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NWS EARLE
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REMEDIAL INVESTIGATION ADDENDUM WORK PLAN

for

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey

Northern Division
Naval Facilities Engineering Command
Contract No. N62472-90-D-1298
Contract Task Order 0231

October 1996

BROWN & ROOT ENVIRONMENTAL

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EXECUTIVE SUMMARY

This work plan has been prepared under Navy CLEAN Contract Number N62472-90-D-1298, Contract Task Order (CTO) 0231, modification 2. The overall scope of this modification to the CTO is to prepare a Remedial Investigation (RI) Addendum Work Plan addressing additional environmental investigation activities for 7 sites at Naval Weapons Station (NWS) Earle under the Navy's Installation Restoration Program (IRP). This investigation supplements RI field activities conducted for 27 sites at NWS Earle in 1995. The July 1996 RI report for the 27 sites indicated a need for further data collection at several sites. These seven sites are addressed in the RI Addendum. Included within the scope of this document are a Quality Assurance Project Plan (QAPP) and a site-specific Health and Safety Plan (HASP).

NWS Earle is located in east-central New Jersey, approximately 30 miles south of Newark. The station was commissioned in 1943 with the primary responsibility of supplying ammunition to the Navy. The station includes a Waterfront area, located adjacent to the Atlantic Ocean, and the Mainside area, located approximately 10 miles inland. The two areas are linked by a narrow strip of land that provides a secure right-of-way for the government-owned road and railroad.

The objective of the RI Addendum will be to further characterize the nature and extent of potential contamination at the seven sites (Sites 3, 6, 12, 13, 16, 17, and 26) and to evaluate the associated risk to human health and the environment. The data collected will be used to determine the need for additional investigation and/or support feasibility studies where appropriate.

Field activities addressed within this work plan include collection and analysis of samples from five environmental media within and adjacent to the study sites. These media are surface soil, subsurface soil, surface sediment, groundwater, and surface water. In addition, lithologic profiling by cone penetrometer will be performed. Individual media selected for sampling at each site have been proposed on the basis of operational history, previous investigation findings, and site physical features. An environmental media background investigation has been completed to determine the background concentrations of suspected site contaminants in each of the sampled media. A total of five additional reference locations have been selected, three from the Ware Creek marsh and two from railroad bed ballast.

RI activities at the sites will include installation of monitoring wells and subsurface investigations utilizing hand augers, hydropunch sampling combined with a field gas chromatograph for field screening of groundwater, lithologic profiling utilizing cone penetrometry (CPT), and site characterization using the CPT in conjunction with induced fluorescence to delineate the extent of petroleum contamination. In addition, surface water and sediment and surface soil samples will be obtained. A total of 4 monitoring wells will be installed and sampled, 72 groundwater samples will be collected in the field during the hydropunch

sampling and field screened for VOCs, 12 surface water and associated sediment samples will be collected, 3 subsurface soils will be obtained, and 10 surface soil samples will be collected. Two samples of railroad bed ballast will also be collected. These sample numbers include background locations but do not include QA/QC samples.

Sample analytes for each site have been determined based on results of previous sampling data and operational history. Background samples will be analyzed for the same parameters as the RI sites. Analytical parameters included within the scope of the RI are TCL volatile organic compounds, TCL semivolatile organic compounds, TCL pesticides and polychlorinated biphenyls, TAL metals, cyanide, biochemical oxygen demand, chemical oxygen demand, chloride, total organic carbon, and total dissolved solids. Analysis of samples from each site will include only those parameters which are representative of the site history and previous analytical data.

Detailed information regarding site locations, past investigation work, analytical data, site-specific work scopes, analytical parameters, quality assurance, and health and safety information is provided within the main body of this document.

1.0 INTRODUCTION

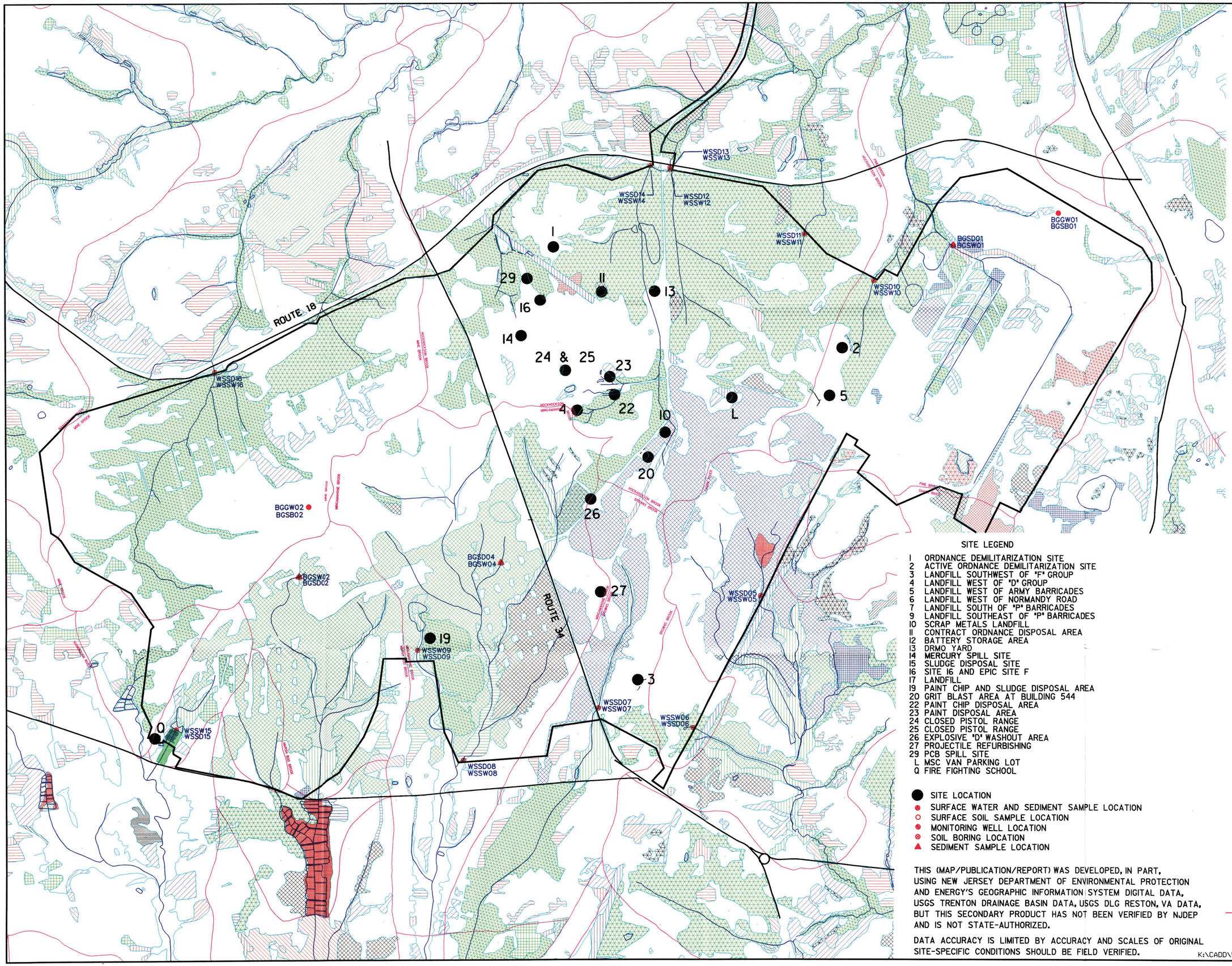
1.1 SCOPE AND OBJECTIVES

Brown & Root Environmental, a division of Halliburton NUS Corporation (HNUS), under the Comprehensive Long-term Environmental Action - Navy (CLEAN) Program, Contract Number N62472-90-D-1298, has been assigned to prepare a comprehensive work plan for seven Remedial Investigation (RI) Addendum sites at Naval Weapons Station (NWS) Earle in accordance with the requirements of Contract Task Order Number 0231. The work is being performed as part of the Navy's Installation Restoration Program (IRP), a program designed to identify environmental concerns at Navy and Marine Corps facilities, and to implement corrective measures if necessary. This Work Plan Addendum is based on the 1995 RI Work Plan prepared by B&R Environmental, the 1996 RI Report prepared by B&R Environmental, and the July 29, 1996 Statement of Work.

IRP activities are typically performed in four distinct phases. Phase 1 consists of a Preliminary Assessment (PA), and Phase 2 consists of a Site Investigation (SI). Phase 3 is a Remedial Investigation (RI) which is intended to characterize the physical and chemical (contaminant) parameters of the site and the associated risks to human health and the environment. Phase 4 consists of Remedial Action (RA) designed to control and mitigate contaminated media at the site. An RI was completed for 27 sites at NWS Earle. The RI identified seven sites requiring additional data. These sites were selected for further investigation under the RI Addendum. This Work Plan Addendum addresses RI activities at the seven sites.

The objective of the RI Addendum is to further characterize the sites so that determinations can be made regarding the sites' environment impairment and the associated risks posed by the site. A further objective is to more accurately define the vertical and horizontal extent of contamination at sites where contaminant concentrations exceed action levels, and to provide data for comparison of site contaminant concentrations with background concentrations and applicable standards.

Sites addressed within the RI Addendum work plan include four sites (Sites 3, 13, 16/F, and 26) located within the Mainside and three sites (Sites 6, 12, and 17) in the Waterfront portion of the station. Relative site locations within the Mainside and Waterfront areas are shown on Figure 1-1.



LEGEND

- UPLAND
- PFØ1A
- PEM1C
- POWHh
- PFØ1B
- R2ØW
- PFØ1C
- PEM1B
- PSS1B
- MODAg
- PEM1B/PFØ1B
- PEM1B/PSS1B
- PSS1C
- PFØ1E
- PEM1F
- MODR
- POWHx
- MODL
- PFØ1/4B
- MODD
- PSS1E/PEM1E
- PEM1E/PSS1E
- PEM1E
- PFØ8C
- PFØ4B
- PFØ1/4C
- PFØ4C
- PFØ4/1B
- PFØ4/1C
- PFØ4/1E
- PFØ4/1A
- PSS4E
- PFØ1E/PEM1E
- PSS4B/PFØ4B
- PFØ1Bn
- PEM1C/PSS1C
- PFØ1C/PEM1C
- PSS1E
- DRAINAGE DIVIDE

SITE LEGEND

1 ORDNANCE DEMILITARIZATION SITE
2 ACTIVE ORDNANCE DEMILITARIZATION SITE
3 LANDFILL SOUTHWEST OF "F" GROUP
4 LANDFILL WEST OF "D" GROUP
5 LANDFILL WEST OF ARMY BARRICADES
6 LANDFILL WEST OF NORMANDY ROAD
7 LANDFILL SOUTH OF "P" BARRICADES
9 LANDFILL SOUTHEAST OF "P" BARRICADES
10 SCRAP METALS LANDFILL
11 CONTRACT ORDNANCE DISPOSAL AREA
12 BATTERY STORAGE AREA
13 DRMO YARD
14 MERCURY SPILL SITE
15 SLUDGE DISPOSAL SITE
16 SITE 16 AND EPIC SITE F
17 LANDFILL
19 PAINT CHIP AND SLUDGE DISPOSAL AREA
20 GRIT BLAST AREA AT BUILDING 544
22 PAINT CHIP DISPOSAL AREA
23 PAINT DISPOSAL AREA
24 CLOSED PISTOL RANGE
25 CLOSED PISTOL RANGE
26 EXPLOSIVE "D" WASHOUT AREA
27 PROJECTILE REFURBISHING
29 PCB SPILL SITE
L MSC VAN PARKING LOT
Q FIRE FIGHTING SCHOOL

- SITE LOCATION
- SURFACE WATER AND SEDIMENT SAMPLE LOCATION
- SURFACE SOIL SAMPLE LOCATION
- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- SEDIMENT SAMPLE LOCATION

THIS (MAP/PUBLICATION/REPORT) WAS DEVELOPED, IN PART, USING NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY'S GEOGRAPHIC INFORMATION SYSTEM DIGITAL DATA, USGS TRENTON DRAINAGE BASIN DATA, USGS DLG RESTON, VA DATA, BUT THIS SECONDARY PRODUCT HAS NOT BEEN VERIFIED BY NJDEP AND IS NOT STATE-AUTHORIZED.

DATA ACCURACY IS LIMITED BY ACCURACY AND SCALES OF ORIGINAL SITE-SPECIFIC CONDITIONS SHOULD BE FIELD VERIFIED.

0 1500 3000
SCALE IN FEET

K:\CADD\5803\5803CM05.DGN 09/16/96 MJJ

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

A/E EFD
DESIGN
DRAWN
REVIEW
CHIEF ARCH./ ENGR.
PROJECT MANAGER
FIRE PROTECTION
QUALITY CONTROL
BRANCH MANAGER
DESIGN DIRECTOR

Brown & Root Environmental

APPROVED DATE
ACTIVITY - SATISFACTORY TO
APPROVED DATE

FOR EFD USE CHANGES MADE:

SEAL

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NORTHERN DIVISION
PHILADELPHIA, PENNSYLVANIA
NWS EARLE
COLTS NECK, NEW JERSEY

MAINSIDE
SITE LOCATION MAP

CODE ID. NO. 80091 SIZE D
SCALE:
EFD NO.
STA. PROJ. NO.
SPEC. NO.
CONSTR. CONTR. NO.
NAVFAC DRAWING NO.
SHEET OF

FIGURE 1-1

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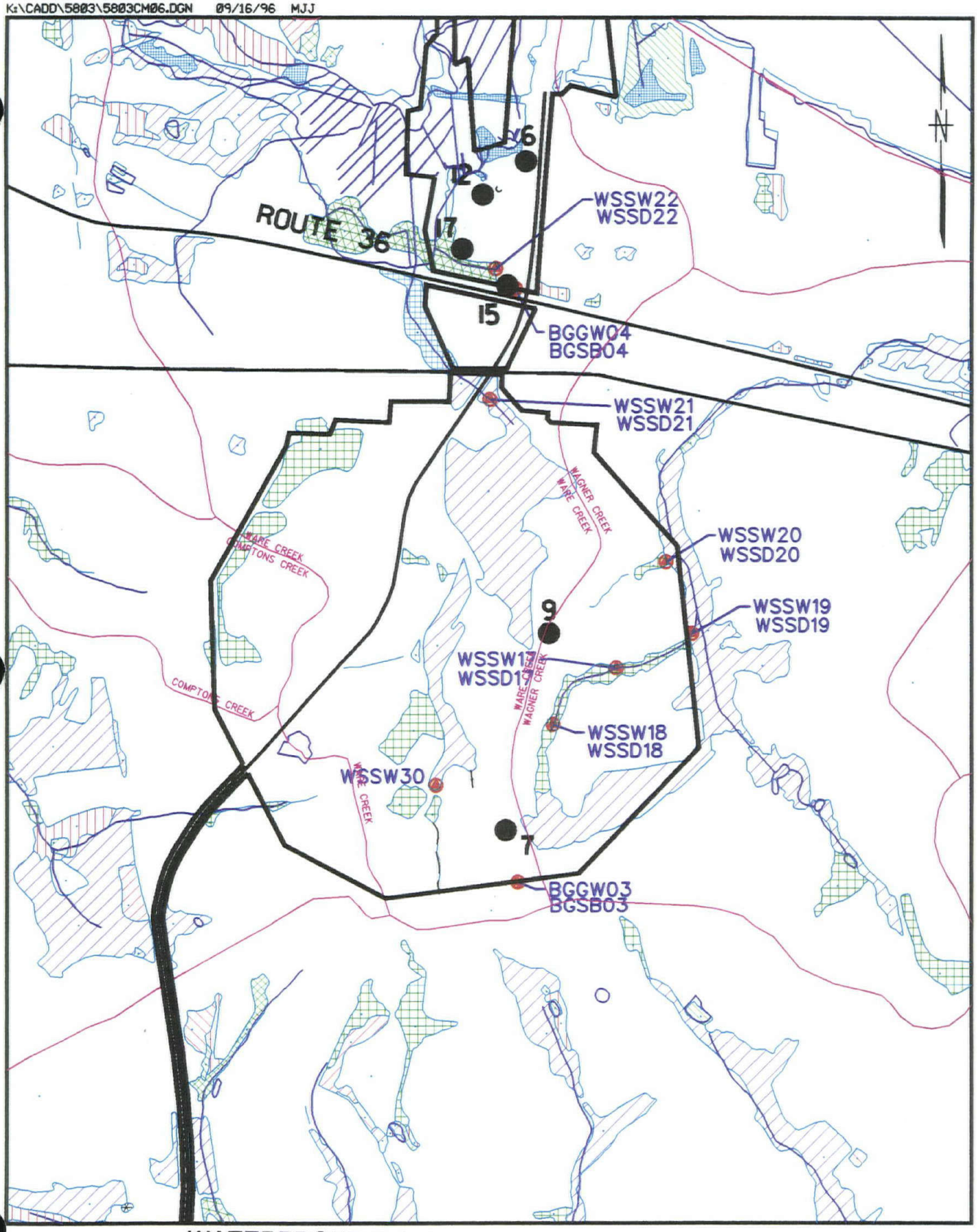


WATERFRONT AREA

SITE LOCATION MAP

0 1500 3000

SCALE IN FEET

FIGURE 1-2

Brown & Root Environmental

1.2 SITE DESCRIPTION

NWS Earle is located in Monmouth County in east-central New Jersey. The station is situated on approximately 11,134 acres that include a Mainside area, approximately 10 miles inland from the Atlantic Ocean at Sandy Hook Bay, and a Waterfront area, which includes an ammunition depot and associated piers. The Mainside and Waterfront areas are linked by a narrow tract of land that serves as a right-of-way for a government road and railroad. The main entrance to NWS Earle is located off State Route 34, and the entrance to the Waterfront area is located adjacent to State Route 36.

1.2.1 Site Operations

The station was commissioned as a Naval Ammunition Depot on December 13, 1943, with the primary responsibility of furnishing ammunition to the Naval fleet. The station's Ordnance Department coordinates all port services and logistic support for home-ported and visiting ships, conducts safety inspections, supervises ammunition loading for the United States Coast Guard, and provides afloat fire fighting capability and standby tug services. Other major active divisions include the Ammunition Distribution and Control Division, responsible for ensuring that a balanced, purified stock of ammunition is maintained in support of Navy, Coast Guard, and Marine Corps programs; the Operations Division, which performs ammunition movement, ship loading, demilitarization of obsolete ammunition, and reclaiming/renovation of various ammunition; the Anti-submarine Warfare (ASW) and Special Weapons Division, which plans and carries out station-level maintenance of air and antisubmarine weapons and provides shore-based support to various commanders; and the Port Services Division, which is responsible for operating the station fireboat, service craft, and oil pollution containment equipment.

1.2.2 Investigative History

Site investigation activities related to areas of potential environmental concern at NWS Earle have been undertaken by the Navy since approximately 1982. Early work included an Initial Assessment Study (IAS) conducted by Fred C. Hart and Associates; the results are included in a report prepared in 1982. Studies and field investigation efforts continued under the IRP by Roy F. Weston, Incorporated. Several documents prepared by Weston were submitted to the Navy, NJDEP, and EPA. These documents include the Draft Report for Naval Weapons Station Earle, Colts Neck, New Jersey, Installation Restoration Program Phase II Confirmation Study, dated September 1986; the Draft Report of Current Situation and Draft Plan of Action, dated December 1988; a Draft Phase II Site Inspection Study for Naval Weapons Station Earle, Colts Neck, New Jersey, dated February 1993; and a final version of the SI report, dated December 1993. An IRP Phase II site inspection work plan was also submitted by Weston in September 1991. In addition, Weston submitted the Installation and Restoration Program Remedial Investigations/Feasibility Study for 11 Sites at NWS Earle, Colts Neck, New Jersey, Volumes 1 to 3. The 1995 work plan for the RI, prepared by B&R Environmental, considered the results of the previous investigations as the basis for most of the 1995 RI field tasks. The July 1996 RI document prepared by B&R Environmental presents the results of the field tasks, the data evaluation, the human health risk assessment, and the preliminary ecological risk evaluation for 27 sites, including the seven sites to be investigated during the RI Addendum field work.

1.2.3 Site Physiography

NWS Earle is located in the coastal lowlands of Monmouth County, New Jersey, within the Atlantic Coastal Plain Physiographic Province. The Mainside area lies in the outer Coastal Plain, approximately 9 miles inland from the Atlantic Ocean. The Mainside area is relatively flat, with elevations ranging from approximately 100 to 300 feet above mean sea level (MSL). The most significant topographic relief within the Mainside area is Hominy Hills, a northeast-southwest-trending group of low hills located near the center of the station.

The Waterfront area lies on the southern coast of Sandy Hook Bay on New Jersey's Atlantic shoreline, in an area known as the Bayshore Lowlands. The property and associated piers occupy a narrow strip of land running roughly perpendicular to the shoreline that serves as access from the ammunition depot (located 1 mile inland). This thin strip of land consists primarily of tidal marsh and swamp with areas of fill and averages approximately 10 feet above MSL.

The ammunition depot occupies a somewhat circular plot of land connected to the Waterfront by the thin strip of property described above. This portion of the station, known as the Chapel Hill area, lies within

the Highland/Mount Pleasant Hills. These hills form the drainage divide between the inner and outer Coastal Plains.

1.2.4 Climate

The Mainside and Waterfront areas are characterized by a predominantly continental climate. NWS Earle's proximity to the Atlantic Ocean and Sandy Hook Bay results in maritime climatic influences. The average annual temperature for Freehold, New Jersey, which is located approximately 6 miles west of the Mainside area and 16 miles southwest of the Waterfront area, is 52.7°F. The average monthly temperatures range from 22° to 39°F in January and 63° to 85°F in July. The average annual precipitation, 45 inches, is generally evenly distributed throughout the year. The mean annual lake evaporation for the area of the site is approximately 32 inches. The net annual precipitation is approximately 13 inches. A 2-year, 24-hour rainfall will produce approximately 3.4 inches of rain [National Oceanic and Atmospheric Administration (NOAA), 1982]. The prevailing wind direction is from the south during the warm seasons and from the northwest during the winter. The growing season in this area ranges from 140 to 160 days.

1.2.5 Surface Drainage

The rivers and streams draining NWS Earle ultimately discharge to the Atlantic Ocean, which is approximately 9 miles east of the Mainside area. The headwaters and drainage basins of three major Coastal Plain rivers (Swimming, Manasquan, and Shark) originate on the Mainside area. The northern half of Mainside is in the drainage basin of the Swimming River, and tributaries include Mine Brook, Hockhockson Brook, and Pine Brook. The southwestern portion of the Mainside drains to the Manasquan River via either Marsh Bog Brook or Mingamahone Brook. The southeastern corner of the Mainside drains to the Shark River. Both the Swimming River and the Shark River supply water to reservoirs used for public water supplies.

Surface water drainage from the Waterfront enters Sandy Hook Bay. Much of this area is under tidal influence. Most of the surface drainage from the Chapel Hill area flows northward to Sandy Hook Bay via Compton, Ware, and Wagner Creeks. A very small area at the topographically high southern end of the Chapel Hill area drains southward through McClees Creek to the Navesink River.

Surface runoff in these areas follows topographic gradients to storm drains and drainage ditches or occurs as overland flow that discharges to local surface water bodies.

1.2.6 Soils

The soils mapped at NWS Earle are described in the Soil Survey of Monmouth County, New Jersey (United States Department of Agriculture, Soil Conservation Service, 1990). Prevalent soils in the Mainside and Waterfront areas and for the seven sites are presented below. Mainside soils formed in acid, loamy or sandy, Coastal Plain sediments, and Waterfront soils formed in acid, clayey Coastal Plain sediments. Slopes range from zero to 25 percent and the soils are generally extremely acid to strongly acid.

Prevalent Soils in the Mainside Area			
Atsion Series	Evesboro Series	Humaquepts	Keyport Series
Klej Series	Lakehurst Series	Lakewood Series	Manahawkin Series
Marlton Series	Pemberton Series	Pits	Sassafras Series
Shrewsbury Series	Tinton Series	Udorthents	

Prevalent Soils in the Waterfront Area		
Elkton Series	Sulfaquents and Sulfihemists	Udorthents-Urban land complex

Site	Soil Name	Description
3	Lakehurst sand, 0 to 2 percent slopes	sand
6	Sulfaquents and Sulfihemists, frequently flooded	organic material
12	Udorthents-Urban land complex, 0 to 3 percent slopes	loamy material
13	Udorthents, smoothed	loamy material
16/F	Udorthents, smoothed	loamy material
17	Udorthents-Urban land complex, 0 to 3 percent slopes	loamy material
26	Lakehurst sand, 0 to 2 percent slopes	sand

A duscussion on background metals concentrations in state-wide soils may be found in Section 3.5 of the RI report.

1.2.7 Site Geology and Hydrogeology

A detailed discussion of site geology is presenter in the B&R Environmental July 1996 RI report, Sections 3.4 and 3.6. A general discussion is presented in this section.

NWS Earle is situated in the Coastal Plain Physiographic Province of New Jersey. The New Jersey Coastal Plain is a seaward-dipping wedge of unconsolidated Cretaceous to Quaternary sediments that were deposited on a pre-Cretaceous basement-bedrock complex. The Coastal Plain sediments are primarily composed of clay, silt, sand, and gravel and were deposited in continental, coastal, and marine environments. The sediments generally strike northeast-southwest and dip to the southeast at a rate of 10 to 60 feet per mile. The approximate thickness of these sediments beneath NWS Earle is 900 feet. The pre-Cretaceous complex consists mainly of PreCambrian and lower Paleozoic crystalline rocks and metamorphic schists and gneisses.

The Cretaceous to Miocene Coastal Plain Formations are either exposed at the surface or subcrop in a banded pattern that roughly parallels the shoreline. The outcrop pattern is caused by the erosional

truncation of the dipping sedimentary wedge. Where these formations are not exposed, they are covered by essentially flat-lying post-Miocene surficial deposits.

Groundwater classification areas were established in New Jersey under NJDEP Water Technical Programs Groundwater Quality Standards in New Jersey Administrative Code (N.J.A.C.) 7:9-6. The Mainside Waterfront areas are located in the Class II-A Groundwater Supporting Potable Water Supply area. Class II-A includes those areas where groundwater is an existing source of potable water with conventional water supply treatment or is a potential source of potable water. In the Mainside and Waterfront, and areas, in general, the deeper aquifers are used for public water supplies and the shallower aquifers are used for domestic supplies.

The Coastal Plain sediments are the most important source of potable water in the Coastal Plain of New Jersey, with wells supplying greater than 75 percent of the potable water supply. Water-supply problems associated with the increased demand for groundwater in the Coastal Plain include decreased groundwater levels and the induced recharge of fresh, brackish, or saline water from surface water or adjacent aquifers.

Recharge to the groundwater system is through the infiltration of precipitation, seepage from surface water bodies, and leakage through semiconfining beds. Groundwater discharge is induced by movement to overlying surface-water bodies, by evapotranspiration, and by withdrawal from wells. Generally, the regressive depositional units (the Cohansey Sand, the Kirkwood and Vincentown Formations, the Red Bank and Mount Laurel Sands, and the Wenonah and Englishtown Formations) form aquifers and the transgressive depositional units (the Manasquan Formation, the Hornerstown Sand, and the Navesink, Marshalltown, and Merchantville Formations) form confining or semiconfining beds.

1.3 SUMMARY OF CHEMICAL DATA FROM PREVIOUS INVESTIGATIONS

Investigative activities performed during the previous SI (Weston, 1993), RI/FS (Weston, 1993), and RI (B&R Environmental, 1996) included the collection and analysis of various media samples at the 27 sites. For the purpose of determining sampling and analysis requirements to be performed during the current RI Addendum, all available analytical data ware reviewed and summarized. Sample analytes to be collected during this phase of field work were determined primarily on the basis of positive detections of analytes during previous sample analysis and, to a lesser degree, on former site use. In order to use the previously acquired data for determining proposed sampling requirements, it was necessary to compare the maximum positive detections from each site with applicable action levels for each analyte. Tables summarizing these data accompany a description of each site (Sections 4 to 11). These tables provide a comparison of maximum contaminant concentrations to applicable regulatory standards by site and

medium for each site. The tables present each medium separately and list the maximum results for all analytes and the sample identification where the maximum result was detected. All chemicals which exceed either applicable state or federal standards or clean-up criteria are distinguished by the code "E".

The analytical program for RI Addendum activities at each site is based on results of previous investigations, particularly the RI performed by B&R Environmental, and direction by the Navy Scope of Work. Analytical parameters were determined first by selecting the maximum contaminant concentrations from the data collected during previous investigations and comparing those concentrations to state and federal regulatory levels. Analytes exceeding regulatory levels during the SI, or those found in significant concentrations, will be analyzed for during this RI investigation. Additionally, the past and present activities and uses for each site were considered in the determination of the analytical program. The goals of the RI Addendum sampling program are to further delineate the extent of contamination at the seven sites. The nature of contaminants has been adequately defined during previous investigations. The contaminants of concern for each site have been evaluated and selected as analytical parameters to define the extent of contamination.

2.0 FIELD OPERATIONS

2.1 FIELD OPERATIONS SUMMARY

Field operations to be performed at NWS Earle during the RI Addendum include mobilization of equipment, monitoring well installation/construction, hydropunch sampling and field screening, cone penetrometer profiling combined with induced fluorescence field characterization, soil sampling, groundwater sampling, surface water and sediment sampling, well development, water-level measurements, ground surveying, equipment decontamination, and waste handling. Activities such as sample collection procedures are described in Section 3.0, Environmental Sampling.

2.2 MOBILIZATION/DEMOBILIZATION

Following approval of this Work Plan Addendum, B&R Environmental will prepare drilling, hydropunch, cone penetrometer, and survey specifications, obtain drilling, hydropunch, and cone penetrometer subcontractors, and begin mobilization activities. All field team members will review the work plan Addendum, Health and Safety Plan (HASP), Quality Assurance Project Plan (QAPP), and NJDEP field sampling procedures. In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities and health and safety concerns and requirements.

B&R Environmental will coordinate project activites with personnel from NORTHDIV, NWS Earle, EPA Region II, and NJDEP.

The field operations leader (FOL) will coordinate the mobilization activities upon arrival at the station. The FOL will make any equipment purchases required to conduct the field investigation. The equipment required for the field activities will be loaded in Wayne, Pennsylvania and driven to the site by the FOL and a technician/geologist. After field activities are completed, the FOL will demobilize the equipment and return the equipment to the appropriate location. Additional project personnel will be utilized in the field as necessary to efficiently perform all contractor oversight and investigation/sample collection work.

2.3 DRILLING FOR MONITORING WELL INSTALLATION

Groundwater monitoring wells will be installed to characterize groundwater contamination at Site 16/F. The hollow-stem auger drilling method will be used to advance the soil borings. During drilling operations of the overburden material, standard penetration tests and split-spoon sampling shall be performed. Drilling fluids will not be used during soil boring activities. A lithologic description will be made of each

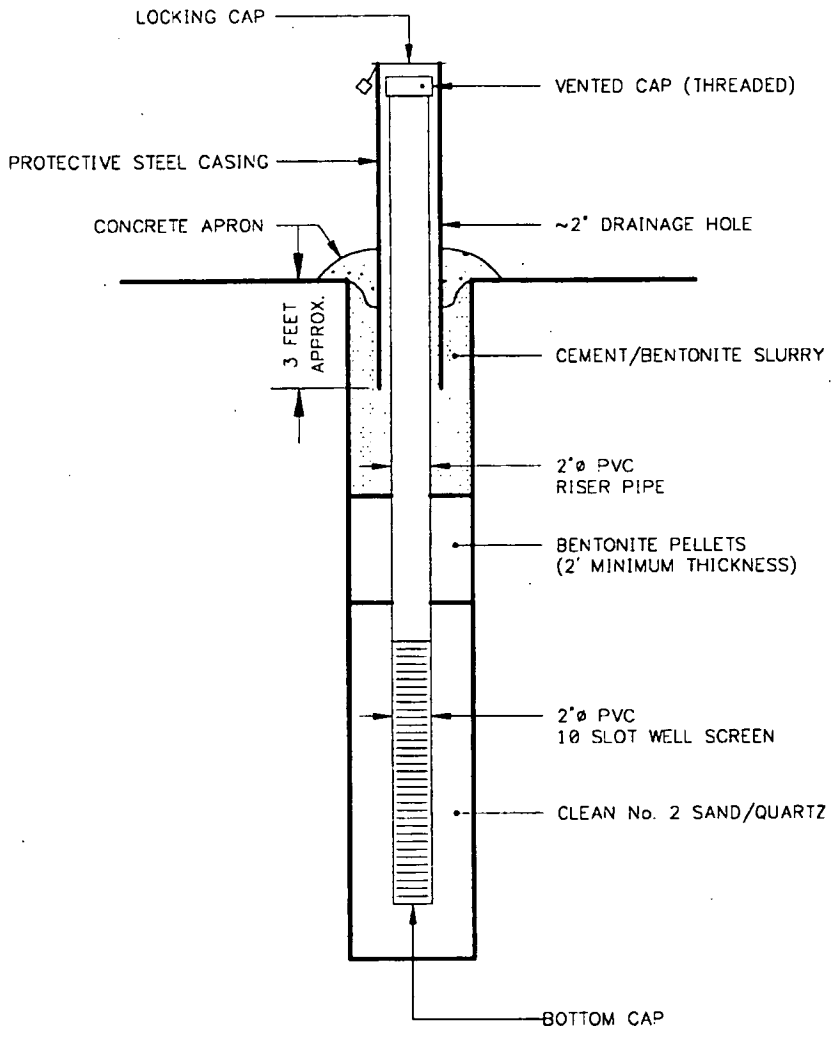
split-spoon sample on a boring log. A complete log of each boring will be maintained by field personnel in accordance with Brown &Root Environmental (formerly Halliburton NUS) Standard Operating Procedure (SOP) GH-1.5: Sections 5.2, 5.4, and 5.5. The USCS classification system will be used for lithologic descriptions. A sample boring log is attached in Appendix A. At a minimum, the boring log will contain the following information:

- Sample numbers and types.
- Sample depths.
- Standard penetration test data.
- Sample recovery/sample interval.
- Soil density or cohesiveness.
- Soil color and moisture.
- USCS classification system material.

In addition, depths of changes in lithology, depth to water, organic vapor analyzer (OVA) or HNu readings, drilling methods, and total depth of each borehole will be included on each boring log where applicable. All pertinent data will be recorded by the field geologist on a boring log form, provided in Appendix A of this report.

2.4 MONITORING WELL CONSTRUCTION/INSTALLATION

Monitoring wells will be constructed of 2-inch I.D. PVC flush-joint riser pipe and flush-joint factory slotted well screen. Well screens will be 10 feet in length. The top of the screened interval will be positioned approximately 2 feet above the stabilized water level in the boring. After the borings are drilled to the desired depth (8-inch minimum diameter boring), the well screen and riser pipe will be installed through the augers to the desired depth. Well screen slots shall be 0.01 inch. The size of sand pack selected will be based on the slot size of each screen and the type of formation present. Figure 2-1 illustrates typical monitoring well construction details. Hollow-stem augers will have a minimum 4¼-inch I.D. to accommodate installation of casing, sandpack, and well seal materials. The annulus of the boring around the well screen, and 2 to 3 feet above the well screen, will be backfilled with clean morie sand (No. 20 to 30 U.S. Standard Sieve size). A bentonite pellet seal (minimum 2-foot thickness) will be installed above the sand pack and allowed to hydrate as per the manufacturer's recommendations. The remainder of the annulus, from the seal to the ground surface, will be backfilled with cement/bentonite grout placed from the bottom of the boring (top of bentonite seal) using a tremie pipe. The depths of all backfill materials will be constantly monitored during the well installation process by means of a weighted stainless-steel or plastic tape. A monitoring well construction form will be completed for each monitoring well installed.



TYPICAL MONITORING WELL CONSTRUCTION
RI INVESTIGATION
NAVAL WEAPONS STATION EARLE, NEW JERSEY
NOT TO SCALE

FIGURE 2-1

HALLIBURTON NUS
Environmental Corporation

A sample well construction form is attached in Appendix A. Well installation will be conducted in accordance with NJDEP Field Sampling Procedure Manual and Halliburton NUS (B& R Environmental) SOP GH-1.7.

A 6- to 8-inch-diameter protective steel casing equipped with a locking steel cap will be installed around each well. The casing will be grouted a minimum of 3 feet into the ground and will have at least one drain hole positioned approximately 0.5 f00t above the ground surface. A 0.5-foot-thick concrete apron measuring 2 by 2 feet will be constructed so it is equally portioned around the casing of each well. Upon completion of groundwater sampling, all monitoring wells will be locked and will be keyed alike.

2.5 WELL DEVELOPMENT

The monitoring wells will be developed after installation to remove fine-grained material from the area around the well screens and to remove drill cuttings and residual fluids from the formation surrounding the monitored interval of the boring. Wells will be developed by bailing and surging or by pumping, as determined by the field geologist. Wells will not be developed by bailing only. Wells will be developed until removed water is visibly clear of suspended solids. Wells will be continuously developed for an estimated duration of 1 hour. Wells will be allowed to stabilize for 2 weeks (14 days) before sampling, as noted in the NJDEP Field Sampling Procedures Manual.

2.6 SURVEYING

All monitoring wells will be surveyed for elevation and location following installation. Horizontal locations will be surveyed for all other sample locations. Existing survey monuments within NWS Earle may be used as reference points. As an alternative, a Global Positioning System (GPS) may be required to establish survey control. Horizontal locations will be surveyed to the nearest 0.10 foot. Vertical elevations will be referenced and surveyed to the nearest 0.01 foot at the measuring point where the uncapped riser pipe is notched. Ground surface elevations and the top of the protective casing will also be surveyed to the nearest 0.01 foot. NAVD 88 and NAD83 datums will be referenced in conjunction with the New Jersey State Plane Coordinate System.

2.7 DECONTAMINATION

Field sampling equipment will be decontaminated prior to use at the first location and between successive drilling and sampling locations. This equipment includes drilling rigs, downhole tools, augers, well casing and screens, and all sampling equipment. Decontamination of the drill rig will be limited to that portion of the equipment that may be expected to come into contact with or be located directly over the sample

locations.

2.7.1 Major Equipment

All downhole drilling equipment and sampling tools will be steam cleaned prior to beginning work, between well borings or test pits, any time the drilling rig leaves the site prior to completing a boring, and at the completion of the project. In addition, well casing and screens will be steam cleaned prior to being installed into the borings unless these materials are certified by the manufacturer to be free of contaminants and have not been removed from the original manufacturers sealed packaging at the time of installation.

These decontamination operations will consist of washing the equipment using a high-pressure steam wash. All decontamination activities will take place at a location determined during mobilization. A decontamination pad will be constructed at this location. After the decontamination pad is constructed, all drilling rig decontamination will be performed at the decontamination pad. All decontamination water will be collected and containerized. The Station will provide a suitable location for decontamination operations along with potable water and electricity. Additional requirements for drilling equipment decontamination can be found in Halliburton NUS (B&R Environmental) SOP GH-1.6: Section 5.

2.7.2 Sampling Equipment

All sampling equipment used for collecting samples will be decontaminated both prior to beginning field sampling and between samples. The following decontamination steps will be taken:

- Alconox or liquinox detergent wash.
- Potable water rinse.
- Distilled or Deionized water rinse.[1]
- 10% Nitric acid (ultra pure) rinse diluted with deionized water[2] (when sampling metals).
- Distilled or Deionized water rinse.
- Methanol followed by hexane rinse of pesticide grade or better (when sampling organics,

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1 NJDEPE may require specific lot numbers from containers or analytical verification that distilled or deionized waters meet specifications, therefore deionized water lot numbers will be noted in the field notebook during sampling activities.

2 When decontaminating carbon steel split-spoons, the nitric acid rinse should be lowered to a concentration of 1% to reduce the possibility of leaching metals from the spoon itself.

pesticides or PCBs).

- Distilled or Deionized water rinse in a quantity of at least 5 times the volume of the previous solvent (when sampling organics, pesticides or PCBs).
- Total air dry.
- Wrap in aluminum foil.

Field analytical equipment such as pH, conductivity, turbidity, dissolved oxygen, and temperature instrument probes will be rinsed first with demonstrated analyte-free water, then with the sample liquid. All decontamination activities will be performed over a container, and fluids will be containerized for proper disposal.

While performing the decontamination procedure, field personnel will use phthalate-free gloves to prevent phthalate contamination of the sampling equipment.

2.8 WASTE HANDLING

Development, purge, decontamination, and steam-cleaning fluids will be collected, containerized, and stored on site in DOT-approved (Specification 17-C) 55-gallon drums when necessary and in accordance with state and EPA guidance regarding the disposition of investigation-derived waste. All drill cuttings will also be collected and stored on site in the DOT-approved drums where required. All drums will be sealed and labeled with drum contents (soil cuttings, decontamination fluid, etc.), well/boring number, and date. NWS Earle will take possession and provide temporary storage of the drums upon project completion. B&R Environmental will determine whether off-site disposal and/or treatment is required after receiving analytical results from the sampling and arrange for appropriate handling or disposal of the drums, if required.

2.9 GROUNDWATER ELEVATION MEASUREMENT

Groundwater elevations will be recorded from all existing and newly installed monitoring wells at Site 16 to define local and regional groundwater flow directions. One round of groundwater elevations will be collected following completion of all new monitoring well installations. Groundwater elevations will be recorded according to procedures outlined in the NJDEP Field Sampling Procedures Manual and HNUS (B&R Environmental) SOP GH-2.5. Elevations will be recorded using an electronic water-level indicator and will be noted to the nearest 0.01 foot.

2.10 SITE MAPPING

All newly installed wells and sample points will be added to site maps, and any additional surveying and mapping activities will be used to improve the quality and accuracy of the site-specific drawings.

2.11 CONE PENETROMETER PROFILING

B&R Environmental will procure a subcontractor and provide oversight for cone penetration testing (CPT) to perform lithologic profiling at Sites 16/F and 26. CPT is effective for stratigraphic logging in soft soils and can be outfitted with sampling cones for the collection of in-situ aqueous samples. CPT is also effective for siting of monitoring wells (EPA, 1993).

A cone-shaped probe is hydraulically pushed by a rod into the soil and the resistance to penetration is measured by strain gauges that transmit directly to an automatic data retrieval system. Resistivity, or the electrical contrast between varying geologic materials is measured and recorded by the CPT probe; thereby allowing lithologic profiling.

Induced fluorescence will be utilized in conjunction and simultaneously with CPT at Site 16/F for the lithologic logging. This method will determine the limits of petroleum hydrocarbon contamination. The induced fluorescence method detects the fluorescence of hydrocarbons generated when stimulated with an ultraviolet light source. Results can be obtained, in-situ, in real time.

3.0 ENVIRONMENTAL SAMPLING

3.1 SAMPLE ANALYSIS SUMMARY

Samples collected at the seven sites will be submitted for the laboratory analyses as presented in Tables 3-1 and 3-2. These tables indicate the analytical parameters, preservation methods, holding times, bottle requirements, and analytical methods for each sample. Number and type of associated field quality control samples are also provided. Table 3-3 summarizes the sampling program for all sites being investigated within this RI Addendum.

3.2 SAMPLING PROCEDURES

This section discusses the procedures for performing environmental sampling at NWS Earle. Sampling to be performed includes groundwater, surface soil, subsurface soil, surface water, and sediment. Other activities include groundwater collection using hydropunch sampling and collection of railroad bed ballast from background locations. All sampling procedures will be consistent with the NJDEP Field Sampling Procedures Manual. Halliburton NUS (B&R Environmental) Standard Operating Procedures (SOPs) and relevant NJDEP procedures have been included in the appendices of this report to provide field sampling personnel with a generalized description of each sampling activity. Note that the NJDEP Field Sampling Procedures Manual will overrule Halliburton NUS (B&R Environmental) SOPs with regard to specific sampling practices. Field personnel will become familiar with the relevant sections of the NJDEP Field Sampling Procedures Manual prior to beginning field activities.

3.2.1 Subsurface Soil Sampling

Subsurface soil samples will be collected from hand auger borings. Soil samples will be collected in accordance with the NJDEP Field Sampling Procedures Manual and relevant HNUS (B&R Environmental) SOP GH-1.3. Soil compositing will not take place. All samples obtained from the boreholes shall be monitored with an organic vapor monitor when sampling for volatile organic compounds (VOCs) or semivolatiles (SVOC). Soil samples collected for volatile and semivolatile analysis will be taken and bottled first. Individual samples collected for metals analysis will be homogenized prior to filling the sample bottle.

TABLE 3-1
ANALYTICAL PROGRAM
NWS EARLE, COLTS NECK, NEW JERSEY

Parameter[1]	Method	Sample Type	No. of Samples	Trip Blanks[2]	Equipment Rinsates[3]	Field Blanks[4]	Field Duplicates[5]	Total No. of Samples
SITE 3 (LANDFILL SOUTHWEST OF "F" GROUP)								
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Surface Soil	2	NA	0	0	0	2
		Sediment	3	NA	0	0	1	4
TAL Metals	CLP SOW ILM02.1	Surface Soil	2	NA	0	0	0	2
		Sediment	3	NA	0	0	1	4
TCL Pesticide/PCB Compounds	CLP SOW ILM01.8	Surface Soil	2	NA	0	0	0	2
		Sediment	3	NA	0	0	1	4
Landfill Parameters	(6)	Surface Soil	2	NA	0	0	0	2
		Sediment	3	NA	0	0	1	4
SITE 6 (LANDFILL WEST OF NORMANDY ROAD)								
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Surface Water	6	NA	1	0	1	8
		Sediment	6	NA	1	0	1	8
TAL Metals	CLP SOW ILM02.1	Surface Water	6	NA	1	0	1	8
		Sediment	6	NA	1	0	1	8
TCL Pesticide/PCB Compounds	CLP SOW OLM01.8	Surface Water	6	NA	1	0	1	8
		Sediment	6	NA	1	0	1	8
Landfill Parameters: TOC, grain size, percent moisture and solids	(6)	Sediment	6	NA	0	0	0	6
Landfill Parameters: includes COD, BOD, TSS, alkalinity, hardness	(7)	Surface Water	6	NA	0	0	0	6

TABLE 3-1 (Continued)
ANALYTICAL PROGRAM
NWS EARLE, COLTS NECK, NEW JERSEY

Parameter[1]	Method	Sample Type	No. of Samples	Trip Blanks[2]	Equipment Rinsates[3]	Field Blanks[4]	Field Duplicates[5]	Total No. of Samples
SITE 12 (BATTERY STORAGE AREA)								
TAL Metals	CLP SOW ILM02.1	Soil	4	NA	0	0	1	5
Total Organic Carbon	SW-846 9060	Soil	4	NA	0	0	1	5
SITE 13 (DEFENSE PROPERTY DISPOSAL OFFICE YARD)								
Volatile Organic Compounds	Field GC	Groundwater	12[8]	NA	1	1	2	16
TCL Volatile Organic Compounds- (Confirmation Samples)	CLP SOW OLM01.8	Groundwater	3	NA	1	1	1	6
SITE 16 (EPIC SITE F/ROUND HOUSE SITE)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	1	0	0	1	6
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	NA	0	0	1	5
SITE 17 (LANDFILL)								
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Surface Water	6	NA	1	0	1	8
		Sediment	6	NA	0	0	0	6
TAL Metals	CLP SOW OLM02.1	Surface Water	6	NA	1	0	1	8
		Sediment	6	NA	0	0	0	6
TCL Pesticide/PCB Compounds	CLP SOW OLM01.8	Surface Water	6	NA	1	0	1	8
		Sediment	6	NA	0	0	0	6
Landfill Parameters: TOC, grain size, percent moisture and solids	(6)	Sediment	6	NA	0	0	0	6
Landfill Parameters: includes COD, BOD, TSS, alkalinity, hardness	(7)	Surface Water	6	NA	0	0	0	6

TABLE 3-1 (Continued)
ANALYTICAL PROGRAM
NWS EARLE, COLTS NECK, NEW JERSEY

Parameter[1]	Method	Sample Type	No. of Samples	Trip Blanks[2]	Equipment Rinsates[3]	Field Blanks[4]	Field Duplicates[5]	Total No. of Samples
SITE 26 (EXPLOSIVE "D" WASHOUT AREA)								
Volatile Organic Compounds	Field GC	Groundwater	60[8]	NA	1	1	6	68
Volatile Organic Compounds (Confirmation Samples)	CLP SOW OLMO1.8	Groundwater	12	NA	1	1	2	16
BACKGROUND SAMPLES								
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Surface Water	3	NA	1	0	1	5
		Sediment	3	NA	0	0	0	3
TAL Metals	CLP SOW ILM02.1	Surface Water	3	NA	1	0	1	5
		Sediment	3	NA	0	0	0	3
TCL Pesticide/PCB Compounds	CLP SOW OLM01.8	Surface Water	3	NA	1	0	1	5
		Sediment	3	NA	0	0	0	3
Synthetic Precipitation Leachate Procedure (RCRA Hazardous Materials/Leachability)	SPLP Method 1312	Railroad Bed Ballast	2	NA	0	0	0	2
Landfill parameters: TOC, grain size, percent moisture and solids	(6)	Sediment	3	NA	0	0	0	3
Landfill Parameters: includes COD, BOD, TSS, alkalinity, hardness	(7)	Surface Water	3	NA	1	0	1	5

TABLE 3-1 (Continued)
ANALYTICAL PROGRAM
NWS EARLE, COLTS NECK, NEW JERSEY

(1) TAL - Target Analyte List; TCL - Target Compound List.

(2) Trip Blanks - Samples which originate from analyte-free water taken from the laboratory to the sampling site and returned to the laboratory with the volatile organic compound (VOC) samples. One trip blank per cooler containing VOCs. Trip Blanks are analyzed for VOCs only.

(3) Low flow pump will be used to obtain all groundwater samples. The rinsate blank indicated represents demonstrated analyte-free water run through the sampling device before use and collected as a rinsate. Equipment blanks will be collected and analyzed for each type of non-dedicated sampling equipment used each day a decontamination event is carried out, not to exceed one per day. Equipment rinsate blanks will be analyzed for the same suite of analytical parameters as the associated environmental samples.

(4) Obtained at a frequency of 1/source/event. Two water sources are applicable (deionized water and potable water used for decontamination). All samples will be obtained in one field event.

(5) Field Duplicates - A single sample split into two portions during a single act of sampling. Assesses the overall precision of the sampling and analysis program. Obtained at a frequency of 10% of the number of samples.

(6) Landfill parameters analytical methods: Total Organic Carbon, SW-846 9060; grain size, ASTM D421 D422; percent moisture and solids.

(7) Landfill parameters analytical methods: Chemical Oxygen Demand, EPA 410.1; Biochemical Oxygen Demand, SM 5210B; Total Suspended Solids; alkalinity; hardness, E130-2.

(8) 20% of field GC samples will be submitted to a fixed laboratory for confirmation analysis using analytical method CLP SOW OLMO1.8 for VOCs.

NA Not Applicable

TABLE 3-2

SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
NWS EARLE, COLTS NECK, NEW JERSEY

Parameter	Sample Container	Container Volume	Preservation[1]	Maximum Holding Time[5]	Analytical Methodology[2]
AQUEOUS (GROUNDWATER AND SURFACE WATER)					
TCL Volatile Organic Compounds	Glass, black phenolic plastic screw cap, Teflon-lined	40 mL	Cool to 4°C, dark, HCl to pH < 2	14 days if preserved, if not preserved 7 days aromatics, 14 days all other	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TCL Semivolatile Organic[8] Compounds	Amber glass, Teflon-lined cap	2000 mL	Cool to 4°C, dark	Extraction 7 days; analysis within 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TCL Pesticides and Polychlorinated Biphenyls[8] (PCBs)	Amber glass, Teflon-lined cap	2000 mL	Cool to 4°C, dark	Extraction 7 days; analysis within 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TAL Metals	Polyethylene bottle, plastic cap, plastic liner	1000 mL	Cool to 4°C, HNO3 to pH < 2	Analysis within 180 days of sample collection; mercury 28 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. #ILM02.1)
Biochemical Oxygen Demand (BOD) 5-day	Polyethylene or Glass	1000 mL	Cool to 4°C	48 hours	Standard Method (SM) 5210B
Chemical Oxygen Demand (COD)[4]	Polyethylene or Glass	50 mL	Cool to 4°C, H_2SO_4 to pH < 2	28 days	EPA 410.1
Total Organic Carbon (TOC)[4]	Polyethylene or Glass	25 mL	Cool to 4°C, H_2SO_4 to pH < 2	petroleum based 3 days; non-petroleum based 24 hours	EPA 415.1
Turbidity[3]	Polyethylene or Glass	100 mL	Cool to 4°C	48 hours	EPA 180.1

TABLE 3-2 (Continued)
SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
NWS EARLE, COLTS NECK, NEW JERSEY

Parameter	Sample Container	Container Volume	Preservation[1]	Maximum Holding Time[5]	Analytical Methodology[2]
SOLID (SURFACE SOIL, SUBSURFACE SOIL, SEDIMENT, AND BALLAST)					
TCL Volatile Organic Compounds	Glass, polypropylene cap, white Teflon-liner	120 mL	Cool to 4°C, dark	10 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TCL Semivolatile Organic Compounds	Amber glass, Teflon-lined cap	1000 mL	Cool to 4°C, dark	Extract 7 days; Analyze 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TCL Pesticides and Polychlorinated Biphenyls (PCBs)	Amber glass, Teflon-lined cap	2000 mL	Cool to 4°C, dark	Extract 7 days; Analyze 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TCL Pesticides only	Amber glass, Teflon-lined cap	1000 mL	Cool to 4°C, dark	Extract 7 days; Analyze 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TCL Polychlorinated Biphenyls (PCBs) only	Amber glass, Teflon-lined cap	1000 mL	Cool to 4°C, dark	Extract 7 days; Analyze 40 days	U.S. EPA-CLP SOW for Organic Analysis, Multi-Media, Multi-Concentration (Doc. #OLM01.8) 5/90
TAL Metals/Cyanide	Flint glass bottle, black phenolic cap, polyethylene liner	8 oz	Cool to 4°C	Analyze within 180 days; mercury 28 days; cyanide 14 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. #ILM02.1)
Total Organic Carbon (TOC)	Clear wide mouth glass	4 oz	Cool to 4°C	14 days	Lloyde Kahn Method
Grain Size	4 Clear wide mouth glass jars	32 oz	None	None	ASTM D421, D422

TABLE 3-2 (Continued)
SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
NWS EARLE, COLTS NECK, NEW JERSEY

(1) $Na_2S_2O_3$ = Sodium Thiosulfate, Cl_2 = Chlorine, HCl = Hydrochloric acid, NaOH = Sodium Hydroxide.

(2) All Methodolgies recommended by "New Jersey Department of Environmental Protection and Energy (NJDEPE) Field Sampling Procedures Manual" May 1992 and 40 CFR 136.3. Except Explosives method U.S. EPA SW-846 Method 8330, Total Organic Carbon (TOC) U.S. EPA SW-846 Method 9060, and Grain Size ASTM Methods D421 and D422.

(3) Chloride, sulfate, and turbidity can be collected for analysis in one bottle. A volume of 500 mL is needed for all.

(4) Chemical oxygen demand (COD), Nitrate-nitrite as (N), total organic carbon (TOC), and phosphate as (P) can all be collected in the same container. A volume of 500 mL is needed to perform all analyses listed.

(5) Maximum holding times refer to the period from sample collection to analysis (technical holding time).

(6) Additionally $CaCO_3$ (Calcium Carbonate) must be added in the presence of sulfide, and 0.6g of ascorbic acid must be added in the presence of chlorine. KI starch paper may be used to test for chlorine. The procedure is detailed in Halliburton NUS SOP SF-1.2.

(8) Field personnel must collect one out of every 20 samples in triplicate volume in order for the laboratory to perform matrix spike and matrix spike duplicate analysis.

TABLE 3-3
SUMMARY OF FIELD ACTIVITIES AND ANALYTICAL SAMPLES AT EACH SITE
NWS EARLE, COLTS NECK, NEW JERSEY

Site	Field Activity			Analytical Samples[1]					
	Soil Boring	Monitoring Well Installation	Hydro-punch	Railroad Bed Ballast	Subsur face Soil	Surface Soil	Ground water Sample	Surface Water Sample	Sediment Sample
Site 3, Landfill SW of "F" Group	---	---	---	---	---	2	---	---	3
Site 6, Landfill West of Normandy Road	---	---	---	---	---	3	---	3	3
Site 12, Battery Acid Spill Site	3	---	---	---	3	1	---	---	---
Site 13, Defense Property Disposal Yard	---	---	4	---	---	---	12[2]	---	---
Site 16, Diesel Line to Building C-50		4	---	---	---	---	4	---	---
Site 17, Disposal Site at Waterfront	---	---	---	---	---	3	---	3	3
Site 26, Explosive "D" Washout Area (Bldg. GB-1)	---	---	20	---	6	---	60[2]	---	---
Background	---	---	---	2	---	---	---	3	3
TOTAL									

1 Does not include QA samples.
2 VOCs by GC- Field Screening

3.2.2 Surface Soil Sampling

Surface soils will be collected in accordance with the NJDEP Field Sampling Procedures Manual and relevant HNUS (B&R Environmental) SOP GH-1.3. Soil compositing will not take place. Soil samples will be collected using stainless-steel trowels and stainless-steel sampling bowls. All samples (except VOAs and SVOCs) will be homogenized prior to filling the required sample containers. Soil samples collected for volatile and semivolatile analysis will be taken and bottled first. Individual samples collected for metals analysis will be homogenized prior to filling the sample bottle.

