length) of vent trench screen (cm)
P_{atm} = Ambient pressure (at sea level 1.013×10^6 g/cm-s^2)
P_W = Absolute pressure at the vent point (g/cm-s^2).

The value of R_I may be determined by either actually measuring the limit of SVE influence in the field during SVE operations or by plotting the vacuum at each monitoring point versus the log of its radial distance from the SVE point and extrapolating to y = 0 (zero vacuum).

After the data is reduced, the calculated air permeabilities are compared to the criteria previously described by others defining adequate soil permeability for SVE. Currently, air permeabilities less than 10^{-10} cm^2 are considered not amenable to SVE (U.S. EPA 1991b).

5.3.3.3 Effective Radial Influence

Magnehelic gauge readings taken at ground-water monitoring wells and/or vapor monitoring points may be linearly regressed against horizontal distance from SVE trenches using a relationship of the form:

$$Log\ dP = a + br$$

where

dP = Pressure differential (vacuum) (in. H_2O)
a = y-intercept at x = 0
b = Slope of the regression line
r = Distance of monitoring point from SVE trench (ft).

The zone of influence can be operationally defined to be that area within a pressure differential of 0.10 in. H_2O (Brown *et al.* 1991; Keech 1989). Using this value and the previously described linear model, the effective radial influence (R_I) of the SVE system may be predicted.

An estimate for R_I can also be obtained by fitting radial pressure distribution data from the air permeability test to the steady-state radial pressure distribution equation (Johnson *et al.* 1990):

$$P(r) = P_w \left[1 + (1-(P_{atm}/P_w)^2) \frac{ln\ (r/R_w)}{ln\ (R_w/R_I)} \right]^{1/2}$$

where

$P(r)$ = Absolute pressure measured at distance *r* from the SVE trench
P_{atm} = Absolute ambient pressure
P_w = Absolute pressure applied at head of SVE trench
R_w = SVE trench radius (ft).

5.3.3.4 Short-Circuiting

The possibility of short-circuiting (Figure 5-9) occurring at the Navy Fuel Farm facility exists since much of the surface is not paved. As part of the pilot study evaluation, an assessment of the presence of short-circuiting will be made.

Figure 5-10 relates the effect of a low permeability surface seal, such as asphalt, on SVE flowpaths. The differential pressure readings recorded during SVE-only operations must be evaluated to qualitatively assess the potential or degree of short-circuiting that may occur. The need for passive or active air injection wells must be considered to promote vertical air flow in the event a high degree of short-circuiting is indicated. Figures 5-9 and 5-11 represent example configurations for such a scenario.

Air injection points can also be utilized for three other purposes. They can be effective in minimizing "dead zones," or "stagnant" regions between SVE trenches where air flow may be limited compared to the flow outside the SVE trenches (Johnson *et al.* 1990). Injection wells can also be utilized to control capture zone of the SVE system and minimize the potential of onsite migration of contaminant vapors residing offsite (Figure 5-12). Injection wells can also be used to create conditions favorable for aerobic biodegradation.

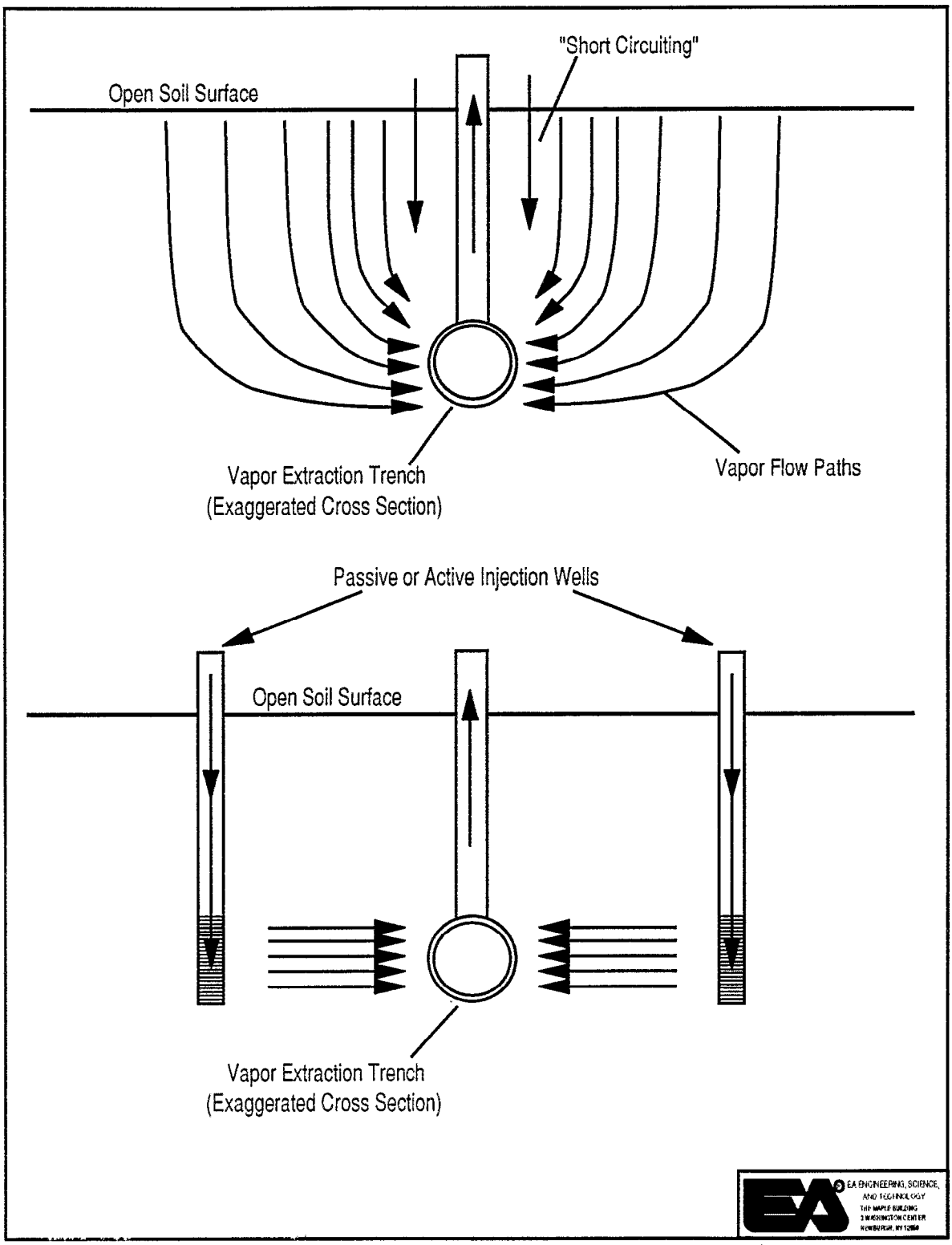

Figure 5-9. Horizontal flow in the vadose zone during soil vapor extraction as induced by air injection wells (modified after EPA 1991a).

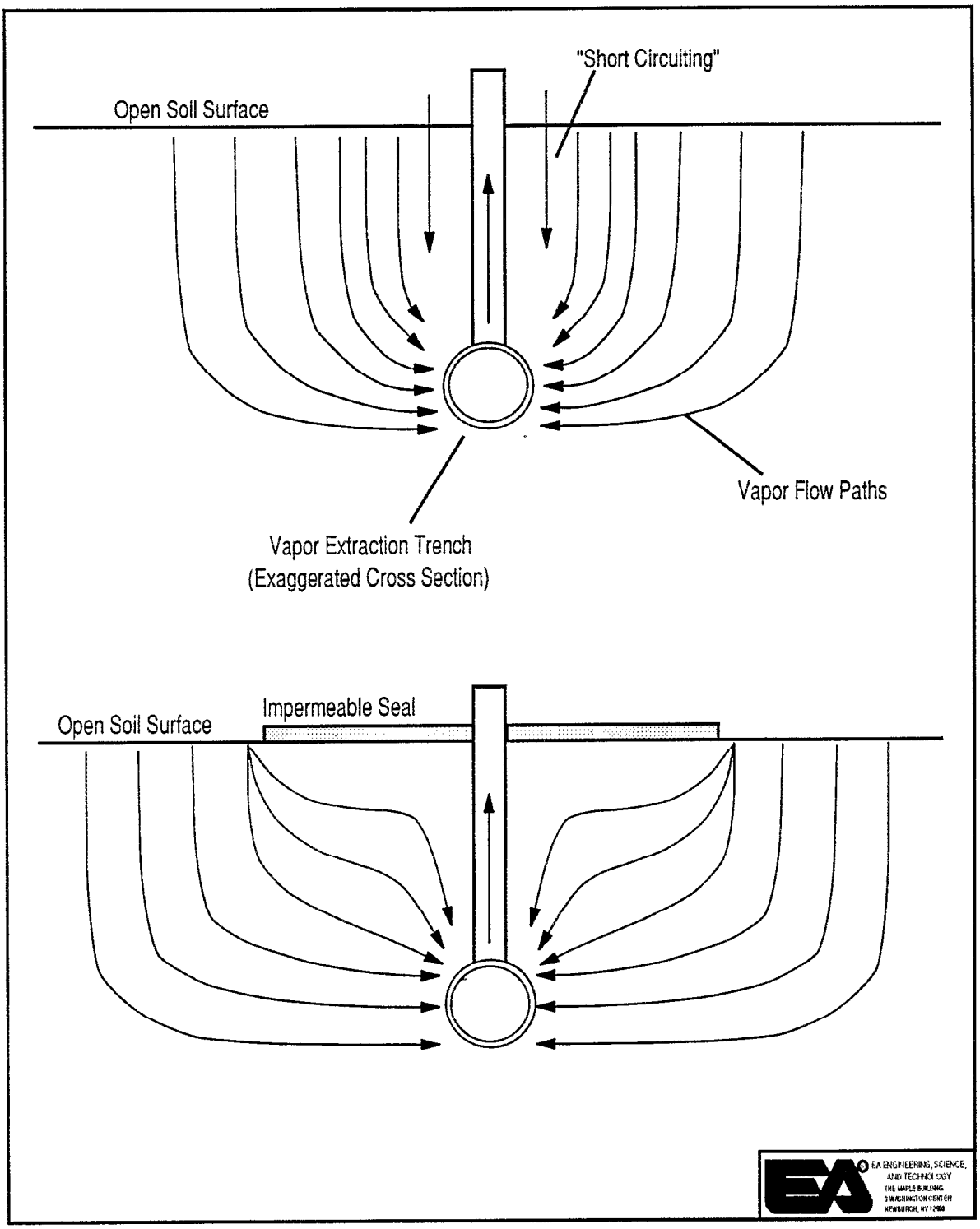

Figure 5-10. Effect of surface seal on soil vapor extraction flowpaths (modified from EPA 1991a).

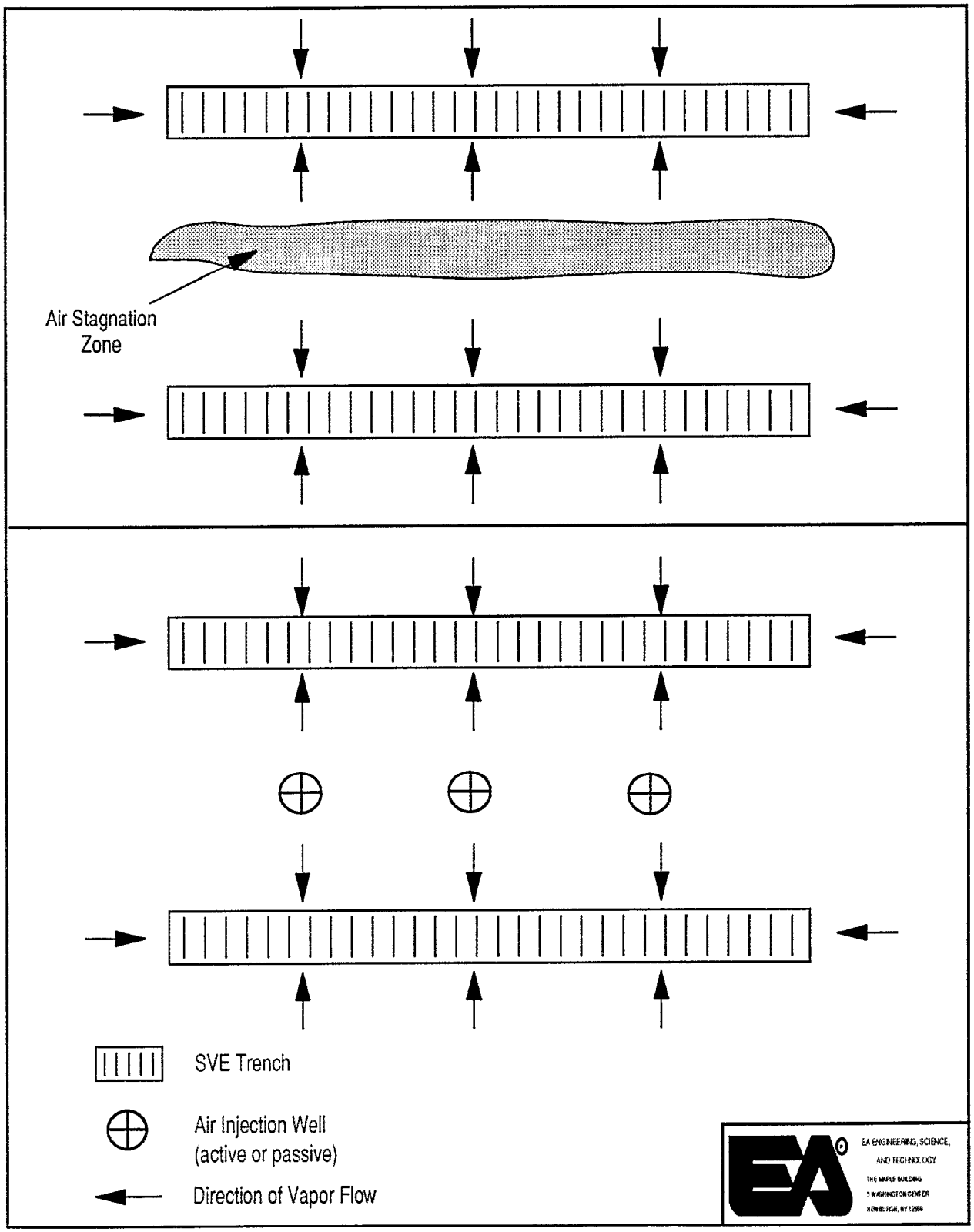

Figure 5-11. Effect of passive ambient air injection in the vadose zone on soil vapor extraction flowpaths (modified after Johnson et al. 1990).

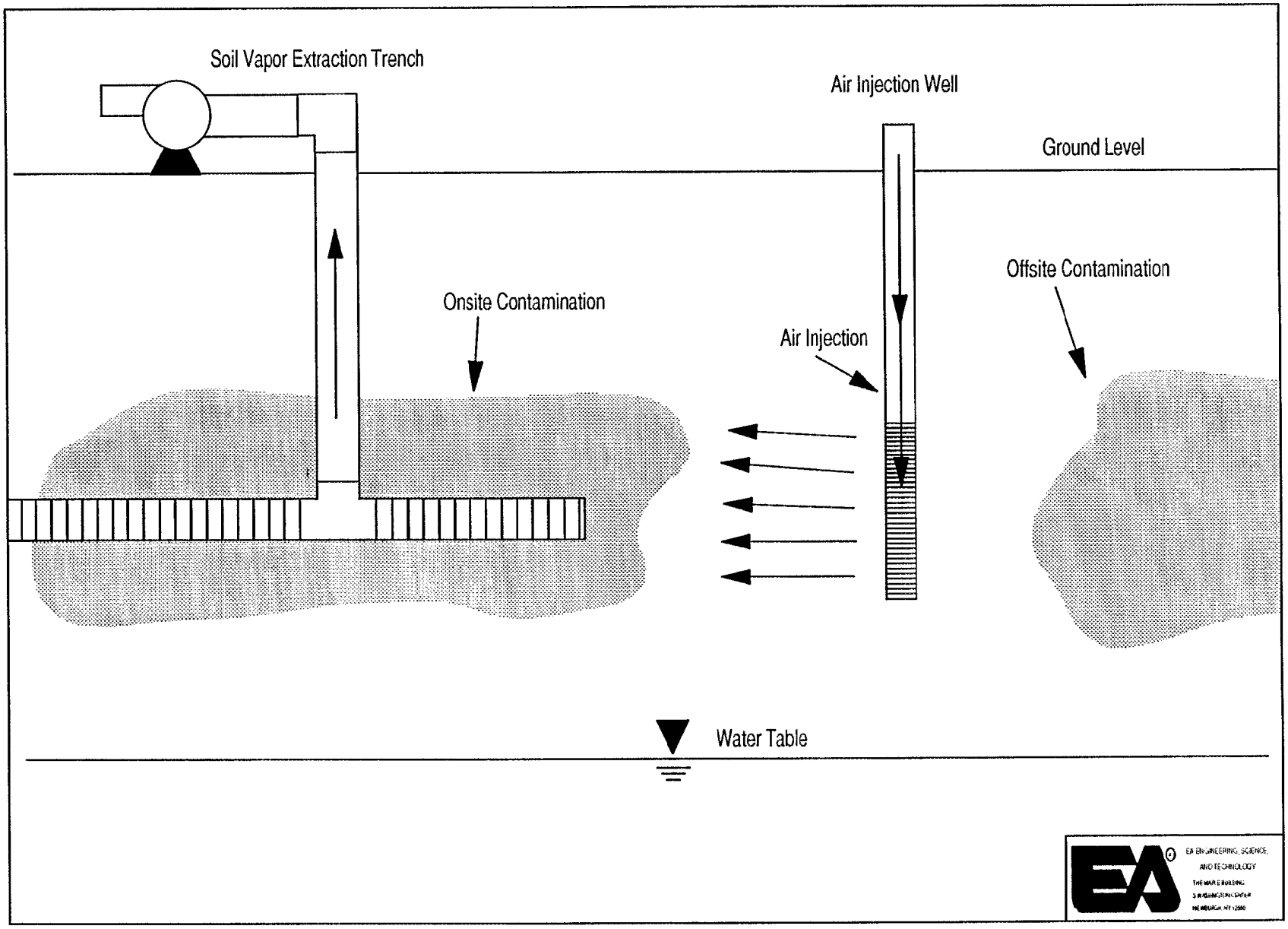

Figure 5-12. The use of air injection wells to minimize onsite migration of offsite contamination (modified after Johnson et al. 1990).

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Appendix A

Resumes of Key Technical Personnel

M. Battle
J. Carnright
K. Hoiem
C. Houlik
G. McCleary
C. Reitenbach
S. Swanson

Michael S. Battle
Hydrogeologist

Mr. Battle is a hydrogeologist with diverse experience in the planning and management of hydrogeologic investigations at RCRA and CERCLA sites, including petroleum bulk storage facilities, industrial and manufacturing facilities, and solid waste disposal sites. He has been primarily involved in the characterization and remediation of hydrocarbon contaminated soil and groundwater at terminals and retail service stations for several major oil companies. Mr. Battle possesses a strong understanding of state and federal environmental regulations affecting RCRA sites and uses his knowledge to develop cost-effective hydrogeologic investigations and, if necessary, corrective action plans for site remediation.