All stainless-steel sampling equipment utilized during sampling will be decontaminated between samples, as described in Section 2.7.2. All pertinent field data will be recorded using the appropriate sample log sheet and the field logbook. Sample handling and preservation requirements are shown in Table 3-2.

3.2.3 Groundwater Sampling

Groundwater samples will be obtained from all newly installed groundwater monitoring wells at Site 16. Groundwater sampling will be conducted in accordance with the EPA Region I Groundwater Sampling Procedure Low Flow Purge and Sampling included in Appendix B-1. Monitoring wells will not be sampled prior to 14 calendar days after development (or redevelopment).

Prior to obtaining samples, water levels will be measured and the wells will be purged using a low-flow pump to reduce turbidity. This technique allows for representative metals samples to be collected. The well will be purged until groundwater parameters (temperature, pH, conductivity, turbidity) stabilize within acceptable limits. Care will be taken to avoid overpumping or pumping the well to dryness. General guidelines for monitoring well purging are as follows:

- Dedicated polyethylene (PE) tubing will be used for each well.
- Wells will not be purged to dryness and will not be purged at a rate greater than the rate at which the well was developed.
- Field measurements of pH, temperature, dissolved oxygen, and specific conductance will be taken for each well volume during purging.
- Hand bailing is the least recommended method of well purging and will not be used unless

no other method can be utilized.

Following well purging, sampling will begin using the following guidelines:

- The time lapse between purging and sampling will not exceed 2 hours.
- Sampling for VOCs and SVOCs will be performed using dedicated low-flow sampling pumps and dedicated sample collection tubing.

The appropriate sample bottles for analysis, and the sample will then be preserved as specified in Table 3-2. If pre-preserved bottles are used, the field sampling team must check pH to assure the sample is properly preserved; the field team must be prepared to add additional preservatives if necessary. The groundwater sample log sheet for each well will contain, at a minimum, pH, temperature, dissolved oxygen, specific conductance, color and turbidity (in NTUs). Well logs at appropriate locations (e.g., Waterfront) will also include salinity and Eh measurements. All pertinent field data will be recorded using the appropriate sample log sheet and the field logbook [see HNUS (B&R Environmental) SOP SA-6.3]. A groundwater sample log sheet can be found in Appendix A of this work plan.

Static water level measurements will also be obtained for each newly installed monitoring well. These wells will be surveyed to the existing mapping datum.

3.2.4 Surface Water/Sediment Sampling

Surface water samples will be obtained from the marsh areas at Sites 3 and 17 and at background locations. Surface water sampling will be conducted in accordance with the NJDEP Field Sampling Procedures Manual and HNUS (B&R Environmental) SOP SA-1.2, Section 5.3. A brass Kemmerer sampling device will not be used to collect surface water samples. General surface water and sediment sampling procedures are as follows:

- Sediment will be sampled from areas of sediment deposition that will have the greatest potential for receiving contamination.
- When surface water and sediment samples are being collected from the same location, surface water will be collected first.
- Downstream samples will be collected first, proceeding upstream.

- Samples of surface water will be obtained by dipping the sample bottle (referred to as a dip or grab sampling method) into the surface water (if possible). If flow from a seep or spring is not sufficient to use this sample method, a small excavation will be made and allowed to fill with the aqueous-phased material and then sampled.

- Water present in sediment sample jars will not be decanted, which may result in a loss of fine material.

Field measurements will be obtained from the surface water samples prior to sample collection. These field measurements include pH, specific conductance, dissolved oxygen, salinity, flow, and temperature. Color and turbidity will also be noted on the sample log form for each surface water sample. Procedures for obtaining these field measurements will be in accordance with HNUS SOP SF-1.1.

Sediment samples will be obtained from on-site drainage, at seeps, from drainage swales, and from background locations. Sediment sampling will be conducted in accordance with the NJDEP Field Sampling Procedures Manual and HNUS (B&R Environmental) SOP SA-1.2 Section 5.4. Samples will be collected using a scoop sampler or stainless-steel trowel. Sediment characteristics shall be noted on the sample log form for each sediment sample. Sediment field parameters include temperature, Eh (EPA Method 9045), pH, conductivity, and color (Munsell). All pertinent field data will be recorded using sample log sheets and the field log book. Surface water and sediment sample forms can be found in Appendix A of this work plan. Sample handling and preservation requirements are shown in Table 3-2.

3.2.5 Hydropunch Groundwater Sampling

To determine general groundwater quality groundwater samples will be collected at several sites using a hydropunch (or similar technology such as Geoprobe™). To obtain these samples, a small stainless-steel screen (approximately 1 inch in diameter) will be pushed below the water table, and a groundwater sample will be collected using a stainless-steel bailer. The samples will be collected using a discrete groundwater sampling mode (Hydropunch I). Since these samples are used as a screening tool for groundwater quality, a less rigorous sampling procedure will be used than is used for sampling monitoring wells. Following the sampling, the hole will be allowed to collapse (if less than 25 feet) or will be sealed with tremie-grouting technique (if greater than 25 feet in depth) according to the NJDEP requirements.

Samples will be anlayzed in the field for VOCs using a portable GC. Twenty percent of the samples will be submitted to a fixed laboratory for confirmation analysis. Sample handling and preservation requirements are shown in Table 3-2.

3.3 SAMPLE HANDLING

Sample handling includes the field-related considerations concerning the selection of sample containers, preservatives, allowable holding times, and sample analyses. In addition, sample identification, packaging, and shipping will be addressed. The NJDEP Field Sampling Procedures Manual addresses the topics of containers and sample preservations. Table 3-2 provides a summary of these sample handling considerations.

3.3.1 Sampling Identification System

Each sample collected will be assigned a unique sample tracking number consisting of an alpha-numeric code that identifies the site, the sample medium and location, and sample depth (for subsurface soils). Any other pertinent information regarding sample identification will be recorded in the field log books.

The alpha-numeric coding to be used in the sample system is explained in the following table:

Site, Medium, Location	Sample Depth
NN AA NN	NNN

Character Type:

A = Alpha

N = Numeric

Site:

03 = Site 3, Landfill Southwest of "F" Group

06 = Site 6, Landfill West of Normansy Road

12 = Site 12, Battery Storage Area

13 = Site 13, Defense Property Disposal Office Yard

16 = Site 16/EPIC Site F, Roundhouse

17 = Site 17, Landfill

26 = Site 26, Explosive "D" Washout Area

BG = Background/Refernce sample

Medium:

SS = Surface Soil

SB = Subsurface Soil

GW = Groundwater

SW = Surface Water

SED = Sediment

Sample Location:

The sample location code will depend on the medium being collected, as shown below:

Subsurface soil	=	soil boring number
Surface soil	=	sample location number
Groundwater sample	=	well number or hydropunch sample number
Sediment/surface water	=	sample location number
Background/Reference sample	=	background or reference sample location number

Sample Depth:

For subsurface soil samples - top of sample interval depth in feet

Not used for surface soils, sediment, groundwater, or surface water samples

Filtered Samples:

No samples for analysis will be filtered.

Example of Sample Labeling System:

A sample taken from Site 16, monitoring well MW-04 would be labeled 16GW04. A subsurface soil sample taken from Site 12, from the first soil boring location starting at 3.0 feet would be labeled 12SB01-03. A surface soil sample taken from the third background sample location would be labeled BGSS03-01. The numerical sequence will commence beginning with the last designation used during 1995 B&R Environmental RI field activities.

Field Duplicate Labels:

Field duplicates will be designated as DUP-01, DUP-02, etc., when they are submitted to the laboratory so that the duplicates are submitted to the laboratory "blind." The chain-of-custody form and other documentation submitted to the laboratory will be filled out so that the laboratory cannot match the duplicates to the original sample. The time on the duplicate samples will be noted as 00:00. The correct sample location, time, etc., will be documented in the field log book.

Quality Control Sample Labels:

Quality control samples will be taken periodically. These samples will be used to document the effectiveness of decontamination to determine the quality of water used for decontamination, and to identify possible cross-contamination occurring during transit. These blank samples, including trip blanks, field blanks, and equipment rinsate blanks are defined in Section 3.5 of this report and will use the quality control sample identification scheme, listed below:

Sample Type	Sample Number	Sample Date
AA	NN	NNNNNN

Sample Type:

TB	=	Trip blank
EB	=	Equipment rinsate blank
FB	=	Field blank of source water
RB	=	Rinsate blank

Sample Number:

A sequential numeric designation will be assigned to each type of blank on a daily basis.

Sample Date:

The format MMDDYR (M=Month, D=Day, Y=Year) will be used to indicate the day the sample is generated.

Example of the Quality Control Labels:

The second trip blank sample taken on December 1, 1996 would have the sample identification label TB-02-120196. The first rinsate blank taken on January 5, 1997 would have the label RB-01-010597. Information regarding sample labels and tags to be attached before shipment to a laboratory is contained in Section 5.2 of the HNUS (B&R Environmental) SOP SA-6.1 (Appendix B).

3.3.2 Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with HNUS (B&R Environmental) SOP SA-6.2 (Appendix B). The FOL will be responsible for completion of the following forms:

- Sample Labels
- Chain-of-Custody Forms
- Appropriate labels applied to shipping coolers
- Chain-of-Custody Labels
- Express Mail Air Bills

3.4 SAMPLE CUSTODY

Custody of samples must be maintained and documented at all times. Chain-of-custody begins with the collection of the samples in the field. Section 5.3 of HNUS (B&R Environmental) SOP SA-6.1 provides a description of the chain-of-custody procedures to be followed. A sample chain-of-custody form is attached in Appendix A.

3.5 QUALITY CONTROL SAMPLES

In addition to regular calibration of field equipment and appropriate documentation, quality control (QC) samples will be collected or generated during environmental sampling activities. QC samples include field duplicates, equipment rinsate blanks, and field blanks. Trip blanks will be provided by the analytical laboratory chosen to support this project. Table 3-1 presents the type and number of required QC samples. Each type of field QC sample is defined as follows:

- Field Duplicates - Field duplicates are two samples collected (1) independently at a sampling location in the case of groundwater or surface water, or (2) a single sample split into two portions in the case of soil or sediment. Duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Ten percent of all samples for each medium will be field duplicates. Duplicates will be analyzed for the same parameters in the laboratory as their environmental sample counterparts. Field duplicates monitor field collection and laboratory analysis precision.

- Equipment Rinsate Blanks - Equipment rinsate blanks are obtained under representative field conditions by running demonstrated analyte-free water through sample collection equipment (bailer, split-spoon, hand auger bucket, etc.) after decontamination. Equipment rinsate blanks will be placed in the appropriate sample containers for analysis. Equipment blanks will be used to assess the effectiveness of decontamination procedures. Equipment blanks will be collected and analyzed for each type of non-dedicated sampling equipment used each day a decontamination event is carried out, not to exceed one per day. Equipment rinsate blanks will be analyzed for the same suite of analytical

parameters as the associated environmental samples.

- Field Blanks - Field blanks are obtained by sampling the waters used for decontamination during the field investigation. Samples consist of the source water used in (1) steam cleaning of large equipment and (2) analyte-free water used for decontamination of sampling equipment. Field blanks will be used to determine if the analyte-free water or the potable water (used for steam cleaning) may be contributing to sample contamination. Field blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event. Field blanks, as applicable, will be analyzed for the entire suite of parameters under investigation.

- Trip Blanks - Trip blanks are prepared under laboratory or controlled conditions (nonfield location) from demonstrated analyte-free water. Trip blanks are prepared no longer than 24 hours prior to the sampling event and will be preserved with HCl in the same manner as volatile samples. If the 24 hour time-frame cannot be met, trip blanks will be preserved in the field. Since it is not standard procedure to receive bottleware daily from the laboratory, samples will be preserved in the field during most sampling events.

  Trip blanks are transported from the point of preparation to the field and returned unopened with the other environmental media samples at the conclusion of the day's field activities. Trip blanks are included when analyzing for volatile organics and will be prepared and provided by the subcontractor laboratory. Trip blanks will remain with the sample containers at all times and are thus subjected to the same field conditions as the field samples. One trip blank will be included in every shipping or sample collection cooler that contains samples of VOCs to be analyzed, regardless of sample matrix.

4.0 SITE 3: LANDFILL SOUTHWEST OF "F" GROUP

4.1 SITE DESCRIPTION

The Landfill Southwest of "F" Group is a 5-acre site used from 1960 to 1968 for the disposal of domestic and industrial wastes; including paints and paint thinners, solvents, varnishes, shellac, acids, alcohols, caustics, pesticide containers and rinse water, wood, and small amounts of asbestos. Records indicate that the industrial wastes comprise only a small portion of a total of approximately 4,800 tons of wastes. Figure 6-1 is a map of the site.

The site is accessible by a dirt road from the southeast and is characterized as an open area surrounded by woodlands. The landfill is primarily covered with a sandy soil and is not closed with an impermeable cap. The site is moderately vegetated with grasses and some scrub pines. There are several scarred areas with no vegetation in the northeastern portion of the site. The ground surface is relatively flat, and ground elevations are typically between 115 and 125 feet above MSL. Wetlands are located southeast of the site. Groundwater flow is generally to the southeast, based on measured groundwater levels.

4.2 PREVIOUS INVESTIGATIONS

The 1995 RI Work Plan and 1996 RI Report present detailed discussions of data generated from previous investigations. These results are summarized below.

The 1983 IAS consisted of interviews and on-site observations. Based on the potential for groundwater impacts to the Kirkwood Aquifer, the site was recommended for a confirmation study.

During the SI in 1986, three monitoring wells were installed. During the RI/FS in 1993, seven test pits were excavated and four additional monitoring wells were installed, one upgradient of the landfill and three downgradient of the landfill. The well depths ranged from 15 to 20 feet. Two soil samples collected from the test pits were analyzed for TCL organics and TAL inorganics. Groundwater from all seven wells was collected and analyzed for full TCL/TAL analytes. Later rounds of groundwater samples were analyzed for VOCs, drinking water metals, and inorganic landfill indicator parameters at a limited number of wells.

Based on visual inspection of test pit excavations, the landfill contains typical municipal waste. In groundwater samples, an elevated level of arsenic (0.37 ppm) was found in one downgradient well (MW3-01). Elevated levels of volatiles and semivolatiles were found in some wells (particularly monitoring well MW3-04). Wells MW3-04 and MW3-05 had low levels of several pesticide compounds. However, this

concentration was not high enough to indicate that the landfill was generating a highly concentrated leachate. Low levels of metals, hydrocarbons, and VOCs were found in groundwater. The RI test pits encountered mostly household trash and debris.

Between May and October 1995, B&R Environmental conducted RI field investigation activities including a soil gas study, test pit excavations, installation of one shallow monitoring well, groundwater sampling, and sampling from adjacent wetlands. Monitoring well results showed low levels of inorganic conpounds. Sediment from the wetlands (drainage swale) showed elevated levels of metals, semi-volatiles and pesticides. Table 4-1 presents the results for the drainage swale sediment in comparison to ARARs and TBCs. Table 4-2 presents monitoring well results in comparison to screening levels.

4.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on previous sampling results, the 1996 RI report concluded that further data were required to assess ecological impacts of the site on adjacent wetlands. Metals, semivolatiles, and pesticides were detected above screening levels in the only sample obtained from the drainage ditch. The sampling for the RI Addendum field work will provide data to assess the impacts of the landfill on the wetlands. Three sediment samples from the drainage pathway southeast of the landfill will be collected. One sample will be upstream of the site, and two will be collected downstream of the landfill. In addition, two soil/sediment samples from the southeast face of the landill will also be obtained to determine if the landfill is the source of contaminants impacting the drainage pathway. Proposed sampling locations are located on Figure 4-1, and the sampling rationale is presented in Table 4-3.

Analytical parameters for these samples will be TAL metals, TCL SVOCs, and TCL pesticides/PCBs. Laboratory paramaters will also include TOC, grain size and percent moisture and solids. Field parameters will include temperature, Eh (EPA Method 9045), pH, conductivity, and color.

4.4 SITE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

TABLE 4-1

07/15/96

FINAL

Page 1

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 3

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	03SDWET3A-1	---	---	---	---	---	---	ARARS & TBCs
LOCATION:	03SDWET3A-1	---	---	---	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI							
INORGANICS	**mg/kg**							**mg/kg**
aluminum	9870							-
antimony	1.3							2.00 M
arsenic	6.2							8.20 L
barium	60.8 E							40.0 B
beryllium	0.26							-
cadmium	2.1 E							1.20 L
calcium	2570							-
chromium, total	22.1 J							81.0 L
cobalt	2.3							50.0 T
copper	24.3							34.0 L
iron	15000							-
lead	89.1 E							47.0 L
magnesium	545							-
manganese	42.3							460 O
mercury	0.26 E							0.150 L
nickel	9.5							21.0 L
potassium	406							-
selenium	2.1 R							-
silver	0.44							1.00 M
sodium	85.3							-
vanadium	31.7							-
zinc	104 R							150 L
SEMIVOLATILES	**ug/kg**							**ug/kg**
2-methylnaphthalene	140 J							330 F
acenaphthene	52.0 J							620 Q
acenaphthylene	130 E J							44.0 L
anthracene	140 J							330 F
benzo(a)anthracene	1300 E							330 F

TABLE 4-1

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 3

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	03SDWET3A-1	---	---	---	---	---	---	ARARS & TBCs
LOCATION:	03SDWET3A-1	---	---	---	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI							
SEMIVOLATILES	ug/kg							ug/kg
benzo(a)pyrene	1400 E							430 L
benzo(b)fluoranthene	2000 E							330 F
benzo(g,h,i)perylene	1000 E							330 F
bis(2-ethylhexyl)phthalate	82.0 J							890000000 S
butylbenzylphthalate	64.0 J							11000 Q
carbazole	70.0 J							330 F
chrysene	1800 E							330 F
dibenz(a,h)anthracene	240 J							330 F
fluoranthene	2200							2900 Q
fluorene	260 J							540 P
indeno(1,2,3-cd)pyrene	880 E							330 F
naphthalene	130 J							480 P
phenanthrene	2400 E							850 Q
pyrene	3400 E							660 L
PESTICIDES	ug/kg							ug/kg
4,4'-DDE	16.0 E R							2.20 L
4,4'-DDT	4.0 E J							1.60 L
alpha-BHC	0.082 JN							3.70 S
alpha-chlordane	2.1 J							7.00 O
endosulfan I	0.89 R							-
gamma-BHC (Lindane)	0.61 R							-
heptachlor	0.49 R							5.00 O
heptachlor epoxide	2.2 J							5.00 O

TABLE 4-1

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCS - SITE 3
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to sediment ecological toxicity criteria:

- No standard is available for this chemical in this classification.

B - Source: Baudo, R., J. Geisy and H. Muntau. eds. 1990. Sediments: Chemistry and Toxicity of In-Place Pollutants. Lewis Publishers, Inc. Ann Arbor, MI.

F - Source: USEPA. 1994c. Draft Region IV Waste Management Division Sediment Screeing Values for Hazardous Waste Sites. 2/16/94 Revision.

L - Effects Range-Low. Source: Long E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management. 19:81-97.

M - Effects Range-Low. Source: Long, E. R. and L. G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA.

O - Ontario screening level. Source: Ontario Ministry of the Environment (OME). 1992. Guidelines for the Protection and Management of the Aquatic Sediment Quality in Ontario. Log 92-2309-067, PIBS 1962.

P - Sediment quality benchmark using equipartition. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

Q - Sediment quality criterion. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

S - Sediment screening benchmark. Source: Suter, G. W., and J. B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. Oak Ridge National Laboratory, Oak Ridge, TN.

T - Threshold for soils. Source: Direction des Substances Dangereuses. 1988. Contaminated Sites Rehabilitation Policy. Gouvernement du Quebec. Ministere de L'Environment. Sainte-Foy, Quebec, Canada. In: R.L. Siegrist. 1989. International Review of Approaches for Establishing Cleanup Goals for Hazardos Waste Contaminated Land. Institute for Georesearch and Pollution Research. Norway.

W - Screening value for wet soil. Source: Will, M.E., and G.W. Suter. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1994 Revision. Oak Ridge National Laboratory.

TABLE 4-2

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 3

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	03GW01	03GW01-F	03GW03	03GW03-F	03GW05	03GW06	ARARS & TBCs		
LOCATION:	03GW01	03GW01	03GW03	03GW03	03GW05	03GW06	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
INORGANICS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
aluminum	7930 E	5520 E	448 E	152	268 E J	498 E J	-	-	200
antimony	2.7 U	6.1 E	2.7 U	10.6 E	2.7 U	2.7 U	6.00	3.00 a	20.0
arsenic	15.1 E	4.5	3.3 U	3.3 U	3.3 U	3.3 U	50.0	-	8.00
barium	689	34.0	16.5	16.0	41.7	2.6	2000	2000 a	2000
beryllium	0.11 U	0.20	0.11 U	0.11 U	0.11 U	0.11 U	4.00	4000 e	20.0
cadmium	11.7 E	12.3 E	2.3	2.2	6.5 E	0.38 U	5.00	5.00 e	4.00
calcium	3920	3730	4540	4440	6340	7260	-	-	-
chromium, total	9.8	3.1	1.0 U	1.0 U	1.4	1.3	100	100 a	100
cobalt	4.4	3.6	0.60 U	0.60 U	8.4	0.60 U	-	-	-
copper	16.3	20.2	0.92	11.9	1.2	0.79	1300	-	1000
iron	26000 E	2670 E	988 E	433 E	930 E J	440 E J	-	-	300
lead	5.1 J	3.1 J	1.5 UJ	1.5 UJ	1.5 U	1.5 U	15.0	-	10.0
magnesium	2560	1740	603	619	807	3240	-	-	-
manganese	43.3	37.2	9.0	11.0	534 E J	4.4	-	-	50.0
mercury	0.12 J	0.13 J	0.11 J	0.10 J	0.0090	0.0080	2.00	2.00 b	2.00
nickel	22.7	20.7	4.3	5.2	8.8	1.1	100	100 a	100
potassium	2270	1810	309	283	1000	497	-	-	-
sodium	7460	7950	3490	3480	4440	4120	-	-	50000
thallium	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U	4.0 E J	2.00	0.400 a	10.0
vanadium	11.3	0.61 U	0.61 U	0.61 U	0.61 U	0.69	-	-	-
zinc	623 J	91.3 J	109 J	107 J	259	1.6 U	-	2000 a	5000
VOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
2-butanone	10.0 U	n/a	5.0 J	n/a	10.0 U	10.0 U	-	-	300
PESTICIDES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
gamma-BHC (Lindane)	0.050 U	n/a	0.050 U	n/a	0.0016 R	0.050 U	0.200	0.200 a	0.200
gamma-chlordane	0.050 U	n/a	0.050 U	n/a	0.0081 J	0.050 U	2.00	2.00 a	0.500

TABLE 4-2

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCS - SITE 3
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to MCLs, MCLGs, or SMCLs:

. - No standard is available for this chemical in this classification.

a - Where applicable, value(s) represent the more stringent of criteria for total, cis-, and trans- isomers.

* - Criteria are for total chromium.

** - Action level 1300 ug/L for water treatment technology for public water supply systems.

*** - Action level 15 ug/L for water treatment technology for public water supply systems.

Footnotes to Health Advisories:

. - No standard is available for this chemical in this classification.

a - The listed health advisory criterion, lifetime adult, is equal to the most stringent of the EPA health advisories for this chemical.

b - The listed health advisory criterion, long-term adult, is equal to the most stringent of the EPA health advisories for this chemical.

c - The listed health advisory criterion, one-day child, is equal to the most stringent of the EPA health advisories for this chemical.

d - The listed health advisory criterion, ten-day child, is equal to the most stringent of the EPA health advisories for this chemical.

e - The listed health advisory criterion, long-term child, is equal to the most stringent of the EPA health advisories for this chemical.

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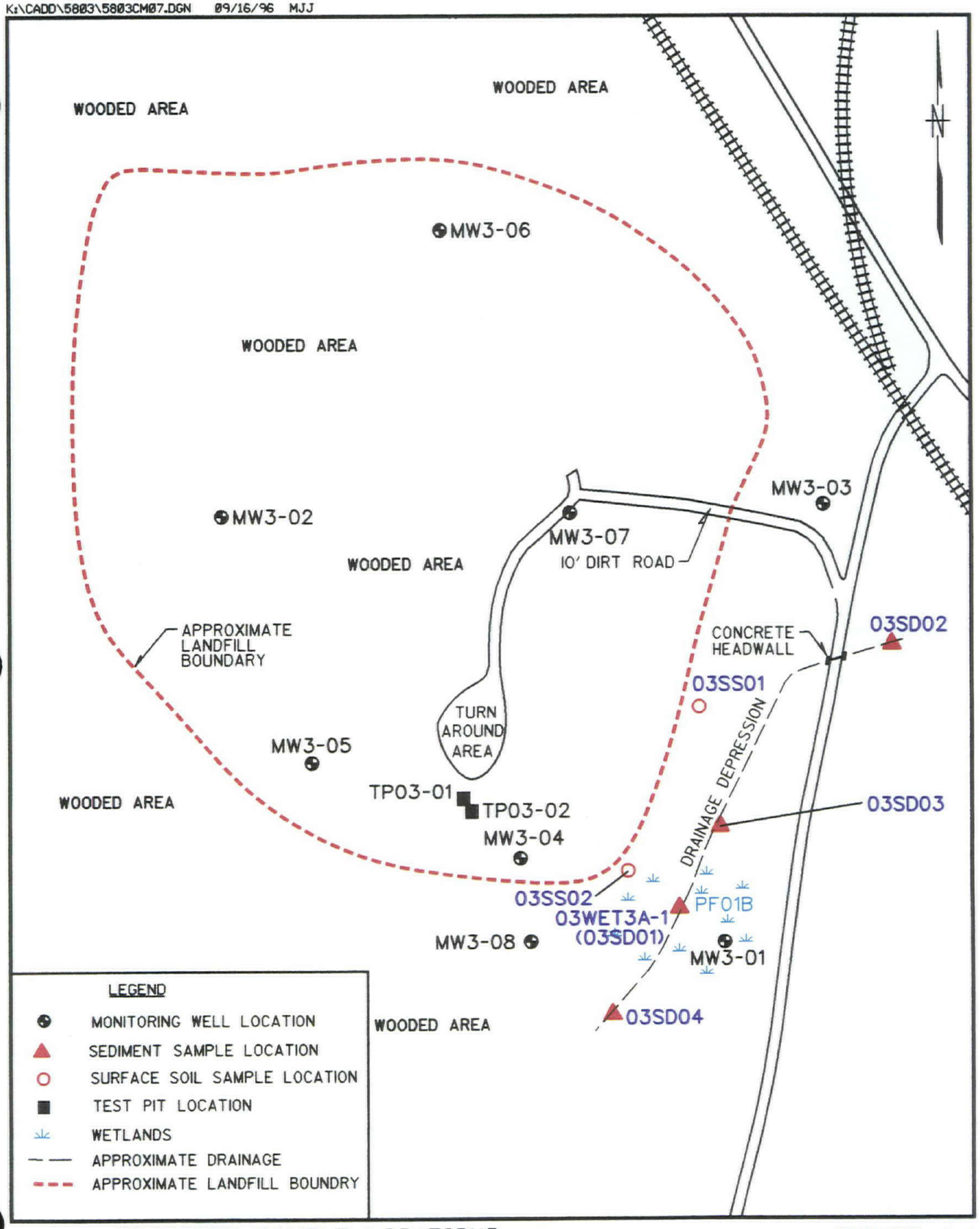

PROPOSED SAMPLE LOCATIONS

SITE 3 - LANDFILL SOUTHWEST OF "F" GROUP

FIGURE 4-1

0 120 240
SCALE IN FEET

Brown & Root Environmental

TABLE 4-3

SAMPLING LOCATIONS AND RATIONALE

SITE 3

NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Three sediment samples	Drainage ditch southeast of the landfill: one upstream, one midstream, one downstream	Determine extent of contamination in wetlands
Two soil/sediment samples	Southeast face of landfill	Determine if COCs detected in wetlands sediment during 1995 RI are site related

5.0 SITE 6: LANDFILL WEST OF NORMANDY ROAD

5.1 SITE DESCRIPTION

The landfill west of Normandy Road is a 4-acre site located in the Waterfront area. From 1943 to 1965, the site was used to dispose of refuse from the Waterfront area. The wastes consisted of dunnage lumber, glass, paper, packing material, and small amounts of paint and solvent. It was reported that the wastes were burned before they were covered, and an estimated 2,500 tons of waste were deposited annually at the landfill. The landfill area may have been part of a salt marsh before disposal began. Currently, the majority of the landfill surface is paved or covered with buildings. The landfill surface is 3 to 10 feet higher than the adjacent marsh wetlands areas, and the toe of the landfill is covered with vegetation. Infiltration is limited and overland flow drains toward the salt marsh and eventually into Sandy Hook Bay. Groundwater flow is to the north and northwest based on measured groundwater levels.

5.2 PREVIOUS INVESTIGATIONS

The 1995 RI Work Plan and 1996 RI Report present detailed discussions of data generated from previous investigations. These results are summarized below.

The 1983 IAS consisted of interviews and on-site observations. The site was not recommended for a confirmation study.

During the 1993 SI, four soil borings were drilled and completed as monitoring wells. Two soil samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Low levels of VOCs and two pesticides were detected in soil samples from the locations of MW6-02 and MW6-03. Low levels of metals were also detected. Four sediment samples were collected from the marsh area downgradient of the site. Elevated levels of metals, pesticides, semivolatiles, and PCBs were detected. Groundwater samples were collected from the four monitoring wells and analyzed for metals, organics, and landfill parameters. Elevated levels of metals, one SVOC, and two miscellaneous parameters were detected. Landfill parameters were relatively low compared to active solid waste landfills.

The 1995 RI included sampling of existing wells using low-flow techniques to confirm previous results and sampling of surface water and sediment to determine the impact on adjacent wetlands. Groundwater samples showed elevated levels of cadmium, iron, and manganese, as well as low levels of pesticides. Sediment samples showed elevated levels of metals, semivolatiles, and pesticides. Surface water

samples indicated the presence of site-related metals. Table 5-1 presents the results for sediment in comparison to ARARs and TBCs. Table 5-2 presents groundwater results in comparison to screening levels. Table 5-3 presents surface water results in comparison to screening levels.

5.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on previous sampling results, the 1996 RI report concluded that further data were required to assess ecological impacts of the site on adjacent wetlands. Metals, semivolatiles, and pesticides were detected above screening levels in surface water and sediment samples. The sampling for the RI Addendum field work will provide data to assess the impacts of the landfill on the wetlands. Six surface water and sediment samples will also be collected from the adjacent marsh northeast of the landfill to determine if it has been impacted by the landfill. Proposed sampling locations are located on Figure 5-1 and the sampling rationale is presented in Table 5-4.

Anlaytical parameters will be TAL metals, TCL SVOCs, and TCL pesticides/PCBs. Surface water samples will also be analyzed in the laboratory for total suspended soilds, alkalinity, hardness, BOD, COD, and TDS. Laboratory parameters for solid samples will include TOC, grain size and percent moisture and solids. Field parameters for surface water samples will be pH, conductivity, salinity, and flow (width and depth). Field parameters for sediment samples include temperature, Eh (EPA Method 9045), pH, conductivity, and color.

5.4 SITE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

TABLE 5-1

07/15/96

FINAL

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 6

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	06SD01	06SD02	06SD03	06SD04	---	---	---	ARARS & TBCs
LOCATION:	06SD01	06SD02	06SD03	06SD04	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI				
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg				mg/kg
aluminum	7610 J	6370	3980	3660 J				-
antimony	9.3 UJ	5.2 U	5.5 U	12.4 E J				2.00 M
arsenic	21.4 E J	3.0	33.1 E	36.3 E J				8.20 L
barium	94.5 E J	138 E J	13.7	114 E J				40.0 B
beryllium	1.0 J	0.57	0.21	0.30 UJ				-
cadmium	1.5 E J	0.61 U	0.65 U	1.8 E J				1.20 L
calcium	4880 J	1170	1080	8820 J				-
chromium, total	44.5 J	18.0	22.5	77.2 J				81.0 L
cobalt	8.2 J	4.3	1.2 U	7.7 J				50.0 T
copper	111 E J	20.9	13.1	228 E J				34.0 L
iron	52200 J	13800	15300	46000 J				-
lead	221 E J	41.0 J	28.7 J	445 E J				47.0 L
magnesium	2460 J	1180	401	2330 J				-
manganese	134 J	27.1 J	32.3 J	451 J				460 O
mercury	0.38 E J	0.027	0.060	0.63 E J				0.150 L
nickel	21.7 E J	8.1	2.3	43.8 E J				21.0 L
potassium	956 J	1770	542	1530 J				-
selenium	3.2 J	1.3 J	1.2 J	3.4 J				-
sodium	335 J	191	28.6	420 J				-
thallium	2.1 J	0.73 U	0.78 U	1.3 UJ				-
vanadium	48.7 J	18.2	43.3	87.8 J				-
zinc	486 E J	87.4 J	61.1 J	1720 E J				150 L
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
acenaphthylene	740 UJ	410 U	430 U	160 E J				44.0 L
anthracene	740 UJ	88.0 J	430 U	260 J				330 F
benzo(a)anthracene	170 J	580 E	75.0 J	1700 E J				330 F
benzo(a)pyrene	160 J	460 E	110 J	2400 E J				430 L
benzo(b)fluoranthene	340 E J	700 E	190 J	4800 E J				330 F

TABLE 5-1

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 6

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	06SD01	06SD02	06SD03	06SD04	---	---	---	ARARS & TBCs
LOCATION:	06SD01	06SD02	06SD03	06SD04	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI				
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
benzo(g,h,i)perylene	170 J	440 E	430 U	2600 E J				330 F
benzo(k)fluoranthene	89.0 J	170 J	66.0 J	1100 E J				330 F
bis(2-ethylhexyl)phthalate	740 U	880	430 U	1700 U				890000000 S
carbazole	740 UJ	410 U	430 U	140 J				330 F
chrysene	240 J	570 E	130 J	2400 E J				330 F
dibenz(a,h)anthracene	740 UJ	150 J	430 U	720 E J				330 F
dibenzofuran	740 UJ	410 U	430 U	78.0 J				2000 P
fluoranthene	380 J	1200	110 J	1600 J				2900 Q
fluorene	740 UJ	83.0 J	430 U	690 UJ				540 P
indeno(1,2,3-cd)pyrene	130 J	290	69.0 J	2300 E J				330 F
naphthalene	740 UJ	410 U	430 U	90.0 J				480 P
phenanthrene	210 J	490	430 U	740 J				850 Q
pyrene	380 J	1000 E	130 J	2000 E J				660 L
VOLATILES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
4-methyl-2-pentanone	2.0 J	12.0 U	13.0 U	21.0 UJ				-
toluene	31.0 J	12.0 U	13.0 U	21.0 UJ				670 P
xylene (total)	3.0 J	12.0 U	13.0 U	21.0 UJ				25.0 P
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
4,4'-DDD	230 E J	43.0 E	2.4 E JN	5.4 E R				1.60 L
4,4'-DDE	66.0 E J	10.0 E	5.2 E	30.0 E J				2.20 L
4,4'-DDT	89.0 E JN	9.3 E J	14.0 E	110 E J				1.60 L
aldrin	38.0 UJ	0.077 R	2.2 U	0.35 R				-
alpha-chlordane	48.0 E J	22.0 E	0.39 R	3.5 UJ				7.00 O
dieldrin	7.3 UJ	4.0 U	0.31 J	1.6 J				52.0 Q
endosulfan II	24.0 E J	2.6 J	4.3 U	5.6 E JN				5.40 P
endrin	7.3 UJ	4.0 U	1.6 JN	6.9 UJ				20.0 Q
endrin ketone	73.0 UJ	4.0 U	4.3 U	7.3 J				20.0 Q
gamma-chlordane	56.0 E J	23.0 E	0.34 JN	3.5 UJ				7.00 O

TABLE 5-1

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 6

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	06SD01	06SD02	06SD03	06SD04	---	---	---	ARARS & TBCs
LOCATION:	06SD01	06SD02	06SD03	06SD04	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI				
PESTICIDES	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**				ug/kg
heptachlor	0.35 J	0.16 J	2.2 U	3.5 UJ				5.00 O
heptachlor epoxide	2.3 J	0.24 J	0.20 J	1.0 J				5.00 O

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to sediment ecological toxicity criteria:

- No standard is available for this chemical in this classification.

B - Source: Baudo, R., J. Geisy and H. Muntau. eds. 1990. Sediments: Chemistry and Toxicity of In-Place Pollutants. Lewis Publishers, Inc. Ann Arbor, MI.

F - Source: USEPA. 1994c. Draft Region IV Waste Management Division Sediment Screeing Values for Hazardous Waste Sites. 2/16/94 Revision.

L - Effects Range-Low. Source: Long E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management. 19:81-97.

M - Effects Range-Low. Source: Long, E. R. and L. G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA.

O - Ontario screening level. Source: Ontario Ministry of the Environment (OME). 1992. Guidelines for the Protection and Management of the Aquatic Sediment Quality in Ontario. Log 92-2309-067, PIBS 1962.

P - Sediment quality benchmark using equipartition. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

Q - Sediment quality criterion. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

S - Sediment screening benchmark. Source: Suter, G. W., and J. B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. Oak Ridge National Laboratory, Oak Ridge, TN.

T - Threshold for soils. Source: Direction des Substances Dangereuses. 1988. Contaminated Sites Rehabilitation Policy. Gouvernement du Quebec. Ministere de L'Environment. Sainte-Foy, Quebec, Canada. In: R.L. Siegrist. 1989. International Review of Approaches for Establishing Cleanup Goals for Hazardos Waste Contaminated Land. Institute for Georesearch and Pollution Research. Norway.

W - Screening value for wet soil. Source: Will, M.E., and G.W. Suter. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1994 Revision. Oak Ridge National Laboratory.

TABLE 5-2

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 6

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	06GW01	06GW02	06GW03	06GW04	---	---	ARARS & TBCs		
LOCATION:	06GW01	06GW02	06GW03	06GW04	---	---	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI					
INORGANICS	ug/L	ug/L	ug/L	ug/L			ug/L	ug/L	ug/L
aluminum	1320 E	420 E	190	145			-	-	200
arsenic	5.1	3.3 U	8.8 E	26.8 E			50.0	-	8.00
barium	30.4	64.9	48.2	45.0			2000	2000 a	2000
beryllium	0.11 U	0.21	0.11 U	0.11 U			4.00	4000 e	20.0
cadmium	7.0 E	1.2	2.2	5.2 E			5.00	5.00 e	4.00
calcium	22000	5670	8290	89800			-	-	-
chromium, total	1.0 U	1.0 U	1.0 U	1.2			100	100 a	100
cobalt	7.6	4.0	0.81	0.60 U			-	-	-
iron	95200 E	13400 E	24800 E	66700 E			-	-	300
magnesium	17300	5220	3120	53000			-	-	-
manganese	1820 E	280 E	61.3 E	855 E			-	-	50.0
nickel	3.7	5.0	0.76	1.0			100	100 a	100
potassium	3620	2250	2440	9270			-	-	-
sodium	83100 E	34800	25000	20800			-	-	50000
zinc	18.9	25.8 R	7.1	3.3			-	2000 a	5000
PESTICIDES	ug/L	ug/L	ug/L	ug/L			ug/L	ug/L	ug/L
endosulfan I	0.050 U	0.050 U	0.050 U	0.0021 J			-	-	0.400
gamma-BHC (Lindane)	0.0008 J	0.050 U	0.050 U	0.050 U			0.200	0.200 a	0.200

TABLE 5-2

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCS - SITE 6
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to MCLs, MCLGs, or SMCLs:

. - No standard is available for this chemical in this classification.

a - Where applicable, value(s) represent the more stringent of criteria for total, cis-, and trans- isomers.

* - Criteria are for total chromium.

** - Action level 1300 ug/L for water treatment technology for public water supply systems.

*** - Action level 15 ug/L for water treatment technology for public water supply systems.

Footnotes to Health Advisories:

. - No standard is available for this chemical in this classification.

a - The listed health advisory criterion, lifetime adult, is equal to the most stringent of the EPA health advisories for this chemical.

b - The listed health advisory criterion, long-term adult, is equal to the most stringent of the EPA health advisories for this chemical.

c - The listed health advisory criterion, one-day child, is equal to the most stringent of the EPA health advisories for this chemical.

d - The listed health advisory criterion, ten-day child, is equal to the most stringent of the EPA health advisories for this chemical.

e - The listed health advisory criterion, long-term child, is equal to the most stringent of the EPA health advisories for this chemical.

TABLE 5-3

06/14/96

COMPARISON OF SURFACE WATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 6

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	06SW01	06SW02	---	---	ARARS & TBCs				
LOCATION:	06SW01	06SW02	---	---	AWQC Freshwater Chronic Aquatic Life	AWQC Ingestion of Water and Fish	AWQC Ingestion of Fish Only	NJDEP Criteria Freshwater Chronic Aquatic Life	NJDEP Surface Water Criteria for Protection of Human Health
DATA SOURCE:	1995 RI	1995 RI							
INORGANICS	ug/L	ug/L			ug/L	ug/L	ug/L	ug/L	ug/L
aluminum	500	305 J			-	-	-	-	-
arsenic	6.2 E	4.4 E			189	0.0180	0.140	-	0.0170
barium	468 J	45.1			-	-	-	-	2000
beryllium	0.14 U	0.14			-	-	-	-	-
cadmium	2.7 E J	0.17 U			1.10 +	-	-	-	-
calcium	20000	20300			-	-	-	-	-
chromium, total	8.5 U	1.1			209 +	-	-	-	160
cobalt	2.7 U	1.8			-	-	-	-	-
copper	13.8 E	15.8 E			11.0 +	-	-	-	-
iron	13600	11400			-	-	-	-	-
lead	5.0 E	4.1 E			3.20 +	-	-	-	5.00
magnesium	5390	5360			-	-	-	-	-
manganese	338	337			-	-	-	-	-
mercury	0.043 E	0.055 E			0.0120	0.140	0.150	-	-
nickel	6.5 U	4.3			160 +	610	4600	-	516
potassium	3610	3250			-	-	-	-	-
selenium	3.9 J	4.4 J			5.00	-	-	-	10.0
sodium	53900	54700			-	-	-	-	-
thallium	5.1 E	3.0 U			-	1.70	6.30	-	1.70
vanadium	4.9 U	1.2			-	-	-	-	-
zinc	323 E J	55.4 J			101 +	-	-	-	-

TABLE 5-3

COMPARISON OF SURFACE WATER ANALYTICAL DATA TO ARARS AND TBCS - SITE 6
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to Ambient Water Quality Criteria:

- - No standard is available for this chemical in this classification.

+ - Criterion is hardness dependent and is generated based upon an assumed hardness of 100 mg/L.

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FIGURE 5-1

PROPOSED SAMPLE LOCATIONS
SITES 6, 17 AND REFERENCE/BACKGROUND

0 400 800
SCALE IN FEET

Brown & Root Environmental

TABLE 5-4

SAMPLING LOCATIONS AND RATIONALE

SITE 6

NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Six surface water and sediment samples	Marsh area northeast and adjacent to landfill	Determine extent of contamination in wetlands

6.0 SITE 12: BATTERY STORAGE AREA

6.1 SITE DESCRIPTION

The battery storage area is a paved area next to the loading dock east of Building R-10. This area was used as a temporary staging area for forklift batteries being sent off site to be reclaimed. The storage area occupied various portions of the paved area at different times but was generally limited to approximately 7,500 to 10,000 square feet at the northern end of the paved area adjacent to Building R-10. As reported in the 1993 SI, batteries have not been stored at the site for several years. It is unknown if a release to the environment occurred at the site in the past. No source of visible contamination, such as batteries, other residues, stressed vegetation, or surface soil staining, is present at the site. Infiltration is limited by an asphalt parking lot that covers the site. Surface runoff is directed to a stormwater collection basin that discharges through a concrete culvert to a drainage swale and eventually to a marsh north of the site. An underground storage tank (UST) was located in this general area, but it has been removed.

6.2 PREVIOUS INVESTIGATIONS

The 1995 RI Work Plan and 1996 RI Report present detailed discussions of data generated from previous investigations. These results are summarized below.

The 1983 IAS consisted of interviews and on-site inspection. The site was not recommended for a confirmation study based on the belief that any acids spilled would be buffered when they drained into the salt marsh.

During the 1993 SI, one surface water sample and one sediment sample were collected from the downstream side of the stormwater culvert outflow. No surface water or sediment was present at the upgradient portion of the drainage culvert at the time these samples were taken. The sediment sample was analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and cyanide. The surface water sample was analyzed for VOCs, metals, and cyanide. Sample analysis indicated that SVOCs, VOCs, pesticides, and metals were present in the sediment sample taken at the site. Metals were detected in the surface water sample. Cyanide was not detected in either sample.

An underground storage tank, R-10 installed at the northeastern corner of Building R-10, was located approximately adjacent to the former battery storage area. The UST was removed in 1994. Visual contamination of the soil was not observed during the tank removal. Upon removal, the tank and associated piping were examined and found in good condition, free of holes, with minor rust and pitting.

Four confirmation soil samples were obtained from the excavation sidewalls, and two samples were taken from the excavated soils. The excavation sidewall samples were analyzed for TPH, and all were found to contain a concentration less than the method detection limit, 56 to 61 mg/kg. The two soil pile samples showed TPH of 460 mg/kg and 520 mg/kg. The soil was disposed as nonhazardous.

In August 1995, B&R Environmental conducted field investigation activities at Site 12, including sampling of surface soil and sediment. No samples were taken in the area labeled "Battery Storage Area" because the asphalt would have been a barrier to infiltration of the spilled battery electrolyte solution. The RI attempted to obtain the worst-case sediment samples in known low-lying areas of likely sedimentation. Surface soil samples collected from the northern end of Building R-10 showed elevated levels of several metals. PAHs were also detected; however, these are common constituents of railroad bed materials and ties, which are located adjacent to the sampling locations. Sediment samples obtained on the northern side of the railroad tracks also showed elevated levels of PAHs, pesticides, and some metals.

Table 6-1 presents the results for surface soil in comparison to ARARs and TBCs. Table 6-2 presents sediment results in comparison to screening levels.

6.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on previous sampling results, the 1996 RI report concluded that further data were required to assess the impact of metals at the site and to further estimate the area of impact. Two locations with high surface soil lead (and other metals) content (12SS02 and 12SS03) will be evaluated further. Subsurface samples at depths of 3 to 4 feet will be obtained to evaluate the extent of contamination. In addition, a location approximately 40 feet east of 12SS03 will be sampled for surface and subsurface soils. Proposed sampling locations are located on Figure 6-1, and the sampling rationale is presented in Table 6-3. Anlaytical parameters will be TAL metals and TOC.

6.4 SITE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

TABLE 6-1

06/14/96

COMPARISON OF SURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 12

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	12SS01	12SS02	12SS03	12SS03-DUP	---	---	ARARS & TBCs		
LOCATION:	12SS01	12SS02	12SS03	12SS03	---	---			
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI			NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg			mg/kg	mg/kg	mg/kg
aluminum	3530	4330	7980	7670			-	-	-
antimony	0.76	71.5 E	3.6	4.4			14.0	340	-
arsenic	10.7	5.1	6.6	7.8			20.0	20.0	-
barium	28.7	187	188	189			700	47000	-
beryllium	0.47	0.050	0.37	0.23			1.00	1.00	-
cadmium	1.4 E	4.0 E	7.8 E	8.7 E			1.00	100	-
calcium	1610	21400	20000	27100			-	-	-
chromium, total	53.3 J	39.6 J	85.6 J	107 J			-	500	-
cobalt	4.6	3.1	7.5	8.3			-	-	-
copper	23.2	66.9	226	339			600	600	-
iron	20300	17500	34600	40300			-	-	-
lead	68.6	1130 E	978 E	1070 E			400	600	-
magnesium	413	1950 J	3250 J	10400 J			-	-	-
manganese	133	140	295	373			-	-	-
mercury	0.42	0.87	0.42	0.37			14.0	270	-
nickel	6.8	11.4	49.1	50.7			250	2400	-
potassium	649	723	893	810			-	-	-
silver	0.21 U	1.7	1.1	1.1			110	4100	-
sodium	76.3	167	200	1170			-	-	-
thallium	0.82 U	0.86 U	2.1 E	1.0 U			2.00	2.00	-
vanadium	18.0	19.2	245	259			370	7100	-
zinc	214 R	835 R	1500 R	1570 E R			1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg			ug/kg	ug/kg	ug/kg
2-methylnaphthalene	170 J	150 J	460 U	460 U			-	-	-
acenaphthene	380 U	64.0 J	57.0 J	49.0 J			3400000	10000000	100000
acenaphthylene	380 U	110 J	140 J	130 J			-	-	-
anthracene	44.0 J	350 J	490	1400			10000000	10000000	100000
benzo(a)anthracene	210 J	1600 E J	2300 E J	5500 E J			900	4000	500000

TABLE 6-1

COMPARISON OF SURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 12

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	12SS01	12SS02	12SS03	12SS03-DUP	---	---	ARARS & TBCs		
LOCATION:	12SS01	12SS02	12SS03	12SS03	---	---			
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI			NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg			ug/kg	ug/kg	ug/kg
benzo(a)pyrene	250 J	1100 E J	1700 E J	2800 E J			660	660	100000
benzo(b)fluoranthene	610	4600 E J	8700 E J	12000 E J			900	4000	50000
benzo(g,h,i)perylene	800	1700 J	2200 J	2400 J			-	-	-
bis(2-ethylhexyl)phthalate	87.0 J	960 J	1700 J	740 J			49000	210000	100000
butylbenzylphthalate	380 U	410 UJ	150 J	110 J			1100000	10000000	100000
carbazole	45.0 J	600	1100	860			-	-	-
chrysene	320 J	2800 J	6400 J	10000 E J			9000	40000	500000
di-n-butylphthalate	380 U	100 J	70.0 J	150 J			5700000	10000000	100000
dibenz(a,h)anthracene	59.0 J	300 J	490 J	590 J			660	660	100000
dibenzofuran	380 U	63.0 J	48.0 J	460 U			-	-	-
fluoranthene	320 J	4600	9600	17000			2300000	10000000	100000
fluorene	380 U	94.0 J	80.0 J	94.0 J			2300000	10000000	100000
indeno(1,2,3-cd)pyrene	340 J	1300 E J	2300 E J	2700 E J			900	4000	500000
naphthalene	83.0 J	130 J	460 U	460 U			230000	4200000	100000
phenanthrene	140 J	1400	1900	1900			-	-	-
pyrene	380 J	6000 J	12000 J	19000 J			1700000	10000000	100000
VOLATILES	ug/kg	ug/kg	ug/kg	ug/kg			ug/kg	ug/kg	ug/kg
tetrachloroethene	3.0 J	12.0 UJ	14.0 UJ	14.0 U			4000	6000	1000
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg			ug/kg	ug/kg	ug/kg
4,4'-DDD	19.0 JN	23.0 R	4.6 U	8.0 U			3000	12000	50000
4,4'-DDE	3.9 U	29.0 J	7.6 R	14.0 R			2000	9000	50000
4,4'-DDT	51.0	460	190 J	200 JN			2000	9000	500000
aldrin	2.0 U	2.1 U	2.0 J	0.89 R			40.0	170	50000
alpha-BHC	2.0 U	0.17 R	0.26 R	0.23 R			-	-	-
alpha-chlordane	2.0 U	4.7 JN	7.1	11.0			-	-	-
endosulfan sulfate	3.8 U	4.1 U	4.6 U	27.0 R			340000	6200000	50000
endrin aldehyde	3.9 U	25.0	46.0 J	74.0 JN			-	-	-
gamma-BHC (Lindane)	0.072 R	0.067 R	2.4 U	2.4 U			520	2200	50000

TABLE 6-1

COMPARISON F SURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 12

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	12SS01		12SS02		12SS03		12SS03-DUP		---	---	ARARS & TBCs		
LOCATION:	12SS01		12SS02		12SS03		12SS03		---	---	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI						
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg				ug/kg	ug/kg	ug/kg
gamma-chlordane	1.8	J	12.0	JN	14.0	J	22.0	R			-	-	-
heptachlor	2.0	U	0.40	R	0.62	R	0.43	R			150	650	50000
heptachlor epoxide	0.60	R	2.5	R	2.4	U	2.4	U			-	-	-
methoxychlor	8.4	R	21.0	U	24.0	U	24.0	U			280000	5200000	50000

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to soil criteria:

- No standard is available for this chemical in this classification.

TABLE 6-2

07/15/98

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 12

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	12SD01	12SD02	12SD02-DUP	---	---	---	---	ARARS & TBCs
LOCATION:	12SD01	12SD02	12SD02	---	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI					
INORGANICS	mg/kg	mg/kg	mg/kg					mg/kg
aluminum	7690	5850	4590					-
arsenic	9.8 E	14.4 E	12.4 E					8.20 L
barium	51.0 E	31.5	28.2					40.0 B
beryllium	0.66	0.72	0.43					-
calcium	4670	10900	7200					-
chromium, total	26.7	28.8	30.5					81.0 L
cobalt	1.9	2.4	1.5					50.0 T
copper	25.6	19.6	28.9					34.0 L
iron	39000	27100	23600					-
lead	67.0 E	45.0	106 E					47.0 L
magnesium	2880	3520	1360					-
manganese	127	120	103					460 O
mercury	0.012 J	0.045 J	0.026 J					0.150 L
nickel	4.0	6.0	4.9					21.0 L
potassium	2360	2150	1210					-
sodium	119	147	103					-
vanadium	23.6	31.9	29.8					-
zinc	34.1	59.2	65.8					150 L
SEMIVOLATILES	ug/kg	ug/kg	ug/kg					ug/kg
2-methylnaphthalene	360 U	53.0 J	50.0 J					330 F
benzo(a)anthracene	250 J	460 E	340 E J					330 F
benzo(a)pyrene	320 J	540 E	430 J					430 L
benzo(b)fluoranthene	520 E	890 E	790 E J					330 F
benzo(g,h,i)perylene	240 J	400 E J	310 J					330 F
benzo(k)fluoranthene	180 J	340 E J	250 J					330 F
bis(2-ethylhexyl)phthalate	67.0 J	80.0 J	110 J					890000000 S
chrysene	280 J	580 E	460 E					330 F
dibenz(a,h)anthracene	60.0 J	97.0 J	62.0 J					330 F

TABLE 6-2

07/15/96

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 12

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	12SD01		12SD02		12SD02-DUP		---	---	---	---	ARARS & TBCs	
LOCATION:	12SD01		12SD02		12SD02		---	---	---	---	Sediment Ecological Toxicity Threshold Values	
DATA SOURCE:	1995 RI		1995 RI		1995 RI							
SEMIVOLATILES	ug/kg		ug/kg		ug/kg						ug/kg	
fluoranthene	350	J	680		500						2900	Q
indeno(1,2,3-cd)pyrene	240	J	410	E	320	J					330	F
naphthalene	360	U	51.0	J	47.0	J					480	P
phenanthrene	110	J	210	J	180	J					850	Q
pyrene	310	J	600		490						660	L
PESTICIDES	ug/kg		ug/kg		ug/kg						ug/kg	
4,4'-DDD	3.6	E R	5.3	E JN	5.5	E JN					1.60	L
4,4'-DDE	11.0	E	19.0	E	18.0	E					2.20	L
4,4'-DDT	35.0	E	35.0	E	35.0	E					1.60	L
alpha-BHC	1.9	U	0.19	J	2.0	U					3.70	S
alpha-chlordane	1.0	J	1.2	J	1.2	J					7.00	O
gamma-BHC (Lindane)	1.9	U	0.070	R	2.0	U					-	
gamma-chlordane	0.54	J	0.79	J	1.0	J					7.00	O
heptachlor epoxide	1.9	U	2.0	U	0.57	JN					5.00	O

TABLE 6-2

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCS - SITE 12
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to sediment ecological toxicity criteria:

. - No standard is available for this chemical in this classification.

B - Source: Baudo, R., J. Geisy and H. Muntau. eds. 1990. Sediments: Chemistry and Toxicity of In-Place Pollutants. Lewis Publishers, Inc. Ann Arbor, MI.

F - Source: USEPA. 1994c. Draft Region IV Waste Management Division Sediment Screeing Values for Hazardous Waste Sites. 2/16/94 Revision.

L - Effects Range-Low. Source: Long E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management. 19:81-97.

M - Effects Range-Low. Source: Long, E. R. and L. G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA.

O - Ontario screening level. Source: Ontario Ministry of the Environment (OME). 1992. Guidelines for the Protection and Management of the Aquatic Sediment Quality in Ontario. Log 92-2309-067, PIBS 1962.

P - Sediment quality benchmark using equipartition. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

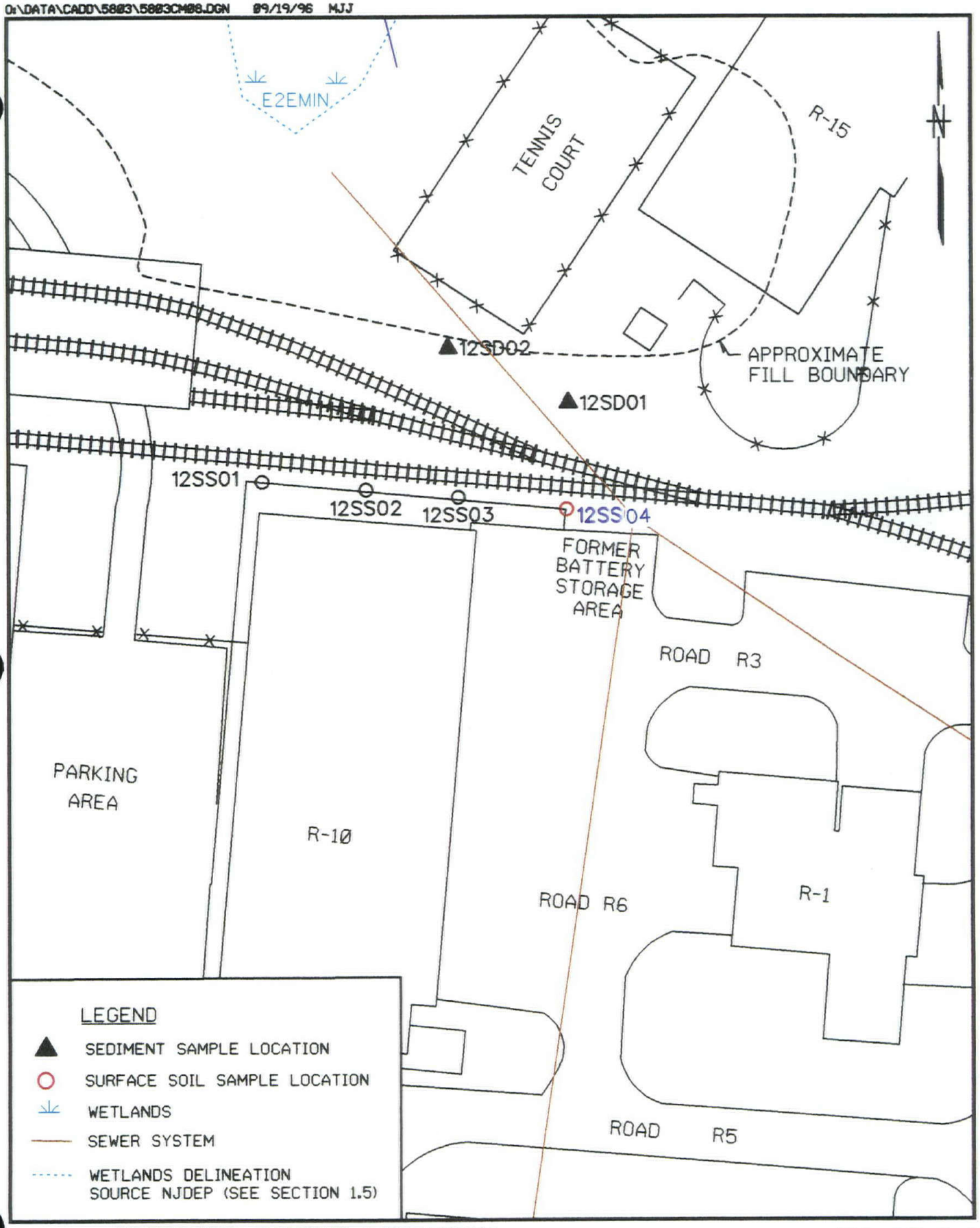
Q - Sediment quality criterion. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

S - Sediment screening benchmark. Source: Suter, G. W., and J. B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. Oak Ridge National Laboratory, Oak Ridge, TN.

T - Threshold for soils. Source: Direction des Substances Dangereuses. 1988. Contaminated Sites Rehabilitation Policy. Gouvernement du Quebec. Ministere de L'Environment. Sainte-Foy, Quebec, Canada. In: R.L. Siegrist. 1989. International Review of Approaches for Establishing Cleanup Goals for Hazardos Waste Contaminated Land. Institute for Georesearch and Pollution Research. Norway.

W - Screening value for wet soil. Source: Will, M.E., and G.W. Suter. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1994 Revision. Oak Ridge National Laboratory.

O:\DATA\CADD\5803\5803CM08.DGN 09/19/96 MJJ



PROPOSED SAMPLE LOCATIONS

SITE 12 - BATTERY STORAGE AREA

0 50 100

SCALE IN FEET

FIGURE 6-1

Brown & Root Environmental

TABLE 6-3

SAMPLING LOCATIONS AND RATIONALE

SITE 12

NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
One surface and three subsurface soil samples	Area between former loading dock and railroad bed	Determine extent of contamination in surrounding soil

7.0 SITE 13: DEFENSE PROPERTY DISPOSAL OFFICE YARD

7.1 SITE DESCRIPTION

The defense property disposal office yard (DPDO yard) is an area of fill material extending into a marsh near the rail classification yards. Activities at the site included storage of scrap metals and batteries and the burial of material, such as cars, trucks, electronic equipment, clothing/shoes, sheet metal, furniture, scrap metal, and batteries. Additionally, batteries were broken open at the site for lead recovery, and acid was drained onto the ground. Obvious fill material is present at the ground surface at several places across the site.

The top of the site is flat, and there is little topographic relief. Runoff from the site drains to the marsh to the north and west to a perennial drainage that flows to Hockhockson Brook. A fence surrounds the DPDO yard, although this fence is not located at the edge of the landfill. The extent of fill material was not clearly defined by previous investigations. The toe of the landfill extends into the marsh area and is clearly defined by an abrupt decrease in elevation of several feet between the top of the landfill slope and the marsh. Groundwater flow is generally to the north-northwest, based on groundwater-level measurements.

7.2 PREVIOUS INVESTIGATIONS

The 1995 RI Work Plan and 1996 RI Report present detailed discussions of data generated from previous investigations. These results are summarized below.

The 1983 IAS consisting of interviews, concluded minimal impact based on site use as a storage area. The site was not recommended for a confirmation study.

During the SI, six soil, three sediment, and three surface water samples were collected. The soil samples were collected from 0 to 3 feet bgs from the area in and around the landfill. The sediment and surface water samples were collected in the drainage west of the site. Soil samples were analyzed for SVOCs, PCBs, metals, and cyanide. Low levels of metals, pesticides, PCBs, and SVOCs were detected in soil samples. Elevated levels of two semivolatiles were also detected. Sediment samples were analyzed for SVOCs, pesticides, and PCBs. Low levels of pesticides, PCBs, and SVOCs were detected. Surface water samples were analyzed for SVOCs, PCBs, pesticides, metals, and cyanide. Elevated levels of several metals were present in samples. No SVOCs, pesticides, or PCBs were detected in surface water.

In 1995 B&R Environemental performed RI activities including excavation of test pits, sampling of surface water and sediment, monitoring well installation and sampling, and aquifer testing. Sampling analysis of surface water and sediment did not reveal significant levels of contaminants above background, with the exception of PCBs in sediment. Groundwater samples revealed the presence of VOCs and slightly elevated levels of pesticides and some metals. Table 7-1 presents groundwater data for the site in comparison to screening levels.

7.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on previous sampling results, VOCs including 1,1,1-TCA, 1,2-DCE, and vinyl chloride have impacted groundwater at the site; however, the extent of the VOC contamination is unknown. Groundwater samples will be obtained from four locations at the site utilizing hydropunch/Geoprobe™ equipment. Samples from each location will be obtained from depths of 15, 30, and 45 feet, resulting in a total of 12 samples. Samples will be analyzed in the field for VOCs, only using a portable GC. The sampling locations will be located in the marsh area downgradient of the DRMO fill area. Proposed sampling locations are located on Figure 7-1, and the sampling rationale is presented in Table 6-2.

7.4 SITE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

TABLE 7-1

06/14/96

C MPARISON F GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 13

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	13GW01	13GW01-F	13GW02	13GW02-DEC95	13GW03	13GW03-F	ARARS & TBCs		
LOCATION:	13GW01	13GW01	13GW02	13GW02	13GW03	13GW03	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI, Dec.	1995 RI	1995 RI			
INORGANICS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
aluminum	14600 E J	530 E J	4160 E J	n/a	15800 E J	13.4	-	-	200
antimony	2.7 U	2.7 U	2.7 U	n/a	2.7 U	2.7 U	6.00	3.00 a	20.0
arsenic	18.0 E	3.3 U	3.3 U	n/a	15.2 E	3.3 U	50.0	-	8.00
barium	70.1	54.7	285	n/a	10.0	2.0	2000	2000 a	2000
beryllium	1.1	0.21	0.11 U	n/a	0.90	0.11 U	4.00	4000 e	20.0
cadmium	4.8 E	5.5 E	1.0	n/a	1.6	0.56	5.00	5.00 e	4.00
calcium	8900	7850	11900	n/a	3890	3150	-	-	-
chromium, total	233 E	2.3	74.4	n/a	296 E	1.0 U	100	100 a	100
cobalt	4.4	2.6	2.1	n/a	3.8	1.4	-	-	-
copper	3.2	2.7	14.2	n/a	3.5	0.90	1300	-	1000
iron	31100 E	459 E	48200 E	n/a	57900 E	22700 E	-	-	300
lead	10.5 E J	1.5 UJ	6.8	n/a	13.4 E	1.5 UJ	15.0	-	10.0
magnesium	4040	1630	2340	n/a	3330	982	-	-	-
manganese	121 E	83.4 E	117 E	n/a	78.2 E	60.5 E	-	-	50.0
mercury	0.049	0.038	0.11	n/a	0.056	0.017	2.00	2.00 b	2.00
nickel	13.9	7.6	0.75 U	n/a	11.5	2.0	100	100 a	100
potassium	9330 J	3000	3920	n/a	7300 J	739	-	-	-
selenium	5.3 J	4.4 U	4.4 U	n/a	4.6 J	4.4 U	50.0	-	50.0
silver	0.94 U	0.94 U	1.0	n/a	0.94 U	0.94 U	-	100 a	-
sodium	8810	3590	6860	n/a	9780	7880	-	-	50000
thallium	3.6 UJ	3.6 U	3.6 U	n/a	10.4 E J	4.3 E	2.00	0.400 a	10.0
vanadium	111	0.61 U	35.6	n/a	146	0.61 U	-	-	-
zinc	94.6	72.8	265	n/a	34.9	7.7	-	2000 a	5000
SEMIVOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
4-methylphenol	10.0 U	n/a	10.0 U	n/a	2.0 J	n/a	-	100 a	-
VOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
1,1,1-trichloroethane	5.0 J	n/a	10.0 U	10.0 U	10.0 U	n/a	200	200 a	30.0
1,2-dichloroethene (total)	10.0 U	n/a	7.0 J	2.0 J	10.0 U	n/a	70.0 a	70.0 a	10.0

TABLE 7-1

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 13

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	13GW01	13GW01-F	13GW02	13GW02-DEC95	13GW03	13GW03-F	ARARS & TBCs		
LOCATION:	13GW01	13GW01	13GW02	13GW02	13GW03	13GW03	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI, Dec.	1995 RI	1995 RI			
VOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
carbon disulfide	10.0 UJ	n/a	10.0 U	10.0 U	10.0 UJ	n/a	-	-	-
vinyl chloride	10.0 U	n/a	11.0 E	10.0 E J	10.0 U	n/a	2.00	10.0 e	5.00
PESTICIDES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
4,4'-DDT	0.051 J	n/a	0.029 J	n/a	0.10 U	n/a	-	-	0.100
alpha-BHC	0.0010 R	n/a	0.050 U	n/a	0.050 U	n/a	-	-	0.0200
delta-BHC	0.025 R	n/a	0.050 U	n/a	0.050 U	n/a	-	-	-
dieldrin	0.022 J	n/a	0.10 U	n/a	0.10 U	n/a	-	0.500 e	0.0300
endosulfan I	0.028 JN	n/a	0.050 U	n/a	0.050 U	n/a	-	-	0.400
heptachlor	0.011 J	n/a	0.0052 JN	n/a	0.050 U	n/a	0.400	5.00 e	0.400
heptachlor epoxide	0.044 R	n/a	0.013 R	n/a	0.050 U	n/a	0.200	0.100 e	0.200

TABLE 7-1

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 13

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	13GW04	13GW05	---	---	---	---	ARARS & TBCs		
LOCATION:	13GW04	13GW05	---	---	---	---	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI							
INORGANICS	ug/L	ug/L					ug/L	ug/L	ug/L
aluminum	7430 E J	1420 E J					-	-	200
antimony	9.7 E	2.7 U					6.00	3.00 a	20.0
arsenic	39.2 E	3.3 U					50.0	-	8.00
barium	57.8	91.3					2000	2000 a	2000
beryllium	1.6	0.67					4.00	4000 e	20.0
cadmium	1.2	63.9 E					5.00	5.00 e	4.00
calcium	3170	4990					-	-	-
chromium, total	252 E	26.3					100	100 a	100
cobalt	8.4	6.1					-	-	-
copper	8.1	2.6					1300	-	1000
iron	27100 E	866 E					-	-	300
lead	18.8 E	3.4 J					15.0	-	10.0
magnesium	2610	2120					-	-	-
manganese	58.3 E	138 E					-	-	50.0
mercury	0.059	0.047					2.00	2.00 b	2.00
nickel	13.0	35.7					100	100 a	100
potassium	8270 J	2620					-	-	-
selenium	39.9	4.4 U					50.0	-	50.0
silver	0.94 U	0.94 U					-	100 a	-
sodium	3520	5860					-	-	50000
thallium	23.8 E J	3.6 UJ					2.00	0.400 a	10.0
vanadium	152	2.6					-	-	-
zinc	52.9	1950					-	2000 a	5000
SEMIVOLATILES	ug/L	ug/L					ug/L	ug/L	ug/L
4-methylphenol	10.0 U	10.0 U					-	100 a	-
VOLATILES	ug/L	ug/L					ug/L	ug/L	ug/L
1,1,1-trichloroethane	10.0 U	10.0 U					200	200 a	30.0
1,2-dichloroethene (total)	10.0 U	10.0 U					70.0 a	70.0 a	10.0

TABLE 7-1

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 13

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	13GW04	13GW05	---	---	---	---	ARARS & TBCs		
LOCATION:	13GW04	13GW05	---	---	---	---	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI							
VOLATILES	ug/L	ug/L					ug/L	ug/L	ug/L
carbon disulfide	1.0 J	10.0 UJ					-	-	-
vinyl chloride	10.0 U	10.0 U					2.00	10.0 e	5.00
PESTICIDES	ug/L	ug/L					ug/L	ug/L	ug/L
4,4'-DDT	0.10 U	0.10 U					-	-	0.100
alpha-BHC	0.050 U	0.050 U					-	-	0.0200
delta-BHC	0.050 U	0.050 U					-	-	-
dieldrin	0.10 U	0.10 U					-	0.500 e	0.0300
endosulfan I	0.050 U	0.050 U					-	-	0.400
heptachlor	0.050 U	0.050 U					0.400	5.00 e	0.400
heptachlor epoxide	0.050 U	0.050 U					0.200	0.100 e	0.200

TABLE 7-1

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCS - SITE 13
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to MCLs, MCLGs, or SMCLs:

. - No standard is available for this chemical in this classification.

a - Where applicable, value(s) represent the more stringent of criteria for total, cis-, and trans- isomers.

* - Criteria are for total chromium.

** - Action level 1300 ug/L for water treatment technology for public water supply systems.

*** - Action level 15 ug/L for water treatment technology for public water supply systems.

Footnotes to Health Advisories:

. - No standard is available for this chemical in this classification.

a - The listed health advisory criterion, lifetime adult, is equal to the most stringent of the EPA health advisories for this chemical.

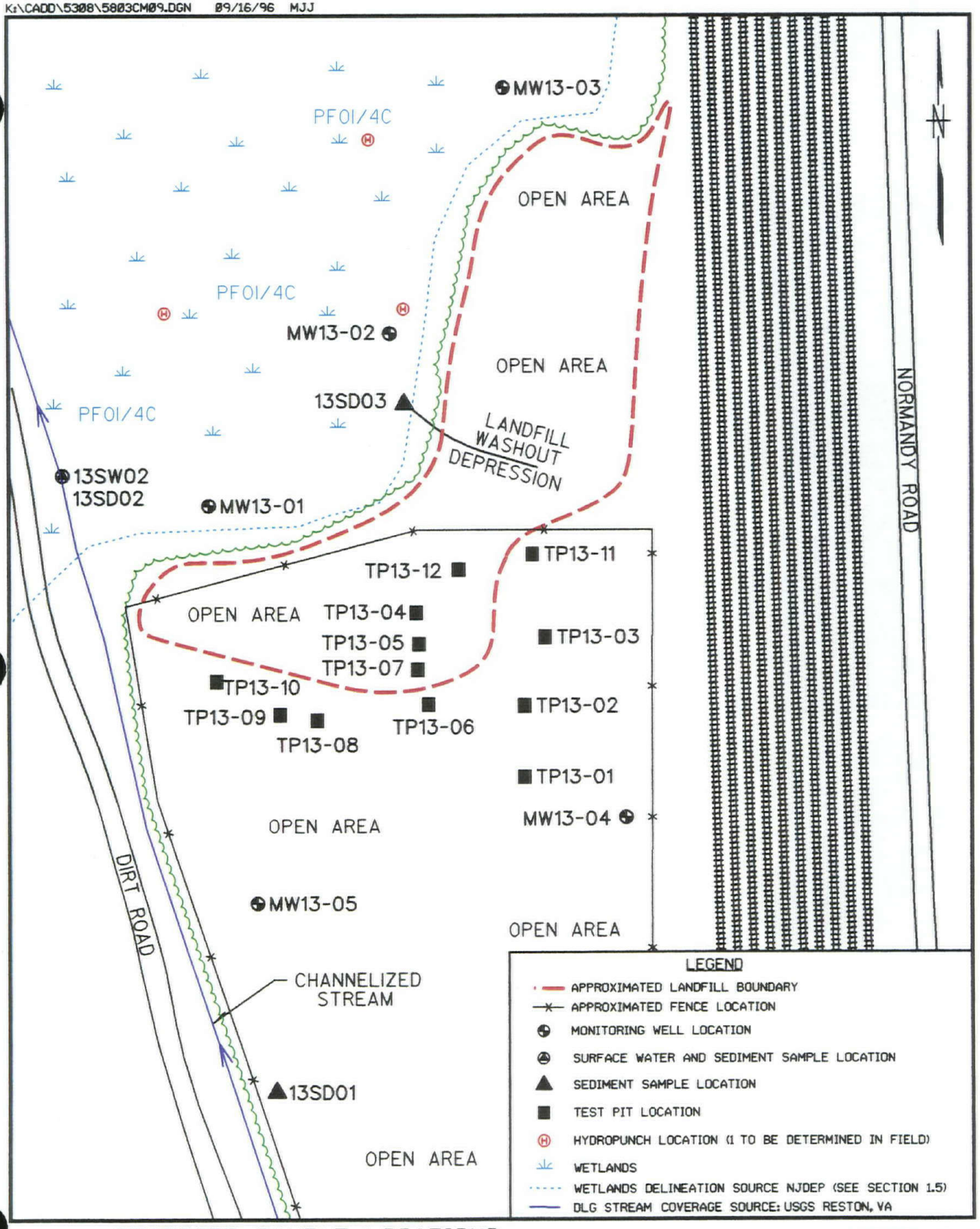
b - The listed health advisory criterion, long-term adult, is equal to the most stringent of the EPA health advisories for this chemical.

c - The listed health advisory criterion, one-day child, is equal to the most stringent of the EPA health advisories for this chemical.

d - The listed health advisory criterion, ten-day child, is equal to the most stringent of the EPA health advisories for this chemical.

e - The listed health advisory criterion, long-term child, is equal to the most stringent of the EPA health advisories for this chemical.

K:\CADD\5308\5803CM09.DGN 09/16/96 MJJ



PROPOSED SAMPLE LOCATIONS

SITE 13 - DRMO YARD

0 100 200

SCALE IN FEET

FIGURE 7-1

Brown & Root Environmental

TABLE 7-2

SAMPLING LOCATIONS AND RATIONALE

SITE 13

NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Four groundwater sampling locations; samples taken at 15, 30, and 45 feet at each	Marsh area downgradient of fill area.	Determine extent of VOC contamination of groundwater by field screening

8.0 SITE 16: SITE 16 AND EPIC SITE F

8.1 SITE DESCRIPTION

Site 16 and EPIC Site F are discussed as one site due to the relative proximity and overlap of the two sites. The 8-acre combined site consists of a heavy equipment storage yard and two railroad car storage yards that have been active since the late 1940s. Groundwater generally flows to the north-northeast based on groundwater-level measurements.

Site 16 is located north of Building C-19, the forklift maintenance and repair shop. EPIC Site F includes two former diesel tank areas around Building C-50, an oil-water separator and leach field east of Building C-50, an oil-stained portion of tracks north of Building C-50, a drainage ditch northeast of Building C-50, and a locomotive wash area and leach field north of Building C-19. Building C-50 is known as the Roundhouse and is used for maintenance and repair of locomotives and rail cars. Investigations at these areas have been concerned with petroleum hydrocarbon contamination of soil, groundwater, surface water, and sediment.

An underground fuel line was used to transport diesel fuel from an UST located at the northeastern corner of Building C-18 to a dispensing station approximately 100 feet north of Building C-50. A leak in the fuel line was discovered in 1977, and use of the pipeline was discontinued after the leak was discovered and excavated. Part or all of the former underground diesel transfer line is still in place. This portion of the site was investigated during the 1992 SI field activities.

Waste oils from locomotive maintenance were stored in a holding tank at the southeastern side of Building C-50. This tank was removed under the UST program. Water from locomotive steam cleaning operations in the past may have discharged to sewer drains and to an oil-water separator near Building C-50. Water discharge from this oil-water separator was reportedly sent to a drainage ditch along the western side of the railroad tracks. No evidence of a suspected leach field, thought to be present near the oil-water separator, has been found. In 1989, the oil-water separator failed and the ditch on the side of Building C-50 was excavated. Excavated material was disposed as hazardous waste. In the south-west corner, inside Building C-50, was a locomotive engine cleaning tank (vat). The vat was approximately 10 feet by 16 feet and was 6 feet deep. The vat was used for soaking locomotive engines, and potentially other oversized parts. An unknown solvent was used in the vat for cleaning. The spent solvent was directed to a leach field via two holding tanks located west of the southwestern corner of Building C-50. The operation was discontinued several years ago and the holding tanks and vat were cleaned. The vat was

filled with concrete and the holding tanks and associated leach field were left in place.

The center of the railroad tracks north of Building C-50 is stained with thick oil, possibly from leaky locomotives awaiting maintenance.

Building C-19 is used as a forklift maintenance and repair facility behind which batteries may have been stored. The railroad yard west of Building C-19 is used for rail car and heavy equipment storage.

8.2 PREVIOUS INVESTIGATIONS

The 1995 RI Work Plan and 1996 RI Report present detailed discussions of data generated from previous investigations. These results are summarized below.

The 1983 IAS consisting of interviews, concluded minimal impact because the leak was discovered quickly and the amount of fuel lost was estimated to be minimal (less than 50 gallons). The site was not recommended for confirmation study.

The PA Addendum in 1992, consisting of interviews and aerial photo analysis, indicated that the site has been an active rail yard for many years.

As part of the 1992 SI field activities, five soil borings were completed in the area north of Building C-18, the reported location of the underground fuel-line leak. Each soil boring was completed to the water table, and one sample was collected approximately 8 feet bgs, below the level of the fuel pipeline and above the water table. All soil samples contained elevated levels of TPH ranging from 4,700 mg/kg to 22,000 mg/kg. Low levels of semivolatiles were also detected. A geophysical survey of the area during the SI indicated a number of buried lines at the site; however, the exact location of the leaking fuel line was not determined.

Between June and October 1995, B&R Environmental conducted the following field investigation activities at Site 16/F:

- Soil gas survey and analysis at 96 locations
- Sampling and analysis of subsurface soil samples from 20 soil borings
- Sampling and analysis of surface soil
- Sampling and analysis of sediment
- Drilling and installation of six shallow permanent monitoring wells
- Sampling and analysis of groundwater from the wells
- Aquifer testing

Surface soil samples from the site showed elevated levels of metals, PAHs, pesticides, and TPH. Pesticides, PAHs, and significant levels of VOCs and TPH were detected in subsurface samples indicating extensive contamination by petroleum products. Sediment samples in the drainage pathway indicated elevated levels of PAHs and pesticides. Table 8-1 presents data for surface soil samples in comparison to screening levels, Table 8-2 presents data for subsurface soils compared to screening levels, and Table 8-3 presents data for sediment samples in comparison to screening levels.

During monitoring well sampling, floating product was obtained from two wells. Fingerprint sampling analysis indicated this product was No. 2 fuel oil. Elevated levels of VOCs including BTEX compounds were detected in groundwater samples. Table 8-4 presents groundwater data in comparison to ARARs and TBCs.

8.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Cone penetrometer (CPT) profiling in conjunction with induced fluorescence will be utilized to delineate the extent of petroleum contamination. Section 2.11 details the procedure used for this method. Four monitoring wells will be installed at this site in accordance with procedures outlined in Section 2.4. Wells are expected to be approximately 20 feet in depth. Well locations will be selected based on interpretation of CPT data. One round of synoptic water-level measurements will be recorded for the newly constructed wells and the existing wells at Site 16/F. Samples from each of the new wells will be obtained utilizing low-flow sampling techniques after installation of dedicated, laboratory-certifed/cleaned, low-flow bladder pumps. Proposed CPT/induced fluorescence sampling locations are located on Figure 8-1, and the sampling rationale is presented in Table 8-5. If floating product is encountered in any newly installed monitoring well, no dedicated low-flow bladder pump will be procured or installed. Samples will be anlayzed for TCL VOCs and TCL SVOCs.

8.4 SITE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

TABLE 8-1

COMPARISON OF SURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SS01	16SS02	16SS03	---	---	---	ARARS & TBCs		
LOCATION:	16SS01	16SS02	16SS03	---	---	---	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI						
INORGANICS	mg/kg	mg/kg	mg/kg				mg/kg	mg/kg	mg/kg
aluminum	2570	4160	4190				-	-	-
antimony	28.0 E	0.75	7.0				14.0	340	-
arsenic	5.2	10.5 J	5.4				20.0	20.0	-
barium	78.3	133	109				700	47000	-
beryllium	0.13	0.25	0.19				1.00	1.00	-
cadmium	6.1 E J	8.1 E J	10.2 E J				1.00	100	-
calcium	4230 J	2280 J	3050 J				-	-	-
chromium, total	40.9	124	171				-	500	-
cobalt	4.0	7.7	4.5				-	-	-
copper	49.8	196	231				600	600	-
iron	26100	57500	28800				-	-	-
lead	1030 E	359	675 E				400	600	-
magnesium	1350	1300	1530				-	-	-
manganese	138	307	94.8				-	-	-
mercury	0.018	0.12	0.28				14.0	270	-
nickel	10.3	13.4	16.5				250	2400	-
potassium	342	537	445				-	-	-
silver	1.8	9.2	25.3				110	4100	-
sodium	155	123	173				-	-	-
vanadium	15.5	23.6	32.1				370	7100	-
zinc	111	235	1180				1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg				ug/kg	ug/kg	ug/kg
4-methylphenol	380 U	380 U	110 J				2800000	10000000	-
N-nitrosodiphenylamine (1)	380 U	63.0 J	1000 U				140000	600000	100000
acenaphthylene	380 U	380 U	100 J				-	-	-
anthracene	380 U	57.0 J	170 J				10000000	10000000	100000
benzo(a)anthracene	160 J	240 J	450 J				900	4000	500000
benzo(a)pyrene	160 J	260 J	1200 E J				660	660	100000

TABLE 8-1

COMPARISON OF SURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SS01		16SS02		16SS03		---	---	---	ARARS & TBCs		
LOCATION:	16SS01		16SS02		16SS03		---	---	---	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI							
SEMIVOLATILES	ug/kg		ug/kg		ug/kg					ug/kg	ug/kg	ug/kg
benzo(b)fluoranthene	350	J	700	J	1000	E J				900	4000	50000
benzo(g,h,i)perylene	150	J	200	J	340	J				-	-	-
benzo(k)fluoranthene	86.0	J	380	U	1000	UJ				900	4000	500000
bis(2-ethylhexyl)phthalate	1800		7000	J	12000	J				49000	210000	100000
butylbenzylphthalate	160	J	380	UJ	1000	UJ				1100000	10000000	100000
carbazole	54.0	J	42.0	J	1000	U				-	-	-
chrysene	250	J	360	J	810	J				9000	40000	500000
di-n-butylphthalate	100	J	44.0	J	1000	U				5700000	10000000	100000
fluoranthene	510		340	J	480	J				2300000	10000000	100000
Indeno(1,2,3-cd)pyrene	120	J	200	J	1000	UJ				900	4000	500000
phenanthrene	210	J	230	J	370	J				-	-	-
pyrene	670		1100	J	4400	J				1700000	10000000	100000
PESTICIDES	ug/kg		ug/kg		ug/kg					ug/kg	ug/kg	ug/kg
4,4'-DDD	3.9	U	7.6	R	360	J				3000	12000	50000
4,4'-DDE	3.9	R	15.0		120					2000	9000	50000
4,4'-DDT	38.0		230		43.0					2000	9000	500000
alpha-BHC	0.047	J	0.13	J	2.6	U				-	-	-
alpha-chlordane	1.9	U	7.0	U	33.0					-	-	-
gamma-BHC (Lindane)	1.9	U	0.13	R	0.13	R				520	2200	50000
gamma-chlordane	1.7	J	7.0	J	35.0					-	-	-
heptachlor	1.9	U	1.5	JN	2.6	U				150	650	50000
heptachlor epoxide	0.39	J	2.0	U	2.6	U				-	-	-

TABLE 8-1

COMPARISON OF SURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCS - SITE 16
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to soil criteria:

- No standard is available for this chemical in this classification.

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB01-06	16SB02-04	16SB03-02	16SB03-06	16SB04-08	16SB04-08-DUP	ARARS & TBCs		
LOCATION:	16SB01	16SB02	16SB03	16SB03	16SB04	16SB04			
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
aluminum	2980	3170	378	2690	3180	2330	-	-	-
arsenic	8.3	11.3	0.73 U	6.1	7.8	8.0	20.0	20.0	-
barium	2.4	1.2	4.5	2.1	1.5	1.3	700	47000	-
beryllium	0.47	0.28	0.024 U	0.19	0.37	0.22	1.00	1.00	-
cadmium	0.92	1.3 E	0.10	0.86	1.0	1.0	1.00	100	-
calcium	216	58.4	98.5	111	261	215	-	-	-
chromium, total	111	125	5.5	93.2	90.9	92.2	-	500	-
cobalt	0.70 U	0.72 U	0.13	0.29	0.69 U	0.70 U	-	-	-
copper	2.0	1.9	1.5	2.1	1.4	1.4	600	600	-
iron	12100	18000	1160	11800	12700	12200	-	-	-
lead	3.3	4.3 J	70.7	4.0	3.8 J	4.8 J	400	600	-
magnesium	532	317	40.8	200	464	286	-	-	-
manganese	0.67 U	0.70 U	3.5	2.2	0.67 U	0.68 U	-	-	-
mercury	0.032 J	0.018 J	0.0022 U	0.0023 U	0.0067 UJ	0.010 J	14.0	270	-
nickel	1.0	1.1 U	0.56	1.0	1.0 U	1.0 U	250	2400	-
potassium	1730	1050	91.2	615	1580	973	-	-	-
selenium	1.0 U	1.1 U	1.0 U	1.0 U	1.0 U	1.0 U	63.0	3100	-
silver	0.49 U	0.50 U	0.21 U	0.22 U	0.49 U	0.49 U	110	4100	-
sodium	282	188	41.7	97.4	21.5	23.0	-	-	-
thallium	0.86 J	1.6 J	0.79 U	0.88	1.5 J	1.4 J	2.00	2.00	-
vanadium	58.7	79.6	6.0	59.2	47.4	47.0	370	7100	-
zinc	7.0 J	6.7 J	3.0 J	3.8 J	6.8 J	7.0 J	1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
2-methylnaphthalene	380 U	400 U	360 U	390 U	130000	170000	-	-	-
acenaphthene	380 U	400 U	360 U	390 U	6900 J	8200 J	3400000	10000000	100000
anthracene	380 U	400 U	360 U	390 U	2300 J	2800 J	10000000	10000000	100000
benzo(a)anthracene	380 U	400 U	360 U	390 U	12000 U	12000 U	900	4000	500000
benzo(a)pyrene	380 U	400 U	360 U	390 U	12000 U	12000 U	660	660	100000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA T ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB01-06		16SB02-04		16SB03-02		16SB03-06		16SB04-08		16SB04-08-DUP		ARARS & TBCs		
LOCATION:	16SB01		16SB02		16SB03		16SB03		16SB04		16SB04		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI		1995 RI		1995 RI				
SEMIVOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
benzo(b)fluoranthene	380	U	400	U	360	U	390	U	12000	U	12000	U	900	4000	50000
benzo(k)fluoranthene	380	U	400	U	360	U	390	U	12000	U	12000	U	900	4000	500000
bis(2-ethylhexyl)phthalate	380	UJ	400	UJ	140	J	150	UJ	12000	UJ	12000	UJ	49000	210000	100000
chrysene	380	U	400	U	360	U	390	U	12000	U	12000	U	9000	40000	500000
dibenzofuran	380	U	400	U	360	U	390	U	5200	J	5900	J	-	-	-
diethylphthalate	380	U	400	U	360	U	390	U	12000	U	12000	U	10000000	10000000	50000
fluoranthene	380	U	400	U	360	U	390	U	12000	U	12000	U	2300000	10000000	100000
fluorene	380	U	400	U	360	U	390	U	13000		13000		2300000	10000000	100000
naphthalene	380	U	400	U	360	U	390	U	39000		42000		230000	4200000	100000
phenanthrene	380	U	400	U	360	U	390	U	21000		24000		-	-	-
phenol	380	U	400	U	360	U	390	U	12000	U	12000	U	10000000	10000000	50000
pyrene	380	U	400	U	360	U	390	U	1600	J	1800	J	1700000	10000000	100000
VOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
1,2-dichloroethene (total)	12.0	U	12.0	U	11.0	U	12.0	U	17.0	J	5800	U	79000	1000000	1000
2-butanone	12.0	U	12.0	U	11.0	U	12.0	U	58.0	UJ	5800	U	1000000	1000000	50000
benzene	12.0	U	12.0	U	11.0	U	12.0	U	300	J	5800	U	3000	13000	1000
carbon disulfide	12.0	UJ	12.0	U	11.0	UJ	12.0	UJ	58.0	UJ	5800	U	-	-	-
ethylbenzene	12.0	U	12.0	U	11.0	U	12.0	U	6300		9600		1000000	1000000	100000
methylene chloride	12.0	U	12.0	U	11.0	J	12.0	J	58.0	UJ	5800	U	49000	210000	1000
tetrachloroethene	12.0	U	12.0	U	11.0	U	12.0	U	58.0	UJ	5800	U	4000	6000	1000
toluene	12.0	U	12.0	U	11.0	U	12.0	U	620	J	5800	U	1000000	1000000	500000
trichloroethene	12.0	U	12.0	U	11.0	U	12.0	U	58.0	UJ	5800	U	23000	54000	1000
xylene (total)	12.0	U	12.0	U	11.0	U	12.0	U	36000	E	52000	E	410000	1000000	10000
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
4,4'-DDD	n/a		4.0	U	n/a		n/a		n/a		n/a		3000	12000	50000
4,4'-DDE	n/a		4.0	U	n/a		n/a		n/a		n/a		2000	9000	50000
4,4'-DDT	n/a		4.0	U	n/a		n/a		n/a		n/a		2000	9000	500000
Aroclor-1254	38.0	U	40.0	U	36.0	U	39.0	U	38.0	U	38.0	U	490	2000	50000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB01-06	16SB02-04	16SB03-02	16SB03-06	16SB04-08	16SB04-08-DUP	ARARS & TBCs		
LOCATION:	16SB01	16SB02	16SB03	16SB03	16SB04	16SB04	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
aldrin	n/a	2.0 U	n/a	n/a	n/a	n/a	40.0	170	50000
alpha-BHC	n/a	2.0 U	n/a	n/a	n/a	n/a	-	-	-
alpha-chlordane	n/a	2.0 U	n/a	n/a	n/a	n/a	-	-	-
dieldrin	n/a	4.0 U	n/a	n/a	n/a	n/a	42.0	180	50000
endosulfan I	n/a	2.0 U	n/a	n/a	n/a	n/a	340000	6200000	50000
endosulfan II	n/a	4.0 U	n/a	n/a	n/a	n/a	340000	6200000	50000
endrin	n/a	4.0 U	n/a	n/a	n/a	n/a	17000	310000	50000
endrin aldehyde	n/a	4.0 U	n/a	n/a	n/a	n/a	-	-	-
gamma-BHC (Lindane)	n/a	2.0 U	n/a	n/a	n/a	n/a	520	2200	50000
gamma-chlordane	n/a	2.0 U	n/a	n/a	n/a	n/a	-	-	-
heptachlor	n/a	2.0 U	n/a	n/a	n/a	n/a	150	650	50000
heptachlor epoxide	n/a	2.0 U	n/a	n/a	n/a	n/a	-	-	-

TABLE 8-2

COMPARISON OF SUBSURFACE S IL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB04-10	16SB05-06	16SB05-08	16SB06-02	16SB06-06	16SB07-04	ARARS & TBCs		
LOCATION:	16SB04	16SB05	16SB05	16SB06	16SB06	16SB07	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
aluminum	2480	1730	3470	1240	1310	3990	-	-	-
arsenic	9.3	8.5	20.3 E	2.8	1.7	7.2	20.0	20.0	-
barium	1.3	1.9	2.7	5.4	4.1	4.4	700	47000	-
beryllium	0.17	0.081	0.34	0.11	0.10	0.46	1.00	1.00	-
cadmium	1.0	0.81	1.3 E	0.28	0.31	0.086 U	1.00	100	-
calcium	113	410	261	129	102	226	-	-	-
chromium, total	103	86.3	158	18.3	12.5	94.7	-	500	-
cobalt	0.72 U	0.22	0.36	0.70 U	0.69 U	0.68 U	-	-	-
copper	1.4	2.1	2.3	3.0	2.6	3.0	600	600	-
iron	12300	11000	17800	3340	2600	13500	-	-	-
lead	2.7	3.1	4.0	7.8 J	6.6 J	5.5	400	600	-
magnesium	284	182	468	84.7	87.2	638	-	-	-
manganese	0.69 U	3.2	0.82	2.1	4.6	2.8	-	-	-
mercury	0.0071 J	0.0051	0.0023 U	0.045 J	0.033 J	0.041 J	14.0	270	-
nickel	1.1 U	0.60	1.3	1.0 U	1.0 U	2.1	250	2400	-
potassium	986	518	1470	147	180	1720 J	-	-	-
selenium	1.1 U	1.0 J	1.0 U	1.0 U	1.0 U	1.0 U	63.0	3100	-
silver	0.50 U	0.21 U	0.22 U	0.49 U	0.48 U	0.48 U	110	4100	-
sodium	32.3	13.6 U	26.2	25.6	23.9	26.8	-	-	-
thallium	0.86 U	0.81 U	0.83 U	1.2 J	1.3 J	0.82 U	2.00	2.00	-
vanadium	53.4	53.3	72.7	15.3	9.5	61.2	370	7100	-
zinc	5.3 J	3.2 J	7.0 J	11.4 J	7.6 J	7.9 J	1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
2-methylnaphthalene	220000	36000	140000	390 U	380 U	380 U	-	-	-
acenaphthene	11000 J	2200 J	8900 J	390 U	380 U	380 U	3400000	10000000	100000
anthracene	3900 J	11000 U	2700 J	390 U	380 U	380 U	10000000	10000000	100000
benzo(a)anthracene	12000 U	11000 U	11000 U	390 U	380 U	380 U	900	4000	500000
benzo(a)pyrene	12000 U	11000 U	11000 U	390 U	380 U	380 U	660	660	100000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB04-10	16SB05-06	16SB05-08	16SB06-02	16SB06-06	16SB07-04	ARARS & TBCs		
LOCATION:	16SB04	16SB05	16SB05	16SB06	16SB06	16SB07	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
benzo(b)fluoranthene	12000 U	11000 U	11000 U	390 U	380 U	380 U	900	4000	50000
benzo(k)fluoranthene	12000 U	11000 U	11000 U	390 U	380 U	380 U	900	4000	500000
bis(2-ethylhexyl)phthalate	12000 U	11000 UJ	11000 UJ	390 UJ	380 UJ	380 U	49000	210000	100000
chrysene	12000 U	11000 U	11000 U	56.0 J	380 U	380 U	9000	40000	500000
dibenzofuran	7800 J	1300 J	5400 J	390 U	380 U	380 U	-	-	-
diethylphthalate	12000 U	11000 U	11000 U	390 U	380 U	380 U	10000000	10000000	50000
fluoranthene	12000 U	11000 U	11000 U	49.0 J	380 U	380 U	2300000	10000000	100000
fluorene	18000	3300 J	13000	390 U	380 U	380 U	2300000	10000000	100000
naphthalene	60000	8000 J	40000	390 U	380 U	380 U	230000	4200000	100000
phenanthrene	31000	6400 J	26000	50.0 J	380 U	380 U	-	-	-
phenol	12000 U	11000 U	11000 U	390 U	380 U	380 U	10000000	10000000	50000
pyrene	2800 J	11000 U	1400 J	390 U	380 U	380 U	1700000	10000000	100000
VOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
1,2-dichloroethene (total)	1500 U	11.0 U	1400 U	12.0 U	11.0 U	11.0 U	79000	1000000	1000
2-butanone	1500 U	5.0 J	1400 U	12.0 U	11.0 U	11.0 UJ	1000000	1000000	50000
benzene	1300 E J	11.0 U	1400 U	12.0 U	11.0 U	11.0 U	3000	13000	1000
carbon disulfide	1500 U	11.0 UJ	1400 U	12.0 U	11.0 U	11.0 U	-	-	-
ethylbenzene	16000	24.0	4100	12.0 U	11.0 U	11.0 U	1000000	1000000	100000
methylene chloride	1500 U	11.0 J	1400 U	12.0 U	11.0 U	7.0 J	49000	210000	1000
tetrachloroethene	1500 U	11.0 U	1400 U	12.0 U	11.0 U	6.0 J	4000	6000	1000
toluene	770 J	11.0 U	190 J	12.0 U	11.0 U	11.0 U	1000000	1000000	500000
trichloroethene	1500 U	11.0 U	1400 U	12.0 U	11.0 U	11.0 U	23000	54000	1000
xylene (total)	92000 E	70.0	9600	12.0 U	11.0 U	11.0 U	410000	1000000	10000
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
4,4'-DDD	n/a	n/a	n/a	n/a	n/a	n/a	3000	12000	50000
4,4'-DDE	n/a	n/a	n/a	n/a	n/a	n/a	2000	9000	50000
4,4'-DDT	n/a	n/a	n/a	n/a	n/a	n/a	2000	9000	500000
Aroclor-1254	39.0 U	37.0 U	38.0 U	39.0 U	38.0 U	37.0 U	490	2000	50000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB04-10	16SB05-06	16SB05-08	16SB06-02	16SB06-06	16SB07-04	ARARS & TBCs		
LOCATION:	16SB04	16SB05	16SB05	16SB06	16SB06	16SB07	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
PESTICIDES	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**
aldrin	n/a	n/a	n/a	n/a	n/a	n/a	40.0	170	50000
alpha-BHC	n/a	n/a	n/a	n/a	n/a	n/a	-	-	-
alpha-chlordane	n/a	n/a	n/a	n/a	n/a	n/a	-	-	-
dieldrin	n/a	n/a	n/a	n/a	n/a	n/a	42.0	180	50000
endosulfan I	n/a	n/a	n/a	n/a	n/a	n/a	340000	6200000	50000
endosulfan II	n/a	n/a	n/a	n/a	n/a	n/a	340000	6200000	50000
endrin	n/a	n/a	n/a	n/a	n/a	n/a	17000	310000	50000
endrin aldehyde	n/a	n/a	n/a	n/a	n/a	n/a	-	-	-
gamma-BHC (Lindane)	n/a	n/a	n/a	n/a	n/a	n/a	520	2200	50000
gamma-chlordane	n/a	n/a	n/a	n/a	n/a	n/a	-	-	-
heptachlor	n/a	n/a	n/a	n/a	n/a	n/a	150	650	50000
heptachlor epoxide	n/a	n/a	n/a	n/a	n/a	n/a	-	-	-

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB08-06	16SB09-00	16SB09-06	16SB10-00	16SB10-04	16SB11-09	ARARS & TBCs		
LOCATION:	16SB08	16SB09	16SB09	16SB10	16SB10	16SB11	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
aluminum	4110	914	2130	1680	1770	4180	-	-	-
arsenic	11.3	1.8	3.7	2.1	3.0	5.3	20.0	20.0	-
barium	3.6	4.2	1.5	13.8	2.4	6.9	700	47000	-
beryllium	0.49	0.12	0.10	0.068	0.10	0.52	1.00	1.00	-
cadmium	0.090 U	0.32	0.66	0.30	0.085 U	0.090 U	1.00	100	-
calcium	297	72.7	34.5	1570 J	105	1240 J	-	-	-
chromium, total	123	5.6	68.4	22.5	34.3	96.5	-	500	-
cobalt	0.71 U	0.67 U	0.74 U	0.68 U	0.67 U	0.71 U	-	-	-
copper	2.9	6.6	1.2	28.0	1.7	2.8	600	600	-
iron	16600	3760	8730	4450	4930	12500	-	-	-
lead	3.7	6.6 J	2.4	62.2	3.3	3.6	400	600	-
magnesium	526	39.8	104	865	153	1030	-	-	-
manganese	0.69 U	4.1	0.71 U	31.8	3.5	3.9	-	-	-
mercury	0.0082 J	0.028 J	0.017 J	0.024 J	0.013 J	0.013 J	14.0	270	-
nickel	1.5	1.0 U	1.1 U	2.5	1.0 U	2.1	250	2400	-
potassium	1670 J	111	297	234	389	1990 J	-	-	-
selenium	1.0 U	1.0 U	1.1 U	1.0 U	1.0 U	1.0 U	63.0	3100	-
silver	0.50 U	0.47 U	0.51 U	0.48 U	0.47 U	0.49 U	110	4100	-
sodium	18.3	23.1	25.6	21.1	20.0	27.9	-	-	-
thallium	0.85 U	0.81 U	1.4 J	0.82 U	0.80 U	0.85 U	2.00	2.00	-
vanadium	79.1	5.5	31.4	17.1	26.8	59.9	370	7100	-
zinc	4.2 J	2.9 J	1.8 J	12.2 J	2.9 J	8.3 J	1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
2-methylnaphthalene	390 U	2600	400 U	5800 J	370 U	390 U	-	-	-
acenaphthene	390 U	370 U	400 U	11000 U	370 U	390 U	3400000	10000000	100000
anthracene	390 U	370 U	400 U	11000 U	370 U	390 U	10000000	10000000	100000
benzo(a)anthracene	390 U	370 U	400 U	11000 U	370 U	390 U	900	4000	500000
benzo(a)pyrene	390 U	370 U	400 U	11000 U	370 U	390 U	660	660	100000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB08-06		16SB09-00		16SB09-06		16SB10-00		16SB10-04		16SB11-09		ARARS & TBCs		
LOCATION:	16SB08		16SB09		16SB09		16SB10		16SB10		16SB11		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI		1995 RI		1995 RI				
SEMIVOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
benzo(b)fluoranthene	390	U	370	U	400	U	11000	U	370	U	390	U	900	4000	50000
benzo(k)fluoranthene	390	U	370	U	400	U	11000	U	370	U	390	U	900	4000	500000
bis(2-ethylhexyl)phthalate	390	U	370	UJ	400	UJ	1400	J	370	U	560	U	49000	210000	100000
chrysene	390	U	370	U	400	U	11000	U	370	U	390	U	9000	40000	500000
dibenzofuran	390	U	370	U	400	U	11000	U	370	U	390	U	-	-	-
diethylphthalate	390	U	370	U	400	U	11000	U	38.0	J	390	U	10000000	10000000	50000
fluoranthene	390	U	370	U	400	U	11000	U	370	U	390	U	2300000	10000000	100000
fluorene	390	U	370	U	400	U	11000	U	370	U	390	U	2300000	10000000	100000
naphthalene	390	U	430		400	U	11000	U	370	U	390	U	230000	4200000	100000
phenanthrene	390	U	46.0	J	400	U	2000	J	370	U	390	U	-	-	-
phenol	42.0	J	370	U	400	U	11000	U	52.0	J	49.0	J	10000000	10000000	50000
pyrene	390	U	370	U	400	U	11000	U	370	U	390	U	1700000	10000000	100000
VOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
1,2-dichloroethene (total)	12.0	U	56.0	U	12.0	U	57.0	U	11.0	U	12.0	U	79000	1000000	1000
2-butanone	12.0	UJ	56.0	U	12.0	U	57.0	U	11.0	U	12.0	UJ	1000000	1000000	50000
benzene	12.0	U	56.0	U	12.0	U	57.0	U	11.0	U	12.0	U	3000	13000	1000
carbon disulfide	12.0	U	56.0	U	12.0	U	57.0	U	11.0	U	12.0	U	-	-	-
ethylbenzene	12.0	U	97.0		12.0	U	57.0	UJ	11.0	U	12.0	U	1000000	1000000	100000
methylene chloride	5.0	J	56.0	U	12.0	U	10.0	J	4.0	J	4.0	J	49000	210000	1000
tetrachloroethene	12.0	U	56.0	U	12.0	U	7.0	J	11.0	U	12.0	U	4000	6000	1000
toluene	12.0	U	56.0	U	12.0	U	57.0	UJ	11.0	U	12.0	U	1000000	1000000	500000
trichloroethene	12.0	U	56.0	U	12.0	U	57.0	U	11.0	U	12.0	U	23000	54000	1000
xylene (total)	12.0	U	96.0		12.0	U	11.0	J	11.0	U	12.0	U	410000	1000000	10000
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
4,4'-DDD	n/a		3.7	U	n/a		3.7	U	n/a		n/a		3000	12000	50000
4,4'-DDE	n/a		3.7	U	n/a		8.5	R	n/a		n/a		2000	9000	50000
4,4'-DDT	n/a		6.0		n/a		3.7	U	n/a		n/a		2000	9000	500000
Aroclor-1254	39.0	U	37.0	U	10.0	J	37.0	U	37.0	U	39.0	U	490	2000	50000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB08-06	16SB09-00	16SB09-06	16SB10-00	16SB10-04	16SB11-09	ARARS & TBCs		
LOCATION:	16SB08	16SB09	16SB09	16SB10	16SB10	16SB11	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
aldrin	n/a	1.9 U	n/a	1.4 R	n/a	n/a	40.0	170	50000
alpha-BHC	n/a	1.9 U	n/a	0.26 R	n/a	n/a	-	-	-
alpha-chlordane	n/a	1.9 U	n/a	1.9 U	n/a	n/a	-	-	-
dieldrin	n/a	3.7 U	n/a	0.77 R	n/a	n/a	42.0	180	50000
endosulfan I	n/a	1.9 U	n/a	9.9	n/a	n/a	340000	6200000	50000
endosulfan II	n/a	3.7 U	n/a	41.0	n/a	n/a	340000	6200000	50000
endrin	n/a	3.7 U	n/a	3.7 U	n/a	n/a	17000	310000	50000
endrin aldehyde	n/a	3.7 U	n/a	25.0 R	n/a	n/a	-	-	-
gamma-BHC (Lindane)	n/a	0.088 R	n/a	0.40 R	n/a	n/a	520	2200	50000
gamma-chlordane	n/a	1.9 U	n/a	0.91 R	n/a	n/a	-	-	-
heptachlor	n/a	1.9 U	n/a	1.9 U	n/a	n/a	150	650	50000
heptachlor epoxide	n/a	1.9 U	n/a	7.8	n/a	n/a	-	-	-

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB12-02	16SB12-06	16SB13-02	16SB13-06	16SB14-04	16SB15-06	ARARS & TBCs		
LOCATION:	16SB12	16SB12	16SB13	16SB13	16SB14	16SB15			
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
aluminum	1780	1730	1810	1430	3600	3170	-	-	-
arsenic	1.2	1.9	1.5	2.1	5.5	9.9	20.0	20.0	-
barium	6.6	3.3	5.5	4.9	4.9	2.6	700	47000	-
beryllium	0.039	0.15	0.14	0.14	0.22	0.31	1.00	1.00	-
cadmium	0.19	0.42	0.31	0.43	0.087 U	0.086 U	1.00	100	-
calcium	439	784	216	550	128	154	-	-	-
chromium, total	4.1	55.3	4.9	32.6	58.9	105	-	500	-
cobalt	0.40	0.14 U	0.63 U	0.67 U	0.69 U	0.68 U	-	-	-
copper	3.0	1.5	4.2	3.4	2.5	2.8	600	600	-
iron	1890	5620	3210	4430	10200	13900	-	-	-
lead	9.1	3.6	8.2 J	6.9 J	5.3	3.7	400	600	-
magnesium	175	364	162	254	253	397	-	-	-
manganese	12.1	7.1	10.7	9.9	3.2	3.8	-	-	-
mercury	0.013	0.0023 U	0.025 J	0.048 J	0.014 J	0.0073 UJ	14.0	270	-
nickel	1.4	0.72	1.1	1.0 U	1.2	1.0	250	2400	-
potassium	74.5	353	70.5	249	721	1240 J	-	-	-
selenium	1.0 U	1.0 U	0.93 U	1.0 U	1.0 U	1.0 U	63.0	3100	-
silver	0.31	0.21 U	0.44 U	1.1	0.48 U	0.47 U	110	4100	-
sodium	55.9	23.7	48.4	32.7	26.4	188	-	-	-
thallium	0.78 U	1.1	1.4 J	0.81 U	0.83 U	0.81 U	2.00	2.00	-
vanadium	4.4	27.0	5.0	18.2	41.2	61.1	370	7100	-
zinc	12.5 J	3.5 J	29.6 J	12.4 J	5.8 J	5.1 J	1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
2-methylnaphthalene	350 U	4900	350 U	2200	380 U	370 U	-	-	-
acenaphthene	350 U	240 J	350 U	160 J	380 U	370 U	3400000	10000000	100000
anthracene	350 U	380 U	350 U	78.0 J	380 U	370 U	10000000	10000000	100000
benzo(a)anthracene	43.0 J	380 U	350 U	41.0 J	380 U	370 U	900	4000	500000
benzo(a)pyrene	43.0 J	380 U	350 U	41.0 J	380 U	370 U	660	660	100000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB12-02		16SB12-06		16SB13-02		16SB13-06		16SB14-04		16SB15-06		ARARS & TBCs		
LOCATION:	16SB12		16SB12		16SB13		16SB13		16SB14		16SB15		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI		1995 RI		1995 RI				
SEMIVOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
benzo(b)fluoranthene	38.0	J	380	U	350	U	40.0	J	380	U	370	U	900	4000	50000
benzo(k)fluoranthene	46.0	J	380	U	350	U	39.0	J	380	U	370	U	900	4000	500000
bis(2-ethylhexyl)phthalate	67.0	J	110	J	350	UJ	370	U	380	U	370	U	49000	210000	100000
chrysene	55.0	J	380	U	350	U	57.0	J	380	U	370	U	9000	40000	500000
dibenzofuran	350	U	380	U	350	U	370	U	380	U	370	U	-	-	-
diethylphthalate	350	U	380	U	350	U	370	U	73.0	J	370	U	10000000	10000000	50000
fluoranthene	110	J	380	U	350	U	140	J	380	U	370	U	2300000	10000000	100000
fluorene	350	U	610		350	U	320	J	380	U	370	U	2300000	10000000	100000
naphthalene	350	U	810		350	U	290	J	380	U	370	U	230000	4200000	100000
phenanthrene	65.0	J	1000		350	U	600		380	U	370	U	-	-	-
phenol	350	U	380	U	350	U	370	U	380	U	370	U	10000000	10000000	50000
pyrene	86.0	J	120	J	350	U	110	J	380	U	370	U	1700000	10000000	100000
VOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
1,2-dichloroethene (total)	11.0	U	11.0	U	10.0	U	11.0	U	96.0		11.0	U	79000	1000000	1000
2-butanone	11.0	U	11.0	U	10.0	U	11.0	U	11.0	UJ	8.0	J	1000000	1000000	50000
benzene	11.0	U	11.0	U	10.0	U	11.0	U	11.0	U	11.0	U	3000	13000	1000
carbon disulfide	11.0	UJ	11.0	UJ	10.0	UJ	11.0	UJ	11.0	U	11.0	U	-	-	-
ethylbenzene	11.0	U	11.0	U	10.0	U	11.0	U	11.0	U	11.0	U	1000000	1000000	100000
methylene chloride	11.0	J	11.0	J	10.0	U	11.0	U	11.0	U	2.0	J	49000	210000	1000
tetrachloroethene	11.0	U	11.0	U	10.0	U	11.0	U	11.0	U	11.0	U	4000	6000	1000
toluene	11.0	U	11.0	U	10.0	U	11.0	U	11.0	U	11.0	U	1000000	1000000	500000
trichloroethene	11.0	U	11.0	U	10.0	U	11.0	U	3.0	J	11.0	U	23000	54000	1000
xylene (total)	11.0	U	11.0	U	10.0	U	11.0	U	11.0	U	11.0	U	410000	1000000	10000
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
4,4'-DDD	2.1	NJ	n/a		3.5	U	3.7	U	26.0		n/a		3000	12000	50000
4,4'-DDE	11.0		n/a		5.6		7.9		1.8	J	n/a		2000	9000	50000
4,4'-DDT	16.0		n/a		6.3		20.0		8.2		n/a		2000	9000	500000
Aroclor-1254	35.0	U	37.0	U	35.0	U	37.0	U	38.0	U	37.0	U	490	2000	50000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB12-02		16SB12-06		16SB13-02		16SB13-06		16SB14-04		16SB15-06		ARARS & TBCs		
LOCATION:	16SB12		16SB12		16SB13		16SB13		16SB14		16SB15		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI		1995 RI		1995 RI				
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
aldrin	1.8	U	n/a		1.8	U	1.9	U	2.0	U	n/a		40.0	170	50000
alpha-BHC	0.032	R	n/a		1.8	U	1.9	U	2.0	U	n/a		-	-	-
alpha-chlordane	3.7		n/a		1.8	U	1.9	U	2.0	U	n/a		-	-	-
dieldrin	3.6		n/a		2.9	J	3.7	U	3.8	U	n/a		42.0	180	50000
endosulfan I	1.8	U	n/a		1.8	U	1.9	U	2.0	U	n/a		340000	6200000	50000
endosulfan II	3.5	U	n/a		3.5	U	3.7	U	3.8	U	n/a		340000	6200000	50000
endrin	3.5	U	n/a		3.5	U	3.7	U	3.8	U	n/a		17000	310000	50000
endrin aldehyde	3.5	U	n/a		3.5	U	3.7	U	3.8	U	n/a		-	-	-
gamma-BHC (Lindane)	1.8	U	n/a		1.8	U	0.23	R	2.0	U	n/a		520	2200	50000
gamma-chlordane	3.3		n/a		1.1	J	1.1	J	0.39	J	n/a		-	-	-
heptachlor	0.27	J	n/a		1.8	U	1.9	U	2.0	U	n/a		150	650	50000
heptachlor epoxide	1.8	U	n/a		1.8	U	1.9	U	2.0	U	n/a		-	-	-