Education:

B.S.; State University of New York at Albany; Geological Sciences; 1989

Certification:

NJDEPE Certification to Perform Subsurface Investigations and Underground Storage Tank Closures; 1992

Training:

Theory and Application of Vadose Zone Monitoring, Sampling, and Remediation; sponsored by the National Water Well Association (NWWA); Chicago, Illinois; 1990
Groundwater Technology Course; IT Corporation, Edison, New Jersey; 1989 and 1990
Sampling Program Management Course; IT Corporation, Stratford, Connecticut; 1991
Occupational Safety and Health Administration (OSHA) courses instructed by IT Corporation:
- Hazards and Protection; 16 hours; 1990
- Site Remediation; 24 hours; 1990
- Qualified Person; 8 hours; 1991
- Hazardous Waste Supervisor; 8 hours; 1991

EA Project Management; 1992

Experience:

Hydrogeologic Investigations—Manages groundwater and soil investigations at numerous RCRA and CERCLA facilities throughout the Northeast. Project types include hydrogeologic studies at petroleum bulk storage and industrial facilities, landfill closure studies, UST removal and installation oversight, and remediation at chemical processing facilities, retail service stations, and bulk storage terminals. Project phases have included soil vapor assessments, selection of appropriate analytical testing procedures, characterization of vadose zone contamination, groundwater monitoring well network design and installation oversight, aquifer pump testing, regulatory records searching, and report preparation. While completing these investigations, has conducted soil sieve analyses, groundwater slug, recharge, and pump tests, downhole geophysical logging, and bedrock and glacial till coring. Also is proficient in the performance of comprehensive field surveying and CADD base map production.

Management capabilities have involved the development of bid solicitations and retention of subcontractors for drilling, trenching, tank excavating, equipment purchasing, electrical installations, analytical testing, geophysical testing, and waste disposal.

Site Remediation—Provides oversight of development and implementation of Corrective Action Plans (CAPs) for a majority RCRA sites in the Northeast. He has conducted numerous pilot tests involving groundwater pump and treat, separate-phase product recovery, and such innovative remedial technologies as aquifer air sparging, soil vapor extraction, and bioremediation. As project manager, he co-authored an intensive report detailing the feasibility of air sparging and soil vapor extraction as viable alternatives to groundwater pump and treat at an inactive bulk storage terminal in New York City. Based on the findings of the report, a quality assurance project plan has been developed and the site has been selected as an innovative technology demonstration site by the EPA and New York State Department of Environmental Conservation (NYSDEC). In addition to field pilot studies, he has successfully permitted and installed several remedial systems, including soil vapor extraction, aquifer air sparging, and groundwater pump and treat systems. Permitting has included SPDES, NYSDEC air discharge, and local building permits.

Emergency Response Projects—Coordinated an emergency response leachate abatement project involving the deployment of 1,400 ft of containment and absorbent boom along a bulkhead in major New York City waterway. The project required extensive interaction among client, U.S. Coast Guard, NYSDEC, and third party property owners in an effort to isolate petroleum leachate areas along bulkhead and reduce total boom length.

At a retail service station involving a line failure, co-managed the installation and testing of monitoring wells and completion of environmental investigation within two weeks of release. Based on the hydrogeologic evaluation, negotiated with State of Connecticut Department of Environmental Protection for the installation and operation of dual pump system onsite. Within 8 months of reported release, greater than 90 percent of product was recovered.

Geologic Data Categorization and Mapping—For the U.S. Geological Survey, transcribed geologic well data into database form for use in the Ground Water Information System. Primary function of this position was to interpolate the lithologies of Lower New York for the completion of a surficial geology map. For the New York State Geological Survey, assisted staff glacial geologists in the design and generation of a Mid-Hudson Valley, New York glacial peneplain map. Duties consisted of transcribing water well data into a data file and using pre-determined parameters to construct a map. Using the map, a report relating the defined peneplains to the region's past glacial history was prepared.

John A. Carnright
Environmental Scientist

Mr. Carnright is an environmental scientist with more than 19 years of experience participating in numerous environmental studies and projects including preliminary assessments, site investigations, Phase I property assessments, and remedial construction projects. In addition, Mr. Carnright has extensive experience in the conduct of environmental impact assessments and aquatic ecology studies providing technical expertise, supervisory and managerial functions, quality assurance auditing, and quality control implementation necessary for the successful completion of many field and laboratory studies. He has served as technical resource manager with direct responsibility for the procurement and allocation of equipment and technical personnel in support of a multidisciplinary staff of geologists, engineers, and biological scientists.

Education:

B.S.; State University of New York; Biology; 1973

Training:

OSHA 40-Hour Hazardous Waste Operations Safety Training
OSHA Hazardous Waste Operations Supervisor's Training
Multimedia CPR and First Aid Training
USACE Certified Endangered Species Monitor
Supervisory Training; Texas Instruments, Inc.; 1977-1979

Certifications:

New York State Secondary Level Provisional Teaching Certificate; 1973
Texas Instruments, Inc. Digital Systems Group Equipment Service Certifications (various)
Open Water Dredged Material Disposal Inspector - New England Division USACE Certification No. 91-10-068

Experience:

Hazardous Waste Investigations—Conducted preliminary assessment investigation at USACE Missouri River main stem dam and hydroelectric facility at Fort Peck, Montana. Work included a reconnaissance and assessment of all developed acreage surrounding the Fort Peck Lake and Dam. Co-authored draft preliminary assessment document in accordance with EPA Region 8 guidance for future site prioritization under CERCLA. Conducted Phase I environmental audits on a variety of commercial properties for major Northeast United States banks and private commercial clients. Provided interpretation, comment, and recommendations based upon reconnaissance, personal interviews, environmental monitoring, and sample analysis. Participated in Phase II supplemental investigations and remedial actions for selected properties. Provided health and safety oversight/OSHA compliance including environmental monitoring for intrusive soil boring and well installation phases supporting a remedial investigation/feasibility study. Conditions at the site required intermittent Level C personal protection. Site work also included collection of air, water, and soil samples and well development with associated documentation. Provided construction oversight and technical support for a major landfill remedial investigation/remedial action (closure). Oversaw intrusive trenching operations and dewatering operations by subcontractors operating in Level B personal protection equipment.

Remedial Operations/Construction—Provided direct site supervision and oversight in support of several construction phase/hazardous waste projects. Participated in the construction, mobilization, and operation of a 50-gpm liquid-phase treatment system treating petroleum-contaminated groundwater for major oil company. Provided health and safety oversight during the early intrusive construction phases of Newport Tower Development Project in New Jersey (Dresdner and Robbins). Planned and executed numerous drywell excavations and the subsequent closure of service station bay drain systems for major oil company. Work included interaction with EPA, local Department of Health, and underground utility personnel to ensure effective work phasing and proper safety during excavation, contaminant storage, and transport of liquid and solid phase waste (both hazardous and non-hazardous). Installed commercial and residential carbon treatment systems for petroleum contaminated well sources. Conducted extended duration pump tests at several large petroleum storage installations in support of hydrogeologic investigations.

Project foreman in an extensive USAF tank removal/replacement program at Eglin AFB, Florida. Project operations included tank removal and cutting, installation of double-walled petroleum product tanks with dual containment piping and electronic leak detection devices, system testing, and site restoration. Coordinated with Eglin AFB Engineering Division to schedule system testing. Directed the activities of crews in construction of prefabricated residential and commercial buildings including layout, excavation, and concrete footings and finish. Participated in the installation and maintenance of the mechanical systems, including metallic and plastic piping, electrical systems and controls, and HVAC components. Participated in the maintenance and installation of pumping and mechanical systems at a 2,500-gpm water treatment/recycle facility involving nitrogen removal and ultraviolet biological sterilization equipment.

Management and Supervisory—Served as project manager for several major aquatic ecology and biomonitoring programs. Functioned as quality control supervisor and quality assurance auditor for utility-sponsored biological monitoring programs in the Hudson River and Lake Ontario. Reviewed field, laboratory, and administrative aspects of the these programs and prepared quality assurance documents for submission to clients and internal corporate quality assurance directors. Supervised field and laboratory operations for the 1983 Hudson River ichthyoplankton and fall juvenile surveys (sponsored by all lower Hudson River Utilities). Specific duties included equipment and material procurement, orientation and scheduling of personnel, research vessel piloting, coordination and routing of sampling data, establishing and maintaining quality control logs, liaison activities with Utility project biologists, and budgetary monitoring and control. Conducted analysis for field fisheries databases and authored manuscript for technical reports, proposals, and standard operating procedural manuals for several New York State Utility projects.

Aquatic Ecology—Worked as fishery biologist/equipment coordinator on multiplant impact 316 study of the effects of power plants on fish populations in the Hudson River estuary. Directed the collection of biological and chemical samples with specific time-dependent quotas, standard operating procedures, and quality assurance criteria. Directed various remodeling and construction projects as well as research vessel outfitting and reconditioning. Responsible for preparation of labor-cost estimates, procurement of materials, and scheduling of tasks. Operated, repaired, and maintained a variety of electronic and mechanical equipment related to this discipline. Piloted research vessels collecting samples in the Hudson River, New York Harbor, Long Island Sound, Mohawk Barge Canal, and Arthur Kill Waterways. Piloted research vessel engaged in electronic fish surveillance/sonic deterrence for a major dredging and blasting project in Boston Harbor. Also participated as a USACE certified open water dredged material dump site inspector and an endangered species monitor for the Massachusetts Bay disposal site. Responsible for orientation and training of new employees.

Kris H. Hoiem, CIH
Chemical Engineer

Mr. Hoiem has more than 20 years of experience in industrial hygiene, including related work in safety and loss control. He established a nationwide industrial hygiene program for a major insurance company based in Baltimore, and also managed an industrial hygiene department for a consulting firm specializing in industrial hygiene and toxicology. His project experience includes supervising asbestos, hazardous waste, and industrial hygiene projects; performing onsite inspections for compliance with health and safety standards; and conducting environmental audits. He has also taught safety, hazardous waste, and health courses; trained and assisted loss control representatives in industrial hygiene; and developed training programs and manuals.

Education:

B.S.; Michigan Technological University; Chemical Engineering; 1971
Associate; Insurance Institute of America; Loss Control Management; 1984

Certifications:

Certified Industrial Hygienist/Comprehensive Practice–
American Board of Industrial Hygiene; 1979

Training:

EPA AHERA Asbestos Inspector, Project Designer and Worker/Supervisor; 1988
Virginia Asbestos Inspector; 1988
Delaware Air Monitor; 1991
EPA AHERA Management Planner; 1992
Maryland Department of the Environment Lead Abatement; 1990
NIOSH 582 Equivalent; Sampling and Evaluating Airborne Asbestos Dust; 1985
OSHA 40-Hour Hazardous Waste Operations Safety Training
EA Project Manager Training

Experience:

Industrial Hygiene Project Management—Managed all industrial hygiene projects for an industrial hygiene and toxicology consulting firm located in Baltimore. Responsibilities included scheduling company projects, and supervising industrial hygienists; supervising asbestos, chemical, hazardous waste, and industrial hygiene surveys; monitoring, inspecting, and writing specifications for asbestos and hazardous waste projects; conducting environmental audits; and reviewing and approving industrial hygiene reports. Also performed onsite inspections for compliance with safety and health standards.

Industrial Hygienist—As an industrial hygienist for a major insurance company located in Baltimore, established a nationwide industrial hygiene and pollution liability program. Additional responsibilities included training loss control representatives in industrial hygiene. Performed complex industrial hygiene surveys and environmental audits.

Loss Control Inspections—Inspected industrial, commercial, and construction companies that were insured by a major insurance company. These inspections included safety, health, fire protection and product liability areas and were done for compliance with OSHA, NFPA, and other standards and guidelines.

Training Programs—Trained and assisted approximately 300 loss control representatives in industrial hygiene as part of an insurance company's loss control program. Also developed slide/tape training programs and manuals in industrial hygiene and related topics. Has made presentations at numerous safety and industrial hygiene seminars and conferences. Trained workers in asbestos and lead abatement and hazardous waste operations.

Professional Affiliations:

American Industrial Hygiene Association
Safety Council of Maryland
–Past Chairman and current member of Industrial Hygiene Section
American Academy of Industrial Hygiene
Chesapeake Section, American Industrial Hygiene Association

Selected Publications and Presentations:

Banks, O. and K. Hoiem. 1987. Mercury Problem in Hospital Dental Service. AIHJ. January.

Charles W. Houlik, Jr., Ph.D., CPG
Chief Geologist

Dr. Houlik has more than 20 years of experience in the performance and management of multidisciplinary investigations addressing environmental issues and/or in support of engineering design. He is a Certified Professional Geologist with extensive experience in waste management, contaminant assessment, impact assessment, environmental remediation, and facilities siting. His responsibilities include active participation in, and supervision of, site and regional geological investigations, surface and groundwater hydrological evaluations for siting or design of facilities, impact assessments for existing and proposed facilities, remedial investigations/feasibility studies (RI/FS), and remedial design. Dr. Houlik has senior responsibility for geological services at EA.

Education:

Ph.D.; Rutgers University; Geology; 1972
M.S.; Rutgers University; Geology; 1970
B.S.; Baylor University; Geology; 1967

Registration/Certification:

Registered Professional Geologist–Delaware, Florida, North Carolina, South Carolina
Certified Professional Geologist–Virginia

Training:

OSHA 40-Hour Hazardous Waste Operations Safety Training
OSHA 8-Hour Hazardous Waste Operations Supervisor Training
EA Expert Witness Training
EA Project Manager Training

Experience:

Hazardous Waste Investigation—Supervised and performed geologic and groundwater investigations for solid waste and hazardous waste disposal site selection and evaluation studies; waste characterization studies, including studies of physical and chemical properties of coal flue gas cleaning wastes and stabilized solid waste; leachate characterization, migration, and attenuation studies; and design of groundwater monitoring programs. On a client confidential basis, developed a program plan for evaluation of potential soil or groundwater contamination by polychlorinated biphenyls (PCBs) at a number of industrial sites in the United States, managed a site assessment project at an active co-disposal (sanitary-hazardous) landfill, and provided hydrogeologic support for closure of a chemical waste processing facility. Provided hydrogeologic support during conceptual design of a closure/redevelopment plan for an aluminum processing waste disposal site for Waste Management, Inc. Supervised design of the groundwater monitoring programs for the Aber Road Secure Landfill (RCRA Part B Application) for CECOS International and an industrial landfill (RCRA closure plan) for W.R. Grace. Supervised hydrogeologic investigations and contaminant assessments at active sanitary landfills in Worcester and Harford counties, Maryland. Managed engineering geology investigations of unstable fill material (chromium tailings) at Dundalk Marine Terminal for Maryland Port Administration.

Site Assessment and Remediation—Served as project manager, principal investigator, or technical consultant on site characterization studies, environmental and human health impact assessments, and design of remedial activities at contaminated industrial sites, active and abandoned waste

disposal sites, manufactured gas plant sites, and leaking underground and aboveground storage tank sites. Responsible for the remedial investigation phase of a CERCLA- funded RI/FS at the Wide Beach development site for the NYSDEC; and managed a CERCLA-funded RI/FS at the Pepe Field Site for NJDEPE. Managed Department of Defense funded site inspections for sites at Naval Air Station Willow Grove, Pennsylvania, and the Navy Ships Parts Control Center, Mechanicsburg, Pennsylvania for the U.S. Navy. Directed an RI/FS, remedial design, and construction oversight for PCBs and metals contamination in a 1.5-mi drainageway and the 500-acre stormwater management system it drains; remedial design and construction oversight for underground storage tank removals; and feasibility studies and remedial design for a removal action at the site of two burn pits at the Navy Ships Parts Control Center. Supervised hydrogeologic investigations for the RI/FS at a chromium tailings fill, Baltimore, Maryland. Managed an RI/FS at the site of a subsurface tank leak (gasoline) North of Baltimore, Maryland, for which the no-action alternative was determined to be the most environmentally sound and cost effective; provided hydrogeologic support for RI/FS in Maryland which culminated with design of groundwater recovery, treatment and infiltration systems, and design of an air stripping tower to treat water produced by a contaminated municipal water supply well.

For Dresdner, Robin & Associates, managed a project to assess levels of polycyclic aromatic hydrocarbon contamination at an urban redevelopment site, which included an abandoned manufactured gas plant site. Evaluated alternatives for mitigative action and prepared the Remedial Action Plan for Jersey City Redevelopment Agency at Newport Development Project, Jersey City, New Jersey. Provided peer review/evaluation of RI/FS at the Old Provost Street Gas Works manufactured gas plant site. Provided hydrogeologic support for site evaluation/risk assessment studies at decommissioned manufactured gas plant sites in Michigan for Consumers Power Company, and RI/FS and remedial design at a fuel tank farm and decommissioned manufactured gas plant in Maryland for Baltimore Gas and Electric Co. Directed RI/FS and preparation of the Remedial Action Plan for a manufactured gas plant site in New Jersey for Jersey Central Power and Light Company. Supervised the assessment of potential for soil or groundwater contamination (for transfer of title) at the Kelley-Springfield tire manufacturing plant, Cumberland, Maryland; the Kennecott copper refinery and rod mill, Baltimore, Maryland; and five properties at the Sparrows Point steel mill, Baltimore, Maryland. Supervised evaluations of potential groundwater contamination at abandoned NIKE missile bases in Pennsylvania, Maryland, and Virginia for the U.S. Army Corps of Engineers and the U.S. Navy.

Facilities Siting—Supervised and performed evaluations of geology, seismology, site and regional fault systems, and surface and groundwater hydrology for numerous existing and proposed nuclear-fueled and coal-fired electric generating stations in the United States, Spain, and Iran. Contributed to preparation of federal and state licensing documents. On a client confidential basis, responsible for the hydrologic, hydrogeologic, and geotechnical aspects of a siting study for a hazardous waste secure landfill site in a mid-Atlantic state and a candidate site evaluation study for a hazardous waste secure landfill site in a northeastern state. For Virginia Electric and Power Company, supervised hydrogeologic investigations as part of environmental site characterization studies at five candidate sites for a coal-fired electric generating station planned to include onsite disposal of fly ash and FGD scrubber sludge. Managed a project to evaluate candidate sites for fly ash/FGD scrubber sludge disposal for Delmarva Power and Light Company. A thorough site characterization study was performed on the selected site. Laboratory waste characterization studies and a pilot scale field application were performed. The site and waste characterization studies provided the basis for computerized aquifer simulation modeling (hydraulic and contaminant migration). The results of groundwater modeling runs initially provided input to the client's landfill design decisions, and finally provided the basis for the environmental impact assessment in the permit application.

Professional Affiliations:

American Institute of Professional Geologists
Association of Engineering Geologists
Association of Ground Water Scientists and Engineers

Gloria D. McCleary, P.E.
Senior Environmental Engineer

Ms McCleary is a registered professional engineer in several states with expertise in environmental engineering. She has 18 years of experience in water and wastewater treatment, hazardous waste, and underground storage tanks. She has managed numerous projects including remedial investigations for both hazardous waste sites and product storage tanks (both above ground and underground). She has conducted treatability studies for oil-creosote laden wastewater. She has managed groundwater and soil cleanup designs and installation.

Education:

M.E.P.C.; Pennsylvania State University; Environmental Pollution Control; 1975
B.A.; West Chester State College; Mathematics; 1973

Training:

8 hour OSHA Hazardous Waste
EA Expert Witness Training
Supervisor Training

Certification:

Registered Professional Engineer: Pennsylvania, Maine, New Hampshire, Alabama

Experience:

Underground Storage Tanks/Hydrocarbon Contamination in Subsurface Environments—Managed more than 200 projects involving subsurface release of organic/petroleum-related constituents. Investigations completed included product source identification, groundwater quality characterization and assessment, groundwater modeling (vadose zone and saturated zone), modeling and evaluation of differential transport of contaminants, and risk assessments. Scopes of the investigations included both onsite and offsite evaluations and tasks such as soil vapor contaminant assessments (SVCAR), soil borings and sampling, monitoring well installation, non-aqueous phase liquid identification (NAPL), and water sampling. She has successfully completed several site models to predict contaminant migration and concentration distributions (i.e., MTBE preferential transport) in support of proposed remediation plans. Completed numerous feasibility studies and corrective action plans for subsurface releases of petroleum constituents. She has also supervised and permitted the installation and operation of remedial systems for groundwater and soil contamination. Installed remediation includes groundwater recovery and treatment and soil vapor venting and treatment.