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB16-06	16SB16-06-DUP	16SB17-04	16SB17-04-DUP	16SB17-06	16SB18-02	ARARS & TBCs		
LOCATION:	16SB16	16SB16	16SB17	16SB17	16SB17	16SB18	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
aluminum	2630	2540	3360	3700	3670	1460	-	-	-
arsenic	4.5	5.2	4.4	4.2	10.2	1.2	20.0	20.0	-
barium	2.0	2.0	4.2	4.5	1.4	6.0	700	47000	-
beryllium	0.32	0.26	0.30	0.35	0.61	0.11	1.00	1.00	-
cadmium	0.085 U	0.086 U	0.10	0.085 U	0.090 U	0.083 U	1.00	100	-
calcium	283	353	218	179	122	62.6	-	-	-
chromium, total	78.4	79.4	71.1	65.5	115	6.8	-	500	-
cobalt	0.67 U	0.68 U	0.68 U	0.67 U	0.71 U	0.75	-	-	-
copper	1.5	1.7	2.2	2.1	1.4	2.6	600	600	-
iron	9040	8530	9830	9790	15700	2860	-	-	-
lead	2.1	2.2	3.4	3.4	2.6	7.1	400	600	-
magnesium	437	365	371	486	727	52.4	-	-	-
manganese	1.0	1.2	8.4	8.2	2.2	5.5	-	-	-
mercury	0.0073 UJ	0.0074 J	0.032 J	0.028 J	0.0088 J	0.011 J	14.0	270	-
nickel	1.0 U	1.0 U	1.5	1.5	1.9	3.3	250	2400	-
potassium	1310 J	970	1140 J	1510 J	2530 J	141	-	-	-
selenium	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	63.0	3100	-
silver	0.47 U	0.48 U	0.47 U	0.47 U	0.49 U	0.46 U	110	4100	-
sodium	25.9	26.1	27.7	27.5	22.1	22.4	-	-	-
thallium	0.81 U	0.82 U	0.81 U	0.81 U	0.85 U	0.78 U	2.00	2.00	-
vanadium	48.1	48.9	43.4	39.9	63.6	5.7	370	7100	-
zinc	5.9 J	2.7 J	6.6 J	9.3 J	3.8 J	5.2 J	1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
2-methylnaphthalene	370 U	380 U	6600 J	8800	74000	11000 U	-	-	-
acenaphthene	370 U	380 U	11000 U	370 U	3000 J	1300 J	3400000	10000000	100000
anthracene	370 U	380 U	11000 U	400	1600 J	11000 U	10000000	10000000	100000
benzo(a)anthracene	370 U	380 U	11000 U	370 U	12000 U	11000 U	900	4000	500000
benzo(a)pyrene	370 U	380 U	11000 U	370 U	12000 U	11000 U	660	660	100000

TABLE 8-2

COMPARISON OF SUBSURFACE S IL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB16-06		16SB16-06-DUP		16SB17-04		16SB17-04-DUP		16SB17-06		16SB18-02		ARARS & TBCs		
LOCATION:	16SB16		16SB16		16SB17		16SB17		16SB17		16SB18		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI		1995 RI		1995 RI				
SEMIVOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
benzo(b)fluoranthene	370	U	380	U	11000	U	370	U	12000	U	11000	U	900	4000	50000
benzo(k)fluoranthene	370	U	380	U	11000	U	370	U	12000	U	11000	U	900	4000	500000
bis(2-ethylhexyl)phthalate	370	U	380	U	11000	UJ	370	U	12000	UJ	11000	UJ	49000	210000	100000
chrysene	370	U	380	U	11000	U	370	U	12000	U	11000	U	9000	40000	500000
dibenzofuran	370	U	380	U	11000	U	370	U	2200	J	11000	U	-	-	-
diethylphthalate	370	U	54.0	J	11000	U	370	U	12000	U	11000	U	10000000	10000000	50000
fluoranthene	370	U	380	U	11000	U	110	J	12000	U	11000	U	2300000	10000000	100000
fluorene	370	U	380	U	1100	J	370	U	5900	J	1600	J	2300000	10000000	100000
naphthalene	370	U	380	U	11000	U	370	U	13000		11000	U	230000	4200000	100000
phenanthrene	370	U	380	U	2800	J	4100		12000		2800	J	-	-	-
phenol	370	U	380	U	11000	U	370	U	12000	U	11000	U	10000000	10000000	50000
pyrene	370	U	380	U	11000	U	220	J	12000	U	11000	U	1700000	10000000	100000
VOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
1,2-dichloroethene (total)	11.0	U	11.0	U	11.0	U	56.0	U	1500	U	54.0	U	79000	1000000	1000
2-butanone	11.0	U	11.0	U	11.0	UJ	56.0	U	1500	U	54.0	U	1000000	1000000	50000
benzene	11.0	U	11.0	U	11.0	U	56.0	U	1500	U	54.0	U	3000	13000	1000
carbon disulfide	11.0	U	11.0	U	2.0	J	56.0	U	1500	U	54.0	U	-	-	-
ethylbenzene	11.0	U	11.0	U	42.0		47.0	J	2100		13.0	J	1000000	1000000	100000
methylene chloride	2.0	J	2.0	J	3.0	J	56.0	U	150	J	54.0	U	49000	210000	1000
tetrachloroethene	11.0	U	11.0	U	4.0	J	10.0	J	1500	U	45.0	J	4000	6000	1000
toluene	11.0	U	11.0	U	11.0	U	56.0	U	1500	U	54.0	U	1000000	1000000	500000
trichloroethene	11.0	U	11.0	U	11.0	U	56.0	U	1500	U	54.0	U	23000	54000	1000
xylene (total)	11.0	U	11.0	U	93.0		110		2000		8.0	J	410000	1000000	10000
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
4,4'-DDD	n/a		n/a		n/a		n/a		n/a		3.6	U	3000	12000	50000
4,4'-DDE	n/a		n/a		n/a		n/a		n/a		3.6	U	2000	9000	50000
4,4'-DDT	n/a		n/a		n/a		n/a		n/a		7.4		2000	9000	500000
Aroclor-1254	37.0	U	37.0	U	37.0	U	37.0	U	39.0	U	36.0	U	490	2000	50000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB16-06	16SB16-06-DUP	16SB17-04	16SB17-04-DUP	16SB17-06	16SB18-02		ARARS & TBCs		
LOCATION:	16SB16	16SB16	16SB17	16SB17	16SB17	16SB18		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI				
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg		ug/kg	ug/kg	ug/kg
aldrin	n/a	n/a	n/a	n/a	n/a	1.8	U	40.0	170	50000
alpha-BHC	n/a	n/a	n/a	n/a	n/a	0.20	R	-	-	-
alpha-chlordane	n/a	n/a	n/a	n/a	n/a	1.8	U	-	-	-
dieldrin	n/a	n/a	n/a	n/a	n/a	3.6	U	42.0	180	50000
endosulfan I	n/a	n/a	n/a	n/a	n/a	1.8	U	340000	6200000	50000
endosulfan II	n/a	n/a	n/a	n/a	n/a	3.6	U	340000	6200000	50000
endrin	n/a	n/a	n/a	n/a	n/a	0.29	R	17000	310000	50000
endrin aldehyde	n/a	n/a	n/a	n/a	n/a	3.6	U	-	-	-
gamma-BHC (Lindane)	n/a	n/a	n/a	n/a	n/a	1.8	U	520	2200	50000
gamma-chlordane	n/a	n/a	n/a	n/a	n/a	0.31	R	-	-	-
heptachlor	n/a	n/a	n/a	n/a	n/a	1.8	U	150	650	50000
heptachlor epoxide	n/a	n/a	n/a	n/a	n/a	0.37	R	-	-	-

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB18-06	16SB19-06	16SB19-08	16SB20-02	16SB20-06	---	ARARS & TBCs		
LOCATION:	16SB18	16SB19	16SB19	16SB20	16SB20	---	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI				
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg
aluminum	3000	3280	2700	3280	3800		-	-	-
arsenic	3.0	7.8	10.4	2.9	8.2		20.0	20.0	-
barium	2.8	3.3	1.7	2.9	3.0		700	47000	-
beryllium	0.19	0.52	0.35	0.16	0.53		1.00	1.00	-
cadmium	0.082 U	0.086	0.091 U	0.084 U	0.090 U		1.00	100	-
calcium	113	318	573	157	172		-	-	-
chromium, total	39.4	138	103	48.9	166		-	500	-
cobalt	0.64 U	0.68 U	0.72 U	0.66 U	0.71 U		-	-	-
copper	3.4	2.4	2.3	1.5	3.0		600	600	-
iron	8230	12900	14800	6580	15200		-	-	-
lead	6.4	2.4	3.9	3.0	2.6		400	600	-
magnesium	226	659	348	155	614		-	-	-
manganese	2.8	0.77	1.0	2.4	0.68 U		-	-	-
mercury	0.020 J	0.014 J	0.0077 UJ	0.0072 UJ	0.0076 J		14.0	270	-
nickel	1.2	1.4	1.1 U	1.1	1.9		250	2400	-
potassium	595	2310 J	1310 J	361	2060 J		-	-	-
selenium	0.94 U	1.0 U	1.1 U	1.0 U	1.0 U		63.0	3100	-
silver	0.45 U	0.48 U	0.50 U	0.46 U	0.50 U		110	4100	-
sodium	20.1	230	292	20.7	30.0		-	-	-
thallium	0.77 U	0.82 U	0.86 U	0.79 U	0.85 U		2.00	2.00	-
vanadium	29.0	67.4	59.6	29.6	69.6		370	7100	-
zinc	3.5 J	2.2 J	3.8 J	3.3 J	2.6 J		1500	1500	-
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg		ug/kg	ug/kg	ug/kg
2-methylnaphthalene	29000	78000	130000	28000	7700		-	-	-
acenaphthene	2000 J	3500 J	4800 J	1900 J	390 U		3400000	10000000	100000
anthracene	11000 U	1400 J	1600 J	11000 U	390 U		10000000	10000000	100000
benzo(a)anthracene	11000 U	11000 U	12000 U	11000 U	390 U		900	4000	500000
benzo(a)pyrene	11000 U	11000 U	12000 U	11000 U	390 U		660	660	100000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB18-06		16SB19-06		16SB19-08		16SB20-02		16SB20-06		---		ARARS & TBCs		
LOCATION:	16SB18		16SB19		16SB19		16SB20		16SB20		---		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI		1995 RI						
SEMIVOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg				ug/kg	ug/kg	ug/kg
benzo(b)fluoranthene	11000	U	11000	U	12000	U	11000	U	390	U			900	4000	50000
benzo(k)fluoranthene	11000	U	11000	U	12000	U	11000	U	390	U			900	4000	500000
bis(2-ethylhexyl)phthalate	11000	UJ	11000	UJ	12000	UJ	11000	UJ	390	U			49000	210000	100000
chrysene	11000	U	11000	U	12000	U	11000	U	390	U			9000	40000	500000
dibenzofuran	2000	J	3500	J	3900	J	11000	U	390	U			-	-	-
diethylphthalate	11000	U	11000	U	12000	U	11000	U	390	U			10000000	10000000	50000
fluoranthene	11000	U	11000	U	12000	U	11000	U	82.0	J			2300000	10000000	100000
fluorene	4000	J	7600	J	9100	J	2500	J	390	U			2300000	10000000	100000
naphthalene	3000	J	21000		30000		5000	J	1200				230000	4200000	100000
phenanthrene	5500	J	13000		16000		4900	J	1400				-	-	-
phenol	11000	U	11000	U	12000	U	11000	U	390	U			10000000	10000000	50000
pyrene	11000	U	11000	U	12000	U	11000	U	98.0	J			1700000	10000000	100000
VOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg				ug/kg	ug/kg	ug/kg
1,2-dichloroethene (total)	54.0	U	1400	U	1500	U	11.0	U	12.0	U			79000	1000000	1000
2-butanone	54.0	U	1400	U	1500	U	11.0	UJ	12.0	UJ			1000000	1000000	50000
benzene	54.0	U	1400	U	330	J	11.0	U	12.0	U			3000	13000	1000
carbon disulfide	54.0	U	1400	U	1500	U	11.0	U	12.0	U			-	-	-
ethylbenzene	120		5400		10000		150		57.0				1000000	1000000	100000
methylene chloride	6.0	J	1400	U	1500	U	3.0	J	5.0	J			49000	210000	1000
tetrachloroethene	17.0	J	1400	U	1500	U	11.0	U	9.0	J			4000	6000	1000
toluene	54.0	U	1400	U	260	J	11.0	U	12.0	U			1000000	1000000	500000
trichloroethene	54.0	U	1400	U	1500	U	11.0	U	12.0	U			23000	54000	1000
xylene (total)	120		5700		47000	E	540		310				410000	1000000	10000
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg				ug/kg	ug/kg	ug/kg
4,4'-DDD	3.6	U	n/a		n/a		n/a		n/a				3000	12000	50000
4,4'-DDE	3.6	U	n/a		n/a		n/a		n/a				2000	9000	50000
4,4'-DDT	9.9		n/a		n/a		n/a		n/a				2000	9000	500000
Aroclor-1254	36.0	U	37.0	U	39.0	U	37.0	U	39.0	U			490	2000	50000

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SB18-06		16SB19-06	16SB19-08	16SB20-02	16SB20-06	---	ARARS & TBCs		
LOCATION:	16SB18		16SB19	16SB19	16SB20	16SB20	---	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI	1995 RI	1995 RI	1995 RI				
PESTICIDES	ug/kg		ug/kg	ug/kg	ug/kg	ug/kg		ug/kg	ug/kg	ug/kg
aldrin	0.16	R	n/a	n/a	n/a	n/a		40.0	170	50000
alpha-BHC	0.29	R	n/a	n/a	n/a	n/a		-	-	-
alpha-chlordane	1.9	U	n/a	n/a	n/a	n/a		-	-	-
dieldrin	3.6	U	n/a	n/a	n/a	n/a		42.0	180	50000
endosulfan I	0.092	R	n/a	n/a	n/a	n/a		340000	6200000	50000
endosulfan II	3.6	U	n/a	n/a	n/a	n/a		340000	6200000	50000
endrin	3.6	U	n/a	n/a	n/a	n/a		17000	310000	50000
endrin aldehyde	3.6	U	n/a	n/a	n/a	n/a		-	-	-
gamma-BHC (Lindane)	0.57	R	n/a	n/a	n/a	n/a		520	2200	50000
gamma-chlordane	1.9	U	n/a	n/a	n/a	n/a		-	-	-
heptachlor	1.9	U	n/a	n/a	n/a	n/a		150	650	50000
heptachlor epoxide	0.49	J	n/a	n/a	n/a	n/a		-	-	-

TABLE 8-2

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCS - SITE 16
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to soil criteria:

- No standard is available for this chemical in this classification.

TABLE 8-3

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SD01	16SD01-DUP	16SD02	16SD02-DUP	16SD03	---	---	ARARS & TBCs
LOCATION:	16SD01	16SD01	16SD02	16SD02	16SD03	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			mg/kg
aluminum	1220	1580	4250	4340	2820			-
antimony	1.5	0.74 U	0.81 U	0.81 U	0.73 U			2.00 M
arsenic	2.2	2.8	8.9 E	6.0	5.7			8.20 L
barium	20.7	24.0	19.4	22.1	16.5			40.0 B
beryllium	0.12	0.13	0.39	0.33	0.23			-
cadmium	2.8 E J	2.0 E J	1.9 E J	2.5 E J	1.9 E J			1.20 L
calcium	443	458	1690 J	2010 J	1160			-
chromium, total	18.3	18.6	59.7	57.7	56.3			81.0 L
cobalt	0.89	0.83	1.9	2.6	1.8			50.0 T
copper	21.2	17.7	21.9	29.3	26.7			34.0 L
iron	11400	10900	12900	14900	11000			-
lead	51.0 E	53.3 E	39.5	50.3 E	57.9 E			47.0 L
magnesium	176	187	1340	1740	1120			-
manganese	41.3	36.1	79.1	107	57.4			460 O
mercury	0.072	0.051	0.063	0.055	0.021			0.150 L
nickel	3.4	3.7	4.9	6.1	4.6			21.0 L
potassium	110	147	1080	804	519			-
silver	0.41	0.33	0.52	0.45	0.63			1.00 M
sodium	29.8	49.9	112	159	110			-
thallium	1.0 UJ	1.0 UJ	1.1 UJ	1.6 J	1.3 J			-
vanadium	9.3	8.4	38.2	43.3	37.2			-
zinc	132	81.1	111	146	132			150 L
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg			ug/kg
2-methylnaphthalene	160 J	79.0 J	490 U	500 U	440 U			330 F
acenaphthene	160 J	130 J	490 U	500 U	440 U			620 Q
anthracene	210 J	220 J	490 U	500 U	440 U			330 F
benzo(a)anthracene	410 E J	660 E	81.0 J	160 J	63.0 J			330 F
benzo(a)pyrene	360 J	590 E	92.0 J	130 J	75.0 J			430 L

TABLE 8-3

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16SD01	16SD01-DUP	16SD02	16SD02-DUP	16SD03	---	---	ARARS & TBCs
LOCATION:	16SD01	16SD01	16SD02	16SD02	16SD03	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg			ug/kg
benzo(b)fluoranthene	590 E J	750 E	180 J	320 J	150 J			330 F
benzo(g,h,i)perylene	260 J	440 E J	59.0 J	140 J	71.0 J			330 F
benzo(k)fluoranthene	200 J	300 J	490 U	96.0 J	440 UJ			330 F
bis(2-ethylhexyl)phthalate	330 J	360 J	250 J	220 J	460			890000000 S
butylbenzylphthalate	440 U	460 U	65.0 J	500 U	440 U			11000 Q
carbazole	170 J	160 J	490 U	500 U	440 U			330 F
chrysene	430 E J	690 E	140 J	250 J	120 J			330 F
dibenz(a,h)anthracene	60.0 J	120 J	490 U	500 UJ	440 UJ			330 F
dibenzofuran	100 J	59.0 J	490 U	500 U	440 U			2000 P
fluoranthene	1100	1400	190 J	360 J	110 J			2900 Q
fluorene	150 J	110 J	490 U	500 U	440 U			540 P
indeno(1,2,3-cd)pyrene	210 J	370 E J	81.0 J	110 J	71.0 J			330 F
naphthalene	98.0 J	47.0 J	490 U	500 U	440 U			480 P
phenanthrene	940 E	990 E	81.0 J	90.0 J	59.0 J			850 Q
pyrene	1500 E	2100 E	280 J	410 J	220 J			660 L
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg			ug/kg
4,4'-DDD	72.0 E	61.0 E	8.3 U	8.3 U	4.5 U			1.60 L
4,4'-DDE	16.0 E	17.0 E	5.0 E	5.1 E	4.9 E			2.20 L
4,4'-DDT	36.0 E J	41.0 E	19.0 E	20.0 E	8.1 E			1.60 L
alpha-BHC	2.3 U	2.4 U	2.5 U	0.045 J	2.3 U			3.70 S
gamma-BHC (Lindane)	2.3 U	2.4 U	2.5 U	2.6 U	0.036 R			-
gamma-chlordane	2.8 J	3.4 J	2.9	2.8	3.0			7.00 O
methoxychlor	23.0 U	24.0 U	25.0 U	25.0 U	9.6 J			19.0 P

TABLE 8-3

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCS - SITE 16
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

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J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to sediment ecological toxicity criteria:

- No standard is available for this chemical in this classification.

B - Source: Baudo, R., J. Geisy and H. Muntau. eds. 1990. Sediments: Chemistry and Toxicity of In-Place Pollutants. Lewis Publishers, Inc. Ann Arbor, MI.

F - Source: USEPA. 1994c. Draft Region IV Waste Management Division Sediment Screeing Values for Hazardous Waste Sites. 2/16/94 Revision.

L - Effects Range-Low. Source: Long E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management. 19:81-97.

M - Effects Range-Low. Source: Long, E. R. and L. G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA.

O - Ontario screening level. Source: Ontario Ministry of the Environment (OME). 1992. Guidelines for the Protection and Management of the Aquatic Sediment Quality in Ontario. Log 92-2309-067, PIBS 1962.

P - Sediment quality benchmark using equipartition. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

Q - Sediment quality criterion. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

S - Sediment screening benchmark. Source: Suter, G. W., and J. B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. Oak Ridge National Laboratory, Oak Ridge, TN.

T - Threshold for soils. Source: Direction des Substances Dangereuses. 1988. Contaminated Sites Rehabilitation Policy. Gouvernement du Quebec. Ministere de L'Environment. Sainte-Foy, Quebec, Canada. In: R.L. Siegrist. 1989. International Review of Approaches for Establishing Cleanup Goals for Hazardos Waste Contaminated Land. Institute for Georesearch and Pollution Research. Norway.

W - Screening value for wet soil. Source: Will, M.E., and G.W. Suter. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1994 Revision. Oak Ridge National Laboratory.

TABLE 8-4

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16GW01	16GW02	16GW02-F	16GW03	16GW04	16GW04-DL	ARARS & TBCs		
LOCATION:	16GW01	16GW02	16GW02	16GW03	16GW04	16GW04	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI Unvalidated Data	1995 RI Unvalidated Data			
GENERAL CHEMISTRY	none	none	none	none	none	none	none	none	none
specific gravity	n/a	n/a	n/a	n/a	n/a	n/a	-	-	-
INORGANICS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
aluminum	5290 E J	3720 E J	161	5480 E J	1340 E	n/a	-	-	200
arsenic	5.6	5.8	3.3 U	5.3	9.4 E	n/a	50.0	-	8.00
barium	321	356	3.1	408	4.4	n/a	2000	2000 a	2000
beryllium	0.18	0.11 U	0.11 U	0.26	5.0 U	n/a	4.00	4000 e	20.0
cadmium	0.38 U	0.38 U	0.38 U	0.38 U	0.65	n/a	5.00	5.00 e	4.00
calcium	7190	2530	1990	6160	23500	n/a	-	-	-
chromium, total	116 E	80.5	13.6	116 E	24.0	n/a	100	100 a	100
cobalt	1.4	1.3	0.88	1.6	0.71	n/a	-	-	-
copper	12.2	15.2	3.2	13.7	0.80	n/a	1300	-	1000
iron	14100 E	11300 E	179	15300 E	178000 E	n/a	-	-	300
lead	3.2	2.0	1.5 UJ	3.1	2.1	n/a	15.0	-	10.0
magnesium	2100	1410	602	2610	5800	n/a	-	-	-
manganese	70.2 E	10.8	10.9	25.6	47.0	n/a	-	-	50.0
mercury	0.086	0.084	0.025	0.088	0.035	n/a	2.00	2.00 b	2.00
nickel	0.75 U	0.75 U	1.9	0.75 U	40.0 U	n/a	100	100 a	100
potassium	3870	2510	323	4320	5000 U	n/a	-	-	-
selenium	4.4 U	4.4 U	4.4 U	4.4 U	13.5	n/a	50.0	-	50.0
sodium	57700 E	49400	50100 E	48000	104000 E	n/a	-	-	50000
thallium	3.6 U	3.6 U	3.6 U	3.6 U	10.0 U	n/a	2.00	0.400 a	10.0
vanadium	52.9	34.1	1.0	53.4	11.0	n/a	-	-	-
zinc	191	260	4.2	208	20.0	n/a	-	2000 a	5000
SEMIVOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
2,4-dimethylphenol	10.0 U	10.0 U	n/a	10.0 U	100 U	400 U	-	-	100
2-methylnaphthalene	10.0 U	10.0 U	n/a	10.0 U	1900 J	1800	-	-	-
acenaphthene	10.0 U	10.0 U	n/a	10.0 U	91.0 J	91.0 J	-	-	400
bis(2-ethylhexyl)phthalate	10.0 U	10.0 U	n/a	1.0 J	100 U	400 U	-	-	30.0

TABLE 8-4

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16GW01	16GW02	16GW02-F	16GW03	16GW04	16GW04-DL	ARARS & TBCs		
LOCATION:	16GW01	16GW02	16GW02	16GW03	16GW04	16GW04	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI Unvalidated Data	1995 RI Unvalidated Data			
SEMIVOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
carbazole	10.0 U	10.0 U	n/a	10.0 U	100 U	400 U	-	-	-
dibenzofuran	10.0 U	10.0 U	n/a	10.0 U	73.0 J	63.0 J	-	-	-
fluorene	10.0 U	10.0 U	n/a	10.0 U	140	140 J	-	-	300
naphthalene	10.0 U	10.0 U	n/a	1.0 J	690 E	690 E	-	20.0 a	-
phenanthrene	10.0 U	10.0 U	n/a	10.0 U	240	230 J	-	-	-
phenol	10.0 U	10.0 U	n/a	10.0 U	100 U	400 U	-	4000 a	4000
pyrene	10.0 U	10.0 U	n/a	10.0 U	27.0 J	400 U	-	-	200
VOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
1,2-dichloroethene (total)	10.0 U	10.0 U	n/a	10.0 U	11.0 E J	10.0 J	70.0 a	70.0 a	10.0
benzene	10.0 U	10.0 U	n/a	10.0 U	350 E	340 E	5.00	200 d	1.00
bromodichloromethane	10.0 U	10.0 U	n/a	1.0 J	25.0 U	100 U	100	2000 e	1.00
chloroform	4.0 J	10.0 U	n/a	6.0 J	25.0 U	100 U	100	100 e	6.00
ethylbenzene	10.0 U	10.0 U	n/a	10.0 U	330	300	700	700 a	700
tetrachloroethene	10.0 U	10.0 U	n/a	1.0 J	25.0 U	100 U	5.00	1000 e	1.00
toluene	10.0 U	10.0 U	n/a	10.0 U	40.0	39.0	1000	1000 a	1000
xylene (total)	10.0 U	10.0 U	n/a	10.0 U	1700 E J	1600 E	10000	10000 a	40.0

TABLE 8-4

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16GW04-OIL	16GW05	16GW05-DL	16GW05-OIL	16GW06	16GW06-F	ARARS & TBCs		
LOCATION:	16GW04	16GW05	16GW05	16GW05	16GW06	16GW06	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI Unvalidated Data	1995 RI Unvalidated Data	1995 RI Unvalidated Data	1995 RI Unvalidated Data	1995 RI	1995 RI			
GENERAL CHEMISTRY	none	none	none	none	none	none	none	none	none
specific gravity	0.85	n/a	n/a	0.86	n/a	n/a	-	-	-
INORGANICS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
aluminum	n/a	900 E	n/a	n/a	85200 E J	132	-	-	200
arsenic	n/a	10.0 U	n/a	n/a	156 E	3.6	50.0	-	8.00
barium	n/a	31.2	n/a	n/a	432	8.1	2000	2000 a	2000
beryllium	n/a	5.0 U	n/a	n/a	9.8 E	0.11 U	4.00	4000 e	20.0
cadmium	n/a	0.56	n/a	n/a	4.9 E	2.0	5.00	5.00 e	4.00
calcium	n/a	17700	n/a	n/a	3210	2490	-	-	-
chromium, total	n/a	5.3	n/a	n/a	2070 E	12.6	100	100 a	100
cobalt	n/a	50.0 U	n/a	n/a	8.8	0.75	-	-	-
copper	n/a	0.88	n/a	n/a	41.9	0.87	1300	-	1000
iron	n/a	49100 E	n/a	n/a	379000 E	53500 E	-	-	300
lead	n/a	5.4	n/a	n/a	46.5 E	1.5 UJ	15.0	-	10.0
magnesium	n/a	4660	n/a	n/a	17700	763	-	-	-
manganese	n/a	84.0 E	n/a	n/a	79.6 E	39.0	-	-	50.0
mercury	n/a	0.050	n/a	n/a	0.18	0.016	2.00	2.00 b	2.00
nickel	n/a	40.0 U	n/a	n/a	20.0	1.3	100	100 a	100
potassium	n/a	1870	n/a	n/a	54900	624	-	-	-
selenium	n/a	5.0 U	n/a	n/a	17.0	4.4 U	50.0	-	50.0
sodium	n/a	159000 E	n/a	n/a	16100	16100	-	-	50000
thallium	n/a	10.0 U	n/a	n/a	15.6 E	3.6 U	2.00	0.400 a	10.0
vanadium	n/a	50.0 U	n/a	n/a	874	0.87	-	-	-
zinc	n/a	17.2	n/a	n/a	360	10.0	-	2000 a	5000
SEMIVOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
2,4-dimethylphenol	n/a	48.0	52.0	n/a	10.0 U	n/a	-	-	100
2-methylnaphthalene	n/a	170 J	250	n/a	10.0 U	n/a	-	-	-
acenaphthene	n/a	8.0 J	11.0 J	n/a	10.0 U	n/a	-	-	400
bis(2-ethylhexyl)phthalate	n/a	92.0 E J	190 E	n/a	3.0 J	n/a	-	-	30.0

TABLE 8-4

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16GW04-OIL	16GW05	16GW05-DL	16GW05-OIL	16GW06	16GW06-F	ARARS & TBCs		
LOCATION:	16GW04	16GW05	16GW05	16GW05	16GW06	16GW06	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI Unvalidated Data	1995 RI Unvalidated Data	1995 RI Unvalidated Data	1995 RI Unvalidated Data	1995 RI	1995 RI			
SEMIVOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
carbazole	n/a	12.0	16.0 J	n/a	10.0 U	n/a	-	-	-
dibenzofuran	n/a	6.0 J	7.0 J	n/a	10.0 U	n/a	-	-	-
fluorene	n/a	11.0	14.0 J	n/a	10.0 U	n/a	-	-	300
naphthalene	n/a	100 E J	220 E	n/a	3.0 J	n/a	-	20.0 a	-
phenanthrene	n/a	17.0	22.0 J	n/a	10.0 U	n/a	-	-	-
phenol	n/a	11.0	15.0 J	n/a	12.0	n/a	-	4000 a	4000
pyrene	n/a	10.0 U	50.0 U	n/a	10.0 U	n/a	-	-	200
VOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
1,2-dichloroethene (total)	n/a	50.0 U	100 U	n/a	38.0 E	n/a	70.0 a	70.0 a	10.0
benzene	n/a	1700 E J	1900 E	n/a	200 E	n/a	5.00	200 d	1.00
bromodichloromethane	n/a	50.0 U	100 U	n/a	10.0 U	n/a	100	2000 e	1.00
chloroform	n/a	50.0 U	100 U	n/a	10.0 U	n/a	100	100 e	6.00
ethylbenzene	n/a	170	160	n/a	2.0 J	n/a	700	700 a	700
tetrachloroethene	n/a	50.0 U	100 U	n/a	10.0 U	n/a	5.00	1000 e	1.00
toluene	n/a	160	160	n/a	7.0 J	n/a	1000	1000 a	1000
xylene (total)	n/a	250 E	250 E	n/a	26.0	n/a	10000	10000 a	40.0

TABLE 8-4

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16MW01	---	---	---	---	---	ARARS & TBCs		
LOCATION:	16MW01	---	---	---	---	---	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI								
GENERAL CHEMISTRY	**none**						**none**	**none**	**none**
specific gravity	n/a						-	-	-
INORGANICS	**ug/L**						**ug/L**	**ug/L**	**ug/L**
aluminum	2110 E						-	-	200
arsenic	3.3 U						50.0	-	8.00
barium	133						2000	2000 a	2000
beryllium	0.44						4.00	4000 e	20.0
cadmium	0.41						5.00	5.00 e	4.00
calcium	14200						-	-	-
chromium, total	34.0						100	100 a	100
cobalt	2.6						-	-	-
copper	5.1						1300	-	1000
iron	1240 E						-	-	300
lead	2.0						15.0	-	10.0
magnesium	2880						-	-	-
manganese	77.9 E						-	-	50.0
mercury	0.084 J						2.00	2.00 b	2.00
nickel	184 E						100	100 a	100
potassium	2650						-	-	-
selenium	4.4 U						50.0	-	50.0
sodium	69300 E						-	-	50000
thallium	13.0 E						2.00	0.400 a	10.0
vanadium	1.0						-	-	-
zinc	2.0						-	2000 a	5000
SEMIVOLATILES	**ug/L**						**ug/L**	**ug/L**	**ug/L**
2,4-dimethylphenol	10.0 U						-	-	100
2-methylnaphthalene	10.0 U						-	-	-
acenaphthene	10.0 U						-	-	400
bis(2-ethylhexyl)phthalate	10.0 U						-	-	30.0

TABLE 8-4

C MPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	16MW01	---	---	---	---	---	ARARS & TBCs		
LOCATION:	16MW01	---	---	---	---	---	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI								
SEMIVOLATILES	ug/L						ug/L	ug/L	ug/L
carbazole	10.0 U						-	-	-
dibenzofuran	10.0 U						-	-	-
fluorene	10.0 U						-	-	300
naphthalene	10.0 U						-	20.0 a	-
phenanthrene	10.0 U						-	-	-
phenol	10.0 U						-	4000 a	4000
pyrene	10.0 U						-	-	200
VOLATILES	ug/L						ug/L	ug/L	ug/L
1,2-dichloroethene (total)	10.0 U						70.0 a	70.0 a	10.0
benzene	10.0 U						5.00	200 d	1.00
bromodichloromethane	10.0 U						100	2000 e	1.00
chloroform	14.0 E						100	100 e	6.00
ethylbenzene	10.0 U						700	700 a	700
tetrachloroethene	10.0 U						5.00	1000 e	1.00
toluene	10.0 U						1000	1000 a	1000
xylene (total)	10.0 U						10000	10000 a	40 0

TABLE 8-4

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCS - SITE 16
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to MCLs, MCLGs, or SMCLs:

- - No standard is available for this chemical in this classification.

a - Where applicable, value(s) represent the more stringent of criteria for total, cis-, and trans- isomers.

* - Criteria are for total chromium.

** - Action level 1300 ug/L for water treatment technology for public water supply systems.

*** - Action level 15 ug/L for water treatment technology for public water supply systems.

Footnotes to Health Advisories:

- - No standard is available for this chemical in this classification.

a - The listed health advisory criterion, lifetime adult, is equal to the most stringent of the EPA health advisories for this chemical.

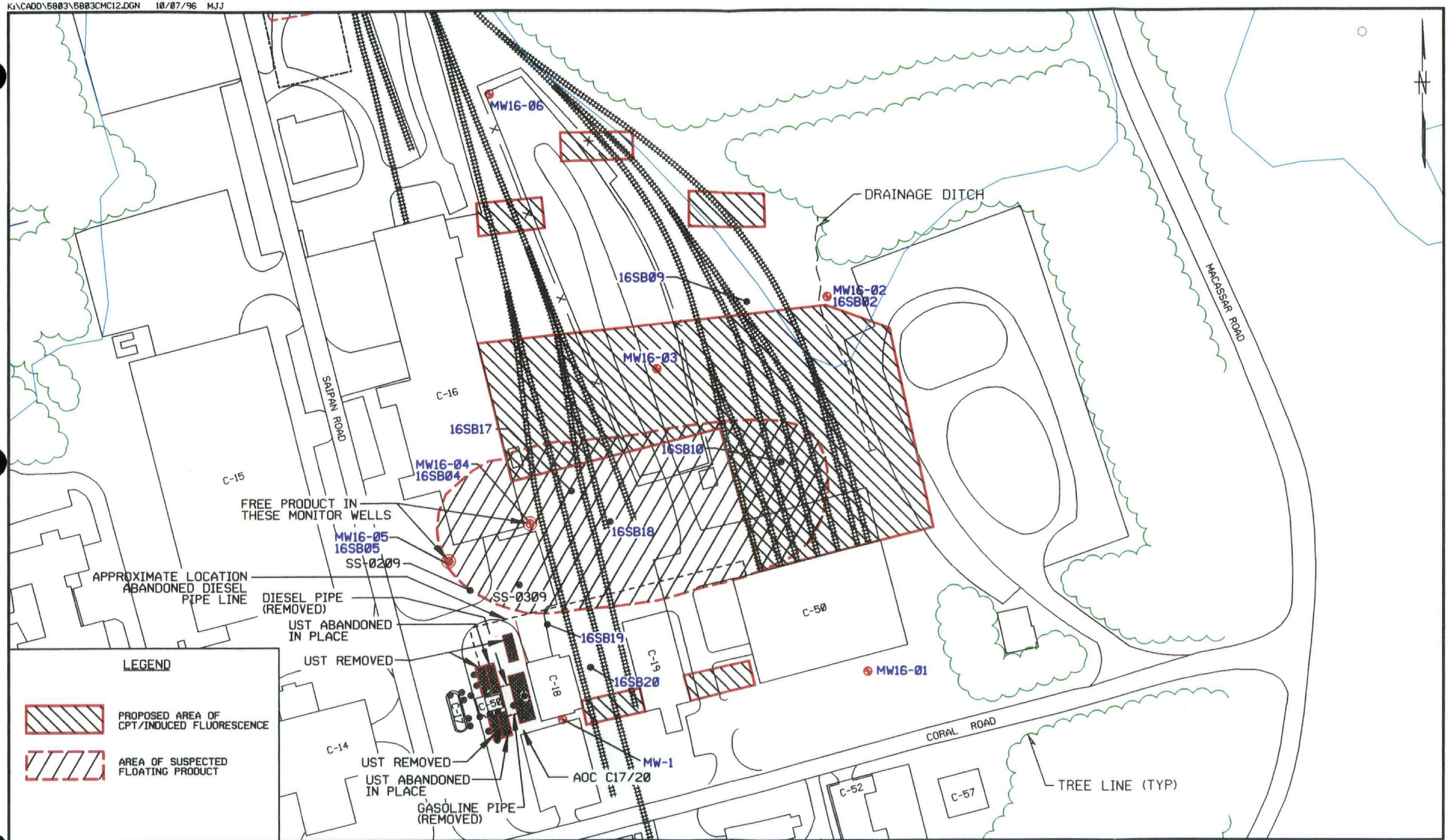
b - The listed health advisory criterion, long-term adult, is equal to the most stringent of the EPA health advisories for this chemical.

c - The listed health advisory criterion, one-day child, is equal to the most stringent of the EPA health advisories for this chemical.

d - The listed health advisory criterion, ten-day child, is equal to the most stringent of the EPA health advisories for this chemical.

e - The listed health advisory criterion, long-term child, is equal to the most stringent of the EPA health advisories for this chemical.

K:\CADD\5803\5803CMC12.DGN 10/07/96 MJJ



SITE 16 AND EPIC SITE F

PROPOSED INVESTIGATION LOCATIONS

NWS EARLE, COLTS NECK, NEW JERSEY

0 100 200

SCALE IN FEET

FIGURE 8-1

Brown & Root Environmental

TABLE 8-5

SAMPLING LOCATIONS AND RATIONALE

SITE 16

NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rational
Four groundwater monitoring wells	Selected in field based on CPT results	Determine extent of VOC and SVOC contamination of groundwater

9.0 SITE 17: LANDFILL

9.1 SITE DESCRIPTION

The Site 17 Landfill occupies 3 acres in the Waterfront area, adjacent to a tidal marsh in the Ware Creek drainage basin. The site was used for the disposal of wood, forklifts, empty paint cans, and construction debris. The landfill surface is covered with and is currently utilized as a parking area for Waterfront personnel. The face of the landfill is 10 to 15 feet higher in elevation than the marsh area and is heavily vegetated. Infiltration is limited to some degree by the nature of the surface cover, and overland flow drains toward the salt marsh north and west of the site. The groundwater flow direction is north-northwest toward the marsh, based upon measured groundwater elevations.

Geo-rectified digital imagery was utilized to interpret the probable extent of disposal areas with respect to the placement of fill material during the early 1940s. Waterfront facilities were originally constructed upon this fill material.

9.2 PREVIOUS INVESTIGATIONS

The 1983 IAS, consisting of interviews and visual inspection, concluded minimal impact. The site was not recommended for a confirmation study because of the presence of largely inert and immobile materials.

During the 1993 SI, soil samples were collected from three soil borings and two of the four monitoring well borings. Soil borings were completed to the water table and subsurface soil samples were taken from between 5 and 11 feet bgs. Four monitoring wells were installed and screened in the upper water-bearing zone. In addition, four sediment samples were collected from the marsh area downgradient of the site. Soil samples were analyzed for metals and cyanide, and analytical results indicated that no significant concentrations of metals or cyanide were present. Elevated levels of volatiles, semivolatiles, and pesticides were detected in sediment samples. Groundwater samples were analyzed for TAL metals, full scan of TCL compounds, and landfill parameters. Elevated levels of metals and landfill parameter indicators were present in groundwater.

Between June and October 1995, B&R Environmental conducted RI field investigation activities at Site 17 that included sampling and analysis of surface soil, surface water and sediment, and drilling and installation and sampling of one shallow permanent monitoring well. PAHs and pesticides were detected at slightly elevated levels in drainage pathway sediments, and elevated levels of metals (probably due to suspended solids) were detected in surface water samples. No other significant contamination resulting in the need for further investigation was observed. Sediment and surface water data and comparisons to

screening levels may be found in Tables 9-1 and 9-2 respectively.

9.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on previous sampling results, the 1996 RI report concluded that further data were required to assess ecological impacts of the site on adjacent wetlands. Metals, semivolatiles, and pesticides were detected above screening levels in surface water and sediment samples. The sampling for the RI Addendum field work will provide data to assess the impacts of the landfill on the wetlands. Six surface water and sediment samples will be collected from the adjacent marsh northeast of the landfill to determine if the marsh has been impacted by the landfill. Proposed sampling locations are located on Figure 9-1, and the sampling rationale is presented in Table 9-3.

Anlaytical parameters will be TAL metals, TCL SVOCs, and TCL pesticides/PCBs. Surface water samples will also be analyzed in the laboratory for total suspended soilds, alkalinity, hardness, BOD, COD, and TDS. Laboratory parameters for solid samples will include TOC, grain size and percent moisture and solids. Field parameters for surface water samples will be pH, conductivity, salinity, and flow (width and depth). Field parameters for sediment samples include temperature, Eh (EPA Method 9045), pH, conductivity, and color.

9.4 SITE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

TABLE 9-1

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 17

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	17SD01	17SD02	17SD03	17SD04	---	---	---	ARARS & TBCs
LOCATION:	17SD01	17SD02	17SD03	17SD04	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI				
INORGANICS	mg/kg	mg/kg	mg/kg	mg/kg				mg/kg
aluminum	1410	19300 J	7770 J	745				-
arsenic	11.4 E J	36.3 E J	13.2 E J	4.0				8.20 L
barium	3.3	71.8 E J	32.2 J	2.4				40.0 B
beryllium	0.11	1.2 J	0.72 J	0.17 U				-
cadmium	0.23	3.1 E J	1.1 UJ	0.62 U				1.20 L
calcium	336	4660 J	1260 J	125				-
chromium, total	10.8 J	53.5 J	20.2 J	6.8				81.0 L
cobalt	0.58	6.4 J	2.8 J	1.2 U				50.0 T
copper	4.0	99.1 E J	26.1 J	2.0				34.0 L
iron	7790	49700 J	20500 J	5640				-
lead	10.9	126 E J	75.9 E J	5.2 J				47.0 L
magnesium	241	3120 J	898 J	117				-
manganese	15.7	74.8 J	33.8 J	4.0				460 O
mercury	0.020	0.32 E J	0.16 E J	0.0080 U				0.150 L
nickel	2.9	27.6 E J	7.2 J	1.9 U				21.0 L
potassium	606	3350 J	1320 J	235				-
selenium	1.1 J	7.4 J	2.2 J	0.93 J				-
sodium	50.2	695 J	165 J	870				-
thallium	1.5	3.6 UJ	1.3 UJ	0.74 U				-
vanadium	16.9	101 J	42.7 J	9.4				-
zinc	12.0 J	242 E J	57.4 J	7.3 J				150 L
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
2-methylnaphthalene	360 U	2100 UJ	170 J	410 U				330 F
4-methylphenol	360 U	420 J	820 J	410 U				-
acenaphthene	360 U	2100 UJ	340 J	410 U				620 Q
acenaphthylene	360 U	2100 UJ	89.0 E J	410 U				44.0 L
anthracene	360 U	2100 UJ	1000 E J	410 U				330 F
benzo(a)anthracene	360 U	500 E J	2600 E J	410 U				330 F

TABLE 9-1

07/15/96

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 17

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	17SD01	17SD02	17SD03	17SD04	---	---	---	ARARS & TBCs
LOCATION:	17SD01	17SD02	17SD03	17SD04	---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI				
SEMIVOLATILES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
benzo(a)pyrene	360 U	490 E J	2600 E J	41.0 J				430 L
benzo(b)fluoranthene	360 U	1000 E J	5000 E J	62.0 J				330 F
benzo(g,h,i)perylene	360 U	530 E J	3100 E J	410 U				330 F
benzo(k)fluoranthene	360 U	260 J	1300 E J	410 U				330 F
bis(2-ethylhexyl)phthalate	360 U	4400 J	9400 J	410 U				890000000 S
butylbenzylphthalate	360 U	2100 UJ	610 J	410 U				11000 Q
carbazole	360 U	2100 UJ	630 E J	410 U				330 F
chrysene	68.0 J	690 E J	3100 E J	52.0 J				330 F
di-n-butylphthalate	360 U	2100 UJ	140 J	410 U				11000 P
dibenz(a,h)anthracene	360 U	2100 UJ	820 E J	410 U				330 F
dibenzofuran	360 U	2100 UJ	220 J	410 U				2000 P
diethylphthalate	360 U	2100 UJ	100 J	43.0 J				630000 P
fluoranthene	130 J	930 J	4700 E J	96.0 J				2900 Q
fluorene	360 U	2100 UJ	590 E J	410 U				540 P
indeno(1,2,3-cd)pyrene	360 U	420 E J	2200 E J	410 U				330 F
isophorone	360 U	2100 UJ	75.0 J	410 U				-
naphthalene	360 U	2100 UJ	160 J	410 U				480 P
phenanthrene	360 U	510 J	4200 E J	410 U				850 Q
pyrene	120 J	1100 E J	7000 E J	80.0 J				660 L
VOLATILES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
toluene	11.0 U	62.0 UJ	4.0 J	12.0 U				670 P
PESTICIDES	ug/kg	ug/kg	ug/kg	ug/kg				ug/kg
4,4'-DDD	1.6 R	58.0 E J	26.0 E J	4.1 U				1.60 L
4,4'-DDE	27.0 E	98.0 E J	98.0 E J	0.36 R				2.20 L
4,4'-DDT	59.0 E	30.0 E J	13.0 E J	4.1 U				1.60 L
Aroclor-1260	n/a	80.0 J	31.0 J	41.0 U				-
alpha-chlordane	1.8 U	8.1 E JN	2.2 R	4.5 J				7.00 O
delta-BHC	1.8 U	11.0 UJ	3.8 UJ	0.094 R				-

TABLE 9-1

07/15/96

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCs - SITE 17

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	17SD01		17SD02		17SD03		17SD04		---	---	---	ARARS & TBCs
LOCATION:	17SD01		17SD02		17SD03		17SD04		---	---	---	Sediment Ecological Toxicity Threshold Values
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI					
PESTICIDES	ug/kg		ug/kg		ug/kg		ug/kg					ug/kg
dieldrin	3.6	U	21.0	UJ	7.3	UJ	0.026	R				52.0 Q
endosulfan II	3.6	U	21.0	UJ	7.3	UJ	0.21	JN				5.40 P
gamma-BHC (Lindane)	0.037	R	11.0	UJ	3.8	UJ	2.1	U				-
gamma-chlordane	1.8	U	7.8	E JN	2.0	R	5.0					7.00 O
heptachlor epoxide	1.8	U	0.63	R	3.8	UJ	2.1	U				5.00 O
methoxychlor	18.0	U	3.9	J	1.6	J	21.0	U				19.0 P

TABLE 9-1

COMPARISON OF SEDIMENT ANALYTICAL DATA TO ARARS AND TBCS - SITE 17
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to sediment ecological toxicity criteria:

- No standard is available for this chemical in this classification.

B - Source: Baudo, R., J. Geisy and H. Muntau. eds. 1990. Sediments: Chemistry and Toxicity of In-Place Pollutants. Lewis Publishers, Inc. Ann Arbor, MI.

F - Source: USEPA. 1994c. Draft Region IV Waste Management Division Sediment Screeing Values for Hazardous Waste Sites. 2/16/94 Revision.

L - Effects Range-Low. Source: Long E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management. 19:81-97.

M - Effects Range-Low. Source: Long, E. R. and L. G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, WA.

O - Ontario screening level. Source: Ontario Ministry of the Environment (OME). 1992. Guidelines for the Protection and Management of the Aquatic Sediment Quality in Ontario. Log 92-2309-067, PIBS 1962.

P - Sediment quality benchmark using equipartition. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

Q - Sediment quality criterion. Source: USEPA. 1996. ECO Update. Volume 3: Number 2. EPA 540/F-95/038.

S - Sediment screening benchmark. Source: Suter, G. W., and J. B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. Oak Ridge National Laboratory, Oak Ridge, TN.

T - Threshold for soils. Source: Direction des Substances Dangereuses. 1988. Contaminated Sites Rehabilitation Policy. Gouvernement du Quebec. Ministere de L'Environment. Sainte-Foy, Quebec, Canada. In: R.L. Siegrist. 1989. International Review of Approaches for Establishing Cleanup Goals for Hazardos Waste Contaminated Land. Institute for Georesearch and Pollution Research. Norway.

W - Screening value for wet soil. Source: Will, M.E., and G.W. Suter. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1994 Revision. Oak Ridge National Laboratory.

TABLE 9-2

06/17/96

COMPARISON OF SURFACE WATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 17

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	17SW02	17SW03	17SW04	---	ARARS & TBCs				
LOCATION:	17SW02	17SW03	17SW04	---	AWQC Freshwater Chronic Aquatic Life	AWQC Ingestion of Water and Fish	AWQC Ingestion of Fish Only	NJDEP Criteria Freshwater Chronic Aquatic Life	NJDEP Surface Water Criteria for Protection of Human Health
DATA SOURCE:	1995 RI	1995 RI	1995 RI						
INORGANICS	ug/L	ug/L	ug/L		ug/L	ug/L	ug/L	ug/L	ug/L
aluminum	9680	6350	1510		-	-	-	-	-
arsenic	88.6 E	20.0 E	6.8 E		189	0.0180	0.140	-	0.0170
barium	331 J	274 J	303 J		-	-	-	-	2000
beryllium	1.3	0.14 U	0.14 U		-	-	-	-	-
cadmium	3.2 E J	2.2 U	2.2 U		1.10 +	-	-	-	-
calcium	21600	16500	52600		-	-	-	-	-
chromium, total	20.4	13.9	8.5 U		209 +	-	-	-	160
cobalt	6.2	2.7 U	3.6		-	-	-	-	-
copper	65.1 E	24.5 E	16.9 E		11.0 +	-	-	-	-
iron	170000	32200	42100		-	-	-	-	-
lead	77.1 E	52.2 E	11.8 E		3.20 +	-	-	-	5.00
magnesium	6430	6770	19400		-	-	-	-	-
manganese	176	646	391		-	-	-	-	-
mercury	0.20 E	0.20 E	0.050 E		0.0120	0.140	0.150	-	-
nickel	11.0	10.2	8.5		160 +	610	4600	-	516
potassium	4020	5740	11300		-	-	-	-	-
selenium	15.7 E J	6.1 E J	2.5 U		5.00	-	-	-	10.0
sodium	50600	56000	3000000		-	-	-	-	-
thallium	12.5 E	5.1 E	3.3 E		-	1.70	6.30	-	1.70
vanadium	73.6	24.1	7.4		-	-	-	-	-
zinc	290 E J	202 E J	221 E J		101 +	-	-	-	-
SEMIVOLATILES	ug/L	ug/L	ug/L		ug/L	ug/L	ug/L	ug/L	ug/L
bis(2-ethylhexyl)phthalate	10.0 U	1.0 J	10.0 U		3.00	1.80	5.90	-	1.76

TABLE 9-2

COMPARISON OF SURFACE WATER ANALYTICAL DATA TO ARARS AND TBCS - SITE 17
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to Ambient Water Quality Criteria:

. - No standard is available for this chemical in this classification.

+ - Criterion is hardness dependent and is generated based upon an assumed hardness of 100 mg/L.

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FIGURE 9-1

PROPOSED SAMPLE LOCATIONS
SITES 6, 17 AND REFERENCE/BACKGROUND

0 400 800
SCALE IN FEET

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TABLE 9-3

SAMPLING LOCATIONS AND RATIONALE

SITE 17

NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Six surface water and sediment samples	Marsh area northeast and adjacent to landfill	Determine extent of contamination in wetlands

10.0 SITE 26: EXPLOSIVE "D" WASHOUT AREA

10.1 SITE DESCRIPTION

The explosive "D" washout area is located behind Building GB-1. For 1 year in the late 1960s, the site was used for the removal and recovery of ammonium picrate (known as explosive "D") from artillery shells. The ammonium picrate was removed from the shells by washing with hot water. The explosive was water soluble, and the resulting solution flowed into a settling tank. Overflow from this settling tank flowed into an unlined percolation pit. Upon cooling, the explosive precipitated, and the precipitate was collected for reuse or disposal. According to the IAS report (Hart, 1983), as much as 20,000 pounds of ammonium picrate could have been lost to surface water due to heavy rainfall before the percolation pit was cleaned.

The site, which is approximately 200 by 200 feet in size, is situated at the intersection of Macassar and Midway Roads. Two railway lines adjacent to the site run toward the northeast. The ground surface at the site is relatively flat, approximately 150 feet above MSL. The percolation pit is located in the center of the site and measures approximately 30 feet in diameter and 10 feet in depth. A tile-lined open pipe runs from Building GB-1 to the percolation pit. A process leach tank system north of the western end of Building GB-1, thought to consist of a grease trap and a cesspool-type leach tank, was used for waste disposal. The general direction of groundwater flow is to the southwest based on measured groundwater levels.

10.2 PREVIOUS INVESTIGATIONS

The 1983 IAS, consisting of interviews and site observations, concluded minimal probable impact based on the presumption that lost material would have been lost as a direct discharge to surface water and would no longer be present. The site was not recommended for a confirmation study.

During the 1993 SI, three monitoring wells were installed. Groundwater samples were analyzed for picric acid and pH. Picric acid was not detected, and pH was within expected levels. During the 1993 RI/FS, four soil samples were collected from the settling basin. Lead was detected at elevated levels in three samples. All other metals were within normal background ranges. Picric acid was detected in one sample. No other explosive compounds were detected. One monitoring well was installed near the percolation pit. Groundwater samples from all SI and RI/FS wells were collected and analyzed for TCL/TAL analytes, explosive compounds, pesticides/PCBs, VOCs, and drinking water metals. TCE was detected at MW26-01 at elevated levels (660 ug/L). Other VOCs, such as dichloroethanes, related to TCE as impurities or breakdown products, were also present. The source of TCE may be associated with the septic system of Building GB-1. Low concentrations of several explosive compounds were detected in wells MW26-01 and MW26-04.

Between June and October 1995, B&R Environmental conducted the following field investigation activities at Site 26:

- Soil gas survey and analysis at 68 locations
- Sampling and analysis of subsurface soil samples from four soil borings
- Drilling and installation of two shallow permanent monitoring wells
- Sampling and analysis of groundwater from the wells
- Measurement of static-water levels in the wells

Results of these activities revealed the presence of TCE and 1,2-dichloroethane in subsurface soil samples in the vicinity of the process leach tank. Table 10-1 presents a comparison of subsurface soil results to ARARs and TBCs. Groundwater samples showed slightly elevated levels of several metals and significant levels of TCE (up to 1,700 ug/L) and 1,2-DCE (up to 1,200 ug/L). The monitoring well with the highest readings was in the location of the process leach tank. Groundwater results and comparison to screening levels are presented in Table 10-2.

10.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on previous sampling results, the VOCs TCE and 1,2-DCE have impacted groundwater at the site; however, the extent of the VOC contamination is unknown. CPT lithologic profiling will be conducted in accordance with procedures detailed in Section 2.11. Groundwater samples will be obtained from up to twenty locations at the site, based on field review of the lithologic logs, utilizing hydropunch/Geoprobe™ equipment. Samples from each location will be obtained from depths of 20, 40, and 60 feet, resulting in a total of 60 samples. Samples will be analyzed in the field for VOCs only using a portable GC. The majority of sampling locations will be focused in the area of the process leach tank. Samples will be obtained by utilizing hydropunch/Geoprobe™ or Conesipper™ equipment. Preliminary proposed sampling locations are located on Figure 10-1, and the sampling rationale is presented in Table 10-3.