Remedial Investigation/Feasibility Study (RI/FS)—Project Manager for RI/FS at NPL site in Pennsylvania. Completed RI and FS for a former landfill site with chlorinated solvent contamination. The scope of work completed on the project included numerous field investigatory techniques such as soil vapor surveys, geophysical surveys, fracture trace analysis, monitoring well installation, and environmental sampling (i.e., surface, soil, sediment, surface water, and groundwater). The FS that addressed remedial alternatives to meet ARARs for the site included both source control and groundwater remediation. Project or task manager on three RI/FS projects. Manager of the

Feasibility Study for NPL site with PCB contamination at a residential/resort community in Wide Beach, NY. Evaluated removal, treatment, and isolation alternatives and presented results in a feasibility study with remediation alternatives. Developed Operations Plan, QA/QC Plan, Health and Safety Plan, Contingency Plan and Contaminated Materials Handling Plan.

Site Remediation—Project manager for investigation and remedial design for site with PCB contaminated oil release. Directed investigation of the 1) vertical extent and oil thickness of PCB contaminated oil on the groundwater table near a tidally influenced river 2) groundwater contamination from the oil release and 3) residual soil contamination. Evaluated remedial alternatives and developed remedial design to recover and dispose of PCB contaminated oil. Final design of the system included eight recovery wells, oil/water separation, groundwater treatment and offsite disposal.

Hazardous Waste Remedial Planning—Directed tasks and projects in hazardous waste remedial planning and groundwater contamination investigations. Evaluated feasibility and costs of cleanup alternatives for several sites with both soil and groundwater contaminated with hazardous waste. Evaluation of treatment alternatives have included bench scale studies and development of conceptual designs and costs.

Hazardous Waste Management—Managed projects assisting clients in handling, storing, and disposing of hazardous wastes. Developed procedures for employees to follow in storing hazardous waste. Developed emergency procedures to follow during an unplanned release of spill of hazardous waste. Assisted in preparation of Part B permit application for a large facility which planned onsite disposal of hazardous waste.

Water/Wastewater Treatment/Treatability—Managed/provided technical assistance to clients in both treatability studies and design studied for systems to treat contaminated groundwater which is presently used or planned for use as drinking water supplies. These studies have addressed the treatment of polynuclear aromatic hydrocarbons, phenols, and benzene compounds. The treatment systems have included granular activated carbon, powdered activated carbon, and air stripping units. Managed projects and completed conceptual designs for wastewater treatment systems. These projects have addressed wastewater treatment needs of both small industrial dischargec requiring pretreatment systems and a large chemical facility planning to discharge over 10 mgd.

Water Quality Management—Assisted and managed several water quality management projects. These projects have included programs for seven different river systems and have included regional planning programs or industrial permits for discharges to the river systems. Managed sampling programs, data collection and analysis, and water quality modeling.

Selected Publications and Presentations:

McCleary, G., I.D. MacFarlane, S.L. Pattison. Three-Phase Liquid Recovery and Treatment at a Former Coal Gasification Site. 1988. NWWA Petroleum Hydrocarbons Conference. November.

Factors Affecting the Utility of Soil Vapor Assessment Data. 1988. NWWA Outdoor Action Conference. Las Vegas, NV.

Soil Vapor Technique Applied to Assessing Subsurface Contamination Resulting from Former Coal Gasification Processes. 1987. Presented at the Edison Electric Institute Conference - 1988 Groundwater Issues for the Electric Utility Conference, Washington, D.C. February 1988.

McCleary, G., D.A. Burke, A.Shahalam. The Modeling of Toxic Substances in Riverine Systems. 1979. Presented at the ASCE Water Systems Specialty Conference. Houston, TX. 25-28 February.

Carl G. Reitenbach, Jr., R.S., C.W.S.

Mr. Reitenbach is a ground water hydrologist with eight years experience in environmental health; air and water monitoring; and hydrology. His project experience in environmental health and sanitation includes soil evaluations; wastewater disposal; percolation tests; well permits; water supplies; asbestos sampling; complaint investigation; subdivision plan review; and public relations. He is also experienced in the coordination of air and water monitoring programs, including solutions for indoor air quality problems. He has also assisted a State Highway Administration in the development of a Geographical Information System.

Education:

M.S., University of Maryland; Civil Engineering (with a concentration in Ground Water Hydrology); 1989
B.S., University of Massachusetts; Environmental Science; 1982

Certifications:

Registered Sanitarian, State of Maryland, License #484
Certified Water Sampler, State of Maryland, #88-0187

Experience:

Ground Water Hydrology—As a Research Assistant for the University of Maryland, College Park, assisted the Department of Civil Engineering in the development of a Geographical Information System for the Maryland State Highway Administration. Previously, while working for a county-level health department, performed various tests involving ground water hydrology, including percolation tests. Was also responsible for issuing well permits and for testing of water supplies. Familiar with a wide range of sampling techniques and laboratory procedures necessary for the study of ground water hydrology.

Environmental Health—As Environmental Sanitarian for the Talbot County (Maryland) Health Department, performed a large number of inspections to determine compliance with Maryland Health and Environmental Laws and Regulations. Supervised the food service facility inspection program. Also gained experience in all aspects of environmental health, including soil evaluations; wastewater disposal; percolation tests; well permits; water supplies; asbestos sampling; complaint investigation; and zoonoses. Was also involved in public relations.

Air Monitoring—As Environmental Scientist, coordinated the air and water monitoring programs for an environmental consulting firm. Experienced in sampling techniques, quality control, and laboratory procedures for air and water monitoring studies. Also knowledgeable in the problems of indoor air quality.

Professional Affiliations:

Tidewater Environmental Health Association
CASA of Food and Drug Officials

Carl G. Reitenbach

Scott C. Swanson
Engineering Inspector

Mr. Swanson is responsible for resident inspection of construction projects, primarily landfill facilities. His responsibilities include daily observation of ongoing work for compliance with contract documents, maintenance of project records (daily reports, journal, record drawings, test reports), attendance of progress meetings, review of payment estimates, assistance in resolution of field problems, and development of punch lists. His additional experience in the geotechnical area includes well drilling, installation and development, soil borings, pump tests, and aquifer characterization. His background includes more than 3 years in environmental resource management.

Education:

B.S.; Pennsylvania State University; Environmental Resource Management

Certifications:

N.I.C.E.T., Level III, Erosion and Sedimentation Control
40-hour OSHA Hazardous Materials Operations Training
8-hour Red Cross CPR
8-hour EA Supervisors Hazardous Waste Operations Safety Training Course

Experience:

Inspection--Onsite inspection of a Maryland industrial landfill refurbishment, including removal of existing liner system, reconstruction of sump area, reconditioning of subbase and installation of 2,000 sq ft of 30-mil PVC dual liner. Resident inspection of a Pennsylvania hazardous waste remediation of a PCB-contaminated stormwater ditch including excavation and removal of 7,000 cubic yd PCB-contaminated soil and installation of R-4 rip rap throughout 2,200 linear ft of ditch. Resident inspection of a Pennsylvania landfill ash storage cell including excavation and subbase preparation, 490,000 sq ft of 60-mil smooth and textured HDPE dual liner, 41,675 sq yd of geotextile, 42,800 sq yd of flownet, 55,700 sq ft of 20 and 30-mil PVC, and leachate collection system including HDPE piping, valves, manholes and filter gravel; resident inspection of a Pennsylvania landfill leachate storage pond including removal of existing liner system, reconditioning of subbase, and installation of 213,500 sq ft of 60 and 80-mil smooth and textured HDPE dual liner, 559 sq yd of geotextile, 11,700 sq yd of flownet and reinstallation of pump station piping; resident inspection of a Maryland central facility single-lined landfill cell including subbase preparation and 735,000 sq ft of 50-mil HDPE liner; onsite inspection of gabion dam construction in PCB contaminated storm water ditch.

Engineering--Performed preliminary design calculations for landfills, chemical treatment systems, and site remediations. Performed cost estimation for both standard and hazardous waste projects. Performed earthwork quantity calculations, prepared topographic maps, plotted survey notes.

Sampling--Supervised and assisted in sampling hazardous surface water sediments on an Alabama Superfund site using a hand corer and following EPA protocol. Sampled ground-water, surface water and storm sewer flows following USATHAMA protocol, and sediments from surface water and sump sites using a hand corer.

Erosion and Sedimentation Control--Developed erosion and sedimentation controls plans for landfills and construction sites. Calculated stormwater basin design, runoff, flow, and channel designs.

Soil Borings--Performed hand auger borings following USATHAMA protocol. Logged soil classifications and characteristics, collected soil samples, and monitored for airborne contamination. Worked with geologists and safety personnel in 50+ hours of level C test auger boring and sampling operations. Supervised and assisted in sampling of shallow auger borings in compliance with USATHAMA protocol.

Drilling--Assisted in drilling and sampling operations during auger and mud rotary drilling.

Remedial Investigations--Supervised and assisted in aquifer testing including slug, swab, and pump tests, and analysis and interpretation of results for final reports. Performed geophysical surveys using both the EM-30 and EM-34 instruments. Assisted in SVCA surveys.

Computer Applications--Knowledge of software systems for micro-computers. Logged and interpreted engineering and geologic data using a wide variety of software including EARTH, SURFER, AQTESOLV, SLUG, and HERMITDM.

Additional Experience--Extensive surveying experience using both horizontal and vertical controls and setting construction stakes. Constructed and inspected concrete well pads and protective posts. Designed and constructed staff gages in water channels to gage water depth. Supervised well development using sand bailer and surge block. Performed stream flow measurements during storm events and normal conditions. Operated heavy equipment to perform ground restoration.

Scott C. Swanson

Appendix B

Site Safety, Health, and Emergency Response Plan

Site Safety, Health, and Emergency Response Plan
Navy Fuel Farm Facility
Naval Air Station, Willow Grove
Horsham Township, Pennsylvania

Contract No. N62472-92-D-1296
Contract Task Order No. 0009

Prepared for

Department of the Navy
Northern Division
Naval Facilities Engineering Command
Lester, Pennsylvania

Prepared by

EA Engineering, Science, and Technology
Newburgh, New York

Approved by: Kris H. Hoiem 11/5/93
Kris H. Hoiem, Certified Industrial Hygienist — Date
Program Safety and Health Officer

Michael S. Battle 11/5/93
Michael S. Battle — Date
CTO Manager

November 1993

EA Project No. 296.0009

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3	Environmental monitoring requirements.
4	Site worker training and physical examination record.
5	Personal protective equipment requirements.
6	Emergency information.

SITE SAFETY, HEALTH, AND EMERGENCY RESPONSE PLAN (SHERP)

1. SITE INFORMATION

Site: Navy Fuel Farm Facility

Location: Naval Air Station, Willow Grove, Horsham Township, Pennsylvania

Scheduled field activities dates: January-November 1994

2. KEY PERSONNEL AND RESPONSIBILITIES

2.1 CTO MANAGER: MICHAEL BATTLE

The responsibilities of the Contract Task Order (CTO) Manager include:

- Assuring compliance with the Program Safety and Health Management Plan and this SHERP.
- Coordinating with the designated Navy Technical Representative.
- Preparing the SHERP.
- Providing overall supervisory control for safety and health protocols in effect for the project.
- Assigning the Site Manager and Site Safety and Health Officer (SSHO) and assuring that the assigned onsite staff will enforce provisions of the approved SHERP.
- Submitting a letter to the Contracting Officer Technical Representative prior to initiating field work certifying that employees, including subcontractors and consultants, who will work onsite and who may be exposed to hazardous wastes, have completed training, and are currently participating in a medical surveillance program in accordance with OSHA 1910.120, the NIOSH/OSHA/USCG/EPA "Occupational Safety and Health Guidance Manual for Hazardous Waste Activities" and the NEESA "Safety and Health Guidelines for Navy Assessment and Control of Installation Pollutants Confirmation Studies."
- Assuring adequate resources are available for safety and health.
- Preparing and submitting project reports.

2.2 SITE SAFETY AND HEALTH OFFICER: SCOTT SWANSON (ANDREW TAYLOR AS ALTERNATE)

The SSHO will be onsite throughout the project (with the exception of routine monitoring and maintenance visits) and will be responsible for daily compliance with site safety and health requirements. The duties of the SSHO[1] include:

- Conducting daily inspections of the site.
- Stopping work when imminent safety or health risks exist or as outlined in the site specific SHERP.
- Implementing usage of forms in appendixes.
- Implementing the SHERP.
- Providing an initial safety and health briefing to site workers and visitors and providing weekly safety and health meetings during the project performance.
- Reviewing training and medical records prior to site work.
- Evaluating reported hazardous conditions and recommending corrective action.
- Conducting necessary monitoring.
- Establishing and ensuring compliance with site control areas and procedures.
- Supervising decontamination to ensure decontamination of personnel, tools, and equipment.
- Supervising the distribution, use, maintenance, and disposal of personal protective clothing and equipment.
- Investigating and preparing incident reports as necessary.

2.3 SITE MANAGER: SCOTT SWANSON

The Site Manager's[1] responsibilities also include:

---

[1] Certification of 8-Hour Supervisor's Training for Hazardous Waste Operations required for SSHO and Site Manager.

- Providing technical support to the SSHO, particularly in the modification of site safety and health requirements.
- Evaluating onsite environmental monitoring results and reporting to the CTO Manager.

- Reviewing site safety and health documentation to ensure compliance with the Program Safety and Health Management Plan.

During any emergency, the Site Manager (or the senior site supervisor in the absence of the Site Manager) will be responsible for initiating and coordinating responses. In this situation, the Site Manager will:

- Work with the SSHO to identify and evaluate hazards.

- Be responsible for initiating the evacuation of the work site when needed, communicating with offsite emergency responders, and coordinating activities of onsite and offsite emergency responders.

- Determine if the abatement of hazardous conditions is sufficient prior to allowing resumption of work operations after an emergency.

2.4 FIELD PERSONNEL

The following personnel are assigned to field work under this CTO:

- John Carnright
- Scott Dopson
- William Parnella
- Carl Reitenbach
- Scott Swanson
- Andrew Taylor.

The following EA subcontractors will be retained:

- Electrical
- General Construction (i.e., trenching)
- Drilling.

Responsibilities of EA and subcontractor personnel include:

- Following the site specific SHERP and applicable safety and health rules, regulations, and procedures.

- Using required controls and safety devices, including personal protective equipment.

- Notifying his/her supervisor of suspected safety or health hazards.
- Complying with training and medical requirements.

3. PURPOSE AND WORK SCOPE

The primary objective of this project is to conduct pilot studies and evaluate the effectiveness of each technology in reducing source hydrocarbons at the Navy Fuel Farm facility. An integral component to achieving this objective is the removal of free-product. EA will install, operate, and maintain free-product recovery pilot systems at three site wells for a period of 9 months. From the point in time at which point free-product has been sufficiently diminished within potential soil vapor extraction/aquifer air sparging (SVE/AAS) pilot test locations, the mitigation of source hydrocarbons located in the phreatic zone via AAS may be evaluated. The SVE/AAS pilot study is proposed to run for a 6-month period.

The pilot study activities under this CTO are broken out into two phases. The first phase of the project involves removal of free-phase product from the subsurface and includes the following activities:

- Installation and operations of free-product recovery systems.
- Routine monitoring, and sampling of free-product recovery systems.
- Routine gauging of site monitoring and recovery wells.
- Routine maintenance of pumping equipment.
- Transferral and/or disposal of free-product.

The second phase of the project involves pilot testing of air sparging in conjunction with soil vapor extraction, and includes the following activities:

- Installation and operation of the SVE/AAS system.
- Routine monitoring, and sampling of SVE/AAS system.
- Routine gauging of site monitoring and recovery wells.
- Routine maintenance of pilot plant equipment.

Work will take place in an area of an inactive fuel farm facility. Trenching and drilling may occur through areas found to contain free-product.

4. SITE DESCRIPTION

The Navy Fuel Farm facility is located along the north side of Privet Road and immediately south of the Pennsylvania Air National Guard portion of the Air Reserve Facility at NAS Willow Grove (Figure 1). The Navy Fuel Farm facility and a portion of the adjoining property to the north, occupied by the Pennsylvania Air National Guard (Buildings 345 and 340), constitute the area requiring remedial efforts. The Navy Fuel Farm facility is bordered on all sides by NAS grounds. West of the subject site, across an access road, sits the aircraft parking apron off Runway 15. To the east, at the previous location of Building 157, sits the newly constructed Navy Fuel Farm facility, complete with a bermed enclosure containing the newly erected aboveground storage tanks. Abutting the Navy Fuel Farm facility to the north are Air Reserve Facility Buildings 330, 340, and 345. Several other base facilities exist within 1,000 ft of the site.

The Navy Fuel Farm facility is approximately 2 acres in area and consists of three aboveground storage tanks, associated aboveground piping, and Buildings 119 and 81. Remaining Navy Fuel Farm facility grounds include a fuel truck parking area and a soil staging area. At present, the newly constructed facility remains inactive.

The topography of the Navy Fuel Farm facility area is characterized as flat and gently sloping to the north-northwest. There is a slight downgrade at the north end of the facility which encourages runoff to flow northeast into the catchment basin or the adjacent ditch.

On and directly adjacent to the Navy Fuel Farm facility grounds exist several buried utilities, including water, electric, sewer, telephone, and product piping. Several storm sewer and sanitary sewer lines traverse the southern portion of Navy Fuel Farm facility grounds. A water main also extends across facility grounds. Updated utility drawings for the Navy Fuel Farm facility grounds have not been provided to EA. It is assumed that NAS personnel will provide these drawings to EA and mark the location of all utilities in the field prior to the commencement of excavations. A complete, updated assessment of the existing conditions will be made during the installation of the pilot system.

Information relating the site's history has been taken from EA (1993). From 1950 to 1991, two partially buried 210,000-gal JP-4/JP-5 aviation fuel tanks (Tank Nos. 115 and 116) were located at the site. A 500-gal underground waste oil tank and an underground diesel tank were also located at the southwestern corner of the site. The former locations of these tanks is provided in Figure 2.

In 1986, a spill occurred when Tank No. 115 was overfilled and fuel was released from the vent pipe onto the ground. The event was attributed to faulty gauges which registered less fuel than was actually present. During this same year, a utility trench was excavated along the western boundary of the site but work discontinued when free-product was observed floating on the water within the trench. Subsequent observations have confirmed the continued presence of at least a sheen of free-product in the trench. The area where the free-product was discovered is immediately adjacent to a former drywell. The drywell accepted water which was periodically siphoned from the bottom of the fuel tanks.