10.4 SITE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

TABLE 10-1

06/17/96

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 26

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	26SB01-02		26SB02-04		26SB03-04		26SB03-06		26SB04-02		26SB04-06		ARARS & TBCs		
LOCATION:	26SB01		26SB02		26SB03		26SB03		26SB04		26SB04		NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI		1995 RI		1995 RI		1995 RI		1995 RI		1995 RI				
INORGANICS	mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg	mg/kg	mg/kg
aluminum	3350		668		1780		557		2300		1280		-	-	-
antimony	0.56	U	0.55	U	0.55	U	0.66		0.61		0.59	U	14.0	340	-
arsenic	1.0	J	0.59	J	3.1	J	0.56	UJ	2.7	J	0.59	UJ	20.0	20.0	-
barium	3.4	J	213	J	2.3	J	1.1	J	2.2	J	2.3	J	700	47000	-
beryllium	0.13		0.25		0.16		0.13		0.16		0.14		1.00	1.00	-
cadmium	0.040		0.068		1.2	E	0.077		0.81		0.20		1.00	100	-
calcium	163		169		63.7		28.7		76.2		32.9		-	-	-
chromium, total	6.4		2.7		7.8		2.2		6.6		3.3		-	500	-
copper	0.59		1.6		2.3		0.088	U	0.94		0.52		600	600	-
iron	3270	J	2240	J	6550	J	961	J	4560	J	1740	J	-	-	-
lead	2.3	J	1.7	J	1.4	J	0.55	J	1.2	J	1.0	J	400	600	-
magnesium	59.0		31.1		52.9		17.3		58.2		29.7		-	-	-
manganese	1.9	J	1.2	J	1.6	J	1.1	J	1.0	J	1.4	J	-	-	-
mercury	0.064	J	0.0070	U	0.0072	U	0.0073	U	0.0068	U	0.0077	U	14.0	270	-
nickel	0.78		0.24		0.50		0.38		0.32		0.29		250	2400	-
potassium	95.2		77.7		185		55.2	U	185		118		-	-	-
silver	0.14	U	0.14	U	2.4		1.0		1.3		0.64		110	4100	-
sodium	160		146		103		144		98.6		131		-	-	-
thallium	0.67	U	0.92	J	0.87	J	0.70	J	0.68	U	0.71	U	2.00	2.00	-
vanadium	5.7		2.5		8.1		1.2		6.2		1.9		370	7100	-
zinc	3.1	J	89.3	J	12.8	J	0.50	UJ	1.6	J	0.52	UJ	1500	1500	-
VOLATILES	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg	ug/kg	ug/kg
1,2-dichloroethene (total)	11.0	U	11.0	U	11.0	U	11.0	U	11.0	U	12.0	U	79000	1000000	1000
methylene chloride	11.0	UJ	11.0	UJ	11.0	UJ	11.0	UJ	11.0	UJ	12.0	UJ	49000	210000	1000
trichloroethene	11.0	U	11.0	U	11.0	U	11.0	U	11.0	U	12.0	U	23000	54000	1000

TABLE 10-1

06/17/96

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCs - SITE 26

NWS EARLE, COLTS NECK, NEW JERSEY

FINAL

SAMPLE NUMBER:	26SBDEC95-01	26SBDEC95-02	---	---	---	---	ARARS & TBCs		
LOCATION:	26SBDEC95-01	26SBDEC95-02	---	---	---	---	NJDEP Soil Residential Direct Contact Cleanup Criteria	NJDEP Soil Non-Residential Direct Contact Cleanup Criteria	NJDEP Soil Impact to Groundwater Cleanup Criteria
DATA SOURCE:	1995 RI, Dec.	1995 RI, Dec.							
INORGANICS	**mg/kg**	**mg/kg**					**mg/kg**	**mg/kg**	**mg/kg**
aluminum	n/a	n/a					-	-	-
antimony	n/a	n/a					14.0	340	-
arsenic	n/a	n/a					20.0	20.0	-
barium	n/a	n/a					700	47000	-
beryllium	n/a	n/a					1.00	1.00	-
cadmium	n/a	n/a					1.00	100	-
calcium	n/a	n/a					-	-	-
chromium, total	n/a	n/a					-	500	-
copper	n/a	n/a					600	600	-
iron	n/a	n/a					-	-	-
lead	n/a	n/a					400	600	-
magnesium	n/a	n/a					-	-	-
manganese	n/a	n/a					-	-	-
mercury	n/a	n/a					14.0	270	-
nickel	n/a	n/a					250	2400	-
potassium	n/a	n/a					-	-	-
silver	n/a	n/a					110	4100	-
sodium	n/a	n/a					-	-	-
thallium	n/a	n/a					2.00	2.00	-
vanadium	n/a	n/a					370	7100	-
zinc	n/a	n/a					1500	1500	-
VOLATILES	**ug/kg**	**ug/kg**					**ug/kg**	**ug/kg**	**ug/kg**
1,2-dichloroethene (total)	3.0 J	140					79000	1000000	1000
methylene chloride	11.0 U	2.0 J					49000	210000	1000
trichloroethene	2.0 J	74.0					23000	54000	1000

TABLE 10-1

COMPARISON OF SUBSURFACE SOIL ANALYTICAL DATA TO ARARS AND TBCS - SITE 26
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to soil criteria:

- No standard is available for this chemical in this classification.

TABLE 10-2

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCs - SITE 26

NWS EARLE, COLTS NECK, NEW JERSEY

SAMPLE NUMBER:	26GW01	26GW02	26GW03	26GW04	26GW05	26GW06	ARARS & TBCs		
LOCATION:	26GW01	26GW02	26GW03	26GW04	26GW05	26GW06	Maximum Contaminant Level (MCL)	Drinking Water Health Advisory (Lowest Criterion Shown)	NJDEP Groundwater Quality Standard
DATA SOURCE:	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI	1995 RI			
INORGANICS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
aluminum	614 E J	927 E J	406 E J	328 E	501 E J	460 E J	-	-	200
barium	518	464	475	13.2	89.6	46.9	2000	2000 a	2000
cadmium	0.52	0.42	0.38 U	4.4 E	0.52	0.38 U	5.00	5.00 e	4.00
calcium	17800	3540	7010	4600	6590	11100	-	-	-
chromium, total	1.3	1.2	1.4	1.0 U	1.0 U	1.0 U	100	100 a	100
cobalt	2.9	0.92	0.60 U	1.2	5.0	5.8	-	-	-
copper	8.7	13.8	9.2	4.0	0.82	0.81	1300	-	1000
iron	4740 E J	828 E J	719 E J	90.8	284	373 E	-	-	300
lead	2.6	1.5 U	1.5 U	1.5 UJ	1.5 U	1.5 U	15.0	-	10.0
magnesium	2170	636	2120	724	923	1920	-	-	-
manganese	106 E J	10.6	3.3	11.0	87.5 E	155 E	-	-	50.0
mercury	0.012	0.021	0.014	0.11 J	0.080	0.083	2.00	2.00 b	2.00
nickel	0.75 U	1.0	0.81	0.75 U	0.75 U	0.75 U	100	100 a	100
potassium	3640	1100	362	569	1350	1290	-	-	-
silver	0.94 U	0.94 U	0.94 U	3.3	0.94 U	0.94 U	-	100 a	-
sodium	4580	3250	2650	3910	2360	12500	-	-	50000
vanadium	1.6	1.0	0.81	0.61 U	0.61 U	0.61 U	-	-	-
zinc	326	326	280	8.3 R	180	100	-	2000 a	5000
VOLATILES	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
1,1-dichloroethene	3.0 E J	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	7.00	7.00 a	2.00
1,2-dichloroethene (total)	2000 E	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	70.0 a	70.0 a	10.0
chloroform	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	1.0 J	100	100 e	6.00
tetrachloroethene	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	1.0 J	5.00	1000 e	1.00
trichloroethene	1700 E	10.0 U	10.0 U	10.0 U	10.0 U	1.0 J	5.00	-	1.00

TABLE 10-2

COMPARISON OF GROUNDWATER ANALYTICAL DATA TO ARARS AND TBCS - SITE 26
NWS EARLE, COLTS NECK, NEW JERSEY

Footnotes to sample results:

U - Compound or element was not detected. Value is the detection limit (inorganics) or quantitation limit (organics).

UJ - Not detected. Detection limit or quantitation limit shown is considered estimated due to exceedance of data validation quality control criteria.

No Value - Constituent was not analyzed for in this sample.

UR - Nondetected result is considered rejected based on exceedance of data validation quality control criteria.

J - Value is estimated because concentration is below the quantitation limit or because of exceedance of data validation quality control criteria.

R - Positive result is considered rejected based on exceedance of data validation quality control criteria.

N - Compound is considered to be tentatively identified based on exceedance of QC criteria for compound identification.

E - Result exceeds one or more of the selected ARARs.

Footnotes to MCLs, MCLGs, or SMCLs:

. - No standard is available for this chemical in this classification.

a - Where applicable, value(s) represent the more stringent of criteria for total, cis-, and trans- isomers.

* - Criteria are for total chromium.

** - Action level 1300 ug/L for water treatment technology for public water supply systems.

*** - Action level 15 ug/L for water treatment technology for public water supply systems.

Footnotes to Health Advisories:

. - No standard is available for this chemical in this classification.

a - The listed health advisory criterion, lifetime adult, is equal to the most stringent of the EPA health advisories for this chemical.

b - The listed health advisory criterion, long-term adult, is equal to the most stringent of the EPA health advisories for this chemical.

c - The listed health advisory criterion, one-day child, is equal to the most stringent of the EPA health advisories for this chemical.

d - The listed health advisory criterion, ten-day child, is equal to the most stringent of the EPA health advisories for this chemical.

e - The listed health advisory criterion, long-term child, is equal to the most stringent of the EPA health advisories for this chemical.

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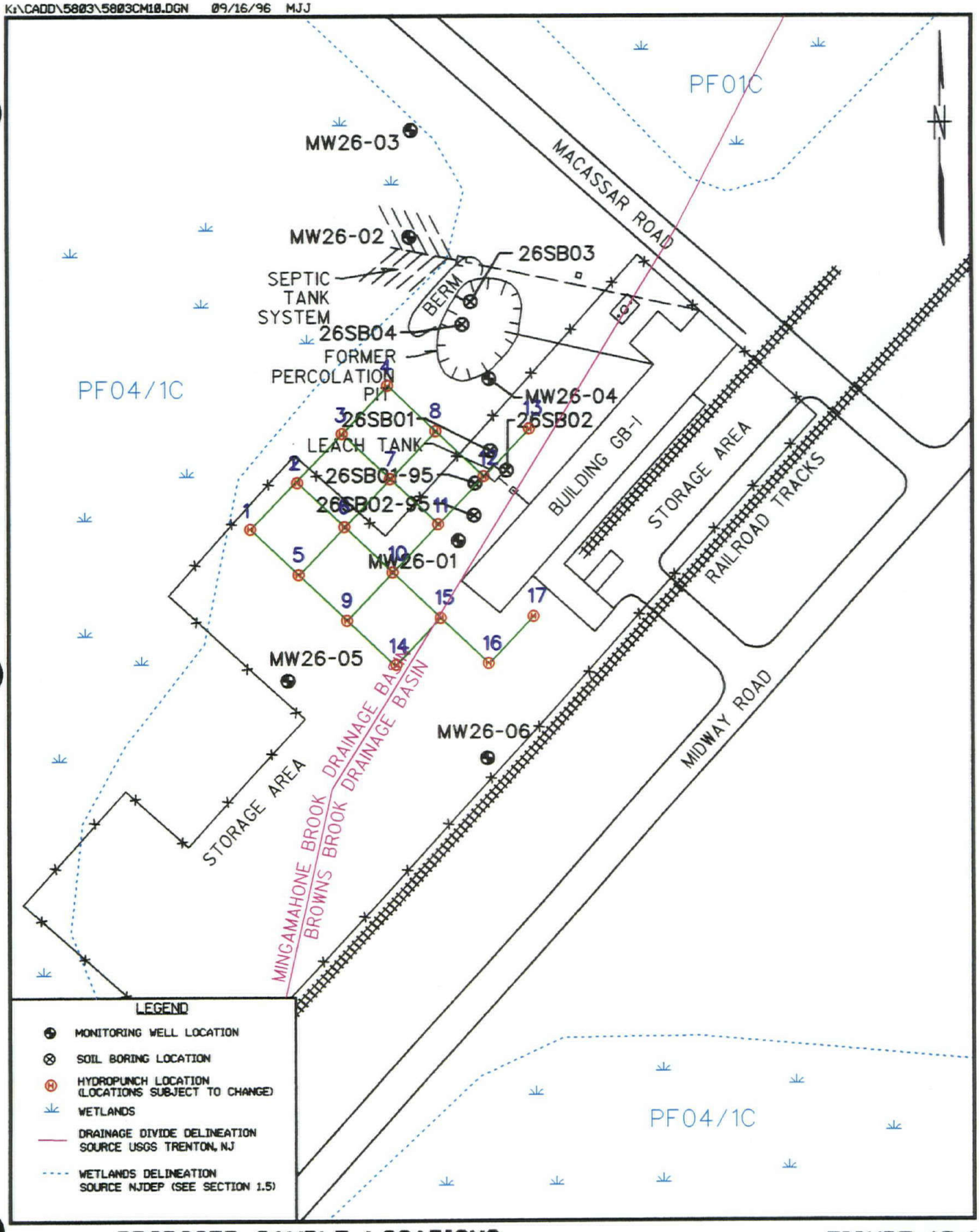

PROPOSED SAMPLE LOCATIONS

SITE 26 - EXPLOSIVE "D" WASHOUT AREA

FIGURE 10-1

0 80 160

SCALE IN FEET

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TABLE 10-3

SAMPLING LOCATIONS AND RATIONALE

SITE 26

NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Twenty groundwater sampling locations; samples taken at 20, 40, and 60 feet	Leach Tank area	Determine extent of VOC contamination of groundwater by field screening

11.0 BACKGROUND/WATERSHED SAMPLES

11.1 BACKGROUND SAMPLE LOCATIONS

In order to determine the background levels of chemicals that are present in and around NWS Earle, background and watershed samples were collected during previous investigations. Results of these investigations did not clearly define the extent of contamination at several sites, three of which (Sites 3, 6, and 17) exhibit potential contamination of wetlands or marsh area. In addition, Site 12, which is adjacent to railroad tracks, contains elevated levels of compounds that may be site related or may have been influenced by the proximity of the tracks. Additional background/reference samples are required to assess if the contaminants that are present are the result of past disposal operations at NWS Earle or are anthropogenic in nature. Sampling locations have been selected in the Ware Creek Watershed to evaluate the contribution of NWS Earle sites to potential wetland contamination. Samples of railroad bed ballast outside the area of influence of disposal operation will also be obtained. These data will be used to evaluate data collected during prior investigations as well as during RI Addendum field operations.

11.2 WATERSHED SAMPLING ACTIVITIES

Three surface water and sediment samples will be obtained from Ware Creek marsh reference stations (see Figure 11-1). Samples will be analyzed for TAL metals, TCL SVOCs, and TCL pesticides/PCBs. Laboratory parameters for aqueous samples will include total suspended solids, alkalinity, hardness, BOD, COD, and TDS. Laboratory parameters for sediment samples will include TOC, grain size, and percent moisture and solids. Field parameters for surface water samples will include temperature, dissolved oxygen, pH, conductivity, salinity, and flow. Field parameters for sediment samples will include Eh, pH, conductivity and color.

11.3 RAILROAD BED BALLAST SAMPLING ACTIVITIES

In order to determine the composition and leachability of the railroad bed ballast and its potential impacts on the conclusions of the RI, two samples of the ballast material will be obtained from background locations. These data will be used for comparison to soil samples collected at Site 12.

Analyses to be performed include TAL metals. In addition, Synthetic Precipitation Leachate Procedure 1312 will be performed to evaluate the leachability of the ballast. It is anticipated that limited particle size reduction will be required in the field or laboratory prior to analysis.

11.4 SAMPLE MAPPING

Basewide mapping of surface features has been conducted as part of the 1995 RI. Additions or changes recorded during the RI Addendum field work will be included in updated maps. Data will be incorporated into the GIS and Intergraph database.

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PROPOSED SAMPLE LOCATIONS
SITES 6, 17 AND REFERENCE/BACKGROUND

0 400 800
SCALE IN FEET

FIGURE 11-1

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12.0 REMEDIALINVESTIGATION ADDENDUM REPORT

12.1 SITE NARRATIVES

For each of the seven sites, the RI Addendum report will present a summary of field activities and provide a discussion of the findings including the nature and extent of contamination and contaminant fate and transport. The format will be in accordance with that presented in the 1996 B&R Environmental RI report.

The nature and extent of environmental contamination at NWS Earle will be presented in each site section for inorganic and organic chemicals detected in all the sampling media (surface soil, subsurface soil, sediment, groundwater, and/or surface water). The validated data generated during the RI provides the basis for the nature and extent presentations. The purpose of the nature and extent of contamination subsection in each site-specific section is to identify primary chemical contaminants based on their frequency of detection and concentrations, to delineate (on an areal- and depth-specific basis) the extent of contamination, and to provide indications of contaminant migration via atmospheric, overland, or subsurface pathways. Tables provided in each site section will present the occurrence and distribution of the data in a particular medium at that site. These tables will provide the basis for selection of chemicals of potential concern (COPCs) at each site per medium.

The ultimate fate of chemicals in the environment is determined by a multitude of physical, chemical, and biological factors. The role and significance of different physical properties such as specific gravity, solubility, and vapor pressure in determining what environmental fate and transport processes occur for a particular chemical can depend upon numerous additional factors. For example, solubilities of metals are not truly constant in the environment but may be dramatically enhanced or reduced when certain ligand species are available for complexation or precipitation, when organic matter is present in dissolved form, or when pH is altered. Physical properties such as soil/water partition ratios and groundwater retardation factors can vary considerably from location to location, even within the same geologic regime. Chemical and biological transformational processes can also be significantly affected by localized effects such as clay or mineral catalysts, chemical or biological inhibitors, and pH, Eh, and dissolved oxygen.

The fate and transport section of the report will provide a summary of the physical and chemical transport properties for the chemicals detected at the site. No distinction of location or magnitude of chemicals will be made in this section. The information presented will discuss chemical persistence and transport phenomena for the general classes of compounds detected in the environmental media sampled at the sites. Each of the site-specific fate and transport sections will address probable contaminant migration routes and qualitatively identify potential routes of human exposure.

12.2 DATA VALIDATION, DATA REDUCTION, AND DATA MANAGEMENT

Data will be validated in accordance with EPA Region II guidelines. A complete discussion on data validation procedures and data management is presented in the 1996 B&R Environmental RI report.

12.3 HUMAN HEALTH RISK ASSESSMENT PROCEDURES

This section will provide a description of the human health risk assessment methods used to evaluate the NWS Earle RI data. The objectives of the risk assessment are to estimate the actual or potential risks to human health resulting from the presence of contamination in surface soil, subsurface soil, sediment, groundwater, and surface water and to provide the basis for determining the need for remedial measures for these media in the FS.

Three major aspects of chemical contamination must be considered when assessing public health risks: contaminants with toxic characteristics must be found in environmental media and must be released by either natural processes or by human action; potential exposure points must exist either at the source or via migration pathways if exposure occurs at a location other than the source; and human or environmental receptors must be present at the point of exposure. Risk is a function of both toxicity and exposure; without any one of the three factors listed above, there will be no risk.

The risk assessment estimates the potential for human health risk attributable to each NWS Earle site. Information regarding the toxicity of the compounds detected in the various media, the distribution of contamination, potential migration pathways, and a site-specific estimate of chemical intake via assumed exposure routes will be combined to estimate potential risks for each NWS Earle site. The risk assessment processes to be used at NWS Earle will be in accordance with current EPA Region II risk assessment guidance.

The human health risk assessment consists of four sections: Data Evaluation, Toxicity Assessment, Exposure Assessment, and Risk Characterization. Each section is briefly discussed below.

- Data Evaluation is primarily concerned with the Identification of Chemicals of Potential Concern, Distributional Analysis of the data, and Representative Concentrations for the COPCs. COPCs selected in this section will be representative of the type and magnitude expected for potential human health exposure. Distributional analysis of the data, contaminant concentrations relative to background levels, contaminant release and environmental transport mechanisms, exposure routes, target-organ grouping, and toxicity are all considered in order to develop a list of COPCs used to define the site-associated risks.

- The Toxicity Assessment presents available Health Effects for all COPCs. Quantitative

toxicity indices, where available, are presented in this section. Dose-response parameters, such as reference doses (RfDs) and cancer slope factors (SFs), are presented in this section for each COPC. Carcinogenic chemicals are classified by EPA as Group A (human), B (probable human), or C (possible human) carcinogens. A special discussion of lead will be included, where applicable, because of the lack of quantitative dose-response parameters for this analyte.

- The Exposure Assessment identifies potential human health exposure including the presentation of a Site-Conceptual Model, selection of Potential Receptors, and Exposure Routes either at the source area or off site. This section generally identifies potential pathways of COPC migration, selected potential receptors, and the estimated intakes of COPCs for the identified receptors.

- Risk Characterization presents the risks for a site including a Determination of Risks, the estimated Receptor Risks, and a presentation of Uncertainty Analysis. This section estimates the risks associated with noncarcinogenic and carcinogenic effects of COPCs via estimated intakes in exposure routes compared to appropriate toxicity values. A discussion of the uncertainties associated with the risk assessment will also be presented in this section.

Further details on the procedures to be utilized are specified in Section 2.0 of the 1996 B&R Environmental RI report.

12.4 ECOLOGICAL RISK ASSESSMENT PROCEDURES

Data collected during the RI Addendum field investigation, as well as all previous data, will be evaluated for the completion of an ecological risk assessment for terrestrial, aquatic, and marine ecosystems which could be impacted by the seven sites. Habitats and potential exposures and effects will be assessed, and a risk characterization will be performed. The ecological risk assessment will be conducted in accordance with USEPA Ecological Risk Assessment Guidance for Superfund (EPA, 1994), specific EPA Region II and NJDEP procedure and input, and guidance from federal and state natural resources trustees as well as the Restoration Advisory Board (RAB).

The general approach to conducting the ecological risk assessment will be to supplement, where necessary, the ecological setting or site characterization presented in the B&R Environmental RI report for each of the seven sites. Assessment and measurement endpoints will be re-evaluated to assure that the conceptual model is the most representative for the risk characterization. After the field activities are completed, site-related contaminants of potential concern (COPCs) will be selected based on medium-

specific ecotoxicity threshold screening levels will be selected and toxicity profiles will be established that summarize the effects and environmental fate of all final COPCs. Details of this process are described in the B&R Environmental RI report, Section 2.6. The procedure will be revised, as applicable, after additional input from regulatory agencies, natural resource trustees and the RAB are received. The general approach is presented in this section.

Screening-level ecological risk assessments (EPAs) were performed for all sites investigated as part of recent RI activities on NWS Earle, as well as all watersheds investigated in that study (B&R Environmental, 1996). Ecological risks at most sites and in most watersheds were determined to be low or negligible, and therefore, no further study or remediation based on potential ecological risks appeared to be warranted. However, significant potential ecological risks from contaminants related to Sites 3, 6, and 17 were determined to be possible based on elevated concentrations of several contaminants in aquatic habitats near those sites. As a result, further ecological study at those sites was recommended as part of additional RI activities on the installation. This section summarizes the methods that will be used to assess potential ecological risks at Sites 3, 6, and 17 as part of the RI Addendum sampling activities, and the objectives of these investigations. The focus of additional sampling at Sites 12, 13, 16 and 26, was subsurface soil and groundwater conditions. No addition ecological risk evaluation is appropriate at the four sites.

The methods to be used as part of the RI Addendum ERAs are described in detail in the 1996 RI report (B&R Environmental, 1996). Thus, a detailed discussion of the approach to be taken will not be included in this work plan. Briefly, the approach to be followed is that recommended by most recent USEPA guidance for conducting ERAs (USEPA, 1994, 1992). In general, the approach consists of four steps: problem formulation, ecological effects assessment, exposure assessment, and risk characterization. In addition, the RI Addendum ERAs, for Sites 3, 6, and 17 will build on and incorporate the data generated during 1993 RI/FS investigations at Site 3 (Weston, 1993) and 1993 SI investigations at Sites 6 and 17 (Weston, 1993), as well the screening-level ERAs conducted at these sites as part of recent RI activities (B&R Environmental, 1996). A description of the site-specific approach and objectives of the RI Addendum ERAs is provided below.

Site 3 is a 5-acre landfill that was used from 1960 to 1968 for the disposal of domestic and industrial wastes, including various liquid wastes, wood, and small amounts of asbestos. Industrial wastes are only believed to constitute a small portion of the approximately 4,900 tons of wastes that were disposed at the site. The site is covered with grass, brush, and some trees, although some bare areas with scattered debris are also present. Most of the site is surrounded by upland forested areas that are dominated by pitch pine, scarlet oak, and white oak. Some forested wetlands, dominated by red maple and blackgum, are located southeast of the site and are lower in elevation than the site. Runoff from the eastern portion of the landfill appears to drain to the wetland area.

Several PAHs were detected in a sediment sample taken in the wetlands, and concentrations of a few PAHs exceeded both the most and less conservative ecological screening values used during most recent RI activities (B&R Environmental, 1996). Therefore, potential ecological risk to aquatic and semi-aquatic receptors that inhabit the wetlands were considered possible. Only one sediment sample; however, was taken and test pit soil samples collected on the eastern portion of the landfill were not sufficient to ascertain whether elevated concentrations of PAHs in Site 3 sediments were attributable to runoff from Site 3. Since contaminants detected in the sediment sample were present in relatively low concentrations in ground water, it was assumed that runoff was the most likely potential contaminant migration pathway from Site 3.

For these reasons, additional sediment samples in the wetlands and surface soil samples on the eastern toe of the landfill are proposed to more fully determine the nature and extent of contaminants, mainly PAHs, in the wetlands and determine whether soils on the landfill are contributing those contaminants to the wetlands. Two sediment samples will be collected slightly downgradient of where runoff from the landfill most likely enters the wetlands area. Also, one sediment sample will be taken upgradient in the small drainageway that enters the wetlands from the north to determine if contaminants in the wetlands may be due to upstream sources (although no other RI sites are located near Site 3). Surface water samples in the wetlands or drainageway are not proposed since water in the area is ephemeral and PAHs would most likely deposit in sediments. As discussed above, contaminant concentrations from these samples will be used to compare against ecological screening values. Additional habitat evaluation on and near Site 3 will also be conducted to determine vegetation types and potential ecological receptors. Site-specific ecological screening values for sediment will be calculated, in part, using site-specific total organic carbon (TOC), which will be measured in the laboratory. Sediment toxicity tests or benthic macroinvertebrate analyses are not proposed as part of RI Addendum ERA activities since the full nature and extent of contamination is not currently known and elevated concentrations of contaminants may be localized.

Since Sites 6 and 17 are situated in the same area of the Waterfront complex, they will be discussed together. As described in earlier sections of this work plan, Sites 6 and 17 are inactive landfills that are located adjacent to a large tidal marsh that is connected to Sandy Hook Bay. The marsh is dominated primarily by *Phragmites*. Sites 6 and 17 received a variety of waste materials, including construction debris, paint cans, and solvents. Most of the landfill surfaces are now covered with asphalt or other developments, but the toes of both landfills extend out into the marsh. Other portions of Site 6 are covered with turfgrass, and some black locust and box elder trees are also present along the edge of the site. Some forested wetlands, dominated by red maple and sweetgum are located immediately south and west of Site 17.

Since most of the sites are paved or otherwise developed, inhibiting significant infiltration and leaching of contaminants, and since concentrations of most contaminants in groundwater were relatively low, except

for some slightly elevated concentrations of some metals, runoff from the landfill toes is expected to be the most relevant contaminant migration pathway. Sediment samples from previous studies indicated the presence of slightly elevated concentrations of several organics adjacent to both landfills. In addition, recent RI surface water and sediment samples taken at the landfill toes indicated elevated concentrations of some metals and organics, primarily PAHs (B&R Environmental, 1996). This suggests that significant potential risks are possible to aquatic and semi-aquatic receptors that inhabit the adjacent saltmarsh. However, the nature and extent of contamination in the saltmarsh has not been fully defined. Potential ecological risks to saltmarsh-related receptors may be mitigated if migration of contaminants is minimal and contaminants are confined to the areas directly adjacent to the landfill.

Additional surface water and sediment/surface soil sampling is proposed adjacent to Sites 6 and 17, along with additional surface water and sediment sampling in the marsh, to more fully assess related potential risks. Three sediment (moist soil) samples will be collected at each of the landfill toes to investigate the potential for runoff and erosion of contaminants. In addition, three surface water and sediment samples will be collected a few hundred feet from each landfill to investigate the potential zone of contaminant influence and related impacts from Sites 6 and 17 on saltmarsh biota. Small fish, acquatic and semi-acquatic macroorganisms, piscivorous birds, and piscivorous mammals will be qualitatively assessed via field surveys or habitate classification.

Several other contaminant sources exist adjacent to the saltmarsh. These include the remainder of the developments at the Waterfront area and roadways, as well as off-site residential areas, a landfill, and other developed areas on the western side of the marsh. Therefore, three surface water and sediment samples will be collected in the central or western side of the marsh where contaminant inputs from Site 6 and 17 are unlikely, to ascertain whether contaminants are being introduced into the marsh from other sources. Samples will be taken as far to the west in the marsh as possible, but may have to be taken on NWS Earle property. Specifically, these samples will help interpret contaminant concentrations that may be detected in the three surface water and sediment samples taken a few hundred feet from the landfill, and therefore, will be identified as "reference" samples. They will also allow the Waterfront area to be evaluated as a watershed.

Contaminant concentrations from these samples will be used to screen against ecological screening values. Site-specific ecological screening values for surface and sediment will be calculated, in part, using site-specific hardness and total organic carbon (TOC), respectively,which will be measured as part of proposed sampling activities. Salinity will also be measured and will be used to decide whether freshwater or saltwater screening levels are most appropriate. Additional habitat evaluation of vegetation types and potential ecological receptors present will also be conducted. Surface water of sediment toxicity tests or

benthic macroinvertebrate analyses are not proposed as part of the RI Addendum ERA activities at Sites 6 and 17 since the full nature and extent of contamination is not currently known and elevated concentrations of contaminants may be localized.

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APPENDIX A: FIELD FORMS

(SEE HNUS RI WORK PLAN)

APPENDIX B: STANDARD OPERATING PROCEDURES

(SEE HNUS RI WORK PLAN)

APPENDIX B1: EPA LOW FLOW PURGE AND SAMPLING PROCEDURES

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U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW FLOW (minimum stress) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

The purpose of this standard operating procedure (SOP) is to provide information on the collection of ground water samples that are "representative" of mobil organic and inorganic loads in the vicinity of the selected open well interval, at near natural flow conditions. The minimum stress procedure emphasizes negligible water level drawdown and low pumping rates in order to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 2 inches or more and a saturated screen, or pen interval, length of ten feet or less. Samples obtained are suitable for analyses of common types of ground water contaminants (volatile and semi-volatile organic compounds, pesticides, PCBs, metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This procedure is not designed to collect samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs) using pumps.

The procedure is flexible for various well construction and ground water yields. The goal of the procedure is to obtain a turbidity level of less than 5 NTU and to achieve a water level drawdown of less than 0.3 feet during purging and sampling. If these goals cannot be achieved, sample collection can take place provided the remaining criteria in this procedure are met.

II. EQUIPMENT

- Adjustable rate, submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Tefl n). Peristaltic pumps may be used only for inorganic sample collection.

Use of trademarked names does not imply endorsement by U.S. EPA but is intended only to assist in identification of a specific product.

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- Disposable clear plastic bottom filling bailers may be used to check for and obtain samples of LNAPLs or DNAPLs.

- Tubing - Teflon, Teflon lined polyethylene or stainless steel tubing must be used to collect samples for organic analysis. For samples collected for inorganic analysis, Teflon or Teflon lined polyethylene, PVC, Tygon, polyethylene or stainless steel tubing may be used.

- Water level measuring device, 0.01 foot accuracy, (electronic devices are preferred for tracking water level drawdown during all pumping operations).

- Flow measurement supplies (e.g., graduated cylinder and stop watch).

- Interface probe, if needed.

- Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.

- Indicator parameter monitoring instruments - pH (EPA Methods 150.1 or 9040), turbidity (EPA Method 180.1), specific conductance (EPA Methods 120.1 or 9050) , and temperature (EPA Method 170.1). Use of a flow-through cell is recommended. Optional Indicators - eH and dissolved oxygen (EPA Method 360.1), flow-through cell is required. Standards to perform field calibration of instruments.

- Decontamination supplies.

- Logbook(s), and other forms (e.g. well purging forms).

- Sample Bottles.

- Sample preservation supplies (as required by the analytical methods).

- Sample tags or labels.

- Well construction data, location map, field data from last sampling event.

- Field Sampling Plan.

- PID or FID instrument for measuring VOCs (volatile organic compounds).

III. PRELIMINARY SITE ACTIVITIES

- Check well for damage or evidence of tampering, r cord pertinent observations.
- Lay out sheet of polyethylene for monitoring and sampling equipment.
- Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.
- If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one.
- Note that if water level data will be used t construct potentiometric surface map(s) then a synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin.
- Measure and record the depth to water (to 0.01 ft) in the well to be sampled before any purging begins. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bott m of the well.
- Measure and record (as appropriate) the depth of any DNAPLs or LNAPLs with an interface probe. Care should be given to minimize disturbance of any sediment which has accumulated at the bottom of the well. If LNAPLs or DNAPLs are present, a decision needs to be made as to whether to collect samples of the free phase liquid(s) and/or the dissolved phase.

IV. PURGING AND SAMPLING PROCEDURE

Use a submersible pump to purge and sample monitoring wells which have a 2.0 inch or greater well casing diameter.

Measure and record the water level again just prior to placing the pump in the well.

Lower pump, safety cable, tubing and electrical lines sl wly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbid free water samples my be difficult if there is three feet or less of standing water in the well.

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When starting the pump, slowly increase the pump speed until a discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown. The target drawdown should be less than 0.3 feet and it should stabilize. If the target of less than 0.3 feet cannot be achieved or maintained, the sampling is acceptable if remaining criteria in the procedure are met. Subsequent sampling rounds will probably have intake settings and extraction rates that are comparable to those used in the initial sampling rounds.

GROUNDFUS 200 ml/min

Monitor water level and pumping rate every three to five minutes (or as appropriate) during purging. Record pumping rate adjustments and depths to water. Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (e.g., 0.1 - 0.2 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During initial pump start-up, drawdown may exceed the 0.3 feet target and then recover as pump flow adjustments are made (minimum purge volume calculations should utilize stabilized drawdown values, not the initial drawdown). If the recharge rate of the well is less than minimum capability of the pump do not allow the water level to fall to the intake level (if the static water level is above the screen, avoid lowering the water level into the screen). Shut off the pump if either of the above is about to occur and allow the water level to recover. Repeat the process until field indicator parameters stabilize and the minimum purge volume is removed. The minimum purge volume with negligible drawdown (0.3 feet or less) is two saturated screen length volumes. In situations where the drawdown is greater than 0.3 feet and has stabilized, the minimum purge volume is two times the saturated screen volume plus the stabilized drawdown volume. After the minimum purge volume is attained (and field parameters have stabilized) begin sampling. For low yield wells, commence sampling as soon as the well has recovered sufficiently to collect the appropriate volume for all anticipated samples.

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During well purging, monitor field indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every three to five minutes (or as appropriate). Purging is complete and sampling may begin when all field indicator parameters have stabilized (variations in values are within ten percent of each other, pH +/- 0.2 units, for three consecutive readings taken at three to five minute intervals). If the parameters have stabilized, but turbidity remains above 5 NTU goal, decrease pump flow rate, and continue measurement of parameters every three to five minutes. If pumping rate cannot be decreased any further and stabilized turbidity values remain above 5 NTU goal record this information. Measurements of field parameters should be obtained using a flow-through cell (preferred

method) or taken in a clean container (a glass beaker is suitable). However, if measurements for dissolved oxygen and eH are to be obtained, they must be obtained using a flow-through cell in a manner in which the sample is not exposed to air prior to the measurement. Prior to collecting the samples for laboratory analyses, the flow-through cell must be disconnected. Note, turbidity, temperature, specific conductance and pH measurements must be recorded. If these measurements are missing, the resulting sampling data may not be acceptable. If the optional indicator parameters, dissolved oxygen and eH, are measured, they must be recorded.

VOCs samples are preferably collected first and directly into pre-preserved sample containers. Fill all sampl containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples: (1) Collect the non-VOCs samples first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample and record the new flow rate; (2) reduce the diameter of the existing tubing until the water column fills the tubing either by adding a connector (Teflon or stainless steel), or clamp which should reduce the flow rate by constricting the end of the tubing; (3) insert a narrow diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, collect sample from the narrow diameter tubing.

Preserve all samples immediately after they are collected.

Check the pH for all samples requiring pH adjustment to assure that the proper pH has been obtained. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If dissolved metal concentrations are desired, collect filtered water samples. The use of an in-line filter is preferred. An in-line 0.45 um particulate filter should be pre-rinsed with approximately 25 - 50 ml of groundwater prior to sample collection. After filtering the sample, preserve the water sample immediately. Note that filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations representative of total mobile loads.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into an ice cooler for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

- Steam clean the outside of the submersible pump.
- Pump hot water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.
- Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.
- Pump tap water through the inside of the pump to rem ve all of the detergent solution. If the solution is recycled, the solution must be changed periodically.
- Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

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Procedure 2

- The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is flushed out. The outside of the pump and the electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

- Flush the equipment/pump with potable water.

- Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

- Flush with tap or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

- Flush with isopropyl alcohol. If equipment blank data shows that the level of contaminants is insignificant, then this step may be skipped.

- Flush with distilled/deionized water. The final water rinse must not be recycled.

VI. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality c ntr l samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one per sample c ler.

- Field duplicate.

- Matrix spike.

- Matrix spike duplicate.

- Equipment blank.

- Trip blank (VOCs).

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Sampling should proceed from wells with the lowest contaminant concentration to the highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

When field duplicates or split samples are to be collected, they will be collected consecutively for the same parameters.

All monitoring instrumentation must be operated in accordance with EPA analytical methods and the operating instructions as supplied by the manufacturer. The instruments must be calibrated at the beginning of each day and the calibration checked at least once throughout the day (i.e. at the end of the day) to verify that the instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, should be checked for accuracy prior to field use according to the EPA Method 170.1 and the manufacturer's instructions.

VII. FIELD LOGBOOK

A field log must be kept each time ground water monitoring activities are conducted in the field. The field logbook should document the following:

- Well identification.
- Well depth, and measurement technique.
- Static water level depth, date, time and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Fi ld bservations f sampling event.

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- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

EXAMPLE

WELL PURGING - FIELD WATER QUALITY MEASUREMENTS FORM[4]

Sheet 1 of 1*; Sheet ___ of ___

Location (Site/Facility Name) _____ Date _____
Project Name / # _____
Field Personnel _____
Sampling Organization _____
Submersible pump with direct line to Flow Cell used for all measurements? (Y, N)*

Sampling Point (common name) _____
Facility ID (for IGWIS data entry only) _____
Station ID (for IGWIS data entry only) _____
Purging Device (type of pump, bailer, etc):* _____
Pump Intake or Bailer set at (ft. below MP) _____

Time	DTW below MP (ft.)	Purge Rate (specify units below) ( )	Cumulative Volume Purged (specify units below) ( )	Water Column Volumes Purged	Temp (C)	Electrical Conductivity (µMhos/cm)	Specific Conductance (µMhos/cm)	pH	Eh (mv)	DO (mg/l)	Turbidity (NTU)	Comments

CALIBRATION	Date									
	Time: military									
	Comment*									

Field Measurements protocol followed with no exceptions (Y, N)* Form completed by _____ Date _____

Form GWS 01

Reference: EPA Groundwater Sampling - A Workshop Summary, EPA/6001R-94/205, January 1995, Appendix E.

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EPA

Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA regional personnel and other environmental professionals engaged in ground-water sampling.

For further information contact: Robert Puls, 405-436-8543, Subsurface Remediation and Protection Division, NRMRL, Ada, OK.

I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in th subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected, initially borrowed ideas, methods, and materials for site characterization from th water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic "units". With tim it became apparent that conventional water supply generalizations of "homogeneity" did not adequately represent field data regarding pollution of these subsurface resources. The important role of "heterogeneity" became increasingly clear not only in geologic terms, but also in terms of complex

[1]National Risk Management Research Laboratory, U.S. EPA
[2]University of Michigan

Superfund Technology Support Center for Ground Water

Technology Innovation Office
Office of Solid Waste and Emergency Response, US EPA, Washington, DC
Walter W. Kovalick, Jr., Ph.D.
Director

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physical, chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and "aquitards" or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g. 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al. 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third "phase" as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al. 1990; McCarthy and Degueldre, 1993; Backhus et al. 1993; USEPA 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the "total" mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias "naturally" suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g. metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Lax n and Chandler, 1982; Horowitz et al. 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic "push" technologies (e.g. cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance then some information regarding plume delineation in three dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on groundwater flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation.

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The use of borehole geophysical techniques are also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations.

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQO's)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with "hybrid" variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objective.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e. ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term representativeness applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on th distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

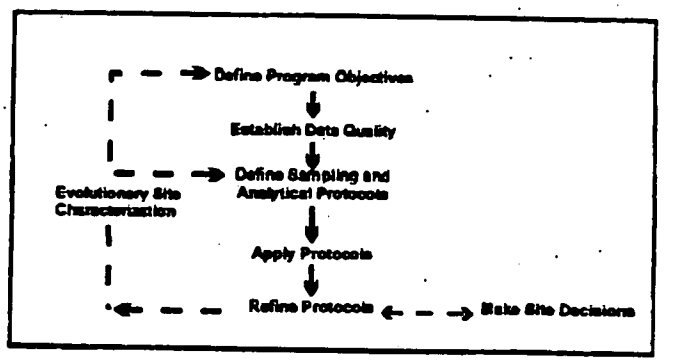

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator dependent methods) and the need to control avoidable errors.

1) Questions of scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e. aquifer) and chemical properties over time or space are not statistically independent. In fact samples taken in close proximity (i.e. within distances of a few yards) or within short time periods (i.e. more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g. monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these "over-sampling" concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g. wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore the spatial frequency of sampling poin should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases "well-point" diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that "short" (e.g. less than 1.6 m) screens be incorporated into the monitoring design where possible so that we might expect comparable results from one device to another. "Short", of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g. auger, rotary, etc.) are generally considered to cause more disturbance than "direct-push" technologies. In either case, there may be a period (i.e. days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality "recovery" period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxyg n concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired

sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging & Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions are important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

- Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (ie, dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of L w-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the 'mobile' load of contaminants present (dissolved and colloid-associated),
- minimal disturbance of the sampling point thereby minimizing sampling artifacts,
- less operator variability, greater operator control,

- reduced stress on the formation (minimal drawdown),
- less mixing of stagnant casing water with formation water,
- reduced need for filtration and therefore less time required for sampling,
- smaller purging volume which decrease waste disposal costs and sampling time.
- better sample consistency; reduced artificial sample variability

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a "change in conditions" and trigger an "action".

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground water sampling procedure has evolved over many years of experience in ground water sampling for organic and inorganic compound determinations and as such summarizes the authors (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground water monitoring and site characterization. The primary limitations to the collection of "representative" ground water samples include: mixing of the stagnant casing and "fresh" screen waters during insertion of the sampling device or ground water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground water flow regime in the vicinity of the monitoring well to stabilize and to let chemical equilibrium with the well construction materials be approached. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g. flow-through cell) be used to establish the stabilization time for several parameters (.g. pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be consid red before, during and after sampling:

- use low flow rates (<0.5 L/min), during both purging and sampling maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacture's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed in relative to ground elevation.

D. Pump Type

The use of low flow (e.g. 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of "low" flow rates (i.e. < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause "significant" drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages & Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-drive pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other "grab" type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of "stagnant" water in the casing and the "dynamic" water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tend to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al (1991), USEPA (1992), Parker (1994) and Thumblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g. 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a "fix" for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally "dissolved" [ie. samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and therefore affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than th pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should

be continuously monitored during purging. The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well if this is known. Generally, volatile (e.g. solvents and fuel constituents) and gas sensitive (e.g. Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site Quality Assurance Project Plan (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, Field Safety Plan [FSP], USEPA, 1992 RCRA guidance document or EPA-SW-846). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the Field Sampling Plan (FSP). The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g. clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available

to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected, i.e. a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e. two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (USEPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

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Figure 2. **Ground Water Sampling Log**

Project _____ **Site** _____ **Well No.** _____ **Date** _____

Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____

Sampling Device _____ **Tubing type** _____ **Water Level** _____

Measuring Point _____ **Other Infor** _____

Sampling Personnel _____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project _____ **Site** _____ **Well No.** _____ **Date** _____
Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____
Sampling Device _____ **Tubing type** _____ **Water Level** _____
Measuring Point _____ **Other Infor** _____

Sampling Personnel _____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

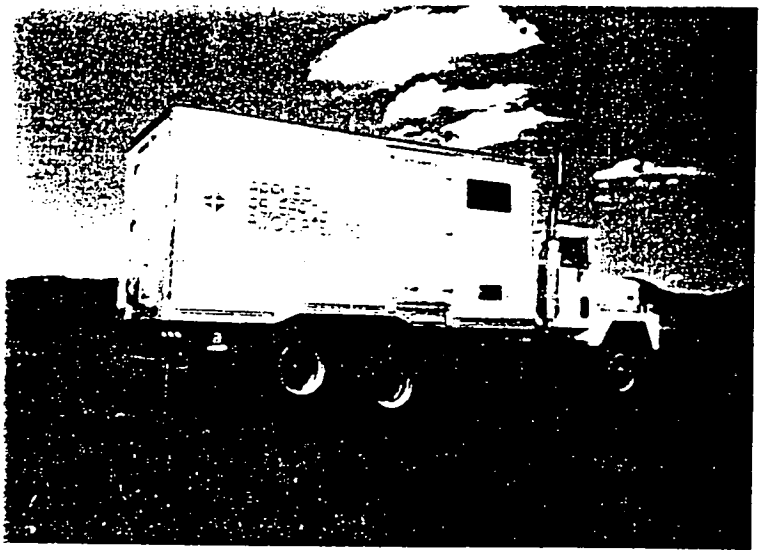
Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

APPENDIX B2: CONE PENETROMETER AND IN-SITU GROUNDWATER EQUIPMENT AND SAMPLING PROCEDURES

APPLIED RESEARCH ASSOCIATES, INC.
CONE PENETRATION EQUIPMENT AND CAPABILITIES



Applied Research Associates, Inc.

James D. Shinn II
ARA, New England Division
120-A Waterman Road
South Royalton, Vermont 05068
(802) 234-8348

Jimmie L. Bratton
ARA, Corporate Offices
4300 San Mateo Blvd. NE, Ste. A-220
Albuquerque, New Mexico 87110
(505) 881-8074

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APPLIED RESEARCH ASSOCIATES, INC.
CONE PENETRATION EQUIPMENT AND FACILITIES

1.0 INTRODUCTION

Applied Research Associates, Inc. (ARA) is an established developer, operator and manufacturer of cone penetrometer technology (CPT) trucks and related equipment, including data acquisition systems and software. As a CPT operator, we use lessons learned during our field operations to continually improve both our technical capabilities and analysis methods, and the CPT equipment we manufacture. Presented below is a summary of ARA's CPT equipment and techniques. Major systems and components described in the following subsections include:

- Truck Mounted Cone Penetrometers
- Special Cone Penetrometer Systems
- Cone Penetrometer Probes and Samplers
- Cone Penetrometer Research Devices
- Data Acquisition Systems and software
- Support Equipment
- Data Analysis Tools

2.0 TRUCK MOUNTED CONE PENETROMETERS

ARA has manufactured eight (8) truck mounted cone penetrometer systems. Five of these units were manufactured for internal use; the others were manufactured for the U.S. Air Force, Ohio University and the Environmental Protection Agency (EPA). Until 1993, ARA was not an active manufacturer of CPT trucks for the general engineering community. Our work was focused mainly on R&D for the CPT and the use of our own CPT units for special geotechnical and environmental site investigations. We were led to manufacture our own units because commercially available equipment was inadequate for the dense, cemented and/or cobbley soils that we needed to investigate. Commercial units, modeled mainly after those used in Europe for soft soils, are inadequate for many soils in the United States.

Our internal units have been successfully used for site investigations at a large number of very difficult sites, including the Department of Defense (DOD) high explosive test site in Yuma, Arizona; White Sands Missile Range; Nevada Test Site; Savannah River Site (SRS) and the Hanford Site. At each site we achieved the deepest successful penetrations of any CPT truck used at the site. A map showing states in which ARA has conducted CPT operations is shown in Figure 1.

The success of our CPT systems has received widespread recognition and interest. This community recognition and our internal evaluations, which indicate a greatly expanded market for CPT trucks in the future because they permit faster and more accurate site investigations, led ARA management to decide to commercially manufacture CPT trucks and related products beginning in late 1993. Our unique CPT development history has provided many significant advances to CPT technology that we implement on the CPT units we manufacture. Our manufacturing capabilities provide our Operations Group the ability to rapidly resupply while also allowing specialized equipment to be developed and obtained for field use.

In 1982 we built our first CPT truck and penetration system, which included the push frame, probes, data acquisition, calibration systems and analysis techniques. Figure 2 shows this first CPT truck testing at the edge of a high explosive crater at a site near Yuma, Arizona. The material was cemented due to clay desiccation, and high tip and sleeve stresses were encountered. ARA developed a push technique that allowed us to routinely penetrate to depths of over 100 ft in these cemented alluviums.

A key to ARA being able to penetrate to these depths was the development of the rod clamping system, shown in Figure 3, which allows us to clamp the rods at any location. When high push capacity is required, the head clamp is raised on the push rod a few inches and the rod reclamped and the push continued. With many commercially available CPT penetration systems, the pushing device must be raised a full rod length (1 m) to continue the push. At high push loads the unsupported rod located between the push cylinders can buckle in the van and the required high push capacities cannot be generated.

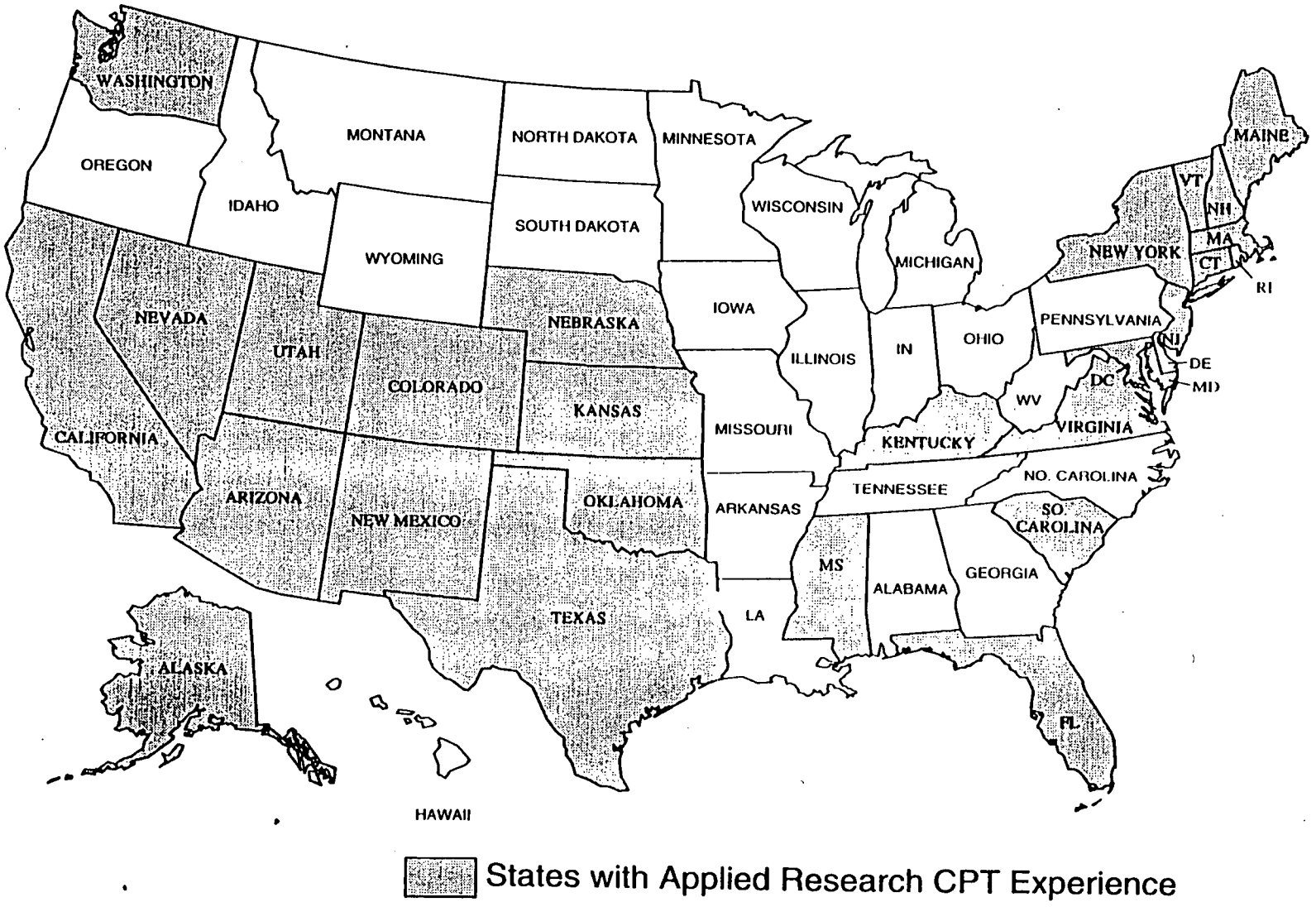


Figure 1. Map of United States showing ARA's CPT project locations.

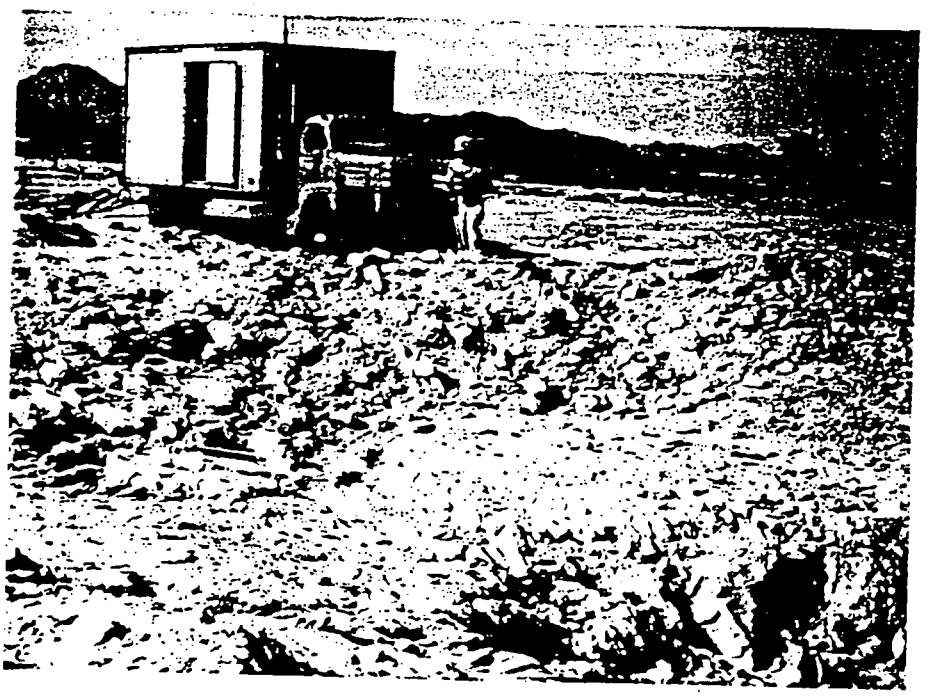


Figure 2. Photograph of the first CPT truck developed and built by ARA in 1982.

Figure 3. Specialized rod clamping system developed by ARA in use at an environmental site.

The tip and sleeve stresses measured in the cemented soils at the Yuma site were well above those normally encountered by standard CPT investigations. As a result, the available correlations between CPT results and engineering properties were not valid. Therefore, ARA developed soil classification and analysis methods to derive engineering properties based on a fundamental modeling of the penetration process.

The original ARA CPT truck was used exclusively for DOD geotechnical site investigations. In 1987, we began expanding our project beyond the DOD market to include commercial clients, other government agencies and environmental site investigations. Since that time we have manufactured five additional CPT trucks, three of which ARA currently operates, and one that was fabricated for the U.S. Air Force. Table 1 contains a list and summary of capabilities of the ARA manufactured trucks.

ARA system performance is well demonstrated by recent projects at DOE sites. Our second CPT truck (ARA #2) spent the majority of its time at SRS demonstrating the need for heavyweight CPT trucks. At the New Production Reactor Site at the Savannah River site, ARA #2 conducted seismic-CPT penetrations to depths as great as 281 ft. To our knowledge no other CPT rig has been able to penetrate to this depth at this site. At the Integrated Demonstration Site, ARA conducted a series of soundings that consisted of Resistivity/Piezo-CPT, soil gas sampling and water sampling. We were generally able to penetrate to a depth of 160 ft, with the deepest penetration going to 187 ft, which is the deepest CPT penetration at this site.