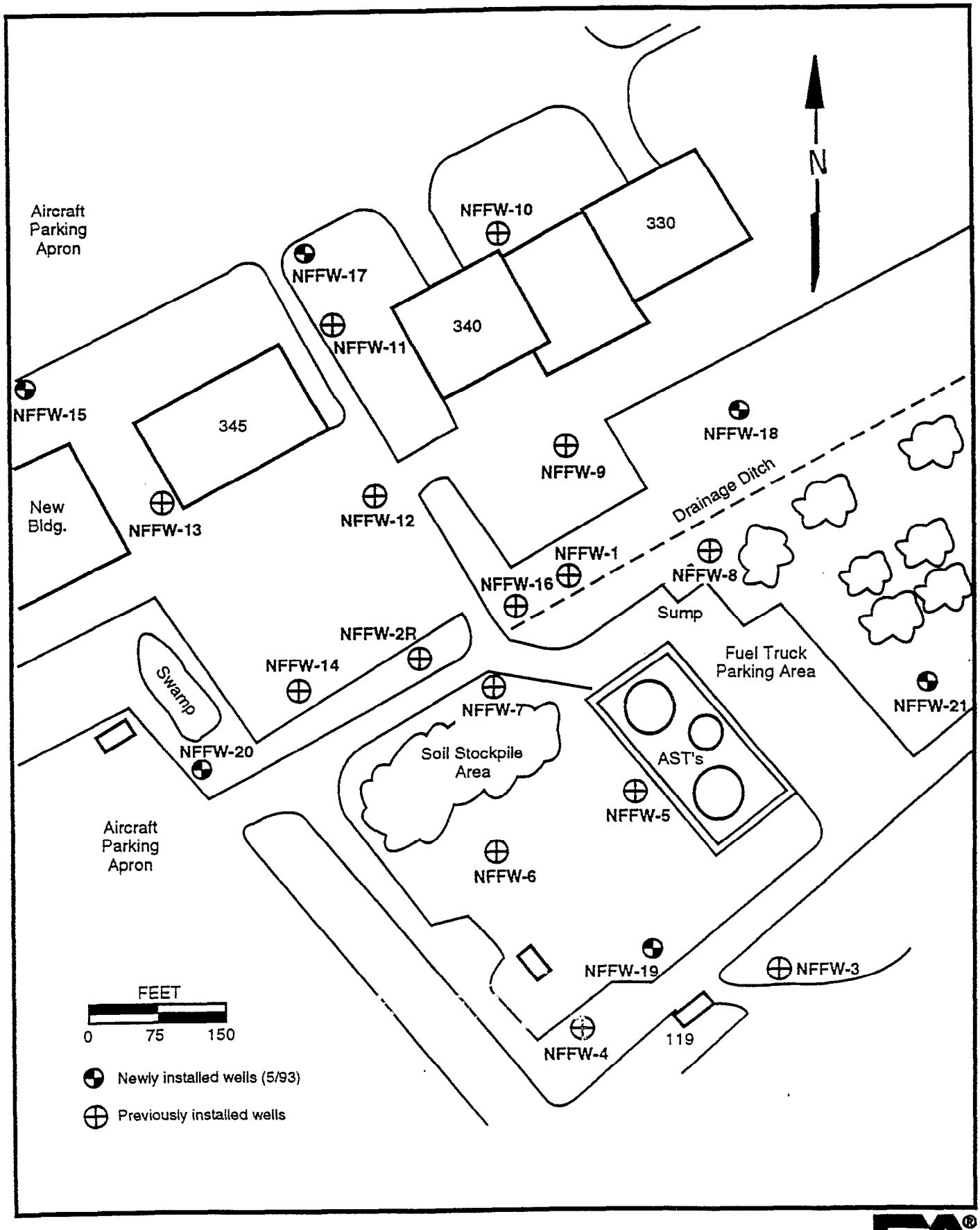

Figure 1. Site plan 1993, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

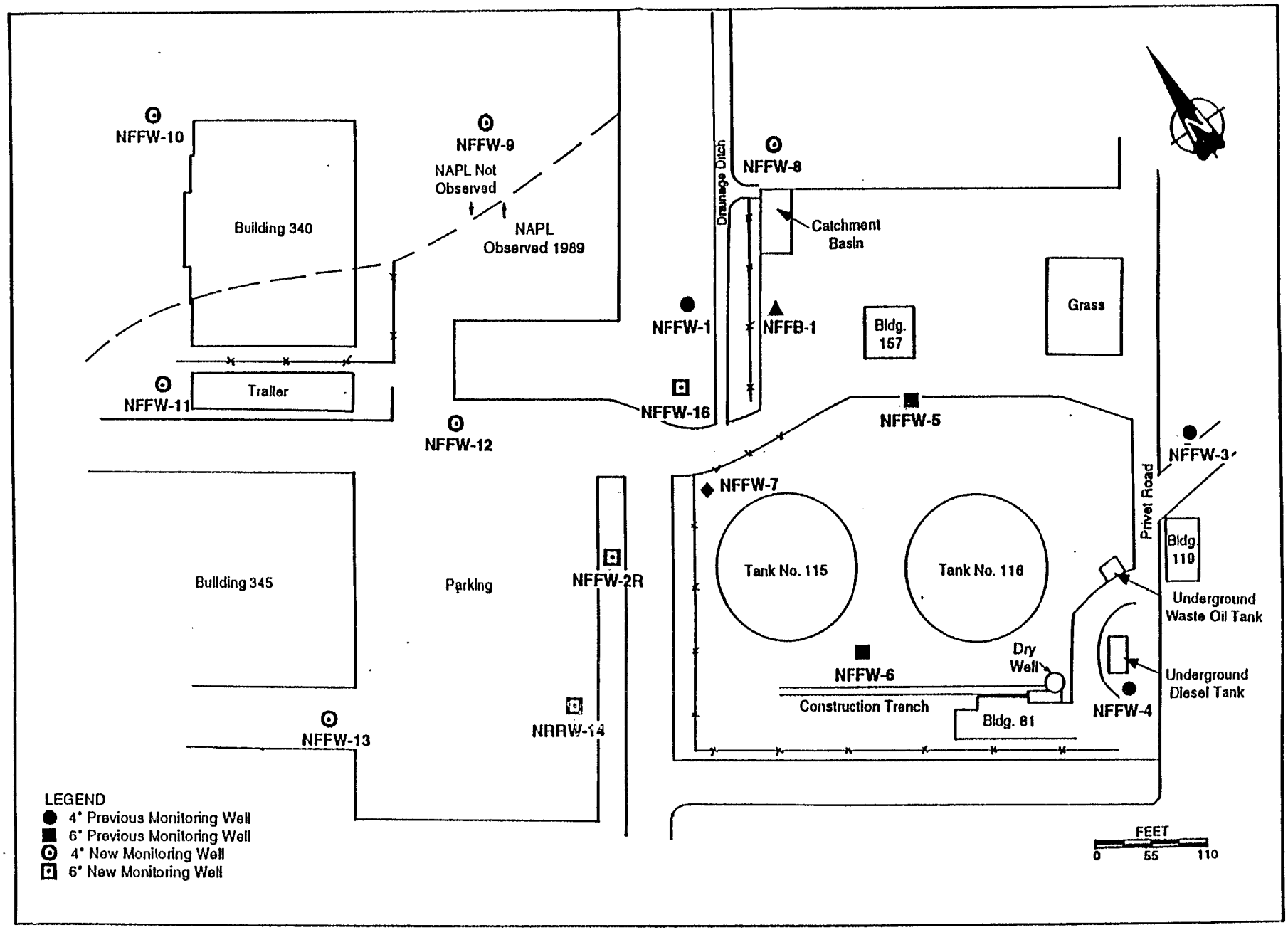

Figure 2. Site plan showing relevant site features, prior to 1991, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

In March 1989, JP-5 jet fuel was detected emanating from two patches of dead grass on the west side of Tank No. 115. Heavy rains flushed this fuel into the ditch on the north side of the site. Navy personnel responded with the placement of sorbent material in the ditch and adjacent to Tank No. 115. With this evidence of tank leakage, it was decided to empty and remove the two main fuel tanks (Tank Nos. 115 and 116). Removal of these tanks occurred in 1991. Also during this time, the waste oil and diesel underground storage tanks were removed. Inspection of the waste oil tank during removal revealed the tank was not intact as holes up to 1-in. in diameter were reported.

Subsequent to the completion of removal activities, a new aboveground tank system was installed to the east of the former tank field location. In order to accommodate the newly constructed Navy Fuel Farm facility, Building 157 was removed. The new tank system at the Navy Fuel Farm consists of aboveground steel tanks set in a concrete berm. The Navy Fuel Farm facility is currently inactive. Figure 1 shows current site conditions.

5. TASK-BY-TASK HAZARD ANALYSIS

5.1 HAZARD COMMUNICATION

A Material Safety Data Sheet (MSDS) for each chemical supplied by EA shall be kept onsite by the Site Safety and Health Supervisor (SSHS). EA employees and EA subcontractors shall be informed of the location of MSDSs. Subcontractors must inform EA about any hazardous substances that they bring to the site and provide appropriate MSDSs. Chemicals brought onsite must be properly labeled in accordance with OSHA's Hazard Communication requirements (29 CFR 1910.1200) and EA's Hazardous Materials Control program.

Chemicals which may be supplied by EA include: methanol and non-phosphate detergent (decontamination); methane and isobutylene (calibration gases); and nitric acid, sulfuric acid, hydrochloric acid (sample preservatives). MSDSs for these substances can be found in Attachment A of this SHERP.

5.2 CHEMICAL HAZARDS

Table 1 provides a summary of the petroleum hydrocarbons detected in ground water recently collected from wells at the Navy Fuel Farm facility. Table 2 provides a summary of maximum free-product thickness as observed in site wells during a recent investigation. Free-product may consist of any of the following fuels: JP-4 jet fuel, JP-5 jet fuel, gasoline, and waste oil. Figure 3 provides an approximation of the aerial extent of free-product and dissolved-phase hydrocarbons at the subject site, based on recently collected well gauging data (EA 1993).

TABLE 1 SUMMARY OF ANALYTICAL RESULTS FOR GROUND-WATER SAMPLES TAKEN 10-21 JUNE 1993 AT THE NAVY FUEL FARM FACILITY, NAVAL AIR STATION, WILLOW GROVE, PENNSYLVANIA

Compound	NFFW-3	NFFW-4	NFFW-5	NFFW-5D	NFFW-8	NFFW-9	NFFW-10	NFFW-11
VOLATILE ORGANIC COMPOUNDS (μg/L)								
Acetone	---	---	---	77	59 B	---	14 B	---
Carbon Disulfide	---	---	14	12	---	---	---	---
Trichloroethene	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	5 J	---	---
Benzene	---	---	53	52	---	29	---	16
Toluene	---	---	---	---	---	---	---	---
Ethylbenzene	---	---	23	21	30	---	---	70
Total Xylenes	---	---	12	11	9 J	---	---	---
Total BTEX	---	---	88	84	39	29	---	86
TOTAL PETROLEUM HYDROCARBONS (μg/L)								
TPH (Gasoline)	1,600	---	1,600	1,700	8,800	1,300	360	8,300
TPH (JP-4)	---	---	---	---	3,200	---	---	40,000

NOTE: Wells NFFW-1, NFFW-2, NFFW-6, NFFW-7, NFFW-12, NFFW-13, NFFW-14, NFFW-16, and NFFW-19 not sampled due to presence of free-product in well.
Dashes (---) indicate not detected; refer to EA (1993) for complete results.
D = Duplicate sample; NA = Not analyzed; J = Estimated concentration; and B = Compound detected in associated method blank.

TABLE 1 (Continued)

Compound	NFFW-15	NFFW-17	NFFW-18	NFFW-19	NFFW-20	NFFW-21	Trip Blank	Trip Blank
VOLATILE ORGANIC COMPOUNDS (μg/L)								
Acetone	13 B	15 B	27 B	24 B	19 B	13 B	16 B	---
Carbon Disulfide	---	---	---	---	17	---	---	---
Trichloroethene	3 J	---	---	---	2 J	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---
Benzene	---	6 J	2 J	67	6 J	1 J	---	---
Toluene	---	---	1 J	17 J	2 J	1 J	---	---
Ethylbenzene	---	---	---	320	---	---	---	---
Total Xylenes	---	---	---	500	46	---	---	---
Total BTEX	---	6	3	904	54	2	---	---
TOTAL PETROLEUM HYDROCARBONS (μg/L)								
TPH (Gasoline)	---	530	6,800	6,900	5,900	---	NA	NA
TPH (JP-4)	---	8,400	---	3,600,000	1,600,000	---	NA	NA

TABLE 2 SUMMARY OF MAXIMUM FREE-PRODUCT THICKNESS OBSERVED DURING MAY-JUNE 1993 GAUGING PROGRAM AT NAVY FUEL FARM FACILITY, NAVAL AIR STATION, WILLOW GROVE, PENNSYLVANIA

Well Number	Maximum Free-Product Thickness (ft)
NFFW-1	0.02
NFFW-2R	0.27
NFFW-3	0.00
NFFW-4	0.00
NFFW-5	0.00
NFFW-6	1.20
NFFW-7	0.61
NFFW-8	0.00
NFFW-9	0.00
NFFW-10	0.00
NFFW-11	0.00
NFFW-12	0.01
NFFW-13	0.00[a]
NFFW-14	0.38
NFFW-15	0.00
NFFW-16	0.20
NFFW-17	0.00
NFFW-18	0.00
NFFW-19	2.00
NFFW-20	0.00[b]
NFFW-21	0.00

a. Free-product present in well during ground-water purging.
b. Green, translucent product detected in Well NFFW-20 after purging.

NOTE: Refer to EA (1993) for complete well gauging results.

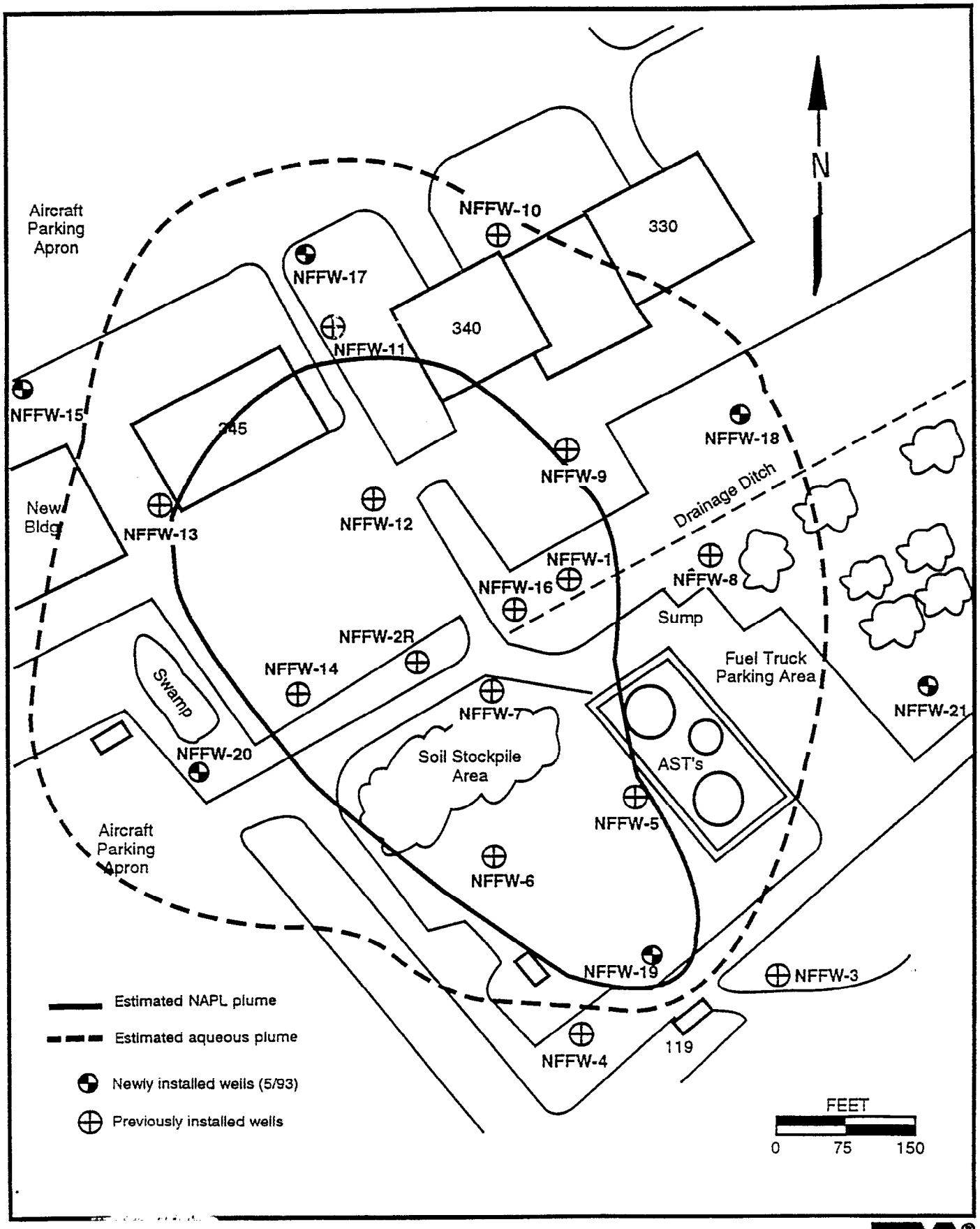

Figure 3. Interpreted hydrocarbon plume distribution, Navy Fuel Farm facility, Naval Air Station, Willow Grove, Pennsylvania.

Potential routes of worker exposure to these chemicals (e.g., inhalation, skin contact) and expected magnitude of exposure are summarized below by task.

- SVCA—Soil gas surveys may take place in soil which contains free-product. Chemical hazards may involve inhalation exposure to benzene or other organic vapors and exposure to potentially explosive levels of such gases.

- Boring/Trenching—Drilling and/or trenching may take place through soil which contains hydrocarbons in the vapor, dissolved, or free-phases. Therefore, exposure during these activities is likely. All site workers will therefore take precautions to guard against dermal and eye contact with potentially contaminated soil.

- Pump Maintenance and Free-Product Disposal—Levels of dissolved-phase hydrocarbons have been shown to vary widely in ground water. Pumps designed to remove free-product will be coated in free-product. Potential routes of exposure during water table depression and free-product pump removal and maintenance are dermal and eye contact with contaminated ground water and free-product. These same routes of exposure exist during the disposal process.

During all phases of the work, strict adherence to the monitoring procedures in Table 3 will help protect against inhalation of organic vapors.

5.3 PHYSICAL HAZARDS

Physical hazards are listed below for <u>each</u> work task (Physical Hazard Information Sheets can be found in Attachment B):

- SVCA: Cold Stress, General Physical Hazards, Electrical Hazards, Underground Utilities.

- Boring Installation/Trenching: Heavy Equipment Hazards, General Physical Hazards, Trenching and Excavation Hazards, Cold Stress, Heat Stress, Drilling, Electrical Hazards, Underground Utilities, Noise Hazards.

- System Monitoring and Maintenance: Cold Stress, General Physical Hazards, Electrical Hazards, Biological Hazards, Material Handling/Moving/Lifting.

TABLE 3 ENVIRONMENTAL MONITORING REQUIREMENTS

SITE: Navy Fuel Farm Facility — CTO No. 0009

Project No.: 29600.09 — Task No. 3130

Task	Instrument	Frequency and Location	Action Levels	Required Response
Boring Installation; Trenching; Pilot Plant Maintenance	PID with 11.7eV lamp or FID	Initially and every 10 minutes in the breathing zone	0-1 ppm above background for 5 minutes	Evacuate to a safe upwind location and wait for levels to dissipate. Retest the area after 15 minutes. If levels have not dissipated continue work in Level C PPE.
			1-5 ppm above background	Continue work in Level C PPE. Monitor continuously.
			>5 ppm above background	Evacuate to a safe upwind location immediately. Retest the area after 15 minutes wearing Level C PPE. If levels have not dissipated in 30 minutes, contact the EA CTO Manager and Program Safety and Health Officer.
Boring; Trenching; Pump Maintenance at Recovery Wells	CGI	Initially and every 10 minutes during soil disturbance. Measure at surface of hole.	0-10% LEL	Continue.
			10-20% LEL	Continuous monitoring. Prepare to shut down.
			>20% LEL	Shut down. Contact SSHO and CTO Manager.

6. EMPLOYEE TRAINING ASSIGNMENTS

Dates of employee training must be documented in Table 4. Any person who does not meet these training requirements is prohibited from engaging in site operations. Once the SHERP has been signed by the CTO Manager and the Program Manager, no other personnel may be added to the project field work without prior written approval by the CTO Manager or SSHO, who must review the proposed employee's training and medical status. The following training must be completed prior to the start of work operations:

All Site Workers:

- Prior to project start-up, 40 hours of initial offsite Hazardous Waste Operations training and 3 days onsite training under the direct supervision of a more experienced site worker.

- Eight-Hour annual Hazardous Waste Operations refresher training (if >12 months have passed since 40-hour initial training or previous 8-hour refresher.

Site Manager, SSHO: Above requirements for site workers, plus one-time 8-Hour Supervisor's Training.

First Aid/CPR: At least two onsite workers must be currently certified in both first aid and CPR by the American Red Cross or equivalent organization. First aid training must be updated every 3 years; CPR training must be updated annually.

Pre-Entry Briefing: Site workers will read the SHERP and will indicate their understanding of the requirements by signing Attachment C, Site SHERP Review Record. The SSHO must check the training status of all onsite personnel and then brief workers on the potential hazards at the site and protective measures to be implemented, both prior to entry and daily during the work. An evacuation location to be used in the event of an emergency must be designated to all personnel. This location should be an upwind point from site activities, in an area not expected to be affected by emergency situations onsite. The SSHO must brief visitors prior to initial entry. Visitors are not permitted to enter areas where they may be exposed to hazardous substances if they do not meet the training requirements summarized above.

Subcontractor Training: Prior to the start of work operations, the CTO Manager must obtain a written list of subcontractor personnel to be present onsite, and written certification from the subcontractor management that these workers meet the training requirements summarized above.

Non-hazardous waste site workers will be trained to meet applicable OSHA requirements specific to their work. Training records and certification letters will be managed and maintained per the Program Management Plan.

TABLE 4 SITE WORKER TRAINING AND PHYSICAL EXAMINATION RECORD

SITE: Navy Fuel Farm Facility, NAS Willow Grove, Pennsylvania — CTO No. 0009

Project No.: 296.0009 — Task No.: 3130

NOTE: No employees other than those listed below are permitted to work onsite without prior written approval by the CTO Manager or SSHO.

Name	HAZWOPER		First Aid[1]	CPR[1]	Supervisor[2]	Last Medical Exam	Fit-Test[3]
	40-Hour Initial	Annual					
Michael Battle	06/13/89	01/21/93	---	---	02/01/91	02/11/93	06/12/89
John Carnright	01/18/91	11/13/92	---	---	03/14/90	10/15/92	11/13/92
Scott Dobson	06/11/90	04/30/93	01/08/93	01/08/93	01/04/91	09/21/92	04/06/92
William Parnella	10/20/88	04/30/93	01/10/93	01/08/93	09/05/90	10/25/93	---
Carl Reitenbach	01/12/90	04/30/93	04/16/93	01/08/93	09/05/90	10/08/92	04/30/93
Scott Swanson	01/12/90	10/22/92	---	---	12/04/90	10/29/92	11/05/91
Andrew Taylor	01/15/93	---	---	---	---	12/29/92	01/15/93
Jerry Weeks	11/03/89	10/22/92	---	01/08/93	01/04/91	07/16/93	---

1. At least two people onsite must have current certification in First Aid/CPR for all tasks.
2. At a minimum, the SSHO or site manager must have had supervisor's training.
3. When air-purifying respirators are required.

7. MEDICAL SURVEILLANCE

Hazardous waste site workers must have satisfactorily completed a comprehensive physical examination within 12 months prior to the start of site operations. Non-hazardous waste site workers will be medically examined to meet OSHA requirements specific to their job. The date of physical examination of each site worker will be recorded on Table 4. Subcontractors shall provide this information in writing to the CTO Manager for their workers onsite. Medical surveillance protocols for hazardous workers must comply with 29 CFR 1910.120. Records will be managed and maintained per the Program Management Program.

8. PERSONAL PROTECTIVE EQUIPMENT

Based on evaluation of the potential safety and health hazards (Section 5), the required initial levels of personal protective equipment (PPE) are presented in Table 5 for each work task. Upgrade and downgrade PPE levels are listed below:

Upgrade PPE Level C. Components: Steel toe/steel shank neoprene safety boots, poly-coated tyvek coveralls, latex inner gloves, nitrile or neoprene outer gloves, hard hat, full face air purifying respirator with organic vapor/HEPA cartridges.

Downgrade PPE Level: None

Only the SSHO can authorize an upgrade or downgrade in the PPE level worn onsite, using only those criteria presented in Section 9. Changes in PPE levels must be documented on Attachment D, along with the rationale for the PPE changes. When respirators are required, site workers must have been successfully fit-tested within one year prior to the start of work operations. Fit-test dates for all site workers are summarized in Table 4.

EA will furnish all employees with the appropriate PPE for work under this CTO. Subcontracted personnel will be required to supply their own appropriate PPE.

The SSHO will review appropriate procedures for donning and doffing PPE prior to the start of work tasks. PPE must be inspected by site workers prior to use and regularly during use. If any site worker experiences a failure or alteration of PPE that affects the level of protection offered, that person shall immediately leave the Exclusion Zone. Re-entry shall not be permitted until the equipment has been repaired or replaced.

9. ENVIRONMENTAL MONITORING

9.1 ENVIRONMENTAL MONITORING REQUIREMENTS

Task-specific environmental monitoring requirements for all site work (except pilot system performance related, which is not health related) are summarized in Table 3, including the type of monitoring to be performed, the frequency and location of monitoring, action levels,

TABLE 5 PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

SITE: Navy Fuel Farm Facility, NAS Willow Grove, Pennsylvania		CTO No. 0009
Project No.: 296.0009		Task No. 3130
Work Task	Initial Level of Protection	Specific PPE
Trenching; Drilling; Gauging; Pilot Plant Maintenance	D	Steel toe/steel shank safety boots, cotton coveralls, safety glasses, hard hat (drilling only), latex inner gloves, butyl/neoprene outer gloves*, faceshield (drilling operator only), hearing protection (during drilling only), tyvek coveralls (during pump maintenance)
Trenching; Drilling; Pump Maintenance	C	Steel toe/steel shank neoprene safety boots, polycoated tyvek coveralls, latex inner gloves, nitrile or neoprene outer gloves, hard hat, full face air purifying respirator with organic vapor/HEPA cartridges

* Work gloves may be worn during drilling. Butyl/Neoprene outer gloves and latex inner gloves are to be worn during pump maintenance and when contact with contaminated soil, free product, or ground water is imminent.

and required responses if action levels are detected. Only personnel trained in proper use and calibration may operate the monitoring instruments.

Measurements must be logged in the Environmental Monitoring Record provided as Attachment E. If no detectable levels are measured, this must be documented on Attachment E at least once every 30 minutes. Each exceedance of an action level must be documented on Attachment E, along with the corrective action/protective measure taken.

If a determination is made by the SSHO, based upon environmental monitoring and visible dust emissions, that full shift personnel or environmental monitoring is necessary, monitoring will be conducted according to NIOSH, OSHA, and EPA protocols. Visible dust in the breathing zone will require dust suppression or monitoring. If visible dust continues in the breathing zone after suppression is implemented, upgrade to Level C is required.

9.2 CALIBRATION OF MONITORING INSTRUMENTS

The calibration of each instrument must be checked at the beginning of each day of use and at least once during the day. The instrument must be recalibrated whenever it is turned "on" after being turned "off." The calibration procedures to be used for each instrument listed in Table 3 are provided in Attachment F.

10. SITE CONTROL

10.1 WORK ZONES

Work zones have been established as follows and shall be delineated on the site map/sketch. Conceptualized work zones are identified in Figure 4.

Exclusion (EZ): A 25-ft radius from any drilling, SVCA, or pumping test operation.

Contamination Reduction (CRZ): Delineated by the SSHO. All decontamination procedures must take place in the CRZ. There shall be only one access point between the EZ and CRZ.

Support Zone: EA vehicle

Personnel who enter any of the work zones must sign the Site Entry and Exit Log, Attachment G.

10.2 SAFE WORK PRACTICES

Safe work practices to be followed by site workers include:

- Eating, drinking, chewing gum or tobacco, and smoking are prohibited in the Exclusion and Contamination Reduction Zones.

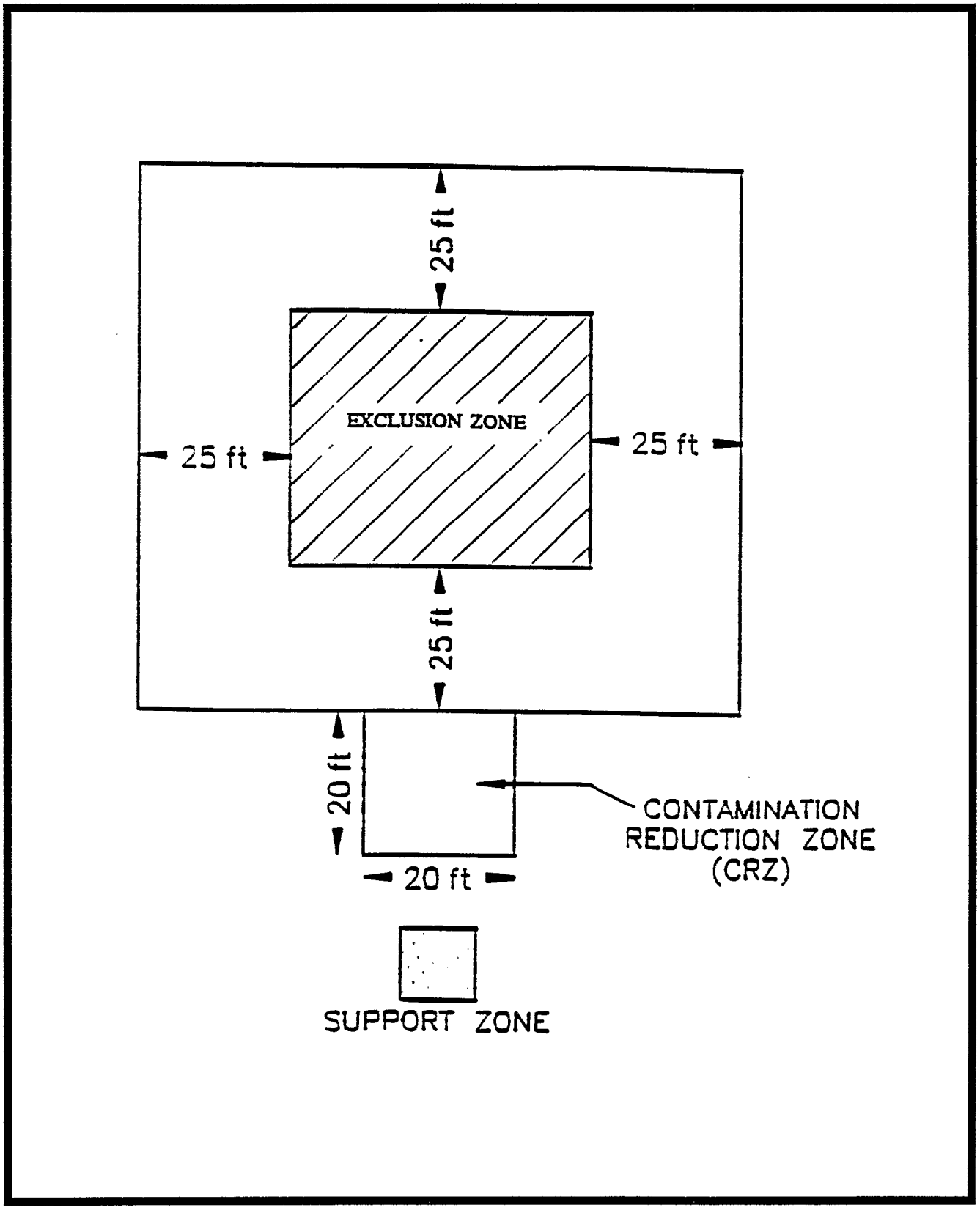

Figure 4. Work zones.

- Hands and face must be thoroughly washed upon leaving the work area.

- Prescription drugs must not be taken by personnel unless specifically approved by a licensed occupational physician who is familiar with the issues of worker exposure to hazardous materials.

- When respirators are required, facial hair that interferes with the face-to-facepiece fit of the respirator will not be permitted.

- Contact lenses will not be permitted to be worn in the Exclusion or Contamination Reduction Zones.

- Personnel onsite must use the buddy system; visual contact must be maintained between team members at all times.

- Work is allowed during daylight hours only.

- If dust is being visually generated in the Exclusion Zone, the SSHO will advise on procedures for misting or wetting the soil to prevent possible exposure from inhalation of soil contaminants.

- Possessing, using, purchasing, distributing, selling, or having controlled substances in your system during the work day, including meal or break periods onsite, is strictly prohibited.

- The use of possession of alcoholic beverages onsite is prohibited. Similarly, reporting to work or performing one's job assignments with excessive levels of alcohol in your system will not be permitted.

11. DECONTAMINATION PROCEDURES

11.1 PERSONNEL DECONTAMINATION

Remove and discard boot covers, if worn. Wash boots with detergent and water; rinse. Wash outer gloves with detergent and water; rinse; and remove. Remove coveralls, then respirator, if worn. Remove and discard inner gloves. Wash hands, face, and other exposed skin with soap and water. Shower and shampoo as soon as possible at the end of the work day, before dining or social activities. Place nondisposable coveralls in plastic bags prior to leaving the site and prior to entering any EA vehicle. Launder nondisposable clothing worn in the exclusion zone prior to reuse, separately from other laundry items.

11.2 EQUIPMENT DECONTAMINATION

Wet-wipe instruments used onsite with clean water prior to leaving the site. Wet-wipe respirator exteriors whenever exiting work areas. Clean respirators with a

manufacturer-recommended sanitizer, then hang to drip dry, and place in plastic bags for protection against dust. Change respirator cartridges at least daily, when breakthrough occurs, or when breathing resistance becomes high, whichever occurs first. Used cartridges shall be damaged to prevent accidental reuse.

11.3 VEHICULAR DECONTAMINATION

Vehicles that enter the exclusion zone must be decontaminated in the contaminant reduction zone. At a minimum, a thorough detergent and water wash is required. No visible soil shall remain on the exterior (including wheels) and the interior shall be wet wiped to remove visible dust and soil.

11.4 WASTE DISPOSAL PROCEDURES

Potentially contaminated materials and equipment must be disposed of properly. Clothing, tools, buckets, brushes, and all cleaning solutions and spoils must be secured in drums or other leak-proof containers and correctly labeled. It is projected that decontamination liquids will be run through the carbon canisters for the aquifer testing prior to discharge onto the ground.

12. EMERGENCY RESPONSE PLAN

Prior to work start-up, all personnel must be familiar with this Emergency Response Plan. The CTO Manager must make this plan available for inspection and copying by all subcontractors. Rehearsals of emergency procedures should be performed regularly as part of the ongoing site safety program. Review the location of evacuation areas and exit routes. Determine the location of the nearest operating telephone for emergency use.

EA site personnel must immediately stop work, evacuate the Exclusion Zone and report to the EA Site Manager under any of the following potential emergency situations:

- Injury to any EA or contractor personnel.
- Discovery of any unexpected chemical hazards.
- Any chemical release or spill.

12.1 PROCEDURES FOR HANDLING EMERGENCY INCIDENTS

In the event of an emergency, the information available at that time must be properly evaluated and the appropriate steps taken to implement the emergency response plan. The Site Manager (or SSHO if the Site Manager is part of the emergency) shall assume command of the situation. He/She must call the appropriate emergency services, evacuate personnel to the predesignated evacuation location as needed, and take other steps necessary to gain control over the emergency. Emergency telephone numbers, directions to the nearest hospital, and the location of the nearest telephone and other site communication equipment are presented in Table 6. Attachment H provides a site plan showing the location of the NAS Medical Clinic.

TABLE 6 EMERGENCY INFORMATION

SITE: Navy Fuel Farm Facility, NAS Willow Grove, Pennsylvania	CTO No. 0009
Project No.: 296.0009	Task No. 3130

ONSITE EMERGENCY CONTACTS

Nearest telephone: Mobile phone in EA vehicle

Other site communication equipment: None

Onsite Dialing Instructions

Calls Within NAS Willow Grove:	Dial 4-digit extension number.
Outside Calls:	Dial 9 then 7-digit number.
Long Distance Calls:	Dial 9, then 1 and area code, then 7-digit number.

Name	Phone Number
Police: Horsham Police Department	(215) 672-2800
NAS Security Police	6067/6068
Fire: NAS Fire Department	1333
Ambulance:	1600
Hospital: NAS Clinic Building 137 Hornet Road	6360

NOTE: Initial medical treatment will be provided by the NAS Clinic located near the main entrance gate (see attachment E). Should additional treatment be required, the NAS ambulance will transfer injured personnel to Abington Hospital or Warminster General Hospital.

OFFSITE EMERGENCY CONTACTS

NAVFAC Technical Manager: Paul Briegel	**(215) 595-0590**
EA CTO Manager: Michael Battle	(914) 565-8100 (work) (914) 896-8197 (home)
Program Safety and Health Officer: Kris Hoiem, CIH	(800) 876-4950 (work) (410) 357-5485 (home)
EA Medical Services: Name: Arden Hill Hospital Address: 4 Harriman Drive, Goshen, New York 10924	(914) 294-5441
EA Corporate Medical Director: Dr. Shirley Conibear	(312) 782-4486
In case of spill, contact Sam Morekas/EA	(800) 876-4950
In case of accident or exposure, contact the EA Human Resources representative within 24 hours: Cheryl MacDonald	(410) 584-7000
Site Manager: Carl Reitenbach	(410) 771-4950
SSHO: Scott Swanson/Andrew Taylor	(914) 565-8100

Give the following information when reporting an emergency:

1. Name and location of person reporting
2. Location of accident/incident
3. Name and affiliation of injured party
4. Description of injuries, fire, spill, or explosion
5. Status of medical aid and/or other emergency control efforts
6. Details of any chemicals involved
7. Summary of accident, including suspected cause and time it occurred
8. Temporary control measures taken to minimize further risk.

This information is not to be released under any circumstances to parties other than those listed in this section and emergency response team members. Once emergency response agencies have been notified, the EA CTO Manager and Safety and Health Manager must be notified immediately.

12.2 MEDICAL EMERGENCIES

Personnel should always be alert for signs and symptoms of illnesses related to chemical, physical, and disease factors onsite. Severe injuries resulting from accidents must be recognized as emergencies and treated as such. At least two personnel currently trained in first aid/CPR must be present onsite at all times.