The third ARA CPT unit was a skid mounted system discussed in the next subsection. ARA Truck #4 was developed for the U.S. Air Force, and is an air transportable, lightweight CPT truck designed for contingency airfield pavement evaluations. This truck contains several design innovations unique to CPT units. The lightweight (12.5 ton) field laboratory/truck, transportable by C-130 aircraft, was built around a load frame that serves both as a clamping/push system for penetrometer tools and as a hydraulic press for testing subgrade reaction and pavement samples. This vehicle included ARA's standard fully instrumented and equipped electric cone penetrometer probe and data acquisition system.

Table 1. ARA CPT Truck Summary

Vehicle	Push Capacity (lbs)	Gross Vehicle Weight: Full Ballast (lbs)	Gross Vehicle Weight: Road Weight (lbs)	Dimensions LxWxH (ft)
ARA #1 Diamond T	45,000	50,000	40,000	28 x 8 x 11.5
First heavy CPT vehicle. Innovative head clamp design. (retired 12/87).				
ARA #2 5-Star GMC General	45,000	57,000	52,000	32 x 8 x 12.5
Heavy vehicle for use in difficult soils. Large manual seismic hammers. (retired 4/1/92).				
ARA #4 Air Force Unit	25,000	26,000	20,000	22 x 8 x 7
Air transportable vehicle. Collapsible van body, water ballast tank, mobile drilling unit.				
ARA #5 International 1600-2T PAYSTAR	60,000	63,000	51,000	34 X 8 X 12.5
Fiberglass and steel interior surfaces to ease decontamination, specifically designed to conduct environmental studies.				
ARA #7 MACK 37-350	60,000	63,000	45,000	36 x 8 x 13
Used on contract to ANL over the last two years for deep water sampling. Automated shear wave generator. Water ballast tank.				
ARA #8 MACK RD688	63,000	66,000	49,500	32 x 8 x 12
Deep push, high mobility unit. Automated shear wave generator. Designed for environmental test services.				
ARA #9 Ohio University FORD LNT 8000	50,000	53,000	43,000	29 x 8 x 12.5
Teaching /Research vehicle. Automated shear wave generator, automated auxiliary rod clamp, hydraulic core drill.				
ARA #10 EPA/Ada, OK MACK RD688	62,700	68,000	52,500	32 x 8 x 12
Deep push environmental research vehicle. Stainless steel interior and hydraulics.				

The vehicle also included a drill rig mounted on the back of the truck, which is used to cut pavement core samples and/or provide an access hole for subgrade penetration testing. To permit transport of the truck by military aircraft, the van has a collapsible roof.

A unique hydraulic and water tank system was designed into the floor of the vehicle to provide sufficient reaction mass to penetrate airfield pavements, yet remain lightweight for aircraft transport. This stiffened the truck frame, provided water for drilling operations, served as the hydraulic tank freeing up valuable interior space, and provided easily obtained ballast at remote sites to achieve the desired push capacity. Figure 4 shows a photograph of the U.S. Air Force CPT truck.

The fourth CPT truck developed by ARA (ARA #5) was the first unit designed specifically for environmental site characterization work. Unique features of this unit included fiberglass and steel interiors that can easily be decontaminated. This unit has worked nationwide, performing standard capacity CPT investigations.

ARA completed a second phase of testing at the Hanford site during the summer of 1992 with our newly designed CPT truck, ARA #7 (ARA #6 was a trailer mounted rig). This truck, built on a new Mack chassis, was designed to be ballasted up to 60,000 lbs for those difficult sites where the added push capacity is required. With the higher capacity CPT truck, ARA was routinely able to push to the target depth of 50 ft and completed a number of pushes to depths between 90 to 140 ft. Our standard 22-ton truck met refusal at 10 to 20 foot depths in an earlier study.

Our newest CPT truck, ARA #8 shown in Figure 5, was also built on a new Mack chassis and was developed to replace the retired ARA #2. This truck was developed to perform deep surveys in difficult soils, and was put into service in June of 1993. With its 30-ton push capacity, well in excess of that of ARA #2 which set our previous 280 ft depth record at SRS, we should be able to push even deeper than previously possible.

Figure 4. Air Force CPT truck being loaded on a C-130 Aircraft.

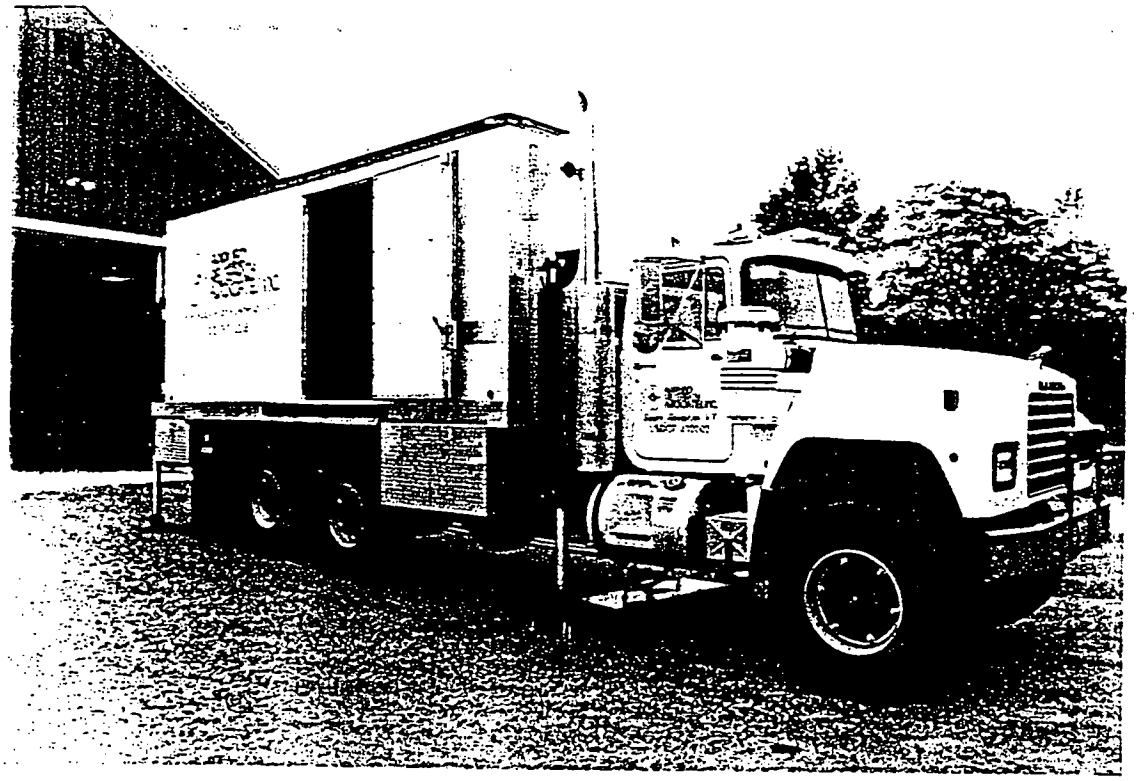


Figure 5. Photograph of ARA's newest 30-ton CPT truck.

Fabrication is underway on our first 40-ton CPT truck. This next generation of ARA CPT trucks, the first of which we are building for ANL, will set new records in terms of push capacity. These trucks will also have the ability to push 2.25-inch diameter rods, which will enhance capabilities for inserting larger diameter environmental instruments. The expected completion date for this unit is late spring of 1994. We currently plan on building a second 40-ton capacity CPT truck to support DOE's operations to be completed in the late fall of 1994.

ARA also manufactures CPT push systems for special applications. For the Defense Nuclear Agency (DNA), ARA manufactured a high capacity CPT system for in situ characterization of soft rock; specifically, the tuffs at Nevada Test Site (NTS). Characterization of the NTS tunnel testbed tuffs had always been biased by the field boring and laboratory testing programs because the retrieved samples represented only the high quality rock. The weaker tuff units cannot be easily sampled or tested, and their properties were only estimated or not reported. ARA conducted a demonstration test program with our truck mounted CPT on outcrops of the NTS tuffs. We were able to penetrate these tuffs to a depth of 4 ft, and this testing led to the development of the Soft Rock Cone Penetrometer (SRCP) for DNA. ARA designed and manufactured a compact CPT rig, shown in Figure 6, which could be rotated 360 degrees to penetrate the tunnel at any angle. The load frame used the opposite side of the tunnel to develop the required reaction forces. A 5,000 psi push system was developed, using our hydraulic head clamp concept, which had a maximum push capacity of 125,000 lbs. The design of this very high capacity system can be used as the basis for the design of a very high capacity CPT truck such as might be needed to penetrate the dense near surface gravel and cobble beds at many sites.

We have developed a trailer or skid mounted CPT unit based on the soft rock penetrometer design that can be used inside buildings, in tight locations, to perform angle pushes beneath structures, and can also be and mounted on all terrain vehicles for sites having difficult access. Figure 7 shows an ARA trailer mounted rig. This unit was used to evaluate strength parameters of a saltcake simulant material for the Westinghouse Hanford Company. During this project, more than 65,000 lbs of penetration force was applied to the simulant material.

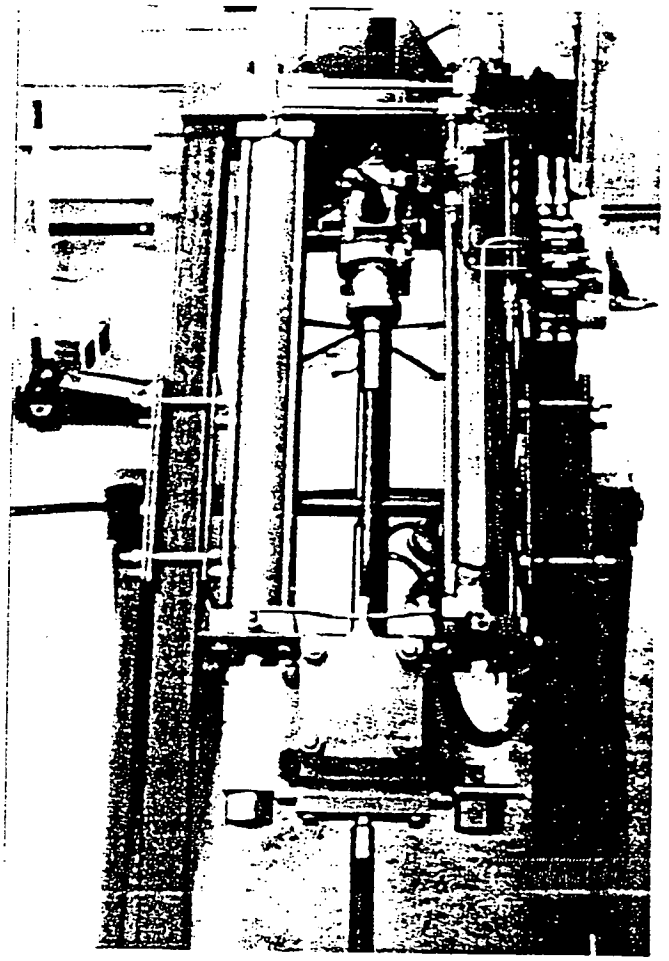


Figure 6. Soft rock penetrometer for inside mine shaf

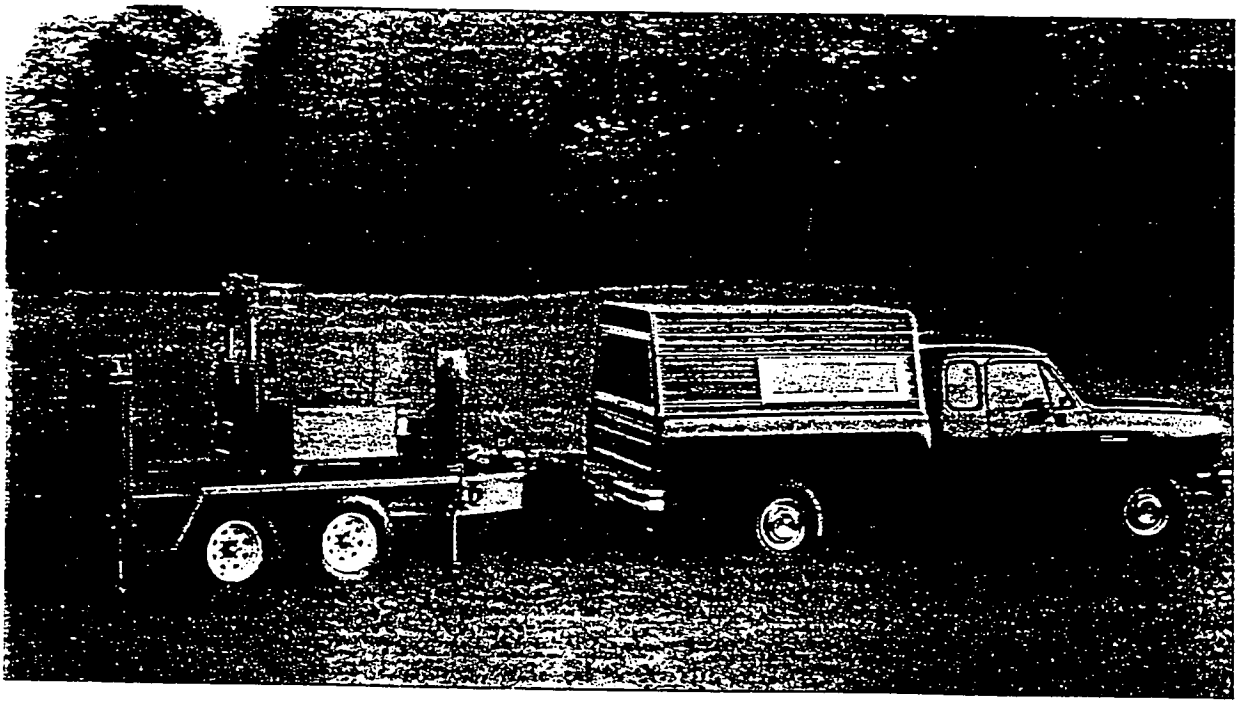


Figure 7. ARA's trailer and mounted CPT unit.

3.0 CONE PENETROMETER PROBES AND SAMPLERS

3.1 Overview of ARA CPT Probes

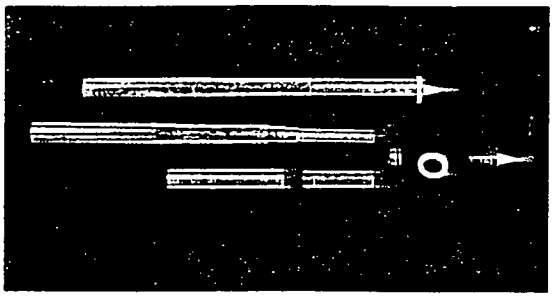
ARA operates and manufactures a wide range of CPT probes for measurement of various geotechnical and environmental parameters. Probes currently utilized by ARA in site investigation work include:

- standard 10 cm^2 sized high resolution piezo cones with demonstrated 23-ton total capacity,
- large 10 cm^2 sized high resolution piezo cones with a 40-ton total capacity,
- three axis seismic cones for developing P and S wave profiles,
- soil resistivity modules,
- two axis precision inclinometers,
- radiation detector/monitors,
- soil/water and gas samplers,
- permanent or temporary monitoring wells for both soil gas and water.
- Self grouting and tremie grouting CPT probes,
- Laser induced fluorescence-CPT probe
- Raman-CPT probes
- Temperature modules
- pH modules

Figure 8 shows some of ARA's CPT probes. The radar and radiation probes are ARA proprietary. The ground penetrating radar probe was developed by ARA under an NSF SBIR contract.

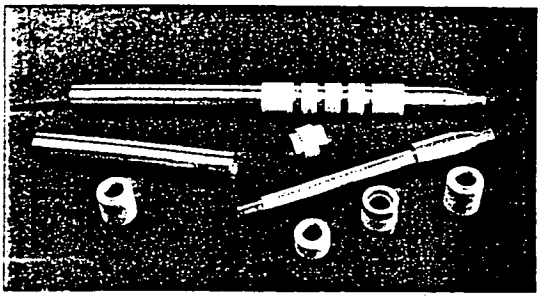
3.2 Seismic and Resistivity Modules

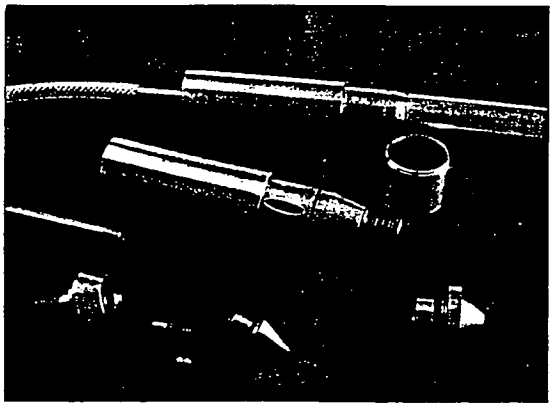
Both ARA's seismic module and our resistivity module (shown schematically in Figure 9) have been used extensively at SRS over the past few years. The seismic module consists of three geophones (Geospace Model GS-14-L9 velocity gages) mounted inside the



ARA STANDARD PIEZO CONE

ARA RESISTIVITY MODULE





ARA SELF GROUT MODULE

ARA RADIATION PROBE

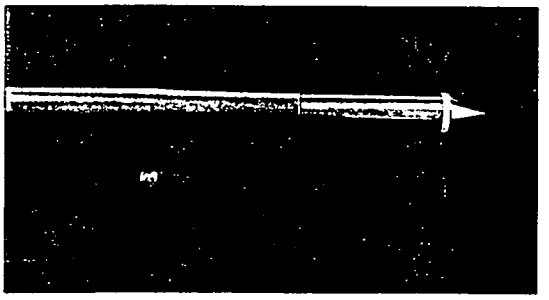


Figure 8 Photograph of a few of ARA's CPT probes and sensors.

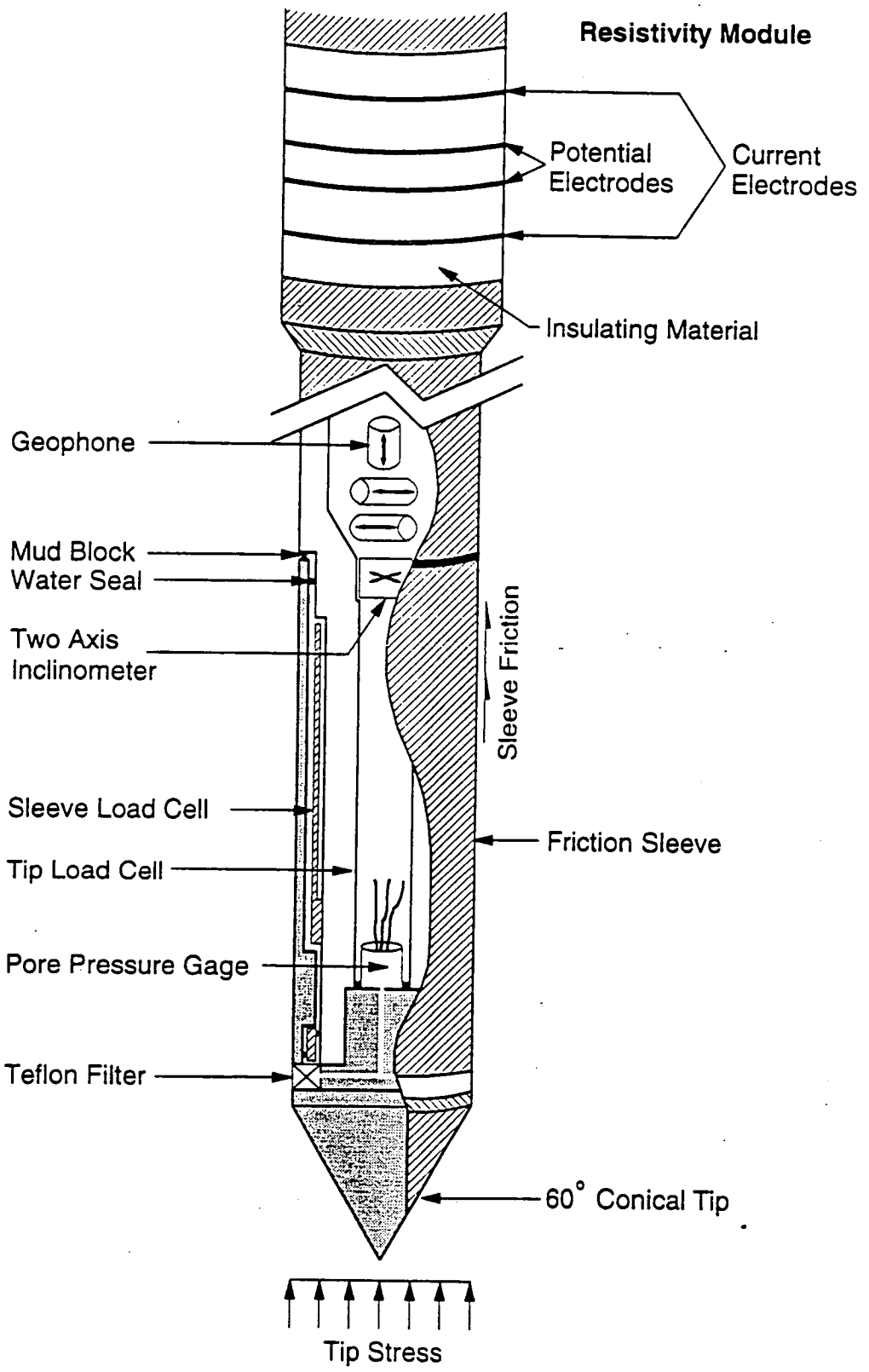


Figure 9. Schematic of ARA's cone penetrometer probe.

penetrometer. These gages are used to detect the arrival at depth of seismic waves generated on the surface. Data from previous seismic surveys at SRS have been used extensively to evaluate seismic wavespeeds, damping characteristics, and soil strength parameters.

The resistivity module used by ARA was developed in-house and represents an example of the utility of being both an operator-developer and manufacturer of equipment. The major limitation of resistivity modules in the past has been the survivability of the insulator pieces in dense, graveling soils. Previous resistivity modules used ceramic pieces as insulators, and these pieces would shatter and crack when penetrating through gravelly materials. ARA developed a resistivity module that used high strength plastic as an insulator. This unit was used at over 20 locations at the A & M area of SRS to an average depth of 150 ft before any noticeable wear occurred on the unit.

3.3 Gamma Radiation Probe

3.3.1 Overview

Applied Research Associates, Inc. has developed a Gamma Radiation-Cone Penetrometer Technique (Gamma-CPT) as a cost effective and intrinsically safe method of locating radiation contamination. Advantages of the ARA Gamma-CPT probe include: 1) workers are not exposed to radioactive material; 2) elimination of drilling waste resulting in significant cost savings; and 3) CPT soundings can be conducted at locations considered too hazardous for conventional drilling operations. In addition, the time to conduct a Gamma-CPT sounding is significantly less than that for a conventional drilling investigation.

3.3.2 Field Test Method

ARA deploys the Gamma-CPT probe in one of two modes. In the first mode, the gamma detector is located in the ARA CPT probe as depicted in Figure 10. Used in this mode, CPT data in addition to the gamma radiation data is gathered. The CPT data is then used to evaluate site stratigraphy and material properties information (such as the water table

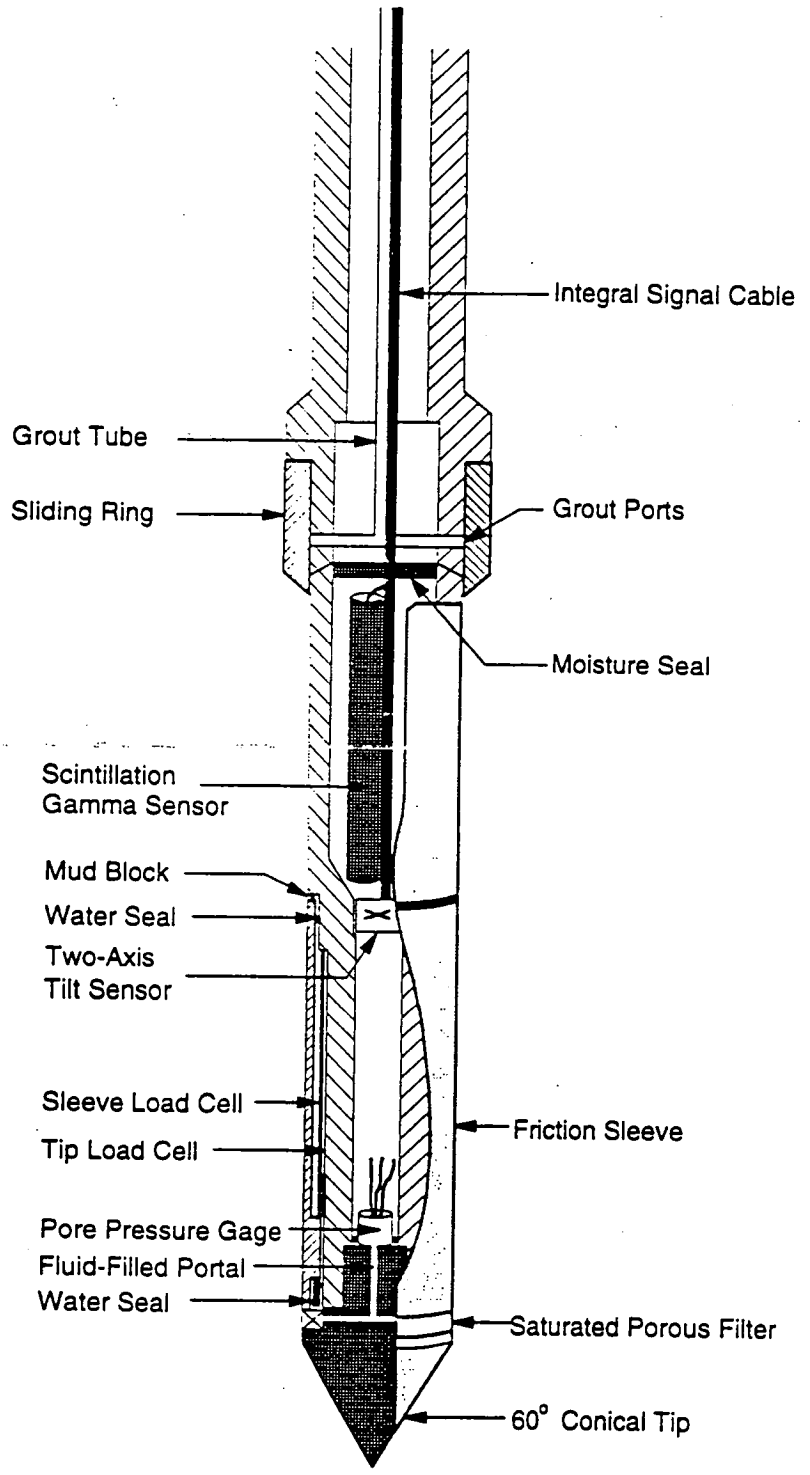


Figure 10. Schematic of ARA's radiation detection cone.

depth, soil strength and hydraulic conductivity). This data is very important in evaluating how radioactive isotopes may be transported from the disposal site to the water table.

In the second method, which we have used at the Hanford Site, a string of 1.75-inch OD by 1-inch ID CPT rods are pushed to the desired depth and the Gamma detector is lowered through the rod string, much like a wireline tool. We have successfully characterized two sites at Hanford using this technique, with data from one of these sites shown in Figure 11. This figure shows the gamma counts as a function of depth, with the most contaminated region occurring at a depth of 15 ft. We have also analyzed Gamma-CPT data to locate disposal cribs at the Hanford Site. A map of the radiation data at a site at Hanford is shown in Figure 12. This method of characterizing radioactive contamination has been documented by Hanford personnel to result in a significant cost savings (Cassem, 1993) over conventional characterization methods because it is faster and the volume of contaminated soils that must be removed is significantly reduced.

For sites where it is possible to set 1.5-inch ID PVC wells as described in Section 7.1, ARA can use a modification of the above technique in which a 1.5-inch ID PVC well is temporarily installed and the Gamma detector lowered through the well. This method has two advantages: 1) larger detectors can be used, significantly improving the spectral resolution and decreasing the data acquisition time, and 2) PVC will attenuate the gamma radiation less than the steel CPT sounding rod or CPT probe.

3.3.3 System Enhancements

Based on our experience at Hanford, ARA is currently developing two enhancements to our Gamma-CPT: enhancements to the radiation detection, and development of a system to decontaminate and monitor radiation-contaminated rods upon withdrawal.

ARA is currently incorporating a new gamma detector into our Gamma-CPT system. For this project, we will use a NaI (TI) detector that has a 1-inch diameter by 6-inch long crystal, which will increase the sensitivity of the system by approximately a factor of 6 to 10. This new detector will allow us to reduce sampling time from 20 minutes per sampling

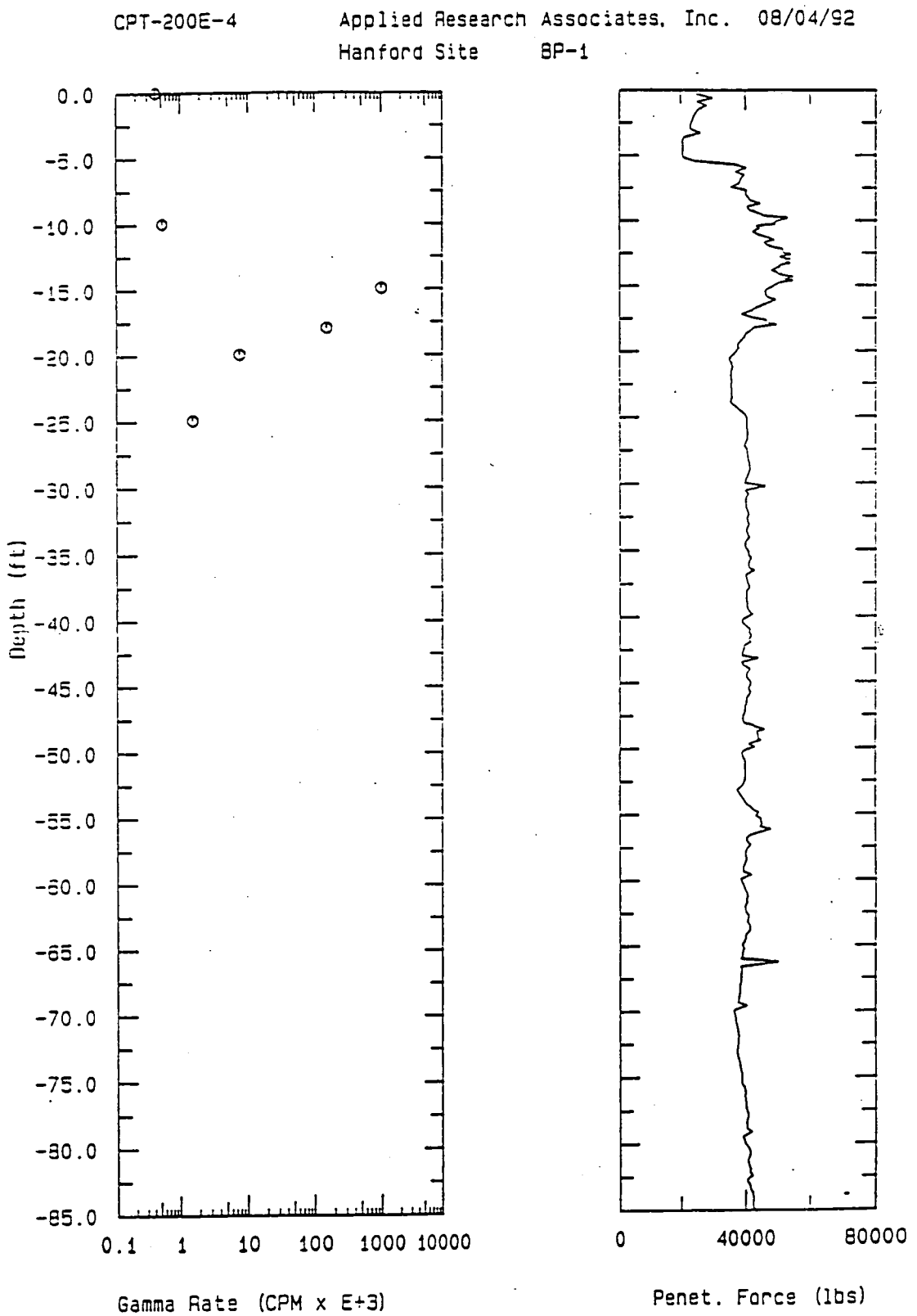


Figure 11. Data from test Location CPT-200E-4.

SECTION A-A'

Figure 4.3 Profile view showing Gamma radiation (CPS) along section line A-A'

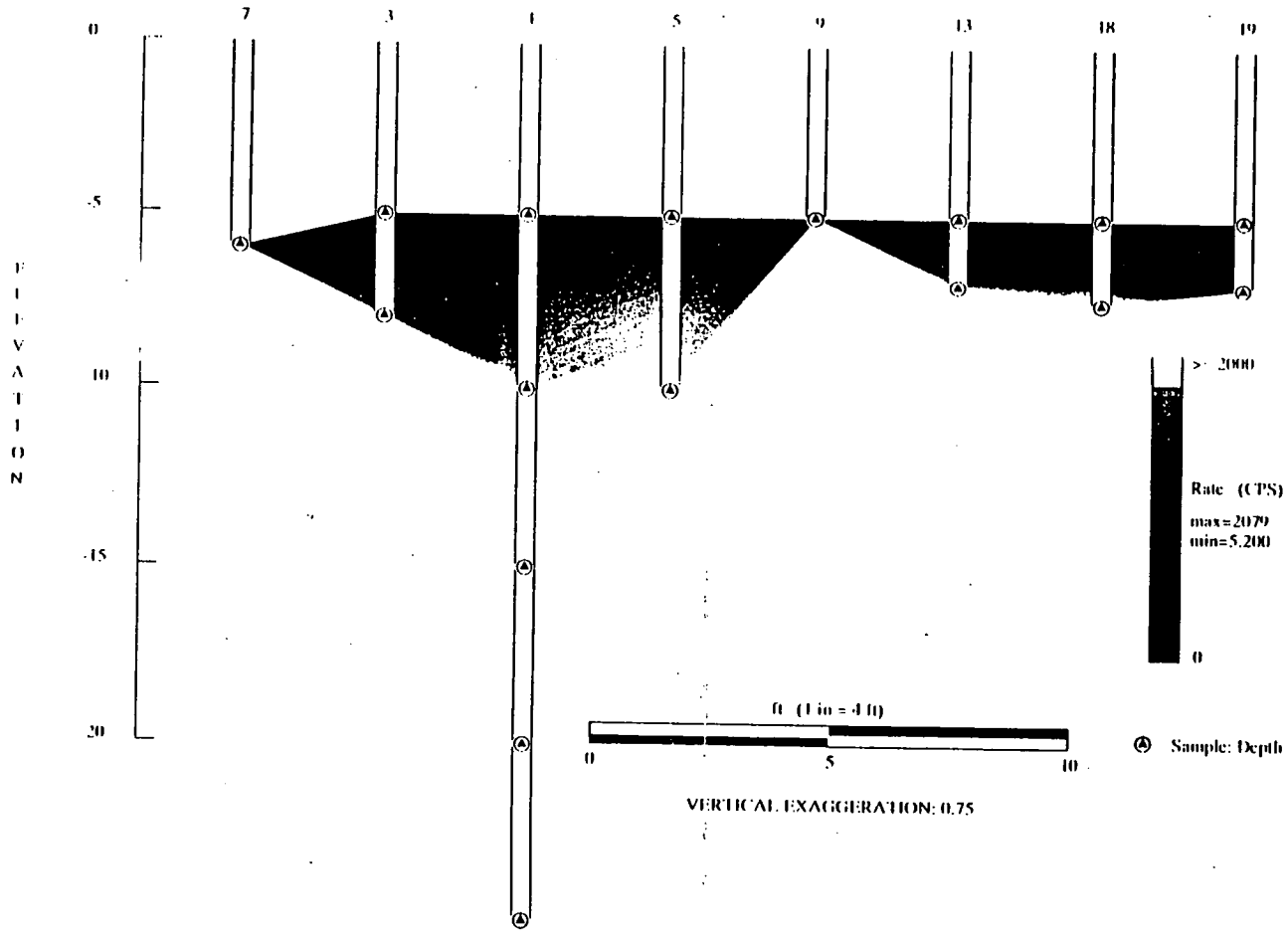


Figure 12. Cross-sectional profile of gamma-radiation measurement.

depth to 1 to 3 minutes per sampling depth. In addition, the new system will be able to detect radiation in the soil at a greater range, and the spectral resolution will be enhanced. We will also be able to resolve energies as high as 2 MeV, versus the current 1 MeV limit.

The second enhancement to the system is incorporation of radiation contamination detectors beneath the CPT truck. ARA is developing a prototype radiation detection system that mounts under the ARA truck and monitors for contamination as the push rods are retracted. Two detectors were used in the preliminary design, as shown in Figure 13; one sensing alpha, and the second sensing beta and gamma radiation. These detectors are mounted 180 degrees apart from each other, and are in contact with the rod string during retraction. Special donut shaped detectors are currently being investigated for application with this system. These detectors would provide a means of monitoring the complete circumference of the rods as they are retracted. This system will increase the operational efficiency of the CPT in radiation contaminated zones.

3.4 pH and Temperature Sensor

ARA has developed and fielded a pH and temperature sensor for the CPT, based on technology developed by ARA for a Sandia National Laboratory project. The sensor resides on the surface of the CPT probe approximately 9 inches above the cone tip. This sensor can operate in highly moist or saturated soil zones. The measurement range of the pH sensor is between 2 to 10. The pH readings are automatically corrected for temperature effects using the temperature sensor located directly above the pH sensor. The temperature sensor has been used to detect biological and chemical activity at superfund subsurface sites.

ARA has fielded the pH and temperature sensor on a project in California to assist in the differentiation of drilling muds from acidic tar materials below grade. Due to the unknown characteristics of the acid tars, a variety of sensors were used to assist in the delineation. On a typical penetration, a total of 7 parameters were measured and profiled versus depth as shown in Figure 14. Data analysis from this project indicated that pH was the best sensor for accurate differentiation of the acid tars from the drilling muds. As shown in Figure 14, an acid tar region exists from a depth of 11 to 23 ft. The resistivity profile

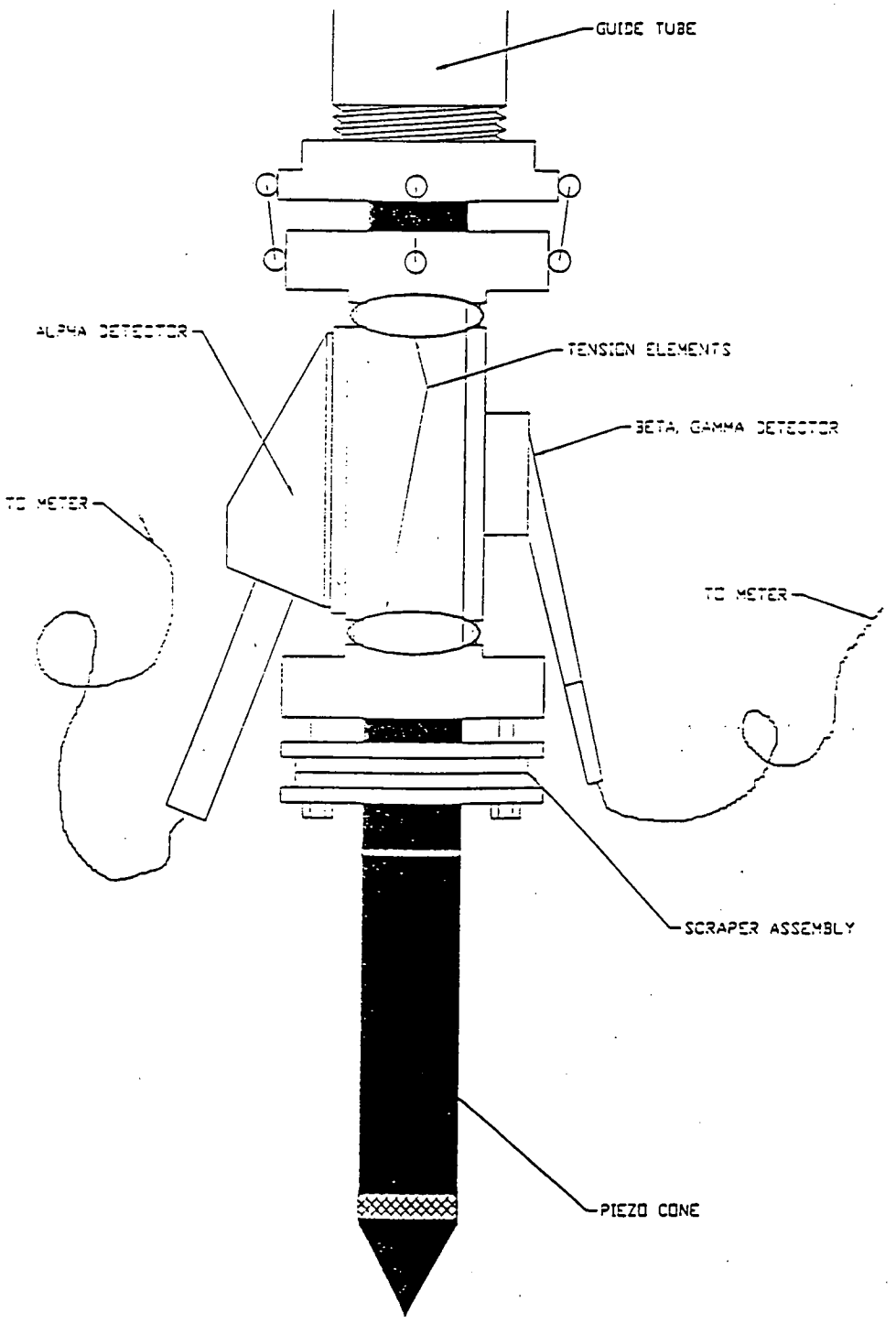


Figure 13. Schematic of radiation monitoring equipment to screen the push rods prior to entering the CPT truck.

could not be used to delineate between the acid tars and the drilling muds. The temperature profile was elevated over the acid tar dept interval and confirmed that chemical reactions were occurring in the acid materials. In summary, ARA's pH sensor allowed the project managers to successfully delineate locations of the acid tar material.

4.0 CONE PENETROMETER RESEARCH DEVICES

ARA is a leader in designing and developing state of the art research probes, and has developed custom probes for the Air Force, Argonne National Laboratory, and Sandia National Laboratory. Presented below is a summary of the probes we have developed.

4.1 Visco-Cone

ARA has designed and manufactured a cone penetrometer tool for Sandia National Laboratories (SNL) that can be used to measure tip stress, pore pressure, and viscosity of soil slurry type mixtures. This tool, called a visco-electric cone penetrometer (Figures 15 and 16), is operated remotely using a robotic arm being developed by SNL. The ultimate objective of the work performed by SNL is to use the robotic arm along with a variety of tools and instruments to safely characterize the highly radioactive sludge located in the tank wastes at the DOE Hanford site.

4.2 LIF-CPT Probe System

ARA is also developing a Laser-Induced Fluorescence-Electronic Cone Penetrometer Test (LIF-CPT) system for the Air Force. The first generation system (see Figure 17) was demonstrated at Tinker Air Force Base (AFB), Oklahoma, and Plattsburgh Air Force Base, New York, as an innovative technology for delineating gross soil contamination resulting from fuel spills. In this project, the North Dakota State University's laser spectrometer and the U.S. Army Engineer Waterways Experiment Station (WES) fiber optic probe's detection capabilities, particularly its specificity and sensitivity to petroleum contaminants, were evaluated in laboratory and field experiments in various soil media. To enable rapid, efficient and minimally-invasive site characterization, the LIF-CPT probe data output have

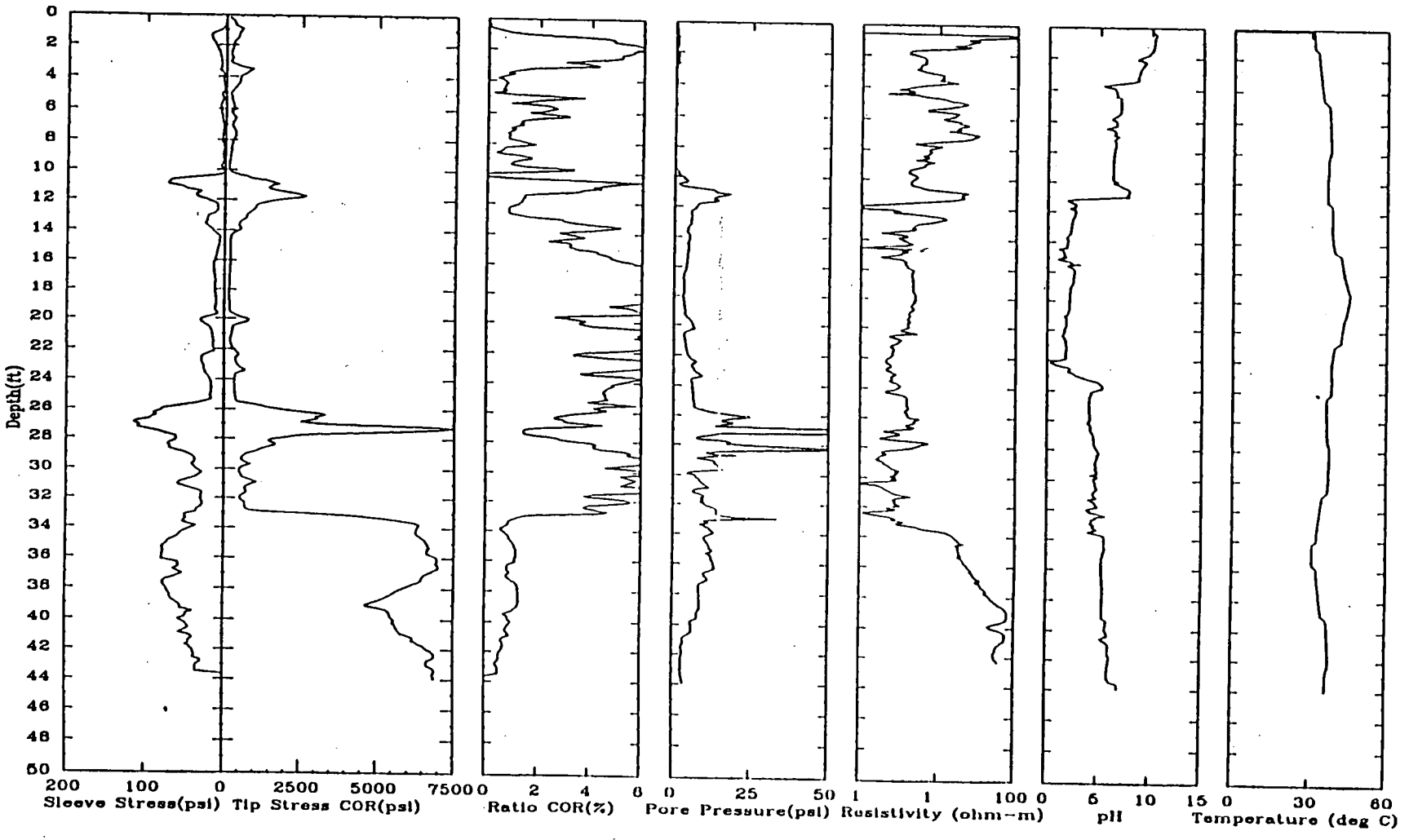


Figure 14. Profiles of 7 measurements made during a single penetration test on a project to delineate acid tars from drilling muds in California.

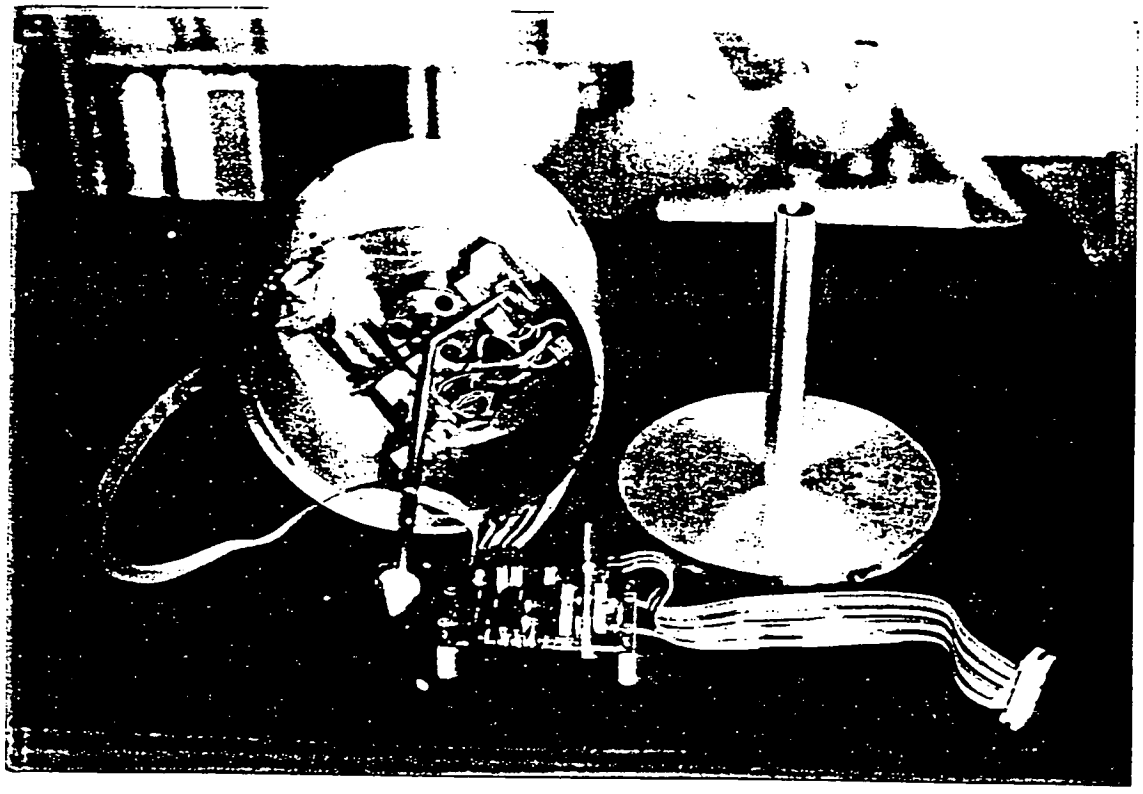


Figure 15. View of ARA's unassembled visco-cone showing the photoelectric sensing assemblies.

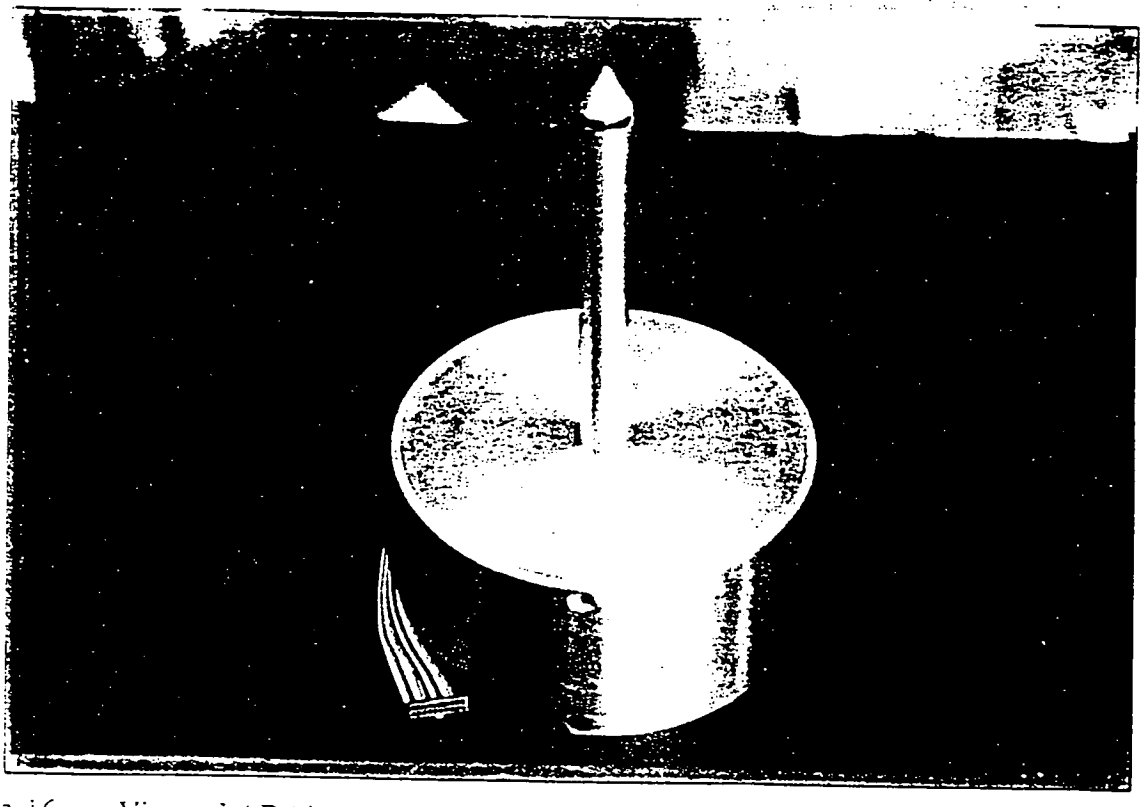


Figure 16. View of ARA's assembled visco-cone ready to be attached to the Sandia robotic arm.

been linked to ARA's real-time analysis system with 3-dimensional modeling and scientific visualization capabilities. LIF-CPT results have been corroborated by a sampling and analysis program that included utilization of ARA's mobile gas chromatography (GC) laboratory. Figure 17 shows the laser used in the experiments and a comparison of LIF and GC data.

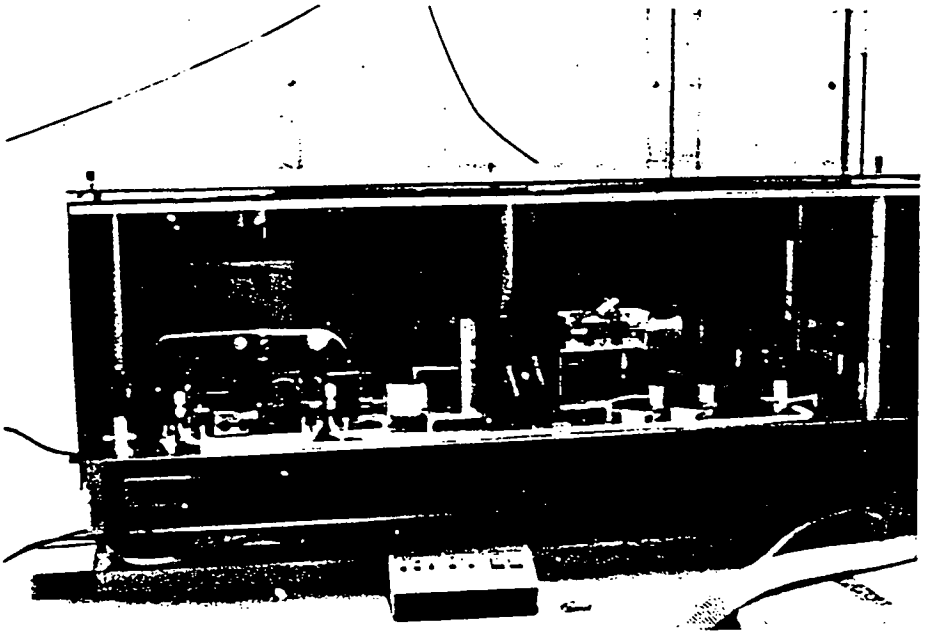
During the field demonstration at Tinker AFB, a JP-4 spill site was delineated in detail using the LIF-CPT system with an adaptive site characterization approach. Variable grid spacings of 100, 50, and 10 feet were used to define the geometry of the gross soil contamination, with locations based on the real-time LIF results. In a 2-day period, 24 pushes were completed that averaged 15 to 20 feet in depth in soil derived from weathered shale. Three-dimensional statistical models were prepared on site and a scientific visualization package was used to review the results. The displays show the lateral and vertical extent of two zones of residual soil contamination resulting from separate spills, one previously unknown. Preliminary assessment of the LIF results with on-site analytical data indicate that the system has detection limits on the order of 100 ppm Total Petroleum Hydrocarbons (TPH) for fuel in soil.

This combination of the cone penetrometer with the tunable (excitation wavelength selectable) laser system will enable the Air Force to address site characterization, remediation and post-remedial monitoring of petroleum, oil and lubricant (POL) contaminated sites, in a rapid and efficient manner.

4.3 Raman-CPT Probe

A third research system that ARA developed and demonstrated at SRS is a Raman spectroscopy system. This system integrates EIC Laboratories' Raman spectroscopy system into ARA's large-scale (15 cm^2) electronic cone penetrometer probe. The initial project was used to detect TCE and PCE contamination at the A/M Area of SRS. We also used this system to locate heating fuel contamination at the Central Shops Area.