In a medical emergency, the Site Manager (or the SSHO if the Site Manager is not available) must sound the emergency alarm, upon which work must stop and personnel must move to the decontamination area. Personnel currently trained in first aid will evaluate the nature of the injury, decontaminate the victim if the victim can be moved safely, and initiate first aid assistance immediately. First aid shall be administered as appropriate. The local Emergency Medical Services must be notified immediately if needed. Victims who are heavily contaminated with toxic or dangerous materials must be decontaminated before being transported from the site. No persons shall re-enter the Exclusion Zone until the cause of the injury or symptoms has been determined. A fellow EA worker must accompany injured workers to the hospital to inform the admitting clerk that the injury is work related and to assist in completing the insurance forms.

The Site Manager must complete an EA Accident Investigation Report (Attachment I) and submit it to the EA CTO Manager and Safety and Health Manager within 24 hours of the following types of incidents:

- Job-related injuries and illnesses.
- Accidents resulting in significant property damage.
- Accidents involving vehicles and/or vessels.

- Accidents in which there may have been no injury or property damage, but which have a high probability of recurring with at least a moderate risk to personnel or property.

- An accident which results in a fatality or the hospitalization of 5 or more employees must be reported within 24 hours to the U.S. Department of Labor via the EA Human Resources representative. Subcontractors are responsible for notification involving their employees.

First aid/emergency equipment is available at the following locations:

First Aid Kit:	EA vehicle
Eye Wash:	Contamination Reduction Zone
Shower:	NA
Fire Extinguisher (list type):	Type A,B,C; EA vehicle
Emergency Alarm:	Kept onsite with the SSHS
Other:	None

The eye wash kit must be portable and capable of supplying at least a 15-minute supply of potable water to the eyes.

12.3 FIRE/EXPLOSION EMERGENCIES

Any fire or explosion must be immediately recognized as an emergency. The Site Manager (or SSHO if the Site Manager is not available) must sound the emergency signal and personnel must be evacuated to the predesignated evacuation location and the local emergency services notified. Decontamination will take place once all personnel have been safely evacuated to the pre-designated evacuation location. Only persons properly trained in fire suppression, spill control, and other emergency response procedures should attempt to deal with these situations. Other than small fires or spills, local emergency response services must be notified to handle the emergency. The Site Manager should take measures to reduce injury and illness, primarily by evacuating personnel as quickly as possible. He/she must then notify the CTO Manager. Cleanup after such events may require specialized services. Work shall not resume until the SSHS declares the incident closed.

13. CONFINED SPACE ENTRY PROCEDURES

No confined space entry is permitted or anticipated under this CTO.

14. SPILL CONTAINMENT PROCEDURES

Small incidental spills, i.e., those that cause no injury to personnel or the public, should be cleaned up quickly. For large spills, i.e., those that contaminate personnel or the environment, attend to first aid measures first, stop the source of the spill if possible, then

notify the Program Manager and the Navy. The Site Manager (or the SSHO in his/her absence) will notify the CTO Manager as soon as possible. Spills of hazardous materials or wastes that are listed by EPA as having a reportable quantity value must be reported to appropriate federal, state, and local agencies if a reportable quantity or greater is released. It is the Navy's responsibility to contact other appropriate federal, state, and local agencies.

Attachment A

Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

LIQUID CARBONIC
SPECIALTY GAS CORPORATION
135 SOUTH LA SALLE STREET • CHICAGO, ILLINOIS 60603-4282
PHONE. (312) 855-2500

Gaseous Hydrogen

Revision Sept. 1987

Emergency Phone Numbers: (504)673-8831; CHEMTREC (800)424-9300

SECTION I--PRODUCT IDENTIFICATION

CHEMICAL NAME: Hydrogen
COMMON NAME AND SYNONYMS: Gaseous Hydrogen, Water Gas, Normal Hydrogen
CHEMICAL FAMILY: Inorganic Flammable Gas FORMULA: H_2

SECTION II--HAZARDOUS INGREDIENTS

MATERIAL	VOLUME %	CAS NO.	1986-7 ACGIH TLV UNITS
Hydrogen	99.9%	1333-74-0	A simple asphyxiant and has no TLV. OSHA PEL-None

SECTION III--PHYSICAL DATA

BOILING POINT (°F.) -423°F
SPECIFIC GRAVITY (H_2O=1) At 1 ATM. and B.Pt. -0.0710
VAPOR PRESSURE (mmHg.) (@-423) 760 % VOLATILE BY VOLUME N/A
VAPOR DENSITY (AIR=1) (@ 70°F) .070 EVAPORATION RATE
SOLUBILITY IN WATER @68°F 1.82% by Volume (BUTYL ACETATE=1) N/A
APPEARANCE AND ODOR Colorless and odorless

SECTION IV--FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED) Autoignition at 1975°F
FLAMMABLE LIMITS by Volume LEL-4.0% UEL-74.2%
EXTINGUISHING MEDIA: Water, carbon dioxide, dry chemical, Halon

SPECIAL FIRE FIGHTING PROCEDURES: If possible, stop the flow of hydrogen. Keep equipment cool with water spray. Hydrogen burns with almost an invisible flame. Ventilate area. Hydrogen is a very light gas and rises rapidly in air.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Danger of re-ignition and possible explosion. Hydrogen fire usually should not be extinguished until H_2 supply can be controlled or shut off. Hydrogen gas leaking from high pressure storage can ignite spontaneously.

SECTION V--HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: As a simple asphyxiant, requires an 18% by volume oxygen in air concentration at normal atmospheric pressure (135mm Hg partial pressure).

EFFECTS OF OVEREXPOSURE: Dizziness, unconsciousness, death. Persons in ill health where such illness would be aggravated by exposure to Gaseous Hydrogen should not be allowed to work with or handle this product.

EMERGENCY AND FIRST AID PROCEDURES: Quickly remove to fresh air. Obtain prompt medical attention. Avoid ignition and be cognizant of extreme fire and explosion hazard. Rescue personnel should wear self-contained breathing apparatus. Provide oxygen and artificial respiration if necessary.
ROUTE(S) OF ENTRY: INHALATION? Yes SKIN? No INGESTION? No
CARCINOGENICITY: NTP? No IARC MONOGRAPHS? No OSHA? No

SECTION VI--REACTIVITY DATA

STABILITY: UNSTABLE ( ) STABLE (X)
CONDITIONS TO AVOID: Sources of ignition, sparks, flames, hot surfaces
INCOMPATIBILITY (MATERIALS TO AVOID): Oxidizers
HAZARDOUS DECOMPOSITION PRODUCTS: None
HAZARDOUS POLYMERIZATION: MAY OCCUR ( ) WON'T OCCUR (X)
CONDITIONS TO AVOID: N/A

SECTION VII--SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Evacuate all personnel from affected area. Do not enter areas containing flammable mixture of hydrogen and air. Ventilate area to prevent formation of flammable or oxygen deficient atmosphere. Eliminate all potential sources of ignition.

WASTE DISPOSAL METHOD: Hydrogen is slowly burned off or allowed to be vented and diffused slowly into the atmosphere as long as flammable mixtures, fires, or explosions are safely avoided in a remote outside area. Follow any applicable local, state and Federal regulations.

SECTION VIII--SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION: Positive pressure air mask or self-contained breathing apparatus.
VENTILATION: LOCAL EXHAUST (X) Avoid flammable or explosive mixtures by adequate ventilation - Ventilate roof areas.
MECHANICAL (GENERAL) ( )
PROTECTIVE GLOVES: Cotton or leather. EYE PROTECTION: Safety goggles or glasses
OTHER PROTECTIVE EQUIPMENT: Safety shoes; Air monitoring for 0-4% hydrogen detection may be necessary.

SECTION IX--SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Protect cylinders from physical damage. Store in well ventilated cool, dry area. "No Smoking or Open Flame" signs should be posted. No oxidizers or corrosives should be in area. No sources of ignition, sparks, flames, or hot surfaces should be in storage or use area. Cylinders should not be exposed to temperatures over 130°F. Major hydrogen equipment and piping should be purged with nitrogen before use to remove air and oxygen.

OTHER PRECAUTIONS: Electrically ground all piping and equipment. Electrical equipment shall be explosion and spark proof. Small H_2 leaks may be invisible. Must take care to prevent leaks. Refer to CGA Bulletin SB-2 "Oxygen Deficient Atmospheres"; CGA Pamphlet G-5, " Hydrogen" and P-1 "Safe Handling of Compressed Gases in Containers"; P-14 "Accident Prevention Oxygen-Rich and Oxygen-Deficient Atmospheres."

Use a check valve or trap on hydrogen cylinder discharge line to prevent hazardous backflow. Cylinders must not be recharged except by or with consent of Liquid Carbonic.

No guaranty is made as to the accuracy of any data or statement contained herein. While this material is furnished in good faith, NO WARRANTY EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE IS MADE. This material is offered only for your consideration, investigation and verification and Liquid Carbonic shall not in any [illegible] for special, incidental or consequential damages in connection with its publication.

American Burdick & Jackson
Material Safety Data Sheet

MATERIAL SAFETY DATA SHEET

METHANOL

emergency telephone no. 312/973-3600 (American Scientific Products)
chemtrec telephone no. 800/424-9300
information telephone no. 616/726-3171 (American Burdick & Jackson)

I. Identification

chemical name Methanol — molecular weight 32.04
chemical family Alcohol — formula CH_4O
synonyms Carbinol, Methyl Alcohol, Wood Alcohol
DOT proper shipping name Methyl Alcohol or Methanol
DOT hazard class Flammable Liquid
DOT identification no. UN1230 — CAS no. 67-56-1

II. Physical and Chemical Data

boiling point, 760mm Hg. 64.7°C — freezing point -97.7°C — evaporation rate (BuAc=1) ca 5
vapor pressure at 20°C 97 mm Hg — vapor density (air = 1) 1.11 — solubility in water @ 20°C complete
% volatiles by volume ca 100 — specific gravity (H_2O = 1) @ 20°C 0.792 — stability Stable
hazardous polymerization Not expected to occur.
appearance and odor A clear, colorless liquid with a slight alcoholic odor.
conditions to avoid Heat, sparks, open flame, open containers, and poor ventilation.

materials to avoid Strong oxidizing agents and reactive metals which will displace hydrogen.

hazardous decomposition products Incomplete combustion can generate carbon monoxide and other toxi vapors such as formaldehyde.

III. Fire and Explosion Hazard Data

flash point, (test method) 12°C (Tag closed cup) — auto ignition temperature 385°C
flammable limits in air % by volume: lower limit 6.0 — upper limit 36.5
unusual fire and explosion hazards May burn with an invisible flame. Mixtures with water as low as 21% by volume are still flammable (flash point below 37.8°C). Under som circumstances can corrode certain metals, including aluminum and zinc, and generate hydrogen gas.
extinguishing media Carbon dioxide, dry chemical, alcohol foam, water mist or fog.

special fire fighting procedures Wear full protective clothing and self-contained breathing apparatus. Heat will build pressure and may rupture closed storage containers. Keep fire-exposed containers cool with water spray.

IV. Hazardous Components

	%	TLV	CAS no.
Methanol	ca 100	200 ppm	67-56-1

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American Burdick & Jackson
Subsidiary of American Hospital Supply Corporation
1953 South Harvey Street
Muskegon MI 49442

V. Health Hazards

Occupational Exposure Limits

OSHA	8-hour PEL	-	200 ppm
	Ceiling	-	not listed
	Peak	-	not listed
ACGIH	TLV-TWA	-	200 ppm
	TLV-STEL (15-min)	-	250 ppm
NIOSH	TLV-TWA	-	200 ppm
	TLV-C	-	800 ppm

Concentration Immediately Dangerous to Health

OSHA/NIOSH	25,000 ppm

Odor Threshold

NSC & OHS	10 ppm
NIOSH	2000 ppm

Carcinogenic, Mutagenic, Teratogenic Data

Positive mutagen (RTEC).

Primary Routes of Entry

Methanol may exert its effects through inhalation, skin absorption, and ingestion.

Industrial Exposure: Route of Exposure/Signs and Symptoms

Inhalation: Exposure can cause drowsiness and intoxication, headache, visual disturbance leading to blindness, coughing and shortness of breath, collapse and death at high concentrations.

Eye Contact: Liquid can cause moderate burning, watering, swelling, and redness; high vapor concentration (greater than 2000 ppm) may cause same symptoms.

Skin Contact: This substance may be absorbed through intact skin and produce toxic effects. Extensive, repeated and/or prolonged skin contact can cause burning, itching, redness, or blisters.

Ingestion: Causes burning of the gastrointestinal tract and toxic effects. Swallowing more than 2 ounces of methanol can cause death.

Effects of Overexposure

Mild poisoning is characterized by fatigue, nausea, headache, and delayed visual blurring. Moderate intoxication results in severe depression. Temporary or permanent blindness may follow in 2-6 days. In severe poisoning, symptoms progress to rapid, shallow respiration, cyanosis, coma, hypotension, dilated pupils, and visual disturbance. Death may result from respiratory failure.

Medical Condition Aggravated by Exposure

Preclude from exposure those individuals with diseases of eyes, liver, kidneys, and lungs.

Emergency First Aid

Inhalation: Immediately remove to fresh air. If not breathing, administer mouth-to-mouth rescue breathing. If there is no pulse administer cardiopulmonary resuscitation (CPR). Contact physician immediately.

Eye Contact: Rinse with copious amounts of water for at least 15 minutes. Get emergency medical assistance.

Skin Contact: Flush thoroughly for at least 15 minutes. Wash affected skin with soap and water. Remove contaminated clothing and shoes. Wash clothing before re-use, and discard contaminated shoes. Get emergency medical assistance.

Ingestion: Call local Poison Control Center for assistance. Contact physician immediately. Never induce vomiting or give anything by mouth to a victim unconscious or having convulsions.

Note to Physician

In case of ingestion or massive inhalation, observe victim as an inpatient because slow metabolism causes a latent period of 24 hours between exposure and acidosis and blindness.

VI. Safety Measures and Equipment

Ventilation: Adequate ventilation is required to protect personnel from exposure to chemical vapors exceeding the PEL and to minimize fire hazards. The choice of ventilation equipment, either local or general, will depend on the conditions of use, quantity of material, and other operating parameters.

Respiratory: Use approved respirator equipment. Follow NIOSH and equipment manufacturer's recommendations to determine appropriate equipment (air-purifying, air-supplied, or self-contained breathing apparatus).

Eyes: Safety glasses are considered minimum protection. Goggles or face shield may be necessary depending on quantity of material and conditions of use.

Skin: Protective gloves and clothing are recommended. The choice of material must be based on chemical resistance and other user requirements. Generally, neoprene or rubber offers acceptable chemical resistance. Individuals who are acutely and specifically sensitive to methanol may require additional protective equipment.

Storage: Methanol should be protected from temperature extremes and direct sunlight. Proper storage of methanol must be determined based on other materials stored and their hazards and potential chemical incompatibility. In general, methanol should be stored in an acceptably protected and secure flammable liquid storage room.

Other: Emergency eye wash fountains and safety showers should be available in the vicinity of any potential exposure. Ground and bond metal containers to minimize static sparks.

VII. Spill and Disposal Data

Spill Control: Protect from ignition. Wear protective clothing and use approved respirator equipment. Absorb spilled material in an absorbent recommended for solvent spills and remove to a safe location for disposal by approved methods. If released to the environment, comply with all regulatory notification requirements.

Waste Disposal: Dispose of methanol as an EPA hazardous waste. Hazardous waste numbers: U154 (Ignitable); D001 (Ignitable).

Revision Date: 1/85

KEY

ca	Approximately	STEL	Short Term Exposure Level
na	Not applicable	TLV	Threshold Limit Value
C	Ceiling	TWA	Time Weighted Average
PEL	Permissable Exposure Level	BuAc	Butyl Acetate

NSC National Safety Council ("Fundamentals of Industrial Hygiene", 1983)
OHS Occupational Health Services ("Hazardline")

100543

Scott Specialty Gases
ROUTE 611 NORTH, PLUMSTEADVILLE, PA 18949 (215) 766-8861

SCIENTIFIC GAS PRODUCTS
2330 HAMILTON BOULEVARD, P.O. BOX 648, SOUTH PLAINFIELD, N.J. 07080 (201) 754-7700
TELEX 844-552 SGP INC SPFD

REGIONAL PHONE NUMBERS

PA (215) 766-8861	CA (714) 887-2571	MI (313) 589-2950	TX (713) 644-4820
NJ (201) 754-7700	CA (415) 659-0162	CO (303) 442-4700	MA (617) 245-8707

MATERIAL SAFETY DATA SHEET

SECTION I - MATERIAL IDENTIFICATION

CHEMICAL NAME: n-Hexane

CHEMICAL FORMULA: C_6H_{14}

CHEMICAL FAMILY: Hydrocarbon

SUPPLIER: Scott Specialty Gases

ADDRESS: Route 611 North
Plumsteadville, PA 189

IN CASE OF EMERGENCY CONTACT YOUR REGIONAL PLANT MANAGER

OTHER DESIGNATION: CAS #100-54-3

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT	CONCENTRATION	TLV
n-Hexane	≈100%	50 ppm

SECTION III - PHYSICAL DATA

BOILING POINT (°F): 152-156°F

VAPOR PRESSURE @60°F: 100 mm Hg

VAPOR DENSITY (AIR = 1): 3

SOLUBILITY IN WATER: Insoluble

SPECIFIC GRAVITY (H_2O = 1) @20°C: 0

PERCENT, VOLATILE BY VOLUME (%): 1

EVAPORATION RATE
(_____=1): N/A

APPEARANCE AND ODOR: Clear, colorless

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT AND METHOD	FLAMMABLE LIMITS	LEL	UEL
<0°F (CC)	Vol. %	1.2%	7.5%

EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, foam.

DISCLAIMER: The information in this Material Safety Data Sheet is offered without charge for use by technically qualified personnel at their discretion and risk. Scott Specialty Gases has made this sheet available with data which we believe is reliable, but the accuracy and completeness of the data is not guaranteed and no warranty is either expressed or implied. Since Scott Specialty Gases has no control over the use of this product described herein, we assume no liability for loss or damage incurred from the proper or improper use of such product. This form is essentially similar to U.S. Department of Labor form OSHA-20.

SPECIAL FIRE FIGHTING PROCEDURES: Use water spray to cool fire exposed cylinders.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Dangerous fire and explosion hazard when heated.

SECTION V - REACTIVITY DATA

STABILITY: Compound is stable in closed containers at room temperature.

INCOMPATABILITY (MATERIALS TO AVOID): Oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal oxidative degradation may form carbon monoxide.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VI - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: 50 ppm 8 hr. TWA.

EFFECTS OF OVER EXPOSURE: Vapor inhalation can cause upper respiratory tract irritation and central nervous system depression. Symptoms can include dizziness, numbness of extremities, giddiness and intoxication. Prolonged exposure at high concentrations may lead to nerve damage. The liquid is a defatting agent. Ingestion will cause irritation of gastro intestinal tract.

EMERGENCY AND FIRST AID PROCEDURES: Inhalation - Remove victim to fresh air; restore and/or support breathing as necessary. Skin contact - Wash effected area immediately with water. Remove contaminated clothing. Replace skin oils with a lotion or cream. Eye contact - Flush with water for at least 15 minutes. Ingestion - Consult a physician. Do not induce vomiting.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Ventilate the area and remove all sources of heat and ignition. Absorb small spills using a solid absorbent such as vermiculite. Flush hexane away from sensitive areas with water (cold). Flush to ground, not sewer.

WASTE DISPOSAL METHOD: For disposal - follow all federal, state and local regulations. Waste can be burned in an approved incinerator.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE): A self-contained breathing apparatus should be available in case of emergency or non-routine use.

VENTILATION: Provide adequate general and local exhaust ventilation to meet TLV requirements. Ventilation must be explosion proof.

OTHER PROTECTIVE EQUIPMENT: Wear protective gloves, goggles and clothi when liquid contact is possible. Safety shower and eyewash station should be available.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Store in a well ventilated area away from heat, sources of ignition and oxidizing agents. Use metal safety cans for handling small amounts. Store and handle as a OSHA Class IB flammable liquid.

OTHER PRECAUTIONS: Protect containers from physical damage.

100543

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ROUTE 611 NORTH, PLUMSTEADVILLE, PA 18949 (215) 766-8861

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OTHER DESIGNATION: CAS #100-54-3

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT	CONCENTRATION	TLV
n-Hexane	≈100%	50 ppm

SECTION III - PHYSICAL DATA

BOILING POINT (°F): 152-156°F

SPECIFIC GRAVITY (H_2O = 1) @20°C: 0.6

VAPOR PRESSURE @60°F: 100 mm Hg

PERCENT, VOLATILE BY VOLUME (%): 100

VAPOR DENSITY (AIR = 1): 3

EVAPORATION RATE (_____=1): N/A

SOLUBILITY IN WATER: Insoluble

APPEARANCE AND ODOR: Clear, colorless

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT AND METHOD	FLAMMABLE LIMITS Vol. %	LEL	UEL
<0°F (CC)		1.2%	7.5%

EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, foam.

DISCLAIMER: The information in this Material Safety Data Sheet is offered without charge for use by technically qualified personnel at their discretion and risk. Scott Specialty Gases has made this sheet available with data which we believe is reliable, but the accuracy and completeness of the data is not guaranteed and no warranty is either expressed or implied. Since Scott Specialty Gases has no control over the use of this product described herein, we assume no liability for loss or damage incurred from the proper or improper use of such product. This form is essentially similar to U.S. Department of Labor form OSHA-20.

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UNUSUAL FIRE AND EXPLOSION HAZARDS: Dangerous fire and explosion hazard when heated.

SECTION V - REACTIVITY DATA

STABILITY: Compound is stable in closed containers at room temperature.

INCOMPATABILITY (MATERIALS TO AVOID): Oxidizing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal oxidative degradation may form carbon monoxide.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VI - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: 50 ppm 8 hr. TWA.

EFFECTS OF OVER EXPOSURE: Vapor inhalation can cause upper respiratory tract irritation and central nervous system depression. Symptoms can include dizziness, numbness of extremities, giddiness and intoxication. Prolonged exposure at high concentrations may lead to nerve damage. The liquid is a defatting agent. Ingestion will cause irritation of gastro intestinal tract.

EMERGENCY AND FIRST AID PROCEDURES: Inhalation - Remove victim to fresh air; restore and/or support breathing as necessary. Skin contact - Wash effected area immediately with water. Remove contaminated clothing. Replace skin oils with a lotion or cream. Eye contact - Flush with water for at least 15 minutes. Ingestion - Consult a physician. Do not induce vomiting.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Ventilate the area and remove all sources of heat and ignition. Absorb small spills using a solid absorbent such as vermiculite. Flush hexane away from sensitive areas with water (cold). Flush to ground, not sewer.

WASTE DISPOSAL METHOD: For disposal - follow all federal, state and local regulations. Waste can be burned in an approved incinerator.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE): A self-contained breathing apparatus should be available in case of emergency or non-routine use.

VENTILATION: Provide adequate general and local exhaust ventilation to meet TLV requirements. Ventilation must be explosion proof.

Attachment B

Physical Hazard Information Sheets

PHYSICAL HAZARD INFORMATION SHEET: COLD STRESS

Cold stress hazards are most likely to occur at low temperatures or low wind chill factors, with wet, windy conditions also contributing to risks. All personnel should be familiar with cold stress symptoms, which include:

- **Hypothermia**—Cold-induced decreasing of the core body temperature that produces shivering, numbness, drowsiness, and muscular weakness. If severe enough, it can lead to unconsciousness and death.

- **Frostbite**—Constriction of blood vessels in the extremities, decreasing the supply of warming blood. May result in formation of ice crystals in the tissues, causing tissue damage. Condition may range from frostnip which is a numbing of extremities, to deep-freezing tissue beneath the skin. Symptoms include white or grayish skin, blisters, numbness, mental confusion, failing eyesight, fainting, shock, and cessation of breathing. Death may occur from heart failure.

Pain in the extremities may be the first warning of cold stress, and precautions (see below) should be taken to reduce exposure. Maximum severe shivering must be taken as a sign of immediate danger to the worker, and exposure to cold must be immediately terminated. Personnel exhibiting signs and symptoms of cold stress must be removed from the site, decontaminated, and given appropriate first aid. Emergency medical services must be contacted if symptoms are severe (e.g., more than numbness of the extremities or shivering). When air temperatures are less than 36 F (including wind chill), workers who become immersed in water or whose clothing becomes wet must be immediately provided a change of clothing and be treated for hypothermia.

To prevent cold stress when air temperature is less than 40 F (including wind chill), personnel should wear layers of loose-fitting clothing including insulated coveralls, head covering, and boots. Protection of the hands, feet, and head is particularly important because these are likely to be injured first by cold. However, actual injury to hands, feet, and head is not likely to occur without prior development of early signs of hypothermia such as numbing and shivering. Bare skin contact with cold surfaces (below 20 F) must be avoided. Personnel should wear wind-resistant outer shell to decrease wind chill effects. No continuous exposure to cold is permitted when the air speed and temperature results in an equivalent chill temperature of 26 F or less.

A temperature-dependent work regimen limiting lengthy periods of outdoor activity may be necessary. Workers entering heated shelters should remove the outer layer of clothing and loosen remaining clothing to permit sweat evaporation. Dehydration must be avoided by drinking warm drinks or soups.

PHYSICAL HAZARD INFORMATION SHEET: GENERAL PHYSICAL HAZARDS

Hazardous waste and other field operation sites include many basic safety hazards, such as:

- Holes, ditches, etc., posing fall, cave-in, and other hazards
- Precariously positioned objects, which may cause crushing or other injuries
- Sharp objects (e.g., nails, metal shards, glass) which may cause cuts, injection, or other injuries
- Slippery surfaces, posing slip and fall hazards
- Steep grades and/or uneven terrain, posing slip, trip, and fall hazards
- Unstable surfaces (e.g., walls that may cave in, unstable underground structures) which may pose fall, crushing, or other injuries.

Basic safety hazards can directly injure workers and create additional hazards. For example, a person may trip due to uneven terrain, fall and be cut on rusty metal shards, and become inoculated with contaminants adhering to the metal.

Site personnel should look constantly, closely, and carefully for these basic safety hazards and immediately inform the SHSO of any conditions that they feel may be hazardous.

PHYSICAL HAZARD INFORMATION SHEET: HEAVY EQUIPMENT HAZARDS

The use of heavy equipment (e.g., backhoes, dump trucks, generators, compressors, etc.) may pose a variety of safety and health hazards to site workers.

All heavy equipment work must be conducted only by trained, experienced personnel. Equipment backing up, swinging loads, buckets, booms, and counter-weights pose serious hazards to ground personnel. If possible, EA personnel must remain outside the turning radius of any large, moving equipment. At a minimum, EA personnel must maintain visual contact with the equipment operator when the equipment is active.

No EA personnel are permitted to work underneath heavy equipment, because this practice poses serious crushing hazards.

Belts, pulleys, sheaves, gears, chains, shafts, clutches, drums, flywheels, and other moving parts of equipment can pose injury hazards. No guard, safety appliance, or other device may be removed or made ineffective unless repairs or maintenance are required, and then only after power has been shut off and locked out. Safety devices must be replaced once repair/maintenance is complete.

Exhaust from all equipment powered by steam or combustion engines must be properly located so that release of exhaust does not endanger workers or obstruct the view of the operator. Gasoline-operated equipment must be refueled properly to prevent fire hazards; power must be off, no smoking allowed, and proper dispensing equipment must be used.

When not operational, equipment shall be set and locked so that it cannot be activated, released, dropped, etc. Backhoe buckets must be lowered to the ground.

Site-Specific Hazards and Protective Measures:

_____

_____

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_____

PHYSICAL HAZARD INFORMATION SHEET: ELECTRICAL HAZARDS

Overhead power lines, electrical wiring, electrical equipment, and buried cables pose risks to workers of electric shock, burns, muscle twitches, heart fibrillation, and other physical injuries, as well as fire and explosion hazards. In accordance with OSHA's standard for Electrical Safety-Related Work Practices (29 CFR 1910.331-.335), protective measures must be taken when working near live electrical parts, including but not limited to:

- Insulation and guarding of life parts
- Grounding
- De-energizing live parts followed by lockout/tagout to prevent inadvertent reactivation of the parts
- Electric protective devices (e.g., insulated tools)
- Safe work practices, including:
  - Inspection of work area to identify potential spark sources
  - Maintenance of a safe distance from all live electrical parts
  - Proper illumination of work areas
  - No "blind reaching" around live electrical equipment
  - Provision of barriers, shields, or insulation to prevent inadvertent contact with live parts
  - Use of non-conductive, intrinsically safe equipment near live parts.

Overhead lines pose electrical hazards at many sites, particularly for work involving the use of equipment with elevated parts (e.g., drill rigs, backhoes). If overhead lines cannot be de-energized prior to the start of work, the following minimum distances must be maintained between the lines and both site workers and the longest conductive object present (including vehicles with elevated structural parts:

- 10 ft from overhead lines with voltage of 50 kV or less.
- 10 ft plus 4 in. for every 10 kV over 50 kV for overhead lines with voltages greater than 50 kV. For example, the minimum distance that must be maintained from a 250 kV line is 16.5 ft.

EA personnel are not permitted to work on electric parts of equipment that have not been de-energized, locked out, and tagged by personnel trained to work with electrical equipment. No EA employee may work near energized exposed live parts without the use of any protective measures. Personal protective equipment designed to protect against electrical hazards may be specified for certain work operations. The Project Manager is responsible

for ensuring that appropriate safety measures are implemented to protect against electrical safety hazards on their sites.

Lightning is a hazard during outdoor operations, particularly for workers handling metal equipment. To eliminate this hazard, weather conditions should be monitored and work suspended at the discretion of the SHSO during electrical storms.

Site-Specific Hazards and Protective Measures:

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PHYSICAL HAZARD INFORMATION SHEET: UNDERGROUND UTILITIES

Underground utilities pose hazardous to workers involved in drilling, excavation, soil vapor contaminant analysis, and other invasive operations. These hazards include electrical hazards, explosion, and asphyxiation, as well as costly and annoying hazards associated with damaging communication, sewer, water, and/or irrigation lines.

The estimated location of underground installations, including sewer, telephone, fuel, electric, water lines, or other underground installations that reasonably may be expected to be encountered during invasive work shall be determined prior to the start of any invasive work. This may be determined by contacting appropriate utilities, contacting a utility clearance service, using site maps and prominent site features, using a pipe and cable locator, etc. Buried utilities encountered during invasive operations must be protected while digging to prevent risks to site personnel and damage to the utilities.

Site-Specific Hazards and Protective Measures: Drilling/trenching operations must be cleared prior to initiation.

PHYSICAL HAZARD INFORMATION SHEET: FIRE/EXPLOSION HAZARDS

Explosion and fire hazards may be present at various sites due to ignition of chemicals, agitation of shock-sensitive compounds, the sudden release of materials under pressure, etc. All site operations must be conducted in accordance with local fire codes and regulations. Continuous monitoring for combustible gases is required at sites where such gases may be present during spark-generating operations. Fire extinguishers and other fire-fighting provisions may also be necessary. Site personnel must be trained in the use of such fire-fighting equipment prior to the start of work operations. Site-specific requirements for monitoring and fire emergency equipment must be specified in the SHERP.

Site-Specific Hazards and Protective Measures:

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PHYSICAL HAZARD INFORMATION SHEET: NOISE HAZARDS

Work around large equipment often creates excessive noise. The effects of noise can include:

- Workers being startled, annoyed, or distracted
- Physical damage to the ear, pain, and temporary and/or permanent hearing loss
- Communication interference that may increase potential hazards due to the inability to warn of danger and provide for proper safety precautions to be taken.

If workers are subjected to noise exceeding an 8-hour time-weighted average (TWA) sound level of 85 decibels on the A-weighted scale (dBA), feasible administrative or engineering controls shall be instituted to reduce noise levels to or below the permissible values. All personnel exposed to excessive noise levels shall be provided with and shall wear a hearing protection device which effectively protects the workers. OSHA regulations on noise can be found in 29 CFR Part 1910.95.

Site-Specific Hazards and Protective Measures:

_____

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PHYSICAL HAZARD INFORMATION SHEET: BIOLOGICAL HAZARDS

Insect Bites/Stings

Protective outer clothing such as gloves, hard hats, and coveralls can help reduce the potential for insect bites and stings. Insect bite symptoms include redness, rash, swelling, chills, fever, diarrhea, and vomiting. Any worker who has been bit or stung and shows symptoms of a severe reaction should seek medical assistance immediately. Workers who know of any allergies they may have to any insects must advise their employer prior to engaging in any field activities and may want to carry antidote kits.

To prevent contact with disease-carrying ticks, wear long-sleeved shirts, long pants, and boots that extend above the ankle with socks pulled over pants cuffs. Permanone insecticide may be used to kill disease-bearing ticks and may be sprayed only on the outside of clothing (not directly on skin). Frequently check clothing, skin, and hair for the presence of ticks at the end of the work day. If a tick attaches to the body, remove by gently tugging with tweezers where the mouth parts enter the skin. Do not kill the tick prior to removal.

Poisonous Plants

Poisonous plants such as poison ivy may be present on certain sites during part of the year. Know how to recognize these plants and avoid contact. If contact occurs, wash affected areas with soap and water immediately.

Snakes/Rodents

On occasion, field workers may come into contact with snakes and/or rodents (rats, gophers, etc.). In case of a snake bite, which can be fatal, workers must immediately seek medical assistance and report the incident to the SSHS and Site Manager, according to the procedures delineated in the SHERP. Prompt medical attention is also required for rodent bites since many rodents carry rabies and other diseases. Field workers must report rodent bites to the SSHS and Site Manager immediately according to SHERP requirements.

Site-Specific Hazards and Protective Measures: Biological hazards are expected to be minimal due to the time of the year for most of the planned activities. However, workers should keep as much skin as possible covered to protect against bites, stings, etc.

PHYSICAL HAZARD INFORMATION SHEET: MATERIAL HANDLING/MOVING/LIFTING

Improper materials handling accounts for a large number of occupational injuries. Materials handling at hazardous waste sites can vary from heavy equipment handling to manually handling items. Hazards associated with materials handling include physical injury, detonation, fire, explosion, and vapor generation.

When using equipment to move materials, proper work practices must be followed. Equipment used must be designed for the task to be performed. Equipment must be inspected regularly by the SSHO and the Site Manager, and damaged or defective equipment must be removed from service. Planning is critical when handling materials. The Site Manager, in conjunction with the CTO Manager, must plan where the materials are to be moved, taking into consideration the current location of such materials and hazards associated with moving them. Routes for moving materials must be clearly outlined, with paths cleaned of all obstructions so materials may be transported.

Injuries to the back and abdominal muscles from improper lifting of loads is one of the most common occupational injuries reported. Such injuries can range from relatively mild strains to major permanently disabling injuries. Before lifting any load, personnel should consider the overall weight, distribution of weight, unwieldiness or awkwardness of the load, distance to be carried, obstacles to be negotiated, site conditions, and visibility. Loads should be inspected for slivers, sharp edges, slippery surfaces, etc. prior to lifting.

Loads should be lifted using the power of the leg muscles rather than the back, stomach, or arm muscles. Approach the item to balance the load evenly. Never bend over when lifting. The back should be kept straight and the arms nearly parallel with the body. The knees should be bent to grasp the load. Lifting should be done by straightening the legs, holding the load as close to the body as possible, and the back remaining as straight as possible.

Bulky, heavy loads should be handled by at least two people, ensuring that the load is level and evenly distributed between all personnel helping to carry it. All carriers should know the destination and path for the load.

Site-Specific Hazards and Protective Measures:

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_____

_____

_____

PHYSICAL HAZARD INFORMATION SHEET: DRILLING

The selection of locations for each drilling activity site will take into account buried utility pipes, wires, conduits, and tanks, or other potentially dangerous structures. Overhead power lines and obstructions will also be surveyed. Prior to raising the mast, the area overhead and surrounding the rig will be checked by the drilling foreman and the SSHO. The longest conductive object on the drill rig will be located with a minimum of 10-ft clearance from overhead lines with voltages less than or equal to 50 kV. For lines with voltages exceeding 50 kV, the longest drill rig object must be at least 10 ft plus 4 in. for every 10 kV over 50 kV (e.g., for 250 kV line, clearance must be at least 16.7 ft). The client will inform EA of the voltages of any overhead lines in the vicinity of drilling operations.

When rotary drilling/sampling, drill rods will not be racked more than 1.5 times the height of the mast. During drilling operations and rig setup and takedown, all persons who enter the Exclusion Zone will wear hard hats, safety shoes/boots, and safety glasses/face shields to protect personnel from the physical hazards.

If during drilling there is any indication that underground tanks, drums, or other containers are being encountered, the drilling will be halted immediately and the SSHO shall notify the Program Safety and Health Officer. Indications that a waste container may have been encountered include: (1) change in the speed or momentum of the auger, (2) visual examination of auger cuttings, (3) odor noted in the cuttings, and/or (4) the presence of airborne total volatile organics as measured with a direct-reading instrument.

Work around drilling equipment also involves basic safety hazards (e.g., snapping cables, slings, ropes, moving heavy equipment, slip and trip hazards, etc.). Accidents may include head injuries from falling tools and equipment, hand and feet injuries due to moving equipment, and crushing injuries from unstable equipment or careless moving of equipment. If possible, EA personnel must remain outside the turning radius of any large moving equipment. If this is not feasible then, at a minimum, EA personnel must maintain visual contact with the equipment operator at all times when equipment is active.

PHYSICAL HAZARD INFORMATION SHEET: TRENCHING AND EXCAVATION HAZARDS

Open excavations and trenches pose a variety of hazards to site workers and equipment working near or inside them, including cave-in hazards (worsened by water accumulation in some excavations), contact with underground utilities, vehicle and pedestrian traffic hazards (see Physical Hazard Information Sheet), dangers from falling loads, hazardous atmospheres inside and emitted from excavations (see Chemical Hazards section of SHERP); stability of adjacent structures, and loose rock and soil. OSHA's standard for Excavations (29 CFR 1926.650-.652) must be enforced at excavation sites.

Personnel are not permitted underneath loads being removed from an excavation. When mobile equipment is operated adjacent to an excavation, or must approach the edge of an excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. Where the stability of adjacent building walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

Entry into Excavations—**No site personnel are permitted to enter excavations without written permission of the EA Corporate Safety and Health Officer or his/her designee.** Excavations must be inspected by a registered professional engineer prior to anyone entering an excavation. The PE must document his/her findings, including assumptions used in determining that the excavation is safe for entry and the conditions required for safe entry. If deemed necessary by the professional engineer, protective systems (e.g., sloping, benching, and supports/shields) must be designed by a professional engineer according to the requirements of 29 CFR 1926.652 and implemented prior to personnel entering the excavation. Excavations must also be inspected daily by the SSHS and the Site Manager to ensure that safe conditions documented by the professional engineer remain intact and to identify potentially hazardous situations. Prior to personnel entering any excavation, access/egress methods must be investigated and implemented, including provisions for emergency exits from excavations. Loose rock and soil which could fall and injure personnel entering excavations must be removed or otherwise stabilized prior to entry. Personnel shall not work in excavations in which water has accumulated or is accumulating.