The above discussion clearly demonstrates ARA's capabilities in designing and developing CPT probes. As discussed previously, ARA began as a research and



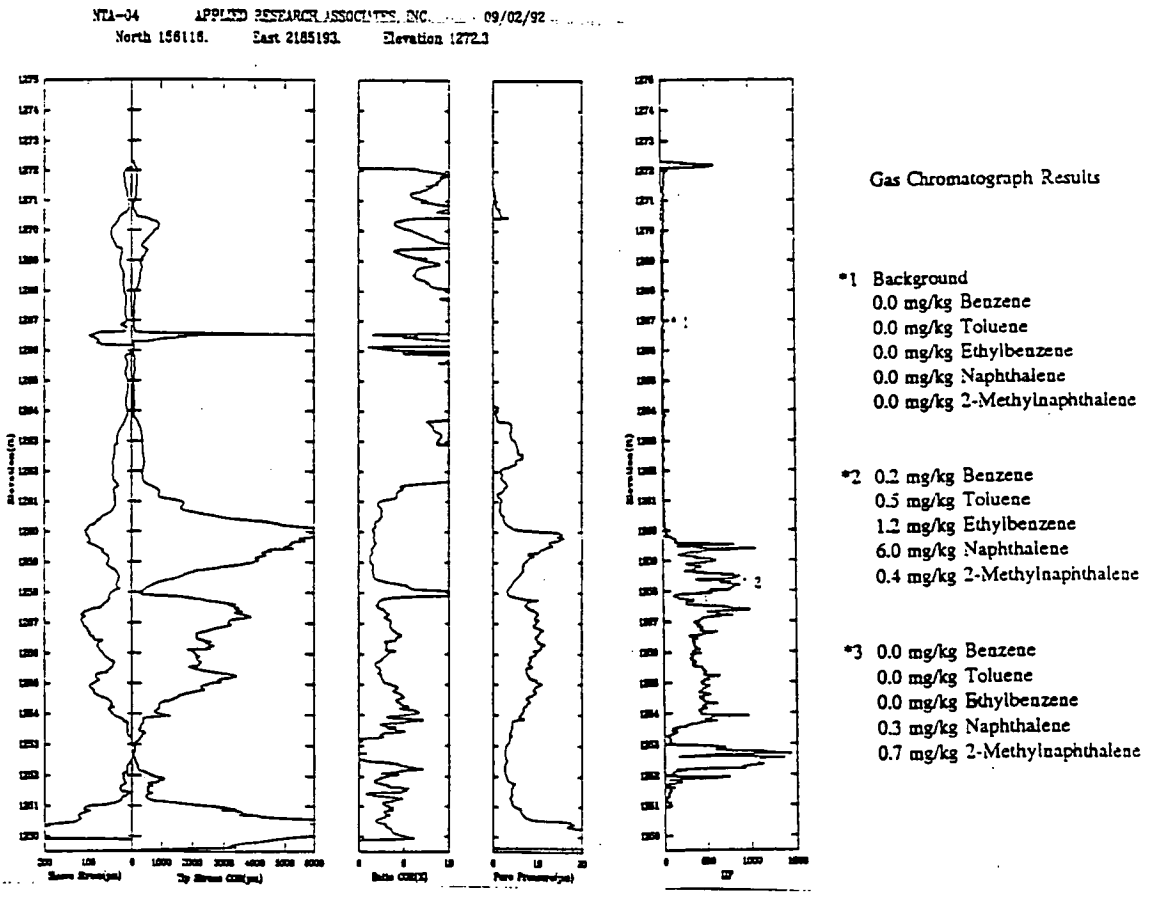


Figure 17. Photograph of laser system installed in CPT rig with typical data set from a site at Tinker AFB.

development firm, and continues to produce significant work in this area. ARA is continually undertaking CPT research work to expound the CPT's capabilities and maintains state of the art technology for use by our customers.

5.0 DATA ACQUISITION HARDWARE AND SOFTWARE

ARA manufactures and operates a number of sophisticated electronic and computer components for CPT data acquisition. Our data acquisition and analysis systems include:

- 16 bit data acquisition systems with numerically controlled amplifiers/fillers/trigger circuits,
- custom designed junction boxes with user friendly cabling connectors,
- calibration and data acquisition software,
- data analysis software,
- data presentation software,
- 3-D site characterization software.

5.1 Data Acquisition Hardware

Our data acquisition systems are based on modern 486 computers. To meet special CPT data acquisition needs, ARA has designed, tested and is producing a number of customized printed circuit boards. A signal conditioning board was developed to meet the unique needs of CPT testing. This board has built-in capability to select, using software, self-documenting signal amplification and filtering. In addition we incorporate a trigger circuit for conducting seismic testing. Our system is designed to have less than $\pm$ .01% variation per degree (Celsius) change in the ambient temperature. This exceeds the specifications of many commercially available systems.

To reduce thermal induced signal drift due to electrical screw connections used in conventional junction box, we designed and manufactured a printed circuit board for the junction box using gold plated snap lock connectors and built in testing points for trouble shooting the system. The instrumentation setup can be easily changed using the computer style snap lock connectors. Ports are included for additional types of instrumentation.

5.2 Data Acquisition and Analysis Software

ARA has designed and written flexible, user friendly software to acquire, analyze and present the test data. The data acquisition software is written in ASYST, a FORTH-like language that is specifically written for scientific data acquisition, analysis and graphics presentation. Our data acquisition software is written around a main module to which subroutines are added to support new gages or testing techniques as they come on line. Data is plotted on-screen and in hard copy on board the CPT truck for immediate review in the field.

ARA has developed a unique CPT analysis software package that is used to determine engineering soil properties. The flow chart for this package is presented in Figure 18. This software offers a wide variety of engineering analysis routines along with simplified ease of use.

The engineering analysis parameters that can be determined from the CPT are shown in Table 2. Each of the parameters is easily plotted versus depth or elevation to create a continuous profile. The software design is modular such that any new or site specific types of engineering analysis can be performed. One analysis routine that has been used extensively is ARA's soil classification and soil stratigraphy. Over the past two years, ARA has conducted over 32,000 ft of penetration at SRS, much of which has been near conventional drilled borings. The CPT derived soil classification has been correlated with the boring logs and adjusted to produce better agreement than the published CPT classification methodologies. In addition, the friction ratio and pore pressure classification systems have been combined to produce a single classification system that has been used to produce soil stratigraphies. Figure 19 presents a comparison between ARA's CPT Soil Classification method and a geologist's description of soil type determined from boring samples for a location at SRS.

CPT Data Analysis Software

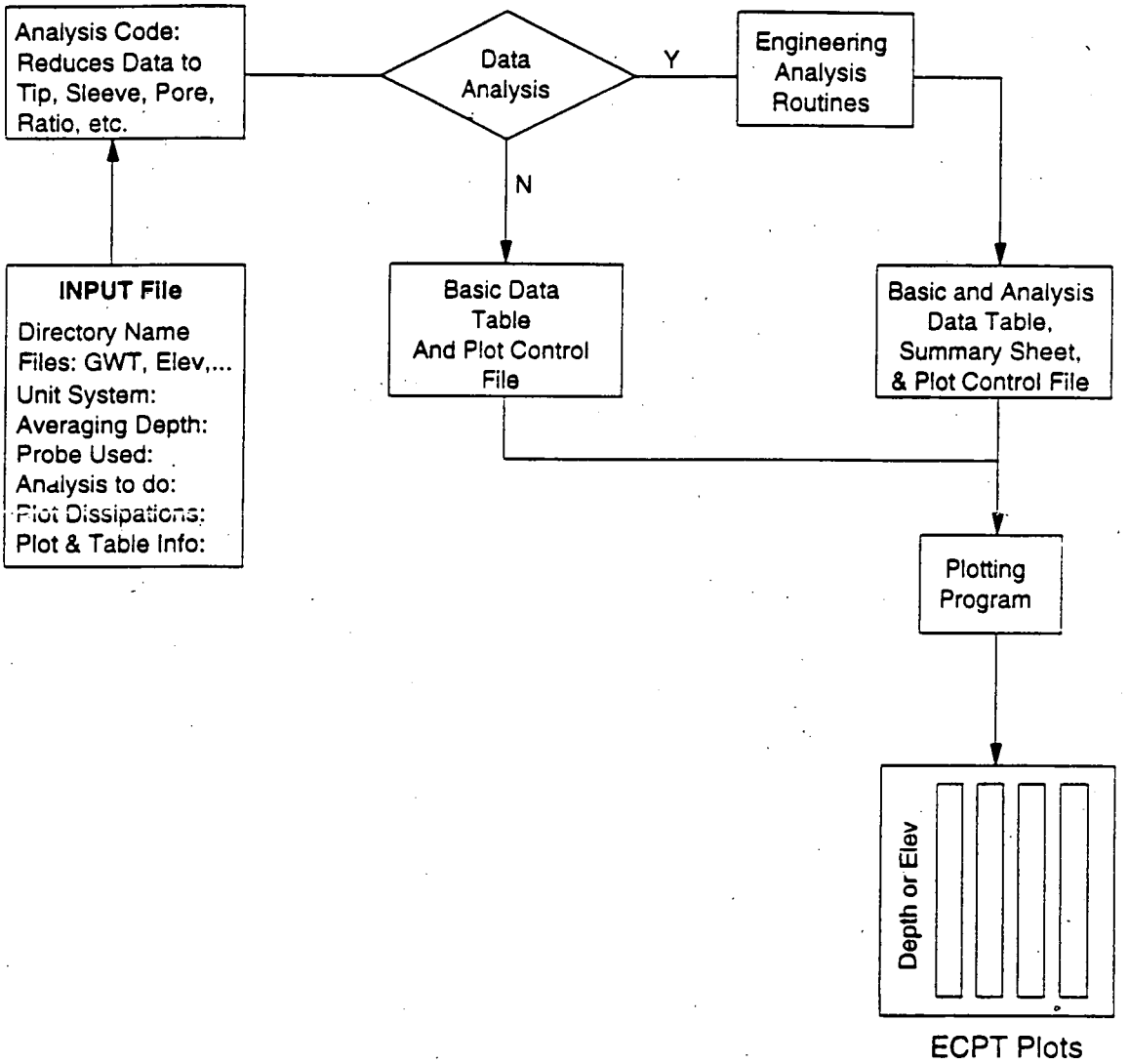
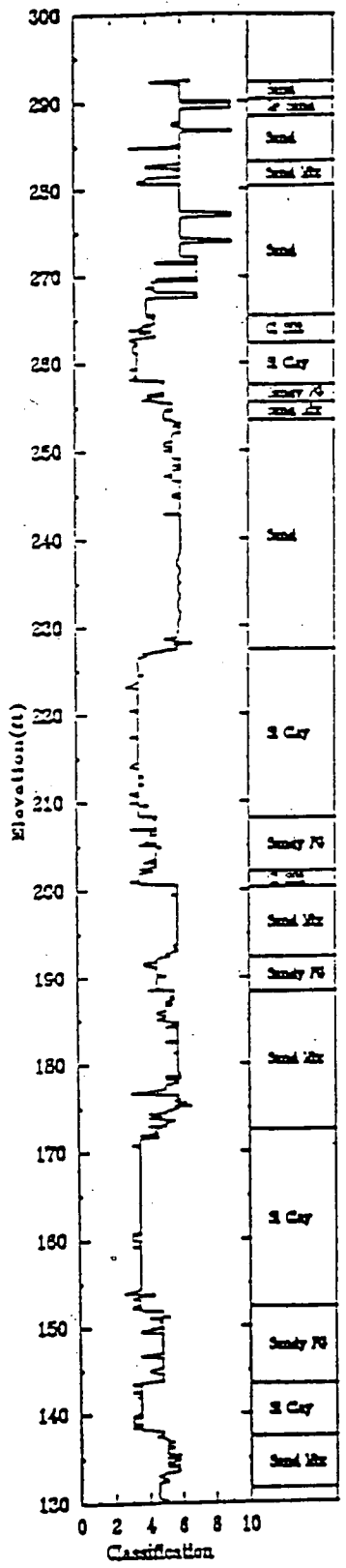


Figure 18. Flowchart of ARA's CPT data analysis program.



Boring Log Information

Description	Grain Size	Depth
Fill - mostly sand w/silt	F/C	9'
Fill	F/C	12'
Fill	F/C	15'
Becoming siltier		19'
	C/F	24'
Silt/clay matrix some sand	M/F	27'
Silt/clay - very few sands	F/M	33'
Mottled clay in fine sand	VF	36'
Mostly fine sand with Kaolin	F	40'
Kaolin in Matrix	F	45'
Kaolin in Matrix	M	50'
Sand with silt	M	55
Sand with few coarse grains	F/M	62'
Sand	M	68'
Kaolin in Matrix	M/C	75'
Kaolin in lenses and matrix	M/C	80'
Kaolin in matrix and lenses	M/C	85'
Sand-little Kaolin present	M	90'
Clean sand	F/M	95'
Clean sand	F/M	100'
Clean sand w/silt	F/M	105'
Clean sand	M	110'
Clean sand	M	116'
Clean sand	M	120'
Striated silt/sand seams	M/C	125'
Silt	VF	133'
Silt	VF	136'
Silty sand	F/C	140'
Silty sand	F	145'
Sand	F	150'
Over drilled 153-163		
Sand w/silt	F	168'

Figure 19. Typical P-CPT data from the ITP area along with boring log soil stratigraphy.

Table 2. Engineering Analysis Parameters

Description Parameters	Strength Parameters	Other Parameters
Soil Classification Soil Stratigraphy Relative Density (Rd) Overconsolidation Ratio (OCR)	Blow Count (n) Undrained Shear Strength (Su) Friction Angle	Resistivity Permeability

The ARA analysis code was designed with several users in mind, so that the code could be operated by the field technicians. This allows the technicians to be able to deliver preliminary data analysis profiles to the client upon completion of each penetration sounding.

Effective, proactive site characterization requires access to data in real time. ARA's penetrometer systems have on-board data processing and graphics hardware. ARA proprietary software is used to acquire, analyze and present the data as it is being acquired in the field for presentation to the client. ARA can also mobilize an analyses staff to the field or the data can be transmitted back to the ARA office using cellular phones and modems for overnight processing to assist with the layout for the next day's work.

A major site characterization program produces large amounts of data from various sources and in various forms. Convenient and flexible storage, retrieval and manipulation of the data are required to provide optimal and timely analysis. In parallel with the database problem is the need for multi-dimensional graphical display of data to aid in analysis.

ARA has developed procedures for handling and analyzing large amounts of site characterization data. Data is transferred to a workstation-type computer located either in ARA's Mobile Environmental Laboratory or back at the New England Division office. SitePlanner® software is used for database management, statistical processing and part of the graphic display. The system incorporates a relational database, a wide range of tools for analysis of stored data, geostatistical modeling and graphics capability to display contours, cross-sections, perspectives, and vector drawings. Some typical output from SitePlanner® of a fuel contaminated site investigated using the CPT is presented in Figures 20 through 22.

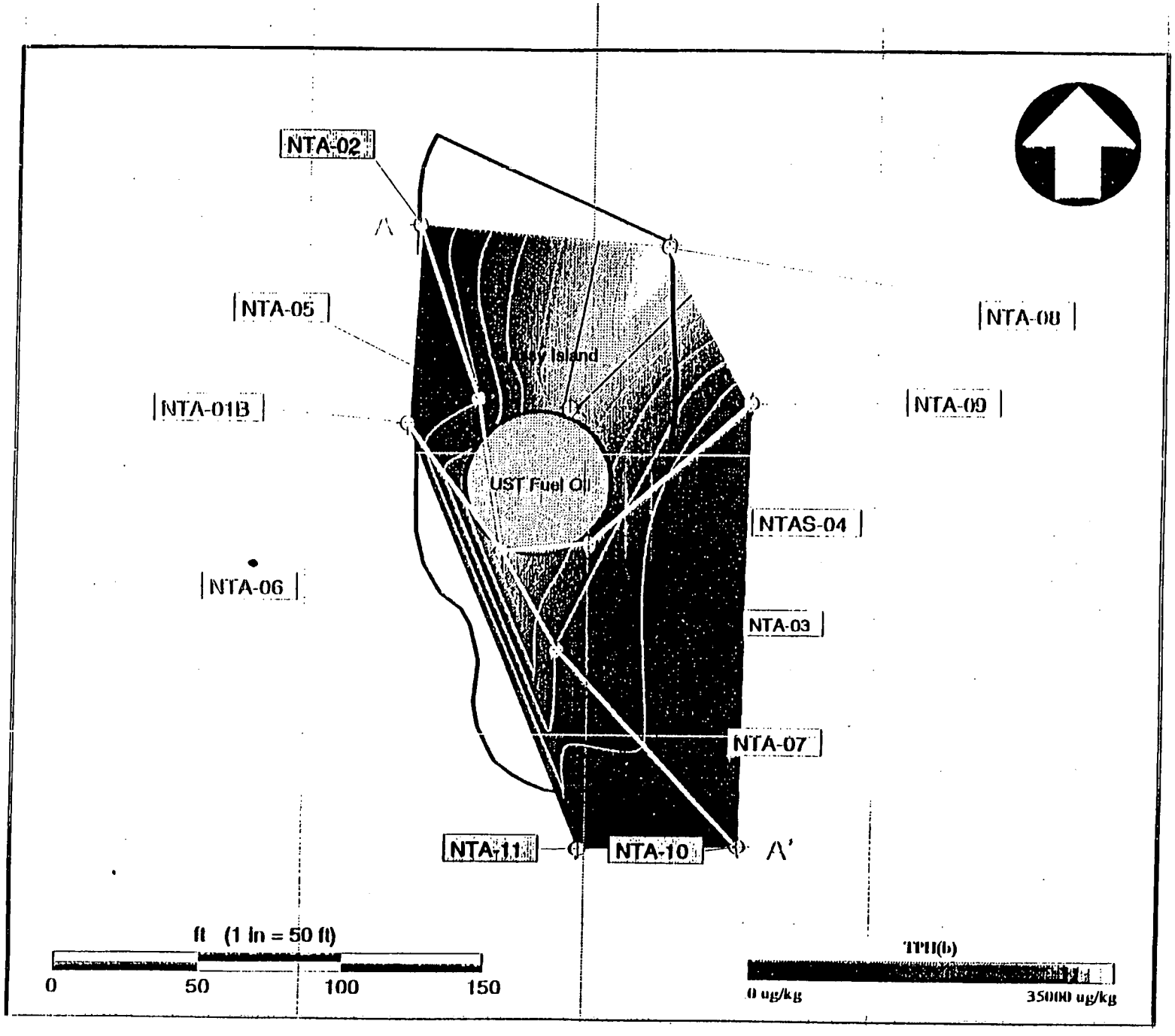


Figure 20. Contamination contours shown on a base map for a leaky fuel oil tank site.

SECTION C-C'

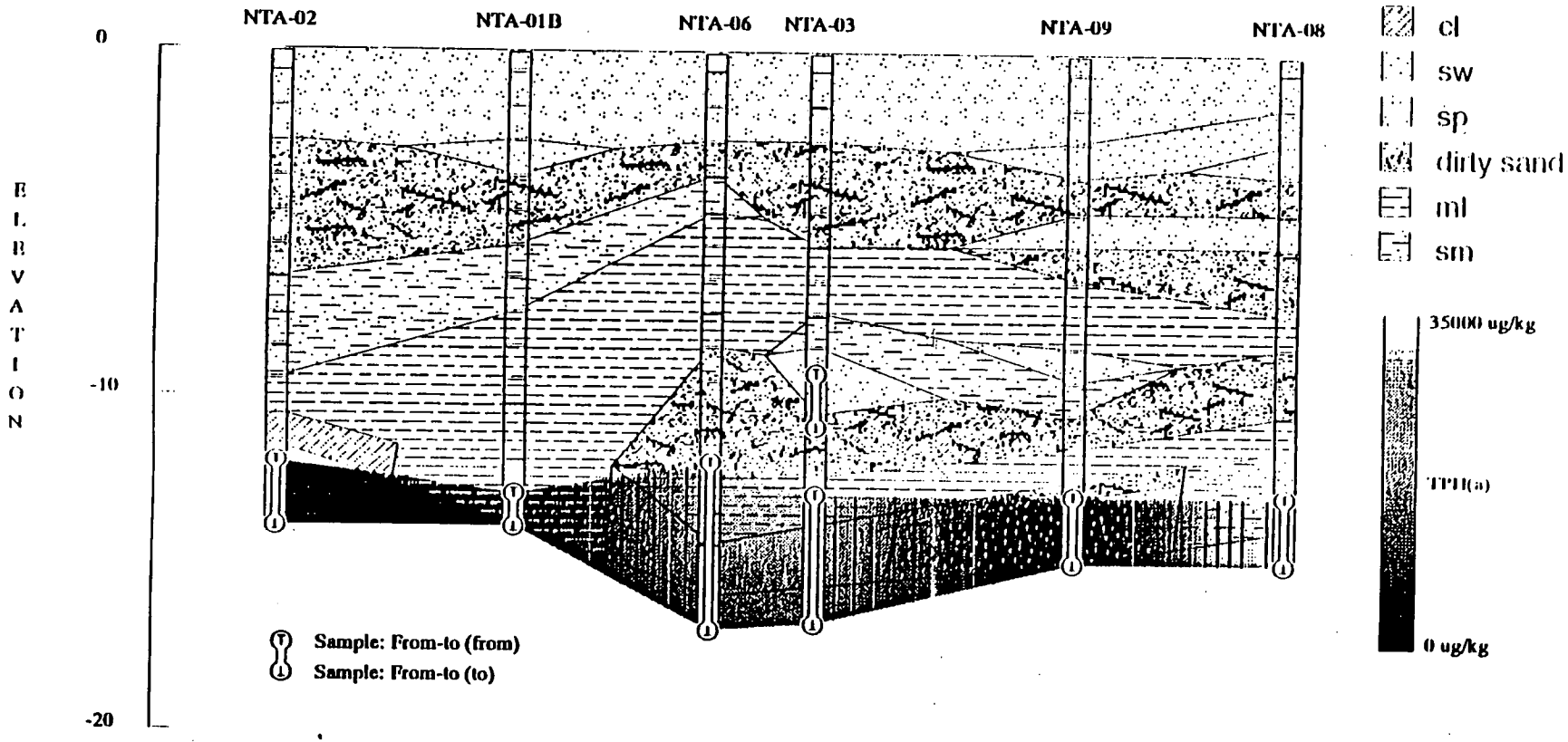


Figure 21. Cross sections of Total Petroleum Hydrocarbons values along Section A-A of the Leaky Fuel Oil Tank site.

ft (1 in = 50 ft)

VERTICAL EXAGGERATION: 10

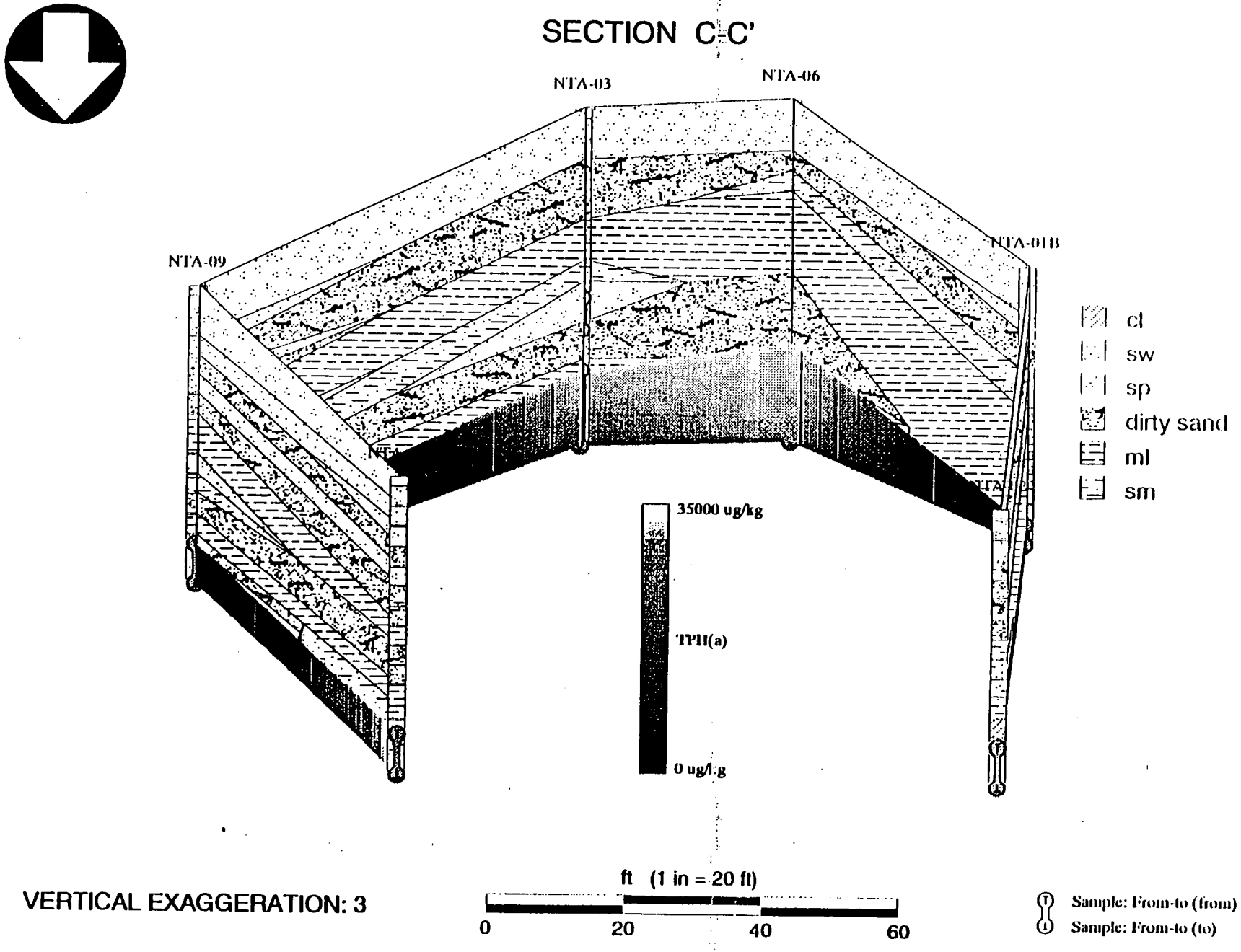


Figure 22. Fence diagram showing the Total Petroleum Hydrocarbons concentrations for the Leaky Fuel Oil Tank site.

For ease of interpretation and presentation purposes, ARA is using Advanced Visualization Systems, Inc.'s (AVS) three-dimensional volume rendering package to create a three-dimensional visualization package for site characterization work. This software allows cross-sections, horizontal slices, isosurfaces and three dimensional volume renderings to be displayed as shown in Figure 23. These various viewing methods assist the site characterization team with developing a three-dimensional understanding of the site.

6.0 IN-SITU GROUNDWATER SAMPLING

ARA currently utilizes three different methods of groundwater sampling depending on the job requirements. All methods begin with decontamination of the sampler and the push rods. The sampler is then pushed to the desired depth and the rod pulled back, exposing a filter on the sampler to the groundwater and allowing water to enter the sampler. The sample is then obtained and the equipment returned to the surface and decontaminated according to procedures specified by the customer.

The most popular sampler used is the HydroPunch®. This sampler collects large volume samples (approximately 1 L) in a single sampling event. A schematic of the HydroPunch® is presented in Figure 24. The disadvantages of this system are that the hole can not be grouted upon retrieval of the sampler and the sampler is not sufficiently robust to push through stiff soils. The second sampling method that ARA uses is the BAT® sampler system shown in Figure 25. The BAT® system utilizes evacuated glass vials to obtain the samples. The glass vials are lowered down the inside of the sounding rods and the septum on the vial is placed over a needle connecting the vial with the water sampler. The vial is allowed to fill and then retrieved. This method collects a sample at the in situ water pressure. Several disadvantages are present with this system. First, the hole can not be grouted upon retrieval of the sampling unit, and second, the needle occasionally plugs with material passing though the filter, resulting in incomplete filling of the vial. In addition, this sampler is sometimes very slow to fill and provides only small sample volumes.

Fuel Purge Area

LIF > 1000

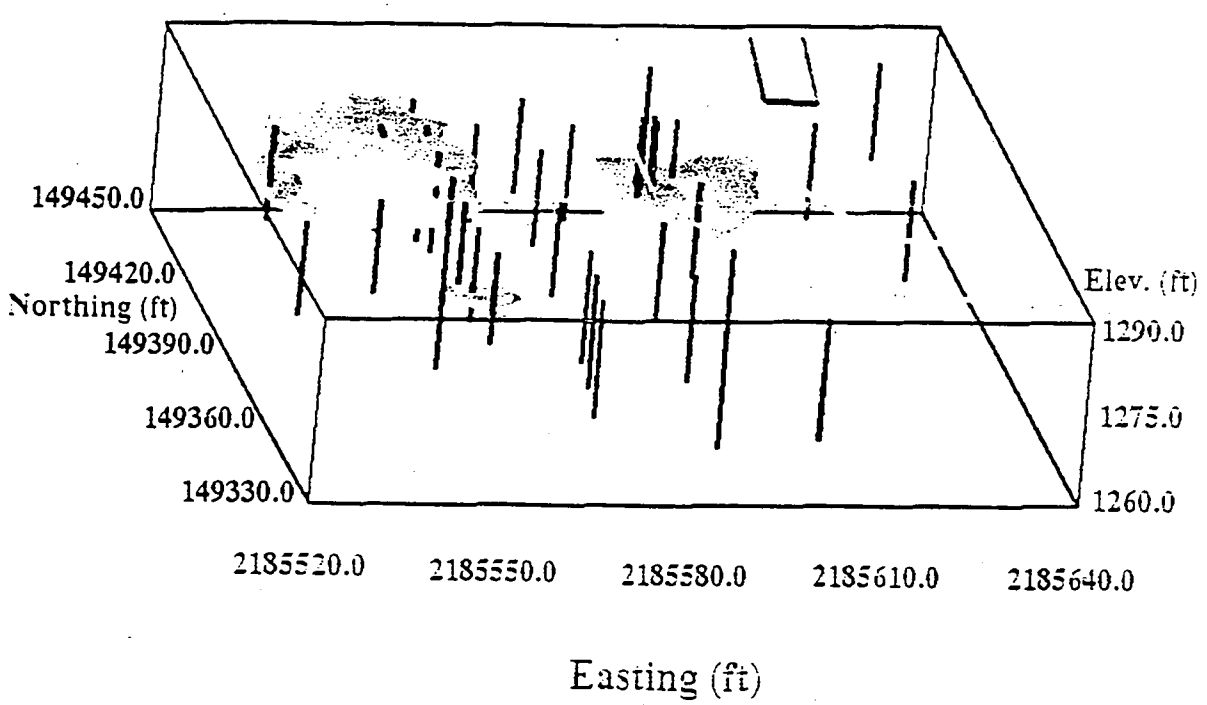


Figure 23. Isosurface plot of LIF values above 1000 in the Fuel Purge Turnaround Area showing three separate plumes.

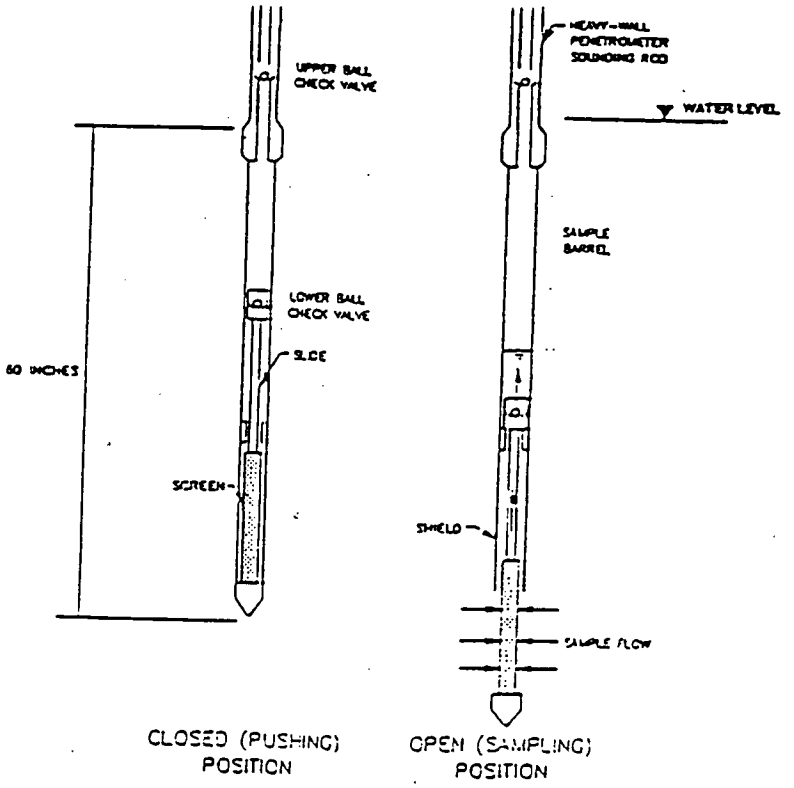


Figure 24. Hydropunch groundwater sampler.

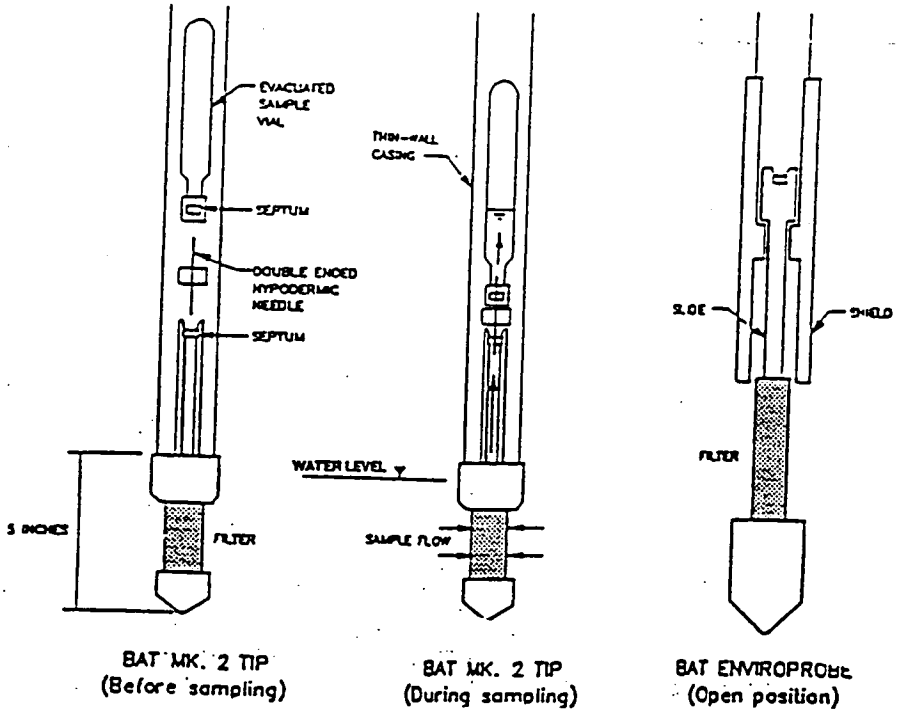


Figure 25. BAT groundwater sampling system.

The final sampler is an ARA designed sampler (see Figure 26) that allows water to enter the decontaminated push rods through a porous filter. The water is then either bailed using a teflon or stainless steel bailer or pumped to the surface using a Solinst Model 403 double valve pump from the interior of the push rods. The sample size depends on the bailer size, but an EPA 40 ml vial is typically filled on a single bail. The main advantage of this sampler is that once the sample is obtained the hole can be grouted upon retraction, saving time and reducing worker exposure to an open hole. Inert gas can also be pumped on top of the water sample to prevent loss of volatile compounds.

7.0 TEMPORARY PIEZOMETER INSTALLATION

ARA has developed rapid and efficient methods for setting 1.5-inch schedule 40 PVC temporary monitoring wells. In addition, we can also offer several other alternative well installation procedures as described in the following subsections.

7.1 1.5-Inch PVC Direct Push Well Installation

For routine temporary well installations, 1.5-inch ID Schedule 40 PVC pipe will be installed using the CPT rig. A steel sacrificial well tip is threaded onto a cleaned slotted PVC section that may contain a filter pack, as shown in Figure 27. This tip section is then threaded onto a 1-meter section of PVC riser. This composite section is lowered through the head clamping system and the guide tube to the ground surface. The 1.4-inch outside diameter CPT push rods are then lowered down the center of the PVC sections and seated against the steel push point. The head clamp is used to grip the CPT push rods and push the PVC sections into the ground. One meter sections of PVC riser material and CPT push rods are added sequentially and used to advance the well until the desired depth has been reached. Once the final depth has been reached, the inner CPT push rods are retracted, leaving an installed well.

Two mechanisms can be used to control the migration of fines into the well. The preferred mechanism consists of a porous plastic tube that retains all fines larger than 20

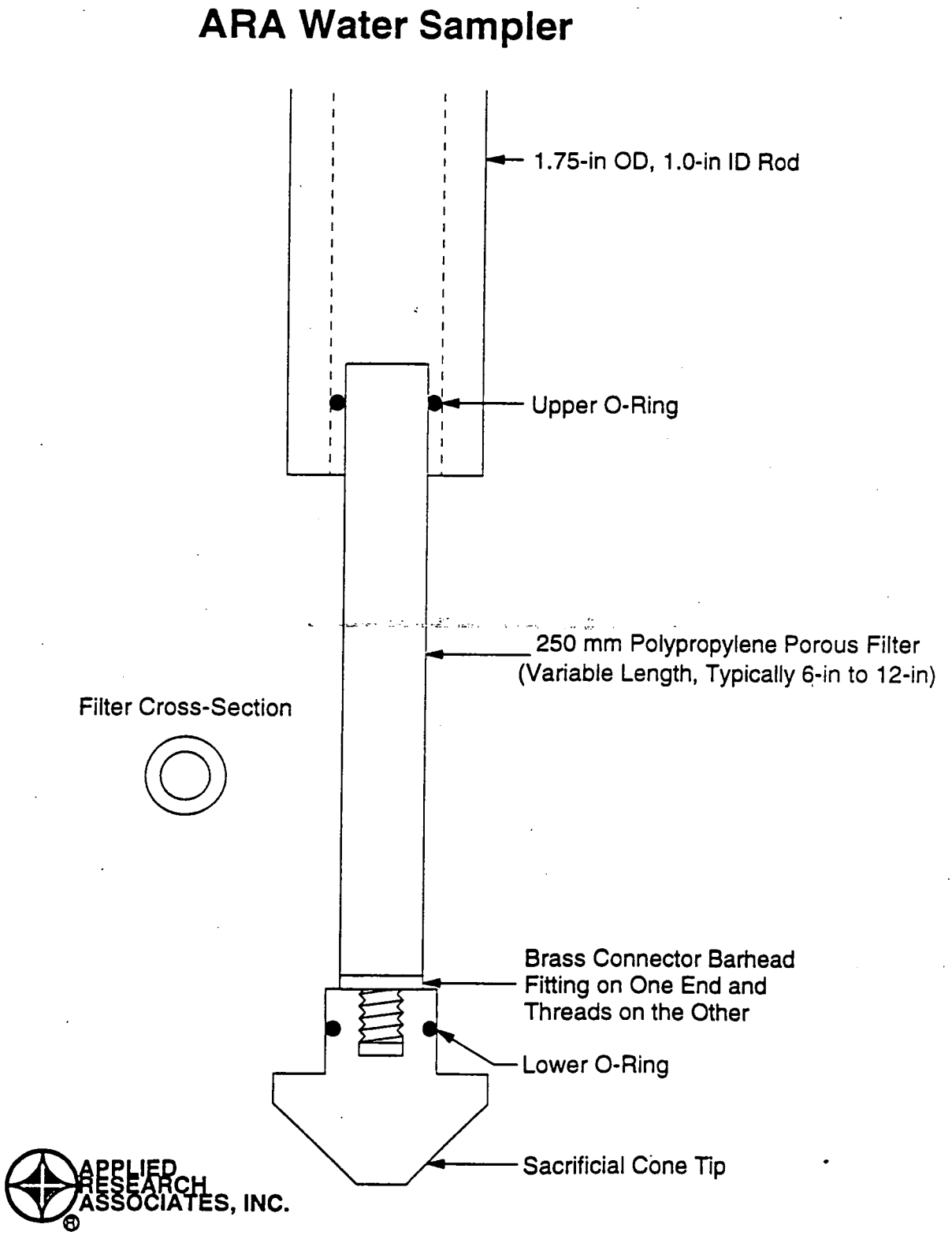


Figure 26. ARA's water sampler for use with 1.4- and 1.75-inch OD cone rods.

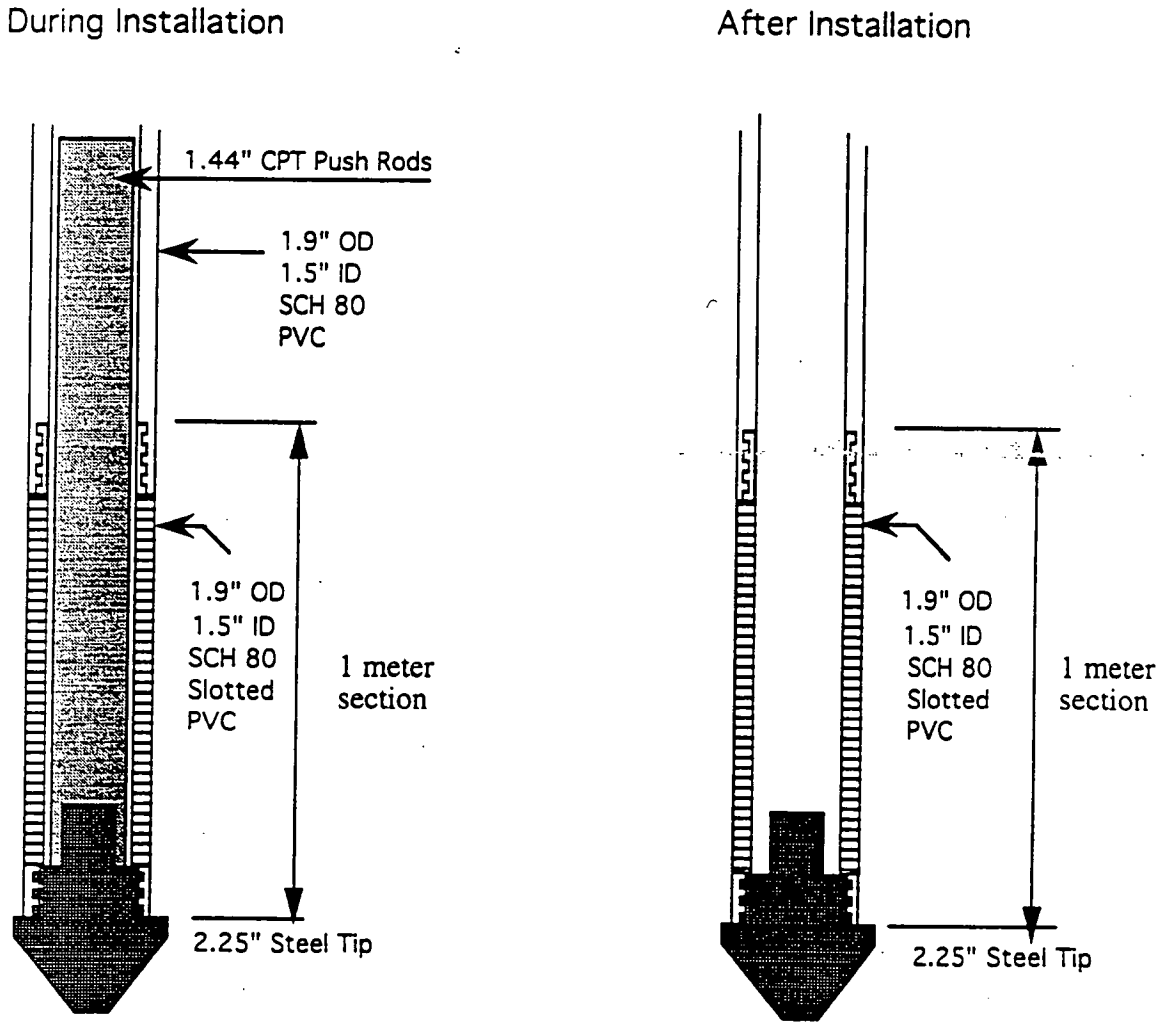


Figure 27. Schematic of direct push well installation technique.

microns. This porous plastic tube is located inside the screened PVC section and will only reduce the inner diameter of the well to 1.0 inch, allowing a small diameter bailer to reach the bottom of the well. The filter material is sealed to the screen to prevent short-circuiting. The second method that can be used is a sand pack. The sand pack is created by pouring sand down the center of the PVC well to fill up the volume of slotted section. This method is simple, but does not allow the full depth of the well to be sampled.

7.2 Grouted 1.5-Inch ID PVC Direct Push Well Installation

In cases where it is desired to grout PVC wells in place, a modification of the above installation technique can be used. The well point is assembled as shown in Figure 28. For this procedure a 3-inch oversized point is attached to a 2 foot section of 3-inch slotted steel well casing. A 1.5-inch ID slotted PVC section is inserted inside the steel casing and a sand pack is placed between the two members. The sand pack is followed by a 6-inch section of bentonite granules to seal in the sand pack. Approximately one foot above the bentonite, a steel grout injection port is clamped to the PVC riser pipes. This entire point assembly is pushed up into the guide tube and 1-meter sections of 1.5-inch ID PVC risers are attached. The entire assembly is inserted and pushed to the final depth using the CPT push rods. During the pushing cycles, grout is pumped through a hose to the injection port. This immediately fills the annulus created by the oversized well tip with grout, eliminating the possibility of the soil pinching off the annulus and creating an ungrouted zone.

Disadvantages of this installation method are that it cannot be pushed to as great depths as other methods, and it is slower.

7.3 CPT Push Rod Well Installation

ARA can also offer installation of temporary wells using CPT push rods. An ARA water sampler is pushed to the required depth and exposed to the media. If the well is to be left in place, the CPT truck will disengage from the well and a locking cap will be placed on the well. Water samples can either be bailed from the well using a ¾-inch diameter x 3-foot

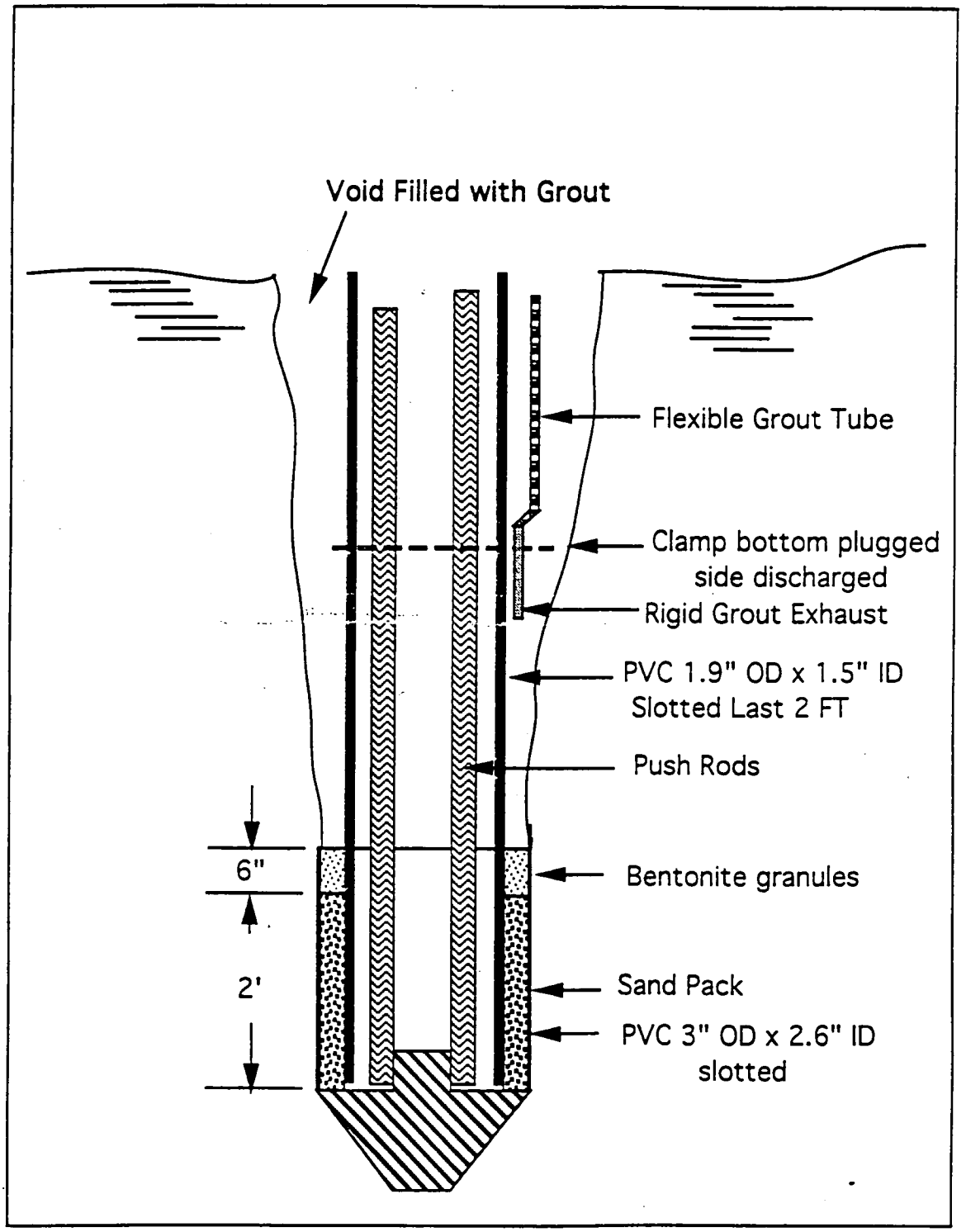


Figure 28. ARA grouted direct push CPT well point

long bailer, or water can be pumped from the well using a Solinst Model 403 double valve pump. A description and schematic of the pump are given in Table 3 and Figure 29. ARA routinely uses this technique to obtain water samples to depths as great as 180 ft.

Table 3. Description of Solinst pump.

Model	#403
Type	Double Valve
Size	Miniature, allows sampling from wells as small as ¾-in diameter
Advantages	• Excellent VOC results, comparable to bailer pumps • Easy decontamination • Portable

Well screen material can be slotted PVC, stainless steel, or porous filter material. The screening material is selected based on the requirements of the sampling protocol.

7.4 Deep Well Installation

For very deep well installations, ARA has developed a method for installing ½-in OD PVC pipe fitted with a slotted sampling section. A schematic of the installation method is shown in Figure 30. In this schematic, the 1.75-in diameter push rods are used to push a disposable tip down to the desired sampling depth. Attached to the tip is a PVC well screen. This well screen and additional riser sections are protected during the penetration by the CPT push rods. Once the desired depth has been obtained, the push rods are retracted, leaving the PVC well in place. This well is sampled using small diameter bailers manufactured by ARA and being used by ANL in York, Nebraska in conjunction with the Expedited Site Characterization program.

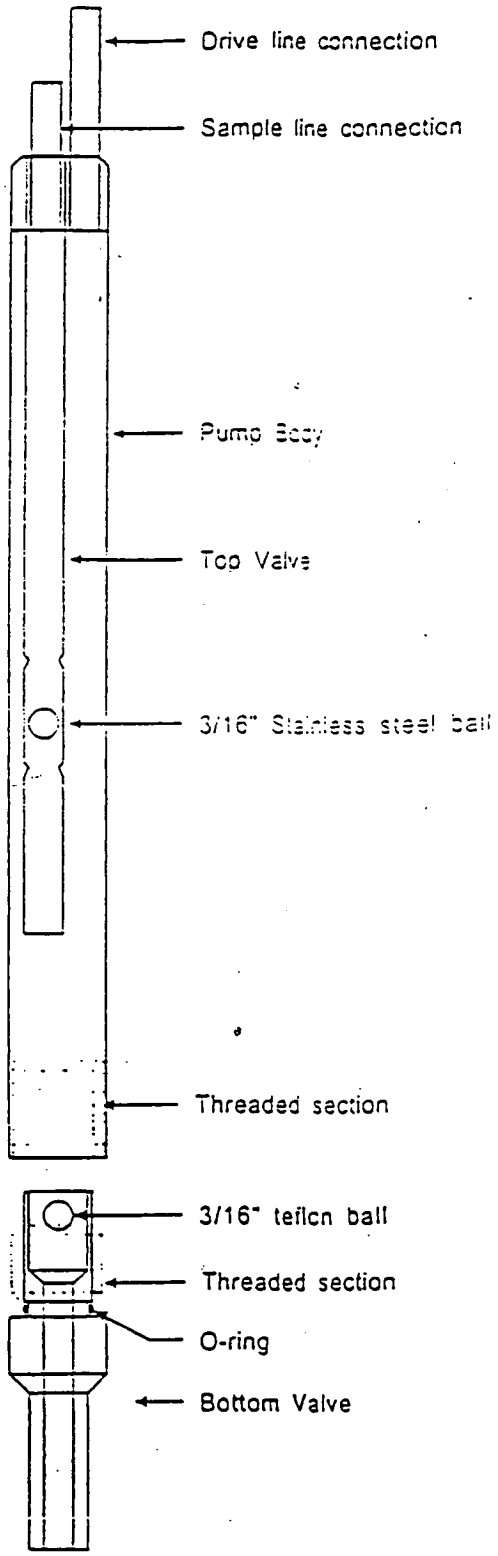


Figure 29. Schematic of a Solinst Model 403 double valve pump.

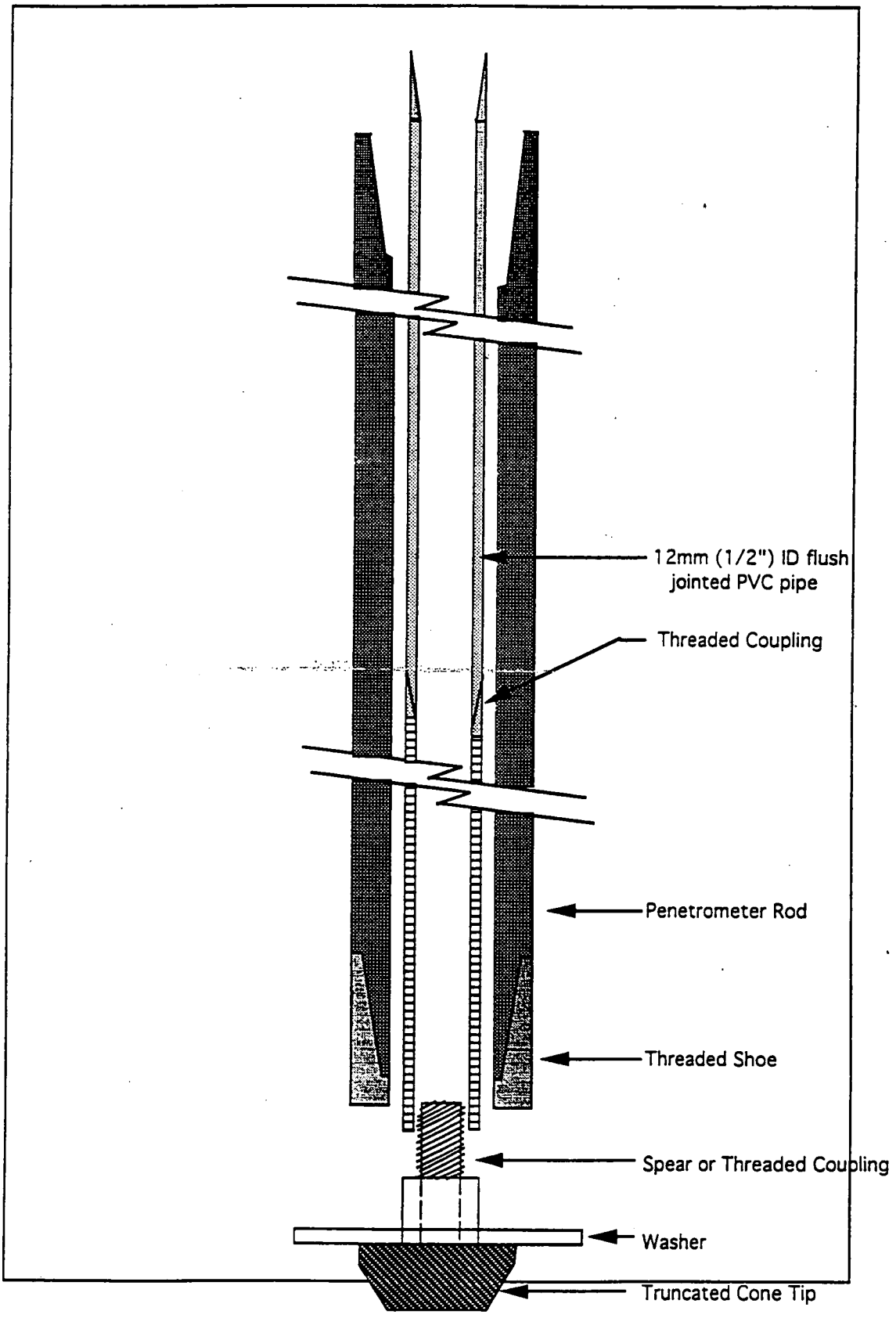


Figure 30. Schematic for installing deep monitoring wells using the CPT.

7.5 Soil Gas Sampling

To obtain soil gas samples ARA has designed a gas sampling module that is used in conjunction with the standard CPT. The soil gas is drawn into ¼-inch plastic tubing of the client's choice through the gas sampling module as shown in Figure 31. The soil gas is drawn up the plastic tubing under a vacuum and is collected in the client's choice of a sample container. Sample containers can be of any desired size since the CPT is stopped during the sampling process. Typical sample containers used in the past are Tevlar® bags, gas tight syringes, and glass or steel gas sampling vessels.

Soil gas monitoring can also be conducted during the pushing process to indicate the presence of gas contamination as a function of depth. To accomplish this, the gas stream is routed through gas monitoring equipment, such as a Bruel & Kjaer Multi-Gas Monitor. The gas monitoring equipment is highly useful in providing a real time measurement of the depth of contaminated soils, and in selecting appropriate depths for sampling. This eliminates many unnecessary non-detect samples. This sampler can be used with either ARA's CPT probe or as a stand alone sampler.

8.0 SOIL SAMPLING

ARA operates two different soil samplers. The MOSTAP® soil sampler was designed for use in soft to medium stiff soils and ARA has used this sampler in a variety of clays, sands, and silt materials to obtain soil samples. The volume of samples obtained with the MOSTAP® sampler is 1924 cc. ARA has modified the MOSTAP® sampler so that a slight vacuum can be drawn on the sample. This modification is only used on loose sands below the water table that are notoriously difficult to sample. The slight vacuum assists in retaining the sands in the soil sampler. If smaller samples are acceptable, then ARA uses the Gouda sampler, which obtains 95 cc samples. The Gouda sampler's main advantage is that it is more robust than the MOSTAP® and can be pushed into stiffer soils.

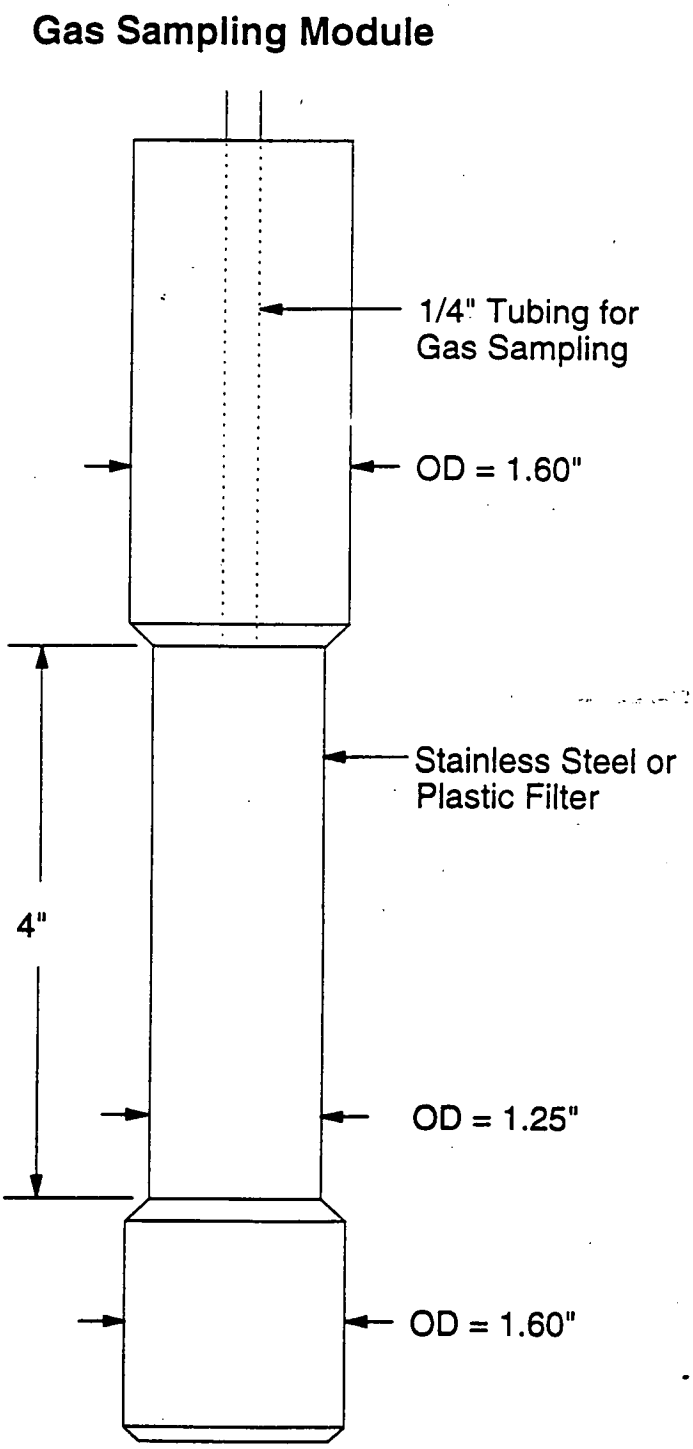


Figure 31. Soil gas sampling module for use with cone penetration testing.

9.0 CLEANING

Cleaning of all equipment upon exiting the hole is accomplished using a specialized CPT steam cleaning module located on the bottom of the guide tube. The sealed cleaning module washes all the rods as they pass into the guide tube with high temperature, high pressure water. The water is only applied to the rods when the rods are moving, which significantly reduces the amount of waste water generated. All waste water from the unit is captured by a vacuum unit and transferred into 55-gallon drum for containerization or local disposal. The drums are located on a support trailer and can easily be transported to proper storage area.

10.0 GROUTING OF SOUNDING HOLE

Grouting of probe holes is now generally required for environmental site investigations to prevent cross-contamination. ARA has developed and manufactures equipment for three different methods of grouting: a tremie method, a method of grouting from behind the instrument probe, and a method for grouting through the tip of the probe. All three methods use a conventional neat cement grout or a mixture of bentonite and cement. These are the commonly accepted grouts for use at environmental sites. The tremie method was developed to grout soil sampling holes, water sampling holes and penetrations performed with the 1.4 inch OD CPT push rods, which have insufficient room for an instrumentation cable and grouting tube. The tremie method employs a second push with a flexible grout tube strung through the push rods to a sacrificial tip.

The second self grouting method uses a sacrificial sleeve apparatus to protect the grout ports. Once a sounding is completed, the probe is withdrawn to expose the grout ports.

The third self grouting method disperses grout through the CPT probe body using a sacrificial mini tip. This system is designed to be used with a pore pressure gage and can be used to pump commonly accepted cement based grouts. The grouting system is incorporated

into the 1.75 in probe and supplies grout through the tip of the probe during instrument retrieval. The tip on this unit is spring loaded such that cycling can be performed to reach a desired depth. The tip portion is released using air pressure in the grout tubing. In all three methods, grout is pumped continually as the probe is withdrawn and the pressure and volume of grout pumped are monitored to insure that the penetration hole is properly sealed.

11.0 CALIBRATIONS

ARA performs calibrations on a daily or per hole basis as requested by the client and required by our QA plan. These calibrations are required, since many factors can effectively change the calibration factors used to convert the raw instrument readouts, measured in volts, to units of force or pressure. As a quality control measure, as well as a check for instrument damage, the load cells, the pressure transducer, and the resistivity sensor are routinely calibrated in the field using standard operating procedures. Calibrations are completed with the probe ready to insert into the ground so that any factor affecting any component of the instrumentation system will be included and detected during the calibration.

The tip and sleeve load cells are calibrated with the conical tip and friction sleeve in place on the probe. For each calibration, the probe is placed in the push frame and loaded onto a precision reference load cell. The reference load cell is periodically calibrated in ARA's laboratory against NIST traceable standards. To calibrate the pore pressure transducer, the saturated probe is inserted into a pressure chamber with air pressure supplied by the compressor on the truck. The reference transducer in the pressure chamber is also periodically calibrated against an NIST traceable instrument in ARA's laboratory. Additionally, the extensiometer, used to measure the depth of penetration, is periodically checked against a tape measure.

Each instrument is calibrated using a specially written computer code that displays the output from the reference device and the probe instrument in graphical form. During the calibration procedure, the operator checks for linearity and repeatability in the instrument output. At the completion of each calibration, this code computes the needed calibration

factors using a linear regression algorithm. In general, each probe instrument is calibrated at the beginning of each day of field testing. Furthermore, the pressure transducer is recalibrated each time the porous filter is changed and the cone is resaturated. Calibrations are also performed to verify the operation of any instrument if damage is suspected. In addition, ARA periodically performs post-calibration after a sounding to ensure the instruments are operating the same as prior to the penetration test

12.0 HEALTH & SAFETY PLAN (HSP) DEVELOPMENT

ARA has developed a Health & Safety plan (HSP) that we use in conjunction with the client's HSP to develop the site specific HSPs required on each environmental CPT job. All of our field technicians and the engineers associated with our CPT operations are current in all required OSHA training. This training plus the extensive experience gained performing CPT investigations at hazardous sites throughout the United States gives us the background to ensure that our safety program is not only comprehensive, but just as important, is easily understood and is readily adopted by field personnel.

13.0 QUALITY ASSURANCE AND QUALITY CONTROL

ARA has specifically developed a CPT field and analysis quality control program for work on DOE sites. This program was approved for NQA level 1 work at the Savannah River Site. Table 4 is a listing of the syllabus for our approved program.

14.0 SUMMARY

ARA has demonstrated capability to operate, manufacture and upgrade, as required, truck mounted cone penetrometers and all associated probes, data acquisition systems, software and support equipment. We have over 12 years of experience conducting CPT investigations at sites located across the U.S. Over these years, ARA has conducted over 153,000 ft of penetration testing. A list of CPT investigations we have conducted is given in Table 5. A significant portion of this work has advanced development of improved

technologies, making us uniquely qualified to tackle many tough problems and develop innovative solutions that reduce time and cost while improving the results. In addition, ARA offers numerous manufacturing services for developing unique or specially designed tools for CPT operations.

Table 4. ARA CPT Quality Assurance Manual Outline

APPLIED RESEARCH ASSOCIATES, INC.
CONE PENETRATION TESTING
QUALITY ASSURANCE MANUAL

INDEX AND STATUS

Section	Title	Rev. No.	Date
I.	Quality Assurance Program	1	1/28/94
II.	Organization	0	1/20/93
III.	Design Control	0	1/20/93
IV.	Procurement Document Controls	0	1/20/93
V.	Instruction, Procedures and Drawings	1	1/28/94
VI.	Document Control	0	1/20/93
VII.	Control of Purchased Material, Equipment and Services	0	1/20/93
VIII.	Identification & Control of Materials, Parts and Components	0	1/20/93
IX.	Control of Special Processes	0	1/20/93
X.	Inspection	0	1/20/93
XI.	Test Control	0	1/20/93
XII.	Control of Measuring and Test Equipment	1	1/28/94
XIII.	Handling, Storage and Shipping	0	1/20/93
XIV.	Inspection, Test and Operating Status	0	1/20/93
XV.	Nonconforming Materials, Parts or Comp.	1	1/28/94
XVI	Corrective Action	0	1/20/93
XVII.	QA Records	1	1/28/94
XVIII.	Audits	1	1/28/94
XIX.	Software Quality	0	1/20/93
APPENDIX A - Definitions		0	1/20/93

Table 5. ARA's Client List

ARA NO.	AWARD DATE	CLIENT	LOCATION	NO. TESTS	FOOTAGE
544	Jun-82	DNA	NTS	34	2197
569	Feb-85	LIVERMORE LAB	NTS	15	35
5951	Apr-95	AFWL	Yuma, AZ	25	1041
5951	Jun-85	AFWL	Yuma, AZ	21	1039
5951	Jul-85	AFWL	Yuma, AZ	4	285
5951	Oct-85	AFWL	Yuma, AZ	25	1055
5951	Nov-85	AFWL	Yuma, AZ	4	147
5998	Apr-86	WES	Ft. Knox, KY	8	326
5965	Jun-86	DNA	Ft. Knox, KY	23	594
5965	Jul-86	DNA	Ft. Knox, KY	29	741
5424	Jan-87	WES	Cofferdam, Ft. Knox, KY	30	772
5408	Jun-87	DNA	NTS (Soft Rock Penetrometer)	7	50
5454	Oct-87	BECHTEL	WSMR, NM	42	3747
5511	Jan-88	GOLDBERG	Dolan Plaza, Danbury, CT	5	196
5567	Jun-88	AFESC	Tyndall AFB, FL (Upheaval Reduction)	16	400
5514	Sep-88	WES	WSMR, NM (MISERS GOLD)	15	600
5515	Sep-88	HALEY & ALDRICH	Sherman Island, NY	11	343
5517	Sep-88	STOPEN ENGINEERING	Syracuse, NY (Carousel Mall)	5	676
5529	Nov-88	AFESC	Tyndall AFB, FL	7	83
5530	Nov-88	GOLDER ASSOC	Saltville, VA (Olin Corp. Waste Ponds)	28	1337
5536	Jan-89	VT ELECTRIC	Cape Cod, MA (Transmission Tower)	11	319
5537	Feb-89	WGI/GOLDBERG ZOINO	Warren, NJ (Ash Landfill)	8	806
5546	Mar-89	FLUOR DANIEL	ALTRESCO CoGen Plant, Pittsfield, MA	10	500
5558	May-89	VT ELECTRIC	Cape Cod, MA (Transmission Tower)	150	2355
5566	Jun-89	GUILD/METCALF & EDDY	Deer Island, Boston, MA	17	595
5573	Aug-89	WOODWARD-CLYDE	Fresh Kills Landfill, Staten Is., NY	43	2686
5583	Sep-89	MUESER RUTLEDGE	Coney Island WPCP, Brooklyn, NY	34	2524
5587	Oct-89	DNA	WSMR, NM (MIDNIGHT HOUR 2)	12	400
5656	Jan-90	GUILD DRILLING	S. Bypass, Boston Central Artery (BCA)	3	456
5657	Jan-90	GUILD DRILLING	S. Bay / Ft. Pt. Channel, BCA	13	1442
5607	Apr-90	GUILD DRILLING	Boston Harbor, MA	8	402
5612	May-90	GOLDBERG ZONIO	Chicopee, MA & Granby, CT	4	120
5613	May-90	HALEY & ALDRICH	Boston Gas Co., MA	12	335
5615	May-90	DNA	WSMR, NM	20	824
5615	May-90	WES	WSMR, NM	15	800
5617	Jun-90	WESTOVER DEVEL.	Chicopee, MA	25	1250

Table 5. ARA's Client List (continued).

ARA NO.	AWARD DATE	CLIENT	LOCATION	NO. TESTS	FOOTAGE
5621	Jun-90	HALEY & ALDRICH	BCA	8	976
5626	Sep-90	WESTINGHOUSE ENV.	SRS (K-,P-,L-Areas)	42	5681
5649	Nov-90	IT CORP	Arthur Kill, Staten Is., NY	17	1159
5660	Feb-91	LAW ENV.	SRS (New Production Reactor)	17	3577
5667	Mar-91	STONE & WEBSTER	BCA	52	2331
5684	May-91	ABB ENVIRONMENTAL	Plattsburgh AFB, NY	27	1565
5693	Jul-91	IT CORP	Fresh Kills Landfill, Staten Isl., NY	189	9118
5697	Jul-91	HALEY & ALDRICH	Manchester Airport, NH	14	393
5698	Jul-91	CDM	Pennsauken, NJ	4	32
5656	Aug-91	GUILD DRILLING	BCA	12	1259
5701	Aug-91	WGI	SRS (K-Reactor Soil Stabilization)	63	5919
5700	Sep-91	GEO-TECHNOLOGY	Aberdeen Proving Ground, MD	6	700
5713	Nov-91	WEHRAN ENVIROTECH	Simmonds Precision, Vergennes, VT	15	768
5716	Dec-91	SAIC	Ravenbrook Landfill, Carver, MA	21	1381
5717	Dec-91	MCPHAIL ASSOC.	MIT Biology Lab, Cambridge, MA	6	625
5722	Jan-92	WGI	East Brunswick Landfill, NJ	43	1751
5755	Jan-92	USDA	Nebraska	23	1055
5729	Apr-92	WGI	Chesapeake Bay, VA	11	1060
5690	May-92	AFESC	Salt Lake City, UT	36	1525
5735	May-92	USAF	AFSCAPS Tinker AFB, OK	120	1500
5737	Jun-92	DESERT RESEARCH INST.	Las Vegas, NM (EPA Resistivity Demo)	21	650
5727	Jun-92	SANTA ANA PUEBLO	Santa Ana Dam, Alb. NM	45	1673
5744	Jun-92	ANL	SRS (Resistivity)	30	4500
5732	Jul-92	MUESLER RUTLEDGE	New York, NY (USTA)	100	3230
5732	Jul-92	WGI/MUESER RUTLEDGE	Long Island, NY (USTA)	100	2643
5740	Jul-92	ABB ENVIRONMENTAL	Brunswick, NAS, ME	22	2075
5749	Jul-92	WESTINGHOUSE HANFORD	Hanford, WA	30	1467
5751	Jul-92	EBASCO	SRS	9	1101
5770	Aug-92	SAIC	San Diego, CA	3	400
5759	Sep-92	EBASCO	SRS, S. Carolina	41	3012
5769	Oct-92	EBASCO	SRS, S. Carolina	31	3591
5777	Nov-92	IT CORPORATION	Charlestown, RI	26	316
5779	Dec-92	S&ME	Charleston, SC	3	340
5769	Jan-93	EBASCO	SRS, S. Carolina	13	1873
5755	Jan-93	USDA	Lincoln, Nebraska	16	1169
5769	Jan-93	EBASCO	SRS, S. Carolina	13	2085

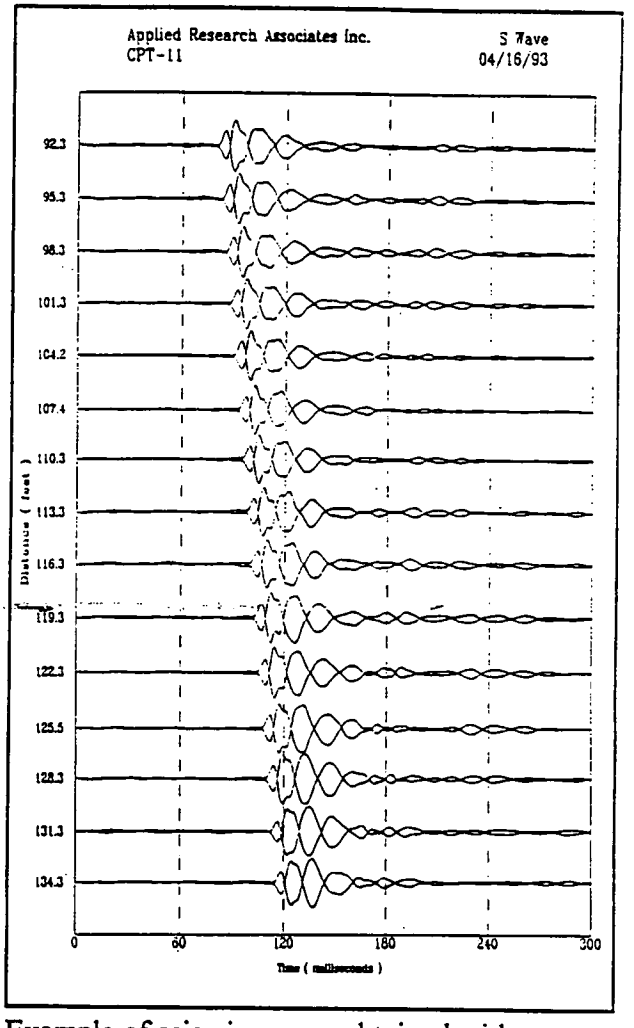
Table 5. ARA's Client List (concluded).

ARA NO.	AWARD DATE	CLIENT	LOCATION	NO. TESTS	FOOTAGE
5782	Jan-93	GEI CONSULTANTS	Plymouth, MA	25	815
5769	Feb-93	EBASCO	SRS, S. Carolina	4	739
5787	Feb-93	CC JOHNSON & MALHOTRA	Minden, NV	27	535
5803	Mar-93	ARGONNE NATIONAL LABS	York, Utica and others, NB (multi-sites)	247	16816
5813	Apr-93	WESTINGHOUSE	Hanford/Richland, WA	112	5632
5829	Jun-93	WARREN GEORGE	Linden, NJ	37	641
5848	Jul-93	SHANNON & WILSON	Hanford/Richland, WA	4	195
5850	Jul-93	SAIC	NAS Coronado, CA	120	14420
5851	Aug-93	ARGONNE NATIONAL LABS	Hanford/Richland, WA	19	225
5852	Jul-93	JACOBS ENGINEERING	NAF El Centro, CA	51	1556
5858	Oct-93	MORRISON KNUDSEN	McColl Superfund Site, Fullerton, CA	125	3068
5868	Oct-93	US AIR FORCE	AFB Plattsburgh, NY	48	2102
5869	Oct-93	MCPHAIL ASSOCIATES	Boston, MA (Third Harbor Tunnel)	6	698
5875	Oct-93	METCALF & EDDY	SRS, S. Carolina	6	602
5877	Oct-93	STEVENS ENGINEERING	Tucson, AZ	7	249
5891	Jan-94	SOUTHERN SERVICES CO.	Wetumpka, AL (Bouldin Dam Project)	3	135
			TOTAL	2,780	152,406

APPENDIX A

SHEAR AND COMPRESSION WAVE DOWNHOLE SURVEYS USING ARA'S HYDRAULIC SEISMIC HAMMER SYSTEM

The seismic cone penetrometer system has been used extensively through the late 80s and early 90s. A seismic downhole survey is conducted using the CPT seismic probe. ARA uses a triaxial gage configuration to conduct both shear and compression wave surveys. Typically a seismic source such as a heavy hammer is used to generate a signal. To generate horizontal shear waves a plank is struck with a sledge hammer or in the case of ARA's early system, hammers attached to the side of the truck which acted like pendulums. While these systems worked reasonably well, the signals were not always repeatable and could only be used to measure arrival times. ARA has been conducting research to determine seismic damping (which is used to predict earthquake inducted ground motions around structures) from the CPT. As a part of this research we have developed a hydraulic hammer system housed in the front support pad of the truck. The system consists of a three hundred pound lead and steel double acting hammer that is activated by a hydraulic ram. A rapid opening valve is used to control the system. The speed at which the hammer is fired and the resulting impact energy can be pre-selected by the operator. Benefits of this system include a repeatable signal and greatly reduced operator fatigue. An example plot or polarized shear waves measured at a site in South Carolina is shown. We have also developed a hydraulic hammer system to generate high frequency (150 Hz) compression waves. This system is also automated.



Example of seismic waves obtained with ARA's hydraulic shear hammer system.

APPENDIX C: NJDEP FIELD SAMPLING PROCEDURES

(SEE HNUS RI WORK PLAN)

APPENDIX D: HEALTH AND SAFETY PLAN ADDENDUM

(SEE HNUS RI WORK PLAN FOR ORIGINAL HASP)

HEALTH AND SAFETY PLAN ADDENDUM
FOR
NAVAL WEAPONS STATION, EARLE
COLTS NECK, NEW JERSEY

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) PROGRAM

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop NO. 82
Lester, Pennsylvania 19113-2090

Submitted by:
Brown & Root Environmental
A Division of Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Contract No. N62472-90-D-1298
Contract Task Order 0231

SEPTEMBER 1996

PREPARED BY:

MICHELLE F. GILLIE, CIH
HEALTH AND SAFETY MANAGER
BROWN & ROOT ENVIRONMENTAL

APPROVED BY:

MATTHEW M. SOLTIS, CSP, CIH
CLEAN HEALTH AND SAFETY MANAGER
BROWN & ROOT ENVIRONMENTAL

SITE-SPECIFIC TRAINING DOCUMENTATION
HEALTH AND SAFETY PLAN ADDENDUM
for
REMEDIAL INVESTIGATION ADDENDUM FOR 7 SITES
at
NAVAL WEAPONS STATION, EARLE
COLTS NECK, NEW JERSEY

My signature below indicates that I am aware of the potential hazardous nature of performing specific tasks within the Work Plan for Remedial Investigation Addendum for 7 Sites at Naval Weapons Station, Earle, Colts Neck, New Jersey and that I have reviewed the HASP and associated addendum and have received site-specific training which included the elements contained therein.

I further state that I have been given the opportunity to ask questions and that all of my questions have been answered to my satisfaction.

Name	Signature	Date

The following information represents modifications to the Health and Safety Plan for the Naval Weapons Station, Earle, Colts Neck, New Jersey, June 1995. These modifications have been generated to address additional sampling activities at 7 of the original 27 sites, as presented in the Work Plan for Remedial Investigation Addendum for 7 Sites at Naval Weapons Station, Earle, Colts Neck, New Jersey. This document will be incorporated as an addendum to the aforementioned Health and Safety Plan (HASP). This addendum addresses the additional tasks at each of the seven sites (Sites 3, 6, 12, 13, 16, 17 and 26) associated with this scope of work. No new chemical or physical hazards have been identified since the sampling activities remain essentially the same; only the locations of the sampling are changed.

The following sections of the final HASP dated May 1994 are to be amended to include the information identified within the text of this addendum. It is the PM's responsibility to forward copies of this addendum to the field crew (Brown and Root Environmental and associated subcontractors) to be inserted into the field copies of the HASP. It is the FOL's responsibility to ensure that all members of the field crew review and understand the addendum. This will be accomplished through the Site-Specific Training. In addition to the review process, the final HASP (field copies) sections will be highlighted to indicate areas revised as a result of this addendum. The FOL will ensure all field crew members indicate, by signing a field team review sheet in the back of this document, they have reviewed the elements of this addendum, understand the requirements, and any questions they may have had, have been answered to their satisfaction.

Sections	1.0	INTRODUCTION
	2.0	SITE/PROJECT BACKGROUND
	3.0	SCOPE OF WORK
	13.0	EMERGENCY RESPONSE PLAN

The modifications of the individual sections are as follows:

SECTION 1.0 INTRODUCTION

Proposed Dates of Work: September 23 through December 31, 1996

Project Team:

NAME	RESPONSIBILITY
Russell Turner	Project Manager (PM)
TBA	Field Operations Leader (FOL)
TBA	Site Safety Officer (SSO)
Matthew M. Soltis, CSP, CIH	CLEAN Health and Safety Manager (HSM)

2.4.1 Site 3 Activities

Additional activities planned for Site 3 include:

- Sediment sampling
- Surface soil sampling

2.7.1 Site 6 (Landfill West of Normandy Road) Activities

Additional activities planned for Site 6 include:

- Soil/sediment sampling
- Surface water/sediment sampling

2.12.1 Site 12 (Battery Storage Area) Activities

Additional activities planned for Site 12 include:

- Surface soil (0-6 inches BGS) and subsurface soil (3-4 feet BGS) sampling

2.13.1 Site 13 (Defense Property Disposal Office Yard) Activities

Additional activities planned for Site 13 include:

- Hydropunch/Geoprobe sampling
- Groundwater sampling (depths of 15 -45 feet)

2.16.1 Site 16 (EPIC Site F - Roundhouse Area) Activities

Additional activities planned for Site 16F include:

- CPT profiling/induced fluorescence
- Monitoring well installation
- Groundwater sampling

2.17.1 Site 17 (Landfill) Activities

Additional activities planned for Site 17 include:

- Soil/sediment sampling
- Surface water/sediment sampling

2.23.1 Site 26 (Explosive Contaminants) Activities

Additional activities planned for Site 26 include:

- CPT Lithographic Profiling
- Groundwater sampling

2.28 BACKGROUND SAMPLING

Background/reference samples will be collected from two locations:

- Ware Creek marsh reference stations surface water and sediment samples
- Railroad bed ballast slag sampling

SECTION 3.0 SCOPE OF WORK

Subsurface Investigations will include Cone Penetrometer Testing (CPT) for soil and groundwater investigations. The procedure is similar to Hydropunch or Geoprobe methods for well installation and monitoring.

SECTION 13.0 EMERGENCY RESPONSE PLAN

13.9 EMERGENCY CONTACTS

Emergency Reference Information is modified to include current project team and Navy personnel.

EMERGENCY REFERENCE
Naval Weapons Station, Earle

Fire, police and ambulance	1-908-866-2333
Poison Control Center	1-800-962-1253
National Response Center	1-800-424-9300
Chemtrec	1-800-424-9300
Hospital- Riverview Hospital	1-908-741-2700
NJDEPE 24-Hour Emergency	1-609-292-7172
Base Contact: Greg Goepfert	1-908-866-2515
Project Manager: Russell Turner	1-610-971-0900
CLEAN Health and Safety Manager: Matthew Soltis, CSP, CIH	1-412-921-8912
Regional Health and Safety Manager: Michelle F. Gillie, CIH	1-610-971-0900
Site Safety Officer: TBA	onsite

13.10 EMERGENCY ROUTE TO HOSPITAL

The procedure is to call the Naval Weapons Station, Earle Fire Department at 1-908-866-2333. They will dispatch First Aid.

The directions to the nearest local hospital, Riverview Hospital in Red Bank, New Jersey, are as follows:

- Proceed North on Naval Weapon Station Earle's Normandy Road.
- Take right on to West Front Street.
- Proceed on West Front Street, past the intersection with Broad Street, Red Bank.
- Take left on to North Washington Street directly leading to emergency room entrance.
- Estimated trip time : 20 minutes.

See map below for route to Riverview Hospital.

APPENDIX E: QUALITY ASSURANCE PROJECT PLAN

Appendix E
Quality Assurance Project Plan
Remedial Investigation Addendum
Work Plan

for

Naval Weapons Station (NWS) Earle

Colts Neck, New Jersey

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0231

September 1996

APPENDIX E
REMEDIAL INVESTIGATION ADDENDUM
QUALITY ASSURANCE PROJECT PLAN
FOR
NAVAL WEAPONS STATION EARLE
COLTS NECK, NEW JERSEY

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

Submitted by:
Brown & Root Environmental
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0231

SEPTEMBER 1996

SUBMITTED BY:

RUSSELL TURNER
PROJECT MANAGER
BROWN & ROOT ENVIRONMENTAL
WAYNE, PENNSYLVANIA

APPROVED FOR SUBMISSION BY:

DAVID YESSO
QUALITY ASSURANCE MANAGER
BROWN & ROOT ENVIRONMENTAL
PITTSBURGH, PENNSYLVANIA

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1.0 PROJECT DESCRIPTION

As requested by the U.S. Navy, Brown & Root (B&R) Environmental has prepared this Quality Assurance Project Plan (QAPP) for a field investigation being performed in support of an Remedial Investigation (RI) Addendum at the Naval Weapons Station (NWS) Earle, Colts Neck, New Jersey. The RI Addendum addresses additional activates at seven of the 27 sites investigated by B&R Environmental during the RI. The seven sites being investigated at NWS Earle include the following:

Site 3 - Landfill Southwest of "F" Group
Site 6 - Landfill West of Normandy Road
Site 12 - Battery Storage Area
Site 13 - Defense Property Disposal Office yard
Site 16 - EPIC Site F (Roundhouse Site)
Site 17 - Landfill
Site 26 - Explosive "D" Washout Area

B&R Environmental has established quality assurance/quality control (QA/QC) measures and a program to ensure that these measures are applied to the collection and interpretation of all environmental quality data at the facility. The QAPP is designed to assure that the precision, accuracy, representativeness, comparability, and completeness (the PARCC parameters) of the data are known, documented, and adequate to satisfy the data quality objectives of the study.

This plan presents the policies, organization, objectives, data-collection activities, and QA/QC activities that will be utilized to ensure that all data collected during, and reported by, this study are representative of existing conditions. Chemical analyses will be conducted by a laboratory subcontractor. The laboratory will have prior Naval Facilities Engineering Service Center (NFESC) approval. QA/QC procedures for the chemical analyses will satisfy NFESC. These requirements are detailed in the NFESC guidance document, "Navy Installation Restoration Laboratory Quality Assurance Guide", dated February 1996.

2.0 FIELD INVESTIGATION SCOPE OF WORK

The field investigation will be performed to support the RI Addendum activities B&R Environmental is conducting at seven sites at NWS Earle. The field investigation will be performed to obtain representative data capable of clearly defining conditions at each of these sites. Descriptions of these seven sites, including physical features and site history, are provided in Section 1.0 of the Work Plan Addendum. A summary of previous investigations conducted at all 27 sites, which includes a summary of existing analytical data, is also presented in Section 1.0. Details of the field investigation, such as the approach, selection of sampling locations, and sample collection activities, are found in Sections 2.0 and 3.0 of the Work Plan Addendum.

3.0 SAMPLE MATRICES, PARAMETERS, AND FREQUENCY COLLECTION

As part of the field investigation being performed in support of the RI/FS, environmental samples will be collected from the following matrices: soil, surface water, sediment, and groundwater. A listing of the sample matrices, parameters, and number of samples being collected is found in Table 3-1 of the Work Plan Addendum. Sampling protocols to be used during this field investigation are provided in Section 6.0 of this QAPP. As required by NFESC, a sampling rationale is included in Sections 2.0 and 3.0 of the Work Plan.

Table 3-2 of the Work Plan presents a summary of the sample containers, preservatives, and allowable holding times required for the analyses requested for the field investigation at the aforementioned seven sites.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

B&R Environmental will be responsible for the overall management of the project, including all field sampling activities. Personnel from the Navy will support B&R Environmental in a number of areas during the project.

4.1 PROJECT ORGANIZATION

The key firms and personnel involved in the RI, as well as the chain-of-communication and responsibility of the project personnel, are as follows:

Northern Division
Naval Facilities Engineering Command
10 Industrial Highway
Lester, Pennsylvania 191 13-2090
(215) 595-0567

John Kolicius (Code 1821)
Remedial Project Manager

Site Point of Contact
Public Works Department
NWS Earle
Colts Neck, New Jersey

Mr. Greg Geopfert
Facility Point of Contact

Brown & Root Environmental
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710
(610) 971-0900

John J. Trepanowski, P.E., Program Manager
Michael Turco, P.E., Deputy Program Manager
Russell Turner, Project Manager

Brown & Root Environmental
Foster Plaza VII
661 Anderson Drive
Pittsburgh, Pennsylvania 15220
(412) 921-7090

David Yesso, Quality Assurance Manager
Matt Soltis, Health and Safety Officer

The Project Manager has the primary responsibility for project and technical management of this project. He is responsible for the coordination of all onsite personnel, and for providing technical assistance for all activities that are directly related to the project. If quality assurance problems or deficiencies requiring special action are identified, the Project Manager, Deputy Program Manager, and Quality Assurance Manager will identify the appropriate corrective action.

4.2 FIELD ORGANIZATION

The B&R Environmental field investigation team will be organized according to the activity planned. For onsite sampling, the sampling team members will be selected based upon the type and extent of effort required. The team will consist of a combination of the following personnel:

Field Operations Leader (FOL)
Field Hydrogeologist/Geologist

The FOL will be responsible for the coordination of all onsite personnel and for providing technical assistance when required. The FOL, or his or her designee, will coordinate and be present during all sampling activities and will assure the availability and maintenance of all sampling materials/equipment. The FOL will be responsible for the completion of all sampling and chain-of-custody documentation, and will assume custody of all samples and ensure the proper handling and shipping of samples.

The FOL will also be responsible for providing technical supervision of the drilling subcontractor and for maintaining a geologic log of all borings drilled. Copies of the forms to be used in this investigation are provided in Appendix A of the Work Plan.

The Quality Assurance Manager (QAM), although not formally part of the field team, will be responsible for the adherence to all QA/QC guidelines as defined in this QAPP. Strict adherence to these procedures is critical to the collection of acceptable and representative data.

A site health and safety officer will be designated prior to field activities and will be responsible for assuring that all team members adhere to the designated health and safety requirements.

5.0 QUALITY ASSURANCE OBJECTIVES

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide environmental monitoring data of known and acceptable quality. Specific procedures to be used for sampling, chain-of-custody, calibration of field instruments, laboratory analysis, reporting, internal quality control, audits, preventive maintenance, and corrective actions are described in later sections of this QAPP. The purpose of this section is to address the data quality objectives in terms of precision, accuracy, representativeness, completeness, and comparability (the PARCC parameters); quantitation and detection limits; field blanks; rinsate blanks; trip blanks; duplicates; and bottleware cleanliness.

5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and/or quantitative statements regarding the quality of data needed to support the decision making. The required data quality is defined by the intended use of the data and the PARCC parameters are used to measure data quality. The sampling rationale provided in the Work Plan explains the choice of sample locations and media that will supply information needed for the field investigation.

5.2 PARCC PARAMETERS

The quality of a data set is measured by certain characteristics of the data, namely the PARCC parameters. Some of the parameters are expressed quantitatively, while others are expressed qualitatively. The objectives of the project and the intended use of the data define the PARCC goals.

5.2.1 Precision

Precision characterizes the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for a sample under the same or similar conditions. Precision is expressed as a range (the difference between two measurements of the same parameter) or as a relative percent difference (the range relative to the mean, expressed as a percent). Range and Relative Percent Difference (RPD) values are calculated as follows:

$$\text{Range} = OR - DR$$

$$RPD = [(OR - DR) / [0.5\ (OR + DR)]] \times 100\%$$

where: OR = original sample result
DR = duplicate sample result

The internal laboratory control limits for precision are three times the standard deviation of a series of RPD or range values. RPD values may be calculated for both laboratory and field duplicates. RPDs for laboratory duplicates will be compared to the statistically established laboratory control limits as a QA check. Laboratory duplicates will be analyzed at the rate required by NFESC (contingent upon analytical method uses; usually one per twenty samples of like matrix.) Field duplicates will be collected for 10 percent of all samples collected, and will be evaluated using a maximum allowable 50 percent RPD for soil matrix samples and 35 percent RPD for aqueous matrix samples.

5.2.2 Accuracy

Accuracy is the comparison between experimental and known or calculated values expressed as a percent recovery (%R). Percent recoveries are derived from analysis of standards spiked into deionized water (standard recovery) or into actual samples (matrix spike or surrogate spike recovery). Recovery is calculated as follows:

$$\%R = E/T \times 100\%$$

where: E = experimental result
T = true value (theoretical result)
and T = $\frac{(\text{sample aliq.})(\text{sample conc.}) + (\text{spike aliq.})(\text{spike conc.})}{\text{Sample aliq.} + \text{spike aliq.}}$

Control limits for accuracy are set at the mean plus or minus three times the standard deviation of a series of %R values.

Accuracy for aqueous and solid samples will be evaluated by use of surrogate and matrix spikes. Out-of-criteria results will be reviewed for data applicability as a part of data validation. Accuracy for miscellaneous parameters analyses (such as Ammonia-as nitrogen, Nitrate/Nitrite, etc.) will be evaluated using laboratory control/check sample results.

5.2.3 Representativeness

All data obtained should be representative of actual conditions at the sampling location. The field investigation is designed so that the samples taken will present an accurate representation of actual site conditions. All sampling activities will conform to the protocols given in Section 6.0 of this QAPP. The use of NFESC-approved analytical protocols and data deliverables will ensure that analytical results and deliverables are representative, and both consistently performed and reported.

5.2.4 Comparability

Comparability will be achieved by utilizing standardized sampling and analysis methods and data reporting format. Both the analytical procedures and sample collection techniques selected will maximize the comparability of these new data to previous data. Additionally, consideration will be given to seasonal conditions and other environmental conditions that could influence analytical results.

5.2.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement program, compared to the total amount collected. For relatively clean, homogeneous matrices, 100 percent completeness is expected. However, as matrix complexity and heterogeneity increase, completeness may decrease. Where analysis is precluded or where DQOs are compromised, effects on the overall investigation must be considered. Whether any particular sample is critical to the investigation will be evaluated in terms of the sample location, the parameter in question, the intended data use, and the risk associated with the error.

Critical data points may not be evaluated until all the analytical results are evaluated. If in the evaluation of results if becomes apparent that the data for a specific medium are insufficient (completeness <95 percent) either with respect to the number of samples or an individual analysis, resampling of the deficient data points may be necessary.

5.3 QUANTITATION LIMITS

Quantitation limits are those required as Contract Required Quantitation Limits (CRQLs) for organic analytes and Contract Required Detection Limits (CRDLs) for inorganic (metal) analytes per the current CLP SOWs, with allowances for dilutions and dry weight conversions.

5.4 DETECTION LIMITS

Instrument Detection Limits (IDLs) for metals analytes are reported quarterly under CLP protocol. The quarterly IDLs applicable at the date of analysis will be supplied in each inorganic data package.. IDLs must be less than or equal to CRDLs. The laboratory continuously monitors the Method Detection Limits (MDLs) for organic analyses. The most current MDLs for each fractional analysis method used will be reported by the laboratory in each organic data package.

5.5 FIELD BLANKS

Field blanks are obtained by sampling the water(s) used in decontamination during the field investigation. Samples consist of analyte-free and potable water used for decontamination of sampling equipment. Field blanks will be used to confirm the effectiveness of decontamination procedures and to determine whether the analyte-free water may be contributing to sample contamination. Field blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event. Field blanks will be analyzed, as applicable, for all parameters analyzed for under this investigation.

5.6 EQUIPMENT RINSATE BLANKS

Equipment rinsate blanks are obtained under representative field conditions by running analyte-free water through sample collection equipment (trowel, hand auger, corer, etc.) after decontamination and placing it in the appropriate sample containers for analysis. Equipment rinsate blanks will be used to assess the effectiveness of decontamination procedures. Equipment rinsate blanks will be collected for each type of non-dedicated sampling equipment used and will be submitted at a frequency of one per day per media. Equipment blanks will be analyzed from every day. Rinsate blanks to be "held" by the laboratory will be indicated as such on the Chain-of-custody Form. It will be the responsibility of the Project Manager to communicate to the laboratory whether a held equipment blank is to be subsequently analyzed as stated above.

5.7 TRIP BLANKS

Trip blanks are included when analyzing for volatile organics and will be prepared and provided by the subcontractor laboratory. Trip blanks will remain with the sample containers at all times and are thus subjected to the same field conditions as the field samples. One trip blank will be included in every shipping or sample collection cooler that contains samples of volatile organics to be analyzed, regardless of sample matrix.

5.8 FIELD DUPLICATES

Field duplicates are two samples collected (1) independently at a sampling location in the case of groundwater or surface water; or (2) a single sample split into two portions in the case of soil or sediment. Duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Ten percent of all samples for each media shall be field duplicates. Duplicates shall be analyzed for the same parameters in the laboratory as their environmental sample counterparts. Twenty percent of field screening analytical samples (on-site GC) will be duplicated by fixed-based laboratory analysis.

5.9 BOTTLE WARE

NFESC requires specific bottleware cleaning procedures. Pre-cleaned bottles will be used at the NWS Earle sites. Pre-cleaned bottles will be provided by the subcontracted laboratory, who will also be responsible for providing the required certification.

6.0 SAMPLING PROCEDURES

6.1 SITE BACKGROUND

The site background information is provided in Section 1.0 of the Work Plan.

6.2 SAMPLING OBJECTIVES

The overall objective of the field investigation will be to characterize the nature and extent of contamination at the seven sites identified in Section 1.0 of the Work Plan Addendum.

6.3 SAMPLE LOCATION AND FREQUENCY

Soils, sediments, surface water, and groundwater samples will be collected during the field activities. These samples will be analyzed in accordance with NFESC methodology for target compound list (TCL) volatile organic compounds, pesticides, PCBs, semivolatile organic compounds, target analyte list (TAL) metals, cyanide, total organic carbon (TOC), biochemical oxygen demand (BOD 5-day), chemical oxygen demand (COD), total dissolved solids, TSS, percent moisture and solids, grain size, and turbidity. A list of the analytes, analytical method, containers, preservatives, and holding times is provided in Table 3-2 of the Work Plan Addendum.

The sampling program consists of the following activities. These activities are as follows and are described in detail in Sections 2.0 and 3.0 of the Work Plan.

Mobilization/Demobilization
Surface Soil and Subsurface Soil Sampling
Monitoring Well Construction, Installation, and Sampling
Surface Water/Sediment Sampling
Hydropunch Groundwater Sampling
Cone Penetrometry
Induced Fluorescence Delineation of Petroloeum Impacted Soils

6.4 SAMPLE DESIGNATION

The sample designations for the NWS Earle site are described in Section 3.0.

6.5 SAMPLE EQUIPMENT AND PROTOCOLS

The sampling equipment and protocols to be used are presented in Appendix B of the Work Plan.

6.6 SAMPLE HANDLING AND ANALYSIS

Sample handling and analysis are presented in Sections 5.0, 6.0, and 7.0 of this QAPP.

6.7 EQUIPMENT DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to and between drilling and sampling activities. This equipment includes drilling rigs, downhole tools, augers, and all sampling equipment.

6.7.1 Major Equipment

All downhole drilling equipment and sampling tools shall be steam cleaned prior to beginning work, between soil borings, any time the drilling rig leaves the site prior to completing a boring, and at the completion of the drilling program.

These decontamination operations will consist of washing the equipment using a high-pressure steam wash. All decontamination activities will take place at a location determined during mobilization. Additional requirements for drilling equipment decontamination can be found in HNUS (B&R Environmental) SOP GH-1.6: Section 5.

6.7.2 Sampling Equipment

All sampling equipment used for collecting samples will be decontaminated both prior to beginning field sampling and between samples. The following decontamination steps will be taken:

Alconox or liquinox detergent wash
Generous potable water rinse
Distilled or Deionized water rinse[1]
10 % Nitric acid rinse diluted with deionized water[2] (when sampling metals)
Distilled or Deionized water rinse
Acetone rinse (when sampling organics, pesticides or PCBS)
Total air dry (when sampling organics, pesticides or PCBS)
Distilled or Deionized water rinse (when sampling organics, pesticides or PCBS)
Wrap in aluminum foil.

Field analytical equipment such as pH, conductivity and temperature instrument probes will be rinsed first with analyte-free water, then with the sample liquid. All decontamination activities will be performed over a container, and fluids will be containerized for proper disposal.

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[1]NJDEPE may require specific lot numbers from containers or analytical verification that distilled or deionized waters meet specifications, therefore DI water lot numbers will be noted in the field notebook during sampling activities.

[2]When decontaminating carbon steel split-spoons the nitric acid rinse should be lowered to a concentration of 1% to reduce the possibility of leaching metals from the spoon itself.

7.0 SAMPLE CUSTODY

Sample custody procedures are designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. An example of the chain-of-custody form, which will be used during this investigation, is included in Appendix A of the Work Plan. A copy of the procedure is included in Appendix B.

Samples collected during the field investigation will be the responsibility of identified persons from the time they are collected until they, or their derived data, are incorporated into the final report. Stringent chain-of-custody procedures will be followed to document sample possession.

7.1 FIELD CUSTODY

The FOL, or his or her designee, is responsible for the care and custody of the samples collected until they are delivered to the analyzing laboratory or entrusted to a carrier.

Sample records will always be signed and dated.

Chain-of-custody sample forms will be completed to the fullest extent possible prior to sample shipment. They will include the following information: project name, sample number, time collected, source of sample and location, description of sample location, matrix, type of sample, grab or composite designation, preservative, type of analysis to be conducted, and name of sampler.

These forms will be filled out in a legible manner, using waterproof ink, and will be signed by the sampler. Similar information will be provided on the sample label, which will be securely attached to the sample bottle. The label will also include the general analyses to be conducted. In addition, sampling forms will be used to document collection, filtration, and preparation procedures. Copies of all forms used during field activities are provided in Appendix B of the
Work Plan.

7.2 TRANSFER OF CUSTODY AND SHIPMENT

The following procedures will be used when transferring custody of samples:

Samples will always be accompanied by a chain-of-custody record. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the

chain-of-custody record. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier). Upon arrival at the laboratory, internal sample custody procedures will be followed.

Prior to shipment to the laboratory for analysis, samples will be properly packaged. Individual custody records will accompany each shipment. Shipping containers will then be sealed for shipment to the laboratory. The methods of shipment, courier name, and other pertinent information, will be entered in the remarks section of the custody record.

All shipments will be accompanied by the chain-of-custody record identifying the contents. The original record will accompany the shipment; and a copy will be retained by the field sampler.

Proper documentation will be maintained for shipments by common carrier.

7.3 SAMPLE SHIPMENT PROCEDURES

The following procedures will be followed when shipping samples for laboratory analysis:

Samples requiring refrigeration will be promptly chilled with ice or Blue Ice to a temperature of 4 degrees C and will be packaged in an insulated cooler for transport to the laboratory. Ice will be sealed in containers to prevent leakage of water. Samples will not be frozen.

Only shipping containers that meet all applicable state and Federal standards for safe shipment will be used.

Shipping containers will be sealed with nylon strapping tape, custody seals will be signed, dated, and affixed, in a manner that will allow the receiver to quickly identify any tampering that may have occurred during transport to the laboratory.

The field chain-of-custody document will be placed inside the shipping container in a sealed plastic envelope after the courier has signed the document.

Shipment will be made by a commercial courier or by the analytical laboratory pickup and delivery service. After samples have been collected, they will be sent to the laboratory within 24 hours.

7.4 FIELD DOCUMENTATION RESPONSIBILITIES

It will be the responsibility of the FOL to secure all documents produced in the field (geologist's daily logs,

lithologic and sampling logs, calibration forms, communications) at the end of each work day. Copies of all forms used during field activities are included in Appendix A of the Work Plan.

The possession of all records will be documented; however, only the project FOL or designee may remove field data from the site for reduction and evaluation.

8.0 CALIBRATION PROCEDURES

Field equipment such as the photoionization equipment (PID), the pH and specific conductance meters, and any other equipment used during this project will be calibrated and operated in accordance with the manufacturers instructions and manuals. A log will be kept documenting the calibration results for each field instrument. The log will include the date, standards, personnel, and results of the calibration. A copy of the calibration form used during the field investigation is included in Appendix A of the Work Plan. The SOP for calibration procedures is included in Appendix B of the Work Plan.

9.0 ANALYTICAL PROCEDURES

Environmental samples collected during the field investigation for chemical analyses will be analyzed using the appropriate analytical procedures as outlined in Section 3.0 and Table 3-1 of the Work Plan Addendum.

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting are basic steps in the control and processing of field and laboratory project-generated data. Data validation procedures are described below.

Data validation consists of a stringent review of an analytical chemical data package with respect to sample receipt and handling, analytical methods, data reporting and deliverables, and document control. The quality of data generated by a laboratory is extremely important; it is an integral part of the investigation and should be clearly tied to the project goals. Data used to develop qualitative trends, for example, will not have the same data validation requirements as data used for litigation purposes.

A qualified Brown & Root chemist will review the analytical data packages using method-specific quality control criteria, the quality control criteria set forth in the NFESC guidelines document, and the data validation protocols detailed in the National Functional Guidelines for Data Review. One hundred percent (100%) of the total number of environmental samples will be validated. After the data is validated, a listing of nonconformities will be generated and used to determine whether the data can be utilized for its intended purpose. Nonconformities require data qualifiers, which are used to alert the data user to inaccurate or imprecise data. For example, if holding times are exceeded, the data reviewer must qualify all associated positive results as estimated and all associated compound quantitation limits as estimated. Gross holding time exceedances (i.e., greater than 2 times the maximum allowance) result in the estimation of affected positive results and the rejection of affected sample quantitation limits. For situations in which there are several quality control criteria out of specification with regard to the quality control limits specified, the data validator may make professional judgments and/or comments on the validity of the overall data package. In situations where the validity of an entire data package is in question, it may be necessary for the sample(s) to be re-analyzed. The reviewer will then prepare a technical memorandum presenting changes in the data, if necessary, and the rationale for making such changes.

The net result is a data package that has been carefully reviewed for its adherence to prescribed requirements and suitability for its intended use. Data validation thus plays a major role in determining the confidence with which key technical evaluations may be made.

The final RI Addendum report will include a data summary. The summary of analytical data will exclude non-detected compounds. No subtraction of blanks will be allowed. Data will be flagged if blank contamination occurs. All data flags will follow the result in the summary.

The laboratory data for each sample will be reported in an appendix. These data will be presented in a spreadsheet format with all field quality control blanks marked. The format recommended by NEESA will

be used. Field forms may be included in another appendix.

11.0 INTERNAL QUALITY CONTROL CHECKS

Quality control samples generated by B&R Environmental will include the collection of field duplicates, the preparation of field blanks, and the preparation of equipment rinsate blanks. An approximate 10 percent duplication (one per 10 samples or one per sample matrix if less than 10 samples) will be collected. See Section 3.0 for the required number of sample duplicates.

As there are VOCs analyses to be performed, trip blanks will be prepared by the subcontracted laboratory for this investigation. Rinsates, prepared by running distilled water through the sampling equipment, will be analyzed to determine whether the sampling procedures may be biasing the data. Field blanks will be prepared at a rate of one per source per event. Procedures for collecting these samples are contained in the Section 6.0 of this QAPP.

In addition to the use of external quality control mechanisms such as those described above, various internal quality assurance mechanisms are also observed to ensure the production of analytical data of known and documented quality. The internal quality control procedures for the analytical services are specified under NFESC guidelines. These specifications include the types of control samples required (sample spikes, surrogate spikes, controls, and blanks), the frequency of each control, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria. It will be the laboratory's responsibility to document, in each package, that both initial and continuing instrument and analytical QC criteria are met. This documentation will be included in the data packages generated by the contracted laboratory.

Analytical results of field-collected quality control samples will also be compared to acceptance criteria, and documentation will be performed showing that criteria have been met. Any samples in nonconformance with the QC criteria will be identified and reanalyzed by the laboratory, as applicable. The following procedures will be employed for the NWS Earle samples:

Proper storage of samples.
Use of qualified and/or certified technicians.
Use of calibrated equipment.
Formal independent confirmation of all computation and reduction of laboratory data and results.
Use of standardized test procedures.
Inclusion of duplicate samples at a frequency of one duplicate per 10 samples or one per sample matrix if less than 10 samples are collected.

12.0 PERFORMANCE AND SYSTEM AUDITS

The overall responsibility for all matters affecting data quality lies with the Quality Assurance Manager. System audits will be performed by the QAM or designee as appropriate, to assure that the work is being implemented in accordance with the approved project standard operating procedures (SOPS) and in an overall satisfactory manner.

The FOL will supervise and check on a daily basis that field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and the field work is accurately and neatly documented.

The data validator will review (in a timely fashion) the data packages submitted by the laboratory. The data validator will check that the data was obtained through the approved methodology, that the appropriate level of QC effort and reporting was conducted, that holding times were met, and that the results are in conformance with the QC criteria. On the basis of these factors, the data validator will evaluate the data quality and limitations.

The project manager will oversee the FOL and (in conjunction with the QAM) the data validator. The project manager will check that management of the acquired data proceeds in an organized and expeditious manner.

System audits for the laboratory are conducted by NFESC on a regular basis as required.

A formal audit of the field sampling procedures may be conducted in addition to the auditing that is an inherent part of the daily project activities. If so conducted, the auditors will check that sample collection, sample handling, decontamination protocols, and instrument calibration and use are in accordance with the approved project SOPS. The auditors will also check that the field documentation logs and chain-of-custody forms are being filled out properly.

The subcontracted analytical laboratory must be either NFESC-approved or have worked for the Navy on a recent project, be eligible to perform the required analysis under NFESC protocols, and must have site-specific approval prior to commencement of work.

13.0 PREVENTIVE MAINTENANCE

B&R Environmental has established a program for the maintenance of field equipment to ensure the availability of equipment in good working order when and where it is needed. This program consists of the following elements:

- The equipment manager keeps an inventory of the equipment in terms of items (model and serial number), quantity, and condition. Each item of equipment is signed out when in use, and its operating condition and cleanliness checked upon return.

- The equipment manager conducts routine checks on the status of equipment and is responsible for the stocking of spare parts and equipment readiness.

- The equipment manager maintains the equipment manual library and trains field personnel in the proper use and care.of equipment.

- The FOL is responsible for working with the equipment manager to make sure that the equipment is tested, cleaned, charged, and calibrated in accordance with the manufacturers instructions and B&R Environmental SOPs before being taken to the job site and during field activities.

14.0 DATA ASSESSMENT PROCEDURES

14.1 REPRESENTATIVENESS, ACCURACY, AND PRECISION

All data generated in the investigation will be assessed for its precision, accuracy, and representativeness. The completeness of the data will also be assessed by comparing the validated data to the project objectives to see that these objectives are being addressed and met. The specific procedures used to determine data precision, accuracy, and completeness will be provided in the analytical reports. Accuracy will be determined using laboratory spiked samples and laboratory blanks.

The representativeness of the data will be assessed by determining whether the data are consistent with known or anticipated hydrogeologic or chemical conditions and accepted principles. Field measurements will be checked for completeness of procedures and documentation of procedures and results.

Precision and accuracy will be determined using duplicate samples and blank and spiked samples, respectively. The specific procedures for determining PARCC parameters are outlined in Section 5.0.

14.2 VALIDATION

One hundred percent of the analytical data packages for each media will be validated. Data validation procedures to be employed are detailed in Section 10.0 of this QAPP.

14.3 DATA EVALUATION

The evaluation of the data collected during the field investigation will be a comparison of chemical concentrations in the hydraulically upgradient groundwater wells versus the chemical concentration in the downgradient groundwater wells; chemical concentrations in groundwater versus ARARs (such as MCLs), and risk-based concentrations; and chemical concentrations in soils versus background and risk-based concentrations. Data from previous investigations will be included as part of the data evaluation.

15.0 CORRECTIVE ACTION

The QA program will enable problems to be identified, controlled, and corrected. Potential problems may involve nonconformance with the SOPs and/or analytical procedures established for the project or other unforeseen difficulties. Any person identifying an unacceptable condition will notify the project manager. The project manager, with the assistance of the Quality Assurance Manager, will be responsible for developing and initiating appropriate corrective action and verifying that the correction action has been effective. Corrective actions may include the following: resampling and/or reanalysis of sample, or amending or adjusting project procedures. If warranted by the severity of the problem (for example, if a change in the approved Work Plan is required), the Navy will be notified in writing and their approval will be obtained prior to implementing any change. Additional work that is dependent on a nonconforming activity will not be performed until the problem has been eliminated.

The laboratory will maintain an internal closed-loop corrective action system that operates under the direction of the laboratory QA coordinator.

16.0 QUALITY ASSURANCE REPORTS

The QA/QC Manager, or designee, will review all aspects of the implementation of this QAPP on a regular basis and may prepare a summary report. Reviews will be performed at the completion of each field activity, and reports will be completed. These reports will include an assessment of data quality and the results of system and/or performance audits. Any significant QA deficiencies will be reported and identified, and corrective action possibilities discussed. Other QA/QC reports are listed in Section 8.0.

17.0 REFERENCES

ASTM, March 1988. Annual Book of Standards - Soil and Rock, Building Stones; Geotextiles. Section 4, Volume 04.08.

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