Site-Specific Hazards and Protective Measures:

_____

_____

_____

_____

_____

Attachment C

Site Safety, Health, and Emergency Response Plan Review Record

ATTACHMENT C

SITE SAFETY, HEALTH, AND EMERGENCY RESPONSE PLAN REVIEW RECORD

Site Name: Navy Fuel Farm Facility, NAS Willow Grove, Pennsylvania CTO No. 0009
Project No.: 296.0009 Task No.: 3130
SHERP Date: 3 November 1993

I have read this Site Safety, Health, and Emergency Response Plan for this site and have been briefed on the nature, level, and degree of exposure anticipated as a result of participation in this project. I agree to conform to the requirements of this Plan.

Name	Signature	Affiliation	Date

Attachment D

Site Safety and Health Activity Report

Project No.: 296.0009.3130

ATTACHMENT D

SITE SAFETY AND HEALTH ACTIVITY REPORT

Site: Navy Fuel Farm Facility Location: NAS Willow Grove, Pennsylvania

Weather Conditions: _____ Onsite Hours: From _____ To _____

Changes in PPE Levels*	Work Operations	Reasons for Change

Site Safety and Health Plan Violations	Corrective Action Specified	Corrective Action Taken (yes/no)

Observations and Comments: _____

Completed by: _____ Date: _____
Site Safety and Health Officer

*Only SSHS may change PPE levels, using only criteria specified in this SHERP.

Attachment E

Environmental Monitoring Record

ATTACHMENT E

ENVIRONMENTAL MONITORING RECORD

Site Name: Navy Fuel Farm Facility, NAS Willow Grove, Pennsylvania CTO No.: 0009
Project No.: 296.0009 Task No.: 3130

INSTRUMENT: _____

CALIBRATION: Gas: _____ Concentration: _____ Span: _____

COMMENTS: _____

Time	Monitoring Location	Reading	Corrective Action Taken(a)

Comments: _____

(a) Corrective actions taken must be documented whenever readings at or above action levels are reached.

Recorded by: _____ Date: _____
Site Safety and Health Officer

Attachment F

Monitoring Instrument Start-Up and Calibration Procedures

START-UP AND CALIBRATION PROCEDURE FOR MODEL MX-251 INDUSTRIAL SCIENTIFIC CGI/O_2 METER

START-UP:

1. Ensure that batteries for both the meter and pump (if to be used with meter) have been fully charged (at least overnight).

2. Turn screw on bottom of meter and rotate metal plate 180 degrees. Tighten screw. Alarm should sound briefly and digital readout should appear.

3. Depress OX switch and ensure that meter reads 20-21 percent. If necessary, loosen metal plate and use small screwdriver to adjust the OX screw until desired oxygen reading appears.

4. Depress LEL Switch and ensure that meter reads 0. If necessary, loosen metal plate and use small screwdriver to adjust the ZERO screw until meter reads 0.

CALIBRATION:

1. If oxygen reading in Step 3 was taken in normal ambient environment, no further calibration of the oxygen meter is needed.

2. Fill Tedlar bag with calibration gas standard (must be in percent concentrations—calibration gas tank label should indicate percent LEL of calibration gas).

3. If meter is to be used in passive mode (i.e., no sampling pump), attach calibration cup to top of meter and attach to Tedlar bag using Tygon tubing. If sampling pump is to be used, attach pump to meter and attach filled Tedlar bag to pump inlet.

4. Depress LEL Switch and note the meter reading. If necessary, adjust the small LEL screw underneath the metal plate as required to make meter reading correspond with calibration gas concentration.

5. Record identity of calibration gas, concentration, and calibration date on the Environmental Monitoring Record each time the instrument is calibrated.

START-UP AND CALIBRATION PROCEDURE FOR THE HNu PHOTOIONIZATION DETECTOR, MODELS HW-101 AND PI-101

START-UP:

1. Connect the probe to the readout assembly, making sure that the red interlock switch is depressed by the ring on the connector.

2. Turn the function switch to BATT. The needle should move to green region. If not, the battery needs to be recharged.

3. Zero Set--Turn the function switch to STANDBY. Allow the instrument to warm up at least 1 minute. Set the zero point with the ZERO set control.

CALIBRATION:

1. Fill empty Tedlar bag with 100 ppm isobutylene gas standard (used to calibrate HNU to 55 ppm). Attach probe to Tedlar bag. Do not connect HNU probe directly to isobutylene tank.

2. Turn the Function Switch to the 0-200 range position and note the meter reading. If meter does not read 55 ppm, use the SPAN Control Knob to set the meter reading at 55 ppm. Lock the SPAN Control Knob.

3. Record identity and concentration of calibration gas and the SPAN Control setting on the Environmental Monitoring Record each time the instrument is calibrated.

4. Re-calibrate the HNU each time the instrument is turned off. Place the instrument on STANDBY when not in active use during the work day.

CAUTION: Check the battery charger frequently throughout the work period--do not allow the needle to fall below the green line when the function switch is on BATT. If needles approach the left range of this green line, stop and recharge the instrument.

Probe must be attached to the readout assembly, with the interlock switch fully depressed, in order to recharge the instrument.

START-UP AND CALIBRATION PROCEDURE FOR MODELS OVA-128 AND 128-GC CENTURY ORGANIC VAPOR ANALYZER

START-UP:

1. Connect the probe/readout assembly to the Sidepack Assembly by attaching both the sample line and the electronic jack.

2. Move the Instr/Batt Switch to the BATT position and check that readout needle moves beyond the white "batt check" line.

3. Move the Instr/Batt Switch to the "On" position and warm up at least 5 minutes.

4. Turn the Pump Switch on, set Sidepack Assembly in upright vertical position, and make sure that sample flow rate is approximately 1.5-2.5 units. If less, check filters.

5. Set CALIBRATE Switch to the X1 position, and use CALIBRATE knob to set meter to read 0.

6. Open the HYDROGEN TANK VALVE one or two turns. [Hydrogen Tank pressure should read at least 1,500 psi if 8-hour supply is desired. Otherwise, shut down instrument and fill tank with hydrogen.] Open HYDROGEN SUPPLY VALVE one or two turns. Hydrogen Supply Pressure Indicator should read between 8 and 12 psi.

7. Wait approximately 1 minute, then depress IGNITER Button until hydrogen flame lights (meter needle will jump upscale and faint "pop" may be heard if flame ignites). Do not depress igniter more than 6 seconds. If flame does not light, wait 1 minute and tray to re-ignite.

8. Use CALIBRATE know to "zero" out background by setting CALIBRATE Switch to X1 and reading zero on meter. To avoid false flame out alarm, set meter to 1 ppm with CALIBRATE knob and make differential readings.

CALIBRATION:

1. Fill empty Tedlar bag with 100 ppm methane gas standard.

2. Use Tygon Tubing to connect bag to probe on OVA Readout Assembly. Never connect the OVA directly to methane gas tank.

3. Set CALIBRATE Switch to X10 and read meter. If meter does not read 100 ppm, use the GAS SELECT KNOB to set the readout meter to correspond to 100 ppm. Lock the GAS SELECT KNOB.

4. RECORD identity of calibration gas, concentration, and GAS SELECT reading on Environmental Monitoring Record each time instrument is calibrated.

START-UP AND CALIBRATION PROCEDURE FOR PHOTOVAC MICROTIP

BACKGROUND

The Microtip measures the concentration of airborne ionizable gases and automatically displays and records these concentrations. The Microtip operates automatically, updating the display every 0.5 second. The Microtip automatically records the minimum, maximum, and average concentration for each 15-second period.

The keypad is used to set up and calibrate the Microtip. It has a tutorial function which is activated by pressing the "tutor" key. When "tutor" is pushed, the remaining keys will give a brief explanation of their function when they are pressed. To end the tutorial session, press "exit" twice.

OPERATION

STEP 1 Place battery pack onto Microtip. Battery must be charged for 8 hours prior to use.

STEP 2 Turn on rocker switch located on handle; display will read: "Machine warming up—please wait." When machine is ready it will read "ready" and show day, date, and time.

STEP 3 Now if you care to, you can activate tutor key as mentioned key.

STEP 4 Fill Tedlar bag included with the Microtip with 100 ppm isobutylene span gas.

STEP 5 Press "CAL" button on keypad—instrument will read: "Enter zero gas." At this point, expose the Microtip to clean outdoor air to set zero standard. Press enter and the Microtip will automatically calibrate itself.

STEP 6 The display will now read "Enter span gas concentration." Since we are using 100 ppm isobutylene, set concentration with the #s of the keypad to 100. Attach Tedlar bag of isobutylene and press enter. Machine will automatically calibrate and display will read "ready" with day, date, time, and event # displayed.

STEP 7 Detach Tedlar bag and Microtip is ready to use. The Microtip should be calibrated at least once a day.

The Microtip has a calibration memory that holds up to five different span gas concentrations. However, regardless of the span gas used, the Microtip cannot pick out separate gases but gives the reading of the total ionizable compounds in the air.

A. SETUP KEY

In order to select the range of detection for the Microtip, press the setup key and then select the range 0-20, 0-200, or 0-2000 ppm using the arrow keys. Hit "enter"; next select calibration memory with arrows (using #1 for isobutylene) and press "enter". The Microtip will now display hours, minutes, day, date, etc. If these are correct, continue to press "enter" until "ready display" appears.

B. EVENT KEY

Press event key if you want to mark a specific sample—otherwise, the event is numbered when you turn on the instrument.

C. PLAY

This key is used to recall date. Press play and the * key for options. You can now enter an event # and the machine will display all data for that event.

THINGS TO BE AWARE OF...

If you get a Lo Bat display you should immediately replace the battery as you will have only 10 minutes of charge left. If you continue to run the Microtip, a second message will appear—"Critically low bat". The Microtip will then turn off to prevent deep discharge and memory loss.

This is a delicate instrument. Please be careful with it as it is not as durable as HNUs and OVAs.

This will get you started in the basic operation of the Microtip. If you have any questions or problems, see the owner's manual as it is clearly laid out and easy to understand.

Attachment G

Site Entry and Exit Log

ATTACHMENT G

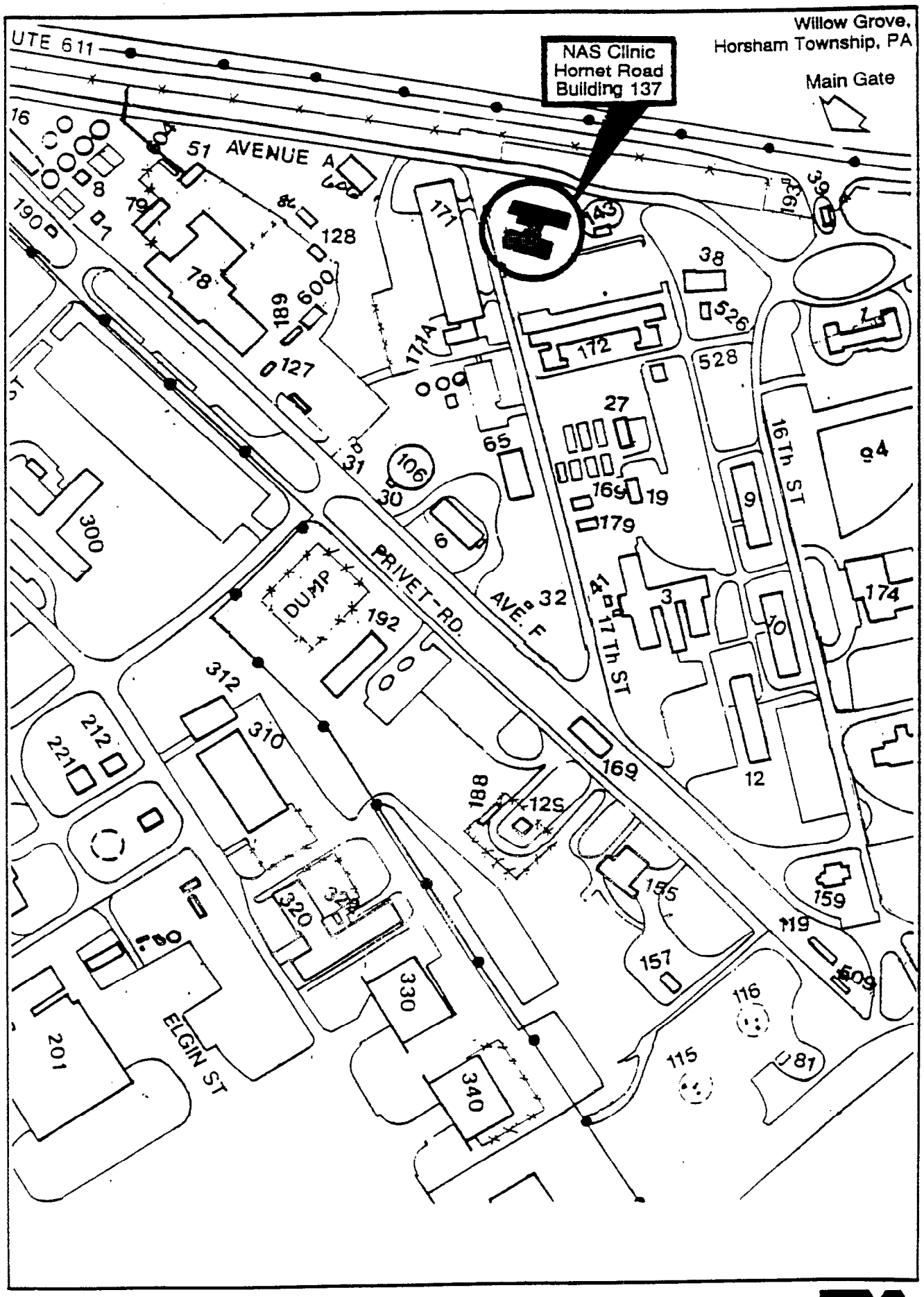
SITE ENTRY AND EXIT LOG

Site Name: Navy Fuel Farm Facility, NAS Willow Grove, Pennsylvania CTO No.: 0009
Project No.: 296.0009 Task No.: 3130

Date	Name	Representing	Time Entry	Time Exit

Attachment H

Map to Hospital


Willow Grove,
Horsham Township, PA
NAS Clinic
Hornet Road
Building 137
Main Gate
UTE 611
51 AVENUE A
PRIVET RD.
AVE. F
16Th ST
17Th ST
ELGIN ST
DUMP
16
8
190
79
78
128
189
600
127
171
171A
143
38
526
172
528
27
65
31
106
30
6
169
19
179
9
4
300
32
41
3
174
192
312
310
212
221
169
12
188
125
155
159
320
330
157
119
509
116
115
81
201
340

Attachment I

Accident Investigation Report

ACCIDENT INVESTIGATION REPORT

CASE NUMBER

COMPANY _____ ADDRESS _____

DEPARTMENT _____ LOCATION (if different from mailing address) _____

1. NAME of INJURED	2. SOCIAL SECURITY NUMBER	3. SEX ☐ M ☐ F	4. AGE	5. DATE of ACCIDENT

6. HOME ADDRESS	7. EMPLOYEE'S USUAL OCCUPATION	8. OCCUPATION at TIME of ACCIDENT

9. LENGTH of EMPLOYMENT	10. TIME in OCCUP. at TIME of ACCIDENT
☐ Less than 1 mo. ☐ 6 mos. to 5 yrs. ☐ 1-5 mos. ☐ More than 5 yrs.	☐ Less than 1 mo. ☐ 6 mos. to 5 yrs. ☐ 1-5 mos. ☐ More than 5 yrs.

11. EMPLOYMENT CATEGORY

☐ Regular, full-time ☐ Temporary ☐ Nonemployee

☐ Regular, part-time ☐ Seasonal

12. CASE NUMBERS and NAMES of OTHERS INJURED in SAME ACCIDENT

_____ _____

_____ _____

13. NATURE of INJURY and PART of BODY

_____

14. NAME and ADDRESS of PHYSICIAN

_____

15. NAME and ADDRESS of HOSPITAL

_____

16. TIME of INJURY

A. _____ A.M. P.M.

B. Time within shift

C. Type of shift

17. SEVERITY of INJURY

☐ Fatality

☐ Lost workdays—days away from work

☐ Lost workdays—days of restricted activity

☐ Medical treatment

☐ First aid

☐ Other, specify _____

18. SPECIFIC LOCATION of ACCIDENT

_____

ON EMPLOYER'S PREMISES? ☐ Yes ☐ No

19. PHASE OF EMPLOYEE's WORKDAY at TIME of INJURY

☐ During rest period ☐ Entering or leaving plant

☐ During meal period ☐ Performing work duties

☐ Working overtime. ☐ Other _____

20. DESCRIBE HOW the ACCIDENT OCCURRED

_____

_____

_____

_____

21. ACCIDENT SEQUENCE. Describe in reverse order of occurrence events preceding the injury and accident. Starting with the injury and moving backward in time, reconstruct the sequence of events that led to the injury.

A. Injury Event _____

B. Accident Event _____

C. Preceding Event #1 _____

D. Preceding Event #2, #3, etc. _____

_____

22. TASK and ACTIVITY at TIME of ACCIDENT

A. General type of task _____

B. Specific activity _____

C. Employee was working:

☐ Alone ☐ With crew or fellow worker ☐ Other, specify _____

23. POSTURE of EMPLOYEE

_____

24. SUPERVISION at TIME of ACCIDENT

☐ Directly supervised ☐ Not supervised

☐ Indirectly supervised ☐ Supervision not feasible

25. CAUSAL FACTORS. Events and conditions that contributed to the accident. Include those identified by use of the Guide for Identifying Causal Factors and Corrective Actions.

26. CORRECTIVE ACTIONS. Those that have been, or will be, taken to prevent recurrence. Include those identified by use of the Guide for Identifying Causal Factors and Corrective Actions.

PREPARED BY _____

TITLE _____

DEPARTMENT _____ DATE _____

APPROVED _____

TITLE _____ DATE _____

APPROVED _____

TITLE _____ DATE _____

Developed by the National Safety Council

EA 0314 F&B 8/5/86

Appendix C

"Request for Determination of Requirement for Plan Approval/ Operating Permit" Form

ER–AQ–17 Rev. 9/85

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY CONTROL

Request for Determination of Requirement for Plan Approval/Operating Permit Application (Submit In Triplicate)

Type of Source: _____ Date of Installation: _____

Owner of Source: _____ Employer I.D. No.: _____

Mailing Address: _____

Contact Person: _____ Telephone: _____

Location of Source(s):

Street Address: _____ Municipality: _____

Estimated Emissions: County: _____

Pollutant				
Quantity lbs/hr				
Quantity lbs/yr				

_____
Signature

_____
Title

_____
Date

OFFICIAL USE ONLY

Date Received: _____ Reviewed By: _____

Pursuant to the authority contained in 25 PA Code §127.14(8) the source(s) is exempted from the plan approval and permitting requirements. This determination does not exempt the source(s) from compliance with all other applicable air quality regulations.

_____
Signature

_____
Title

_____
Date

The source(s) does not qualify for exemption from plan approval/permitting requirements under PA Code §127.14(8) and plan approval application(s) must be submitted. The Department is prohibited from acting on an application until 30 days after the municipality and county have received notification by the company. Pertinent forms are attached.

_____
Signature

_____
Title

_____
Date

(Over)

Narrative Source Description (attach additional sheet(s) if necessary):
(Include: process description, exhaust volume, stack data, schematic flow diagram, material data safety sheet, etc

OFFICIAL USE ONLY

Remarks: