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REMEDIAL INVESTIGATION WORK 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
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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) Number 0147. The overall scope of the CTO is to prepare a Remedial Investigation Work Plan addressing environmental investigation activities for 27 sites at Naval Weapons Station (NWS) Earle under the Navy's Installation Restoration Program (IRP). 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 located 10 miles inland. The two areas are linked by a narrow strip of land which provides a secure right-of-way for the government-owned road and railroad.

The objective of the Remedial Investigation (RI) will be to characterize the nature and extent of potential contamination at the sites 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 remediation of the sites. Sites determined to pose no significant threat to human health or the environment will be recommended for No Further Action (NFA) in order to concentrate RI efforts and funding on the expedient characterization and cleanup of sites where potential significant risk exist.

This document addresses 27 individual sites within and immediately adjacent to the NWS Earle. Twenty-one of the sites are associated with the Mainside and six are located at the Waterfront portion of the station. Twenty-five of the 27 sites have been included under previous investigations performed under the IRP. Two additional sites included within the scope of this RI were identified, and action requested by the United States Environmental Protection Agency (USEPA), on the basis of aerial photographic analysis performed for USEPA by the Environmental Photographic Interpretation Center (EPIC). No onsite investigation activities have been performed at these two sites under past IRP work.

Field activities addressed within this Work Plan include collection and analysis of samples from six environmental media within and adjacent to the sites. These media include surface soil, subsurface soil, surface sediment, groundwater, surface water, and subsurface soil vapors. Individual media selected for sampling at each of the sites has been proposed on the basis of the site's operational history, previous investigation findings, site physical features, and the presence of specific media at the site. 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 four background locations have been selected, including two within the Mainside and two in the vicinity of the Waterfront area.

RI activities at the sites will include installation of monitoring wells and soil borings, excavation of test pits, inspection of selected site areas for groundwater seeps and erosional features, and collection of surface media samples. Sixty-six soil borings are proposed to be completed during the investigation. Twenty-six of the soil borings will be converted to monitoring wells for collection of groundwater samples. An additional 59 monitoring wells installed during previous investigations will be sampled during the RI. A total of 92 subsurface soil samples will be collected from locations, which will include boreholes, shallow subsurface hand auger locations, and test pits. Surface sampling will include collection of 34 surface soil samples, 34 surface water samples, and 38 sediment samples. A total of 96 groundwater samples will be collected from 85 monitoring wells and 11 hydropunch locations. Soil gas surveys will be performed at three of the project sites and one sample will be collected to determine the contents of a partially filled drum.

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, explosives, total petroleum hydrocarbons, ammonia (nitrogen), biochemical oxygen demand, chemical oxygen demand, chloride, nitrate-nitrite, total organic carbon, phosphate, and sulfate. With the exception of the background samples, 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

Halliburton NUS Corporation, under Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Number N62472-90-D-1298, has been assigned to prepare a comprehensive Work Plan for 27 Remedial Investigation (RI) sites at Naval Weapons Station (NWS) Earle in accordance with the requirements of Task Order Number 0147. The work is being performed as part of the Navy's Installation Restoration Program (IRP), which was designed to identify environmental concerns at Navy and Marine Corps facilities, and to implement corrective measures if necessary.

IRP activities are typically performed in four distinct phases. Phase 1 consists of a Preliminary Assessment (PA). 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.

This Work Plan addresses RI activities at 27 sites located within and immediately adjacent to the NWS Earle. Twenty-five of the 27 sites have been investigated previously under PA and/or SI work. Two of the sites have not been addressed previously but are included within the current RI as a means of expediting investigation efforts and moving toward remedial action, if necessary, in a cost- and time-efficient manner.

The objective of the RI 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 for all site media. For the two sites which have not been previously investigated, samples will be collected to determine the presence or absence of contamination.

Sites addressed within the current RI Work Plan include 21 sites located within the Mainside and 6 sites in the Waterfront portion of the station. Relative site locations within the Mainside and Waterfront areas are shown on Figures 1-1 and 1-2, respectively. Note that the number of site areas where investigation activities will be performed under the scope of this RI have been reduced by combining Site 16 with EPIC Site F (due to overlapping site boundaries) and by combining Sites 24 and 25 (due to similar use and close proximity).

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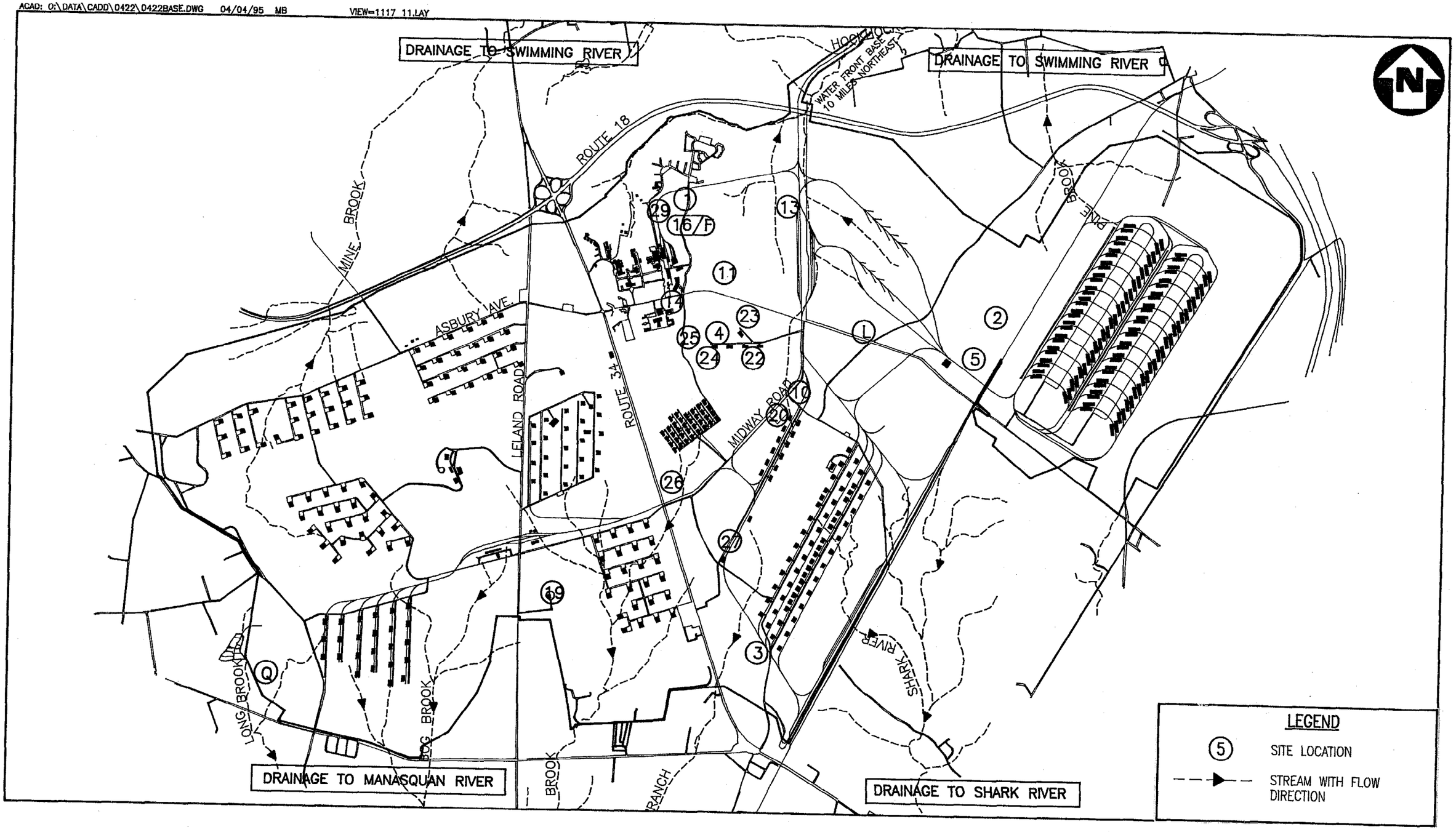

SITE LOCATIONS AND SURFACE DRAINAGE MAP

NAVAL WEAPONS STATION EARLE, NJ

0 3000 6000
SCALE IN FEET

FIGURE 1-1

Halliburton NUS CORPORATION

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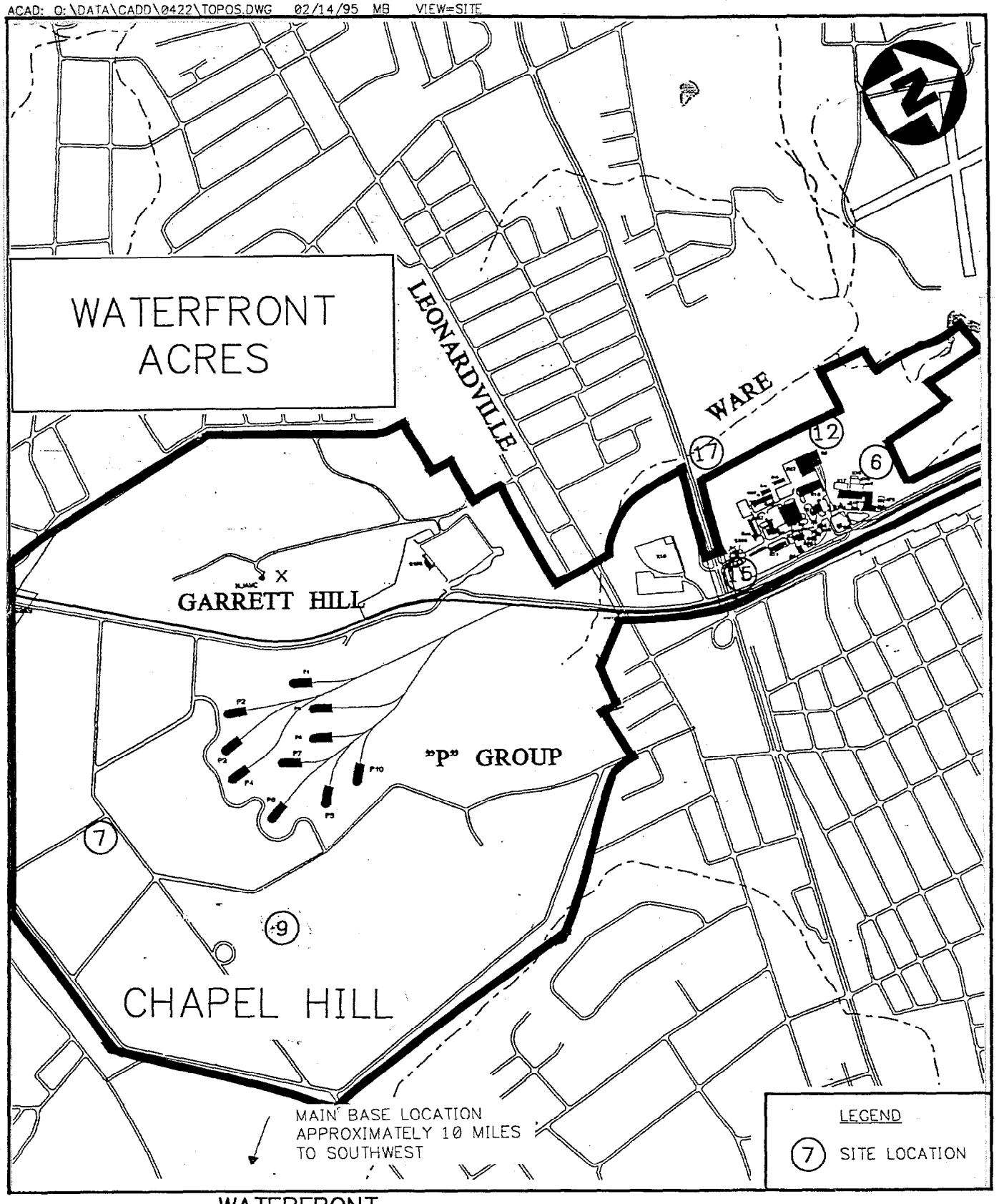


WATERFRONT
SITE LOCATIONS
NAVAL WEAPONS STATION, EARLE, NJ

0 1200 2400
SCALE IN FEET

FIGURE 1-2

Halliburton NUS CORPORATION

1.2 SITE DESCRIPTION

NWS Earle is located in Monmouth County, east-central New Jersey. The station is situated on approximately 11,134 acres which includes 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 which serves as a right-of-way for a government road and railroad. The main entrance to NWS Earle is located off of 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 caries out station-level maintenance of air and antisubmarine weapons and provides shore-based support to various commanders; and the Port Services Division 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 have been undertaken at the station since approximately 1982. Early work included an Initial Assessment Study (IAS) conducted by Fred C. Hart and Associates and the results are included in a report prepared in 1982. Studies and field investigation efforts have continued under the IRP by Weston. Several documents have been prepared by Weston under the IRP and were submitted to the Navy, New Jersey Department of Environmental Protection and Energy (NJDEPE) and the United States Environmental Protection Agency (USEPA). These documents include "Draft Report for Naval Weapons Station Earle, Colts Neck, New Jersey, Installation Restoration Program Phase II Confirmation Study" dated September 1986; "Draft Report of Current Situation and Draft Plan of Action" dated December 1988; and 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 report entitled "Installation and Restoration Program Remedial Investigations/Feasibility Study for 11 Sites at NWS Earle, Colts Neck, New Jersey, Volumes 1 to 3.

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 main portion of the station lies in the outer Coastal Plain, approximately 10 miles inland from the Atlantic Ocean. The area of the Mainside 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 consists of the 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 occupies a narrow strip of land running roughly perpendicular to the shoreline and serving as access from the ammunition depot (located 1 mile inland) to the Waterfront and associated piers. This thin strip of land consists primarily of tidal marsh and swamp with areas of fill and averages approximately 10 feet above msl (Weston, 1991).

The ammunition depot is located approximately 1 mile inland from the Waterfront and occupies a somewhat circular plot of land connected to the Waterfront by the thin strip of property described above. This portion of the station is known as the Chapel Hill area and lies within the Highland/Mt. Pleasant Hills. These hills form the drainage divide between the inner and outer coastal plains and result in the greatest topographic relief at NWS Earle (Weston, 1991).

1.2.4 Climate

The climate of NWS Earle varies somewhat between the Mainside and the Waterfront area due to the significant influence of the Atlantic Ocean on shorefront land. In general, however, the station (Monmouth County) climate may be described as fairly moderate with an annual precipitation of slightly over 45 inches. The average annual snowfall in Monmouth County is 25 inches. The distribution of precipitation is relatively uniform with approximately 50 percent of the moisture occurring during the 6-month period of April through September. The prevailing wind direction is from the south, with the highest average wind speed (11 miles per hour) occurring in the spring (USDA-SCS, 1989).

1.2.5 Surface Drainage

The Mainside lies within the headwaters of three Coastal Plain rivers. The northern portion of the station lies within the drainage basin of the Swimming River. The southwestern section of the Mainside drains toward the Manasquan River and the remainder of the station drains to the Shark River. Surface drainage is primarily by overland flow to small swales and tributaries which feed perennial streams, and swamps within the individual river drainage basins. Figure 1-1 shows the major drainages of the station.

Much of the Waterfront portion of the station is under tidal influence, with most surface drainage entering Sandy Hook Bay through Compton, Ware, and Wagner Creeks. A small section of the Chapel Hill area surface water drains through McClees Creek to the Navesink River.

1.2.6 Soils

The dominant soil characteristic at the NWS Earle station is a sandy, well drained soil having high iron and sulfur content. Some soils are typically acidic as a result of being formed by weathering of iron sulfide and coal-rich (lignite) sediments. Naturally developed soils having a pH value as low as 3.5 have been reported to have been observed at the station. Soils within the Mainside range from well-drained sandy material in upland areas to very poorly drained, floodplain soils found adjacent to streams and swamps. Soils in the Chapel Hill area are a generally well drained sandy to loamy sand material lacking flood plain deposits. No highly acidic soils have been reported in the Chapel Hill area. Waterfront area soils are predominantly characterized as tidal marsh soil, although significant areas of former tidal marsh have been altered and reclaimed by filling for development and sanitary landfill disposal (Weston, 1991).

1.2.7 Site Geology and Hydrogeology

The Atlantic Coastal Plain sediments (such as those underlying NWS Earle) provide the most important source of potable water in the region, supplying greater than 75 percent of the fresh water used in the New Jersey Coastal Plain. Recharge to the groundwater system occurs predominantly through infiltration of precipitation, leaking through confining beds, and from surface water bodies (Weston, 1991).

There are four sedimentary formations of the Coastal Plain physiographic province that outcrop within the area of the Mainside. Two of these, the Kirkwood and the Cohansey Sand, are grouped together and make up the Kirkwood-Cohansey aquifer system, a principal, local, unconfined source of potable water. The two additional formations outcropping at the Mainside include the Hornerstown Sand and the Vincentown Formation (Weston, 1991).

The youngest formation to outcrop at the Mainside is the Miocene-age Cohansey Sand. This formation is described as a light-colored, medium- to coarse-grained quartz sand which forms the topographically prominent Horniny Hills area of the station. Hydrogeologically, the formation is significant because it serves as a recharge zone for the underlying Kirkwood Formation (Weston, 1991).

The Miocene-age Kirkwood Formation consists of fine- to medium-grained quartz sand with lesser amounts of mica, lignite, and diatomaceous clay. The formation thickness ranges from approximately 30 feet near the station to approximately 800 feet near the Atlantic Coast. The particle distribution grades from fine-grained sand and silt updip (inland) to clay beds with fine sand stringers along the coast. The formation is an important aquifer, both regionally and locally, with yields ranging from 15 to greater than 1,000 gallons per minute (gpm). The formation is used locally for domestic wells and in other areas of the Coastal Plain for municipal water supplies (Weston, 1991).

Stratigraphically underlying the Kirkwood Formation (Eocene formations do not outcrop in the vicinity) at the Mainside is the Paleocene-age Vincentown Formation, which consists of a fossiliferous quartz sand containing some coarse-grained glauconite and clay. An upper limey sand contains abundant fossils. The formation is up to 130 feet thick at the Mainside and is an important source of water for domestic wells, with an average yield of 10 to 15 gpm. This formation outcrops across the northern quarter of the Mainside (Weston, 1991).

The Paleocene-age Hornerstown Sand outcrops near the northwestern boundary of the Mainside. This formation is a massive, green, glauconitic sand, interbedded with shale. It is lithologically homogeneous with a relatively constant thickness of 30 to 50 feet (Weston, 1991).

1.3 SUMMARY OF CHEMICAL DATA FROM PREVIOUS INVESTIGATIONS

Investigative activities performed during the previous SI (Weston, 1993) and RI/FS (Weston, 1993) included the collection and analysis of various media samples at 25 of the 27 RI sites. For the purpose of determining sampling and analysis requirements to be performed during the current RI, all available analytical data was 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 which summarize this data accompany a description of each site (in Sections 4 to 29). These tables provide a comparison of maximum contaminant concentrations to applicable regulatory standards by site and media for each site.

The tables present each media 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 cleanup criteria are distinguished by shading.

The analytical program for RI activities at each site was 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. Positive results for compounds that have no State and Federal regulatory criteria (excluding reference doses and cancer slope factors) will also be further investigated during this RI. Additionally, the past and present activities and uses for each site were considered in the determination of the analytical program. In some cases, the Weston site inspection data did not address all potential analytes that may be expected for a given site. At such sites, analytes of concern are included in the RI sampling even though no previous positive analytical results exist.

2.0 FIELD OPERATIONS

2.1 FIELD OPERATIONS SUMMARY

Field operations to be performed at NWS Earle during the RI include mobilization of equipment, borehole drilling, monitoring well installation/construction, soil-gas surveying, soil and groundwater sampling, well development, test pit excavation, water-level measurements, ground surveying, equipment decontamination and waste handing. Other activities, such as sample collection procedures are described in Section 3.0, Environmental Sampling.

2.2 MOBILIZATION/DEMOBILIZATION

Following approval of this Work Plan, Halliburton NUS will prepare drilling and survey specifications, obtain a drilling subcontractor, and begin mobilization activities. All field team members will review the Work Plan, Health and Safety Plan (HASP), Quality Assurance Project Plan (QAPP), and NJDEPE 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.

The Field Operations Leader (FOL) will coordinate the mobilization activities upon arrival at the station. The FOL will also make any equipment purchases required to conduct the field investigation. The equipment required for the field activities will be loaded in Pittsburgh, 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 drive back to Pittsburgh. Additional project personnel will be utilized in the field as necessary to efficiently perform all contractor oversight and investigation/sample collection work.

2.3 BOREHOLE DRILLING

Soil borings will be drilled at the station for installation of groundwater monitoring wells and to characterize subsurface soil contamination. The hollow-stem auger drilling method will be used for advancing 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 Halliburton NUS Standard Operating Procedure (SOP) GH-1.5: Sections 5.2, 5.4, and 5.5. The Burmiester 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:

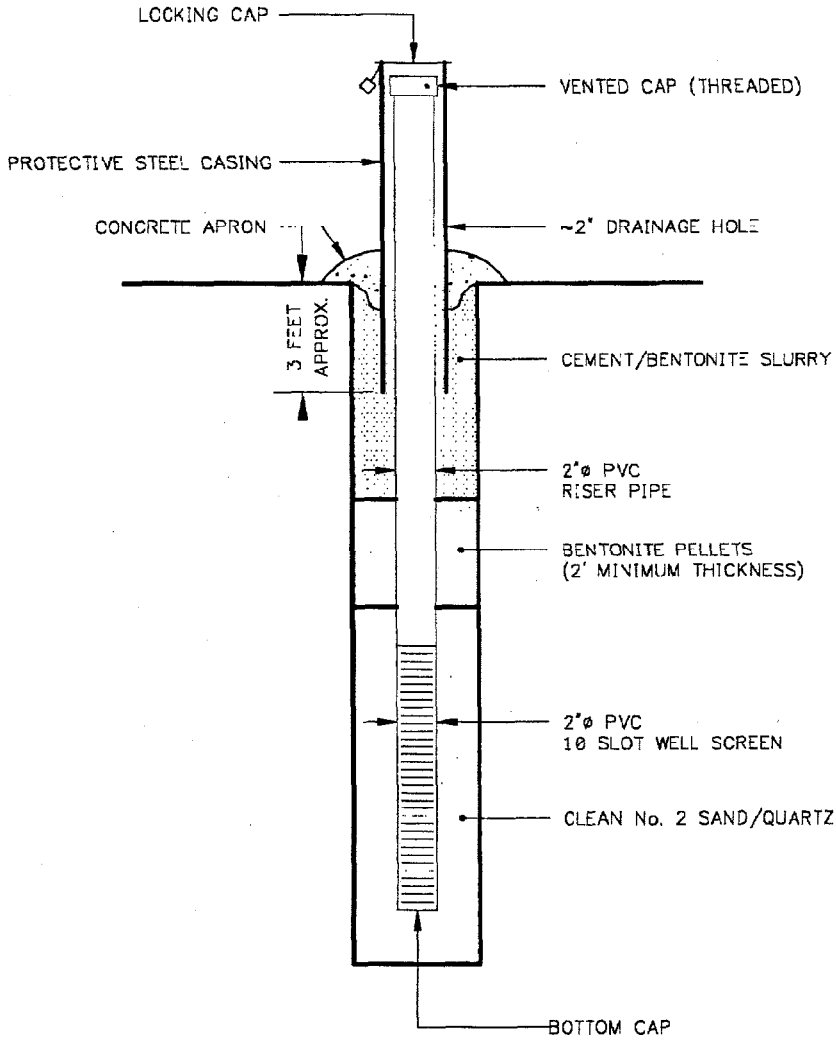
- Sample numbers and types
- Sample depths
- Standard Penetration Test data
- Sample recovery/sample interval
- Soil density or cohesiveness
- Soil color and moisture
- Burmiester classification system material description and symbol

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. Due to the relatively large volume of soil needed to fulfill multiple analytical parameters, 3-inch interior diameter (I.D.) split-spoon samplers may be required at some sites.

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 inches. 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 inside diameter 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. A sample well construction form is attached in Appendix A. Well installation will be conducted in accordance with NJDEPE Field Sampling Procedure Manual and Halliburton NUS 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



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

FIGURE 2-1

HALLIBURTON NUS
Environmental Corporation

hole positioned approximately 0.5 feet above the ground surface. A 0.5-foot-thick concrete apron measuring 2 feet by 2 feet will be constructed equally portioned around the casing of each well. Upon completion of groundwater sampling, all monitoring wells will be locked and will be keyed alike.

If extremely shallow water table conditions are encountered [water at less than 5 ft below ground surface (bgs)] similar well construction techniques will be used as listed above. The minimum thickness of bentonite (2 feet) and cement/bentonite grout (3 feet) will be maintained to keep the well seal intact, and to assure well integrity and strength. In this case the well screen may not intersect the water table because the top of the well screen may be submerged. This well construction technique will be used only if necessary in low-lying areas or in wetland areas.

2.5 WELL DEVELOPMENT

The monitoring wells will be developed after installation to remove fine-grain 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 water removed 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 NJDEPE 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 utilized 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 to the 1929 North American Datum and be 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.

2.7 TEST PITS

Test pits will be excavated at landfill sites to visually define and characterize the extent of fill at these locations. Test pit excavations will not be sampled, although the contents of the fill will be described. All excavated material removed from the test pit will be placed on a tarp or plastic sheet to prevent contamination of surface soil. After test pit activities are completed, the excavated material will be used

as backfill and a wooden stake will be positioned at each end of the pit for determining location during site survey work. All test pits will be filled in immediately after a test pit log is completed. A photo log will be made of all test pit activities which will show depth of fill, type of fill material and any landfill/clean fill contact that may be encountered. Test pits will be excavated in accordance with the NJDEPE Field Sampling Procedures Manual and Halliburton NUS SOP GH-1.8 Section 5.0. Test pit log forms are included in Appendix A of this report.

2.8 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 'ocations.

2.8.1 Major Equipment

All downhole drilling equipment, backhoes and sampling tools shall 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 shall 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. The backhoe bucket and arm will be thoroughly decontaminated by steam cleaning prior to use and between test pit locations. 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 SOP GH-1.6: Section 5.

2.8.2 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, 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, phthalate-free gloves will be used to prevent phthalate contamination of the sampling equipment by interaction between the gloves and the organic solvent.

2.9 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 of the drums upon project completion and will determine whether offsite disposal and/or treatment is required after receiving analytical results from the sampling. Material derived from excavation of test pits will be placed back in the excavated area.

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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.

2.10 GROUNDWATER ELEVATION MEASUREMENT

Groundwater elevations will be recorded from all existing and newly installed monitoring wells to define local and regional groundwater flow directions. Two rounds of groundwater elevations will be collected, one following completion of all new monitoring well installations, and one at the conclusion of field activities. Groundwater elevations will be recorded according to procedures outlined in the NJDEPE Field Sampling Procedures Manual and HNUS SOP GH-2.5. Elevations will be recorded using an electronic water-level indicator and will be noted to the nearest 0.01 foot. Synoptic groundwater elevations will be collected on an area-wide basis during a period of consistent weather and atmospheric conditions to minimize these effects on survey results.

2.11 SITE MAPPING

A general evaluation of each site will be made for comparison with existing site-specific drawings and determination will be made regarding the need for site surveying and mapping activities. The existing site maps are based on horizontal locations of significant site features such as building corners, previous sampling locations, site boundaries etc. 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. In addition, a detailed mapping effort will be performed in association with the RI. This effort will incorporate information available in both Geographical Information Systems (GIS) and Intergraph formats. Surface features including topography, surface drainage/watershed boundaries, wetlands, and cultural features will be provided as overlays to the NWS Earle Base maps.

2.12 WELL SURVEY

As part of the RI effort the Navy will complete an updated groundwater well survey. This survey will focus on municipal and residential wells located within a 1 mile radius of the NWS Earle property boundary.

3.0 ENVIRONMENTAL SAMPLING

3.1 SAMPLE ANALYSIS SUMMARY

Samples collected at the station 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.

3.2 SAMPLING PROCEDURES

This section discusses the procedures for performing environmental sampling at the NWS Earle station. Sampling to be performed at the station includes groundwater, surface soil, subsurface soil, surface water, and sediment. Other activities include drum sampling, soil-gas surveys, and groundwater collection using hydropunch sampling. All sampling procedures will be consistent with the New Jersey Department of Environmental Protection and Energy (NJDEPE) Field Sampling Procedures Manual. Halliburton NUS Standard Operating Procedures (SOPs) and relevant NJDEPE 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 NJDEPE Field Sampling Procedures Manual will overrule Halliburton NUS SOPs in regards to specific sampling practices. Field personnel will become familiar with the relevant sections of the NJDEPE Field Sampling Procedures Manual prior to beginning field activities.

3.2.1 Subsurface Soil Sampling

Subsurface soil samples will be collected from soil borings and hand auger borings. Soil samples will be collected in accordance with the NJDEPE Field Sampling Procedures Manual and relevant Halliburton NUS 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. At Sites 24 and 25, sampling for residual lead contamination below the zone of lead projectile accumulation will be performed by removing surficial material to a depth below the zone of lead fragment accumulation and then advancing a shallow boring with a hand auger below the lead fragment zone for collection of a soil sample.

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 1 (ORDNANCE DEMILITARIZATION SITE)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	12	1	1	2	1	17
		Soil	20	NA	1	0	1	22
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	12	NA	1	2	1	16
TCL Pesticide Compounds	CLP SOW OLM01.8	Groundwater	12	NA	0	0	1	13
TAL Metals	CLP SOW ILM02.1	Groundwater	4	NA	1	2	1	8
		Soil	20	NA	1	0	1	22
Explosives[7]	SW-846 8330	Groundwater	12	NA	1	2	1	16
		Soil	20	NA	1	0	1	22
Nitrate-Nitrite, COD, BOD, and TOC	[6]	Groundwater	12	NA	1	0	1	14
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Groundwater	12	NA	1	2	1	16
		Soil	20	NA	1	0	1	22
Nitrate-Nitrite		Soil	20	NA	1	0	1	22
SITE 2 (ACTIVE ORDNANCE DEMILITARIZATION SITE)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	7	1	1	2	1	12
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	7	NA	1	2	1	11
		Soil	8	NA	1	0	1	10
TAL Metals	CLP SOW ILM02.1	Groundwater	7	NA	1	2	1	11
		Soil	8	NA	1	0	1	10
Explosives	SW-846 8330	Groundwater	7	NA	1	2	1	11
		Soil	8	NA	1	0	1	10
Chromium^{+6}	SW-846 7195	Soil	8	NA	1	0	1	10
		Groundwater	7	NA	1	2	1	11

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 3 (LANDFILL SOUTHWEST OF "F" GROUP)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	7	1	0	0	1	9
		Soil	1	0	0	0	0	1
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	7	NA	0	0	1	8
		Soil	1	NA	0	0	0	1
TAL Metals	CLP SOW ILM02.1	Groundwater	7	NA	0	0	1	8
		Soil	1	NA	0	0	0	1
TCL Pesticide Compounds	CLP SOW OLM01.8	Groundwater	7	NA	0	0	1	8
		Soil	1	NA	0	0	0	1
SITE 4 (LANDFILL WEST OF "D" GROUP)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	12	1	1	0	1	15
		Surface Water	4	1	0	0	1	6
		Soil	1	1	0	0	1	2
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	12	NA	1	0	1	15
		Surface Water	4	NA	0	0	1	5
		Soil	1	NA	0	0	1	2
TAL Metals	CLP SOW ILM02.1	Groundwater	9	NA	1	0	1	11
		Surface Water	4	NA	0	0	1	5
		Soil	1	NA	0	0	1	2
TCL PCBs	CLP SOW OLM01.8	Surface Water	4	NA	0	0	1	5
Landfill Parameters: includes nitrate-nitrite, ammonia, COD, BOD, TOC, chloride, sulfate, and phosphate.	(6)	Groundwater	12	NA	0	0	1	13
		Surface Water	4	NA	0	0	1	5
		Soil	1	NA	0	0	1	2

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 5 (LANDFILL WEST OF ARMY BARRICADES)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	15	1	1	0	2	19
TAL Metals	CLP SOW ILM02.1	Groundwater	8	NA	1	0	2	11
Landfill Parameters: includes nitrate-nitrite, ammonia, turbidity, COD, BOD, TOC, chloride, sulfate, and phosphate.	(6)	Groundwater	8	NA	0	0	1	9
SITE 6 (LANDFILL WEST OF NORMANDY ROAD)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	1	1	0	1	7
		Surface Water	6	0	0	0	0	6
		Sediment	6	0	1	0	1	8
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	NA	1	0	1	6
		Surface Water	6	NA	0	0	0	6
		Sediment	6	NA	1	0	1	8
TAL Metals	CLP SOW ILM02.1	Groundwater	4	NA	1	0	1	6
		Surface Water	6	NA	0	0	0	6
		Sediment	6	NA	1	0	1	8
TCL Pesticide Compounds	CLP SOW OLM01.8	Groundwater	4	NA	1	0	1	6
		Sediment	6	NA	1	0	1	8
Explosives	SW-846 8330	Groundwater	4	NA	1	0	1	6
Landfill Parameters: includes nitrate-nitrite, ammonia, turbidity, COD, BOD, TOC, chloride, sulfate, and phosphate.	(6)	Groundwater	4	NA	1	0	1	6
		Surface Water	6	NA	1	0	1	8
Total Organic Carbon	SW-846 9060	Sediment	6	NA	0	0	1	7

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 6 (LANDFILL WEST OF NORMANDY ROAD) (continued)								
Grain Size	ASTM D421 D422	Sediment	6	NA	0	0	0	6
Hardness	E 130-2	Surface Water	6	NA	1	1	1	9
SITE 7 (LANDFILL SOUTH OF "P" BARRICADES)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	5	1	0	0	1	7
		Soil	1	NA	1	0	0	2
TAL Metals	CLP SOW ILM02.1	Groundwater	5	NA	0	0	1	6
		Soil	1	NA	0	0	1	2
Landfill Parameters: includes nitrate-nitrite, ammonia, turbidity, COD, BOD, TOC, chloride, sulfate, and phosphate.	(6)	Groundwater	5	NA	0	0	1	6
		Soil	1	NA	0	0	1	2
SITE 9 (LANDFILL SOUTHEAST OF "P" BARRICADES)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Surface Water	4	1	1	0	1	7
		Sediment	3	0	1	0	1	5
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Surface Water	4	NA	0	0	0	4
		Sediment	3	NA	1	0	1	5
TCL Pesticide Compounds	CLP SOW OLM01.8	Surface Water	4	NA	1	0	1	6
		Sediment	3	NA	1	0	1	5
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Surface Water	3	NA	1	1	1	6
		Sediment	3	NA	1	0	1	5
TAL Metals/Cyanide	CLP SOW ILM02.1	Surface Water	4	NA	1	0	1	6
		Sediment	3	NA	1	0	1	5

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 10 (SCRAP METAL LANDFILL)								
TCL Volatile Organic compounds	CLP SOW OLM01.8	Groundwater	7	1	0	0	1	9
TAL Metals	CLP SOW ILM02.1	Groundwater	7	NA	0	0	1	8
Landfill Parameters: includes nitrate-nitrite, ammonia, COD, BOD, TOC, chloride, sulfate, and phosphate.	[6]	Groundwater	7	NA	0	0	1	8
SITE 11 (CONTRACT ORDNANCE DISPOSAL AREA)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	5	1	1	0	1	8
TAL Metals	CLP SOW ILM02.1	Groundwater	5	NA	1	0	1	7
SITE 12 (BATTERY STORAGE AREA)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Soil	3	1	0	0	1	5
		Surface Water	1	0	0	0	1	2
		Sediment	2	0	0	0	0	2
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Soil	3	NA	0	0	1	4
		Surface Water	1	NA	0	0	1	2
		Sediment	2	NA	0	0	0	2
TAL Metals	CLP SOW ILM02.1	Soil	3	NA	0	0	1	4
		Surface Water	1	NA	0	0	1	2
		Sediment	2	NA	0	0	0	2
TCL Pesticide Compounds	CLP SOW OLM01.8	Soil	3	NA	0	0	1	4
		Surface Water	1	NA	0	0	1	2
		Sediment	2	NA	0	0	0	2

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 13 (DEFENSE PROPERTY DISPOSAL OFFICE YARD)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	5	1	1	0	1	8
		Surface Water	3	1	0	0	0	4
		Sediment	3	0	1	0	1	5
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	5	NA	1	0	1	7
		Surface Water	3	NA	0	0	0	3
		Sediment	3	NA	1	0	1	5
TAL Metals	CLP SOW ILM02.1	Groundwater	5	NA	1	0	1	7
		Surface Water	3	NA	0	0	0	3
		Sediment	3	NA	1	0	1	5
TCL Pesticide Compounds/PCBs	CLP SOW OLM01.8	Groundwater	5	NA	1	0	1	7
		Surface Water	3	NA	0	0	0	3
		Sediment	3	NA	1	0	1	5
Explosives	SW-846 8330	Groundwater	5	NA	1	0	1	7
		Surface Water	3	NA	0	0	0	3
		Sediment	3	NA	1	0	1	5
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Surface Water	3	NA	0	0	1	4
		Sediment	3	NA	1	0	1	5
Landfill Parameters: includes nitrate-nitrite, ammonia, COD, BOD, TOC, chloride, sulfate, and phosphate.	(6)	Groundwater	5	NA	0	0	1	6
		Surface Water	3	NA	0	0	0	3
Total Organic Carbon	SW-846 9060	Sediment	3	NA	0	0	1	4
Grain Size	ASTM D421 D422	Sediment	3	NA	0	0	0	3

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 14 (MERCURY SPILL)								
Mercury	CLP SOW ILM02.1	Soil (Floor Sweeping)	1	0	0	0	0	1
SITE 15 (SLUDGE DISPOSAL SITE)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Soil	6	1	1	0	1	9
		Surface Water	2	0	1	0	1	4
		Sediment	3	0	0	0	0	3
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Soil	6	NA	1	0	1	8
		Surface Water	2	NA	1	0	1	4
		Sediment	3	NA	0	0	0	3
TAL Metals	CLP SOW ILM02.1	Soil	6	NA	1	0	1	8
		Surface Water	2	NA	1	0	1	4
		Sediment	3	NA	0	0	0	3
TCL Pesticide Compounds/PCBs	CLP SOW OLM01.8	Soil	6	NA	1	0	1	8
		Surface Water	2	NA	1	0	1	4
		Sediment	3	NA	0	0	0	3
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Soil	6	NA	1	0	1	8
		Surface Water	2	NA	1	0	1	4
		Sediment	3	NA	0	0	0	3
SITE 16 (EPIC SITE F/ROUND HOUSE SITE)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	1	0	0	1	6
		Soil	36	3	2	0	4	45
		Sediment	8	1	1	0	1	11
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	NA	0	0	1	5
		Soil	36	NA	2	0	4	42
		Sediment	8	NA	1	0	1	10

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 16 (EPIC SITE F/ROUND HOUSE SITE)								
TAL Metals	CLP SOW ILM02.1	Groundwater	4	NA	0	0	1	5
		Soil	36	NA	2	0	4	42
		Sediment	8	NA	1	0	1	10
TCL PCBs	CLP SOW OLM01.8	Soil	36	NA	2	0	4	42
		Sediment	8	NA	1	0	1	10
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Groundwater	4	NA	0	0	1	5
		Soil	36	NA	2	0	4	42
		Sediment	8	NA	1	0	1	10
Total Organic Carbon	SW-846 9060	Sediment	8	NA	0	0	0	8
Grain Size	ASTM D421 D422	Sediment	8	NA	0	0	0	8
SITE 17 (LANDFILL)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Soil	2	1	1	0	1	5
		Groundwater	4	1	0	0	1	6
		Surface Water	6	0	0	0	0	6
		Sediment	6	0	0	0	1	7
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Soil	2	NA	1	0	1	4
		Groundwater	4	NA	0	0	1	5
		Surface Water	6	NA	0	0	0	6
		Sediment	6	NA	0	0	1	7
TAL Metals	CLP SOW ILM02.1	Soil	2	NA	1	0	1	4
		Groundwater	4	NA	0	0	1	5
		Surface Water	6	NA	0	0	0	6
		Sediment	6	NA	0	0	1	7

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 17 (LANDFILL) (continued)								
TCL Pesticide Compounds	CLP SOW OLM01.8	Soil	2	NA	1	0	1	4
		Sediment	6	NA	0	0	1	7
Landfill Parameters: includes nitrate-nitrite, ammonia, COD, BOD, TOC, chloride, sulfate, and phosphate.	[6]	Groundwater	4	NA	0	0	1	5
		Surface Water	6	NA	0	0	0	6
Total Organic Carbon	SW-846 9060	Sediment	6	NA	0	0	0	6
Grain Size	ASTM D421 D422	Sediment	6	NA	0	0	0	6
TCL PCBs	CLP SOW OLM01.8	Soil	2	NA	1	0	1	4
SITE 19 (PAINT CHIP AND SLUDGE DISPOSAL AREA)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	7	1	1	0	1	10
		Soil	8	1	1	0	1	12
		Surface Water	1	0	0	0	1	2
		Sediment	1	0	0	0	0	1
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Surface Water	1	0	0	0	0	1
		Sediment	1	0	0	0	1	2
TAL Metals	CLP SOW ILM02.1	Groundwater	7	NA	1	0	1	9
		Soil	9	NA	1	0	1	11
		Surface Water	1	NA	1	0	1	3
		Sediment	1	NA	0	0	0	1
Chromium^{+6}	SW 846 7195	Soil	2	NA	0	0	0	2
		Groundwater	1	NA	0	0	0	1
TCL Pesticide Compounds	CLP SOW OLM01.8	Surface Water	1	NA	1	0	1	3
		Sediment	1	NA	0	0	0	1

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 20 (GRIT BLASTING AREA AT BUILDING 544)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Soil	8	1	1	0	1	11
		Surface Water	2	1	1	0	1	5
		Sediment	2	0	0	0	0	2
		Aqueous (Septic)	1	0	0	0	0	1
		Sludge (Septic)	1	0	0	0	0	1
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Soil	8	NA	1	0	1	10
		Surface Water	2	NA	1	0	1	4
		Sediment	2	NA	0	0	0	2
		Aqueous (Septic)	1	0	0	0	0	1
		Sludge (Septic)	1	0	0	0	0	1
TAL Metals	CLP SOW ILM02.1	Soil	8	NA	1	0	1	10
		Surface Water	2	NA	1	0	1	4
		Sediment	2	NA	0	0	0	2
		Aqueous (Septic)	1	0	0	0	0	1
		Sludge (Septic)	1	0	0	0	0	1
SITE 23 (PAINT DISPOSAL AREA)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	3	1	1	0	1	6
		Soil	7	1	1	0	1	10
		Surface Water	5	1	0	0	0	6
		Sediment	5	0	0	0	1	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 23 (PAINT DISPOSAL AREA) (continued)								
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	3	NA	1	0	1	5
		Soil	7	NA	1	0	1	9
		Surface Water	5	NA	0	0	0	5
		Sediment	5	NA	0	0	1	6
TAL Metals	CLP SOW ILM02.1	Groundwater	3	NA	1	0	1	5
		Soil	7	NA	1	0	1	9
		Surface Water	5	NA	0	0	0	5
		Sediment	5	NA	0	0	1	6
TCL Pesticide Compounds	CLP SOW OLM01.8	Groundwater	3	NA	1	0	1	5
		Soil	7	NA	1	0	1	9
TCL Pesticide Compounds (continued)	CLP SOW OLM01.8	Surface Water	5	NA	0	0	0	5
		Sediment	5	NA	0	0	1	6
Explosives	SW-846 8330	Groundwater	3	NA	1	0	1	5
		Soil	7	NA	1	0	1	9
		Surface Water	5	NA	0	0	0	5
		Sediment	5	NA	0	0	1	6
SITE 24/25 (CLOSED PISTOL RANGES)								
TAL Metals	CLP SOW ILM02.1	Soil	8	0	1	0	1	10
Nitrate-Nitrite	[6]	Soil	8	NA	1	0	1	10
SITE 26 (EXPLOSIVE "D" WASHOUT AREA)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	5	1	1	0	1	8
		Soil	6	1	0	0	1	8
TAL Metals	CLP SOW ILM02.1	Groundwater	5	NA	0	0	1	6
		Soil	6	NA	1	0	1	8

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) (continued)								
Explosives	SW-846 8330	Groundwater	5	1	1	0	1	8
		Soil	6	NA	1	0	1	8
SITE 27 (PROJECTILE REFURBISHING AREA)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Soil	9	1	0	0	1	11
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Soil	9	NA	0	0	1	10
TAL Metals	CLP SOW ILM02.1	Soil	9	NA	0	0	1	10
TCL Pesticide Compounds/PCBs	CLP SOW OLM01.8	Soil	9	NA	0	0	1	10
SITE 29 (PCB SPILL SITE)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	6	1	1	0	1	9
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	6	NA	1	0	1	8
TAL Metals	CLP SOW ILM02.1	Groundwater	6	NA	1	0	1	8
TCL PCBs	CLP SOW OLM01.8	Groundwater	6	NA	1	0	1	8
		Soil	2	NA	1	0	1	4
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Soil	2	NA	1	0	1	4
SITE L (MSC VAN PARKING LOT)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Soil	7	1	1	0	1	10
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Soil	7	NA	1	0	1	9

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 L (MSC VAN PARKING LOT) (continued)								
TAL Metals	CLP SOW ILM02.1	Soil	7	NA	1	0	1	9
TCL Pesticide Compounds/PCBs	CLP SOW OLM01.8	Soil	7	NA	1	0	1	9
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Soil	7	NA	1	0	1	9
SITE Q (FIRE FIGHTING SCHOOL)								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Soil	5	NA	1	0	1	7
		Sediment	1	NA	1	0	1	3
		Groundwater	4	1	1	0	1	7
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Soil	5	NA	1	0	1	7
		Sediment	1	NA	1	0	1	3
		Groundwater	4	1	1	0	1	7
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Soil	1	N/A	0	0	0	1
		Sediment	1	N/A	1	0	1	3
		Groundwater	4	1	1	0	1	7
BACKGROUND SAMPLES/WATERSHED SAMPLES								
TCL Volatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	4	2	0	1	11
		Soil	8	1	2	0	1	12
		Surface Water	4	1	1	0	1	7
		Sediment	4	0	1	0	1	6
TCL Semivolatile Organic Compounds	CLP SOW OLM01.8	Groundwater	4	NA	2	0	1	7
		Soil	8	NA	2	0	1	11
		Surface Water	4	NA	1	0	1	7
		Sediment	4	NA	1	0	1	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
BACKGROUND SAMPLES/WATERSHED SAMPLES (continued)								
TCL Pesticide Compounds/PCBs	CLP SOW OLM01.8	Groundwater	4	NA	2	0	1	7
		Soil	8	NA	2	0	1	11
		Surface Water	4	NA	0	0	0	22
		Sediment	4	NA	0	0	0	22
Explosives	SW-846 8330	Groundwater	4	NA	2	0	1	7
		Soil	8	NA	2	0	1	11
		Surface Water	4	NA	0	0	0	22
		Sediment	4	NA	0	0	0	22
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	Groundwater	4	NA	2	0	1	7
		Soil	8	NA	2	0	1	11
		Surface Water	4	NA	0	0	0	22
		Sediment	4	NA	0	0	0	22
Landfill Parameters: includes nitrate-nitrite, ammonia, COD, BOD, TOC, chloride, sulfate, and phosphate.	(6)	Groundwater	4	NA	2	0	1	7
		Soil	8	NA	0	0	0	8
		Surface Water	4	NA	1	0	1	6
		Sediment	4	NA	1	0	1	6
BACKGROUND SAMPLES/WATERSHED SAMPLES (continued)								
TAL Metals/Cyanide	CLP SOW ILM02.1	Groundwater	4	NA	2	0	1	7
		Soil	8	NA	2	0	1	11
		Surface Water	4	NA	2	0	2	26
		Sediment	4	NA	2	0	2	26
Grain Size	ASTM D421 D422	Sediment	4	NA	0	0	0	4
Hardness	E130-2	Surface Water	4	NA	NA	NA	1	5
Mercury	Soil	Sediment	8	NA	0	0	0	8

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: nitrate-nitrite as (N), EPA 353.3; ammonia as (N), EPA 350.3; Chemical Oxygen Demand, EPA 410.1; Biochemical Oxygen Demand, SM 5210B; Total Organic Carbon, EPA 415.1; chloride, EPA 325.2; phosphate as (P), EPA 365.4; sulfate, EPA 375.4.

(7) Compound list for explosives includes the following: HMX, RDX, 1,3,5-Dinitrobenzene, 1,3-Dinitrobenzene, Tetryl, 2,4,6-Trinitrotoluene, 2-6-Dinitrotoluene, 2,4-Dinitrotoluene, Picric Acid, and Nitro cellulose/Nitro glycerin.

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
TCL Pesticides only[8]	Amber glass, Teflon-lined cap	1000 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 Polychlorinated Biphenyls (PCBs) only[8]	Amber glass, Teflon-lined cap	1000 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)
Cyanide	Polyethylene bottle, plastic cap, plastic liner	1000 mL	Cool to 4°C, Na OH to pH > 12[6]	14 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. #ILM02.1)
Explosives[7]	Glass, Teflon-lined cap	1000 mL	Cool to 4°C, dark	Extract 7 days; Analysis 40 days after extraction	SW-846 Method 8330
Total Petroleum Hydrocarbons (TPH)	Glass	1000 mL	H_2SO_4 to pH <2; Cool to 4°C	28 days	EPA Method 418.1
Ammonia (as N)	Polyethylene or Glass	400 mL	Cool to 4°C, H_2SO_4 to pH < 2	28 days	EPA Method 350.3

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]
AQUEOUS (GROUNDWATER AND SURFACE WATER) (continued)					
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
Chloride[3]	Polyethylene or Glass	50 mL	Cool to 4°C	28 days	EPA 325.2
Nitrate-Nitrite (as N)[4]	Polyethylene or Glass	100 mL	Cool to 4°C, H_2SO_4 to pH < 2	28 days	EPA 353.3
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
Phosphate (as P)[4]	Polyethylene or Glass	50 mL	Cool to 4°C, H_2SO_4 to pH < 2	28 days	EPA 365.4
Sulfate (as SO_4)[3]	Polyethylene or Glass	50 mL	Cool to 4°C	28 days	EPA 375.4
Turbidity[3]	Polyethylene or Glass	100 mL	Cool to 4°C	48 hours	EPA 180.1
SOLID (SURFACE SOIL, SUBSURFACE SOIL, AND SEDIMENT)					
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
Chromium^{+6}	Polyethylene or Glass	400 mL	Cool to 4°C, dark	24 hours	SW-846 3rd Edition, Vol. 1A; 7195

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, AND SEDIMENT) (continued)					
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)
Selected TAL Metals (Lead, Zinc, Copper, Chromium, Cadmium)	Flint glass bottle, black phenolic cap, polyethylene liner	8 oz	Cool to 4°C	Analyze within 180 days	U.S. EPA-CLP SOW for Inorganic Analysis, Multi-Media, Multi-Concentration (Doc. #ILM02.1)
Mercury only	Flint glass bottle, black phenolic cap, polyethylene liner	4 oz	Cool to 4°C	28 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
Nitrate-Nitrite	Clear wide mouth glass	4 oz	Cool to 4°C	28 days	Technical Report EPA/CE-81-1 Procedures for Handling and Chemical Analysis of Sediment and Water Samples
Total Petroleum Hydrocarbons (TPH)	Wide mouth glass	4 oz	Cool to 4°C	28 days	Extract using extraction procedure in SW-846 Method 9071 followed by analysis using EPA Method 418.1
Explosives[7]	Wide mouth glass	8 oz	Cool to 4°C	7 days to extract; 40 days to analysis	SW-846 Method 8330

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.

(7) Compound list for explosives includes the following: HMX, RDX, 1,3,5-Dinitrobenzene, 1,3-Dinitrobenzene, Tetryl, 2,4,6-Trinitrotoluene, 2-6-Dinitrotoluene, 2,4-Dinitrotoluene, Picric Acid, and Nitro cellulose/Nitro glycerin.

(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	Test Pits	Locate Seeps	Subsurface Soil	Surface Soil	Groundwater Sample	Surface Water Sample	Sediment Sample	Soil Gas Survey
Site 1, Ordnance Demo Range	10	1	8	---	---	20	---	12	---	---	---
Site 2, Active Ordnance Demo Range	---	---	---	---	---	---	8	7	---	---	---
Site 3, Landfill SW of "F" Group	---	---	---	2	---	---	1	7	---	---	Yes
Site 4, Landfill West of "D" Group	---	3	3	---	Yes	---	---	12	4	1	---
Site 5, Landfill West of Army Barricades	---	---	7	---	---	---	---	15	---	---	---
Site 6, Landfill West of Normandy Road	---	---	---	---	Yes	---	---	4	6	6	---
Site 7, Landfill South of "P" Barricades	---	---	---	---	---	---	1	5	---	---	---
Site 9, Landfill SE of "P" Barricades	---	---	---	2	Yes	---	---	---	4	3	---
Site 10, Scrap Metal Landfill	---	---	---	---	---	---	---	7	---	---	---
Site 11, Contract Ordnance Disposal Area	---	---	---	---	---	---	---	5	---	---	---
Site 12, Battery Acid Spill Site	---	---	---	---	---	---	3	---	1	2	---
Site 13, Defense Property Disposal Yard	---	5	---	2	---	---	---	5	3	3	---
Site 14, DRMO Warehouse (Mercury Spill)	---	---	---	---	---	---	1	---	---	---	---
Site 15, Sludge Disposal Near Waterfront S Gate	4	---	---	---	---	4	2	---	2	3	---
Site 16, Diesel Line to Building C-50	20	4	---	---	---	32	4	4	---	8	Yes
Site 17, Disposal Site at Waterfront	---	---	---	---	Yes	---	2	4	6	6	---
Site 19, Paint Sludge Disposal Site (Bldg. S-34)	4	1	---	---	---	5	4	7	1	1	---
Site 20, Grit Blast Disposal Area (Bldg. 544)	3	---	---	---	---	3	5	---	2	2	---

TABLE 3-3 (Continued)
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	Test Pits	Locate Seeps	Subsurface Soil	Surface Soil	Groundwater Sample	Surface Water Sample	Sediment Sample	Soil Gas Survey
Site 22, Paint Sludge Disposal Site (Bldg. D-2)	---	---	---	---	---	---	---	---	---	---	---
Site 23, Paint Sludge Disposal Site (Bldg. D-5)	3	3	---	---	---	6	---	3	5	5	---
Site 24, Closed Pistol Range	2	---	---	---	---	4	---	---	---	---	---
Site 25, Closed Pistol Range	2	---	---	---	---	4	---	---	---	---	---
Site 26, Explosive "D" Washout Area (Bldg. GB-1)	4	1	---	---	---	6	---	5	---	---	Yes
Site 27, Projectile Refurbishing Area	3	---	---	---	---	9	---	---	---	---	---
Site 29, PCB Spill Site (Bldg. C-16)	2	---	---	---	---	2	---	6	---	---	---
Site L, MSC Van Parking Lot	---	---	---	---	---	---	7	---	---	---	---
Site Q, Firefighting School	3	3	---	---	---	---	---	3	---	---	---
Background/Watershed	4	4	---	---	---	4	4	4	22	22	---
TOTAL	**72**	**27**	**18**	**6**	**4**	**89**	**34**	**97**	**55**	**62**	**3**

1 Does not include QA samples.
2 Activity may be performed pending groundwater sample results.

Due to the relatively large volume of soil sample needed to fulfill multiple analytical parameters, it is probable that 3-inch I.D. split-spoon samplers will be required at some sites where subsurface soils are collected. Split-spoon samplers will be decontaminated between samples as described in Section 2.8.2. Sample handling and chain-of-custody requirements are addressed in Section 3.4.

3.2.2 Surface Soil Sampling

Surface soils will be collected in accordance with the NJDEPE Field Sampling Procedures Manual and relevant Halliburton NUS 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 2.8.2. All pertinent field data will be recorded using the appropriate sample log sheet and the field log book. 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 and all existing monitoring wells present at each site. Groundwater sampling will be conducted in accordance with the USEPA Region I Groundwater Sampling Procedure Low Flow Purge and Sampling (Draft Final) included in Appendix B-1. Monitor 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 volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) will be performed first using dedicated low flow sampling pumps and dedicated sample collection tubing.

- All samples other than VOCs and SVOCs will then be collected using the low-flow sampling method to reduce turbidity. No filtered metals samples will be collected.

- Samples will be collected for analysis in the following order: VOCs, SVOCs, polychlorinated biphenyls (PCBs), pesticides, total metals, cyanide, chromium^{+6}, TPH, explosives, sulfate and chloride, nitrate-nitrite, ammonia (nitrogen), and other landfill parameters.[1]

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 and 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 shall be recorded using the appropriate sample log sheet and the field log book (see Halliburton NUS SOP SA-6.3). A groundwater sample log sheet can be found in Appendix A of this Work Plan.

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1 Landfill parameters include nitrate-nitrite (as N), ammonia (as N), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total organic carbon (TOC), chloride, and phosphate (as P).

3.2.4 Surface Water/Sediment Sampling

Surface water samples will be obtained from onsite drainages, seeps, and at background locations. Surface water sampling will be conducted in accordance with the NJDEPE Field Sampling Procedures Manual and Halliburton NUS 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 which 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 leachate, and will then be 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 and temperature. Color and turbidity shall also be noted on the sample log form for each surface water sample. Procedures for obtaining these field measurements will be in accordance with Halliburton NUS SOP SF-1.1.

Sediment samples will be obtained from onsite drainage, at seeps, from drainage swales, and from background locations. Sediment sampling will be conducted in accordance with the NJDEPE Field Sampling Procedures Manual and Halliburton NUS 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. All pertinent field data shall 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 Soil-Gas Survey

Soil-gas surveys will be performed at two sites to identify the potential source of VOCs previously detected at the sites. Soil-gas surveys will be conducted in accordance with the NJDEPE Field Sampling Procedures Manual. At each site a grid will be laid out that will encompass the area of concern. A soil-gas sample will be collected from each grid point. Soil-gas survey grid spacings vary at each site based on site conditions, and range from 25 feet to 100 feet. Specific spacings are discussed in later chapters. A drive probe or retractable probe will be driven into the soil to facilitate collection of soil-gas samples. Soil-gas samples will be collected using a vacuum pump and samples will be stored in a Tedlar bag. Analysis will be performed with an portable gas chromatograph. Holding times for soil-gas samples will not exceed 48 hours. Soil-gas analysis will be performed following the Quality Assurance/Quality Control (QA/QC) parameters outlined in the NJDEPE Field Sampling Procedures Manual.

3.2.6 Hydropunch Groundwater Sampling

To determine general groundwater quality and the potentiometric surface prior to selecting monitoring well locations, groundwater samples will be collected at several sites using a hydropunch (or similar technology such as geoprobe, temporary or drivepoint wells). To obtain these samples, a small stainless-steel screen (approximately 1 inch diameter) will be pushed below the water table, and a groundwater sample will be collected using a peristaltic pump and/or stainless-steel bailer. 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 or will be backfilled.

All sample parameters, sample containers and analytical methods will be similar to those used for monitoring wells. 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 NJDEPE 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:

01 = Site 1, Ordnance site
02 = Site 2, Active Ordnance Demolition Range
03 = Site 3, Landfill Southwest of "F" Group
04 = Site 4, Landfill West of "D" Group
05 = Site 5, Landfill West of Army Barricades
06 = Site 6, Landfill
07 = Site 7, Landfill South of "P" Barricades
09 = Site 9, Landfill
10 = Site 10, Scrap Metal Landfill
11 = Site 11, Contract Ordnance Disposal Area
12 = Site 12, Battery storage location
13 = Site 13, Landfill
14 = Site 14, Mercury spill site
15 = Site 15, Sludge disposal site
16 = Site 16/EPIC Site F, Roundhouse
17 = Site 17, Landfill
19 = Site 19, Paint Sludge Disposal Site
20 = Site 20, Grit Blast Disposal Area
22 = Site 22, Paint Sludge Disposal Site
23 = Site 23, Paint disposal area
24 = Site 24, Firing range

25 = Site 25, Firing range

26 = Site 26, Explosive "D" Washout Area

27 = Site 27, Projectile refurbishing area

29 = Site 29, PCB spill area

L = EPIC Site L

Q = EPIC Site Q

BG = Background sample location

Medium:

SS = Surface Soil

SB = Subsurface Soil

GW = Groundwater

SW = Surface Water

SED = Sediment

DRUM = Drum Sample

Sample Location:

The sample location code will depend on the media 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 sample	=	background 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 06, monitoring well MW-04 would be labeled 06GW04. A subsurface soil sample taken from Site 16, from the tenth soil boring location starting at 6.0 feet would be labeled 16SB10-06. A surface soil sample taken from the third background sample location would be labeled BGSS01-03.

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:

Day the sample is generated, 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, 1995 would have the sample identification label TB-02-120195. The first rinsate blank taken on January 5, 1995 would have the label RB-01-010595.

Information regarding sample labels and tags to be attached before shipment to a laboratory is contained in Section 5.2 of the Halliburton NUS SOP SA-6.1 (Appendix B).

3.3.2 Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with Halliburton NUS 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 Halliburton NUS 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 media shall be field duplicates. Duplicates shall 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 can not 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 1 (ORDNANCE DEMILITARIZATION SITE)

4.1 SITE DESCRIPTION

The Ordnance Demilitarization Site 1 is a 6-acre open field that was used for burning ordinance material for several decades. Operations were discontinued in 1975. During site abandonment, the area was plowed, and a layer of diesel-soaked hay was burned on site to remove residual ordnance. This procedure was carried out three times. A US Army communications station and tower were located near the center of the site for several years. The site is currently cleared of all structures.

The site is bordered by Macassar Road to the east, a railroad spur to the north, and an 8 to 10 feet high berm to the west and south. No drainage swales or streams are located on the site. Groundwater flow is generally to the southeast.

4.2 PREVIOUS INVESTIGATIONS

During the Site Investigation (SI) (Weston, 1993), 16 surface soil samples were collected on a grid across the site, as shown in Figure 4-1. Samples were taken at 0 to 0.5 feet below ground surface (bgs), and at 0.5 to 1.5 ft bgs. Analysis of soil samples indicated explosive compounds were present at sample 01-005-S001 (at 1 to 1.5 feet). A high total petroleum hydrocarbons (TPH) concentration (450 ppm) was detected at sample 01-004-S001. Maximum soil contaminant concentrations are summarized in Table 4-1. Metals and TPH were present in all other soil samples. Three monitoring wells were installed. Groundwater samples were analyzed for TCL organics, TAL inorganics, and explosive compounds, and sampled. Elevated levels of volatile organic compounds (VOCs) and the explosives, RDX and 2,4-DNT, were detected in MW1-2, in what was assumed to be the upgradient well for the site. Dietylphthalate was detected in well MW1-3. Metals were detected in site monitoring wells. The highest concentrations of chromium, lead, and zinc were detected at MW-1. Maximum groundwater contaminant concentrations that were recorded during the SI are presented in Table 4-2.

4.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

To determine the extent of soil contamination and to determine if groundwater is being effected by contaminated soils at the site, eight hydropunch groundwater samples will be collected and ten soil borings will be completed at the site. Ten soil borings will be installed in the upgradient direction from the site. Five soil borings (SB-01 to SB-05) will be drilled north of existing well MW1-1, and five borings (SB-06 to SB-10) will be drilled west of existing well MW1-2. Soil samples collected from these borings will be used

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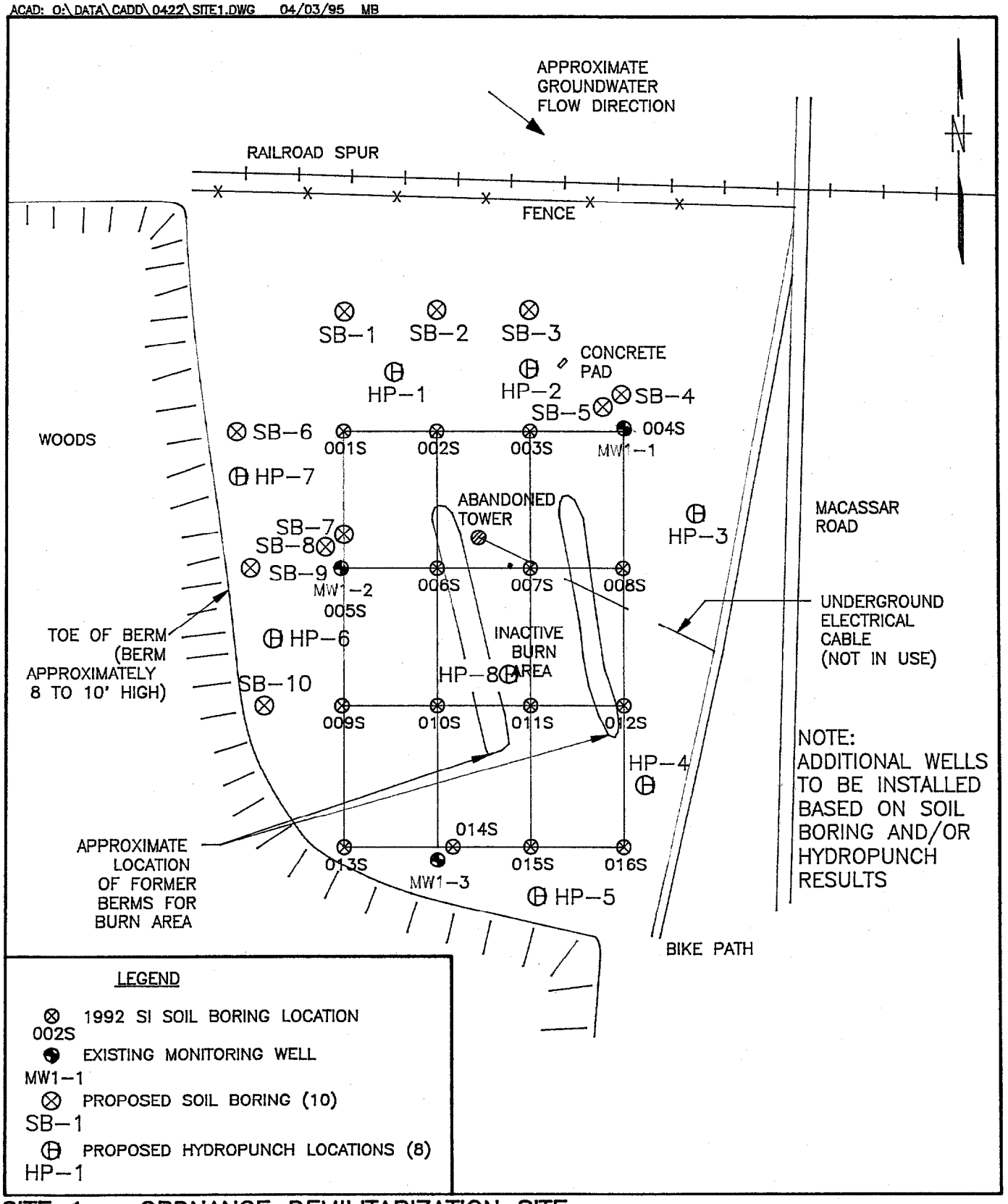

SITE 1 – ORDNANCE DEMILITARIZATION SITE
MONITOR WELL AND SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 4-1

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TABLE 4-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 1[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Silver	26.9	01-012-S001	2,000
Aluminum	2,980	01-006-S001	---
Arsenic	4	01-006-S001	20
Barium	290	01-007-S001	26,000
Cadmium	2.2	01-001-S001	100
Chromium	65.7	01-006-S001	---
Copper	136	01-007-S001	600
Iron	11,200	01-006-S001	---
Mercury	0.96	01-007-S001	260
Potassium	1,130	01-006-S001	---
Manganese	45.8	01-007-S001	---
Lead	179	01-007-S001	600
Vanadium	43.8	01-006-S001	7,000
Zinc	204	01-006-S001	1,500
MISCELLANEOUS	**(mg/kg)**		**(mg/kg)**
Nitrite	0.32	01-015-S201	---
Nitrate	2.6	01-003-S001	---
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbons	450	01-004-S001	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.
2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.
--- Criteria not available.

TABLE 4-2

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 1[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level (MCL)[3]
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	**31,000**	MW01-01	**200**	---
Barium	220	MW01-01	2,000	2,000
Beryllium	**6**	MW01-01	**0.008 (20)**	**4**
Chromium	**538**	MW01-01	**100**	**100**
Copper	26.7	MW01-01	1,000	1,300[G]
Iron	**75,700**	MW01-01	**300**	---
Potassium	13,700	MW01-01	---	---
Magnesium	6,200	MW01-01	---	---
Manganese	**110**	MW01-01	**50**	---
Lead	**12.5**	MW01-01	**5**	---15[A]
Vanadium	172	MW01-01	---	---
Zinc	652	MW01-01	5,000	---
ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Acetone	7 J	MW01-01	700	---
1,1-Dichloroethylene	**80**	MW01-02	**1 (2)**	**7**
Diethylphthalate	1 J	MW01-03 Dup. sample also	5,000	---
RDX	8.98	MW01-02	---	---
2,4-DNT	0.82	MW01-02	0.05 (10)	---
Nitrate-Nitrite	1,400	MW01-01	10,000	10,000

1 Weston Report: Phase II - Site Inspection Study Report, 1993. Note: It should be noted that additional concentrations of other analytes were identified in this report (e.g. RDX and 2,4 DNT were detected in well MW01-01: 96.6 ppb and 93.2 ppb respectively plus five unlisted volatile organics) but are not presented here in that these data were unvalidated and therefore their usefulness are questionable.
Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

TABLE 4-2 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 1[1]
NWS EARLE, COLTS NECK, NEW JERSEY

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs -Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

J Estimated value.
--- Criteria not available.

to determine if upgradient soils are contributing to groundwater contamination. In addition, eight groundwater samples will be collected (using hydropunch). These samples and will be used to determine the location of an additional monitoring well(s) necessary to define the extent of groundwater contamination at the site. It is anticipated that one additional well will be installed northwest (upgradient) of the site. Additional wells may be considered if hydropunch samples indicate significant upgradient groundwater contamination is present.

Soil borings will be sampled at two depths, at approximately 0.5 to 1.5 and 3 to 4 feet below ground surface (bgs). Proposed RI sampling locations are illustrated on Figure 4-1. Sample depths were selected to determine if contamination extends vertically beyond the SI sampling depth (of 1.5 ft) and to evaluate the possibility of contaminants impacting the water table. Groundwater samples will be taken from the three existing monitoring wells, the proposed new monitoring well and the eight hydropunch sample locations.

Groundwater samples (from monitoring wells and hydropunch) will be analyzed for TCL volatiles, semivolatiles, pesticides, TAL metals, explosives, and nitrate-nitrite, biological oxygen demand (BOD), total organic carbon (TOC), chemical oxygen demand (COD) and total petroleum hydrocarbons (TPH). Groundwater samples (from hydropunch and monitoring wells) will be taken at the beginning of field activities to determine the locations of any additional wells at the site. All groundwater will be analyzed using quick turn (2 week) sample analysis to allow for the installation of additional monitoring wells within the same field mobilization. Surface and subsurface soil samples will be analyzed for TPH, TCL volatiles, target analyte list (TAL) metals, explosives and nitrate-nitrite. Table 4-3 summarizes the sample rationale for Site 1. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

4.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 4-3

SITE 1
SAMPLING LOCATIONS AND RATIONALE
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Locations	Sampling Rationale
Soil Boring 1 to 10 (2 samples per boring)	0.5 to 1.5 and 3 to 4 ft bgs	Determine vertical extent of soil contamination upgradient of site.
Hydropunch samples 1 to 8	2 north of site, 2 east of site, 1 south of site, 1 west of site	Define extent of groundwater contamination. Results will be used to determine location of additional monitoring well(s).
Install one additional monitoring well (MW1-04).*	Location to be determined based on groundwater and hydropunch sample results	Define extent of groundwater contamination. Additional wells may be installed to define extent of contamination.
Groundwater samples at 3 existing monitoring wells and proposed well	MW1-01, MW1-02, MW1-03, MW1-04 (proposed)	Determine groundwater quality at site.

* Additional monitoring wells may be required based on the results of the hydropunch samples.

5.0 SITE 2 (ACTIVE ORDNANCE DEMILITARIZATION SITE)

5.1 SITE DESCRIPTION

The Active Ordnance Demilitarization Site 2 is an 11-acre site that has been used for the demilitarization and disposal of ordnance since 1973. The ordnance consists of explosives and propellants such as ammonium picrate, TNT, RDX, Composition 4, black powder, and propellants. Based on current operations, an estimated total of 80,000 pounds of explosives and propellants have been disposed of at this site (Hart, 1983).

Figure 5-1 shows the physical characteristics and data point locations for the Active Ordnance Demilitarization Site. The site is characterized as a shallow, open, non-vegetated, oval-shaped sand pit. The perimeter of the site is defined by a berm, which is surrounded by woodlands. The ground surface slopes downward toward the north from approximately 125 feet above mean sea level (msl) at the bunker to approximately 90 feet above msl at the open detonation area. In the center of the site, there is a sand hill that is approximately 200 feet long and 15 feet high. Standing water and wetlands are prevalent in the northeast portion of the site. The dominant wind direction is towards the southwest. The general groundwater flow direction is to the north.

5.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), four monitoring wells were installed at the site. Surface and subsurface soil samples were collected and analyzed for constituents associated with the explosives and potential nitrate residues from detonation activity. Of the parameters analyzed, none were detected.

During the Remedial Investigation/Feasibility Study (RI/FS) (Weston, 1993), three additional monitoring wells were installed, one within the detonation area and two outside of the site perimeter. These wells were installed to depths of 20 feet. Groundwater from the seven wells were analyzed for TCL organics, TAL inorganics, and explosive compounds. Five subsurface soil samples were collected and analyzed for TAL inorganics, cyanide, and explosive compounds. Three sediment samples were collected from a drainage depression on the eastern portion of the site. The samples were analyzed for TAL inorganics, cyanide, and explosive compounds. Figure 5-1 shows the existing monitoring wells, sample locations, and proposed sample locations for the Active Ordnance Demilitarization Site.

Analytical results from these samples indicate very low concentrations of explosive compounds were found in two wells (MW2-03 and MW2-06). Nitrates were detected in MW02-6. The concentrations of metals in

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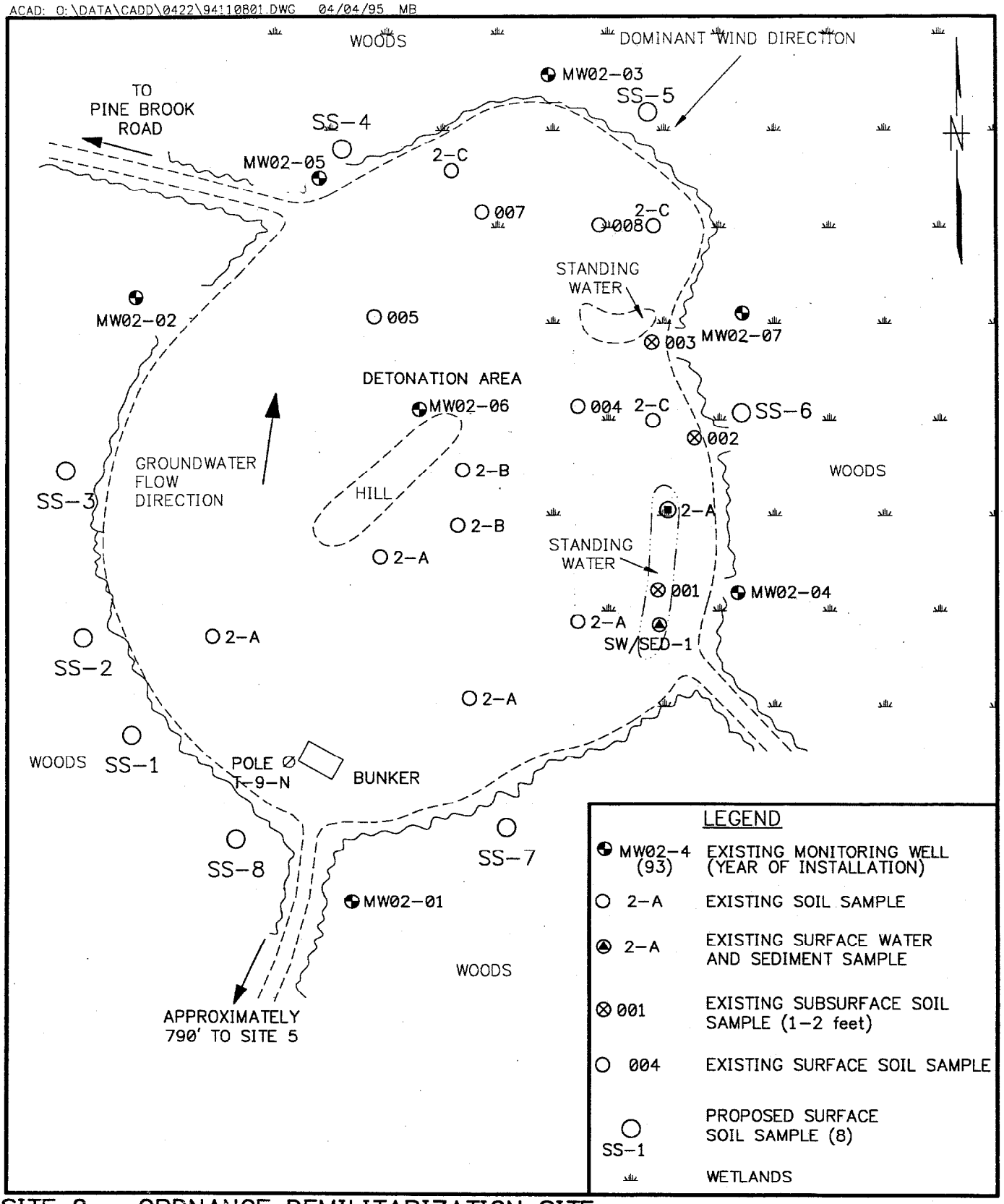

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 2 – ORDNANCE DEMILITARIZATION SITE
MONITOR WELL AND SAMPLING LOCATIONS
NWS EARLE, NJ

0 200 400
SCALE IN FEET

FIGURE 5-1

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soil and sediment samples were within normal background levels, except for chromium and cadmium (in sediment sample 2-001). High iron concentrations were attributable to naturally-occurring conditions. Elevated metals concentrations were detected in several groundwater samples. Maximum contaminant concentrations detected at the site are summarized in Tables 5-1 to 5-3.

5.3 RI SAMPLING ACTIVITIES

Data gathered from inside the bermed area during previous investigations will be re-examined under the current RI scope of work to determine the potential effect of this site on the surrounding soils and groundwater. In order to determine if ordnance disposal activities have effected the area outside the bermed area, a total of eight surface samples will be collected from outside this area. Five samples (SS-1, -2, -3, -7, -8) will be collected from the an area that is downwind (southwest) of the detonation area to determine if ordnance demilitarization activities have effected surface soils downwind of the site. Three additional samples (SS-4, -5, -6) will be collected from the upwind direction. Surface soil samples will be collected from the top 0.5 foot of the soil. Sample locations are shown in Figure 5-1.

Groundwater samples will be collected from the seven existing monitoring wells at the site. Note that groundwater samples will be sampled using a low-flow sampling method to minimize turbidity.

Additional samples are collected regularly as a condition of the RCRA Subpart X permit. Results from these data will also be included in the RI report.

Surface soils will be sampled for semivolatiles, explosives and TAL metals. Groundwater will be analyzed for TCL volatiles, semivolatiles, explosives and TAL metals. In addition the valence of chromium (trivalent or hexavalent) and percentages of the $^{+}3$ and $^{+}6$ ions will be determined by using an inductively coupled plasma (ICP) method to determine total chromium and a colorimetric method to quantify the hexavalent chromium. Table 5-4 summarizes the sample rationale for Site 2. Sample analytes, bottle requirements and holding times are listed in Table 3-2.

5.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways have been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 5-1
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 2[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	58	MW02-02	2	5
Acetone	820	MW02-02	700	---
Chloroform	6	MW02-01	6	100/80[4]
Benzene	4 J	MW02-06	0.2 (1)	5
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Nitrate	1,900	MW02-07	1,000	1,000
Aluminum	45,400	MW02-05	200	---
Barium	292	MW02-07	2,000	2,000
Beryllium	8.3	MW02-05	0.008 (20)	4
Calcium	33,200	MW02-06	---	---
Cadmium	5	MW02-07	4	5
Cobalt	9.8	MW02-05	---	---
Chromium	2,370	MW02-07	100	100
Copper	62	MW02-07	1,000	1,300[G]
Iron	300,000	MW02-07	300	---
Mercury	1.1	MW02-06	2	3
Potassium	34,400	MW02-05	---	---
Magnesium	11,900	MW02-05	---	---
Manganese	328	MW02-06	50	---
Sodium	13,500	MW02-07	50,000	---
Nickel	51	MW02-07	100	100
Lead	190	MW02-07	5	15[A]
Antimony	13	MW02-05	2 (20)	6
Vanadium	1,100	MW02-05	---	---
Zinc	190	MW02-05	5,000	---
EXPLOSIVES	**(µg/L)**		**(µg/L)**	**(µg/L)**
Picric Acid	2.1	MW02-06	---	---
RDX	5.91	MW02-06	---	---
2,4-DNT	3.2	MW02-06	0.05 (10)[5]	---

TABLE 5-1 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 2[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
EXPLOSIVES (continued)	**(µg/L)**		**(µg/L)**	**(µg/L)**
Nitrocellulose/Nitroglycerin	2,900	MW02-03	---	---
Nitrate (as N)	13.3	MW02-06	1,000	1,000
1,3,5-TNB	3.02	MW02-03	---	---
Tetryl	1.15	MW02-06	---	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.
Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:
G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

4 Current MCL for trihalomethanes is 100 µg/L. 1994 Proposed Rule for Disinfectants and Disinfection Byproducts: Total for Trihalomethanes combined cannot exceed 80 µg/L.

5 Value provided is for a mixture of 2,4- and 2,6-dinitrotoluene.

J Estimated value.
--- Criteria not available.

TABLE 5-2

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 2[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	8,490	2-007	---
Arsenic	7.5	2-007	20
Barium	2.0	2-007	26,000
Beryllium	1.1	2-007	2
Calcium	15.4	2-007	---
Cobalt	1.4	2-007	---
Chromium	265	2-007	---
Copper	3.4	2-004	600
Cyanide	0.57	2-005	5,200
Iron	33,900	2-007	---
Potassium	6,480	2-007	---
Nitrate	3.1	2-004	---
Magnesium	2,060	2-007	---
Manganese	6.5	2-004	---
Sodium	50.4	2-006	---
Lead	10.8	2-005	600
Selenium	0.65	2-007	1,000
Vanadium	168	2-007	7,000
Zinc	21.1	2-007	1,500

1 Weston Report: Phase II - Site Investigation Study Report, 1993.
2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.
--- Criteria not available.

TABLE 5-3

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 2[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	10,300	02-001	---	---
Arsenic	7.5	02-002	20	33
Barium	10.1	02-002	26,000	---
Beryllium	1.2	02-001	2	---
Calcium	44.5	02-001	---	---
Cadmium	1.2	02-001	100	5
Cobalt	1.4	02-001	---	---
Chromium	**286**	02-001	---	**80**
Copper	17.6	02-002	600	70
Iron	41,300	02-001	---	---
Potassium	6,560	02-001	---	---
Nitrate	1.7	02-003	---	---
Magnesium	2,160	02-003	---	---
Manganese	10.6	02-001	---	---
Sodium	36.3	02-001	---	---
Lead	27	02-001	600	35
Vanadium	210	02-001	7,000	---
Zinc	26.6	02-001	1,500	120

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed new Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

J Not detected.
- - - Criteria not available.

TABLE 5-4

SAMPLING LOCATIONS AND RATIONALE
SITE 2
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Five surface soil samples (SS-1, 2, 3, 7, 8).	Taken downwind (southwest) of the detonation area outside the berm.	Determine if ordnance disposal activities have effected downwind soils outside the berm.
Three surface soils (SS-4, 5, 6).	Taken upwind (north) of the detonation area outside the berm.	Determine if ordnance disposal activities have effected upwind soils outside the berm.
Seven groundwater samples.	From existing monitoring wells at the site (MW2-1 to MW2-7).	Determine groundwater quality at the site.

6.0 SITE 3 (LANDFILL SOUTHWEST OF "F" GROUP)

6.1 SITE DESCRIPTION

The Landfill Southwest of "F" Group is a 5-acre site that was used from 1960 to 1968 for the disposal of domestic and industrial wastes. The domestic wastes consisted of paper, glass, and plastics. The reported industrial wastes consisted of paints and paint thinners, solvents, varnishes, shellac, acids, alcohols, caustics, pesticide containers and rinse waters, wood and small amounts of asbestos. These industrial wastes apparently comprise only a small portion of an approximate 4,800 tons of total waste.

Figure 6-1 shows the physical characteristics and data point locations of the Landfill Southwest of "F" Group. The site is accessible by a dirt road from the southeast and is characterized as an open area that is surrounded by woodlands. 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 120 and 125 feet msl. Wetlands are located to the southeast of the site. A 55-gallon drum was noted on site during a site visit during December 1994. This drum was partially buried with soil and contains material of unknown composition. No evidence of rupture or leaking was observed. No other drums or containers were noted at the site. The drum recently has been removed from the site.

6.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), three monitoring wells were installed. During the RI/FS (Weston, 1993), seven test pits were excavated. Two soil samples were collected from the test pits and analyzed for TCL organics and TAL inorganics. 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. Groundwater in all seven wells was collected and analyzed for full TCL/TAL analytes. Later rounds of groundwater samples were analyzed for VOCs and drinking water metals at a limited number of wells. Figure 6-1 shows the existing monitoring wells and sampling locations for the Landfill Southwest of "F" Group.

Based on visual inspection of test pit excavations, the landfill contains a normal range of municipal waste. In groundwater samples, an elevated level of arsenic was found in one downgradient well (MW3-01). Elevated levels of volatiles and semivolatiles were found in some wells particularly monitoring well MW03-04. Wells MW03-4 and MW03-5 had low levels of several pesticide compounds. Other wells (MW3-1, MW3-05 and MW3-07) also contained levels of metals, indicator parameters, COD and sulfate (SO_4) was detected in an upgradient well above background levels. However, this concentration was not high enough to indicate that the landfill is generating a highly concentrated leachate. Maximum contaminant concentrations for soil and groundwater samples are summarized on Tables 6-1 and 6-2.

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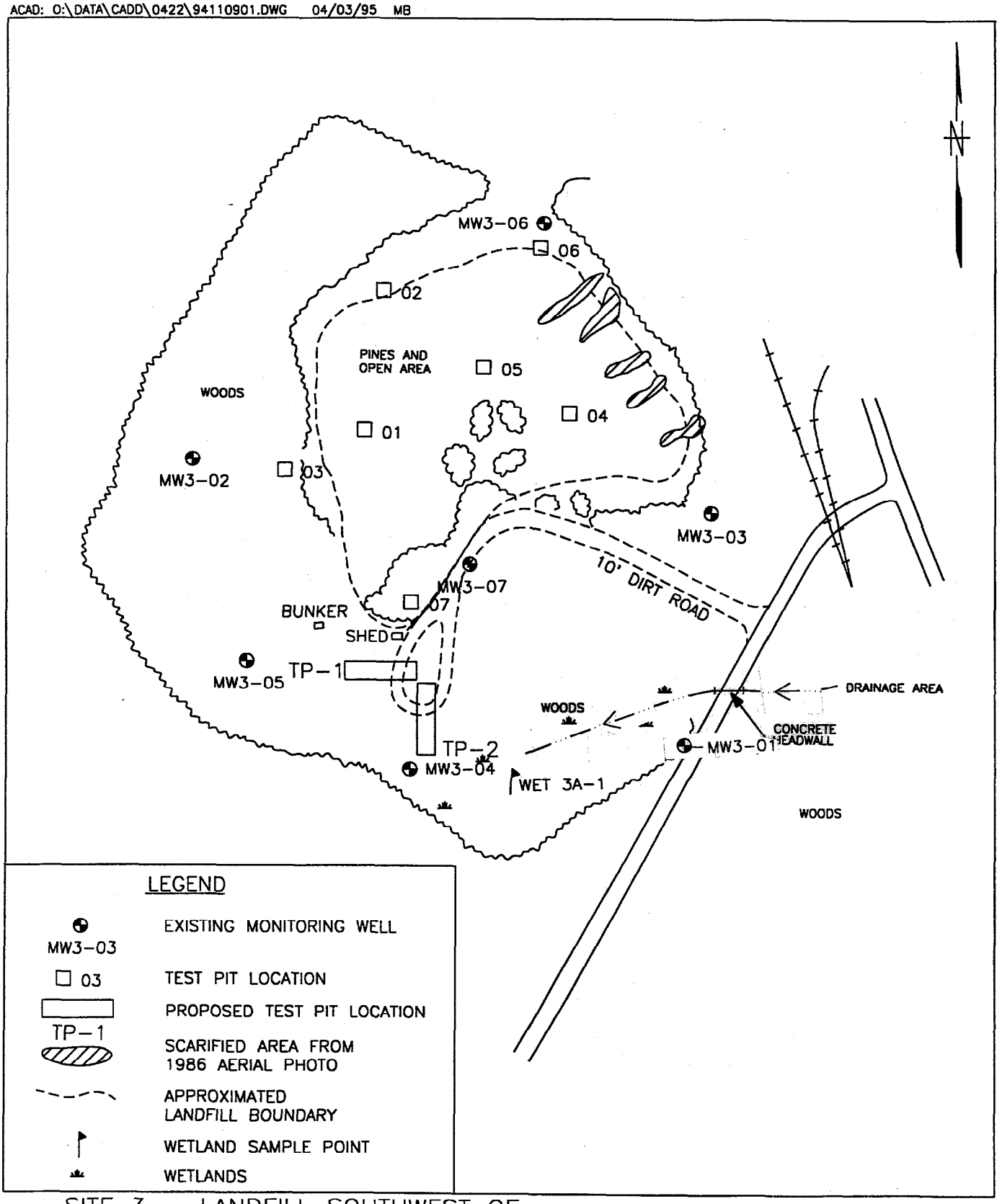

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 3 – LANDFILL SOUTHWEST OF
"F" GROUP MONITOR WELL LOCATIONS
NWS EARLE, NJ

0 150 300
SCALE IN FEET

FIGURE 6-1

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TABLE 6-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 3[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Benzoic acid	0.91	03-TP03-001	---
Phenanthrene	0.25 J	03-TP03-001	---
Anthracene	0.062 J	03-TP03-001	500
Fluoranthene	0.35 J	03-TP03-001	500
Pyrene	0.41 J	03-TP03-001	500
Benzo(a)anthracene	0.2 J	03-TP03-001	500
Chrysene	0.23 J	03-TP03-001	500
Bis(2-ethylhexyl)phthalate	0.35 J	03-004-T001	100
Benzo(b)fluoranthene	0.19 J	03-TP03-001	500
Benzo(k)fluoranthene	0.21 J	03-TP03-001	500
Benzo(a)pyrene	0.19 J	03-TP03-001	100
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	1,250	03-004-T001	---
Arsenic	0.94	03-TP03-001	---
Barium	1,320	03-004-T001	---
Beryllium	0.16	03-004-T001	---
Calcium	7,410	03-TP03-001	---
Cobalt	1.8	03-TP03-001	---
Chromium	7.7	03-007-T001	---
Copper	16.3	03-TP03-001	---
Cyanide	1.0	03-004-T001	---
Iron	3,590	03-TP03-001	---
Potassium	141	03-007-T001	---
Magnesium	1,150	03-TP03-001	---

TABLE 6-1 (continued)
SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 3[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Manganese	43.7	03-TP03-001	---
Sodium	43.4	03-TP03-001	---
Nickel	2.9	03-004-T001	---
Lead	32.4	03-004-T001	---
Selenium	0.34	03-TP03-001	---
Vanadium	6.9	03-004-T001	---
Zinc	34.7	03-004-T001	---
Nitrate	1.3	03-004-T001	---
PESTICIDES	**(mg/kg)**		**(mg/kg)**
Dieldrin	0.031 J	03-004-T001	50
4,4'-DDE	0.052 J	03-004-T001	100
4,4'-DDD	0.120 J	03-004-T001	100
4,4'-DDT	0.050 J	03-004-T001	100
Alpha-chlordane	0.051 J	03-004-T001	---
Gamma-chlordane	0.035 J	03-004-T001	---
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbon	110	03-004-T001	---
ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene chloride	0.061	03-004-T001	10
Acetone	0.045	03-007-T001	50

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.
--- Criteria not available.

TABLE 6-2

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 3[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Levels[3] (MCLs)
SEMIVOLATILES	**(µg/L)**		**(µg/L)**	**(µg/L)**
1,4-Dichlorobenzene	10 J	MW03-04	75	75
4-Methylphenol	52	MW03-04	---	---
Naphthalene	74	**MW03-04**	---	---
2-Methylnaphthalene	5 J	**MW03-04**	---	---
Diethylphthalate	4 J	**MW03-04**	5,000	---
N-nitrosodiphenylamine (1)	1 J	**MW03-04**	7	---
Bis(2-ethylhexyl)phthalate	3 J	**MW03-06** **MW03-05**	3 (30)	6
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene Chloride	**42 J**	MW03-01	**2**	**5**
Acetone	**4,400**	MW03-02	**700**	---
Toluene	77 J	MW03-04	1,000	1,000
Chlorobenzene	**13**	MW03-05	**4**	---
Ethylbenzene	180	MW03-04	700	700
Xylene	**470**	MW03-04	**40**	10,000
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	11.2	MW03-01	200	---
Arsenic	**3,500**	MW03-01	**0.02 (8)**	**50**
Barium	290	MW03-05	2,000	2,000
Beryllium	**1.2**	MW03-01	**0.008 (20)**	4
Calcium	24,300	MW03-06	---	---
Cadmium	**49.2**	MW03-01	**4**	**5**
Cobalt	16	MW03-05	---	---
Chromium	**641**	MW03-01	**100**	**100**
Copper	122	MW03-05	1,000	1,300[G]
Iron	**369,000**	MW03-05	**300**	---
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Mercury	**2**	MW03-07	**2**	**2**
Potassium	2,800	MW03-05	---	---
Magnesium	6,200	MW03-06	---	---

TABLE 6-2 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 3[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Levels[3] (MCLs)
INORGANICS (continued)	**(µg/L)**		**(µg/L)**	**(µg/L)**
Manganese	**2,640**	MW03-05	**50**	---
Sodium	3,200	MW03-01	50,000	---
Nickel	4.5	MW03-02	100	100
Lead	**147**	MW03-01	**5**	**15[4]**
Antimony	**25**	MW03-04	**2 (20)**	**6**
Selenium	7.7	MW03-01	50	50
Vanadium	490	MW03-01	---	---
Zinc	870	MW03-01	5,000	---
PESTICIDES/PCBs	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aldrin	0.031 J	MW03-04	0.002 (0.04)	---
4,4'-DDE	0.021 J	MW03-05	0.1	---
4,4-DDT	0.093 J	MW03-05	0.1	---
Alpha-chlordane[4]	**0.54**	MW03-07	**0.01 (0.5)**	2
Gamma-chlordane[4]	0.26	MW03-04	0.01 (0.5)	2

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

4 Values presented are for chlordane in general.

J Estimated value.
--- Criteria not available.

6.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on past sampling, groundwater may have been impacted by former activities, although no pattern is evident. To confirm if a continuing source of contamination may be present at the site, a general soil-gas survey (located in the vicinity of well MW3-04) will be conducted and all seven existing monitoring wells will be sampled. The results of this survey and groundwater sampling will define the location of additional soil borings and/or wells which may be required to further define the limits of groundwater contamination. The soil-gas survey and the groundwater sampling will occur early in the field investigation to allow for additional field operations to be conducted at the site during the same field mobilization.

Two test pits (TP-1 and TP-2) will be excavated in the turn-around area near MW3-04 to determine if this area contains landfill material which may be contributing to the VOC and SVOCs which were detected in this well during the SI. Test pits will be approximately 20 feet long and 10 feet deep. Visual observations will be made to determine if soils in this area contain landfill, clean fill or natural material. No predetermined samples for chemical analysis will be collected from these test pits. If landfill material is encountered the test pit will be extended until natural soil is encountered and the edge of the landfill is defined. During the excavation, all material removed will be screened with a PID/FID to determine if a significant source of volatiles may be present. Samples will be collected for laboratory analysis of VOCs/SVOCs if appropriate (based on a sustained elevated reading on the PID/FID). Immediately following the excavation activities, each test pit will be filled.

One surface soil sample will be collected from the wetlands areas (WET 3A-1) at the southern boundary of the site to evaluate potential wetland contamination from the landfill. Groundwater and the soil samples will be analyzed for TCL volatiles, TCL semivolatiles, TAL metals, and pesticides. Sampling locations and rationale are provided in Table 6-3.

6.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 6-3

SAMPLING LOCATIONS AND RATIONALE
SITE 3
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Seven groundwater samples.	Existing monitoring wells (MW3-01, MW3-02, MW3-03, MW3-04, MW3-05, MW3-06, MW3-07).	Determine groundwater quality. Based on groundwater results.
Two test pits (TP-1 and TP-2). No samples collected for chemical analysis, unless sustained elevated PID/FID readings are observed during field screening of the excavated materials.	In turn-around area south of landfill.	Determine if landfill extends to this area.
One surface soil sample (WET 3A-1).	In wetlands area in south side of site.	Determine if landfill has contributed to wetlands contamination.
Soil gas survey	Within the triangular area between MW3-05, MW3-04, and MW3-07.	To locate the source of VOCs previously detected at these wells.
Additional groundwater monitoring wells may be required based on the soil gas survey.	To be determined.	To further define the limit of contamination.
Additional soil samples may be required based on the soil gas survey.	To be determined.	To further define the limit of contamination.

7.0 SITE 4 (LANDFILL WEST OF "D" GROUP)

7.1 SITE DESCRIPTION

The Landfill West of "D" Group is a 5-acre site that from 1943 to 1960 was used for the disposal of station domestic and industrial wastes. Activity at this site included the burning of wastes in trenches prior to burial. The industrial wastes consisted of demolition wastes, pesticide containers and rinsewaters, discarded containers of paint, paint thinners, varnishes, shellacs, acids, alcohols, caustics and asbestos. These industrial wastes apparently comprise only a small portion of an approximate 10,200 tons of total waste. Figure 7-1 shows the physical characteristics and data point locations of the Landfill West of "D" Group. The site is characterized as an open area that is surrounded by woodlands. The site is moderately vegetated with grasses and some scrub pines although there are a few bare areas with no vegetation. The site is bordered by Macassar Road to the west and by an unpaved road to the north, east, and south.

The ground surface slopes downward to the southeast from approximately 170 feet above msl near MW04-1 to approximately 150 feet msl at MW04-6. Along the southeastern portion of the site, the fill face is approximately 25 feet high but tapers to the original ground surface. A broad low-lying wetland extends from the eastern portion of the site beyond the unpaved boundary road. Surface and groundwater flow directions are to the southeast toward the wetland.

7.2 PREVIOUS INVESTIGATIONS

Figure 7-1 shows the existing monitoring well and sample locations for the Landfill West of "D" Group. During the SI (Weston, 1993), three monitoring wells were installed and groundwater samples were collected and analyzed. The RI/FS (Weston, 1993) field investigation included test pit excavation, surface water and sediment sampling, and the installation of three additional monitoring wells. Six test pits were excavated to characterize the waste materials. The waste consisted primarily of metal scrap such as steel banding, pipes, and empty metal trash barrels. Lumber, concrete, bricks, and other construction debris were also encountered. No anomalous organic vapor readings were detected in any of the test pits. Of the six total test pits, two were sampled and analyzed for full TCL/TAL analytes and TPH. One semivolatile compound [bis(2-ethylhexyl)phthalate] was detected in test pit 3. The pesticide 4,4-DDT (13 µg/kg) and TPH (2,100 mg/kg) were detected in test pit 2. No other pesticides or PCBs were detected in either sample. Maximum analytical results from soil samples are summarized in Table 7-1.

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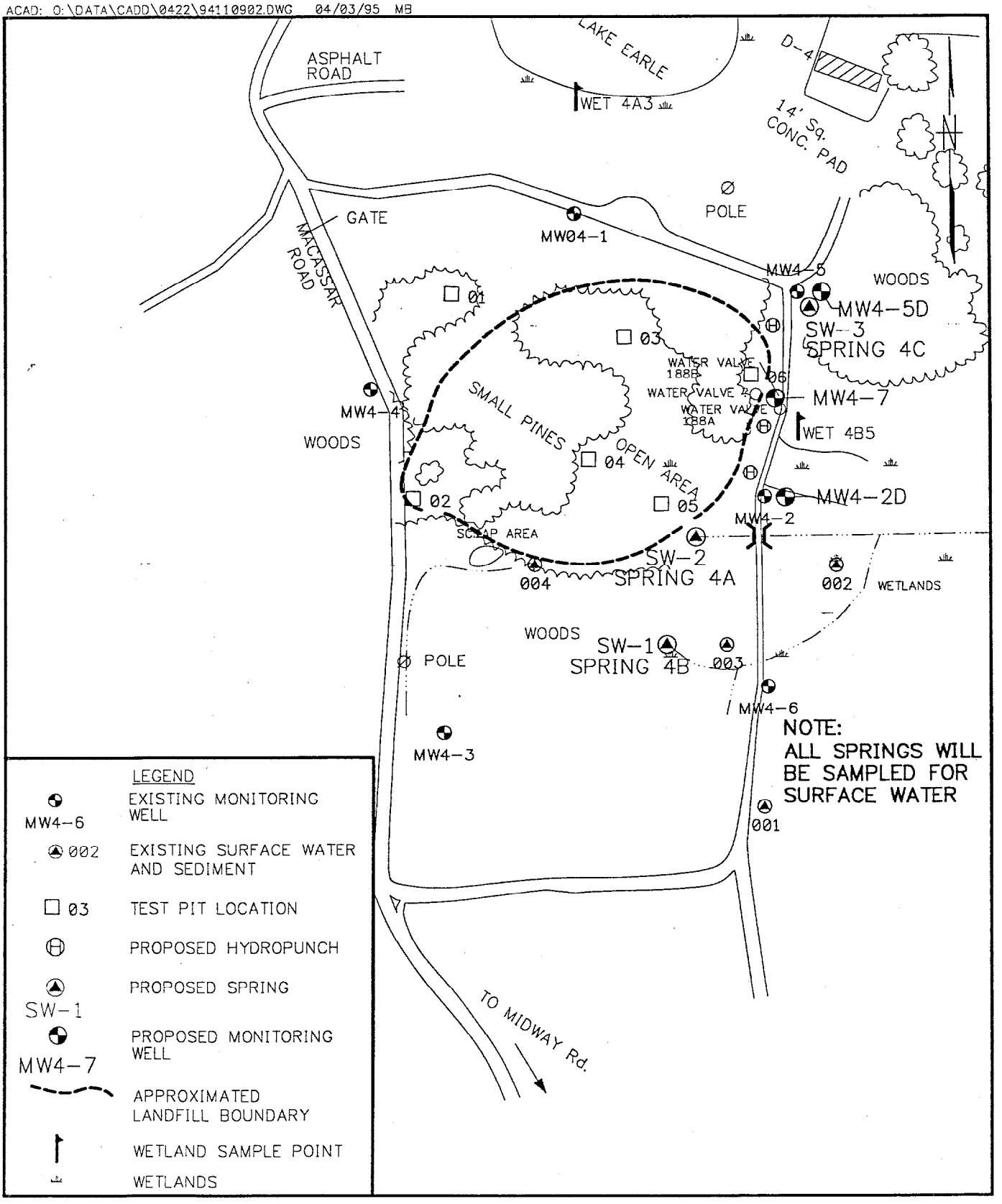

SOURCE: WESTON 1993 RI/FS-RI REPORT

FIGURE 7-1

SITE 4 – LANDFILL WEST OF "D" GROUP

NWS EARLE, NJ

0 250 500

SCALE IN FEET

Halliburton NUS CORPORATION

TABLE 7-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 4[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Bis(2-ethylhexyl)phthalate	0.044 J	04-003-T001	100
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	2,060	04-002-T001	---
Arsenic	0.48	04-002-T001	---
Barium	20.8	04-002-T001	---
Beryllium	0.17	04-002-T001	---
Cobalt	1.5	04-002-T001	---
Chromium	5.6	04-002-T001	---
Copper	5.9	04-002-T001	---
Iron	3,200	04-002-T001	---
Potassium	177	04-002-T001	---
Magnesium	80.8	04-002-T001	---
Manganese	20.4	04-003-T001	---
Sodium	35.4	04-002-T001	---
Nickel	3.3	04-002-T001	---
Lead	13.8	04-002-T001	---
Vanadium	7.9	04-002-T001	---
Zinc	71.1	04-002-T001	---
Nitrate	0.64	04-002-T001	---
PESTICIDES	**(mg/kg)**		**(mg/kg)**
4,4-DDT	0.013 J	04-002-T001	100
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbons	2,100	04-002-T001	---

TABLE 7-1 (continued)
SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 4[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene chloride	0.058	04-002-T001	10
Acetone	0.064	04-002-T001	50
Toluene	0.004 J	04-002-T001	500
Xylene	0.004 J	04-002-T001	10

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.
--- Criteria not available.

Four surface water and sediment samples were collected from the spring-fed stream and drainage along the southeastern portion of the site. Sediment samples contained very low levels of volatiles, semivolatiles and elevated levels of metals and Aroclor-1260. No other PCB or pesticide compounds were found. The surface water samples were analyzed for VOCs and TPH. No VOCs were detected that were not also identified in blanks. No TPH was detected. Maximum analytical results for sediment and surface water are summarized in Tables 7-2 and 7-3.

Groundwater samples were collected from all SI and RI/FS wells. One round was analyzed for full TCL/TAL compounds. A second and third round were analyzed for VOCs, drinking water metals, and landfill indicator parameters. Volatiles such as methylene chloride and acetone which are commonly associated with laboratory contamination were detected in some samples. Trichloroethene exceeded the comparison regulatory standards in MW04-5. No pesticides or PCBs were detected. Lead was detected at a concentration of 17.3 µg/L at MW04-4. Results of the landfill parameters indicated slightly elevated levels of COD and sulfates in the downgradient wells relative to the upgradient well, MW04-4. Maximum analytical results for groundwater are summarized in Table 7-4.

7.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Existing monitoring wells (six) will be sampled in order to further define the extent of groundwater contamination at the site. Three additional monitoring wells will also be installed and sampled. Two deep wells will be installed immediately adjacent to existing wells MW4-2 and MW4-5. These deep wells will be used to determine if groundwater at depth in the aquifer has been effected by volatile contamination which has been noted in the shallow portion of the aquifer. Deep wells will be screened at least 10 feet below the bottom of the monitored interval of the shallow well. Target screening depth for MW-2D is 30 to 40 feet, and is 37 to 47 feet for MW-5D. One additional shallow well (MW4-7) will be installed equidistant between MW4-2 and MW4-5 to determine if groundwater contamination extends between these wells. This well will be screened at a similar interval to other shallow wells. The target screening depth for MW4-7 is 15 to 25 feet. The location and need for this well will be based on the results of three multidepth hydropunch locations between MW4-2 and MW4-5. The results of this survey will be used to determine where and at what depth any additional wells should be located. If no contamination is found at depth, the proposed well(s) will be eliminated.

In addition to groundwater samples, surface water samples will be collected from all springs present along the south and southeast portion of the landfill. At least two springs have been identified south of the site and one at the north (see Figure 7-1). Sampling activities will be conducted during spring when and all natural seeps are likely to be flowing. It is estimated that three surface water samples will be collected (note that all surface water springs will be sampled).

TABLE 7-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 4[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
VOLATILE ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Methylene chloride	0.10	04-002-D001	170	---
Acetone	0.085	04-003-D001	1,000	---
Carbon disulfide	0.002 J	04-002-D001	---	---
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Phenanthrene	0.068 J	04-004-D001	---	0.225[4]
Pyrene	0.13 J	04-004-D001	10,000	0.350[4]
Bis(2-ethylhexyl)phthalate	0.37 J	04-002-D001	210	---
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Silver	1.3	04-004-D001	2,000	1
Aluminum	14,100	04-004-D001	---	---
Arsenic	3	04-004-D001	20	33
Barium	113	04-004-D001	26,000	---
Beryllium	0.24	04-004-D001	2	---
Calcium	1,530	04-004-D001	---	---
Cadmium	5.7	04-004-D001	100	5
Cobalt	3.7	04-004-D001	---	---
Chromium	36.8	04-004-D001	---	80
Copper	71.5	04-004-D001	600	70
Iron	22,100	04-004-D001	---	---
Mercury	1.9	04-004-D001	260	0.15
Potassium	999	04-004-D001	---	---
Magnesium	545	04-004-D001	---	---

TABLE 7-2 (continued)
SUMMARY OF MAXIMUM ANALYTICAL RESULTS FOR SEDIMENT SAMPLES
SITE 4[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Manganese	77.6	04-004-D001	---	---
Sodium	60.2	04-004-D001	---	---
Nickel	10.1	04-004-D001	2,400	30
Lead	**192**	04-004-D001	600	**35**
Antimony	**6.1**	04-004-D001	340	**2**
Vanadium	48.1	04-004-D001	7,000	---
Zinc	**688**	04-004-D001	1,500	**120**
PESTICIDES/PCBs	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aroclor-1260	**1.6**	04-004-D001	2	**0.05**

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 ER-L value of 4.0 mg/kg for total PAHs also applies.

ND Not detected.

--- Criteria not available.

TABLE 7-3

SURFACE WATER RESULTS VERSUS REGULATORY CRITERIA
SITE 4[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	Basin Classification FW2	Freshwater Aquatic Chronic Exposure
			New Jersey Surface Water Quality Criteria[2]	Ambient Water Quality Criteria[3]
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	**30**	04-001-W001	**2.49[hc]**	---
Acetone	74	04-003-W001	---	---
Carbon disulfide	2 J	04-004-W001	---	---
TPH	**(µg/L)**		**(µg/L)**	**(µg/L)**
Petroleum Hydrocarbons	0.54 J	04-004-W001	Nondetectable[4]	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Administrative Code (NJAC) 7:9B-1.14 Surface Water Quality Criteria. Criteria based on human health information. All metals criteria based on Total Recoverable metal.
Designations are as follows:

h - Protection of human health (noncarcinogenic effects).
hc - Protection of human health (carcinogenic effects).
R - Reserved.

3 U.S. EPA Office of Water Regulations and Standards. Quality Criteria for Water 1986 Updates No. 2 dated May 1, 1987 (EPA/440/5-86-011). Designations are as follows:

A - Acute criterion.
C - Chronic criterion.

4 Non detectable goal via EPA Environmental Monitoring and Support Laboratory Method (Freon Extractable - Silica Gel Adsorption - Infrared Measurement). Present criterion is "None noticeable in the water or deposited along the short or on the aquatic substrata in quantities detrimental to the natural biota. None which would render the waters unsuitable for the designated uses."

J Estimated value.
--- Criteria not available.

TABLE 7-4

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 4[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Levels[3] (MCLs)
SEMIVOLATILES	**(µg/L)**		**(µg/L)**	**(µg/L)**
Bis(2-ethylhexyl)phthalate	2 J	MW04-04	3 (30)	6
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	13	MW04-04	2	5
Acetone	5,000	MW04-06	700	---
Chloroform	3 J	MW04-03	6	100/80[4]
1,2-Dichloroethene	33	MW04-05	10/100	70/100
Trichloroethene	78	MW04-05	1	5
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	9,500	MW04-05	200	---
Barium	61	MW04-05	2,000	2,000
Calcium	34,800	MW04-02	---	---
Chromium	26	MW04-05	100	100
Copper	24	MW04-04	1,000	1,300[G]
Cyanide	20	MW04-01	200	200[P]
Iron	53,200	MW04-02	300	---
Potassium	5,200	MW04-02	---	---
Magnesium	16,400	MW04-02	---	---
Manganese	306	MW04-04	50	---
Sodium	5,190	MW04-02	50,000	---
Nickel	20	MW04-03	100	100
Lead	17.3	MW04-04	5	15[A]
Selenium	1.5	MW04-02	50	50
Vanadium	28	MW04-05	---	---
Zinc	156	MW04-04	5,000	---
Mercury	0.34	MW04-04	2	2

TABLE 7-4 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 4[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Levels[3] (MCLs)
MISCELLANEOUS	**(µg/L)**		**(µg/L)**	**(µg/L)**
BOD 5-Day	9,500	MW04-03	---	---
Chloride	7,200	MW04-02	250,000	250,000[S]
Chemical Oxygen Demand	2,270,000	MW04-01	---	---
Nitrate/Nitrite	330	MW04-02	10,000	10,000
Ammonia, as N	410	MW04-02	500	---
Phosphate, as P	58	MW04-01	---	---
Sulfate	31,800	MW04-02	250,000	---
Turbidity	2,550 NTU	MW04-04	---	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

4 Values presented are for chlordane in general.

J Estimated value.
--- Criteria not available.

One surface water/sediment sample will be collected from the wetlands area (WET 4B-5) at the eastern boundary of the landfill to determine if the landfill has contributed to wetlands contamination.

Groundwaters surface water and sediment will be analyzed for TCL volatiles, TCL semivolatiles, TAL metals, and landfill indicator parameters. Surface water samples will be analyzed for TCL PCBs. Hydropunch samples will be analyzed for TCL volatiles and TCL semivolatiles. Sample analytes, bottle requirements, and holding times are listed on Table 3-2. Table 7-5 summarizes sampling locations and rationale.

7.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 7-5

SAMPLING LOCATIONS AND RATIONALE
SITE 4
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Three additional monitoring wells, MW4-2D, MW4-5D and MW4-7 (two deep and one shallow).	Two deep wells to be installed adjacent to MW4-2 and MW4-5. One shallow well to be installed equidistant between these wells.	Determine vertical and lateral extent of groundwater contamination downgradient of landfill.
Nine groundwater samples.	All new and existing monitoring wells (MW4-01, MW4-02, MW4-2D, MW4-03, MW4-04, MW4-05, MW4-5D, MW4-06 and MW4-7).	Determine groundwater quality in shallow and deeper portion of the aquifer.
Surface water samples, three estimated (SW-1 to SW-3).	From springs along southern and northern edge of landfill. All springs will be sampled.	Determine effect of landfill on surface water.
One surface water and sediment sample (WET 4B-5).	Wetlands immediately adjacent to landfill boundary.	Determine if landfill has contributed to wetlands contamination.
Three hydropunch samples	Between well MW4-2 and MW4-5.	Define extent of groundwater contamination. Results will be used to determine location of additional monitoring well(s).

8.0 SITE 5 (LANDFILL WEST OF ARMY BARRICADES)

8.1 SITE DESCRIPTION

The Landfill West of Army Barricades is a 13-acre site that was used from 1968 to 1978 for the disposal of domestic and industrial wastes. The domestic wastes consisted of paper, glass, and plastics. The industrial wastes consisted of waste wood, pesticide containers and rinsewaters, and discarded containers of paint, paint thinner, solvents, varnishes, shellacs, acids, alcohols, and caustics. Figure 8-1 shows the physical characteristics and sampling locations of the site. The site is characterized as an open area surrounded by woodlands. It is located approximately 1,000 feet southwest of Site 2 (Active Ordnance Demilitarization Site). The landfill is accessible via a dirt road along the northwestern border. Railroad tracks are located along the northwestern boundary. There is a wetland between the access road and the railroad siding. The site is moderately vegetated with grasses and scrub pines. Groundwater flow is generally to the north-northeast (Weston, 1993).

8.2 PREVIOUS INVESTIGATIONS

Figure 8-1 shows the existing monitoring well and sample locations at the Landfill West of the Army Barricades. During the SI (Weston, 1993), four monitoring wells were installed. During the RI/FS (Weston, 1993), four test pits were excavated to characterize the wastes that were disposed of at the site. A layer of trash, which ranged in thickness from 6 to 13 feet, was encountered in all four test pits. The trash consisted of foam rubber, glass, paper, plastic, metal scrap materials, lumber, concrete, bricks, and other construction debris. The cover material was thin to non-existent. Groundwater was not encountered. Elevated organic vapor readings (HNu) were detected in one of the four test pits (TP5-1). Two soil samples were analyzed for full TCL/TAL analytes. Low levels of metals, semivolatiles, volatiles and one pesticide were detected. Maximum concentrations of contaminants found in subsurface soils are listed on Table 8-1.

During the RI/FS, four monitoring wells were installed. Groundwater samples were collected from all SI and RI/FS wells and analyzed for TCL/TAL analytes, cyanide, VOCs, drinking water metals, and landfill indicator parameters. Chloroform was detected in wells MW05-04 and MW05-08 (an upgradient well). Contaminants of concern include, beryllium, chromium, cadmium, and to a lesser extent, lead, that were detected in several wells. Lead and chromium were highest at MW05-6. Volatile organics including DCE, TCE, and benzene were also detected in MW05-6. Results of landfill parameters indicated elevated levels of sulfate.

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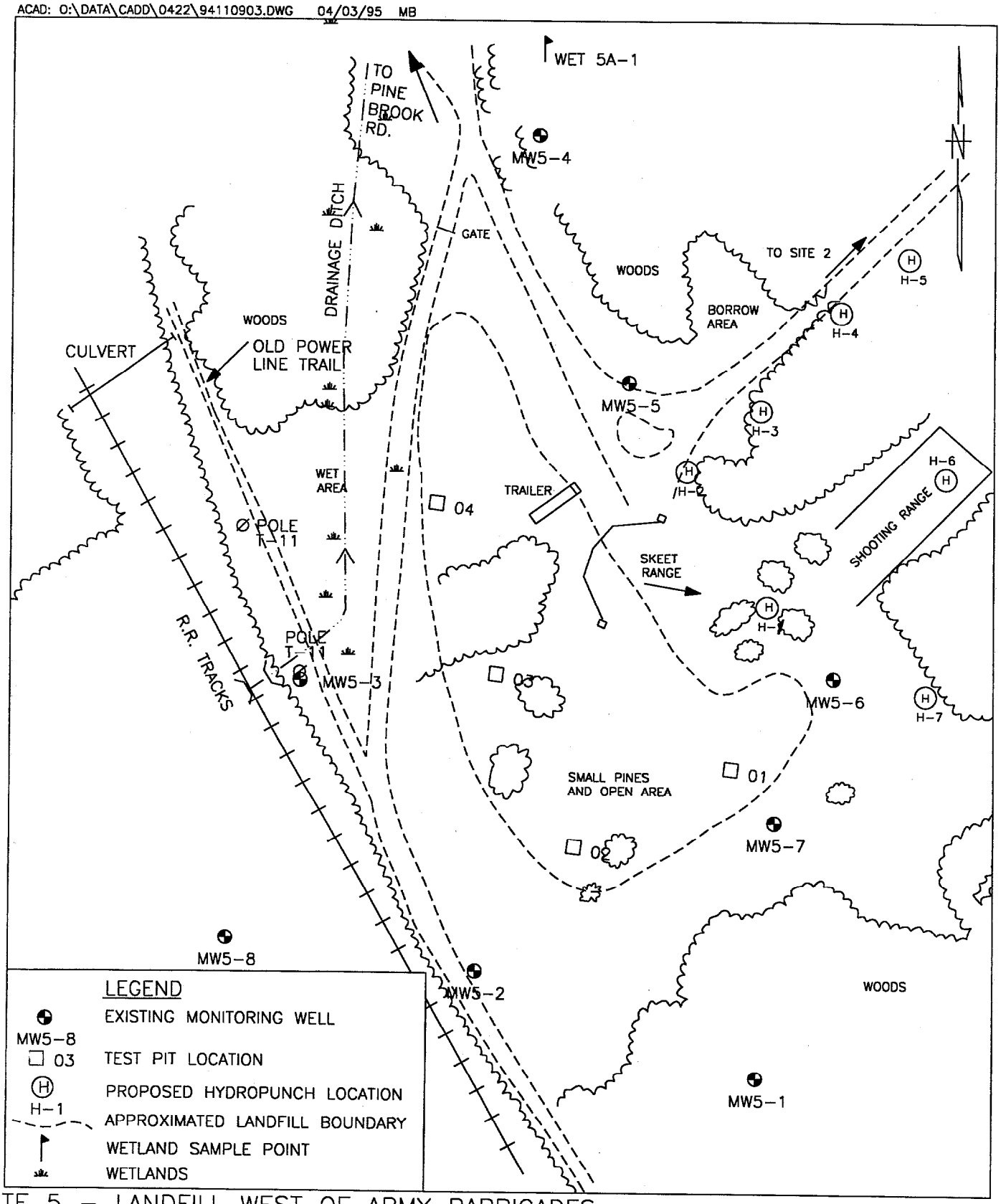

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 5 – LANDFILL WEST OF ARMY BARRICADES

MONITOR WELL AND SAMPLING LOCATIONS

NWS EARLE, NJ

0 150 300

SCALE IN FEET

FIGURE 8-1

Halliburton NUS CORPORATION

TABLE 8-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 5[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
VOLATILE ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene chloride	0.049	05-001-T101	10
Acetone	0.062	05-003-T001	50
Toluene	0.022	05-001-T001	500
Ethylbenzene	0.003 J	05-001-T001	100
Xylene	0.012	05-001-T001	10
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Dibenzofuran	0.082 J	05-001-T101	---
Acenaphthene	0.110 J	05-001-T101	100
Phenanthrene	0.310 J	05-001-T101	---
Anthracene	0.049 J	05-001-T101	500
Fluoranthene	0.31 J	05-001-T101	500
Pyrene	0.180 J	05-001-T101	500
Benzo(a)anthracene	0.083 J	05-003-T001	500
Chrysene	0.095 J	05-003-T001	500
Bis(2-ethylhexyl)phthalate	0.180 J	05-003-T001	100
Benzo(a)fluoranthene	0.089 J	05-003-T001	500
Benzo(b)fluoranthene	0.071 J	05-003-T001	500
Benzo(a)pyrene	0.079 J	05-003-T001	100
INORGANICS	**(mg/kg)**		**(mg/kg)**
Silver	2.3	05-003-T001	---
Aluminum	4,220	05-001-T101	---
Arsenic	5.6	05-001-T101	---

TABLE 8-1 (continued)
SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 5[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
INORGANICS (continued)	**(mg/kg)**		**(mg/kg)**
Barium	5.6	05-001-T101	---
Beryllium	0.72	05-001-T101	---
Calcium	236	05-001-T101	---
Cobalt	0.78	05-001-T001	---
Chromium	126	05-001-T101	---
Copper	2.2	05-001-T001	---
Iron	28,200	05-001-T101	---
Potassium	4,200	05-001-T101	---
Magnesium	1,230	05-001-T101	---
Manganese	9.0	05-001-T101	---
Sodium	63.5	05-001-T001	---
Nickel	0.93	05-003-T001	---
Lead	16.0	05-003-T001	---
Selenium	1.0	05-001-T001	---
Vanadium	106	05-001-T101	---
Zinc	98.9	05-001-T101	---
Nitrate	3.7	05-001-T001	---
PESTICIDES	**(mg/kg)**		**(mg/kg)**
4,4-DDD	11 J	05-003-T001	100
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbons	57	05-003-T001	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D.

J Estimated value.
--- Criteria not available.

There was no distinction between the upgradient well (MW05-8) and downgradient wells for other landfill parameters. Maximum concentrations of contaminants found in groundwater are summarized on Table 8-2.

8.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

In order to confirm the degree of groundwater contamination in the vicinity of this site, all existing wells will be sampled. Wells will be sampled using a low-flow pump to minimize turbidity. Seven groundwater samples will be collected using the hydropunch sampling method to define the extent of any plume of groundwater contamination that may extend away from the site. Two hydropunch groundwater samples (H-1 and H-2) will be collected equidistant between wells MW5-5 and MW5-6 near the station of the landfill. These samples will be used to define the extent of groundwater contamination immediately downgradient of the landfill. Three additional samples (H-3, H-4, H-5) will be collected along the access road leading towards Site 2 (Active Ordnance Demilitarization Site). This road is approximately parallel to the groundwater flow direction and will allow access to the area downgradient of the landfill. These three samples will be used to determine the extent of groundwater contamination at increasing downgradient distances away from the landfill. Two samples (H-6 and H-7) will be collected downgradient of well MW5-6.

The general locations of the hydropunch samples are shown in Figure 8-1, however due to potential access problems, the actual locations will be determined in the field based on site conditions. Based on the results of the hydropunch samples and the groundwater samples from existing monitoring wells a determination will be made on whether additional monitoring wells are necessary to further define and characterize groundwater contamination. Groundwater and hydropunch samples will be collected and analyzed early in the field investigation to allow for additional wells to be installed during the same field mobilization.

Groundwater samples collected from monitoring well locations will be analyzed for TCL volatiles, TAL metals, and landfill indicator parameters. Hydropunch samples will be analyzed for TCL volatiles. Sample analytes, bottle requirements, and holding times are listed on Table 3-2. Table 8-3 summarizes sampling locations and rationale.

8.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 8-2
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 5[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Vinyl chloride	2 J	MW05-04	0.08 (5)	2
Chloroethane	2 J	MW05-06	---	---
Methylene chloride	340 J	MW05-06	2	5
Acetone	7,600	MW05-06	700	---
1,1-Dichloroethane	16	MW05-06	70	---
1,2-Dichloroethene	17	MW05-06	10/100	70/100
Chloroform	6	MW05-08	6	100
1,2-Dichloroethane	8	MW05-06	70	5
Trichloroethene	14	MW05-06	1	5
Benzene	4 J	MW05-06	0.2	5
1,1,2,2-Tetrachloroethane	3 J	MW05-06	2	---
Chlorobenzene	2 J	MW05-05	5	---
Ethylbenzene	4 J	MW05-06	700	700
Xylene	11	MW05-06	40	10,000
SEMIVOLATILES	**(µg/L)**		**(µg/L)**	**(µg/L)**
1,4-Dichlorobenzene	2 J	MW05-05	75	75
Naphthalene	2 J	MW05-06	---	---
Di-n-butylphthalate	1 J	MW05-06	900	---
Bis(2-ethylhexyl)phthalate	4 J	MW05-06	3 (30)	6
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	69,600	MW05-07	200	---
Barium	180	MW05-06	2,000	2,000
Beryllium	45	MW05-06	0.008 (20)	4
Calcium	55,900	MW05-06	---	---
Cadmium	34	MW05-07	4	5
Cobalt	66	MW05-07	---	---
Chromium	6,060	MW05-06	100	100
Copper	51	MW05-06	1,000	[G]
Iron	880,000	MW05-06	300	---
Potassium	74,400	MW05-06	---	---
Magnesium	27,700	MW05-06	---	---
Manganese	1,460	MW05-06	50	---

TABLE 8-2 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 5[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
INORGANICS (continued)	**(µg/L)**		**(µg/L)**	**(µg/L)**
Sodium	35,100	MW05-06	50,000	---
Nickel	58	MW05-06	100	100
Lead	**98.5**	MW05-06	**5**	**15[A]**
Antimony	**62**	MW05-06	**2 (20)**	**6**
Vanadium	250	MW05-01	---	---
Zinc	1,120	MW05-06	5,000	---
MISCELLANEOUS	**(µg/L)**		**(µg/L)**	**(µg/L)**
BOD 5-day	7,700	MW05-06	---	---
Chloride	47,200	MW05-06	250,000	---
Chemical Oxygen Demand	60,300	MW05-07	---	---
Nitrate, as N	630	MW05-07	10,000	10,000
Ammonia, as N	340	MW05-06	500	---
Phosphate, as P	1,200	MW05-07	---	---
Sulfate	184,000	MW05-07	250,000	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

J Estimated value.
--- Criteria not available.

TABLE 8-3

SAMPLING LOCATIONS AND RATIONALE
SITE 5
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Groundwater from seven hydropunch locations (H-1 to H-7).	Two locations immediately downgradient of landfill. Three locations at increasing distances downgradient of landfill (along access road). Two downgradient of MW5-6.	Determine lateral extent of groundwater contamination downgradient of landfill.
Eight groundwater samples.	From all existing monitoring wells (MW5-01, MW5-02, MW5-03, MW5-04, MW5-05, MW7-06, MW7-7 and MW7-8).	Determine groundwater quality upgradient and downgradient of landfill.
Additional monitoring well(s) to be considered.	Location to depend on monitoring well and hydropunch sampling results.	Additional well may be installed to define the extent and magnitude of groundwater plume.

9.0 SITE 6 (LANDFILL WEST OF NORMANDY ROAD)

9.1 SITE DESCRIPTION

The landfill west of Normandy Road is a 4-acre site that is 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. Currently, the majority of the landfill surface is paved or covered with buildings. The landfill surface is 10 to 15 feet higher than the adjacent marsh/wetland 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 the bay. Groundwater flow is reported to be to the north-northwest, toward the marsh. Major features of the site are shown in Figure 9-1.

9.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), four soil borings were drilled and converted to monitoring wells. Two soil samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and metals. Low levels of organics and two pesticides were detected in samples from the location of MW6-2 and MW6-3. Low levels of metals were also detected. Table 9-1 summarizes the maximum results for soil samples. Four sediment samples were collected from the marsh area downgradient of the site. Elevated levels of metals, pesticides, semivolatiles and PCBs were detected. Table 9-2 summarizes the maximum results for sediment samples. Groundwater samples were collected from the four monitoring wells and analyzed for metals, organics, and landfill parameters. Elevated levels of metals, one semivolatile and two miscellaneous parameters were detected. Table 9-3 summarizes the maximum analytical results for groundwater samples. Landfill parameters were relatively low compared to active solid waste landfills.

9.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

To determine if the landfill is impacting the sediment in the marsh, surface water and sediment samples will be taken from the wetland and any flowing seeps along the toe of the landfill will be sampled. RI field activities at Site 6 will include a site inspection along the toe of the landfill for the purpose of identifying any groundwater seeps that might be present. Any flowing seeps or wet areas are found along the landfill edge, surface water samples will be collected from each seep location (three estimated). In order to determine if the wetlands area adjacent to the site has been effected, three surface water and sediment samples will be collected. These samples will be taken from the marshy areas in the immediate vicinity of the landfill. The locations of surface water and sediment samples will be determined during field

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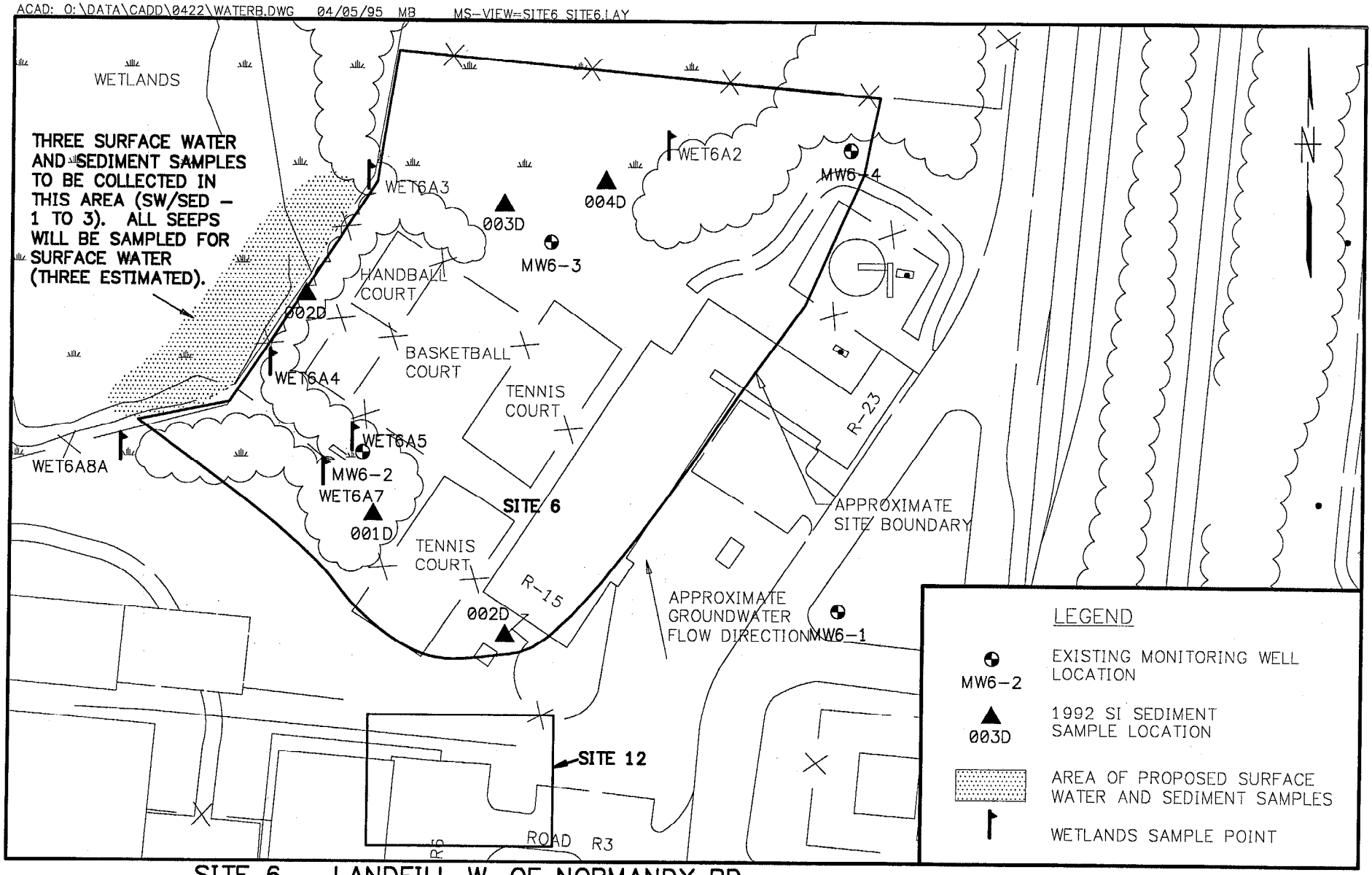

SITE 6 – LANDFILL W. OF NORMANDY RD.
MONITORING WELLS AND SAMPLING LOCATIONS
NWS EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 9-1

Halliburton NUS CORPORATION

TABLE 9-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 6[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	3,090	06-002-B014[3]	---
Arsenic	3.7	06-002-B014	20
Barium	11.7	06-003-B010[4]	26,000
Beryllium	0.38	06-002-B114	2
Calcium	2,240	06-003-B010	---
Chromium	14.4	06-002-B014	---
Cobalt	2.2	06-003-B010 06-002-B014	---
Copper	5.5	06-003-B010	600
Iron	123,000	06-002-B014	---
Lead	11.6	06-003-B010	600
Magnesium	372	06-003-B010	---
Manganese	37.5	06-002-B014	---
Potassium	854	06-002-B014	---
Silver	3	06-003-B010	2,000
Sodium	72.7	06-003-B010	---
Vanadium	13.3	06-003-B010	7,000
Zinc	25.7	06-003-B010	1,500
PESTICIDES	**(mg/kg)**		**(mg/kg)**
4,4'-DDE	0.00085 J	06-002-B114	9
4,4'-DDT	0.01	06-003-B010	9
ORGANICS	**(mg/kg)**		**(mg/kg)**
Acetone	0.034	06-002-B014	1,000
2-Butanone	0.012	06-002-B014	1,000
Phenol	0.024 J	06-002-B014	10,000
Diethylphthalate	0.390 J	06-003-B010	10,000

TABLE 9-1 (continued)
SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 6[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
ORGANICS (continued)	**(mg/kg)**		**(mg/kg)**
Phenanthrene	0.028 J	06-003-B010	---
Di-n-butylphthalate	0.120 J	06-003-B010	10,000
Fluoranthene	0.039 J	06-003-B010	10,000
Pyrene	0.041 J	06-003-B010	10,000
Butyl benzyl phthalate	0.023 J	06-003-B010	10,000
Benzo(a)anthracene	0.029 J	06-003-B010	2.5
Chrysene	0.027 J	06-003-B010	2.5
Bis(2-ethylhexyl)phthalate	0.160 J	06-003-B010	210
Benzo(b)fluoranthene	0.028 J	06-003-B010	2.5
Benzo(k)fluoranthene	0.022 J	06-003-B010	2.5
Benzo(a)pyrene	0.021 J	06-003-B010	0.25

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 Sample 06-002-B014 was collected from a depth of 12 feet below ground level.

4 Sample 06-002-B010 was collected from a depth of 9 feet below ground level.

J Estimated value.
--- Criteria not available.

TABLE 9-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 6[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	3,100	06-003-D001	---	---
Arsenic	5.1	06-003-D001	20	33
Barium	25	06-003-D001	26,000	---
Beryllium	0.55	06-003-D001	2	---
Cadmium	1.3	06-003-D001	100	5
Calcium	3,630	06-003-D001	---	---
Chromium	16.1	06-003-D001 06-002-D001	---	80
Cobalt	4.3	06-003-D001	---	---
Copper	29.6	06-002-D001	600	70
Iron	16,400	06-003-D001	---	---
Lead	66.7	06-003-D001	600	35
Magnesium	1,350	06-003-D001	---	---
Manganese	112	06-002-D001	---	---
Mercury	0.32	06-002-D001	260	0.15
Nickel	5.2	06-002-D001	2,400	30
Potassium	792	06-002-D001	---	---
Silver	2.1	06-002-D001	2,000	1
Sodium	332	06-002-D001	---	---
Vanadium	18.3	06-002-D001	7,000	---
Zinc	139	06-003-D001	1,500	120
PESTICIDES/PCBs	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Heptachlor	0.0091 J	06-003-D001	0.65	---
Heptachlor epoxide	0.0011 J	06-003-D001	---	---
Dieldrin	0.023 J	06-003-D001	0.18	0.00002
4,4'-DDE	0.034	06-003-D001	9	0.002
4,4'-DDD	0.022 J	06-004-D001	12	0.002
4,4'-DDT	0.100	06-004-D001	9	0.001
Alpha-chlordane	0.012	06-001-D001	---	0.0005[4]

TABLE 9-2 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 6[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
PESTICIDES/PCBs (continued)	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Gamma-chlordane	0.013	06-001-D001	---	0.0005[4]
Aroclor-1260	0.150 J	06-002-D001	2	0.05
ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Methylene chloride	0.029	06-004-D001	170	---
Acetone	0.036	06-001-D001	1,000	---
2-Methylnaphthalene	0.022 J	06-003-D001	---	0.065[5]
Acenaphthylene	0.2 J	06-003-D001	---	---[5]
Acenaphthene	0.028 J	06-003-D001	10,000	0.15[5]
Fluorene	0.041 J	06-003-D001	10,000	0.035[5]
Pentachlorophenol	0.03 J	06-004-D001	10,000	---
Phenanthrene	0.59	06-003-D001	---	0.225[5]
Anthracene	0.36	06-003-D001	---	0.085[5]
Carbazole	0.11 J	06-003-D001	---	---
Di-n-butylphthalate	0.03 J	06-002-D001	10,000	---
Fluoranthene	1.6	06-003-D001	10,000	0.6[5]
Pyrene	1.5	06-003-D001	10,000	0.350[5]
Benzo(a)anthracene	0.95	06-003-D001	2.5	0.23[5]
Chrysene	1.2	06-003-D001	2.5	0.4[5]
Bis(2-ethylhexyl)phthalate	0.039 J	06-002-D001	210	---
Benzo(b)fluoranthene	1.1	06-003-D001	2.5	---[5]
Benzo(k)fluoranthene	0.89	06-003-D001	2.5	---[5]
Benzo(a)pyrene	0.9	06-003-D001	0.25	0.4[5]
Indeno(1,2,3-cd)pyrene	0.6	06-003-D001	2.5	---[5]
Dibenz(a,h)anthracene	0.24 J	06-003-D001	0.25	0.06[5]
Benzo(g,h,i)perylene	0.62	06-003-D001	2.5	---[5]

TABLE 9-2 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 6[1]
NWS EARLE, COLTS NECK, NEW JERSEY

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 Value represents total chlordane (alpha- and gamma-isomers combined).

5 ER-L value of 4.0 mg/kg for total PAHs also applies.

J Estimated value.
--- Criteria not available.

TABLE 9-3

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 6[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	3,110	MW06-01	50 to 200	---
Arsenic	2.6	MW06-01	0.02	50
Barium	112	MW06-02	2,000	2,000
Calcium	102,000	MW06-04	---	---
Chromium	9.9	MW06-01	100	100
Cobalt	7.1	MW06-04	---	---
Copper	18.9	MW06-04	1,000	1,300[G]
Iron	49,800	MW06-01	300	---
Lead	20.7	MW06-04	5	15[A]
Magnesium	42,400	MW06-04	---	---
Manganese	1,650	MW06-01	50	---
Potassium	9,450	MW06-04	---	---
Sodium	60,800	MW06-01	50,000	---
Vanadium	13.6	MW06-04	---	---
Zinc	216	MW06-04	5,000	---
ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	8 J	MW06-01 MW06-02 MW06-04	2	5
Acetone	82	MW06-01	700	---
2-Butanone	27	MW06-01	300	---
Diethylphthalate	10 J	MW06-03 MW06-04	5,000	---
Di-n-butylphthalate	10 J	MW06-02 MW06-04	900	---
Bis(2-ethylhexyl)phthalate	7 J	MW06-03	3 (30)	6

TABLE 9-3 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 6[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
MISCELLANEOUS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Biological Oxygen Demand (BOD)	3,500	MW06-01	---	---
Chloride	155,000	MW06-01	250,000[S]	---
Chemical Oxygen Demand (COD)	158,000	MW06-01	---	---
Nitrate-Nitrite	550	MW06-02	10,000	10,000
Ammonia	**5,100**	MW06-01	**500**	---
Total Organic Carbon (TOC)	18,400	MW06-01	---	---
Phosphate	510	MW06-04	---	---
Sulfate	75,700	MW06-03	250,000	---
Turbidity	1,440 NTU	MW06-01	---	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.
Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

J Estimated value.
NTU Nephelometric Turbidity Units
--- Criteria not available.

activities based on actual site conditions and the presence of surface water at the time of sampling. It is estimated that six surface water and sediment samples will be collected. Surface water samples will be collected from all flowing seeps. In addition to these surface water and sediment samples, the four existing monitoring wells at the site will be sampled.

A summary of the locations and rationale of all samples are listed in Table 9-4. Analytical parameters for sediment will include TAL metals, TCL volatile and semivolatile organic compounds, and TCL pesticides, grain size and total organic carbon (TOC). Surface water will be analyzed for TAL metals, TCL volatiles and semivolatiles, hardness and landfill indicator parameters, which include total organic carbon (TOC), biochemical oxygen demand (BOD 5-day), nitrate-nitrate (as N), ammonia (as N), chloride, phosphate (as P), chemical oxygen demand (COD), and sulfate. Groundwater will be analyzed for TAL metals, TCL volatiles and semivolatiles, explosives, pesticides, dissolved oxygen (in the field) and landfill indicator parameters. Monitoring wells will be sampled for total metals using a low flow sampling pump to minimize turbidity. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

9.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 9-4

SAMPLING LOCATIONS AND RATIONALE
SITE 6
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Six surface water and sediment samples (WET 6A2, 6A3, 6A4, 6A5, 6A7, and 6A8.	Wetlands area immediately adjacent to landfill area.	Determine if landfill has contributed to wetlands contamination.
Groundwater samples at 4 existing monitoring wells.	MW6-01, MW6-02, MW6-03, MW6-04.	Determine groundwater quality.

10.0 SITE 7 (LANDFILL SOUTH OF "P" BARRICADES)

10.1 SITE DESCRIPTION

The Landfill South of "P" Barricades is a 5-acre site that from 1965 to 1977 was used for the disposal of municipal-type solid waste and waste from Waterfront industrial operations. The disposed materials consisted of munitions shipping wastes (dunnage, packing), shop wastes from the Waterfront Public Works Shop and the Munitions Handling Laboratory (glass, wood, and small quantities of waste paints, thinners, and solvents), and domestic refuse. The site is now covered with loose sand quarried from the surrounding area. Figure 10-1 shows the physical characteristics and data point locations of the Landfill South of "P" Barricades. The site is characterized as an open area and small pines surrounded by woodlands. The site is vegetated with grasses and some scrub pines, except for a few scarred areas where no vegetation exists. There is an unpaved road that borders the site to the north, west, and south. The ground surface slopes downward to the west from approximately 165 feet msl near MW07-3 to approximately 125 feet msl near MW07-2. Groundwater generally flows toward the west. There is an elongated wetland that trends north-south across the site.

10.2 PREVIOUS INVESTIGATIONS

Figure 10-1 shows the existing monitoring well and sample locations of the Landfill South of "P" Barricades. During the RI/FS (Weston, 1993), seven test pits were excavated, and two samples were analyzed for full TCL/TAL analytes and TPH. A layer of trash, which ranged in thickness from 2.5 to 6 feet, was encountered in five of the seven test pits. The encountered waste consisted of glass, paper, plastic, cans, and other types of household or shipboard-generated waste. Metal scrap, lumber, concrete, bricks, and other construction debris were also encountered. The cover material was thin to nonexistent. No anomalous organic vapor readings were detected in any of the test pits.

During the RI/FS (Weston, 1993) five monitoring wells were installed and sampled for full TCL/TAL analytes, VOCs, drinking water metals, and landfill indicator parameters. Volatiles were detected in wells MW07-05 and MW07-02. Chemicals often associated with laboratory contamination (methylene chloride and acetone) were detected in MW07-1. Elevated levels of metals including chromium, arsenic and lead were detected in wells at the site. Results of the landfill parameters indicated elevated levels of COD, chlorides, and sulfates in the downgradient wells relative to the upgradient well, MW07-3. Table 10-1 summarizes the maximum values of contaminants detected in groundwater.

Low levels of two semivolatiles were detected in both samples taken at test pits 01 and 07. Table 10-2 summarizes the maximum values of contaminants detected in soils.

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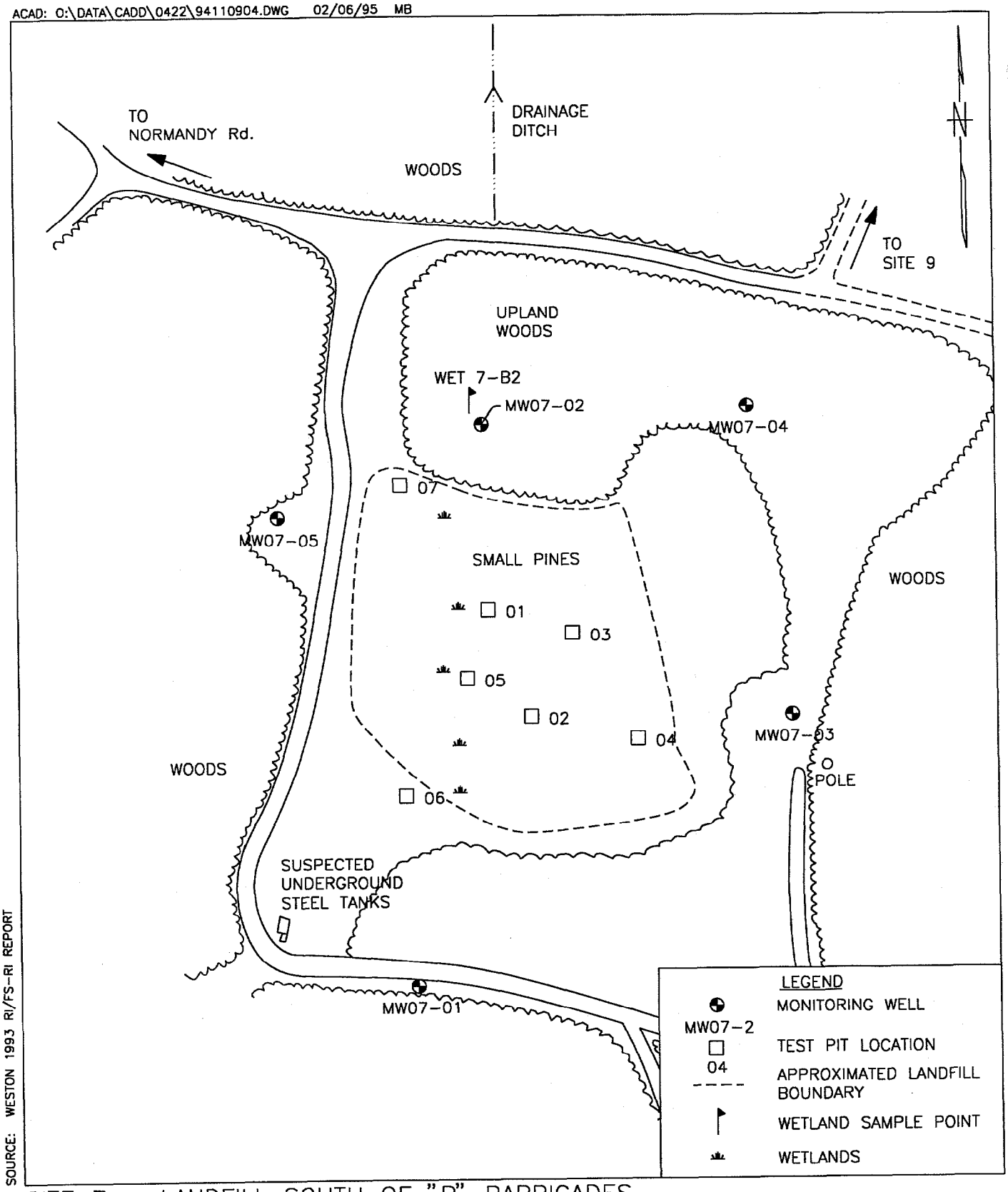

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 7 – LANDFILL SOUTH OF "P" BARRICADES
MONITOR WELL AND SAMPLING LOCATIONS
NWS EARLE, NJ

0 150 300
SCALE IN FEET

FIGURE 10-1

Halliburton NUS CORPORATION

TABLE 10-1

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 7[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene Chloride	4 J	MW07-01	2	5
Acetone	10,000	MW07-01	700	---
Chlorobenzene	5	MW07-02	4	---
1,2-Dichloroethene	4 J	MW07-05	10/100	70/100
2-Butanone	88	MW07-05	300	---
1,1,2-Trichloroethane	26	MW07-05	3	5
1,1,2,2-Tetrachloroethane	8	MW07-05	2	---
SEMIVOLATILES	**(µg/L)**		**(µg/L)**	**(µg/L)**
Bis(2-chloroisopropyl)ether	1 J	MW07-05	300	---
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	27,800	MW07-01	200	---
Arsenic	196	MW07-05	0.02 (8)	50
Barium	416	MW07-05	2,000	2,000
Beryllium	1.3	MW07-01	0.008 (20)	4
Calcium	5,900	MW07-05	---	---
Cobalt	9.4	MW07-04	---	---
Chromium	289	MW07-05	100	100
Copper	160	MW07-05	1,000	1,300[G]
Iron	282,000	MW07-05	300	---
Potassium	3,200	MW07-01	---	---
Magnesium	5,600	MW07-05	---	---
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Manganese	682	MW07-05	50	---
Sodium	18,800	MW07-05	50,000	15A
Nickel	55	MW07-03	100	100
Lead	150	MW07-05	5	---
Vanadium	62	MW07-04	---	---
Zinc	464	MW07-05	5,000	---

TABLE 10-1 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 7[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
MISCELLANEOUS	**(µg/L)**		**(µg/L)**	**(µg/L)**
BOD 5-day	8,600	MW07-05	---	---
Chloride	28,200	MW07-05	250,000	250,000[S]
Chemical Oxygen Demand	323,000	MW07-05	---	---
Nitrate/Nitrite	2,200	MW07-02	10,000	10,000
Ammonia, as N	**2,100**	MW07-02	**500**	---
Phosphate, as P	1,400	MW07-04	---	---
Sulfate	38,700	MW07-02	250,000	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quali Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

J Estimated value.
--- Criteria not available.

TABLE 10-2

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 7[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Di-n-butylphthalate	0.049 J	07-007-T001	100
Bis(2-ethylhexyl)phthalate	0.110 J	07-007-T001	100
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	7,634	07-007-T001	---
Arsenic	18.3	07-007-T001	---
Barium	14.9	07-007-T001	---
Beryllium	0.69	07-007-T001	---
Calcium	170	07-007-T001	---
Cobalt	1.3	07-007-T001	---
Chromium	24.3	07-007-T001	---
Copper	3.3	07-007-T001	---
Iron	15,200	07-007-T001	---
Potassium	769	07-007-T001	---
Magnesium	559	07-007-T001	---
Manganese	16.9	07-007-T001	---
Sodium	162	07-007-T001	---
Nickel	1.4	07-007-T001	---
Lead	13.8	07-007-T001	---
Selenium	0.61	07-007-T001	---
Vanadium	36.1	07-007-T001	---
Zinc	16.9	07-007-T001	---
Nitrite	0.64	07-007-T001	---
Nitrate	0.81	07-007-T001	---
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbons	58.0	07-007-T001	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.
--- Criteria not available.

10.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

All five existing monitoring wells on the site will be sampled to determine the quality of groundwater at the site. Note that wells will be sampled using a low flow pump to minimize turbidity and to provide a better estimation of dissolved metals. Groundwater samples collected from monitoring wells will be analyzed for TCL volatiles, metals and landfill indicator parameters. Sample analytes, bottle requirements, and holding times are listed on Table 3-2. Table 10-3 summarizes sampling locations and rationale.

One surface soil will be collected from the wetlands area (WET 7-B2) at the northern boundary of the landfill to determine if the landfill has contributed to wetlands contamination. The wetland sample will be analyzed for TCL volatiles, TAL metals, and landfill parameters.

10.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 10-3

SAMPLING LOCATIONS AND RATIONALE
SITE 7
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Five groundwater samples.	Collected from all existing monitoring wells (MW07-01, MW07-02, MW07-03, MW07-04 and MW07-05).	Determine groundwater quality at the site.
One surface soil sample (WET 7-B2)	Wetland immediately north of landfill boundary.	Determine if landfill has contributed to wetlands contamination.

11.0 SITE 9 (LANDFILL SOUTHEAST OF "P" BARRICADES)

11.1 SITE DESCRIPTION

The Landfill Southeast of "P" Barricades is an isolated 3-acre site that is located in the Waterfront area. From 1967 to 1972, the site was used for the disposal of dunnage lumber and construction debris. Lumber was stacked, burned, (using a petroleum ignition source) and then covered. An estimated 4,500 to 7,500 cubic yards of lumber were disposed (IAS, 1983). The area reforestation with pine species was completed several years ago. The area is surrounded on all sides by mature hardwood stands. There are some scarred areas where vegetation is sparse. The landfill cover is thin and waste is exposed in some areas. The landfill surface slopes gently toward the south. A small, discontinuous stream is present approximately 300 feet south of the site. Stream flow volume is low and this stream may be intermittent.

11.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993) six test pits were excavated at the site to define the limits of the landfill and to determine if material in the landfill had adversely affected subsurface soils. Test pit locations are illustrated in Figure 11-1. Fill material, which consisted primarily of construction debris and some household trash, was encountered in some of the test pits. Six soil samples, one from each test pit, were collected and analyzed for VOCs, SVOCs, metals, cyanide, and TPH. Analysis of the subsurface soils indicated low levels of TPH, VOCs, pesticides, metals, and cyanide in test pit samples. Three pesticides were also detected at low concentrations at test pits 004 and 005. Maximum contaminant concentrations recorded during the SI are presented in Table 11-1.

11.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Due to the low level of contamination found at this site, no further samples will be taken from within the site boundary. However, to define the extent of landfill materials, two additional test pits (TP9-7 and TP9-8) will be excavated along the northern edge of the landfill. The test pits will be located in the vicinity of where the small pine trees end, which is likely to mark the edge of the landfill.

In addition, one spring sample and two surface water and sediment samples (SW/SED 1 to 3) will be collected from drainage south of the site to determine if groundwater flow and/or surface runoff have effected surface water and sediment. Two surface water and sediment samples (SW/SED-1,2) will be collected from the stream downstream (south) of the site. One additional surface water sample will be

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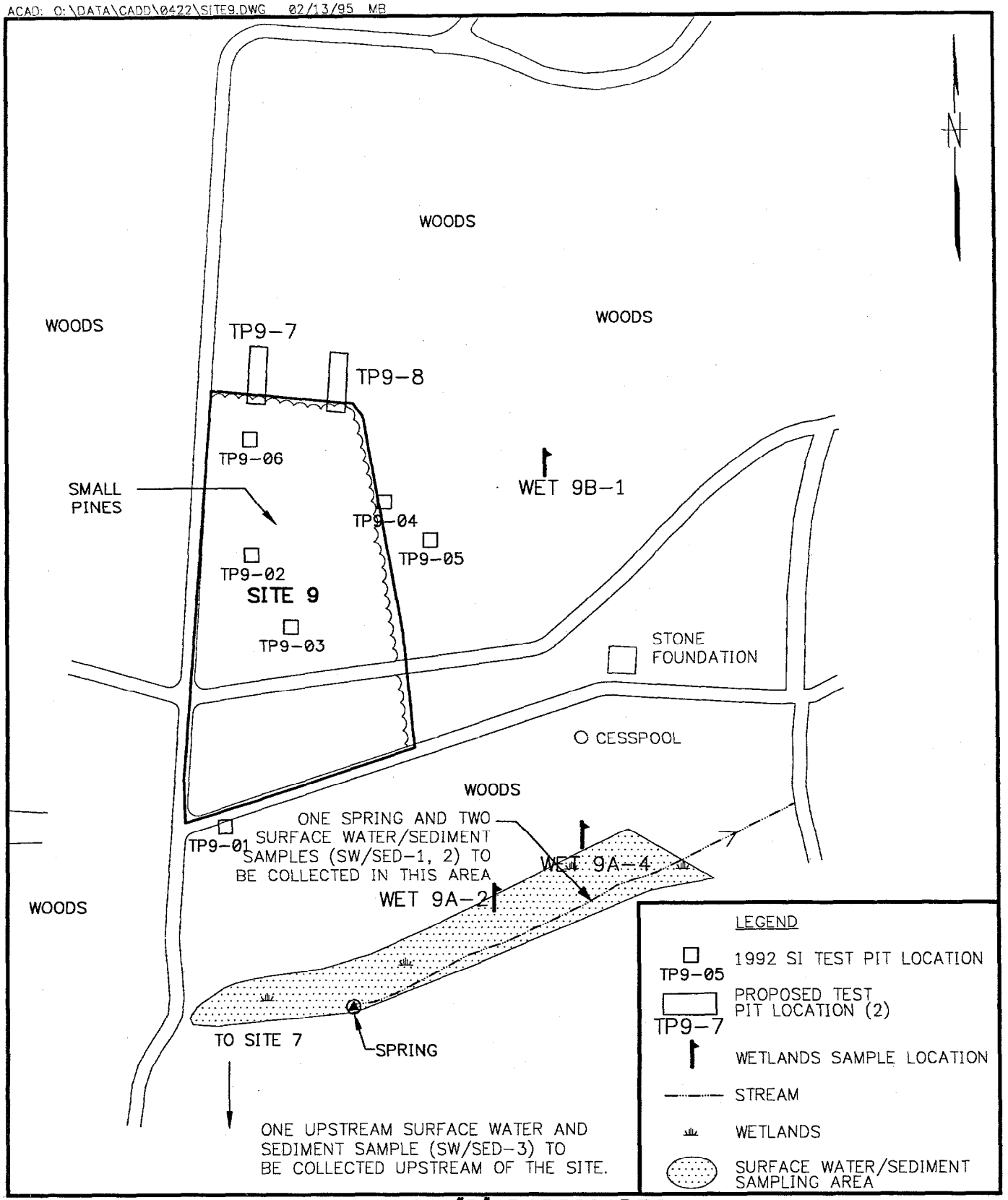

SITE 9 – LANDFILL SOUTHEAST OF "P" BARRICADES

SAMPLING LOCATIONS

NAVAL WEAPONS STATION EARLE, NJ

0 200 400

SCALE IN FEET

FIGURE 11-1

Halliburton NUS CORPORATION

TABLE 11-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 9[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	9,220	09-006-T008	---
Arsenic	13.2	09-003-T009	---
Barium	31.8	09-005-T006	---
Beryllium	1.2	09-002-T010	---
Cadmium	0.99	09-003-T009	---
Calcium	799	09-005-T006	---
Chromium	25.8	09-006-T008	---
Cobalt	4.6	09-004-T005	---
Copper	6.3	09-005-T006	---
Iron	36,300	09-002-T010	---
Lead	17.4	09-005-T006	---
Magnesium	1,520	09-006-T008	---
Manganese	168	09-005-T006	---
Potassium	4,120	09-006-T008	---
Silver	2.7	09-002-T010	---
Sodium	52.8	09-002-T010	---
Vanadium	23.2	09-001-T007	---
Zinc	60.3	09-004-T005	---
Cyanide	1.57	09-006-T008	---
PESTICIDES	**(mg/kg)**		**(mg/kg)**
4,4'-DDE	0.0012 J	09-005-T006	100
4,4'-DDT	0.00082 J	09-004-T005	100
Methoxychlor	0.093	09-004-T005	500

TABLE 11-1 (continued)
SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 9[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
ORGANICS	**(mg/kg)**		**(mg/kg)**
Chloroform	0.001 J	09-001-T007 09-002-T010	1
Di-n-butylphthalate	0.037 J	09-002-T010	100
Bis(2-ethylhexyl)phthalate	0.44 J	09-003-T009	100
TPH			
Total Petroleum Hydrocarbons	4.7 J	09-001-T007	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.
--- Criteria not available.

collected from a spring or seep (if present) in this area. One surface water and sediment sample (SW/SED-3) will be collected from the drainage upstream (west) of the landfill, if possible. Although sampling will occur in the spring, this stream may be intermittent in nature and no surface water may be present when sampling occurs. In this case only a sediment sample will be collected from the upstream location. Sample locations and rationale are outlined in Table 11-2. Note that background samples for soils, surface water, sediment and groundwater will be collected from the area to the west of Site 9. The proposed background samples and locations at NWS Earle are discussed in Section 30.

Surface water and sediment samples collected from Wagner Creek will be analyzed for TCL volatiles and semivolatiles, TCL pesticides, TPH, and TAL metals/cyanide. Sample analytes, bottle requirements, and holding times are listed on Table 3-2.

11.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 11-2

LOCATIONS AND RATIONALE
SITE 9
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Two surface water and sediment samples (SW/SED-1 and 2)	The stream downstream of Site 9.	Determine if the drainage has been impacted by Site 9.
One surface water and sediment sample (SW/SED-3)	The stream/spring upstream of Site 9.	Determine upstream surface water and sediment quality.
Two test pits (no analytical samples to be collected)	Along the northern edge of the landfill material.	Define the northern edge of landfill material and clean soil.
One surface water sample from a spring or seep	Southeast of the Site 9 landfill.	Determine leachate quality.

12.0 SITE 10 (SCRAP METAL LANDFILL)

12.1 SITE DESCRIPTION

The Scrap Metal Landfill is a 2-acre site that was used from 1953 to 1965 for the disposal of demilitarized munitions and spent munitions cases. The disposed material consisted primarily of aluminum and steel containers. Spent grit and paint chips from the ammunition re-work operations were also buried. An estimated 65,000 cubic yards, which includes cover material, has been disposed at this site. Since the site closure, the cover material has eroded and 40-mm shell cases have been uncovered. The Scrap Metal Landfill is characterized as an open area surrounded by wetlands (see Figure 12-1). The site is accessible via a dirt road from the southwest. The site is bordered by railroad tracks to the south, a wetland to the north, and a drainage ditch to the east. The site is vegetated with grasses and scrub pines, except for a open area in the middle where no vegetation exists. The ground surface is relatively flat and the average elevation is approximately 110 feet above msl. The groundwater flow direction is to the northeast toward the drainage ditch.

12.2 PREVIOUS INVESTIGATIONS

Figure 12-1 shows the existing monitoring well and sampling locations for the Scrap Metal Landfill. During the SI (Weston, 1993), three monitoring wells were installed, and surface and groundwater samples were analyzed. Methylene chloride (possible laboratory artifact) was detected at MW10-01, MW10-02, and MW-03. One metal and one semivolatile were detected in surface water samples.

During the RI/FS (Weston, 1993), four test pits were excavated and one sample from test pit 1 was analyzed for TCL/TAL analytes and TPH. Waste was encountered in two of the four test pits. The waste consisted of metallic debris such as rusted shell casings. The cover material was thin to nonexistent. No anomalous organic vapor readings were detected in any of the test pits. Two organics (possible lab contaminants) and a low level of TPH were detected. Table 12-1 summarizes the maximum analytical results of soil samples.

Three surface water and sediment samples were collected and analyzed for TCL/TAL analytes. The sediment samples were also analyzed for TPH and VOCs. Low levels of semivolatiles and inorganics were detected in the sediment samples. It was considered to be likely that these materials were associated with run-off from the adjacent railroad bed. Several volatile compounds typically associated with laboratory contaminants were detected in surface water samples. Metals concentrations were relatively low and no PCB or pesticide compounds were detected. For the surface water samples, low levels of VOCs were detected. Table 12-2 summarizes the maximum analytical results for sediment samples and Table 12- summarizes the maximum analytical results for surface water samples.

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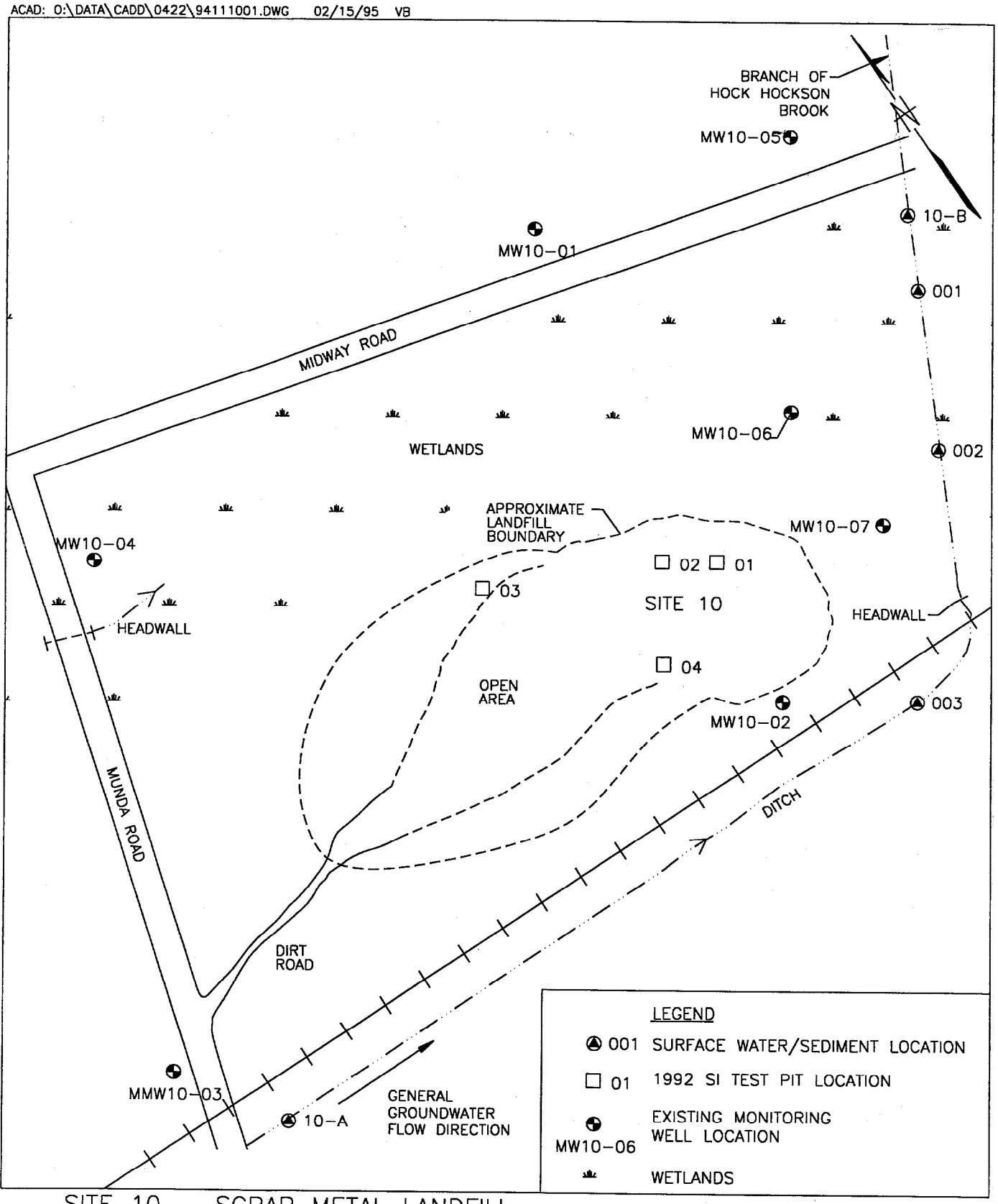

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 10 – SCRAP METAL LANDFILL
MONITOR WELL AND SAMPLING LOCATIONS
NWS EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 12-1

Halliburton NUS CORPORATION

TABLE 12-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 10[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
VOLATILE ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene chloride	**15**	10-004-T201	**10**
Acetone	6 J	10-004-T201	50
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Bis(2-ethylhexyl)phthalate	36 J	10-004-T001	100
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	7,550	10-004-T001	---
Arsenic	5.3	10-004-T001	---
Barium	6.0	10-004-T001	---
Beryllium	0.069	10-004-T001	---
Calcium	117	10-004-T001	---
Cadmium	0.0045	10-004-T201	---
Cobalt	0.55	10-004-T001	---
Chromium	94.4	10-004-T001	---
Copper	0.004	10-004-T201	---
Iron	20,000	10-004-T001	---
Potassium	4,240	10-004-T001	---
Magnesium	1,480	10-004-T001	---
Manganese	11.8	10-004-T001	---
Sodium	19.6	10-004-T001	---
Lead	2.6	10-004-T001	---
Selenium	0.52	10-004-T001	---
Vanadium	76.4	10-004-T001	---
Zinc	8.9	10-004-T001	---
Nitrate	5.1	10-004-T001	---
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbons	4.9	10-004-T001	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.
Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.
--- Criteria not available.

TABLE 12-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 10[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
VOLATILE ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Methylene chloride	0.074	10-001-D001	170	---
Acetone	0.079	10-003-D001	1,000	---
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Phenanthrene	0.170 J	10-003-D001	---	0.225[4]
Fluoranthene	0.088 J	10-003-D001	10,000	0.6[4]
Pyrene	0.092 J	10-003-D001	10,000	0.335[4]
Benzo(a)anthracene	0.054 J	10-001-D001	2.5	0.23[4]
Chrysene	0.090	10-003-D001	2.5	0.4[4]
Bis(2-ethylhexyl)phthalate	0.061 J	10-003-D001	210	---
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	676	10-003-D001	---	---
Arsenic	1.7	10-003-D001	20	33
Barium	5.5	10-003-D001	26,000	---
Calcium	139	10-003-D001	---	---
Cobalt	2.8	10-003-D001	---	---
Chromium	6.3	10-003-D001	---	80
Iron	9,790	10-003-D001	---	---
Mercury	0.13	10-003-D001	260	0.15
Potassium	97.6	10-003-D001	---	---

TABLE 12-2 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 10[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Magnesium	41.8	10-002-D001	---	---
Manganese	58.9	10-003-D001	---	---
Sodium	44.7	10-003-D001	---	---
Lead	5.8	10-003-D001	600	35
Antimony	3.2	10-001-D001	340	2
Vanadium	7.2	10-003-D001	7,000	---
Zinc	14.9	10-003-D001	1,500	120

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 ER-L value of 4.0 mg/kg for total PAHs also applies.

J Estimated value.
--- Criteria not available.

TABLE 12-3
SURFACE WATER RESULTS VERSUS REGULATORY CRITERIA
SITE 10[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	Basin Classification FW2	Freshwater Aquatic Chronic Exposure
			New Jersey Surface Water Quality Criteria[2]	Ambient Water Quality Criteria[3]
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	**28**	10-001-W001	**2.49[hc]**	---
Acetone	140	10-003-W001	---	---
Carbon disulfide	1 J	10-001-W001	---	---
Chloroform	5	10-003-W301	---	0.19 28,900[(A)(4)]/ 1,240[(C)(4)]

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Administrative Code (NJAC) 7:9B-1.14 Surface Water Quality Criteria. Criteria based on human health information. All metals criteria based on Total Recoverable metal. Designations are as follows:

h - Protection of human health (noncarcinogenic effects).
hc - Protection of human health (carcinogenic effects).
R - Reserved.

3 U.S. EPA Office of Water Regulations and Standards. Quality Criteria for Water 1986 Updates No. 2 dated May 1, 1987 (EPA/440/5-86-001). Designations are as follows:

A - Acute criterion.
C - Chronic criterion.

4 Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level.

J Estimated value.
--- Criteria not available.

During the RI/FS, four monitoring wells were installed. Groundwater samples were collected from all seven wells and analyzed for TCL/TAL analytes, VOCs, drinking water metals, and landfill parameters. Elevated levels of metals were detected in several wells. Results of landfill parameters showed no distinction between downgradient wells and the upgradient wells, MW10-3 and MW10-4. Volatiles were detected although these compounds are consistent with common laboratory artifacts. Table 12-4 summarizes the maximum analytical results for groundwater samples.

12.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

All seven existing monitoring wells on the site will be sampled to determine the quality of groundwater at the site. Wells will be sampled using a low flow pump to minimize turbidity and to obtain a better estimation of dissolved metals. Groundwater samples collected from monitoring wells will be analyzed for TCL volatiles, TAL metals, and landfill indicator parameters. If elevated levels of metals are found, additional wells may be installed to further define the magnitude and depth of groundwater contamination. Groundwater at this site will be sampled early in the field investigation to allow for analytical results to be examined and additional wells to be installed during the same mobilization. Sample analytes, bottle requirements, and holding times are listed on Table 3-2. Table 12-5 summarizes sampling locations and rationale.

12.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 12-4

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 10[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Levels[3] (MCLs)
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	30	MW10-06	2	5
Acetone	4,000	MW10-02	700	---
Carbon disulfide	2 J	MW10-03	---	---
SEMIVOLATILES	**(µg/L)**		**(µg/L)**	**(µg/L)**
Bis(2-ethylhexyl)phthalate	2 J	MW10-06	3 (30)	6
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	122,000	MW10-07	200	---
Antimony	51	MW10-07	2 (20)	6
Arsenic	96	MW10-07	0.02 (8)	50
Barium	130	MW10-07	2,000	2,000
Beryllium	17	MW10-07	0.008 (20)	4
Calcium	5,400	MW10-01	---	---
Cadmium	15	MW10-07	4	5
Cobalt	150	MW10-07	---	---
Chromium	3,600	MW10-07	100	100
Copper	1,060	MW10-04	1,000	1,300[G]
Iron	45,200	MW10-07	300	---
Potassium	63,800	MW10-07	---	---
Magnesium	19,700	MW10-07	---	---
Manganese	430	MW10-07	50	---
Sodium	161,000	MW10-04	50,000	---
Nickel	380	MW10-07	100	100
Lead	200	MW10-07	5	15[A]
Selenium	1.6	MW10-05	50	50
Vanadium	3,000	MW10-07	---	---
Zinc	310	MW10-02	5,000	---

TABLE 12-4 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 10[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Levels[3] (MCLs)
MISCELLANEOUS	**(µg/L)**		**(µg/L)**	**(µg/L)**
BOD 5-day	36,000	MW10-05	---	---
Chloride	**473,000**	MW10-01	**250,000**	**250,000[S]**
Chemical Oxygen Demand	81,600	MW10-05	---	---
Ammonia, as N	380	MW10-05	500	---
Nitrate, as N	380	MW10-05	10,000	10,000
Phosphate, as P	440	MW10-06	---	---
Sulfate	108,000	MW10-07	250,000	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

J Estimated value.
--- Criteria not available.

TABLE 12-5

SAMPLING LOCATIONS AND RATIONALE
SITE 10
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Seven groundwater samples.	Collected from all existing monitoring wells (MW10-01, MW10-02, MW10-03, MW10-04, MW10-05, MW10-06, MW10-07).	Determine groundwater quality at the site.
Additional monitoring wells to be considered.	Locations to depend on groundwater sampling results.	Additional wells may be installed to defined the magnitude and depth of groundwater contamination.

13.0 SITE 11 (CONTRACT ORDNANCE DISPOSAL AREA)

13.1 SITE DESCRIPTION

Site 11 is a 2-acre site that was used for disposal of obsolete ordnance material for several years (dates unknown). Also, the site was used from 1974 to 1977 for occasional fire fighting training. These activities took place in two unlined pits approximately 20 feet long. During fire training operations, reject vehicles were soaked with fuel or oil and ignited, then extinguished. Unburned fuel and waste oil used for ignition was allowed to evaporate or soak into the soil. It has been estimated that 50 gallons of oil per year may have been lost in this manner. The site is a fan-shaped open area surrounded by woods on all sides. Groundwater flow directions are generally to the west. Topography of the site slopes to the northwest from approximately 100 ft near MW11-02 to 90 ft near MW11-05. Most of the site is characterized as wetlands. A threatened species of beak-rush may be present at the site. Figure 13-1 shows the physical features of the site.

13.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), four soil borings were analyzed. One soil boring had high concentrations of oil and grease. Three monitoring wells were installed at the site as shown on Figure 13-1. Eight soil samples (from 0.5 to 1.5 feet) were collected from the site during the RI/FS (Weston, 1993). Samples were analyzed for explosives, TPH and nitrate/nitrite. Analytical results indicated that no explosive compounds were present, although six samples showed low TPH results. Table 13-1 summarizes the maximum concentrations detected in soil samples. Two monitoring wells were installed during the RI/FS. All SI and RI/FS monitoring wells were sampled for TCL volatiles, SVOCs, TAL metals/Cn, pesticides/PCBs, and explosives. One semivolatile, three volatiles (common laboratory artifacts), and metals were detected in site wells. Table 13-2 summarizes the maximum results of groundwater samples. Groundwater results indicate that no pesticides, PCBs or explosives were detected at the site. Similar results were obtained during later rounds of sampling at these wells. Later rounds of groundwater sampling confirmed that elevated levels of metals were present in groundwater.

13.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Due to the minimal amount of soil contamination at the site the proposed field activities will focus on groundwater characterization. The five existing monitoring wells will be sampled to determine the quality of groundwater at the site. Groundwater samples will be analyzed for TCL volatiles and TAL metals.

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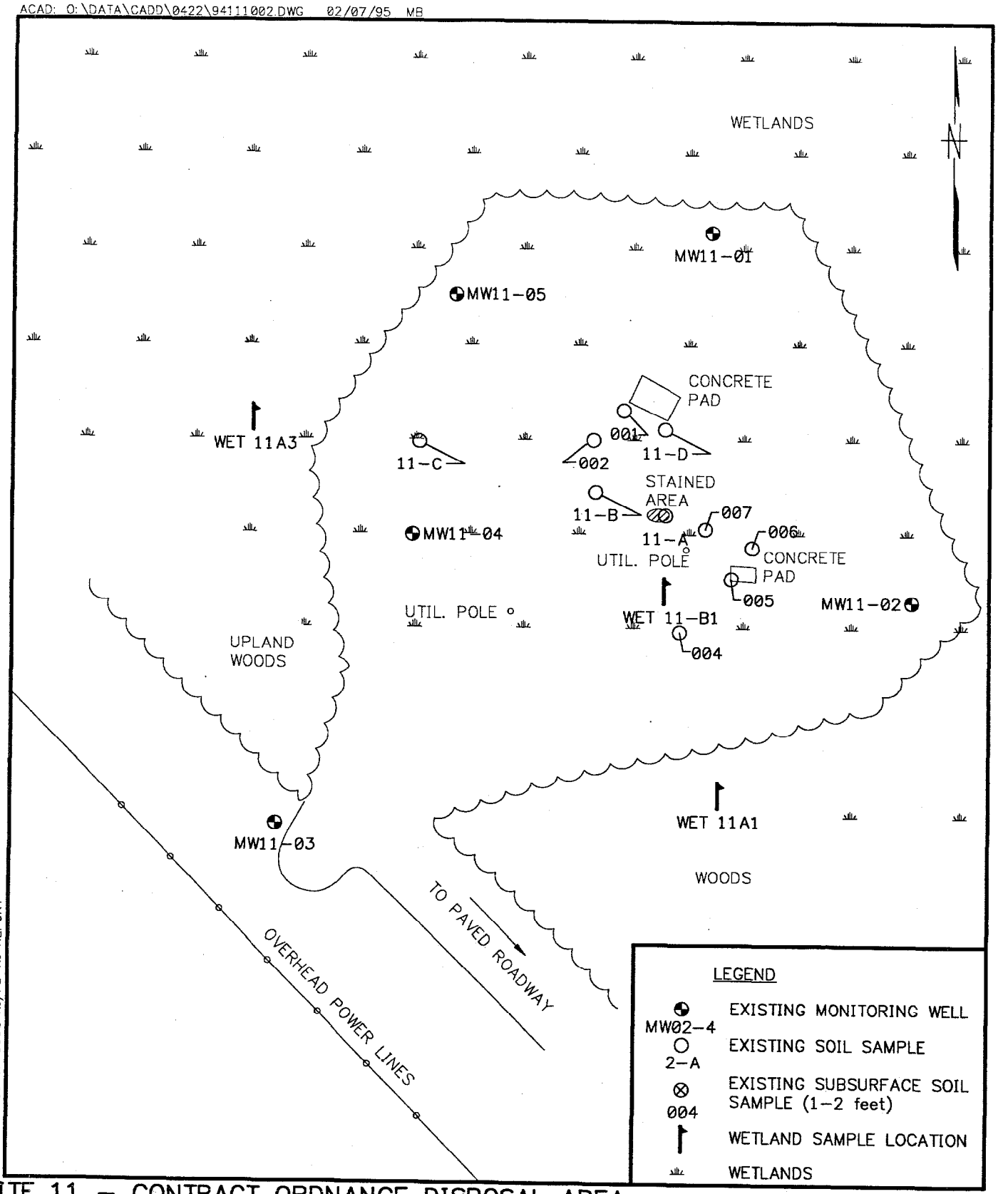

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 11 – CONTRACT ORDNANCE DISPOSAL AREA
MONITOR WELL AND SAMPLING LOCATIONS
NWS EARLE, NJ

FIGURE 13-1

0 100 200
SCALE IN FEET

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TABLE 13-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 11[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Nitrate	3.0	11-02	---
Nitrite	0.66	11-03	---
TPH			
Total Petroleum Hydrocarbons	640	11-01	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

--- Criteria not available.

TABLE 13-2
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 11[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
SEMIVOLATILES	**(µg/L)**		**(µg/L)**	**(µg/L)**
Bis(2-ethylhexyl)phthalate	3 J[5]	MW11-05	3 (30)	6
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	**58**	MW11-04	**2**	5
Acetone	**87,000**	MW11-05	**700**	---
Chloroform	**6**	MW11-01	**6**	100/80[4]
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Nitrate	**2,700**	MW11-03	**1,000**	**1,000**
Aluminum	**2,500**	MW11-03	**200**	---
Barium	57	MW11-01	2,000	2,000
Calcium	4,800	MW11-04	---	---
Cadmium	**4.2**	MW11-03	**4**	5
Chromium	**881**	MW11-01	**100**	**100**
Copper	1.6	MW11-02	1,000	1,300[G]
Iron	**96,000**	MW11-01	**300**	---
Potassium	1,700	MW11-01	---	---
Magnesium	1,700	MW11-04	---	---
Manganese	**53.6**	MW11-03	**50**	---
Sodium	8,300	MW11-04	50,000	---
Nickel	8.3	MW11-02	100	100
Lead	**51.5**	MW11-01	**5**	**15[A]**
Vanadium	4.9	MW11-01	---	---
Zinc	181	MW11-01	5,000	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

TABLE 13-2 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 11(1)
NWS EARLE, COLTS NECK, NEW JERSEY

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

4 Current MCL for trihalomethanes is 100 µg/L. 1994 Proposed Rule for Disinfectants and Disinfection Byproducts: Total for Trihalomethanes combined cannot exceed 80 µg/L.

J Estimated value.
--- Criteria not available.

Samples for metals analysis will be collected using a low-flow pump to minimize turbidity and to obtain a representative dissolved metals sample. Sample analytes, bottle requirements, and holding times are listed on Table 3-2. Table 13-3 summarizes sampling locations and rationale.

13.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 13-3

SAMPLING LOCATIONS AND RATIONALE
SITE 11
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Five groundwater samples.	Collected from all existing monitoring wells (MW11-01, MW11-02, MW11-03, MW11-04, MW11-05).	Determine groundwater quality at the site.

14.0 SITE 12 (BATTERY STORAGE AREA)

14.1 SITE DESCRIPTION

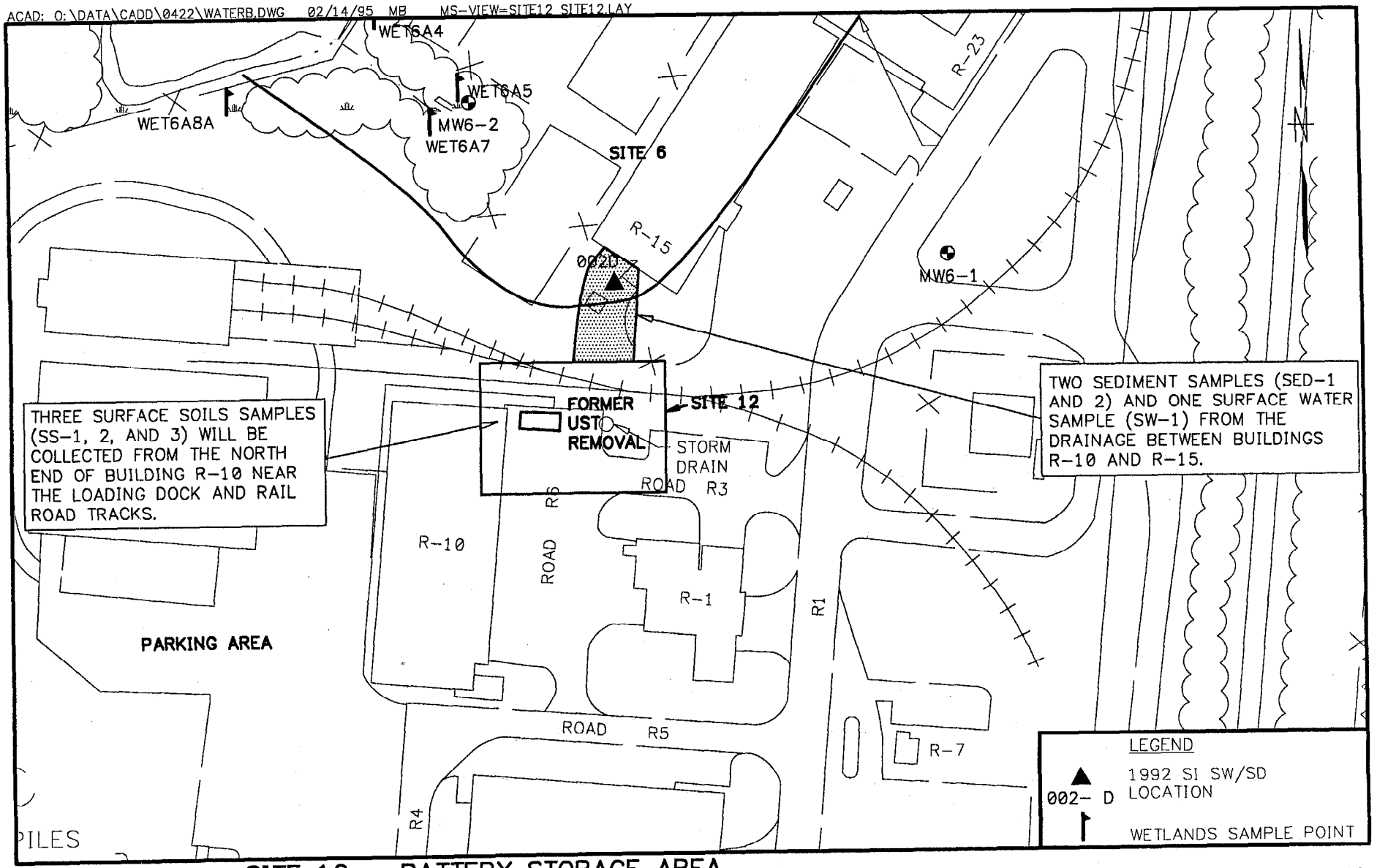
The Battery Storage Area occupies a paved area next to the loading dock behind (east of) Building R-10. This area was used as a transient staging area for forklift batteries being sent off site to be reclaimed. The storage area occupied various portions of the paved area at different times but was generally limited to approximately 7,500 to 10,000 square feet at the north end of the paved area adjacent to Building R-10. As reported in the 1993 SI (Weston, 1993), 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 storm water collection basin, which discharges through a concrete culvert, to a drainage swale, and eventually to the marsh north of the site. An underground storage tank was located in this area, but this tank has been removed.

14.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), one surface water sample and one sediment sample were collected from the downstream side of the stormwater culvert outflow. The location of these samples is shown on Figure 14-1. 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 semivolatiles, volatiles, 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. Maximum contaminant concentrations recorded for the SI are presented in Tables 14-1 and 14-2.

14.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Sampling activities at Site 12 will include collecting surface soils, sediment and surface water. Three surface soils will be collected from the vicinity of the north end of Building R-10 near the loading dock and railroad tracks. These areas may have been impacted by previous battery storage. Preferred sampling locations for the surface soils include drainage swales or unpaved areas downslope from the former battery storage (loading dock) area. Sample locations will be chosen during the field activity based on the presence of unpaved areas in these locations.



SITE 12 – BATTERY STORAGE AREA
SAMPLE LOCATIONS
NWS EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 14-1

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TABLE 14-1

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 12[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	5,220	12-002-D001	---	---
Arsenic	10.2	12-002-D001	20	33
Barium	61.7	12-002-D001	26,000	---
Beryllium	1.1	12-002-D001	2	---
Cadmium	1.7	12-002-D001	100	5
Calcium	2,000	12-002-D001	---	---
Chromium	45.4	12-002-D001	---	80
Cobalt	8.2	12-002-D001	---	---
Copper	58	12-002-D001	600	70
Iron	19,900	12-002-D001	---	---
Lead	**261**	12-002-D001	600	**35**
Magnesium	1,380	12-002-D001	---	---
Manganese	71.1	12-002-D001	---	---
Mercury	**0.37**	12-002-D001	260	**0.15**
Nickel	15.6	12-002-D001	2,400	30
Potassium	1,010	12-002-D001	---	---
Silver	**3.5**	12-002-D001	2,000	**1**
Sodium	341	12-002-D001	---	---
Vanadium	21.2	12-002-D001	7,000	---
Zinc	**306**	12-002-D001	1,500	**120**

TABLE 14-1 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 12[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
PESTICIDES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Dieldrin	0.054 J	12-002-D001	0.18	0.00002
4,4'-DDE	0.057 J	12-002-D001	9	0.002
4,4'-DDD	0.091	12-002-D001	12	0.002
4,4'-DDT	0.033 J	12-002-D001	9	0.001
Alpha-chlordane	0.087	12-002-D001	---	0.0005[4]
Gamma-chlordane	0.09	12-002-D001	---	0.0005[4]
ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Chloromethane	0.02 J	12-002-D001	1,000	---
Methylene chloride	0.028	12-002-D001	170	---
Acetone	0.021	12-002-D001	1,000	---
2-Butanone	0.059	12-002-D001	1,000	---
Phenol	0.042 J	12-002-D001	10,000	---
Acenaphthylene	0.100 J	12-002-D001	---	---
Acenaphthene	0.100 J	12-002-D001	10,000	0.15[5]
Phenanthrene	1.6	12-002-D001	---	0.225[5]
Anthracene	0.52 J	12-002-D001	10,000	0.085[5]
Carbazole	0.63 J	12-002-D001	---	---
Fluoranthene	3.3	12-002-D001	10,000	0.6[5]
Pyrene	2.3	12-002-D001	10,000	0.350[5]
Butylbenzylphthalate	0.16 J	12-002-D001	10,000	---

TABLE 14-1 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 12[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Benzo(a)anthracene	**1.1**	12-002-D001	2.5	**0.23[5]**
Chrysene	**1.6**	12-002-D001	2.5	**0.4[5]**
Bis(2-ethylhexyl)phthalate	3.7	12-002-D001	210	---
Di-n-octylphthalate	0.17 J	12-002-D001	10,000	---
Benzo(b)fluoranthene	1.4	12-002-D001	2.5	---
Benzo(k)fluoranthene	1.3	12-002-D001	2.5	---
Benzo(a)pyrene	**1.2**	12-002-D001	**0.25**	**0.4[5]**
Indeno(1,2,3-cd)pyrene	0.77	12-002-D001	2.5	---
Dibenz(a,h)anthracene	**0.3 J**	12-002-D001	0.25	**0.06[5]**
Benzo(g,h,i)perylene	0.73	12-002-D001	2.5	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 Value represents total chlordane (alpha- and gamma-isomers combined).

5 ER-L value of 4.0 mg/Kg for total PAHs also applies.

J Estimated value.
--- Criteria not available.

TABLE 14-2
SURFACE WATER RESULTS VERSUS REGULATORY CRITERIA
SITE 12[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	Basin Classification FW2	Freshwater Aquatic Chronic Exposure
			New Jersey Surface Water Quality Criteria[2]	Ambient Water Quality Criteria[3]
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	243,000	12-002-W001	(R)	---
Arsenic	2,900	12-002-W001	0.017[hc]	V - 850[A][4]/48[C][4] III - 360[A]/190[C]
Barium	59,300	12-002-W001	2,000[h]	---
Calcium	22,600,000	12-002-W001	---	---
Iron	23,200,000	12-002-W001	---	1,000[C]
Lead	20,500	12-002-W001	5[h]	82[A][5]/32[C][5]
Magnesium	7,380,000	12-002-W001	---	---
Manganese	591,000	12-002-W001	100[h]	---
Potassium	3,480,000	12-002-W001	---	---
Sodium	57,900,000	12-002-W001	---	---
Zinc	47,300	12-002-W001	(R)	120[A][5]/110[C][5]

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Administrative Code (NJAC) 7:9B-1.14 Surface Water Quality Criteria. Criteria based on human health information. All metals criteria based on Total Recoverable metal. Designations are as follows:

h - Protection of human health (noncarcinogenic effects).
hc - Protection of human health (carcinogenic effects).
R - Reserved.

3 U.S. EPA Office of Water Regulations and Standards. Quality Criteria for Water 1986 Updates No. 2 dated May 1, 1987 (EPA/440/5-86-001). Designations are as follows:

A - Acute criterion.
C - Chronic criterion.

4 Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level.

5 Based on hardness of 100 mg/L.

--- Criteria not available.

Two sediment samples and one surface water sample will be collected from the drainage which flows from the site towards the wetlands northwest of the site. Sampling locations will be from the drainage between Buildings R-10 and R-15. The surface water and sediment samples will be collected from areas which receive drainage from the site. One sediment sample will be taken along the drainage from the nearest location to the site where sediment can be collected. The second sediment sample will be collected at the upgradient portion of the concrete culvert (if sediments are present), or at the downgradient side of the culvert. Because flow in the drainage ditch downgradient of the site is ephemeral, surface water may not be present near the site, unless a precipitation event is occurring. If surface water is present in the drainage, one sample will be collected from the upgradient portion of the concrete culvert, or as close to the site boundary as possible. A list of the proposed samples and the sampling rationale is given in Table 14-3. Sample locations will be determined during the sampling activity depending on availability of sediment and surface water in the drainage ditch at the time of sampling. The approximate sample locations are shown in Figure 14-1.

In addition to the samples listed above, background samples of soil, surface water, sediment and groundwater will be collected from the vicinity of Site 12. Background sampling locations are detailed in Section 30.

Soils, sediment and surface water will be analyzed for TCL volatiles, semivolatiles, pesticides, and TAL metals. Analytes, bottle requirements and holding times are listed in Table 3-2.

14.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 14-3

SAMPLING LOCATIONS AND RATIONALE
SITE 12
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Three surface soil samples (SS-1 to 3)	Unpaved area near battery storage area (loading dock) behind Building R-10 and railroad tracks.	Determine if soil contamination is present near site from past operations.
Two sediment samples (SED-1 and 2).	Drainage downgradient of site. One as close to site as possible, one at upgradient side of culvert.	Determine extent of sediment contamination (if any) downgradient of the site.
One surface water sample (SW-1).	Drainage downgradient of site, as close to site as possible	Determine if surface water contamination is present downgradient of site

15.0 SITE 13 (DEFENSE PROPERTY DISPOSAL OFFICE YARD)

15.1 SITE DESCRIPTION

The Defense Property Disposal Office Yard is an area of fill material extending into a marsh near the rail classification yards. Activities at the site have 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 has 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. Presently, a fence exists around the site, although this fence is not located at the edge of the landfill. The extent of fill material has not been 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.

15.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), six soil samples were collected (from 0 to 3 ft bgs) from the area in and around the landfill. Three sediment and three surface water samples were collected in the drainage west of the site. Figure 15-1 shows the SI sampling locations and the site layout. Soil samples were analyzed for SVOCs, PCBs, metals and cyanide. Low levels of metals, pesticides, PCBs, and organics were detected in soil samples. Elevated levels of two semivolatiles were also detected. Table 15-1 summarizes maximum concentrations for soil samples. Sediment samples were analyzed for SVOCs, pesticides, and PCBs. Low levels of pesticides, PCBs and SVOCs were detected. Maximum concentrations for sediment samples are summarized in Table 15-2. The three 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. Maximum contaminant concentrations in surface water samples are summarized in Table 15-3.

15.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

In order to characterize the extent of fill material and the extent of clean fill or natural soil, two test trenches (TP-1 and TP-2) will be excavated along the southern boundary of the landfill. These test pits will define the limit of fill material and provide additional information regarding waste material which may be present in the landfill. The approximate extent of the landfill and the locations of the test pits has been determined based on historic aerial photographs of the site. Each trench will extend from a location which is assumed to be landfill material and will continue until clean fill or natural soil is encountered. Figure 15-1 illustrates

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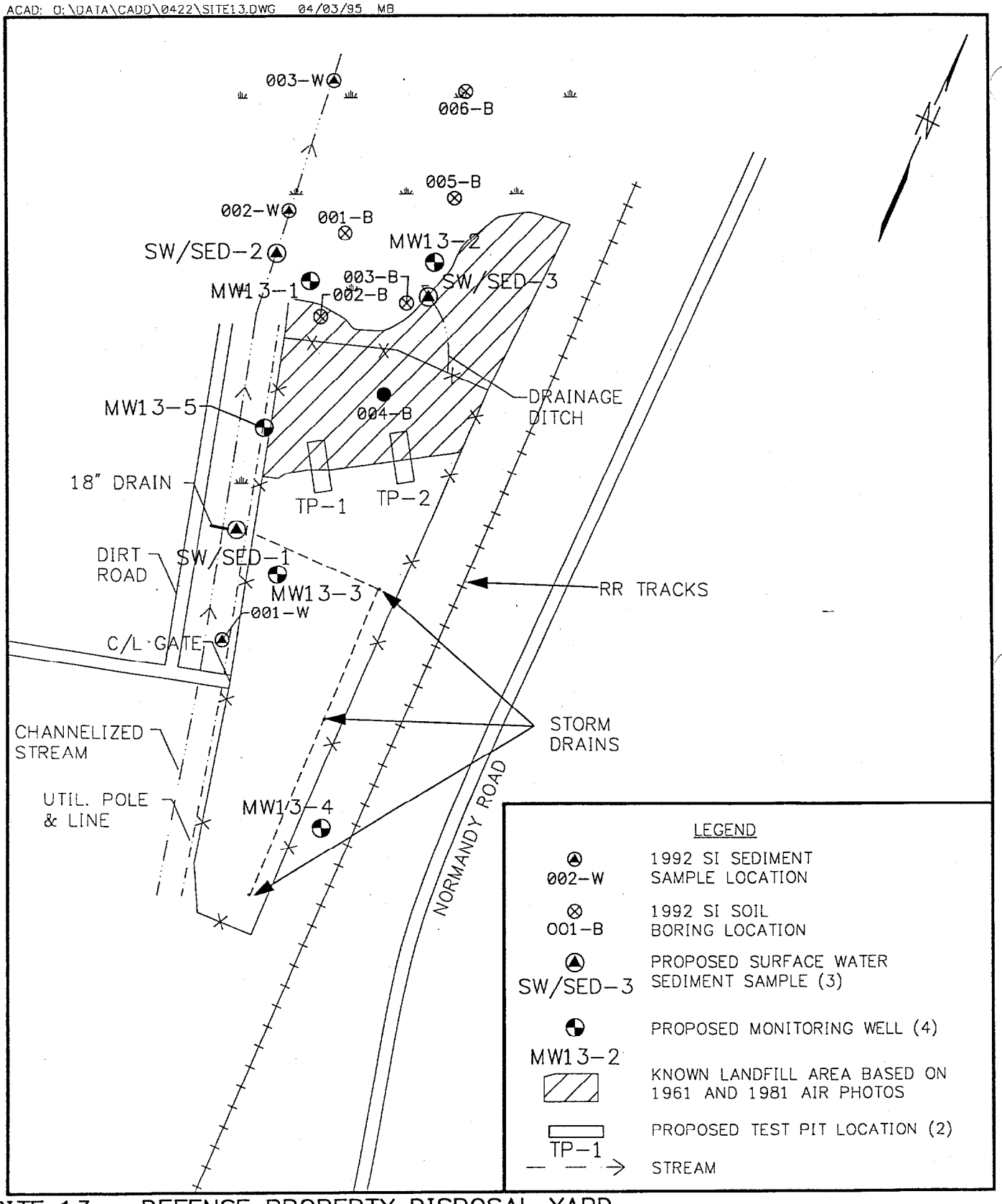

SITE 13 – DEFENSE PROPERTY DISPOSAL YARD
SAMPLING LOCATIONS DISPOSAL OFFICE YARD
NAVAL WEAPONS STATION EARLE, NJ

FIGURE 15-1

0 250 500
SCALE IN FEET

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TABLE 15-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 13[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	2,050	13-001-B001	---
Arsenic	3	13-001-B001	20
Barium	14.5	13-001-B001	26,000
Beryllium	0.47	13-006-B001	2
Cadmium	1.1	13-006-B001	100
Calcium	329	13-001-B001	---
Chromium	44.1	13-006-B001	---
Cobalt	2.4	13-001-B001	---
Copper	25.2	13-001-B001	600
Iron	8,040	13-001-B001	---
Lead	96.9	13-001-B001	600
Magnesium	236	13-001-B001	---
Manganese	27	13-001-B001	---
Mercury	0.83	13-002-B101	260
Potassium	545	13-006-B001	---
Silver	42.1	13-006-B001	2,000
Sodium	24.1	13-003-B001	---
Vanadium	53.9	13-006-B001	7,000
Zinc	50.6	13-001-B001	1,500
PESTICIDES	**(mg/kg)**		**(mg/kg)**
4,4'-DDE	0.011	13-002-B001	9
4,4'-DDT	0.0044	13-005-B001	9
PCBs	**(mg/kg)**		**(mg/kg)**
Aroclor-1260	0.3	13-001-B001	2
ORGANICS	**(mg/kg)**		**(mg/kg)**
Phenol	0.035 J	13-001-B001	10,000
Naphthalene	0.061 J	13-001-B001	4,200
2-Methylnaphthalene	0.044 J	13-001-B001	---
Acenaphthalene	0.68 J	13-001-B001	---

TABLE 15-1 (continued)
SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 13[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
ORGANICS (continued)	**(mg/kg)**		**(mg/kg)**
Acenaphthene	0.089 J	13-001-B001	10,000
Carbazole	0.26 J	13-001-B001	---
Di-n-butylphthalate	0.04 J	13-003-B001	10,000
Fluoranthene	0.024 J	13-005-B001	10,000
Pyrene	0.051 J	13-002-B001	10,000
Benzo(a)anthracene	0.033 J	13-002-B001	2.5
Chrysene	0.053 J	13-002-B001	2.5
Bis(2-ethylhexyl)phthalate	2.7	13-002-B001	210
Benzo(b)fluoranthene	0.046 J	13-005-B001	2.5
Benzo(k)fluoranthene	0.045 J	13-002-B001	2.5
Benzo(a)pyrene	**2.4 J**	13-001-B001	**0.25**
Indeno(1,2,3-cd)pyrene	0.87 J	13-001-B001	2.5
Dibenz(a,h)anthracene	**0.88 J**	13-001-B001	**0.25**
Benzo(g,h,i)perylene	1.7 J	13-001-B001	2.5
Dibenzofuran	0.1 J	13-001-B001	---
Fluorene	0.28 J	13-001-B001	10,000
Anthracene	1.8 J	13-001-B001	10,000

--- No criteria available.
J Estimated value.

1 Weston Report: Phase II - Site Inspection Study, Draft Report, February 1993.
2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

Note: Bolded/shaded value indicates maximum concentration exceeds New Jersey Nonresidential Surface Soil Cleanup Standards.

TABLE 15-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 13[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
PESTICIDES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
4,4'-DDE	0.00084 J	13-002-D001	9	0.002
PCBs	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aroclor-1260	0.027 J	13-002-D001	2	0.05
ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Phenanthrene	0.021 J	13-002-D001	---	0.225[4]
Di-n-butylphthalate	0.048 J	13-002-D001	10,000	---
Pyrene	0.022 J	13-002-D001	10,000	0.350[4]

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 ER-L value of 4.0 mg/Kg for total PAHs also applies.

--- Criteria not available.

TABLE 15-3
SURFACE WATER RESULTS VERSUS REGULATORY CRITERIA
SITE 13[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	Basin Classification FW2	Freshwater Aquatic Chronic Exposure
			New Jersey Surface Water Quality Criteria[2]	Ambient Water Quality Criteria[3]
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	2,630,000	13-003-W001	(R)	---
Barium	43,400	13-002-W001	2,000[h]	---
Beryllium	1,200	13-001-W001	(R)	130[A][4]/5.3[C][4]
Calcium	7,960,000	13-001-W001	---	---
Chromium	35,900	13-003-W001	160[h]	VI - 16[A]/11[C] III - 360[A]/210[C][5]
Iron	5,750,000	13-003-W001	---	1,000[C]
Lead	16,900	13-002-W001	50	82[A][5]/3.2[C][5]
Magnesium	2,300,000	13-003-W001	---	---
Manganese	62,000	13-001-W001	100[h]	---
Nickel	21,900	13-003-W001	---	1,400[A][5]/160[C][5]
Potassium	2,380,000	13-003-W001	---	---
Sodium	4,410,000	13-001-W001	---	---
Vanadium	13,900	13-003-W001	---	---
Zinc	72,700	13-003-W001	(R)	120[A][5]/110[C][5]

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

2 New Jersey Administrative Code (NJAC) 7:9B-1.14 Surface Water Quality Criteria. Criteria based on human health information. All metals criteria based on Total Recoverable metal. Designations are as follows:
- h - Protection of human health (noncarcinogenic effects).
- hc - Protection of human health (carcinogenic effects).
- R - Reserved.

3 U.S. EPA Office of Water Regulations and Standards. Quality Criteria for Water 1986 Updates No. 2 dated May 1, 1987 (EPA/440/5-86-001). Designations are as follows:
- A - Acute criterion.
- C - Chronic criterion.

4 Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level.

5 Based on hardness of 100 mg/L.

--- Criteria not available.

the approximate location of the proposed test pits. The exact location will be determined during field activities on the basis of observable conditions, site access and surface evidence of fill material. Sampling locations and rationale are listed in Table 15-4.

In addition to the test pits, five monitoring wells will be installed at the site. Two wells (MW13-1, and 13-2) will be installed downgradient (north) and one side gradient (MW13-5) along the edge of the toe of the landfill. Although groundwater elevations have not been measured at the site, the inferred groundwater flow direction is north towards the wetlands based on topographic relief and surface water flow directions. These three wells will determine if past disposal activities at the site have adversely effected groundwater immediately downgradient or sidegradient of the landfill. Two additional wells will be installed upgradient of the landfill material after the extent of fill material is determined by test trenches. These wells (MW13-3 and MW13-4) will be used to determine the groundwater flow direction at the site and will determine groundwater quality in the immediate vicinity of the landfill. Figure 15-1 illustrates the approximate location of the proposed monitoring wells. Groundwater samples will be collected from all newly installed monitoring wells.

Three surface water and sediment samples will be collected at the site to determine if contamination is moving off site. Two surface water and sediment samples will be collected along the drainage ditch which parallels the landfill and receives runoff from the site. One sample (SW/SED-1) will be collected from the outfall pipe which drains into this stream. The second sample (SW/SED-2) will be taken from this drainage downstream of the landfill. One additional surface water and sediment sample (SW/SED-3) will be collected from the base of a drainage which has developed channeling through the landfill toe material and may be responsible for contaminant transport to the marsh. Surface water pathways are not well-defined in this area and ponded water is not always present. Although, if possible, two additional surface water/sediment samples will be taken north of the site, in the wetlands.

Sediment samples will be analyzed for TCL volatiles and semivolatiles, TCL pesticides/PCBs, explosives, TPH, TAL metals, total organic carbon (TOC) and grain size. Groundwater and surface water will be analyzed for TCL volatiles and semivolatiles, TCL pesticides/PCBs, landfill parameters and TAL metals. Groundwater will also be analyzed for explosives. Surface water will also be analyzed for TPH and explosives. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

15.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 15-4

SAMPLING LOCATIONS AND RATIONALE
SITE 13
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Two test trenches (no analytical samples)	Along southern edge of landfill based on air photos.	Define edge of fill material to the south.
Two downgradient monitoring wells (MW13-1 and MW13-2).	In wetlands immediately downgradient of the toe of the landfill.	Determine quality of groundwater downgradient of landfill. Define groundwater flow directions at the site.
One sidegradient monitoring well (MW13-5).	Immediately west of landfill.	Determine quality of groundwater sidegradient of landfill. Define groundwater flow directions at the site.
Two upgradient monitoring wells (MW13-3 and MW13-4).	Upgradient of landfill material as determined by test trenches.	Determine upgradient water quality. Define groundwater flow directions at the site.
Three surface water and sediment samples (SW/SED-1 to SW/SED-3)	One at outfall pipe which drain from site to stream. One along stream downstream of landfill. One at drainage along toe of landfill.	Determine if contamination is moving off site by surface water or sediment transport.

16.0 SITE 14 (MERCURY SPILL)

16.1 SITE DESCRIPTION

A small amount of mercury (reportedly ranging in size from that of a thermometer to as much as several ounces) was spilled inside Building C-33, the Defense Property Disposal Warehouse, in 1970. The location of the spill within the building was not documented. According to the Weston Phase II SI (1993) it is probable that the mercury was cleaned up by vacuuming after the spill. The warehouse has solid concrete floors precluding the mercury spill from affecting soil below the building. The floors of the warehouse have been coated with a concrete protecting material since the spill and it is unlikely that any residue from the spill remains.

16.2 PREVIOUS INVESTIGATIONS

No previous sampling has been conducted within the Defense Property Disposal Warehouse.

16.3 SAMPLING ACTIVITIES

To determine if any traces of mercury remain on the warehouse floor surface, the floor of the warehouse will be swept and the sweepings will be collected and analyzed. Because the location of the mercury spill is unknown, the sweepings from the entire warehouse floor will be included. A sample will be collected from the floor sweepings for mercury analysis. Sample analytes, bottle requirements and holding times are listed in Table 3-2.

17.0 SITE 15 (SLUDGE DISPOSAL SITE)

17.1 SITE DESCRIPTION

The Sludge Disposal Site reportedly occupied a small area along the railroad tracks near the main entrance to the Waterfront area. In the early 1970's, the site was used for disposal of an unknown amount of oily bilge sludge. It is estimated that over 5,000 gallons of sludge, which may have ranged from 1% to 25% oil, may have been disposed of at the site (Hart IAS, 1983). The exact location of the sludge disposal activities was not apparent during site inspections. The site is near a railroad grade which is built approximately 6 feet above the surrounding ground surface. It is unknown whether sludge disposal occurred along one or both sides of the railroad tracks. A small drainage swale runs parallel to the railroad bed on the north side, and surface water from the site and the adjacent paved parking area flows towards this drainage. This drainage is not influenced by groundwater and contains water only after precipitation. Wetlands are present to the north and south of the site.

17.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), two soil borings were drilled at the site. Subsurface soil samples were collected at 8 ft bgs from soil boring 1 and at 7 ft bgs from soil boring 2. Sampling locations are shown on Figure 17-1. Four sediment samples (at 0 to 0.5 ft bgs) were collected from the drainage swale northeast of the site. Surface water was not collected. One groundwater sample was collected from a hydropunch location between the two soil borings. The soil samples were analyzed for SVOCs. Four SVOCs were detected at low concentrations. The sediment samples were analyzed for SVOCs with very low concentrations being detected. The groundwater sample was analyzed for TAL metals and the full scan of TCL compounds. This analysis indicated that elevated levels of metals were present. Maximum contaminant concentrations recorded during the SI are listed in Tables 17-1 to 17-3.

17.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

In order to investigate the potential soil contamination which may be present at this site, four soil borings will be installed (using a hand auger) on each side of the railroad tracks. Soil borings SB-1 and SB-2 will be taken from the north side of the railroad tracks and SB-3 and SB-4 will be taken along the south side of the railroad tracks. The soil borings locations are illustrated on Figure 17-1. Subsurface soils will be collected and analyzed from each boring at 2 to 3 ft bgs (i.e., above the SI sample depths). Each auger bucket removed from the boring will be continuously monitored with a PID/FID, and the sample at each boring will be collected from the interval with the highest PID/FID reading between 2 and 3 ft bgs or at an

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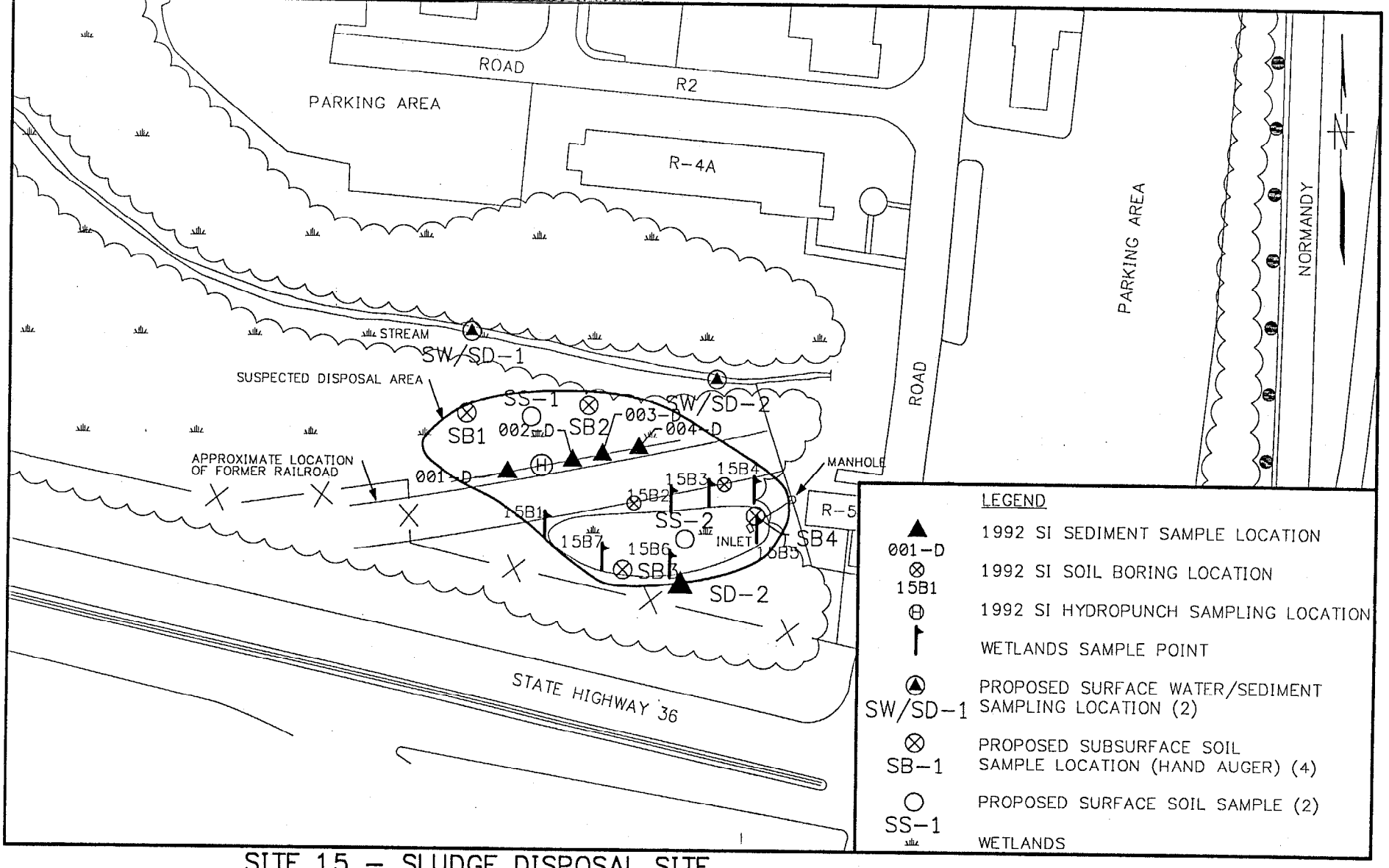

SITE 15 – SLUDGE DISPOSAL SITE
SAMPLING LOCATIONS
NWS EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 17-1

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TABLE 17-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 15[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Subsurface Soil Standards[2]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Phenol	0.024 J	15-002-B007	50
Di-n-butylphthalate	0.15 J	15-001-B008	100
Butylbenzylphthalate	0.047 J	15-001-B008	100
Bis(2-ethylhexyl)phthalate	0.53 J	15-001-B008	100

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.

TABLE 17-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 15[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Phenol	0.23 J	15-001-D001	10,000	---
Diethylphthalate	23	15-001-D001	10,000	---
Phenanthrene	0.058 J	15-002-D001	---	0.225[4]
Anthracene	0.036 J	15-002-D001 15-004-D001	10,000	0.085[4]
Carbazole	0.024 J	15-004-D001	---	---
Di-n-butylphthalate	0.056 J	15-001-D001	10,000	---
Fluoranthene	0.25 J	15-002-D001	10,000	0.6[4]
Pyrene	0.18 J	15-002-D001	10,000	0.35[4]
Butylbenzylphthalate	0.021 J	15-004-D001	10,000	---
Benzo(a)anthracene	0.074 J	15-002-D001	2.5	0.23[4]
Chrysene	0.16 J	15-002-D001	2.5	0.4[4]
Bis(2-ethylhexyl)phthalate	0.29 J	15-003-D001	210	---
Benzo(b)fluoranthene	0.14 J	15-002-D001	2.5	---
Benzo(k)fluoranthene	0.13 J	15-002-D001	2.5	---
Benzo(a)pyrene	0.063 J	15-002-D001	0.25	0.4[4]
Indeno(1,2,3-cd)pyrene	0.061 J	15-002-D001	2.5	---
Benzo(g,h,i)perylene	0.039 J	15-002-D001	2.5	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 ER-L value of 4.0 mg/Kg for total PAHs also applies.

J Estimated value.
--- Criteria not available.

TABLE 17-3

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 15[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3]
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	621,000	15-001-K011	200	---
Barium	2,040	15-001-K011	2,000	2,000
Beryllium	42.5	15-001-K011	0.008 (8)	4
Cadmium	11.9	15-001-K011	4	5
Calcium	37,900	15-001-K011	---	---
Chromium	1,840	15-001-K011	100	100
Cobalt	388	15-001-K011	---	---
Iron	3,070,000	15-001-K011	300	---
Lead	264	15-001-K011	5	15[A]
Magnesium	65,800	15-001-K011	---	---
Manganese	7,620	15-001-K011	50	---
Mercury	2.8	15-001-K011	2	2
Nickel	557	15-001-K011	100	100
Potassium	52,000	15-001-K011	---	---
Silver	198	15-001-K011	(2)	---
Sodium	16,200	15-001-K011	50,000	---
Vanadium	541	15-001-K011	---	---
Zinc	1,470	15-001-K011	5,000	---

TABLE 17-3 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 15[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3]
ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene Chloride	**9 J**	15-001-K011	**2**	**5**
Acetone	18	15-001-K011	700	---
Chloroform	**10 J**	15-001-K211	**6**	100/80[4]
Diethylphthalate	1 J	15-001-K011	5,000	---
Di-n-butylphthalate	10 J	15-001-K211	900	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

4 Current MCL for trihalomethanes is 100 µg/L. 1994 Proposed Rule for Disinfectants and Disinfection Byproducts: Total for trihalomethanes combined cannot exceed 80 µg/L.

J Estimated value.
--- Criteria not available.

alternate interval where contamination is evident based on PID/FID readings and/or evidence such as soil staining or discoloration. These data will be used in concert with data collected in the SI report to provide information on the vertical and horizontal extent of contamination, if any, at the site.

One surface soil sample will be collected from each side of the railroad tracks. Sample SS-1 and SS-2 will be collected approximately halfway between the soil boring sample locations on each side of the railroad tracks. These surface soils will be used to determine if past disposal activities have effected soils at the approximate center of the site along the north and south side of the railroad tracks. Sample locations and rationale are summarized in Table 17-4. Also, to define the impact of this site on adjacent wetlands, two surface water/sediment sample (SW-SD-1 and 2) will be collected from the stream to the north of the site. One sediment samples (SD-2) will be collected from the southern wetlands, adjacent to the site. These wetlands to the south do not contain standing water, therefore no surface water sample will be collected from this location. Note that background soil and groundwater samples will be collected approximately 250 feet east of Site 15, as detailed in Section 30.

Surface and subsurface soils, sediment and surface water will be analyzed for TCL volatiles and semivolatiles, pesticides/PCB, TAL metals, and TPH. Sample analytes, bottle requirements and holding times are listed in Table 3-2.

17.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 17-4

SAMPLING LOCATIONS AND RATIONALE
SITE 15
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Four subsurface soil samples (SB-1, SB-2, SB-3 and SB-4)	Two samples collected from each side of the railroad tracks, at 2 to 3 ft bgs.	Will compare with SI data results to determine depth and extent of contamination, if any.
Two surface soil samples (SS-1 and SS-2)	Collected from location half way between the two soil borings on each side of the railroad tracks.	Determine if surface soil contamination is present from past activities.
Two surface water and sediment samples (SW/SED-1 and 2)	Collected from the stream to the north of the railroad tracks.	Determine if surface water and sediment in wetlands north of the site have been impacted.
One sediment sample (SED-2)	Collected from the wetlands to the south of the railroad tracks.	Determine if the wetlands south of the site have been impacted.

18.0 SITE 16 (EPIC SITE F (ROUNDHOUSE SITE))

18.1 SITE DESCRIPTION

Site 16 and EPIC Site F are discussed within this Work Plan as one site due to the relative proximity and overlap of the two sites. This area is a 8-acre site, which is composed of a heavy equipment storage yard, and two railroad car storage yards that have been active since the late 1940s. Building C-50 is known as the Roundhouse and is used for maintenance and repair of locomotives and rail cars. Building C-19 is the forklift maintenance and repair shop.

Site 16 is located north of Building C-19. 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. The site layout is illustrated in Figure 18-1. Investigations at these areas are concerned with petroleum hydrocarbon contamination of soil, groundwater, surface water and sediment.

An underground fuel line is located in the area north of Building C-19 and was used to transport diesel fuel from an underground fuel storage tank located at the northeast corner of Building C-50 to a dispensing station near Building C-19. This portion of the site was investigated during the 1992 SI field activities (Weston, 1993), as described below. A leak in the fuel line was discovered in 1977 and use of the pipeline was discontinued after the leak was discovered and excavated.

Waste oils from locomotive maintenance were stored in a holding tank at the southeast side of Building C-50. This tank has since been removed under the UST program. Water from locomotive steam-cleaning operations in the past may have discharged water to sewer drains and to an oil-water separator near Building C-50. Water discharge from this oil-water separator is reported to have been sent to a drainage ditch along the west side of the railroad tracks, although a buried leach field may be present near the oil-water separator. The location of the oil-water separator leach field is shown on Figure 18-1 and was installed on the downslope side of the separator. In 1989 the oil-water separator failed, and the ditch on the side of Building C-50 was excavated. Excavated material was disposed of as hazardous waste. Rinse water is currently collected and sent off site for disposal. The center of the tracks near Building C-50 is stained with thick oil, possibly from locomotive maintenance.

Building C-19 is used as a forklift maintenance and repair facility and batteries may have been stored behind this building. Currently, high-pressure parts washing is performed on the concrete pad north of Building C-19. This wash water is not contained. The railroad storage yard to the west of Building C-19 is used for rail car storage, and for heavy equipment storage.

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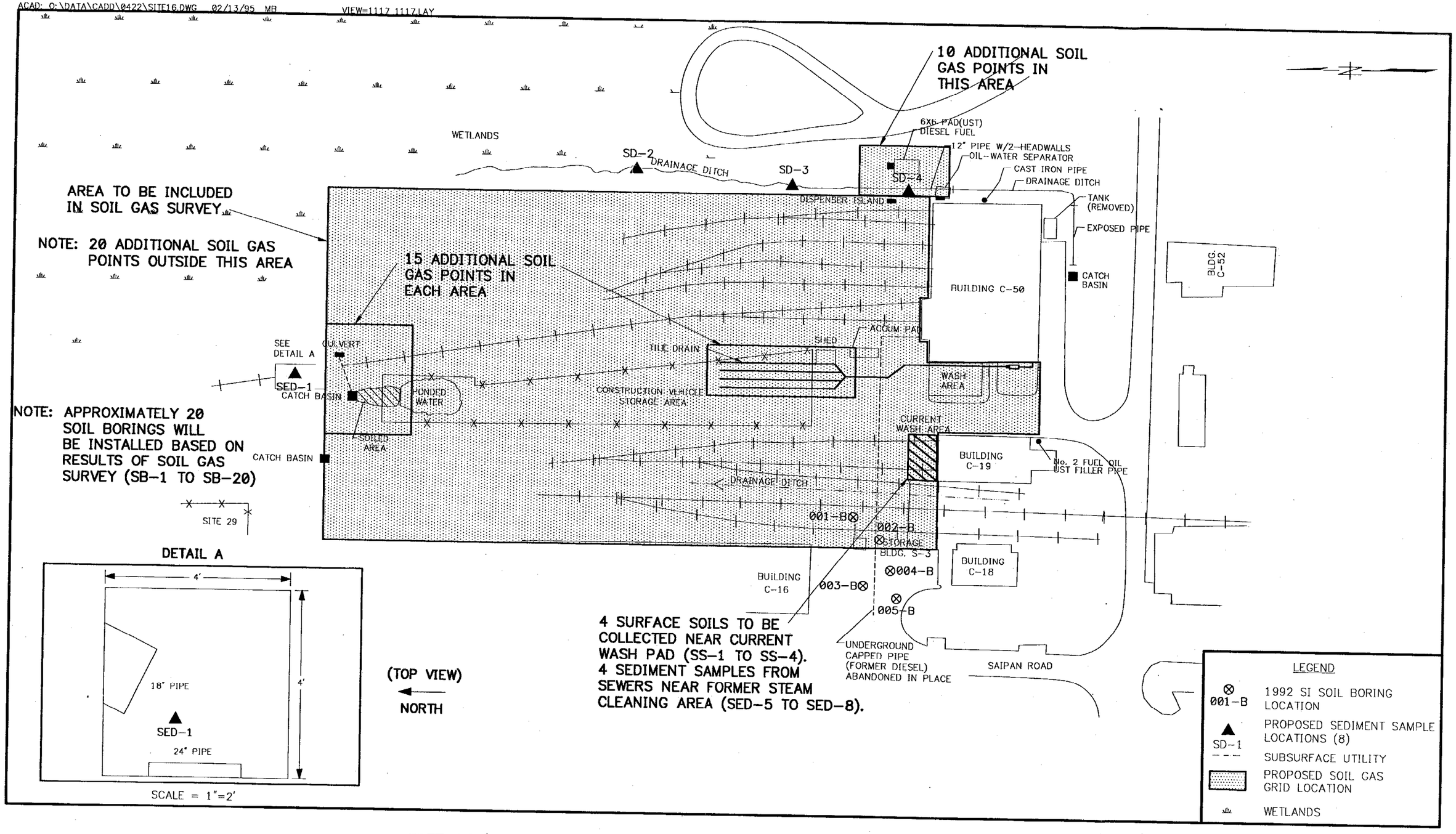

SITE 16/F – ROUND HOUSE
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 18-1

Halliburton NUS CORPORATION

00368A022

18.2 PREVIOUS INVESTIGATIONS

As part of the 1992 SI field activities, five soil borings were completed in the area north of Building C-18 where the underground fuel-line leak was reported to have been located (Weston, 1993). Each soil boring was completed to the water table and one sample was collected at approximately 8 ft bgs, below the level of the fuel pipeline and above the water table. SI sample locations are shown in Figure 18-1. 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. Maximum contaminant concentrations recorded during the SI are presented in Table 18-1.

18.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on the results of the SI soil data, additional sampling is warranted in the vicinity of the fuel-line leak and at other areas across the site. Due to the size of the site and the suspected presence of petroleum-contaminated soil at a variety of areas, a soil-gas survey will be performed across the site. A grid with 100-foot spacings will be set up across the area (shown in Figure 18-1) and soil-gas samples will be collected from each gridline intersection. Several areas are suspected to contain petroleum-contaminated soils and the soil gas grid spacing will be reduced in these areas. Ten additional soil-gas points will be collected from the area around a diesel UST northeast of Building C-50. Fifteen additional soil-gas points will be collected from the tile drain leach field area northwest of Building C-50, and 15 additional points will be taken from an area of obviously contaminated soil at the north end of the site. A total of 20 additional soil-gas points will be collected along the outside of the site to determine the location of uncontaminated soils surrounding the site. Soil-gas samples will be collected and analyzed using an onsite facility to allow rapid sample turnaround. Based on the results of the soil-gas survey, soil borings and subsurface soil samples will be installed to investigate areas which may contain contamination.

A total of 20 soil borings will be installed during the RI. The locations of 17 borings will be based on the soil-gas sampling data and three borings will be located in the vicinity of a removed UST near the southeast corner of Building C-50. Soil borings will be installed in areas suspected to be contaminated to define the magnitude, depth, and extent of soil contamination. Approximately 32 soil samples will be collected from these borings. At each boring, one soil sample will be collected from directly above the water table to determine if free product is present and if the release of contaminants has impacted the shallow groundwater. The remaining 12 soil samples will be collected from soil boring intervals which show the highest level of contamination based on visual observations, PID/FID readings, or to define the level of contamination at a specific depth interval. A summary of sample locations and sampling rationale are provided in Table 18-2.

TABLE 18-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 16[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Subsurface Soil Standards[2]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Naphthalene	25	16-003-B010	100
2-Methylnaphthalene	110	16-003-B110	---
Fluorene	4.6 J	16-002-B007	100
Phenanthrene	16 J	16-003-B110	---
Pyrene	1.2 J	16-002-B007	500
Bis(2-ethylhexyl)phthalate	1.8 J	16-002-B007	100
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbons	22,000	16-003-B010 16-003-B110	---

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.
--- Criteria not available.

TABLE 18-2

SAMPLING LOCATIONS AND RATIONALE
SITE 16
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Soil gas samples.	Collected from site area every 100 feet, plus specific areas will receive additional samples.	Determine locations where soil borings will be installed. Soil gas samples will be analyzed on site with portable GC.
Twenty soil borings (SB-1 to SB-20)	Installed in areas with elevated soil gas results. (Seventeen locations to be based on soil gas survey results. Three locations within the vicinity of the former UST at the SE corner of Building C-51.)	Determine if subsurface soils are contaminated
Twenty subsurface soil samples. Twelve additional subsurface soil samples.	One sample collected from above water table at each soil boring. To be collected as needed to define soil contamination.	Determine if free product is present. Determine extent of soils contamination.
One sediment sample (SED-1)	Collected from catch basin at north end of site.	Determine if past activities or runoff have impacted sediments.
Three sediment samples (SED-2 to SED-4)	From drainage ditch northeast of Building C-50.	Determine if drainage or wetlands have been impacted by site activities.
Four sediment samples from sewers near former steam-cleaning area (SED-5 to SED-8)	Collected from storm sewer intakes in vicinity of former steam-cleaning area.	Determine if contamination present in sewers from parts washing activities.
Four surface soils near current wash pad (SS-1, SS-2, SS-3, SS-4)	Collected at 0 to 0.5 ft bgs from areas effected by wash water.	Determine if wash activities have impacted surface soils.
Four groundwater samples (GW-1 to GW-4)*	From newly installed monitoring wells (MW16-01, MW16-02, MW16-03, MW16-04)	Determine quality of groundwater below site. Define extent of free-phase or dissolved-phase product.

* Four additional monitoring wells may be installed based on the results of the soil gas survey.

A total of four soil borings will be converted into monitoring wells (MW16-1 to MW16-4). One well will be located on the downgradient side of the former UST location. The remaining three well locations will be determined based on the results of the soil-gas investigation and soil borings. Up to four additional wells may be installed based on the results of the soil-gas investigation. Monitoring wells will be used to determine if free-phase or dissolved-phase product is present in the groundwater and to determine the groundwater flow direction at the site.

Four surface soil samples (SS-1 to SS-4) will be collected from unpaved areas north of the high-pressure parts wash pad currently in use located near Building C-19 to determine if washing activities have impacted soils. Soils will be collected from the top 6 inches of soil from areas which show obvious soil staining. The approximate locations of samples are illustrated in Figure 18-1, although exact sample locations will be determined during field activities based on site conditions or location of surface staining.

One sediment sample (SED-1) will be collected from the catch basin at the north end of the site. This basin may have received some surface water runoff from the site. Three sediment samples (SED-2 to SED-4) will be collected from the drainage ditch east of the railroad tracks which may have received discharge from the oil-water separator. Of these samples, one sediment sample will be taken from a location as close to the oil-water separator as possible, and two additional sediment samples will be collected along the drainage ditch. In addition, up to four sediment samples (SED-5 to SED-8) will be collected from the sewers in the vicinity of the former locomotive steam-cleaning area to determine if water from these activities may have spread contamination. Sediment samples will be collected from 0 to 0.5 ft bgs.

Soil and sediment samples will be analyzed for TPH, TCL volatiles and semivolatiles, PCBs and TAL metals. Sediment samples will also be analyzed for TOC and grain size. Groundwater samples will be analyzed for TPH, TCL volatiles and semivolatiles, and TAL metals. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

18.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

19.0 SITE 17 (LANDFILL)

19.1 SITE DESCRIPTION

The Site 17 Landfill occupies 3 acres adjacent to a tidal marsh. The site was used for the disposal of wood, forklift vehicles, empty paint cans and construction debris. The landfill surface is paved and is 10 to 15 feet higher in elevation than the marsh area. The toe of the landfill is covered with vegetation. Infiltration is limited by pavement, and overland-flow drains toward the salt marsh north of the site. Groundwater flow is to the north-northwest toward the marsh.

19.2 PREVIOUS INVESTIGATIONS

During the SI, soil samples were collected from three soil borings and two monitoring well borings (Weston, 1993). Soil borings were completed to the water table and subsurface soil samples were taken from between 5 and 11 ft 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. Figure 19-1 illustrates the site layout and previous sampling locations. 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. Maximum contaminant concentrations recorded during the SI are provided on Tables 19-1 to 19-3.

19.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

To determine if the landfill is impacting the sediment in the marsh, a total of six surface water and sediment samples will be collected from the marsh area. During RI field activities an inspection along the toe of the landfill will be performed to identify any groundwater seeps. Sampling will be performed in spring when seeps should be flowing. If flowing seeps or moist areas are found along the landfill edge, surface water and sediment samples will be collected at all seep locations. One seep has been identified at the site and will be sampled (SW/SED-1). It is estimated that two additional seeps will be located and sampled during the field effort (SW/SED-2 and -3). If additional seeps are not located, the remaining surface water and sediment samples (SW/SED-4 to -6) will be collected in the wetlands immediately adjacent to the landfill where surface water and sediment is present.

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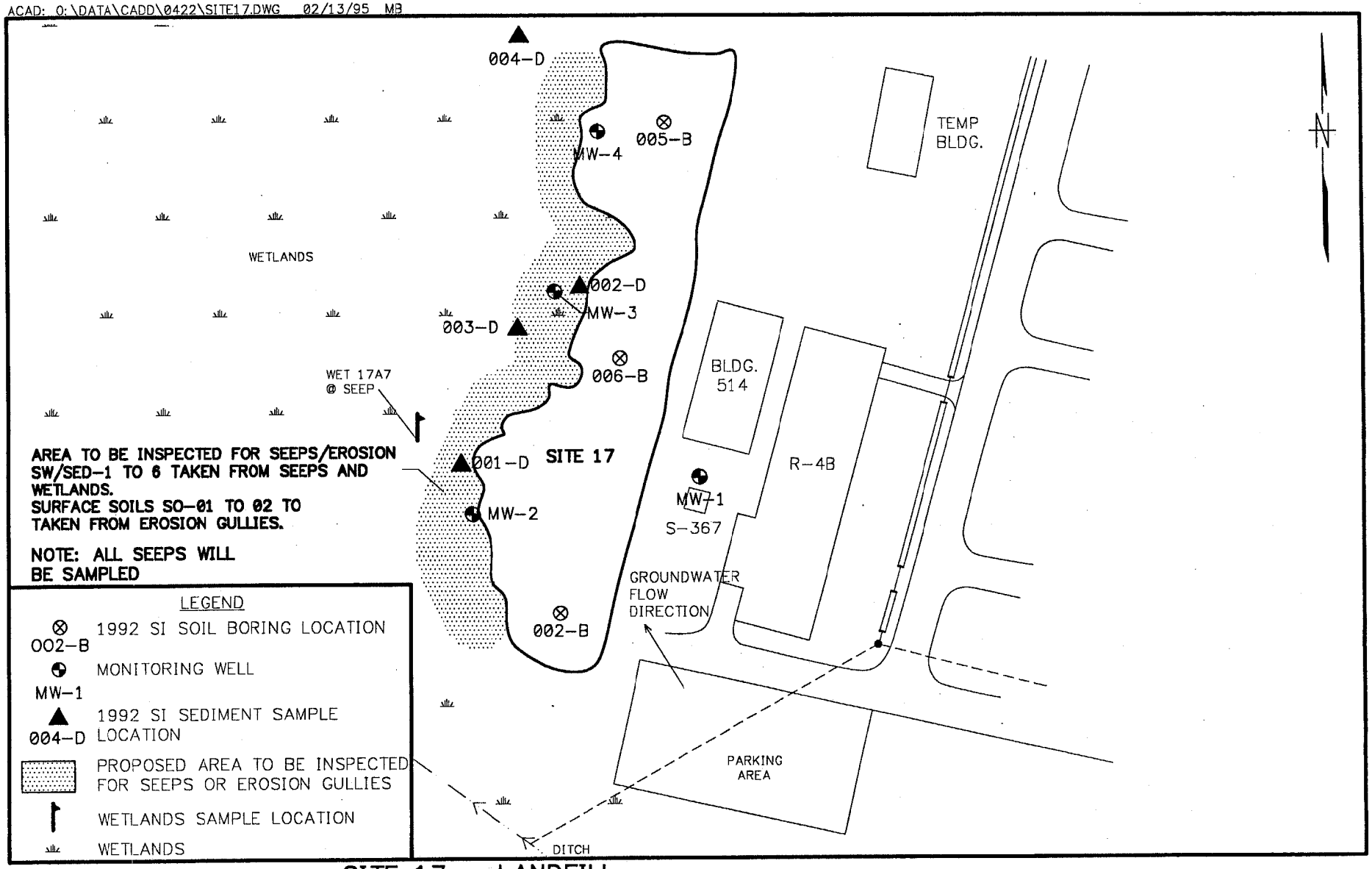

SITE 17 – LANDFILL
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 19-1

Halliburton NUS CORPORATION

TABLE 19-1

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 17[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3]
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	27,400	MW17-01	200	---
Arsenic	37	MW17-02	0.02 (8)	50
Barium	551	MW17-04	2,000	2,000
Beryllium	6.1	MW17-01	0.008 (20)	4
Cadmium	4.7	MW17-02	4	5
Calcium	466,000	MW17-04	---	---
Chromium	156	MW17-02	100	100
Cobalt	44	MW17-02	---	---
Copper	81.5	MW17-02	1,000	1,300[G]
Iron	136,000	MW17-04	300	---
Lead	80	MW17-01	5	15[A]
Magnesium	76,100	MW17-04	---	---
Manganese	2,380	MW17-04	50	---
Mercury	0.13	MW17-01 MW17-02	2	2
Nickel	43.3	MW17-02	100	100
Potassium	58,900	MW17-04	---	---
Selenium	2.2	MW17-02	50	50
Sodium	703,000	MW17-04	50,000	---
Vanadium	376	MW17-01	---	---
Zinc	253	MW17-01	5,000	---
ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Acetone	51	MW17-04	700	---

TABLE 19-1 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 17[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3]
MISCELLANEOUS	**(µg/L)**		**(µg/L)**	**(µg/L)**
BOD	19,200	MW17-03	---	---
Chloride	**19,900,000**	MW17-04	**250,000**	250,000[S]
COD	119,000	MW17-01 MW17-03	---	---
Nitrate/Nitrite	100	MW17-02	10,000	10,000
Ammonia	**6,600**	MW17-04	**500**	---
TOC	97,200	MW17-02	---	---
Phosphate	480	MW17-01 MW17-04	---	---
Sulfate	**4,513,000**	MW17-03	**250,000**	---
Turbidity	550 NTU[4]	MW17-04	---	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995. Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

4 NTU - Nephelometric Turbidity Unit

J Estimated value.
--- Criteria not available.

TABLE 19-2

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 17[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Subsurface Soil Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	7,310	17-007-B010	---
Arsenic	13.9	17-003-B005	---
Barium	14.9	17-003-B005	---
Beryllium	0.82	17-003-B005	---
Calcium	17,600	17-005-B006	---
Chromium	36.1	17-003-B006	---
Cobalt	6.5	17-007-B010	---
Copper	19.1	17-005-B006	---
Iron	103,000	17-007-B010	---
Lead	63.6	17-005-B006	---
Magnesium	1,900	17-005-B006	---
Manganese	127	17-007-B010	---
Mercury	1.2	17-006-B006	---
Nickel	11.8	17-005-B006	---
Potassium	1,130	17-003-B005	---
Silver	4.6	17-007-B010	---
Sodium	1,300	17-005-B006	---
Vanadium	72.5	17-003-B006	---
Zinc	41.5	17-003-B005 17-005-B006	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

--- Criteria not available.

TABLE 19-3

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 17[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	1,530	17-003-D001	---	---
Arsenic	3.5	17-003-D001	20	33
Barium	5.5	17-003-D001	26,000	---
Beryllium	0.27	17-003-D001	2	---
Calcium	959	17-003-D001	---	---
Chromium	12.4	17-003-D001	---	80
Copper	6.4	17-003-D001	600	70
Iron	10,400	17-003-D001	---	---
Lead	12.8	17-003-D001	600	35
Magnesium	386	17-003-D001	---	---
Manganese	29.6	17-003-D001	---	---
Potassium	219	17-003-D001	---	---
Sodium	5,500	17-003-D001	---	---
Vanadium	16.1	17-003-D001	7,000	---
Zinc	33.9	17-003-D001	1,500	120
Cyanide	3.09	17-003-D001	5,200	---
PESTICIDES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
4,4'-DDE	0.12	17-004-D001	9	0.002
4,4'-DDD	0.019 J	17-004-D001	12	0.002
4,4'-DDT	0.21	17-004-D001	9	0.001
Endrin Aldehyde	0.21	17-003-D001	---	---
Alpha Chlordane	0.042 J	17-004-D001	---	0.0005[4]
Gamma Chlordane	0.023	17-003-D001	---	0.0005[4]

TABLE 19-3 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 17[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Methylene Chloride	0.046	17-004-D001	170	---
Acetone	0.15	17-003-D001	1,000	---
2-Butanone	0.19	17-004-D001	1,000	---
Phenol	1.9	17-004-D001	10,000	---
Phenanthrene	**2.3 J**	17-004-D001	---	**0.225[5]**
Di-n-butylphthalate	0.028 J	17-003-D001	10,000	---
Fluoranthene	0.46 J	17-004-D001	10,000	0.6[5]
Pyrene	**0.39 J**	17-004-D001	10,000	**0.35[5]**
Benzo(a)anthracene	0.060 J	17-001-D001	2.5	0.23[5]
Chrysene	0.12 J	17-004-D001	2.5	0.4[5]
Bis(2-ethylhexyl)phthalate	0.077 J	17-001-D001	210	---
Benzo(b)fluoranthene	0.23 J	17-004-D001	2.5	---
Benzo(k)fluoranthene	0.24 J	17-004-D001	2.5	---
Benzo(a)pyrene	0.19 J	17-004-D001	0.25	0.4[5]
Indeno(1,2,3-cd)pyrene	0.18 J	17-004-D001	2.5	---
Benzo(g,h,i)perylene	0.19 J	17-004-D001	2.5	---
Anthracene	0.073 J	17-004-D001	10,000	0.085[5]

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 Value represents total Chlordane (alpha- and gamma-isomers combined).

5 ER-L value of 4.0 mg/Kg for total PAHs also applies.

J Estimated value.
--- Criteria not available.

The site inspection will also identify erosion gullies which might be present along the toe of the landfill and may be transporting material into the marsh. If areas of erosion are found, up to two surface soil samples will be taken from areas of deposition along the gullies (SS-1 and SS-2). The exact locations where sediment and surface soil samples will be collected from the erosion channels and seeps, if any, will be determined during sampling operations. In addition, the four existing monitoring wells at the site will be sampled. A summary of sample locations and rationale is listed in Table 19-4.

Analytical parameters for sediment and surface soil samples will include TAL metals, TCL volatiles and semivolatiles, and TCL pesticides. Soil samples will also be analyzed for TCL PCBs. Grain size and total organic carbon (TOC) will be determined for sediment samples only. Groundwater and surface water will be analyzed for TAL metals, TCL volatiles, semivolatiles and landfill indicator parameters. Sample analytes, bottle requirements and holding times are listed in Table 3-2.

19.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 19-4

SAMPLING LOCATIONS AND RATIONALE
SITE 17
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Three surface water and sediment samples (estimated) (SW/SED-1 to 3).	Groundwater seeps along the toe of the landfill.	Determine if any contaminated leachate is originating from landfill.
Three remaining surface water and sediment samples (SW/SED-4 to 6).	From wetlands immediately adjacent to landfill where surface water and sediment are present.	Determine if any contamination is migrating from the landfill and has impacted wetlands.
Groundwater samples at 4 existing monitoring wells.	MW17-01, MW17-02, MW17-03, MW17-04	Determine groundwater quality,
Two surface soil samples (potentially) (SS-1 and 2).	If areas of erosion are found, up to two surface soil samples will be taken from areas of deposition along the gullies.	Determine if contaminated soil is being transported into the marsh.

20.0 SITE 19 (PAINT CHIP AND SLUDGE DISPOSAL AREA)

20.1 SITE DESCRIPTION

Site 19 is an ordnance maintenance area where paint chips and paint sludge generated during painting operations were discharged to a topographic depression near Building S-34. The site was in operation from the early 1940s to the early 1960s. Paint slurries and solvent residues were discharged into the open drainage swale. Approximately 400 gallons of solvent/paint sludge were disposed of at the site. Past construction activities and building construction at the site may have removed a significant portion of the contaminated material. The site is a circular area approximately 300 feet in diameter that is surrounded by woodlands. Half of the site, from Building S-34 south to the site perimeter, is paved. The remainder has a gravel surface. The depression, which received sludge discharge is approximately 50 feet in diameter and 5 to 10 feet deep, is located in the center of the site behind a barricade. A small drainage ditch runs from the depression to the west, toward a wetlands. General groundwater flow direction is toward the small stream to the west of the site. Figure 20-1 shows the physical features of the site.

20.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993), three monitoring wells were installed, and soil, sediment, surface water, and groundwater samples were analyzed. Cadmium, lead, and zinc were detected at elevated concentrations in soil. The upgradient well (19-1) contained a detectable level of cadmium.

During the RI/FS (Weston, 1993), 24 surface soil samples were collected. Four samples were analyzed for TAL inorganics, and 20 were analyzed for cadmium and lead. Twelve sediment samples were collected from the depression and adjoining drainage swale and analyzed for TAL inorganics. Low levels of volatiles and metals were detected in surface soil samples and elevated levels of metals were detected in sediments, most notably from samples taken within the depression. Soil and sediment maximum contaminant concentrations are summarized on Tables 20-1 and 20-2.

During the RI/FS (Weston, 1993), three monitoring wells were installed. Groundwater samples were collected from all SI and RI/FS monitoring wells and analyzed for TCL organics, TAL inorganics, VOCs, and drinking water metals. MW19-2 and MW19-06 were analyzed for explosives. Two volatile compounds, methylene chloride and acetone, were detected in almost all samples and in blanks. These detections are likely due to laboratory/field contamination. No other VOCs were detected. DDE and DDT were detected at MW19-02 from one sampling round. These compounds were undetected in later rounds. Elevated levels of metals were detected at monitoring wells. Table 20-3 summarizes the maximum analytical results for groundwater samples.

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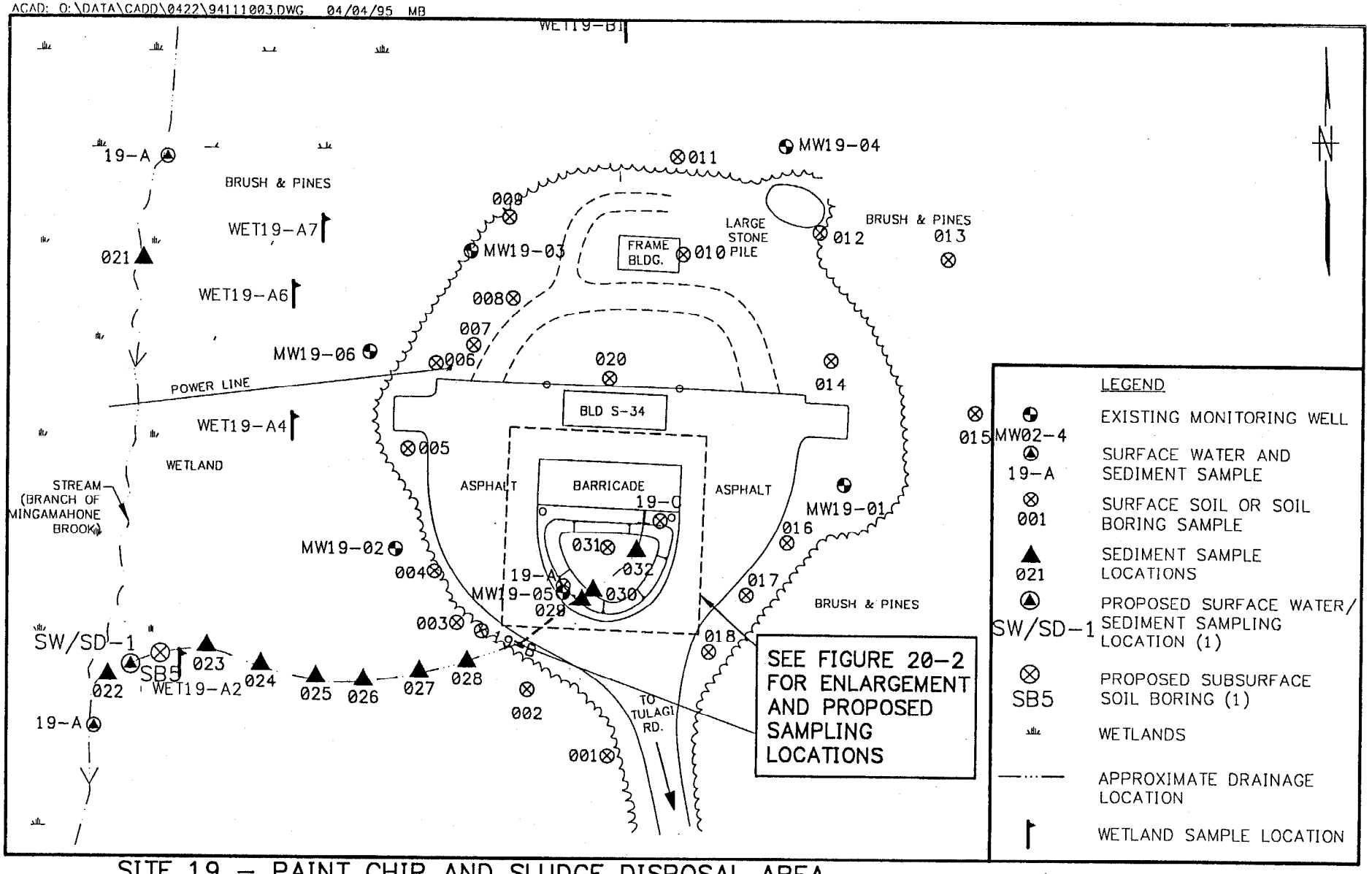

SITE 19 – PAINT CHIP AND SLUDGE DISPOSAL AREA
SAMPLING LOCATIONS,
NAVAL WEAPONS STATION EARLE, N.J.

0 100 200
SCALE IN FEET

FIGURE 20-1

Halliburton NUS CORPORATION

TABLE 20-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 19[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
VOLATILE ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene chloride	60	19-028-S002	170
Acetone	42	19-030-S002	1,000
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	1,990	19-003-S001	---
Antimony	3.8	19-003-S001	340
Arsenic	1.2	19-003-S001	20
Barium	17.3	19-013-S001	26,000
Calcium	619	19-003-S001	---
Cadmium	1.1	19-007-S001	100
Chromium	7.8	19-003-S001	---
Copper	6.5	19-003-S001	600
Iron	6,090	19-003-S001	---
Lead	33.6	19-007-S001	600
Magnesium	363	19-003-S001	---
Manganese	24.9	19-003-S001	---
Nickel	1.3	19-003-S001	2,400
Potassium	236	19-003-S001	---
Silver	0.71	19-003-S001	2,000
Sodium	58.9	19-003-S001	---
Vanadium	10.5	19-003-S001	7,000
Zinc	25.5	19-003-S001	1,500

1 Weston Report: Phase II - Site Investigation Study Report, 1993.
2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.
--- Criteria not available.

TABLE 20-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 19[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	3,110	19-027-D001	---	---
Arsenic	2	19-023-D001	20	33
Barium	84.2	19-027-D001	6,000	---
Beryllium	0.25	19-027-D001	2	---
Calcium	1,100	19-031-D001	---	---
Cadmium	**33.7**	19-032-D001	100	**5**
Chromium	**464**	19-023-D001	---	**80**
Cobalt	2.7	19-023-D001	---	---
Copper	27.8	19-027-D001	600	70
Iron	5,280	19-027-D001	---	---
Lead	**12,600**	19-032-D001	**600**	**35**
Magnesium	473	19-027-D001	---	---
Manganese	43.7	19-027-D001	---	---
Mercury	0.13	19-027-D001	260	0.15
Potassium	332	19-027-D001	---	---
Sodium	41.5	19-031-D001	---	---
Vanadium	14.6	19-027-D001	7,000	---
Zinc	**1,050**	19-027-D001	1,500	**120**

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

--- Criteria not available.

TABLE 20-3

GROUNDWATER RESULTS VERSUS REGULATORY REQUIREMENTS
SITE 19[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
SEMIVOLATILES	**(µg/L)**		**(µg/L)**	**(µg/L)**
Naphthalene	1 J	MW19-02	---	---
Bis(2-ethylhexyl)phthalate	2 J	MW19-02	3 (30)	6
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene chloride	730	MW19-06	2	5
Acetone	33,000	MW19-06	700	---
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	35,500	MW19-06	200	---
Arsenic	80.8	MW19-06	0.02 (8)	50
Barium	237	MW19-06	2,000	2,000
Beryllium	4.1	MW19-06	0.008 (20)	4
Calcium	12,200	MW19-02	---	---
Cadmium	48.2	MW19-06	4	5
Cobalt	26	MW19-06	---	---
Chromium	4,540	MW19-06	100	100
Copper	140	MW19-06	1,000	1,300[G]
Iron	534,000	MW19-06	300	---
Potassium	20,200	MW19-06	---	---
Magnesium	13,000	MW19-01	---	---
Manganese	1,170	MW19-06	50	---
Sodium	4,800	MW19-05	50,000	---
Nickel	82	MW19-06	100	100
Lead	282	MW19-06	5	15[A]
Antimony	23	MW19-01	2 (20)	6

TABLE 20-3 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY REQUIREMENTS
SITE 19[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3] (MCL)
Selenium	3.9	MW19-01	50	50
Vanadium	630	MW19-06	---	---
Zinc	1,190	MW19-06	5,000	---
Mercury	0.58	MW19-05	2	2
PESTICIDES/PCBs	**(µg/L)**		**(µg/L)**	**(µg/L)**
4,4-DDE	**22 J**	MW19-02	**0.1**	---
4,4-DDT	**140**	MW19-02	**0.1**	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

J Estimated value.
--- Criteria not available.

20.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

In order to further define the extent of metals contamination at the site, four soil borings will be installed in the small depression behind the barricades. Three soil borings (SB-1, -2 and -3) will be located along the edge of the depression, as shown in Figure 20-2. Borings SB-2 and SB-3 will be collected in the vicinity of previous sampling locations 032 and 030 which showed high metals concentrations. In addition to analysis for TCL VOCs and TAL metals, these two samples will be analyzed for hexavalent chromium. One additional boring (SB-4) will be collected from near the center of the depression, in the vicinity of previous sampling location 031. One additional monitoring well (MW 19-7) will be placed south of the site, along the drainage path, to determine groundwater quality south of the depression area. At each soil boring, two soil samples will be collected. One sample will be collected from 0 to 2 feet to define the extent of surficial soil contamination. One additional soil sample will be collected from 3 to 5 ft bgs, to determine if metals have migrated through the soil from the surface. Previous soil samples at the site were collected from a depth of less than 2 feet. Therefore, one sample at each boring will be collected at 3 to 5 ft bgs to provide data on the depth and extent of soil contamination.

One additional subsurface soil sample will be collected (SB-5) along the culvert (near previous sampling point 023) from a depth of 2 to 3 feet. The sample will be used to determine potential risk to receptors and vertical extent of contamination near the culvert. The sample will be analyzed for TAL metals only.

Groundwater samples will be collected from all six existing monitoring wells and the one newly installed well. Groundwater samples will be collected using a low-flow pump to reduce turbidity and obtain a representative dissolved metals sample.

Groundwater and soil samples will be analyzed for TCL volatiles and TAL metals. One groundwater sample and two soil samples will also be analyzed for hexavalent chromium. Table 20-4 lists the sample rationale for Site 20. Table 3-2 summarizes sample analytes, bottle requirements and holding times.

One surface water/sediment sample will be collected from the discharge location of the culvert (near the SI sampling location 022). The sample will be analyzed for TCL volatiles, TCL semivolatiles, TAL metals, and TCL pesticides.

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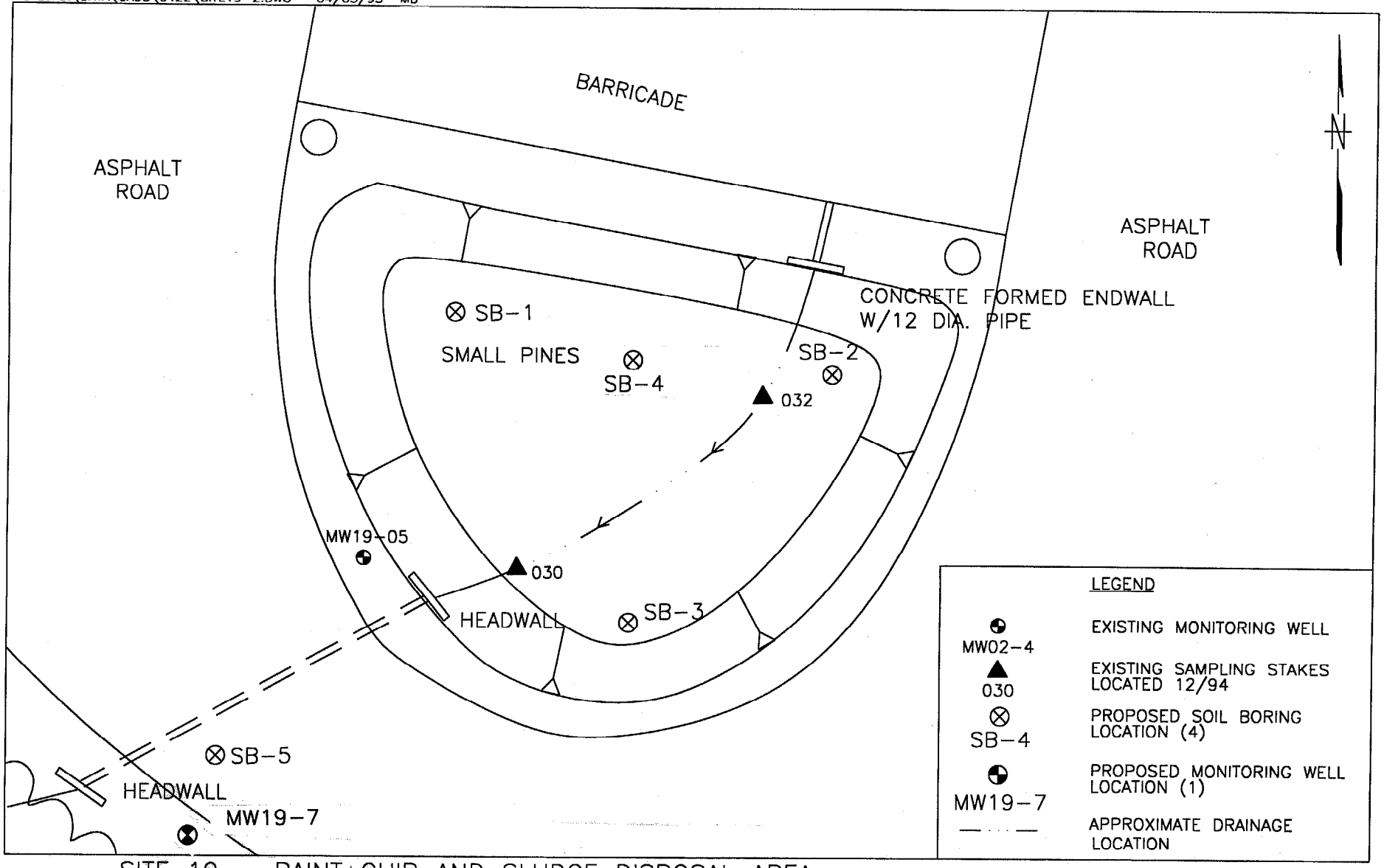

SITE 19 – PAINT CHIP AND SLUDGE DISPOSAL AREA
ENLARGEMENT OF AREA SOUTH OF BARRICADE
NAVAL WEAPONS STATION EARLE, N.J.

0 20 40
SCALE IN FEET

FIGURE 20-2

Halliburton NUS CORPORATION

TABLE 20-4

SAMPLING LOCATIONS AND RATIONALE
SITE 19
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Four surface soil samples.	From 0 to 2 feet from all proposed soil borings (SB-1, SB-2, SB-3, SB-4).	Determine extent and magnitude of surface soil contamination.
Four subsurface soil samples.	From 3 to 5 feet from all proposed soil borings (SB-1, SB-2, SB-3, SB-4).	Determine depth and magnitude of soil contamination.
One subsurface soil sample.	From 2 to 3 feet (SB-5).	For risk (receptors) and remediation purposes of culvert soils.
Seven groundwater samples.	From the six existing and one newly installed monitoring wells (MW19-1, MW19-2, MW19-3, MW19-4, MW19-5, MW19-6, MW19-7).	Determine groundwater quality at the site.
One surface water and sediment sample (SW/SD-1).	Near discharge location of the culvert (near SI sampling location 022).	Determine if contaminants are leaving the disposal area.

20.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

21.0 SITE 20 (GRIT BLASTING AREA AT BUILDING 544)

21.1 SITE DESCRIPTION

The Grit Blasting Area at Building 544 is a small area behind Building 544 which houses blasting operations for the removal of paint from ordnance. A leaching field is reported to be present behind this building. Past disposal activities at this leaching field are unknown. Activities at the site included the disposal of paint chips and spent grit from site operations. An estimated yearly volume of disposed paint chips is 53 gallons (IAS, 1983). The spent grit was staged in an open pile southwest of Building 544. The pile was approximately 10 feet in diameter and 1 foot high and has recently been excavated. The material has recently been removed from the site. The site is bordered on the northeast by a marsh and wetlands. A gravel road accesses the site from Midway Road. A shallow drainage depression, which is approximately 300 feet in length and 1 foot deep runs along the east and southeast boundaries of the site and discharges to the northeast toward the marsh. Surface water flows towards this marshy area.

21.2 PREVIOUS INVESTIGATIONS

Figure 21-1 shows the existing sample locations of the Grit Blasting Area at Building 544. During the RI/FS (Weston, 1993), five sediment samples were collected, one in the grit pile and four in the drainage ditch. The soil samples were analyzed for TAL inorganics and cyanide. Two samples were also analyzed for pesticides/PCBs and SVOCs, and one sample was analyzed for VOCs. Elevated levels of semivolatile compounds and metals were detected from samples along the drainage. Only very low levels of volatiles (possible lab artifacts) were detected in surface soil samples. Analytical results for these samples are summarized in Tables 21-1 and 21-2.

21.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

To determine whether further action is required in the areas where blasting grit was stored, confirmation samples will be collected in the areas where the grit has been excavated. A total of five surface soils will be collected, as shown on Figure 21-1. Four samples (SS-01 to SS-04) will be collected from the excavated area to the south and southwest of the site. Sample SS-05 will be collected from the former location of a smaller pile southwest of the other samples. Samples will be collected from the top 0.5 feet of soil.

Two surface water and sediment samples will be collected from these locations to determine the effect of past activities on the surrounding wetlands. These samples will be collected from the wetlands at the nearest point to the site where standing water is present. Sediment samples will be collected from natural migration pathways in areas of sediment deposition. Based on recent site visits, these sampling locations

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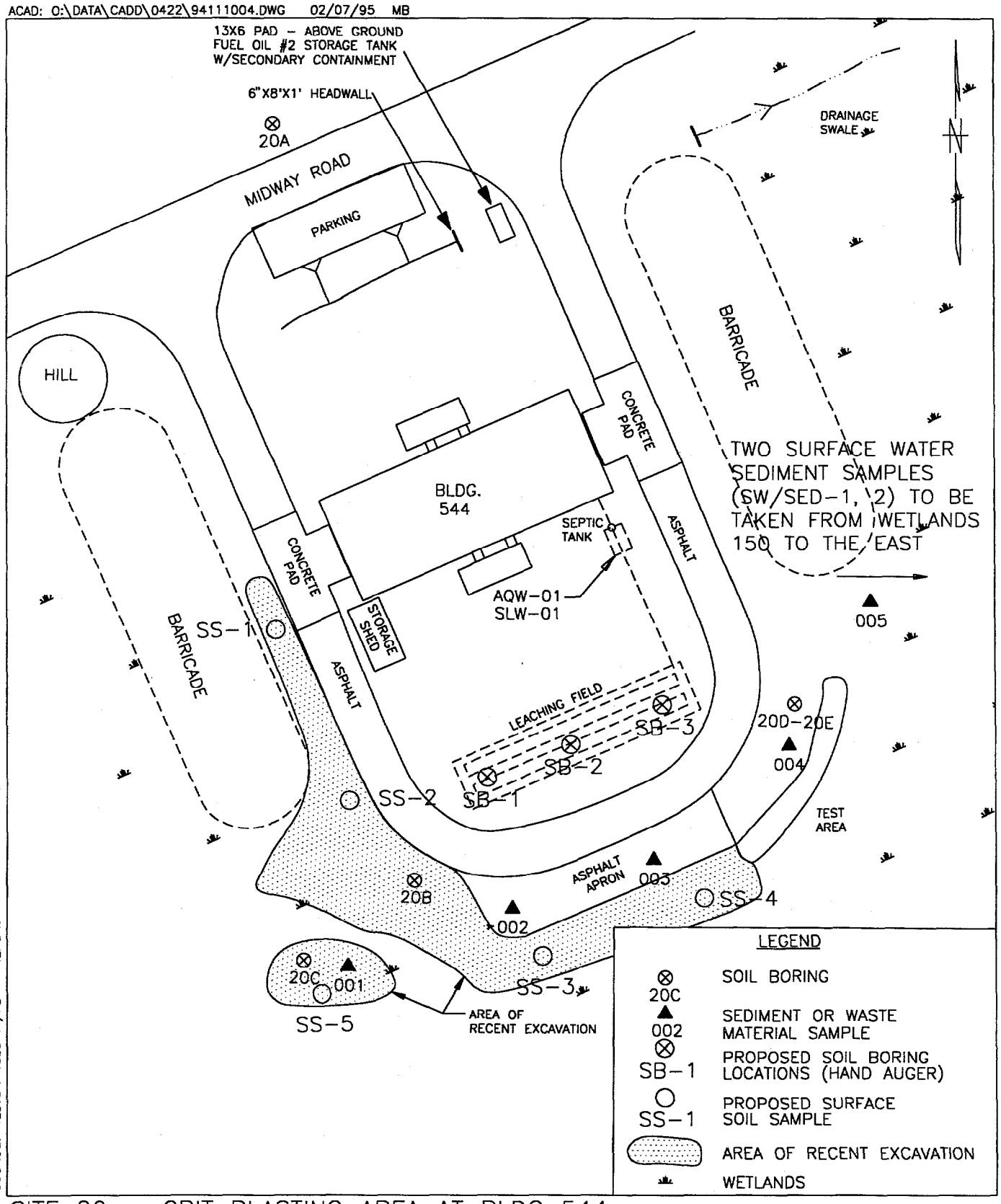

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 20 - GRIT BLASTING AREA AT BLDG 544

SAMPLING LOCATIONS

NWS EARLE, NJ

0 50 100

SCALE IN FEET

FIGURE 21-1

Halliburton NUS CORPORATION

TABLE 21-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 20[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Subsurface Soil Standards[2]
VOLATILE ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene Chloride	0.130	20-05	10
Acetone	0.078	20-05	50

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

TABLE 21-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 20[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Phenanthrene	0.91	20-05	---	0.225[4]
Anthracene	0.21 J	20-05	10,000	0.085[4]
Di-n-butylphthalate	0.2 J	20-05	10,000	---
Fluoranthene	3.4	20-05	10,000	0.6[4]
Pyrene	3.9	20-05	10,000	0.35[4]
Butylbenzylphthalate	0.55 J	20-05	10,000	---
Benzo(a)anthracene	1.9	20-05	2.5	0.23[4]
Chrysene	2.6	20-05	2.5	0.4[4]
Bis(2-ethylhexyl)phthalate	1.9	20-05	210	---
Benzo(b)fluoranthene	2.8	20-05	2.5	---
Benzo(k)fluoranthene	2.6	20-05	2.5	---
Benzo(a)pyrene	2.7	20-05	0.25	0.4[4]
Indeno(1,2,3-cd)pyrene	2	20-05	2.5	---
Dibenz(a,h)anthracene	0.83 J	20-05	0.25	0.06[4]
Benzo(g,h,i)perylene	2.4	20-05	2.5	---
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	17,300	20-03	---	---
Arsenic	4.6	20-05	20	33
Barium	325	20-03	26,000	---

TABLE 21-2 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 20[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
Beryllium	**9.9**	20-03	**2**	---
Calcium	6,750	20-03	---	---
Cadmium	1.8	20-03	100	5
Cobalt	64.9	20-01	---	---
Chromium	**204**	20-03	---	**80**
Copper	**1,320**	20-01	**600**	**70**
Iron	54,100	20-03	---	---
Potassium	1,930	20-03	---	---
Magnesium	2,280	20-03	---	---
Manganese	329	20-03	---	---
Nickel	**711**	20-01	2,400	**30**
Lead	**780**	20-03	**600**	**35**
Antimony	**4.6**	20-05	340	**2**
Selenium	2.9	20-05	1,000	---
Vanadium	47.1	20-05	7,000	---
Zinc	**2,890**	20-03	**1,500**	**120**

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 Value represents total Chlordane (alpha- and gamma-isomers combined).

5 ER-L value of 4.0 mg/Kg for total PAHs also applies.

J Estimated value.
--- Criteria not available.

are estimated to be approximately 150 feet to the east of the site. Actual sampling locations will be chosen in the field based on the location of surface water and sediment and natural migration pathways (channels) which may have been effected by past site operations. One sample (SW/SED-1) will be taken from areas which may have been effected by the former grit piles and the other sample (SW/SED-2) will be taken from northeast of the first sample location, at a wetland point adjacent to the leaching field.

Three soil borings (SB-1, -2 and -3) will be collected from the leaching field area to determine if the leaching field may have affected the site. These samples will be collected using a hand auger, due to access problems for large equipment. Samples will be collected from 3 to 5 ft bgs to determine what effect the leach field may have had on the soils in the immediate vicinity.

One aqueous and one sludge sample will be collected from the septic tank, and analyzed for TCL volatiles, TCL semivolatiles, and TAL metals.

All soils, surface water, and sediment samples will be analyzed for TCL volatiles, SVOCs and metals. Table 21-3 lists the sample rationale for Site 20. Table 3-2 summarizes sample analytes, bottle requirements and holding times.

21.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 21-3

SAMPLING LOCATIONS AND RATIONALE
SITE 20
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Five surface soil samples (SS-1, SS-2, SS-3, SS-4, SS-5).	Confirmation samples from excavated areas. Taken from 0 to 0.5 feet.	Determine effectiveness of grit removal.
Three subsurface soil samples (SB-1, SB-2, SB-3).	Collected from leaching field area at depth of 3 to 5 feet.	Determine effect of leaching field on soils.
Two surface water and sediment samples (SW/SED-1 and -2).	Nearest surface water and sediment to leaching field and former grit pile locations.	Determine if past activities have effected wetlands.
One aqueous and one sludge sample (AQW-01/SLW-01).	Septic tank at the south east side of Building 544.	Determine if the septic tank is a potential source of site contamination.

22.0 SITE 22 (PAINT CHIP DISPOSAL AREA)

22.1 SITE DESCRIPTION

The Paint Chip Disposal Area is behind Building D-2 and previously consisted of approximately 50 square feet of stressed vegetation and discolored soils. The discolored soils resulted from past grit blasting and painting operations. However, the discolored soils and stressed vegetation are no longer visible at the site. The ground surface at the site is predominantly sand and gravel. Traces of paint stains were barely evident in the surface materials and were limited to black and red staining on the surface. The site is bordered by a railroad siding and to the east, a marshy area. A shallow drainage depression, which is 275 feet in length and 1 foot deep, runs to the east of the site.

22.2 PREVIOUS INVESTIGATIONS

Figure 22-1 shows the existing sample locations of the Paint Disposal Area. During the SI (Weston, 1993), three soil samples were collected. No contamination exceeding the NJDEPE ECRA soil guidelines were detected. During the RI/FS (Weston, 1993), six soil samples were collected in stained areas, three at 0 to 1 ft bgs and three samples at 3 ft bgs. The three shallow samples were analyzed for TAL inorganics and cyanide, semivolatiles, and pesticides/PCBs. The three deeper samples were analyzed for VOCs. Metals were detected within normal ranges for naturally-occurring soils. Very low values of volatile and semivolatile compounds were detected in some samples. One pesticide, 4,4-DDT, was detected in one sample. Table 22-1 summarizes the maximum concentrations detected in soil samples.

Sediment samples were collected at six locations in the drainage ditch and analyzed for TAL inorganics, TPH, and pesticides/PCBs. Some metals were detected at slightly elevated levels, several semivolatile compounds were detected at J levels, and one pesticide was detected in a sediment sample (22-03). Table 22-2 summarizes the maximum concentrations detected in sediment samples.

22.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Based on the lack of significant contamination noted in samples collected during previous investigations, past activities at the site have not significantly effected soils and sediment to warrant additional sample collection. Because of the minimal concentrations of compounds detected no additional samples will be collected during this phase of investigation. The data collected previously at the site will be re-evaluated and the site will be discussed in the RI/FS report.

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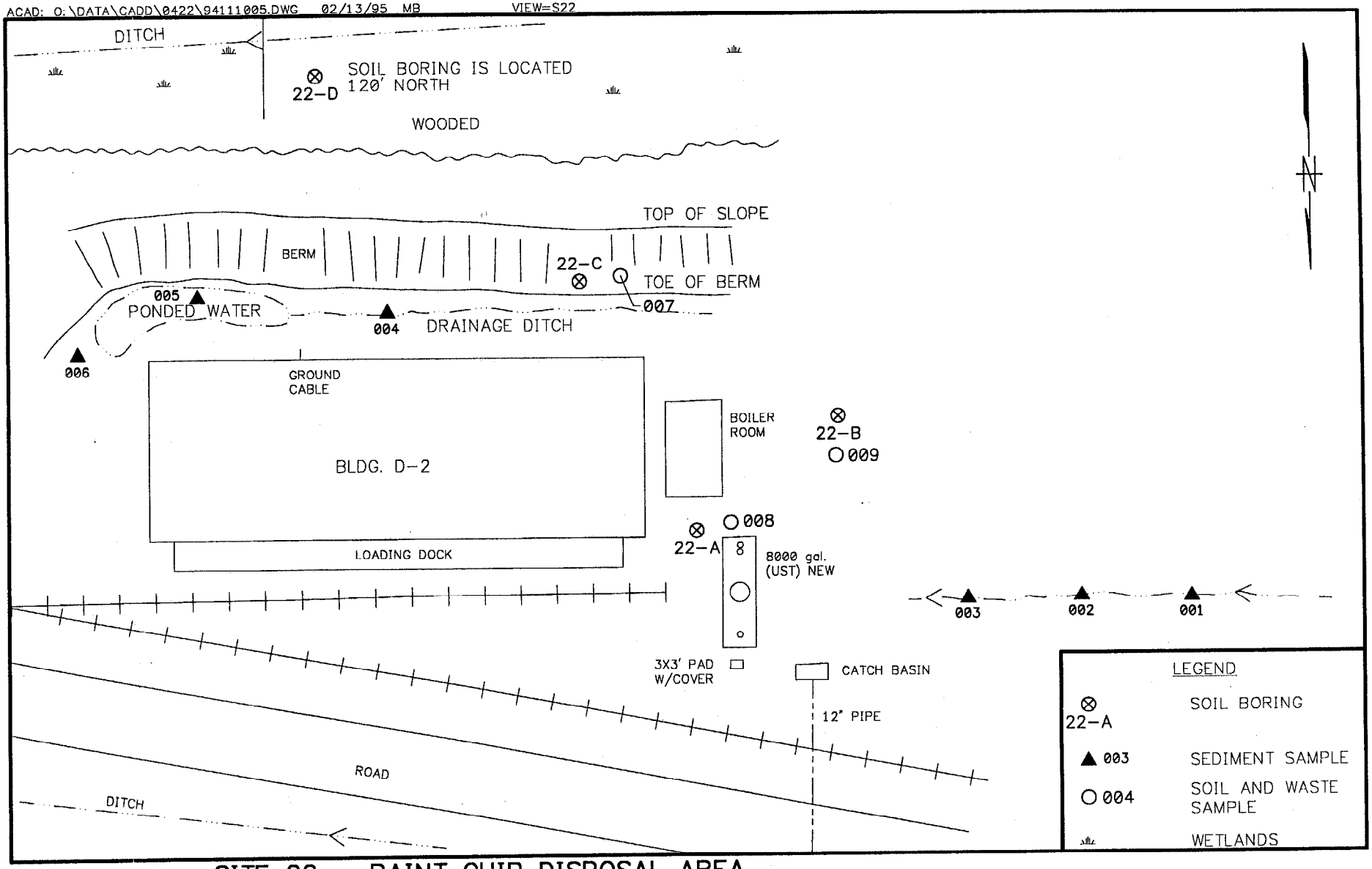

SITE 22 – PAINT CHIP DISPOSAL AREA
SAMPLING LOCATIONS
NWS EARLE, NJ

0 40 80
SCALE IN FEET

FIGURE 22-1

Halliburton NUS CORPORATION

TABLE 22-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 22[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
VOLATILE ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene chloride	0.053	22-09	170
Acetone	0.22	22-09	1,000
1,1,1-Trichloroethane	0.002 J	22-09	210
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**
Benzoic acid	0.54 J	22-08	---
Phenanthrene	23 J	22-08	---
Anthracene	0.082 J	22-08	10,000
Di-n-butylphthalate	0.071 J	22-08	10,000
Fluoranthrene	0.58	22-08	10,000
Pyrene	0.57	22-08	10,000
Benzo(a)anthracene	0.28 J	22-08	2.5
Chrysene	0.073 J	22-08	2.5
Bis(2-ethylhexyl)phthalate	0.097 J	22-08	210
Benzo(b)fluoranthene	0.26 J	22-08	2.5
Benzo(k)fluoranthene	0.2 J	22-08	2.5
Benzo(a)pyrene	0.21 J	22-08	0.25
Indeno(1,2,3-cd)pyrene	0.097 J	22-08	2.5
Benzo(g,h,i)perylene	0.1 J	22-08	2.5
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	4,350	22-09	---
Arsenic	2.7	22-08	20
Barium	9.6	22-09	26,000
Beryllium	0.45	22-08	2
Calcium	55.2	22-07	---
Chromium	48.2	22-08	---
Copper	17.2	22-08	600

TABLE 22-1 (continued)
SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 22[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
INORGANICS (continued)	**(mg/kg)**		**(mg/kg)**
Iron	9,480	22-08	---
Potassium	2,270	22-08	---
Magnesium	661	22-08	---
Manganese	11.2	22-07	---
Sodium	97.4	22-07	---
Nickel	2.8	22-08	2,400
Lead	29.8	22-07	600
Selenium	0.35	22-09	1,000
Vanadium	36.1	22-08	7,000
Zinc	33.3	22-08	1,500
PESTICIDES/PCBs	**(mg/kg)**		**(mg/kg)**
4,4-DDT	5.2 J	22-09	9

1 Weston Report: Phase II - Site Inspection Study, Draft Report, February 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

J Estimated value.
--- Criteria not available.

TABLE 22-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 22[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
SEMIVOLATILES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Acenaphthene	0.300 J	22-06	10,000	0.15[4]
Fluorene	0.150 J	22-06	10,000	0.035[4]
Phenanthrnene	6.3	22-06	---	0.225[4]
Anthracene	8	22-06	10,000	0.085[4]
Di-n-butylphthalate	0.069	22-03	10,000	---
Fluoranthene	5	22-06	10,000	0.6[4]
Pyrene	3.3	22-06	10,000	0.35[4]
Benzo(a)anthracene	1.8	22-06	2.5	0.23[4]
Chrysene	1.7	22-06	2.5	0.4[4]
Bis(2-ethylhexyl)phthalate	0.077	22-06	210	---
Benzo(b)fluoranthene	1.2	22-06	2.5	---
Benzo(k)fluoranthene	1.2	22-06	2.5	---
Benzo(a)pyrene	0.97	22-06	0.25	0.4[4]
Indeno(1,2,3-cd)pyrene	0.78	22-06	2.5	---
Dibenzo(a,h)anthracene	0.22 J	22-06	0.25	0.6[4]
Benzo(g,h,i)perylene	0.83	22-06	2.5	---
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	3,930	22-01	---	---
Arsenic	3.3	22-07	20	33
Barium	16.5	22-01	26,000	---
Beryllium	0.27	22-03	2	---
Calcium	1,260	22-01	---	---
Cadmium	2.7	22-01	100	5
Cobalt	5.2	22-01	---	---

TABLE 22-2 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 22[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS (continued)	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Chromium	31.8	22-03	---	80
Copper	18.3	22-01	600	70
Iron	13,400	22-01	---	---
Potassium	1,440	22-03	---	---
Magnesium	641	22-01	---	---
Manganese	155	22-01	---	---
Sodium	67.1	22-01	---	---
Nickel	8.6	22-01	2,400	30
Lead	**106**	22-03	600	**35**
Selenium	0.37	22-04	1,000	---
Vanadium	29.0	22-03	7,000	---
Zinc	119	22-01	1,500	120
PESTICIDES/PCBs	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
4,4-DDT	**13 J**	22-03	**9**	**0.001**

1 Weston Report: Phase II - Site Inspection Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 ER-L value of 4.0 mg/Kg for total PAHs also applies.

--- Criteria not available.

22.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

23.0 SITE 23 (PAINT DISPOSAL AREA)

23.1 SITE DESCRIPTION

The Paint Disposal Area near Building D-5 has been used since the early 1970s for repainting and stenciling torpedoes, aerial bombs, and other large ordnance. SI work at the site (Weston, 1993) found a small amount of paint residue present inside the fence line, southwest of Building D-5, although no such residue was visible during an October 1993 preliminary RI site visit. An earthen berm about 20 feet high surrounds the north, east and west sides of the site. A drainage ditch and a small marsh are present west and north of the building within the bermed area. The site is partially paved, and overland runoff flows radially across the site into shallow drainage depressions which surround the site on three sides. The drainages flow toward the marshland, which contains standing water throughout the year. A tributary of Hockhockson Brook is located approximately 500 feet to the southwest of the site. SI work indicated that a shallow perched water layer may be present above the water table aquifer at the site.

23.2 PREVIOUS INVESTIGATIONS

During the SI (Weston, 1993) six soil samples (from 0 to 3 ft bgs), eight sediment samples, and one hydropunch groundwater sample were collected for analysis. Sampling locations are shown on Figure 23-1. Sample analysis indicated that low levels of VOCs and metals were present in soil samples, low levels of organics and one pesticide were detected in sediment, and elevated metals were detected in sediments. Groundwater contained low levels of organics and some elevated levels of metals. Maximum contaminant concentrations recorded during the SI are listed in Tables 23-1 through 23-3.

23.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

In order to define the extent of soil and groundwater contamination at this site, subsurface soil, surface water, sediment and groundwater will be sampled. Three soil borings will be drilled at the site. Each boring will be converted into a monitoring well. Well/boring locations are shown on Figure 23-1. Boring 1 (23MW-1) will be located at the northeast corner of Building D-5. The second boring (23MW-2) will be located a the southwest corner of the building where surface paint residue was observed previously. The third boring (23MW-3) will be located across the railroad siding, to the east (upgradient) of Building D-5. All three soil borings will be sampled at two intervals. One sample from each boring will be collected at perched water (if it is encountered during the drilling activity), or will be sampled based on field PID/FID readings or based on visual evidence of contamination. A second sample from each boring will be collected from the interval directly above the water table, at approximately 20 ft bgs. Each soil boring will

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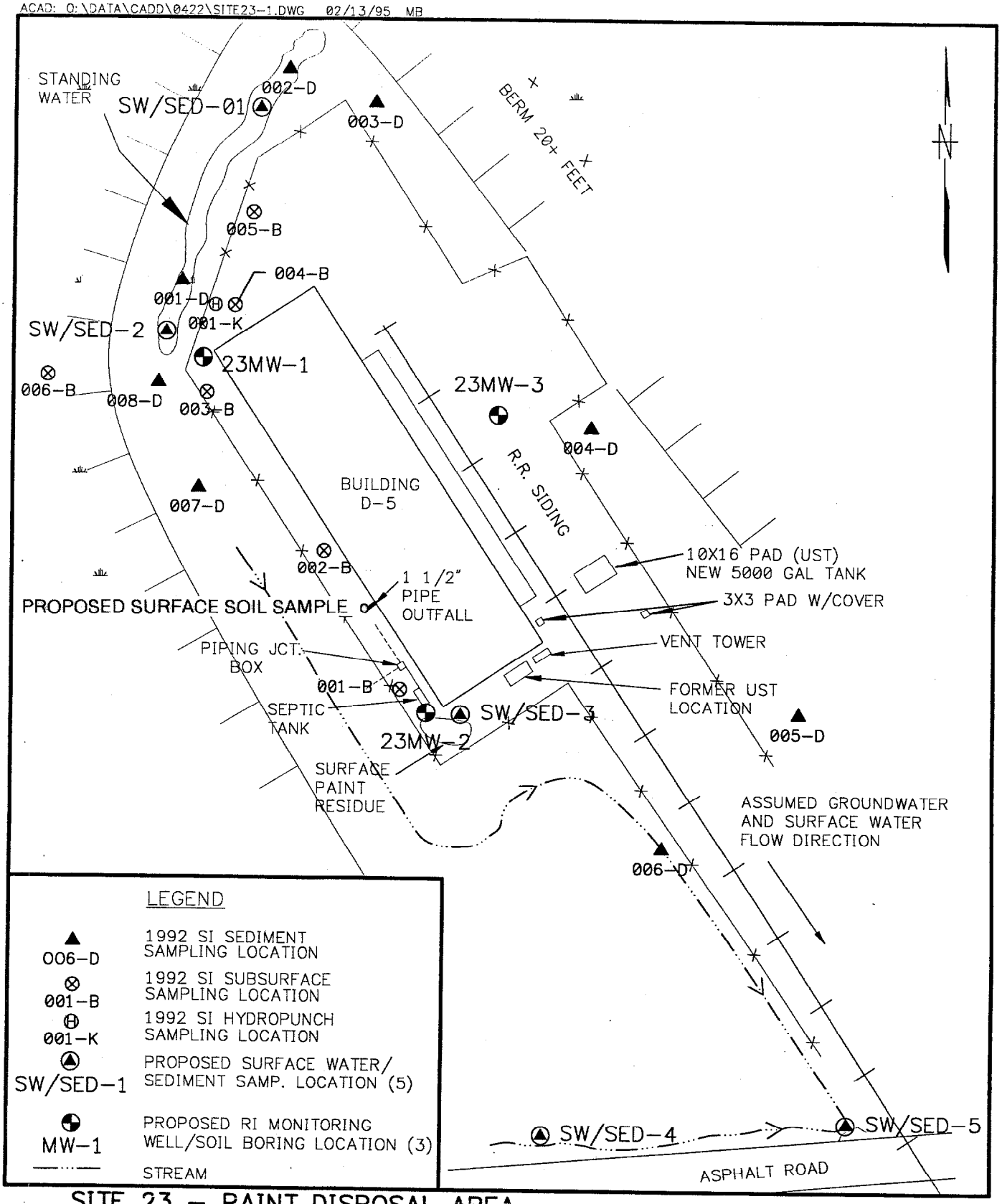

SOURCE: WESTON 1993 DRAFT SITE

SITE 23 – PAINT DISPOSAL AREA
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 60 120
SCALE IN FEET

FIGURE 23-1

Halliburton NUS CORPORATION

TABLE 23-1

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 23[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3]
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Aluminum	**158,000**	23-001-K029	**200**	---
Arsenic	**144**	23-001-K029	**0.02 (8)**	**50**
Beryllium	**34.8**	23-001-K029	**0.008 (20)**	**4**
Calcium	16,100	23-001-K029	---	---
Cadmium	**10.5**	23-001-K029	**4**	**5**
Cobalt	240	23-001-K029	---	---
Chromium	**5,680**	23-001-K029	**100**	**100**
Copper	141	23-001-K029	1,000	1,300[G]
Iron	**230,000**	23-001-K029	**300**	---
Potassium	69,100	23-001-K029	---	---
Magnesium	22,100	23-001-K029	---	---
Manganese	**469**	23-001-K029	**50**	---
Nickel	**812**	23-001-K029	**100**	**100**
Lead	**395**	23-001-K029	**5**	**15[A]**
Vanadium	3,340	23-001-K029	---	---
Zinc	587	23-001-K029	5,000	---
ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Methylene Chloride	**5 J**	23-001-K029	**2**	**5**
Acetone	55	23-001-K029	700	---
MISCELLANEOUS	**(µg/L)**		**(µg/L)**	**(µg/L)**
TOC	76,000	23-001-K029	---	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

Some elevated organics including DNT were reported in the draft interim SI but were unvalidated and were therefore not included in this table.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

TABLE 23-1 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 23[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

- G Maximum Contamination Level Goal
- A Action Level
- S Secondary Maximum Contaminant Level
- P Proposed

J Estimated value.
--- Criteria not available.

TABLE 23-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 23[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	3,140	23-002-D001	---	---
Arsenic	6.7	23-002-D001	20	33
Barium	27.5	23-002-D001	26,000	---
Beryllium	1.2	23-002-D001	2	---
Cadmium	6.7	23-004-D001	100	5
Calcium	1,480	23-002-D001	---	---
Chromium	280	23-006-D001	---	80
Cobalt	2.6	23-008-D001	---	---
Copper	27.9	23-004-D001	600	70
Iron	23,600	23-008-D001	---	---
Lead	143.1	23-004-D001	600	35
Magnesium	1,110	23-002-D001	---	---
Manganese	52.6	23-002-D001	---	---
Potassium	2,360	23-002-D001	---	---
Silver	1.8	23-008-D001	2,000	1
Sodium	73	23-002-D001	---	---
Vanadium	94.9	23-002-D001	7,000	---
Zinc	499	23-004-D001	1,500	120
PESTICIDE	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
4,4'-DDD	0.00084	23-002-D101	12	0.002

TABLE 23-2 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 23[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Methylene Chloride	0.003 J	23-002-D001	170	---
Acetone	0.038 J	23-002-D101	1,000	---
Phenol	0.057 J	23-002-D001	10,000	---
4-Methylphenol	0.13 J	23-002-D001	---	---
Phenanthrene	0.046 J	23-007-D001	---	0.225[4]
Di-n-butylphthalate	0.058 J	23-002-D101	10,000	---
Fluoranthene	0.11 J	23-007-D001	10,000	0.6[4]
Pyrene	0.09 J	23-007-D001	10,000	0.35[4]
Benzo(a)anthracene	0.039 J	23-007-D001	2.5	0.23[4]
Chrysene	0.07 J	23-007-D001	2.5	0.4[4]
Benzo(b)fluoranthene	0.054 J	23-007-D001	2.5	---
Benzo(k)fluoranthene	0.055 J	23-007-D001	2.5	---
Benzo(a)pyrene	0.041 J	23-007-D001	0.25	0.4[4]

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 ER-L value of 4.0 mg/Kg for total PAHs also applies.

J Estimated value.
--- Criteria not available.

TABLE 23-3

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 23[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Subsurface Soil Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Cadmium	2.1	23-005-B001	---
Chromium	239	23-002-B001	---
Copper	9	23-007-B001	---
Lead	560	23-002-B001	---
Zinc	558	23-002-B001	---
ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene Chloride	0.008 J	23-006-B001	10
Di-n-butylphthalate	0.048 J	23-003-B001	100

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

J Estimated value.
--- Criteria not available.

be converted into a monitoring well, which will be constructed such that the screened interval intersects the water table. Groundwater will be collected from each well for chemical analysis and water table elevations will be measured to define groundwater flow patterns at the site. A summary of site field sampling and rationale is included in Table 23-4.

Five surface water and sediment samples will be collected at the site to define any potential impact past activities may have had on the surrounding wetlands. Two surface water and sediment samples (SW/SED-1 and -2) will be collected from the marsh just north of Building D-5. One sample (SW/SED-3) will be collected from standing water observed at the southwest end of the building, near 23MW-2. Two additional samples (SW/SED-4 and -5) will be collected from the drainage which may receive some runoff from the site.

One shallow hand-auger boring sample will be collected from the base of the 1 1/2 inch pipe outfall located at the west side of Building D-5. The sample will be obtained from the 12 to 18 inch depth zone below the surface.

Analytical parameters for all soil samples, all sediment, all surface water and groundwater will include TAL metals, TCL volatiles and semivolatiles, explosives and TCL pesticides. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

23.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 23-4

SAMPLING LOCATIONS AND RATIONALE
SITE 23
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Six subsurface soil samples from three borings.	One sample from each boring collected above water table. Additional sample from each boring from interval based on PID/FID or visual contamination or at perched water zone.	Determine depth of soil contamination which may be present.
Two surface water/sediment samples (SW/SED-1, -2).	Collected from wetlands north of Building D-5.	Determine if wetlands surrounding site have been impacted by site activities.
One surface water/sediment sample (SW/SED-3).	Collected from ponded water southwest of Building D-5.	Determine if area surrounding site have been impacted by site activities.
Two surface water/sediment samples (SW/SED-4 and -5).	Collected from drainage south of Building D-5. One sample to be taken upstream of where site runoff encounters drainage.	Determine if wetlands surrounding site have been impacted by site activities.
Three groundwater samples	Monitoring wells 23MW-1, 23MW-2, 23MW-3.	Determine if groundwater contamination is present at site.
One soil sample from a shallow hand-auger boring.	Collected from the soil at the base of the 1.5 inch pipe located at the west side of Building D-5. The sample will be obtained from the 12 inch to 10 inch depth zone, below the surface.	Determine if the 1.5 inch pipe was a source of site contamination.

24.0 SITES 24/25 (CLOSED PISTOL RANGES)

24.1 SITE DESCRIPTION

Sites 24 and 25 are closed pistol ranges which are no longer used for target practice. Due to the similar nature of the sites, their similar history, and the close proximity of the pistol ranges these sites will be combined and addressed by the RI in this one section. Activities at the site consisted of target practice using lead and copper-jacketed bullets which were fired into the impact berm (natural sand bank). It has been estimated that approximately 250 pounds of lead may be present at each site (Weston, 1993). Site layouts are illustrated in Figures 24-1 and 24-2. Preserved wooden posts are present at the site and form the firing platform. The impact berms are approximately 70 feet high and are composed of sand. No drainage swales are present at either site and precipitation infiltrates through the soil. Wetlands are not present near the sites.

24.2 PREVIOUS INVESTIGATIONS

Four soil samples were collected from shallow soil borings at each site from the berm behind the target area during the 1992 SI field activities (Weston 1993). The samples were collected from approximately 3 ft bgs and lead slugs were removed from the material sent for analysis. Soil samples were analyzed for lead, zinc, copper, chromium and cadmium. Analysis indicated that lead was the primary metal of concern present at the site. Although 7 out of 8 analyses were rejected (the only acceptable analysis is the one listed in Table 24-1 which was 113 mg/kg), the maximum contaminant concentrations recorded during SI work are listed in Table 24-1.

24.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

In order to determine the amount of lead and other metals which may be present at the pistol ranges, soil samples will be collected at both site areas (24 and 25). At two locations within the impact berm at each site the approximate percent of lead slugs will be estimated at 6-inch intervals. Sample locations at each pistol range are shown on Figures 24-1 and 24-2, respectively. A hand auger or hand-driven spilt-spoon will be used to retrieve samples, and the contents of each sample will be sieved, and the percentage of whole or partial slugs will be noted in the site log book. It is estimated that the slugs are present to a depth of approximately 3 ft bgs. To determine the extent of soil contamination due to metals migration, two samples will be collected from each boring. One sample will be collected at 1.5 feet below the last depth where slugs are found, and one sample will be taken from 3 feet below this zone to be sent for analysis.

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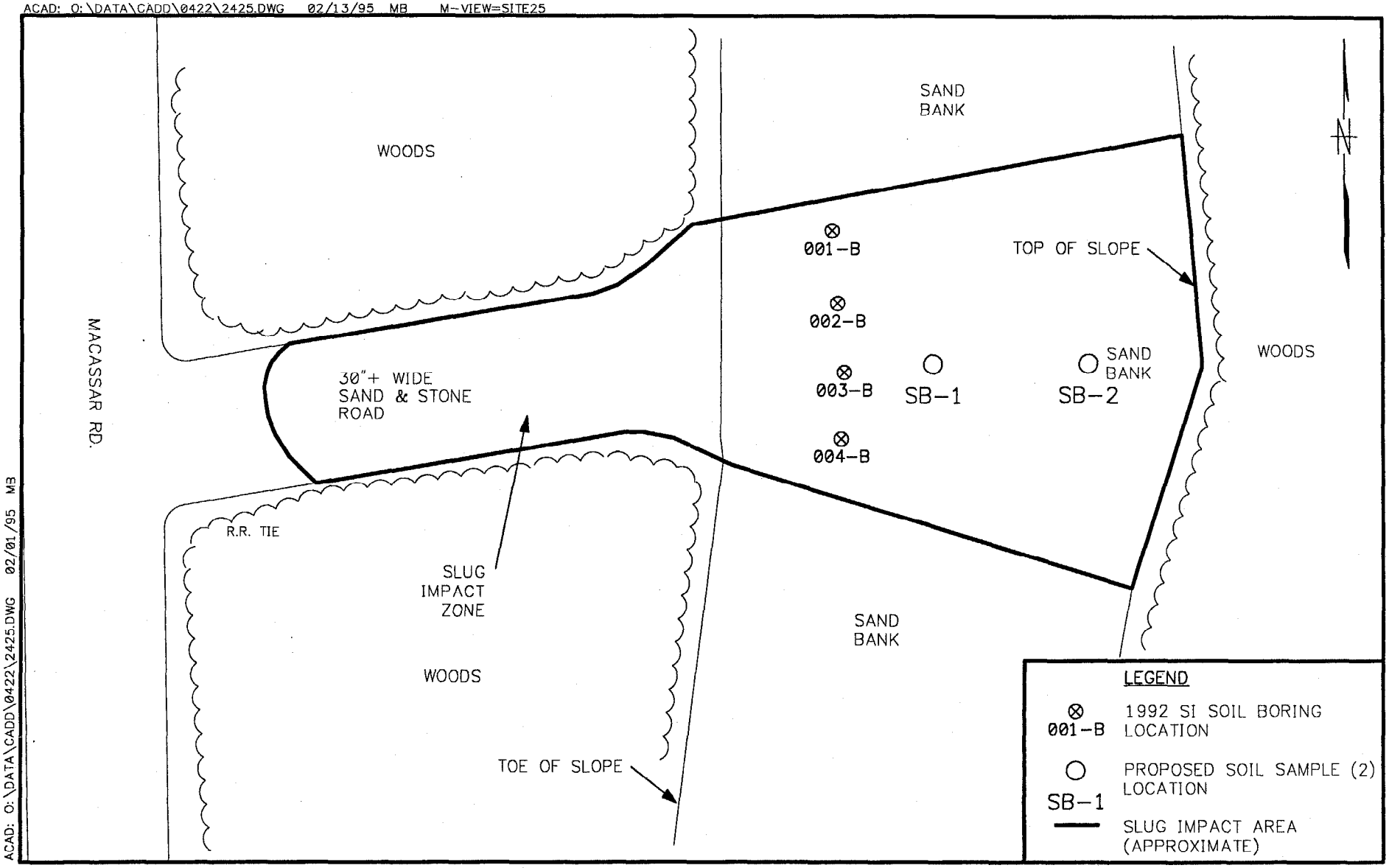


ACAD: O:\DATA\CADD\0422\2425.DWG 02/01/95 MB

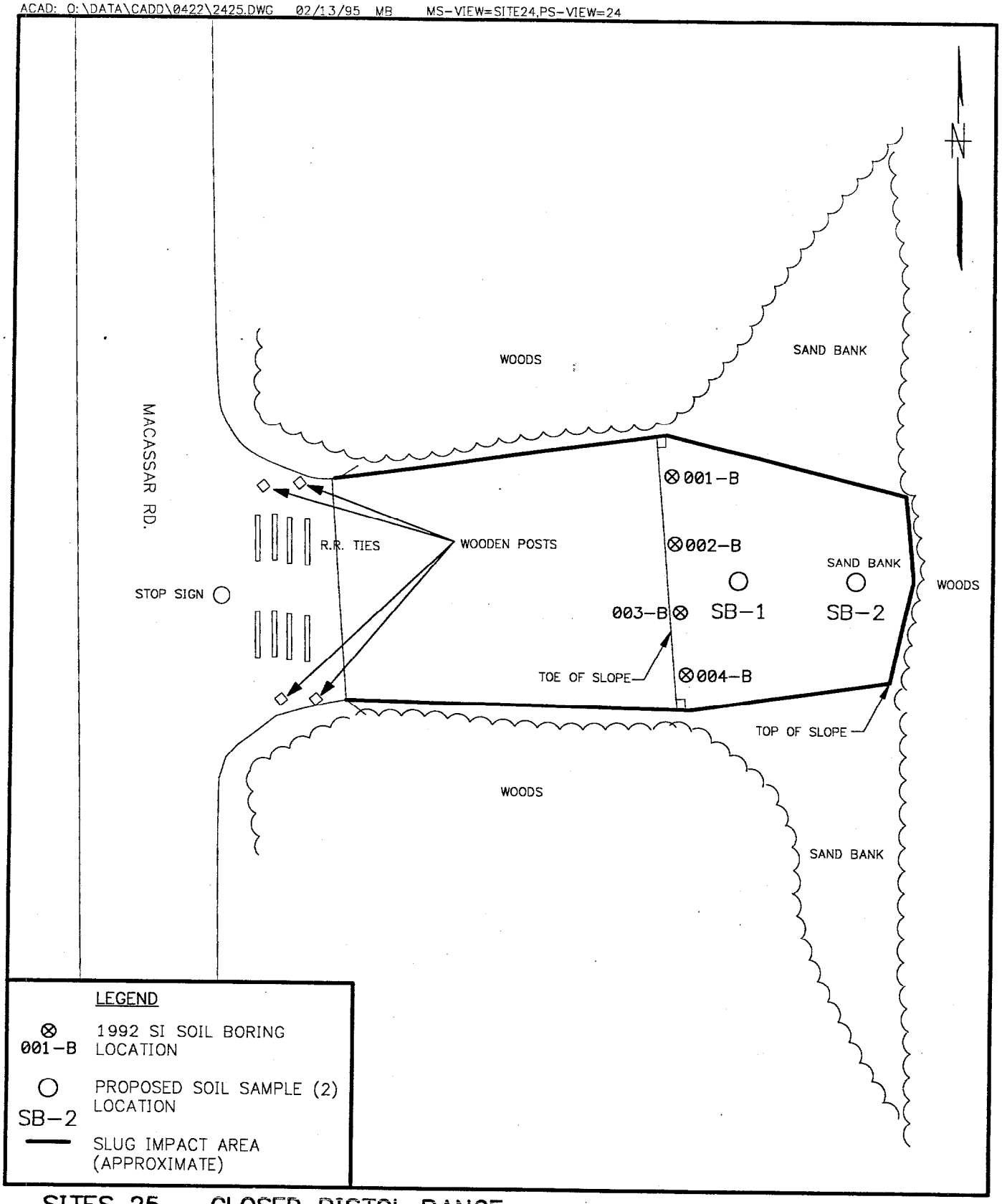
SITES 24 – CLOSED PISTOL RANGE
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 30 60
SCALE IN FEET

FIGURE 24-1

Halliburton NUS CORPORATION

ACAD: O:\DATA\CADD\0422\2425.DWG 02/13/95 MB MS-VIEW=SITE24,PS-VIEW=24



SITES 25 – CLOSED PISTOL RANGE
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 30 60
SCALE IN FEET

FIGURE 24-2

Halliburton NUS CORPORATION

TABLE 24-1

SUBSURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITES 24 AND 25[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Subsurface Soil Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Chromium	2.4	24-004-B001	---
Copper	82.6	25-004-B001	---
Lead	113	25-003-B001	---
Zinc	2.9	25-004-B001	---

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-3.

--- Criteria not available.

Table 24-2 provides a summary and rationale of samples to be taken at each pistol range. The area will also be surveyed for possible drainage or erosion features which may transport lead or metals contaminated sediment away from the site.

Analytical parameters for soil samples will include TAL metals and nitrate-nitrite. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

24.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 24-2

SAMPLING LOCATIONS AND RATIONALE
SITE 24/25
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Two borings at each pistol range (SB-1 and SB-2).	Top and middle of berm impact zone.	Determine depth and relative percentage of lead slugs in berm.
Two subsurface soil samples collected from each boring.	Samples taken from 1.5 feet and 3 feet below maximum depth of slug penetration.	Determine if lead contamination is migrating vertically into soil.

25.0 SITE 26 (EXPLOSIVE "D" WASHOUT AREA)

25.1 SITE DESCRIPTION

The Explosive "D" Washout Area is located behind Building GB-1. For one year in the late 1960's, 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.

Figure 25-1 shows the physical characteristics of the Explosive "D" Washout Area. The site, which is approximately 200 by 200 feet in size, is situated at the intersection of Macassar and Midway Roads. There are two railway lines adjacent to the site that run toward the northeast. The ground surface at the site is relatively flat at 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. There is a septic system from Building GB-1 that crosses the site. The general direction of groundwater flow is to the southwest.

25.2 PREVIOUS INVESTIGATIONS

Figure 25-1 shows the existing and proposed monitoring well and sample locations for the Explosive "D" Washout Area. During the SI (Weston, 1993), 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 RI/FS (Weston, 1993), 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 at sample 004. 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 µg/L). Other volatile organic compounds, such as dichloroethanes, related to TCE as impurities or breakdown products, were also present. Because TCE is used as a degreaser for septic systems, 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 MW26-1 and MW26-4. Maximum concentrations detected at the site are summarized in Tables 25-1 to 25-3.

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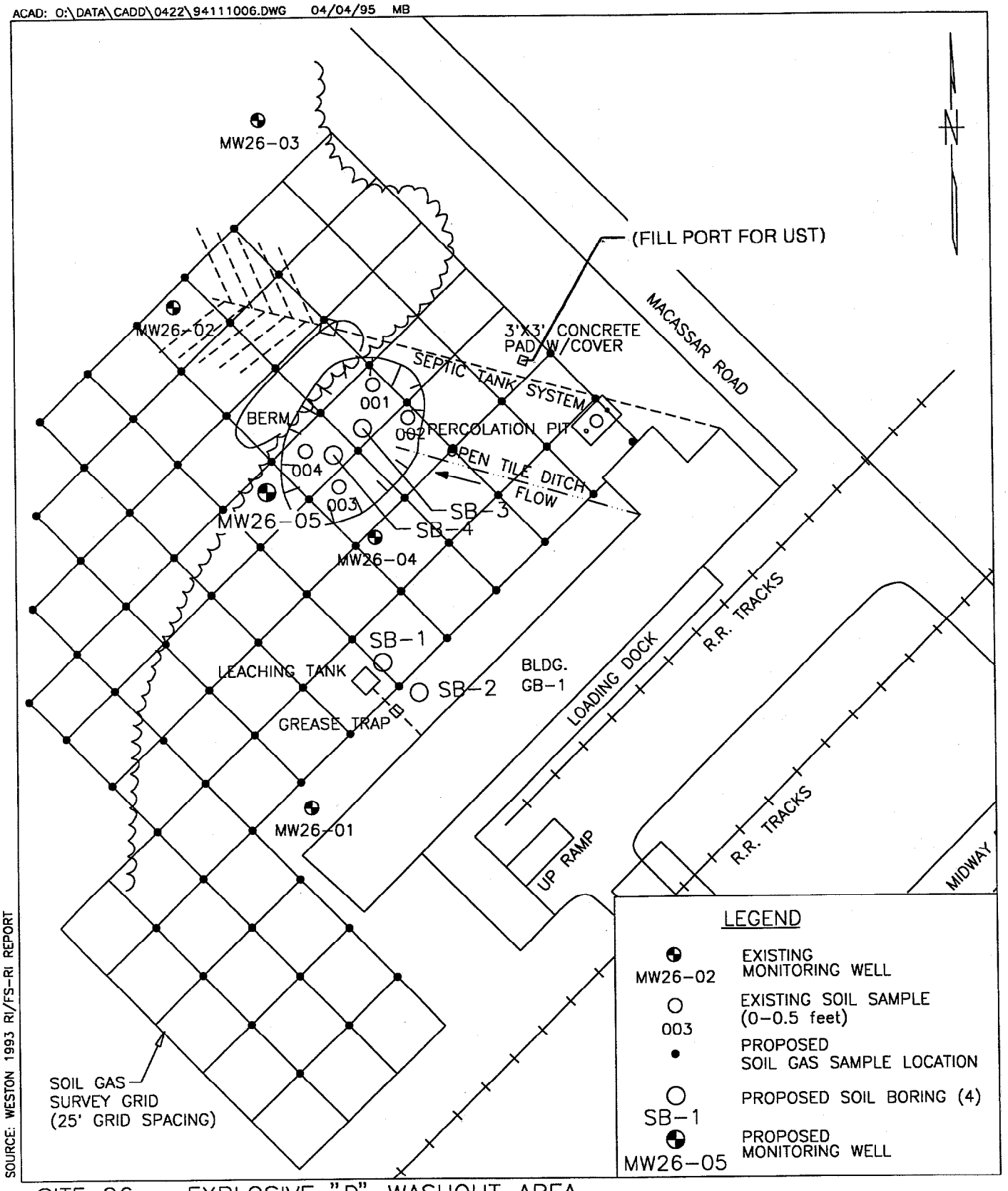

SOURCE: WESTON 1993 RI/FS-RI REPORT

SITE 26 - EXPLOSIVE "D" WASHOUT AREA
MONITOR WELL AND SAMPLING LOCATIONS
NWS EARLE, NJ

FIGURE 25-1

0 50 100
SCALE IN FEET

Halliburton NUS CORPORATION

TABLE 25-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 26[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresident & Surface Soil Cleanup Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Nitrate	6.1	26-01	---
Nitrite	3.4	26-01	---
EXPLOSIVES	**(mg/kg)**		**(mg/kg)**
Picric acid	27	26-04	---

--- No criteria available.

1 Weston Report: Phase II - Site Investigation, Draft Report, February 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

TABLE 25-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 26[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	9,000	26-04	---	---
Antimony	**4.4**	26-04	340	**2**
Arsenic	6.0	26-04	20	33
Barium	16.8	26-04	26,000	---
Beryllium	0.35	26-04	2	---
Calcium	289	26-04	---	---
Cadmium	**16.5**	26-04	100	**5**
Chromium	**123**	26-04	---	**80**
Cobalt	0.9	26-04	---	---
Copper	52.6	26-04	600	70
Iron	16,200	26-04	---	---
Lead	**300**	26-04	600	**35**
Magnesium	719	26-04	---	---
Manganese	7.6	26-04	---	---
Mercury	0.13	26-04	260	0.15
Nickel	2.4	26-04	2,400	30
Sodium	23.1	26-04	---	---
Vanadium	85.2	26-02	7,000	---
Zinc	99.4	26-04	1,500	120

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

--- Criteria not available.

TABLE 25-3

GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 26[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3]
VOLATILE ORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Vinyl chloride	1 J	MW26-1	0.08 (5)	2
Methylene chloride	**44**	MW26-1	**2**	**5**
Acetone	79	MW26-3	700	---
Carbon disulfide	1 J	MW26-1	---	
1,1-Dichloroethene	**3 J**	MW26-1	**1 (2)**	7
1,2-Dichloroethene	**810**	MW26-1	**10/100**	**70/100**
Trichloroethene	**660**	MW26-1	**1**	**5**
Toluene	1 J	MW26-1	1,000	1,000
Xylene	3 J	MW26-1	40	10,000
INORGANICS	**(µg/L)**		**(µg/L)**	**(µg/L)**
Silver	**36.4**	MW26-4	**(2)**	---
Aluminum	**22,800**	MW26-4	**200**	---
Barium	214	MW26-4	2,000	2,000
Beryllium	1.1	MW26-4	0.008 (20)	4
Calcium	13,100	MW26-4	---	---
Cobalt	4.5	MW26-4	---	---
Chromium	**168**	MW26-4	**100**	**100**
Copper	79.3	MW26-4	1,000	1,300[G]
Iron	**167,000**	MW26-4	**300**	---
Potassium	5,300	MW26-2	---	---
Magnesium	1,900	MW26-4	---	---
Manganese	**331**	MW26-4	**50**	---
Sodium	5,660	MW26-2	50,000	---
Lead	**28.1**	MW26-4	**5**	**15[A]**

TABLE 25-3 (continued)
GROUNDWATER RESULTS VERSUS REGULATORY CRITERIA
SITE 26[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Class IIA Groundwater Quality Criteria[2]	Federal Maximum Contaminant Level[3]
INORGANICS (continued)	**(µg/L)**		**(µg/L)**	**(µg/L)**
Antimony	**38**	MW26-4	**2 (20)**	**6**
Vanadium	61	MW26-4	---	---
Zinc	163	MW26-4	5,000	---
Nitrate	**3,400**	MW26-4	**1,000**	**1,000**
Cadmium	**8.1**	MW26-4	**4**	**5**
Mercury	1.9	MW26-4	2	2
EXPLOSIVES	**(µg/L)**		**(µg/L)**	**(µg/L)**
2,4,6-TNT	1.27	MW26-1	---	---
RDX	0.94	MW26-4	---	---
Nitrocellulose/ Nitroglycerine (mg/L)	3.9	MW26-4	---	---
Nitrate (as N)	1,500	MW26-1	10,000	10,000

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Groundwater Quality Standards: New Jersey Administrative Code (N.J.A.C.) 7:9-6. Bureau of National Affairs - Environmental Reporter - CD ROM. February 1995.

Values in parentheses are Practical Quantitation Limits. "Where a constituent standard (the criterion as adjusted by the antidegradation policy and applicable criteria exceptions); is of a lower concentration than the relevant PQL (Table 1 in the Appendix), the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (NJAC 7:9-6.9(c)).

3 Drinking Water Regulations and Health Advisories. USEPA Office of Water, November 1994. Designations are as follows:

G Maximum Contamination Level Goal
A Action Level
S Secondary Maximum Contaminant Level
P Proposed

J Estimated value.
--- Criteria not available.

25.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

To determine if the source of the TCE is present behind Building GB-1 or in the percolation pit, a soil-gas survey will be performed in this area. A grid with 25-foot spacings will be set up across the area (shown in Figure 25-1) and soil gas will be collected every 25 feet. If areas show elevated soil-gas readings the grid will be modified in these areas. Approximately 75 soil-gas samples will be collected from the site. Soil-gas samples will be collected and analyzed using an onsite facility to allow rapid sample turnaround. Two soil borings will be installed in the area of the most significant soil-gas readings. It is assumed that these will be near the leaching tank and grease trap area. Samples will be collected continuously to the water table. Samples will be field screened for volatiles with a PID/FID. The sample with the highest reading from each boring will be submitted to the laboratory for analysis.

One additional well (MW26-05) will be installed directly downgradient (west) of the percolation pit to determine the effect of the percolation pit on site groundwater. All monitoring wells at the site will be sampled. Based on the results of the soil-gas survey, up to two additional wells may be added to the current RI. Previous comprehensive sampling in the percolation pit was performed at a shallow depth (0 - .5 feet). In the 30 years since this pit was used, this depressed area may have been covered by additional sediment from erosion, vegetation decay, etc. Therefore, two additional borings will be installed in the pit. Two subsurface samples from each boring will be analyzed for VOCs, TAL metals, and explosives.

Groundwater samples will be analyzed for TCL volatiles, metals and explosives. Sample analytes, bottle requirements, and holding times are listed in Table 3-2. Table 25-4 lists sample locations and sampling rationale.

25.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 25-4

SAMPLING LOCATIONS AND RATIONALE
SITE 26
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Soil-gas survey.	25-foot intervals behind Building GB-1.	Identify source of volatiles (if present) behind building.
Install one monitoring well (MW26-05).	Downgradient (west) of percolation pit.	Determine if percolation pit is adversely effecting groundwater.
Five groundwater samples.	From the four existing and one newly installed monitoring wells (MW26-01, MW26-02, MW26-03, MW26-04, MW26-05).	Determine groundwater quality at the site.
Four soil borings	Two borings at leaching tank/grease trap (SB-1 and SB-2) and two borings in percolation pit (SB-3 and SB-4).	Determine effect of leaching tank, grease trap and percolation pit on soils.

26.0 SITE 27 (PROJECTILE REFURBISHING AREA)

26.1 SITE DESCRIPTION

Site 27, located near Building E-14, has been used for shot-blasting, repainting, and restenciling of projectiles. Some of the waste material stored at the site includes oil-contaminated rags, paint chips, blasting shot and toluene. An accumulation of paint sludge covers a small portion of the site surface near the southeast corner of Building E-14. A railroad siding and small drainage swale are present on the east side of the site. Drainage at the site moves to the shallow depression immediately downslope and approximately 15 feet in distance from the area of paint sludge. Surface water infiltration occurs within this drainage depression.

26.2 PREVIOUS INVESTIGATIONS

The SI field activities at the site included collecting two soil samples (at 0 to 0.5 ft bgs and 0.5 to 1.5 ft bgs) from five different locations across the site, and collecting eight sediment samples (at 0 to 0.5 ft bgs) from the drainage ditch southeast of the site (Weston, 1993). Sample locations are illustrated on Figure 26-1. Analysis of soil samples detected low levels of pesticides, metals, PCBs, VOCs and semivolatiles. Elevated levels of lead and copper were detected. Sediment samples contained some elevated levels of metals and pesticides, and low levels of volatiles and semivolatiles. Maximum contaminant concentrations recorded during the SI are listed in Tables 26-1 and 26-2.

26.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Sampling activities for the RI phase will include drilling soil borings and sampling subsurface soil to determine the vertical extent of contamination below the previous sampled depth of 0.5 to 1.5 feet. Three soil boring locations will be sampled as shown in Figure 26-1. Borings SB-1 and SB-2 will be drilled on either side of former sampling location 001-S, within the paint chips which are present on the surface. Boring SB-3 will be located immediately downgradient of these borings, in the drainage basin southeast of the site. In order to define the vertical extent of contamination, three subsurface sample intervals will be collected from each boring. Subsurface soil samples will be collected for analysis at 1 to 2 ft bgs (below SI sample interval), immediately above the water table, and at one additional interval to be determined on the basis of field FID/PID readings or visual evidence of contamination. If no visual evidence or instrument readings are noted, the sample will be collected from 3 to 4 ft bgs. A summary of the sample locations and rationale is provided in Table 26-3.

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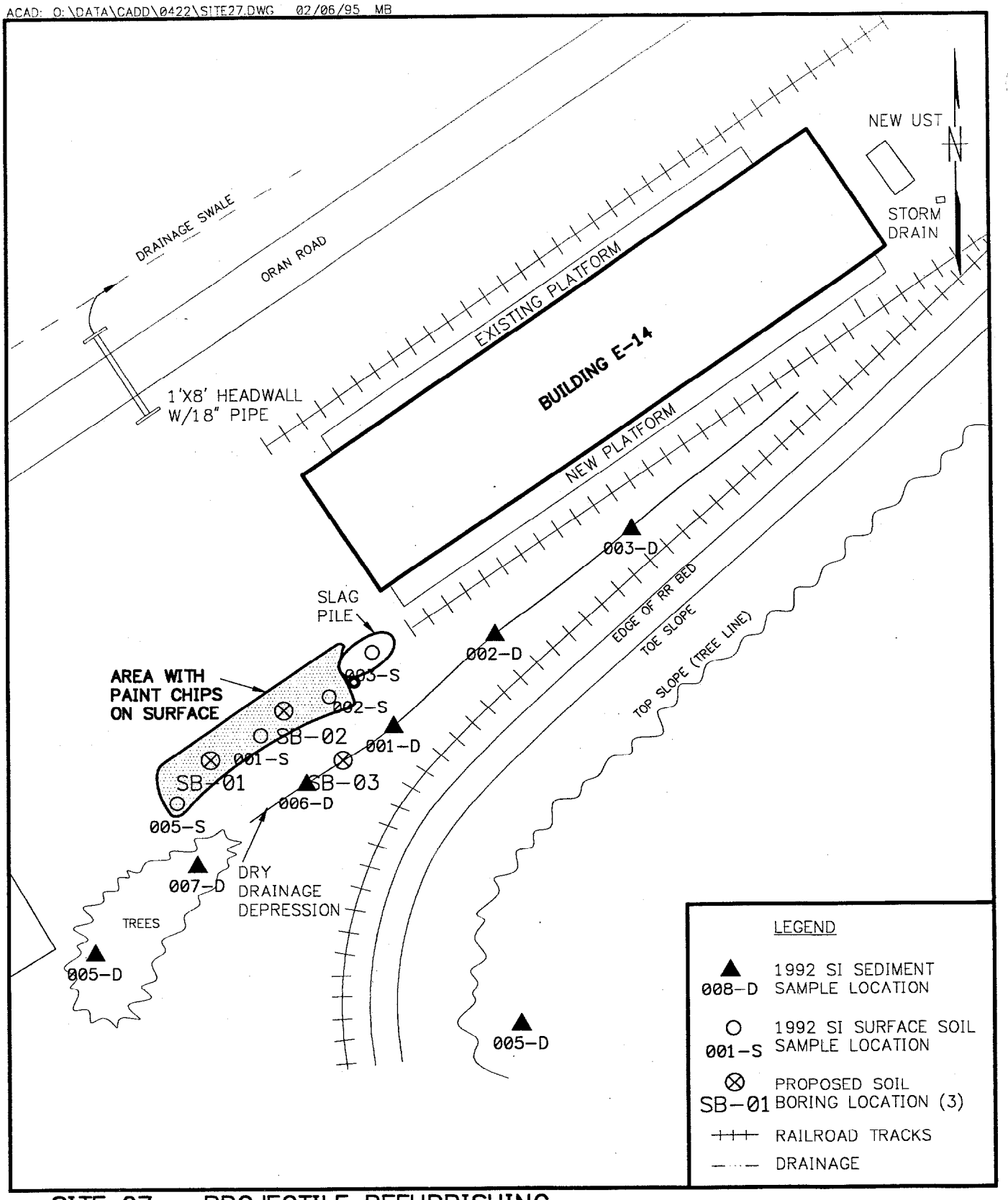


SITE 27 – PROJECTILE REFURBISHING
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 50 100
SCALE IN FEET

FIGURE 26-1

Halliburton NUS CORPORATION

TABLE 26-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 27[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
INORGANICS	**(mg/kg)**		**(mg/kg)**
Aluminum	6,990	27-005-S002	---
Arsenic	17.1	27-002-S001	20
Barium	129	27-002-S001	26,000
Beryllium	0.54	27-001-S001	2
Cadmium	64.4	27-002-S001	100
Calcium	364	27-003-S001	---
Chromium	1,620	27-002-S001	---
Cobalt	52.4	27-002-S001	---
Copper	1,450	27-002-S001	600
Iron	349,000	27-002-S001	---
Lead	787	27-002-S001	600
Magnesium	466	27-002-S001	---
Manganese	2,560	27-002-S001	---
Mercury	0.41	27-002-S001	260
Nickel	377	27-002-S001	2,400
Potassium	265	27-001-S002	---
Selenium	2.5	27-001-S001	1,000
Silver	32.2	27-002-S001	2,000
Sodium	33	27-005-S001	---
Vanadium	13.6	27-005-S002	7,000
Zinc	774	27-002-S001	1,500
Cyanide	2.76	27-004-S001	5,200
PESTICIDES	**(mg/kg)**		**(mg/kg)**
Heptachlor	0.00071 J	27-002-S001	0.65
Endosulfan I	0.0032 J	27-002-S001	52
4,4'-DDE	0.00075 J	27-004-S001	9
PCBs	**(mg/kg)**		**(mg/kg)**
Aroclor-1260	0.6	27-002-S001	2

TABLE 26-1 (continued)
SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA SAMPLES
SITE 27[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
ORGANICS	**(mg/kg)**		**(mg/kg)**
Methylene chloride	0.031	27-004-S002	170
Acetone	0.024 J	27-004-S002	1,000
Tetrachloroethylene	0.003 J	27-003-S001	37
Phenol	0.027 J	27-005-S001	10,000
Naphthalene	0.15 J	27-001-S001	4,200
2-Methylnaphthalene	0.067 J	27-001-S001	---
Acenaphthalene	0.047 J	27-003-S001	---
Phenanthrene	0.05 J	27-004-S001	---
Anthracene	0.041 J	27-003-S001	10,000
Di-n-butylphthalate	0.051 J	27-002-S001	10,000
Fluoranthene	0.12 J	27-003-S001	10,000
Pyrene	0.13 J	27-003-S001	10,000
Benzo(a)anthracene	0.088 J	27-003-S001	25
Chrysene	0.13 J	27-003-S001	2.5
Benzo(b)fluoranthene	0.13 J	27-003-S001	2.5
Benzo(k)fluoranthene	0.12 J	27-003-S001	2.5
Benzo(a)pyrene	0.13 J	27-003-S001	0.25
Indeno(1,2,3-cd)pyrene	0.15 J	27-003-S001	2.5
Dibenz(a,h)anthracene	0.061 J	27-003-S001	0.25
Benzo(g,h,i)perylene	0.19 J	27-003-S001	2.5

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum concentration exceeds New Jersey Surface Soil Cleanup Standards.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

J Estimated value.
--- Criteria not available.

TABLE 26-2

SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 27[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
INORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Aluminum	1,190	27-001-D001	---	---
Antimony	15.9	27-001-D001	340	2
Arsenic	4.3	27-001-D001	20	33
Barium	199	27-001-D001	26,000	---
Beryllium	0.31	27-001-D001	2	---
Cadmium	36.3	27-001-D001	100	5
Calcium	270	27-003-D001	---	---
Chromium	471	27-006-D001	---	80
Cobalt	9.3	27-001-D001	---	---
Copper	434	27-002-D001	600	70
Iron	22,500	27-001-D001	---	---
Lead	786	27-006-D001	600	35
Magnesium	226	27-001-D001	---	---
Manganese	165	27-001-D001	---	---
Mercury	0.2	27-001-D001	260	0.15
Nickel	15.8	27-001-D001	2,400	30
Selenium	1.6	27-001-D001	---	---
Silver	2.5	27-001-D001	2,000	1
Sodium	25.9	27-001-D001	---	---
Vanadium	3.1	27-003-D001	7,000	---
Zinc	840	27-006-D001	1,500	120
Cyanide	1.84	27-001-D001	5,200	---

TABLE 26-2 (continued)
SEDIMENT RESULTS VERSUS REGULATORY CRITERIA
SITE 27[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]	ER-L Ecological Criteria[3]
PESTICIDES	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
4,4'-DDE	**0.0073**	27-008-D001	9	**0.002**
4,4'-DDT	**0.021**	27-008-D001	9	**0.001**
Gamma-chlordane	0.00037 J	27-008-D001	---	0.0005[4]
ORGANICS	**(mg/kg)**		**(mg/kg)**	**(mg/kg)**
Methylene Chloride	0.034	27-008-D001	170	---
Acetone	0.02 J	27-008-D001	1,000	---
Toluene	0.003 J	27-008-D001	1,000	---
Phenanthrene	0.046 J	27-008-D001	---	0.225[5]
Di-n-butylphthalate	0.032 J	27-008-D001	10,000	---
Fluoranthene	0.062 J	27-008-D001	10,000	0.6[5]
Pyrene	0.057 J	27-008-D001	10,000	0.350[5]
Benzo(a)anthracene	0.019 J	27-008-D001	2.5	0.23[5]
Chrysene	0.031 J	27-008-D001	2.5	0.4[5]

1 Weston Report: Phase II - Site Investigation Study Report, 1993.

Bolded/shaded value indicates maximum detected concentration exceeds New Jersey Groundwater Quality Criteria and/or Federal MCLs.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D-7.

3 The Potential for Biological Effects of Sediment - Sorbed contaminants tested in the National Status and Trends Program, NOAA Technical Memorandum No. OMA52 8/91.

4 Value represents total Chlordane (alpha- and gamma-isomers combined).

5 ER-L value of 4.0 mg/Kg for PAHs also applies.

J Estimated value.
--- Criteria not available.

TABLE 26-3

SAMPLING LOCATIONS AND RATIONALE
SITE 27
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
One shallow subsurface soil sample from each boring.	Collect at 1 to 2 ft bgs from SB-1, SB-2, SB-3.	Determine the vertical extent of soil contamination extends below previous sampling interval.
One intermediate subsurface soil sample from each boring.	Collect from SB-1, SB-2, SB-3 at 3 to 4 ft bgs or from zone of obvious contamination.	Determine the vertical extent of soil contamination.
One deep subsurface soil sample from each boring.	Collect from SB-1, SB-2, SB-3 immediately above water table.	Determine the vertical extent of soil contamination.

Analytical parameters for soil samples will include TAL metals, TCL volatile and semivolatile organic compounds, TCL pesticides/PCBs. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

26.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

27.0 SITE 29 (PCB SPILL SITE)

27.1 SITE DESCRIPTION

This site is located in a storage yard that was the location of a PCB spill from a transformer in 1981. Within 5 days after the spill, all discolored soil (over 120 cubic feet) was disposed of off site. Confirmatory sampling at the spill site was not performed. NWS Earle is planning to build a one-story, brick building at the site which will function as a new hazardous waste storage facility. A railroad spur and wetlands are located to the east of the site and Saipan Road is located along the west side of the site.

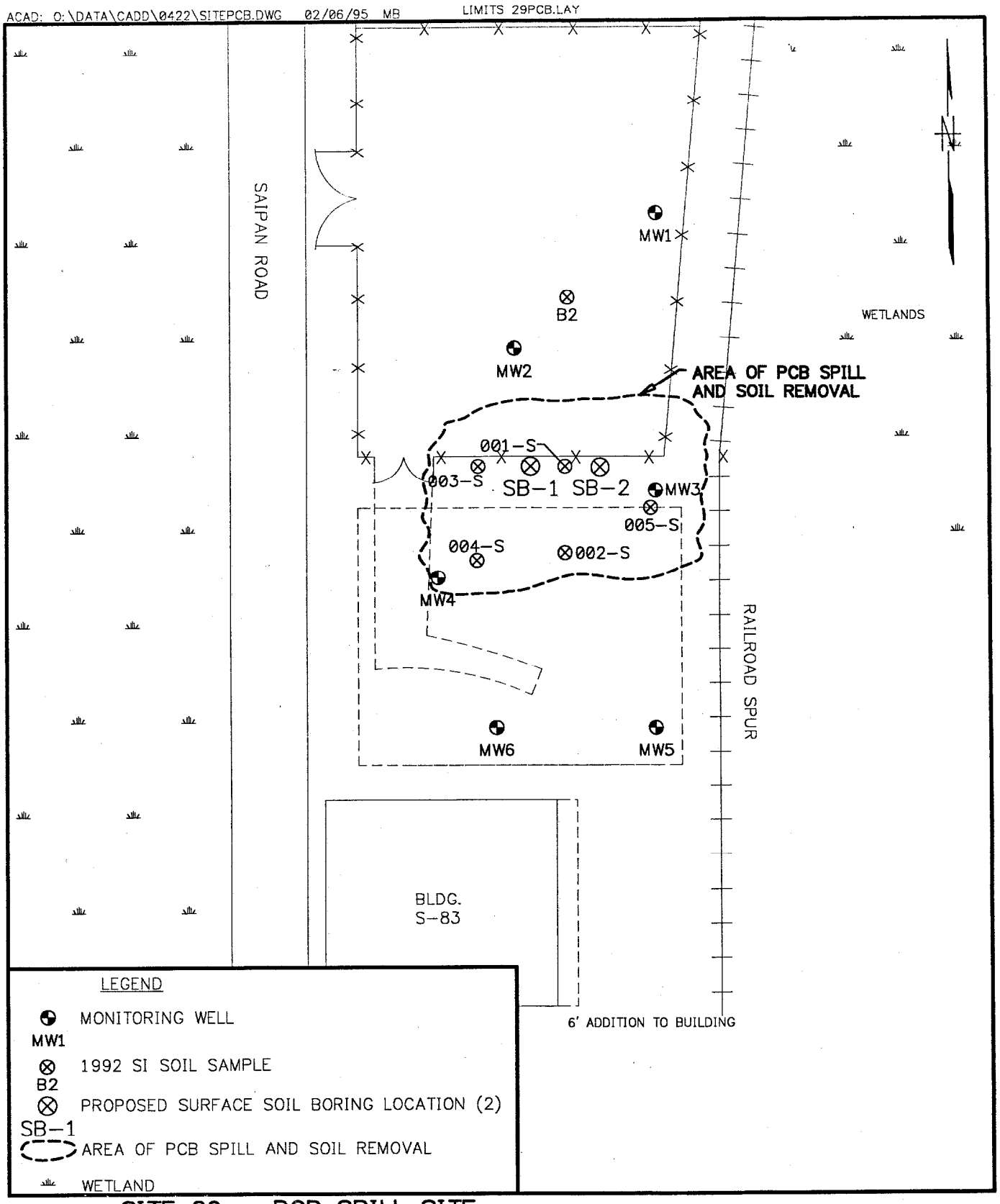
27.2 PREVIOUS INVESTIGATIONS

During the 1992 SI field investigation, five soil samples (from 0.5 to 1.5 ft bgs) were collected from the area of the PCB spill at Site 29 (Weston, 1993). Figure 27-1 illustrates the sample locations at the site. Minor amounts of pesticides and PCBs were detected at concentrations below New Jersey cleanup standards. One sample (S001) contained high concentrations of TPH (28,000 mg/kg). Maximum contaminant concentrations recorded during the SI are listed in Table 27-1.

As part of the environmental site evaluation for the proposed hazardous waste storage facility additional field work was performed at the site. To further evaluate the possible contamination which might exist, and to assess site foundation conditions, seven soil borings were completed at the site in mid-1993 (Haley & Aldrich, Inc., 1993). Soil borings were completed to depths ranging from 17 to 42 ft bgs, and were sampled at 5 and 10 ft bgs. Six of the seven borings were converted to monitoring wells. Trace levels of VOAs, semivolatiles, pesticides and PCBs were detected in the soils, all below New Jersey subsurface soil criteria. Groundwater samples indicated that trace to low levels of VOCs and semivolatiles were present, and no detectable concentrations of pesticides or PCBs were present. Elevated levels of benzene (30 ppb) and DCE (25 ppb) were reported in MW-4. Total lead and total chromium were present in levels above State cleanup criteria.

27.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Field activities for the RI phase of work will focus on the high TPH hit found during the SI, and will sample groundwater to determine if levels of organics persist. Two soil borings (SB-1 and SB-2) will be installed in the immediate vicinity (within 10 feet) of the high TPH reading at former sampling location 001-S. Sample locations are shown on Figure 27-1. Continuous split spoons will be collected and screened with a PID/FID. One sample will be collected from each boring based on visual contamination or PID/FID



SITE 29 – PCB SPILL SITE
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 40 80
SCALE IN FEET

FIGURE 27-1

Halliburton NUS CORPORATION

TABLE 27-1

SURFACE SOIL RESULTS VERSUS REGULATORY CRITERIA
SITE 29[1]
NWS EARLE, COLTS NECK, NEW JERSEY

Analyte	Maximum Concentration Detected	Sample ID	New Jersey Nonresidential Surface Soil Cleanup Standards[2]
PESTICIDES	**(mg/kg)**		**(mg/kg)**
Alpha-BHC	0.0018	29-001-S001	---
Gamma-BHC (Lindane)	0.0047	29-001-S001	2.2
Heptachlor	0.005	29-001-S001	0.65
Dieldrin	0.0061 J	29-001-S001	0.18
4,4'-DDE	0.01	29-004-S001	9
Endrin	0.0044	29-004-S001	310
Endosulfan II	0.0036 J	29-001-S001	---
4,4'-DDD	0.0093 J	29-001-S001	12
4,4'-DDT	0.032	29-004-S001	9
Alpha-chlordane	0.00036 J	29-002-S001	---
PCBs	**(mg/kg)**		**(mg/kg)**
Aroclor-1260	0.16	29-005-S001	2
TPH	**(mg/kg)**		**(mg/kg)**
Total Petroleum Hydrocarbons	28,000	29-001-S001	---

1 Weston Report: Phase II - Site Investigation Inspection Study, Report, 1993.

2 New Jersey Cleanup Standards for Contaminated Sites Proposed New Rules: New Jersey Administrative Code (N.J.A.C.) 7:26D.

J Estimated value.
--- Criteria not available.

results. If no indication of contamination is observed the samples will be collected at similar depths as the SI soil sample which showed soil contamination (at 0.5 to 1.5 feet). These samples will be used to define the horizontal extent of the TPH-contaminated soil. In addition, groundwater samples will be collected from the six existing monitoring wells on site to determine the quality of groundwater below the site. Table 27-2 provides a summary of sample locations and rationale.

Analytical parameters for groundwater samples will include TAL metals, TCL volatiles, semivolatiles, and PCBs. Soils will be analyzed for TPH and TCL PCBs. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

27.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

TABLE 27-2

SAMPLING LOCATIONS AND RATIONALE
SITE 29
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Two subsurface soil samples. One from borings SB-1 and SB-2.	Collect sample based on visual or instrument indications of contamination, or at 0.5 to 1.5 feet.	Determine horizontal and vertical extent of soil TPH contamination.
Six groundwater samples	Monitoring wells MW-01, MW-02, MW-03, MW-04, MW-05, MW-06	Determine quality of groundwater on site

28.0 EPIC SITE L (MSC VAN PARKING LOT)

28.1 SITE DESCRIPTION

Epic Site L is comprised of a 15.7-acre area near Asbury Avenue and Pine Brook Road. Approximately one-third of the site is currently used for storage of new and old telephone poles, railroad ballast stone, and miscellaneous metal, plastic, and wood scrap material. The remaining majority of the site is a power line easement. Storage at the site is currently limited to a few small scrap piles, a telephone pole staging area, and small asphalt and concrete piles. Materials have been stored at the site for 25 to 30 years, and past storage practices are not known.

28.2 PREVIOUS INVESTIGATIONS

The site was identified after reviewing aerial photographs of the NWS Earle station to detect areas of potential environmental concern (NEESA, 1992). No previous sampling has occurred at this site. Site layout is shown in Figure 28-1.

28.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

Sampling at this site during the RI will focus on determining if soils have been impacted by ongoing storage activities, or activities which have occurred in the past. In order to determine if material storage has effected the soils at the site, one surface soil sample (SS-01) will be collected from the asphalt pile in the power line easement. Two surface soil samples (SS-2 and SS-3) will be collected from below the pile of old telephone poles, and one surface soil sample (SS-4) will be collected from below the asphalt pile to the north. Samples will be collected from areas of these piles which appear stained or discolored. Three additional surface soil samples (SS-5 to SS-7) will be collected from possible drainage depressions which may have the potential to move contaminated material off site or from drainage swales or areas where off site transport due to runoff may occur. Proposed RI sample locations are shown in Figure 28-1. Table 28-1 provides a summary of the proposed sample locations and rationale. All surface soil samples will be taken from 0 to 0.5 ft bgs.

Surface soils will be analyzed for TCL volatiles and semivolatiles, TPH, TAL metals and TCL pesticides/PCBs. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

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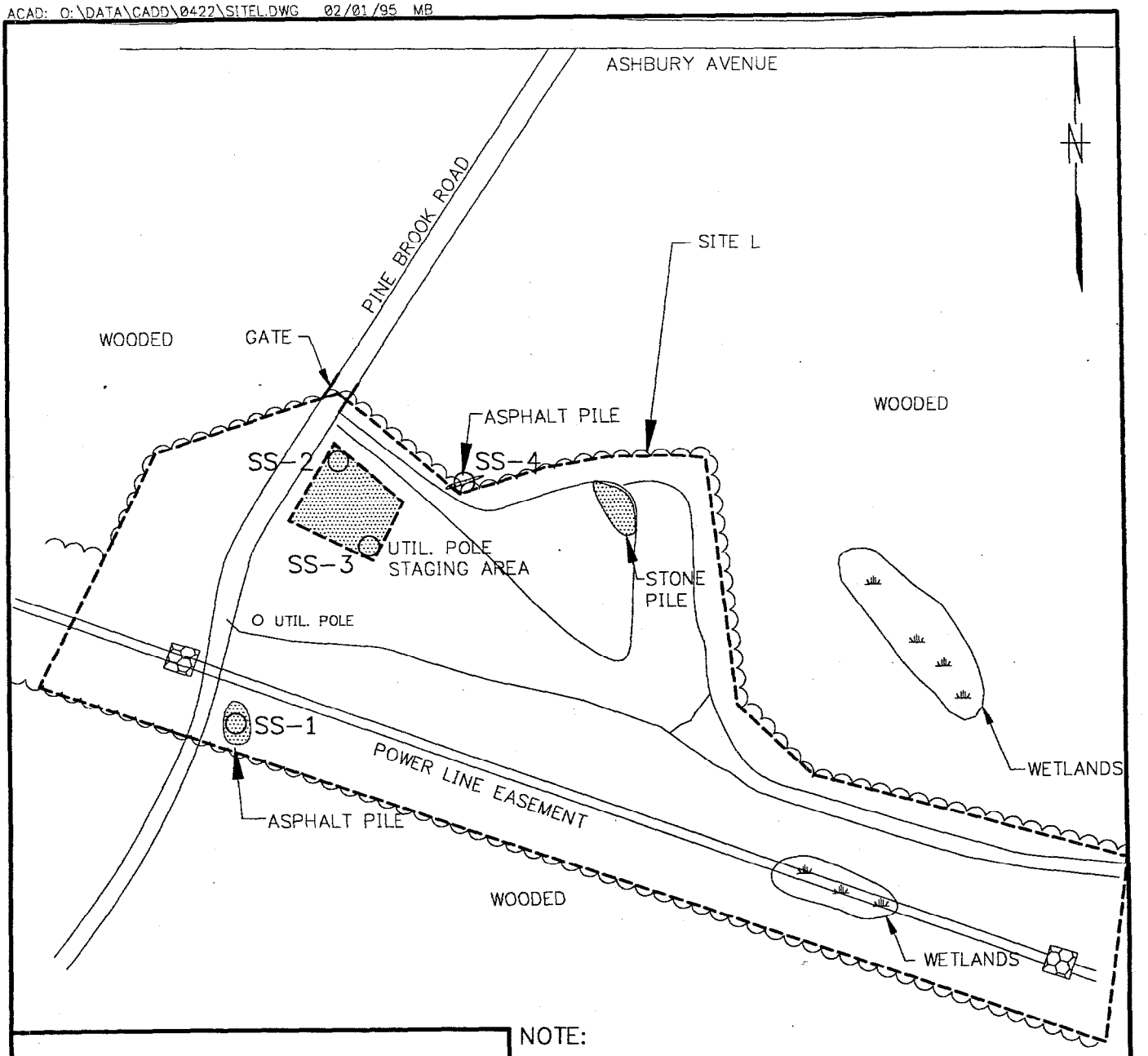

LEGEND

POWER TOWER

AREA BOUNDARY

PROPOSED SURFACE SOIL SAMPLE (7)
SS-3

WETLANDS

NOTE:

1. THREE SURFACE SOIL SAMPLES (SS-5, 6, 7) TO BE TAKEN FROM AREAS OF DRAINAGE DEPRESSIONS OR CHANNELS OF OFF-SITE MIGRATION.

EPIC SITE L-MSC VAN PARKING LOT
SAMPLING LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 200 400
SCALE IN FEET

FIGURE 28-1

Halliburton NUS CORPORATION

TABLE 28-1

EPIC SITE L SAMPLING LOCATIONS AND RATIONALE
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
One surface soil sample (SS-1).	Collect from asphalt pile along powerline.	Determine if asphalt storage has impacted soil.
Two surface soil samples (SS-2 and SS-3).	Collect from pile of telephone poles.	Determine if telephone pole storage has impacted soil
One surface soil sample (SS-4).	Collect from asphalt pile north of site.	Determine if past/current storage activities have impacted soil.
Three surface soil samples (SS-5 to SS-7).	Collect at drainage depressions or areas where offsite migration is possible.	Determine if contamination may be moving from site.

28.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

29.0 EPIC SITE Q (FIRE FIGHTING SCHOOL)

29.1 SITE DESCRIPTION

This site occupies a 5.5-acre area at the extreme southwestern corner of NWS Earle. The fire-fighting school has been in use since 1975 and is used by a variety of state and county groups to practice fire fighting. The station is operated by the Military Sealift Command, which reports having all necessary operating permits and is inspected on a regular basis by the NJDEPE. An oil/water separator and retention pond is present at the site and the station has a permit for disposal of the water from the separator to the pond. The pond is monitored and is maintained at or below discharge limits. Fire fighting training takes place on a concrete pad, which prevents the infiltration of flammable material into the soil. Figure 29-1 shows the site layout.

29.2 PREVIOUS INVESTIGATIONS

The site was identified by reviewing aerial photographs of the NWS Earle station to detect areas of potential environmental concern (NEESA, 1992). No previous sampling has occurred at this site.

29.3 REMEDIAL INVESTIGATION SAMPLING ACTIVITIES

RI activities will consist of hydropunch groundwater investigations and soil/sediment sampling. Approximate sample locations are shown on Figure 29-1.

Four hydropunch samples will be obtained, one (HP-1) northwest of the existing leach field, one (HP-2) east of the existing leach field (east of the fence), one (HP-3) northeast of the Damage Control Building, and one (HP-4) southwest of Oil/Waste Separator No. 7.

Two soil borings will be installed to the water table using continuous split spoon sampling and monitoring with a FID/PID. Two samples will be obtained from each soil boring for analysis, one at the water table and one based on visual observations and FID/PID readings. One soil boring (SB-1) will be located northeast of the Ship Fire Simulator and one (SB-2) will be located east of Oil Separator/Skimmer No. 3.

One sediment sample (SED-1) will be collected from the pond near the outfalls.

One shallow soil boring (SB-3) sample will be obtained at an interval of 6 to 12 inches bgs from the area downgradient of the first oil water separators.

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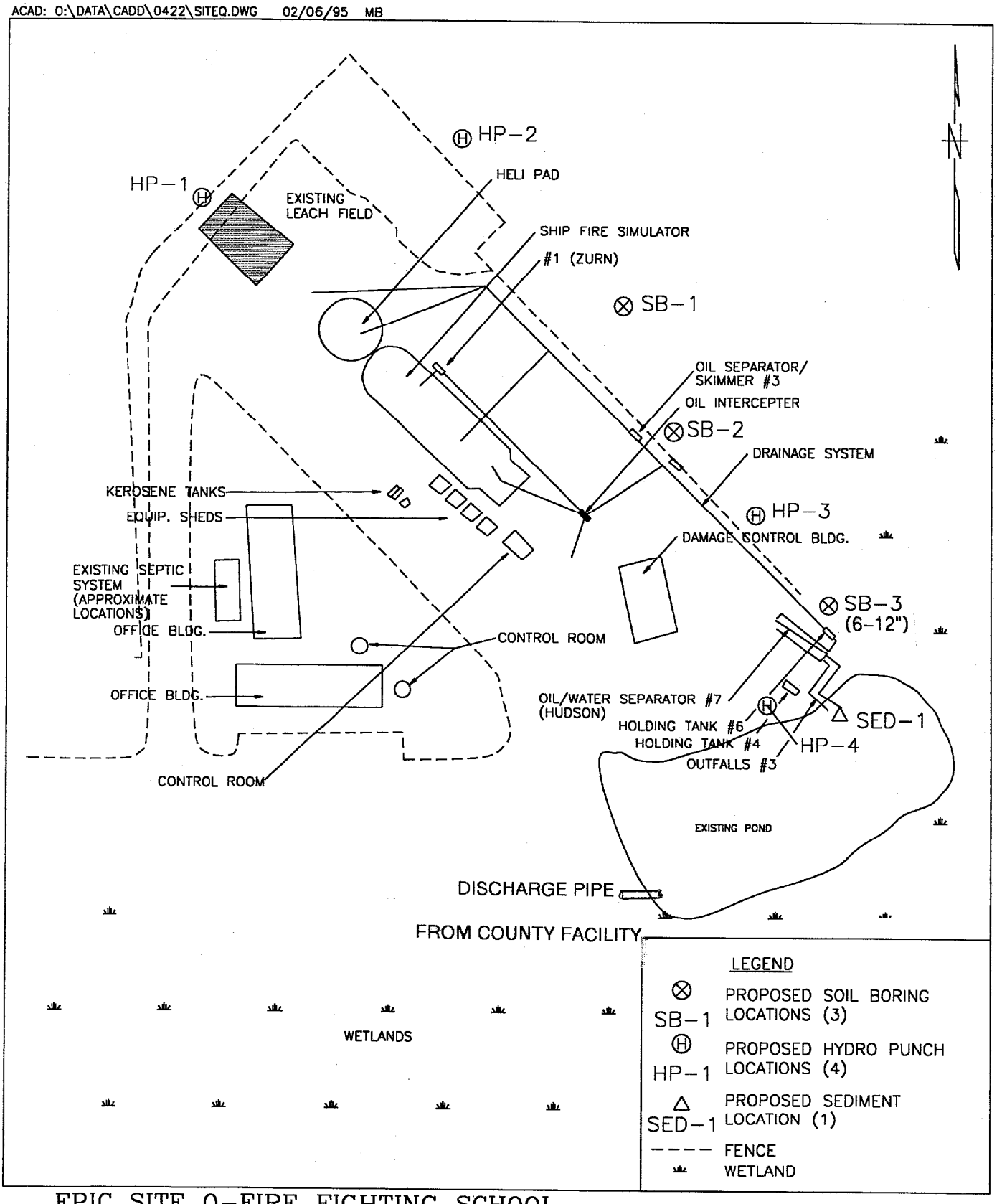

EPIC SITE Q-FIRE FIGHTING SCHOOL
MONITORING WELL LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 100 200
SCALE IN FEET

FIGURE 29-1

Halliburton NUS CORPORATION

TABLE 29-1

EPIC SITE Q SAMPLING LOCATIONS AND RATIONALE
NWS EARLE, COLTS NECK, NEW JERSEY

Sample	Sample Location	Sampling Rationale
Four soil samples	Collected from SB-1 and SB-2	Evaluate VOCs, SVOC contamination in soil.
Four groundwater (hydropunch) samples	Collected from HP-1 through HP-4	Evaluate potential presence of contaminants in groundwater.
One soil sample	Collected from shallow soil boring (SB-3)	Evaluate potential presence of contaminants in shallow soil down-gradient of oil/water separators.
One sediment sample	Collected from pond bottom near outfalls	Determine potential fire fighting training impacts on pond sediments.

Soil samples from SB-1 and SB-2 will be analyzed for TCL volatiles and TCL semivolatile compounds only. The four groundwater samples the remaining soil sample, and the sediment samples will be analyzed for TCL volatiles, TCL semivolatiles, and total petroleum hydrocarbons.

29.4 SITE MAPPING

A general overview of the site dimensions, wetlands, surface features and adjacent structures, and roadways has been performed and that data has been used to update and improve site drawings. These changes have been incorporated into the site maps included in this section. Basewide mapping of surface features will be completed during the RI effort utilizing available GIs and Intergraph data.

30.0 BACKGROUND/WATERSHED SAMPLES

30.1 BACKGROUND SAMPLE LOCATIONS

In order to determine the background level of chemicals which are present in and around NWS Earle, samples will be collected from several media at locations on station where past or present operations are not expected to have impacted site media by the release or accumulation of contaminants. Samples of surface soil, subsurface soil, sediment, surface water and groundwater will be collected and analyzed from areas throughout the station. To accurately determine what background levels of compounds are present, samples will be collected in areas where industrial activities have not occurred. These areas will be hydraulically upgradient, and, where possible, upwind of station areas where industrial operations or other potential sources of contaminant accumulation in site media may occur. The results of the background sampling will be used for comparison to the analytical results obtained from the sampling activities at sites described in Sections 4 through 29. A total of four background samples will be collected for each of the five media (surface soil, subsurface soil, sediment, surface water, and groundwater) being sampled during the current RI phase of work.

Three background sampling locations on the Mainside will be sampled. These locations are illustrated on Figure 30-1. A full suite of background samples will be collected (surface soil, subsurface soil, sediment, groundwater and surface water) in the northeast portion of the station, southeast of the town of Macedonia. This location (BG-1) is upgradient of the station and is located several thousand feet from an industrial portion of the station. Another background location (BG-2) is located on the north side of Hominy Hills, approximately 1,000 feet southeast of the intersection of Leland Road and Asbury Avenue. A complete suite of background media will also be collected at this location. In addition, background surface water and sediment samples will be collected on the south side of Hominy Hills, west of the intersection of Route 34 and Midway Road. This additional location on the Mainside has been included in the sampling program to complete a full suite of media at four locations and was required due to a lack of available surface water sediment background sample locations on the Mainside. Background sample locations on the Mainside are shown on Figure 30-1 and 30-2. To the extent possible background samples will be taken from each of the four major surficial geologic units at the station.

At the Waterfront portion of the station, two background sites will be sampled. A complete suite of background samples will be collected at location BG-3, located approximately 1,000 feet northwest of High Point Chapel. This location is upgradient and upwind of all industrial operations at the Waterfront portion of the station. The final background sample (BG-4) will be located approximately 250 feet east of Site 15. A monitoring well and soil samples will be collected at this location to provide data on background conditions near the shoreline. No surface water or sediment sample can be collected from this location. Surface water and sediment sample for background location BG-04 will be collected from the Mainside. Background sample locations at the Waterfront area are shown on Figure 30-2.

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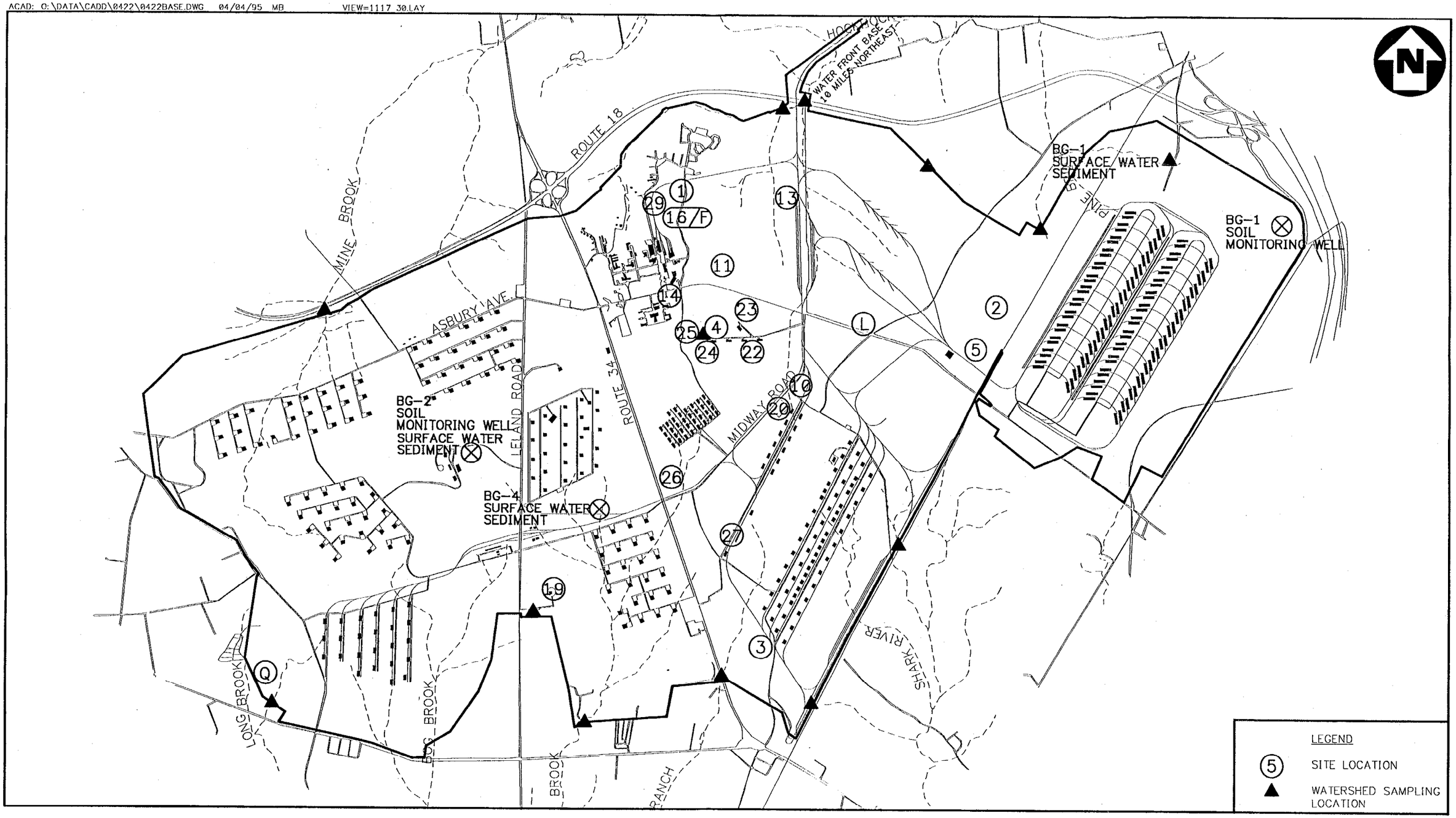

MAIN BASE
BACKGROUND SAMPLE LOCATIONS
NAVAL WEAPONS STATION EARLE, NJ

0 3000 6000
SCALE IN FEET

FIGURE 30-1

Halliburton NUS CORPORATION

00368A03Z

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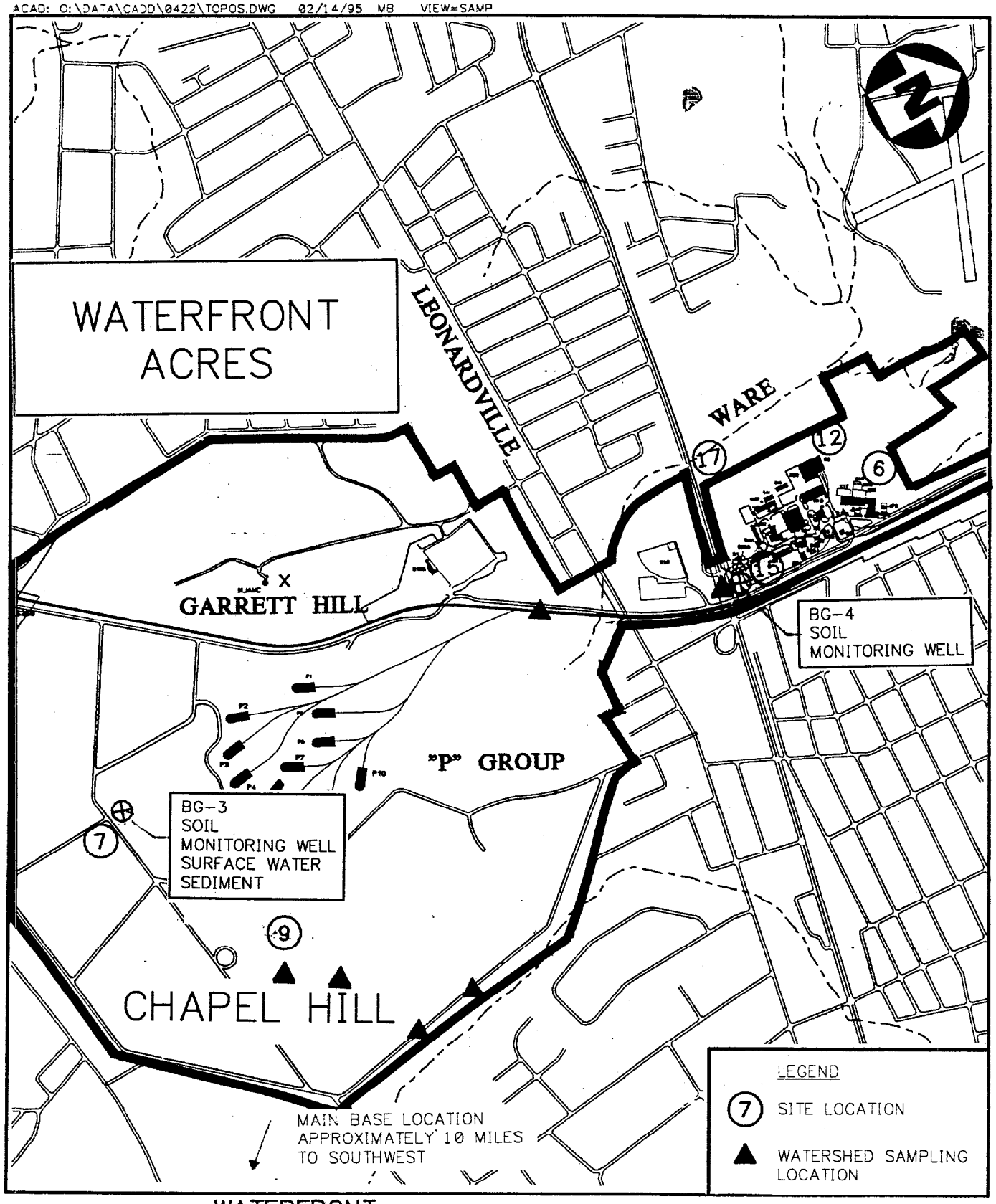

WATERFRONT
BACKGROUND SAMPLE LOCATIONS
NAVAL WEAPONS STATION, EARLE, NJ

0 1200 2400
SCALE IN FEET

FIGURE 30-2

Halliburton NUS CORPORATION

30.2 BACKGROUND SAMPLING ACTIVITIES

Surface and subsurface soils will be collected at each background location where monitoring wells will be installed. Surface soils will be collected from below the uppermost soil (organic) horizon. Effort will be made to avoid collecting roots and other organic material within the sample. In addition, surface soil sampling will occur before the drilling rig moves onto the site, or before clearing is started at the site for drilling activities. During drilling, one subsurface soil will be collected from approximately 5 ft bgs. Groundwater will be collected from all four background monitoring wells. Surface water and sediment samples will be collected at the four locations noted above. If surface water is not present in the drainages at the time field sampling occurs, the Field Operations Leader will select an alternative background sampling location.

All background samples will be analyzed for TCL volatiles and semivolatiles, TCL pesticides/PCBs, TAL metals, cyanide, explosives, and TPH. Soil, groundwater, and four surface water/sediment samples will also be analyzed for landfill indicator parameters. Sediment samples will also be analyzed for grain size. All aqueous samples will also be analyzed for hardness. Sample analytes, bottle requirements, and holding times are listed in Table 3-2.

30.3 WATERSHED SAMPLING

Due to the relatively sensitive nature of the hydrologic setting at NWS Earle, which includes forming a significant area of groundwater recharge and encompassing the headwaters and/or drainage basins of three major coastal plain rivers, a comprehensive watershed sampling program will be conducted. Sampling locations will include eight watershed divisions. These include the Shark River as well as 7 tributary drainages upstream of the remaining three coastal plain river drainages. Six of the watersheds are located within the Main base area and two are located within the Waterfront area. A total of 18 surface water and sediment samples will be collected in addition to those associated with background sampling. Sample locations are shown on Figures 30-1 and 30-2 and are provided in the following list:

MAINSIDE

Pine Brook Watershed

- Location in Wayside Area identified in workplan as BG-1.
- Pond northeast of Site 2 at perimeter road.

Hockhockson Brook Watershed

- Wetlands drainage at pipe under perimeter road northwest of Site 2.
- Junction of two major branches east of Normandy road near security checkpoint (1 sample from each branch).
- West of Normandy Road at NWS boundary, upstream of drainage from Site 13.

Shark River Watershed

- Two locations along southeastern boundary of NWS where tributaries pass under railroad tracks.

Mingamahone Brook Watershed

- East branch where it crosses under Route 34 near Site 3.
- South of Site 19 at NWS perimeter fence.
- Southeast of Site 19 where middle branch crosses under perimeter road near trailer park.
- Flooded marsh at perimeter road east of Site Q.

Mine Brook Watershed (background)

- Pond at station boundary north of Tarawa Road.

Lake Earle

- At south side of lake.

WATERFRONT

Wagner(?) Creek Watershed

- Spring south of Site 9.
- Same drainage east of spring where ponded at fire road.
- Same drainage at pipe under perimeter road.
- Wetlands drainage at pipe under perimeter road (north of location listed above).

Ware Creek Watershed

- Location where creek passes under Normandy Road.
- Drainage near Site 15.

Sampling at each watershed location will include both surface water and sediment. Analytical parameters will include VOCs, SVOCs, TAL metals, (including cyanide) landfill parameters, TOC, grain size, and hardness, as appropriate for each of the media.

30.4 MAPPING SAMPLE LOCATIONS

The location of each background surface water and sediment sample will be marked by driving a 1-inch by 1-inch wooden stake into the ground at the sample location. Surface and subsurface soil and groundwater sample locations will be identifiable by the installed monitoring wells. Each location will be surveyed for elevation and location.

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22. 40 CFR 136, September 11, 1992. [Sec. 136.3(a)].

5803-2.1-001

TtNUS
FILES

Remedial Investigation Work Plan

for

Naval Weapons Station Earle

Colts Neck, New Jersey

VOLUME II - APPENDICES

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0147

June 1995

APPENDICES

VOLUME II

APPENDIX A - FIELD FORMS
APPENDIX B - HNUS STANDARD OPERATING PROCEDURES
APPENDIX B.1 - USEPA LOW FLOW PURGE AND SAMPLING PROCEDURES
APPENDIX C - NJDEPE FIELD SAMPLING PROCEDURES
APPENDIX D - HEALTH AND SAFETY PLAN
APPENDIX E - QUALITY ASSURANCE PROJECT PLAN

APPENDIX A

FIELD FORMS

NWS EARLE, NEW JERSEY

BORING LOG

HALLIBURTON NUS

PROJECT: ______________________ BORING NO.: ______________

PROJECT NO.: ______________ DATE: ______________ DRILLER: ______________

ELEVATION: ______________ FIELD GEOLOGIST: ______________________

WATER LEVEL DATA: ______________________________________

(Date, Time & Conditions) ______________________________________

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.)	MATERIAL DESCRIPTION*			ROCK BR. OR USCS	REMARKS
					SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		

REMARKS ______________________________________

BORING ______________

PAGE ____ OF ____

* See Legend on Back

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE GRAINED SOILS

More than half of material is LARGER than No. 200 sieve size

		FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)	GROUP SYMBOL	TYPICAL NAMES
GRAVELS 50%(+)> 1/4"Ø	CLEAN GRAVELS Low % fines	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel sand mixtures, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
	GRAVELS w/FINES High % Fines	Non plastic fines (for identification procedures see ML)	GM	Silty gravels, poorly graded gravel sand silt mixtures.
		Plastic fines (for identification procedures see CL)	GC	Clayey gravels, poorly graded gravel sand clay mixtures.
SANDS 50%(+)< 1/4"Ø	CLEAN SANDS Low % Fines	Wide range in grain size and substantial amounts of all intermediate particle sizes.	SW	Well graded sand, gravelly sands, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing.	SP	Poorly graded sands, gravelly sands, little or no fines
	SANDS w/FINES High % Fines	Non plastic fines (for identification procedures see ML)	SM	Silty sands, poorly graded sand-silt mixtures.
		Plastic fines (for identification procedures see CL)	SC	Clayey sands, poorly graded sand-clay mixtures.

FINE GRAINED SOILS

More than half of material is SMALLER than No. 200 sieve size

Identification procedures on fraction smaller than No. 40 sieve size

	FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)			GROUP SYMBOL	TYPICAL NAMES
	DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)		
SILTS & CLAYS Liquid limit < 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	Slight to medium	Slow	Slight	OL	Organic silts and organic silt clays of low plasticity
SILTS & CLAYS Liquid limit > 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
	Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example GW GC, well graded gravel sand mixture with clay binder.
All sieve sizes on this chart are U.S. standard.

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE BLOWS/FOOT
Very loose	0-4
Loose	5-10
Medium dense	11-30
Dense	31-50
Very dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC. COMPRESSIVE STR. TONS/SQ. FT.	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Very stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)

DESCRIPTIVE TERMS	SCREWDRIVER OR KNIFE EFFECTS	HAMMER EFFECTS
Soft	Easily gouged	Crushes when pressed with hammer
Medium soft	Can be gouged	Breaks (one blow) Crumbly edges
Medium hard	Can be scratched	Breaks (one blow) Sharp edges
Hard	Cannot be scratched	Breaks conchoidally (several blows) Sharp edges

ROCK BROKENNESS

DESCRIPTIVE TERMS	ABBREVIATION	SPACING
Very broken	(V. Br.)	0 - 2"
Broken	(Br.)	2" - 1'
Blocky	(Bl.)	1' - 3'
Massive	(M.)	3' - 10'

LEGEND

SOIL SAMPLES - TYPES

S - 2" O.D. Split Barrel Sample
ST - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X - NX (Conventional) Core (~2-1/8" O.D.
Q - NQ (Wireline) Core (~1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18
▼ 12.6' Initial Level ▼/Date & Depth

12/18
▼ 12.6' Stabilized Level ▼/Date & Dept

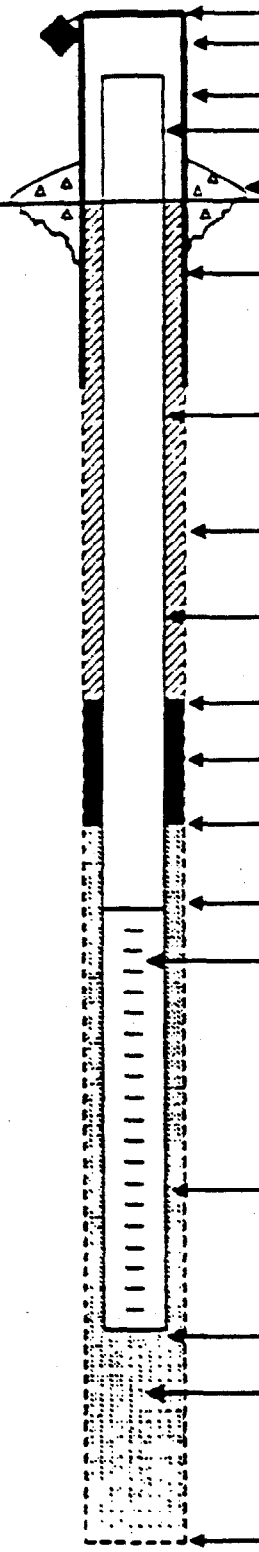
BORING NO _____

HALLIBURTON NUS
Environmental Corporation

MONITORING WELL SHEET

PROJECT _____ LOCATION _____
PROJECT NO. _____ BORING _____
ELEVATION _____ DATE _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING : _____
ELEVATION OF TOP OF RISER PIPE: _____

STICK - UP TOP OF SURFACE CASING: _____
STICK - UP RISER PIPE : _____

TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF BACKFILL: _____

ELEVATION / DEPTH TOP OF SEAL: _____

TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION / DEPTH TOP OF SCREEN: _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

I.D. OF SCREEN: _____

TYPE OF SAND PACK: _____

ELEVATION / DEPTH BOTTOM OF SCREEN: _____

ELEVATION / DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

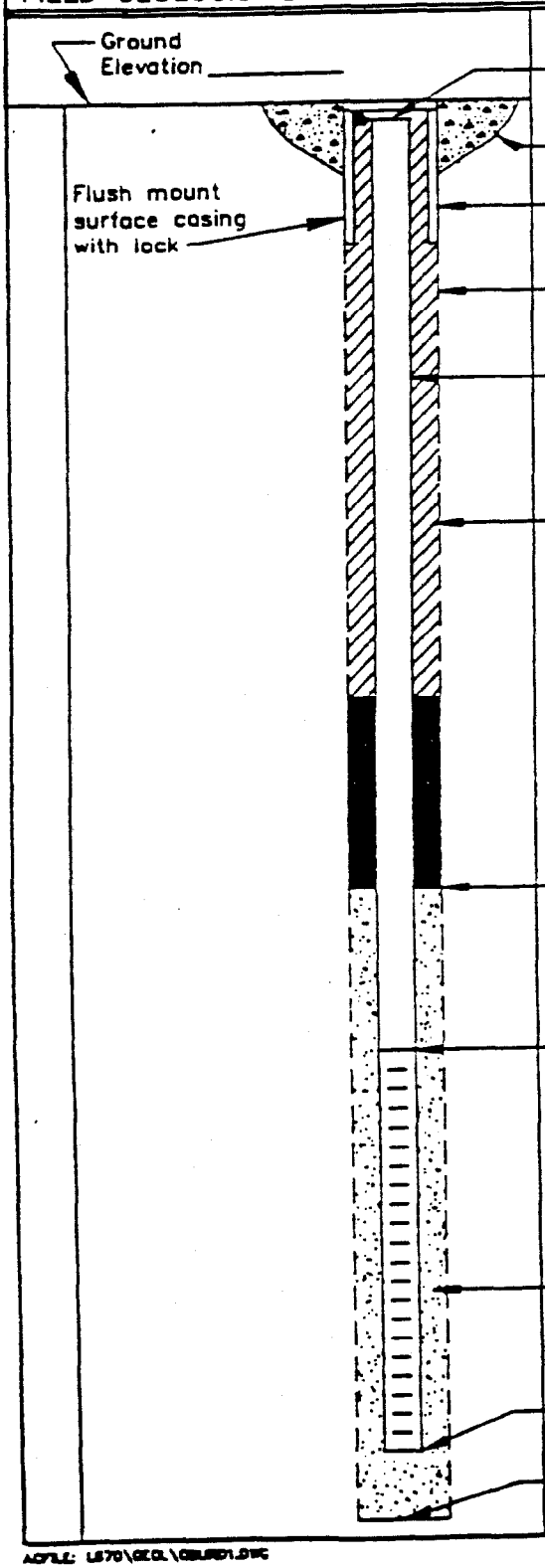
ELEVATION / DEPTH OF HOLE: _____

HALLIBURTON NUS
Environmental Corporation

WELL NO.: _____

MONITORING WELL SHEET

PROJECT: _____	LOCATION: _____	DRILLER: _____
PROJECT NO.: _____	BORING: _____	DRILLING METHOD: _____
ELEVATION: _____	DATE: _____	DEVELOPMENT METHOD: _____
FIELD GEOLOGIST: _____		



ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: _____

TYPE OF PROTECTIVE CASING: _____

I.D. OF PROTECTIVE CASING: _____

BOREHOLE DIAMETER: _____

TYPE OF RISER PIPE: _____

RISER PIPE I.D.: _____

TYPE OF BACKFILL/SEAL: _____

_____

DEPTH/ELEVATION TOP OF SAND: _____ / _____

DEPTH/ELEVATION TOP OF SCREEN: _____ / _____

TYPE OF SCREEN: _____

SLOT SIZE x LENGTH: _____

TYPE OF SAND PACK: _____

DEPTH/ELEVATION BOTTOM OF SCREEN: _____ / _____

DEPTH/ELEVATION BOTTOM OF SAND: _____ / _____

DEPTH/ELEVATION BOTTOM OF HOLE: _____ / _____

BACKFILL MATERIAL BELOW SAND: _____

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

PAGE____OF____

☐ SURFACE SOIL
☐ SUBSURFACE SOIL
☐ SEDIMENT
☐ LAGOON/POND
☐ OTHER

SAMPLERS SIGNATURE_____

SITE NAME_____

SITE NUMBER_____

SAMPLE No.	SAMPLE METHOD	DEPTH (FT)	DATE	TIME	SAMPLED BY	CONCENTRATION (L)LOW (H)HIGH	(G)GRAB (C)COMPOSITE	ANALYSES							No. OF CONT (TOTAL)	SOIL DESCRIPTION

REMARKS:

LAB:

ACAD: FORMS\LOG.DWG 2/11/93 MB

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

☐ Monitoring Well Data
☐ Domestic Well Data
☐ Other _____

Page _____ of _____
Case # _____
By _____

Project Site Name _____ Project Site Number _____
NUS Source No. _____ Source Location _____

Total Well Depth:	Purge Data						
Well Casing Size & Depth:	Volume	pH	S.C.	Temp. (°C)	TURB	DO	SAL
Static Water Level:							
One Casing Volume:							
Start Purge (hrs.):							
End Purge (hrs.):							
Total Purge Time (min.):							
Total Amount Purged (gal.):							
Monitor Reading:							
Purge Method:							
Sample Method:							
Depth Sampled:							
Sample Date & Time:	Sample Data						
	pH	S.C.	Temp. (°C)	TURB	DO	SAL	
Sampled By:							

Signature(s):

Type of Sample
- ☐ Low Concentration
- ☐ High Concentration
- ☐ Grab
- ☐ Composite
- ☐ Grab - Composite

Observations / Notes:

Analysis:	Preservative				

SAMPLE LOG SHEET

HALLIBURTON NUS
Environmental Corporation

☐ Spring
☐ Lake
☐ Stream
☐ Other _____

Page _____ of _____

Case # _____

By _____

Project Site Name _____ Project Site Number _____

NUS Source No. _____ Source Location _____

Sample Method:	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Depth Sampled:					
Sample Date & Time:					
	DO	Eh	SALINITY		
Sampled By:					
Signatures:					

Type of Sample

☐ Low Concentration
☐ High Concentration
☐ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative	Bottle Req.

GROUNDWATER LEVEL MEASUREMENT SHEET

Halliburton NUS

Project Name: _____ Location: _____
Project No.: _____ Weather Conditions: _____
Personnel: _____ Measuring Device: _____
Date: _____ Remarks: _____
Tidally Influenced: Yes _____ No _____ _____

Well or Piezometer Number	Date/Time	Elevation of Reference Point (Feet)*	Water Level Indicator Reading (Feet)*	Correction Factor	Adjusted Depth (Feet)*	Groundwater Elevation (Feet)*

* ALL MEASUREMENTS TO NEAREST 0.01 FOOT

ACAD: 1049\GW-LEVEL.DWG 3/18/91 MJJ

TEST PIT LOG

HALLIBURTON NUS

PROJECT: ..... TEST PIT NO.: .....

PROJECT NO.: ..... DATE: .....

LOCATION: .....

FIELD GEOLOGIST: .....

DEPTH (ft.)	LITHOLOGY CHANGE (Depth.ft.)	MATERIAL DESCRIPTION (Soil Density / Consistency, Color)	USCS	REMARKS

Test Pit Cross Section and / or Plan View

REMARKS .....

.....

.....

.....

PHOTO LOG ..... TEST PIT .....

.....

.....

PAGE.....OF.....

DAILY ACTIVITIES RECORD **HALLIBURTON NUS**

PROJECT _____ LOCATION _____
CLIENT _____ ARRIVAL TIME _____ JOB NO. _____
DATE _____ DEPARTURE TIME _____
CONTRACTOR _____ DRILLER _____
BORING NO. _____ HNUS REPRESENTATIVE _____

ITEM	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

COMMENTS: _____

APPROVED BY:

_____ _____
HNUS FIELD REPRESENTATIVE DRILLER OR REPRESENTATIVE

HALLIBURTON NUS
Environmental Corporation

EQUIPMENT CALIBRATION LOG

Instrument (Name/Model No./Serial No.): _____

Manufacturer _____ Date Purchased _____

Calibration Date	Initial Settings	Standard/Gas Used	Procedure	Adjustments Made	Final Settings	Signature	Comments

CHAIN-OF-CUSTODY SEAL

HALLIBURTON NUS Environmental Corporation

CUSTODY SEAL

Date

Signature

HALLIBURTON NUS Environmental Corporation

CUSTODY SEAL

Date

Signature

HALLIBURTON NUS
Environmental Laboratories
5350 CAMPBELLS RUN ROAD
PITTSBURGH, PA. 15205

NUS SAMPLE #

Client Name _____

Date Sampled _____ Time _____

Client Sample # _____

Sample Source _____

_____

HALLIBURTON NUS Environmental Corporation and Subsidiaries

CHAIN OF CUSTODY RECORD

PROJECT NO.:	SITE NAME:
SAMPLERS (SIGNATURE):	

STATION NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CON-TAINERS							REMARKS

RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED BY(SIGNATURE):
RELINQUISHED BY (SIGNATURE):	DATE / TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE / TIME:	REMARKS:	

NUS 440 REVISED 0891

APPENDIX B

HNUS STANDARD OPERATING PROCEDURES

NWS EARLE, NEW JERSEY

APPENDIX B

REMEDIAL INVESTIGATION

STANDARD OPERATING PROCEDURES (SOPs)

NWS EARLE, NEW JERSEY

APPENDIX B

STANDARD OPERATING PROCEDURES

SOP	Title
GH-1.3, Section 5:	Soil and Rock Sampling
GH-1.5, Section 5:	Borehole and Sample Logging
GH-1.6, Section 5:	Decontamination of Drilling Rigs and Monitoring Well Materials
GH-1.7, Section 5:	Groundwater Monitoring Point Installation
GH-2.5, Section 5:	Water Level Measurement/Contour Maps
SA-1.1, Section 5:	Groundwater Sample Acquisition
SA-1.2, Section 5:	Surface Water and Sediment Sampling
SA-1.3, Section 5:	Soil Sampling in Test Pits and Trenches
SA-6.1, Section 5:	Sample Identification and Chain-of-Custody
SA-6.2, Section 5:	Sampling Packaging and Shipping
SA-6.3, Section 5:	Site Logbook
SF-1.1, Section 5:	On-Site Water Quality Testing
SF-1.2, Section 5:	Sample Preservation
SF-2.3, Section 5:	Decontamination of Chemical Sampling and Field Analytical Equipment
ASTM D 1586-84, Section 7:	Penetration Test and Split Barrel Sampling of Soils

APPENDIX B

HNUS STANDARD OPERATING PROCEDURES

NWS EARLE, NEW JERSEY

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-1.3	Page 1 of 13
		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Earth Sciences	
Subject SOIL AND ROCK SAMPLING		Approved D. Senovich	

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3.0 GLOSSARY

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1.0 PURPOSE

The purpose of this procedure is to identify the equipment, sequence of events, and appropriate methods necessary to obtain soil, both surface and subsurface, and rock samples during field sampling activities.

2.0 SCOPE

The methods described within this procedure are applicable while collecting surface and subsurface soil samples; obtaining rock core samples for lithologic and hydrogeologic evaluation; excavation/foundation design and related civil engineering purposes.

3.0 GLOSSARY

Hand Auger- A sampling device used to extract soil from the ground in a relatively undisturbed form.

Thin-Walled Tube Sampler - A thin-walled metal tube (also called Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from 2 to 5 inches O.D. and 18 to 54 inches long. A stationary piston device may be included in the sampler to reduce sampling disturbance and increase sample recovery.

Split-Barrel Sampler - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. Also called a split-spoon sampler, this device can be driven into resistant materials using a drive weight mounted in the drilling string. A standard split spoon sampler (used for performing Standard Penetration Tests) is 2 inches outside diameter (OD) and 1-3/8 inches inside diameter (ID). This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. These split-spoon samplers range in size from 2-inch O.D. to 3-1/2-inch O.D., depending upon manufacturer. The larger sizes are commonly used when a larger volume of material is required.

Rock Coring - A method in which a continuous solid cylindrical sample of rock or compact rock-like soil is obtained by the use of a double tube core barrel that is equipped with an appropriate diamond-studded drill bit which is advanced with a hydraulic rotary drilling machine.

Wire-Line Coring - As an alternate for conventional coring, this is valuable in deep hole drilling, since this method eliminates trips in and out of the hole with the coring equipment. With this technique the core barrel becomes an integral part of the drill rod string. The drill rod serves as both a coring device and casing.

4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for overall management of field activities and ensuring that the appropriate sampling procedures are being implemented.

Site Geologist - The site geologist directly oversees the sampling procedures, classifies soil and rock samples, and directs the packaging and shipping of soil samples. Such duties may also be performed by geotechnical engineers, field technicians, or other qualified field personnel.

5.0 PROCEDURES

5.1 SUBSURFACE SOIL SAMPLES

Subsurface soil samples are used to characterize subsurface stratigraphy. This characterization can indicate the potential for migration of chemical contaminants in the subsurface. In addition, definition of the actual migration of contaminants can be obtained through chemical analysis of the soil samples. Where the remedial activities may include in-situ treatment or the excavation and removal of the contaminated soil, the depth and areal extent of contamination must be known as accurately as possible.

Engineering and physical properties of soil may also be of interest should site construction activities be planned. Soil types, grain size distribution, shear strength, compressibility, permeability, plasticity, unit weight, and moisture content are some of the physical characteristics that may be determined for soil samples.

Penetration tests are also described in this procedure. The tests can be used to estimate various physical and engineering parameters such as relative density, unconfined compressive strength, and consolidation characteristics of soils.

The procedures described here are representative of a larger number of possible drilling and sampling techniques. The choice of techniques is based on a large number of variables such as cost, DQOs, local geology, etc. The final choice of methods must be made with the assistance of drilling subcontractors familiar with the local geologic conditions. Alternative techniques must be based upon the underlying principles of quality assurance implicit in the following procedures.

5.1.1 Equipment

The following equipment is used for subsurface soil sampling and test boring:

- Drilling equipment, provided by subcontractor.
- Split barrel (split spoon) samplers, OD 2 inches, ID 1-3/8 inches, either 20-inch or 26 inches long. Larger O.D. samplers are available if a larger volume of sample is needed. A common size is 3-inch O.D. (2-1/2-inch I.D.).
- Thin walled tubes (Shelby), O.D. 2 to 5 inches, 18 to 54 inches long.
- Drive weight assembly, 140-lb. (± 2 lb.) weight, driving head and guide permitting free fall of 30 inches (± 1 inch).
- Drive weight assembly, 300-lb. (± 2 lb.) weight, driving head and guide permitting free fall of 18 inches (± 1 inch).
- Accessory equipment, including labels, logbook, paraffin, and sample jars.

5.1.2 Split Barrel (Split Spoon) Sampling (ASTM D1586-84)

The following method will be used for split barrel sampling:

- Clean out the borehole to the desired sampling depth using equipment that will ensure that the material to be sampled is not disturbed by the operation. In saturated sands and silts, withdraw the drill bit slowly to prevent loosening of the soil around the hole and maintain the water level in the hole at or above groundwater level.

- Side-discharge bits are permissible. A bottom-discharge bit shall not be used. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. Where casing is used, it may not be driven below the sampling elevation.

- Install the split barrel sampler and sampling rods into the boring to the desired sampling depth. After seating the sampler by means of a single hammer blow, three 6-inch increments shall be marked on the sampling rod so that the progress of the sampler can be monitored.

- The 2-inch OD split barrel sampler shall be driven with blows from a 140-lb. (± 2 lb.) hammer falling 30 inches (± 1 inch) until either a total of 50 blows have been applied during any one of the three 6-inch increments, a total of 100 blows have been applied, there is no observed advance of the sampler for 10 successive hammer blows, or until the sampler has advanced 18 inches without reaching any of the blow count limitation constraints described herein. This process is referred to as the Standard Penetration Test.

- A 300-lb. weight falling 18 inches is sometimes used to drive a 2-1/2-inch or 3-inch O.D. spoon sampler. This procedure is used where dense materials are enountered or when a large volume of sample is required. However, this method does not conform the ASTM specifications.

- Repeat this operation at intervals not greater than 5 feet in homogeneous strata, or as specified in the sampling plan.

- Record the number of blows required to effect each 6 inches of penetration or fraction thereof. The first 6 inches is considered to be seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the penetration resistance, N. If the sampler is driven less than 18 inches, the penetration resistance is that for the last 1 foot penetrated.

- Bring the sampler to the surface and remove both ends and one half of the split barrel so that the soil recovered rests in the remaining half of the barrel. Describe carefully the sample interval, recovery (length), composition, structure, consistency, color, condition, etc., of the recovered soil then put a representative portion of each sample into a jar, without ramming. Jars with samples not taken for chemical analysis shall be sealed with wax, or hermetically sealed (using a teflon cap liner) to prevent evaporation of the soil moisture, if the sample is to be later evaluated for moisture content. Affix labels to the jar and complete Chain-of-Custody and other required sample data forms. Protect samples against extreme temperature changes and breakage by placing them in appropriate cartons stored in a protected area. Pertinent data which shall be noted on the label or written on the jar lid for each sample includes the project number, boring number, sample number, depth interval, blow counts, and date of sampling.

- An addition to the sampler mentioned above is an internal liner, which is split longitudinally and has a thin-wall brass, steel, or paper liner inserted inside, which will preserve the sample. However, since the development of the thin-walled samplers (mentioned below) the split barrel sampler with liner has declined in use.

5.1.3 Thin Walled Tube (Shelby Tube) Sampling (ASTM D1587-83)

When it is desired to take undisturbed samples of soil, thin-walled seamless tube samplers (Shelby tubes) will be used. The following method will be used:

- Clean out the borehole to the sampling depth, being careful to minimize the chance for disturbance of the material to be sampled. In saturated materials, withdraw the drill bit slowly to prevent loosening of the soil around the borehole and maintain the water level in the hole at or above groundwater level.

- The use of bottom discharge bits or jetting through an open-tube sampler to clean out the hole shall not be allowed. Any side discharge bits are permitted.

- A stationary piston-type sampler may be required to limit sample disturbance and aid in retaining the sample. Either the hydraulically operated or control rod activated-type of stationary piston sampler may be used. Prior to inserting the tube sampler in the hole, check to ensure that the sampler head contains a check valve. The check valve is necessary to keep water in the sampling rods from pushing the sample out of the tube sampler during sample withdrawal and to maintain a suction within the tube to help retain the sample.

- To minimize chemical reaction between the sample and the sampling tube, brass tubes may be required, especially if the tube is stored for an extended time prior to testing. While steel tubes coated with shellac are less expensive than brass, they are more reactive, and shall only be used when the sample will be tested within a few days after sampling or if chemical reaction is not anticipated. With the sampling tube resting on the bottom of the hole and the water level in the boring at the groundwater level or above, push the tube into the soil by a continuous and rapid motion, without impacting or twisting. In no case shall the tube be pushed farther than the length provided for the soil sample. Allow about 3 inches in the tube for cuttings and sludge.

- Upon removal of the sampler tube from the hole, measure the length of sample in the tube and also the length penetrated. Remove disturbed material in the upper end of the tube and measure the length of sample again. After removing at least an inch of soil from the lower end and after inserting an impervious disk, seal both ends of the tube with at least a 1/2-inch thickness of wax applied in a way that will prevent the wax from entering the sample. Newspaper or other types of filler must be placed in voids at either end of the sampler prior to sealing with wax. Place plastic caps on the ends of the sampler, tape in the caps place, and dip the ends in wax.

- Affix labels to the tubes as required and record sample number, depth, penetration, and recovery length on the label. Mark the same information and "up" direction on the tube with indelible ink, and mark the end of the sample. Complete Chain-of-Custody and other required forms. Do not allow tubes to freeze and store the samples vertically (with the same orientation they had in the ground, i.e., top of sample is up) in a cool place out of the

sun at all times. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

Thin-walled undisturbed tube samplers are restricted in their usage by the consistency of the soil to be sampled. Often, very loose and/or wet samples cannot be retrieved by the samplers, and soils with a consistency in excess of very stiff cannot be penetrated by the sampler. Devices such as Denison or Pitcher core samplers can be used to obtain undisturbed samples of stiff soils. Using these devices normally increases sampling costs and therefore their use shall be weighed against the increased cost and the need for an undisturbed sample. In any case, if a sample cannot be obtained with a tube sampler, an attempt shall be made with a split barrel sampler at the same depth so that at least a sample can be obtained for classification purposes.

5.1.4 Continuous Core Soil Samples

The CME continuous sample tube system provides a method of sampling soil continuously during hollow stem augering. The 5-foot sample barrel fits within the lead auger of a hollow auger column. The sampling system can be used with a wide range of I.D. hollow stem augers (from 3-1/4-inch to 8-1/4-inch I.D.). This method has been used to sample many different materials such as glacial drift, hard clays and shales, mine tailigs, etc. This method is particularly used when SPT samples are not required and a large volume of material is needed. Also, this method is useful when a visual description of the subsurface lithology is required.

5.2 SURFACE SOIL SAMPLES

For loosely packed earth or waste pile samples, stainless steel scoops or trowels can be used to collect representative samples. For densely packed soils or deeper soil samples, a hand or power soil auger may be used.

The following methods are to be used:

- Use a soil auger for deep samples (6 to 24 inches) or a scoop or trowel for surface samples. Remove debris, rocks, twigs, and vegetation before collection of soil. Mark the location with a numbered stake if possible and locate sample points on a sketch of the site.

- Use a new or freshly-decontaminated sampler for each sample taken. Attach a label and identification tag. Record all required information in the field logbook and on the sample log sheet, Chain-of-Custody record, and other required forms.

- Pack and ship accordingly.

- When a representative composited sample is to be prepared (e.g., samples taken from a gridded area or from several different depths), it is best to composite individual samples in the laboratory where they can be more precisely composited on a weight or volume basis. If this is not possible, the individual samples (all of equal volume, i.e., the sample bottles shall be full) shall be placed in a decontaminated stainless steel bucket, mixed thoroughly using a stainless steel spatula or trowel, and a composite sample collected.

5.3 WASTE PILE SAMPLES

The use of stainless steel scoops or trowels to obtain small discrete samples of homogeneous waste piles is usually sufficient for most conditions. Layered (nonhomogeneous) piles require the use of tube samplers to obtain cross-sectional samples.

- Collect small, equal portions of the waste from several points around the pile, penetrating it as far as practical. Use numbered stakes, if possible, to mark the sampling locations and locate sampling points on the site sketch.

- Place the waste sample in a glass container. Attach a label and identification tag. Record all the required information in the field logbook and on the sample log sheet and other required forms.

For layered, nonhomogeneous piles, grain samplers, sampling triers, or waste pile samplers must be used at several representative locations to acquire a cross-section of the pile. The basic steps to obtain each sample are

- Insert a sampler into the pile at a 0- to 45-degree angle from the horizontal to minimize spillage.

- Rotate the sampler once or twice to cut a core of waste material. Rotate the grain sampler inner tube to the open position and then shake the sampler a few times to allow the material to enter the open slits. Move the sampler into position with slots upward (grain sampler closed) and slowly withdraw from the pile.

5.4 ROCK SAMPLING (CORING) (ASTM D2113-83)

Rock coring enables a detailed assessment of borehole conditions to be made, showing precisely all lithologic changes and characteristics. Because coring is an expensive drilling method, it is commonly used for shallow studies of 500 feet or less, or for specific intervals in the drill hole that require detailed logging and/or analyzing. It can, however, proceed for thousands of feet continuously, depending on the size of the drill rig. It yields better quality data than air rotary drilling, although at a substantially reduced drilling rate. Rate of drilling varies widely, depending on the characteristics of lithologies encountered, drilling methods, depth of drilling, and condition of drilling equipment. Average output in a 10-hour day ranges from 40 to over 200 feet. Downhole geophysical logging or television camera monitoring is sometimes used to complement the data generated by coring.

Borehole diameter can be drilled to various sizes, depending on the information needed. Standard sizes of core barrels (showing core diameter) and casing are shown in Attachment No. 1.

Core drilling is used when formations are too hard to be sampled by soil sampling methods and a continuous solid sample is desired. Usually, soil samples are used for overburden, and coring begins in sound bedrock. Casing is set into bedrock before coring begins to prevent loose material from entering the borehole, to prevent loss of drilling fluid, and to prevent cross contamination of aquifers.

ATTACHMENT 1

STANDARD SIZES OF CORE BARRELS AND CASING

Coring bit size	Nominal *		Set size *	
	O.D.	I.D.	O.D.	I.D.
RWT	$1\frac{5}{32}$	$\frac{3}{4}$	1.160	.735
EWT	$1\frac{1}{2}$	$\frac{29}{32}$	1.470	905
EX, EXL, EWG, EWM	$1\frac{1}{2}$	$\frac{13}{16}$	1.470	.845
AWT	$1\frac{7}{8}$	$1\frac{9}{32}$	1.875	1.281
AX, AXL, AWG, AWM	$1\frac{7}{8}$	$1\frac{3}{16}$	1.875	1.185
BWT	$2\frac{3}{8}$	$1\frac{3}{4}$	2.345	1.750
BX, BXL, BWG, BWM	$2\frac{3}{8}$	$1\frac{5}{8}$	2.345	1.655
NWT	3	$2\frac{5}{16}$	2.965	2.313
NX, NXL, NWG, NWM	3	$2\frac{1}{8}$	2.965	2.155
HWT	$3\frac{29}{32}$	$3\frac{3}{16}$	3.889	3.187
HWG	$3\frac{29}{32}$	3	3.889	3.000
$2\frac{3}{4} \times 3\frac{7}{8}$	$3\frac{7}{8}$	$2\frac{3}{4}$	3.840	2.690
$4 \times 5\frac{1}{2}$	$5\frac{1}{2}$	4	5.435	3.970
$6 \times 7\frac{3}{4}$	$7\frac{3}{4}$	6	7.655	5.970
AX Wire line 1/	$1\frac{7}{8}$	1	1.875	1.000
BX Wire line 1/	$2\frac{3}{8}$	$1\frac{7}{16}$	2.345	1.437
NX Wire line 1/	3	$1\frac{15}{16}$	2.965	1.937

* All dimensions are in inches; to convert to millimeters, multiply by 254.
1/ Wire line dimensions and designations may vary according to manufacturer.

6.0 REFERENCES

American Society for Testing and Materials, 1985. Method for Penetration Test and Split Barrel Sampling of Soils. ASTM Method D 1586-84, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

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7.0 RECORDS

None.

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-1.5	Page 1 of 26
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		Applicability EMG	
		Prepared Earth Sciences	
Subject BOREHOLE AND SAMPLE LOGGING		Approved D. Senovich	

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7.0 RECORDS

1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Geologist - Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used onsite the Site Geologist must make sure that each field geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

5.1 MATERIALS NEEDED

When logging soil and rock samples, the geologist or engineer may be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute HCl
- Ruler (marked in tenths and hundreths of feet)
- Hand Lens

5.2 CLASSIFICATION OF SOILS

All data shall be written directly on the boring log (Exhibit 4-1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Exhibit 4-2. This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse grained soils shall be divided into rock fragments, sand, or gravel. The terms and sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as (1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and SA-1.2. Those designations are:

Designation	Standard Penetration Resistance (Blows per Foot)
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140 pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, and SC (see Exhibit 4-2).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Exhibit 4-3. Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Exhibit 4-2).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength) or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are as follows:

Consistency	Unc. Compressive Str. Tons/Square Foot	Standard Penetration Resistance (Blows per Foot)	Field Identification Methods
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Very stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Hard	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
trace	0 - 10 percent
some	11 - 30 percent
and or adjective form of the soil type (e.g., "sandy")	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

5.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

5.2.6 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Exhibit 4-4.

5.2.7 Texture/Fabric/Bedding

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

5.2.8 Summary of Soil Classification

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

5.3 CLASSIFICATION OF ROCKS

Rocks are grouped into three main divisions, including sedimentary, igneous and metamorphic rocks. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.

- Siltstone - Made up of granular materials less than 1/16 to 1/256 mm in diameter. ractures irregularly. Medium thick to thick bedded.

- Claystone - Vary fine grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

- Shale - A fissile very fine grained rock. Fractures along bedding planes.

- Limestone - Rock made up predominantly of calcite ($CaCO_3$). Effervesces strongly upon the application of dilute hydrochloric acid.

- Coal - Rock consisting mainly of organic remains.

- Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. These include conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam - Thin (12 inch or less), probably continuous layer.

- Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

- Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

- Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

- Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt - A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.

- Rhyolite - A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.

- Granite - A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.

- Diorite - A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.

- Gabbro - A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate - A very fine-grained foliated rock possessing a well developed slaty cleavage. Contains predominantly chlorite, mica, quartz, and sericite.
- Phyllite - A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.
- Schist - A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.
- Gneiss - A coarse-grained foliated rock with bands rich in granular and platy minerals.
- Quartzite - A fine to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

5.4 ABBREVIATIONS

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

C - Coarse	Lt - Light	Yl - Yellow
Med - Medium	BR - Broken	Or - Orange
F - Fine	BL - Blocky	SS - Sandstone
V - Very	M - Massive	Sh - Shale
Sl - Slight	Br - Brown	LS - Limestone
Occ - Occasional	Bl - Black	Fgr - Fine grained
Tr - Trace		

5.5 BORING LOGS AND DOCUMENTATION

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceeding sections shall be used to complete the logs. A sample boring log has been provided as Exhibit 4-6. The field geologist/engineer shall use this example as a guide in completing each borings log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided on the back of the boring log, for field use.

5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.
- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology a 13.7 feet, shall be lined off at the proportional location between the 13 and 14 foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.

- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.

- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this increment. This information is helpful in the construction of cross-sections. As an alternative, symbols may be used to identify each change in lithology.

- The density of granular soils is obtained by adding the number of blows for the last two increments. Refer to Density of Granular Soils Chart of back of log sheet. For consistency of cohesive soils refer also to the back of log sheet - Consistency of Cohesive Soils. Enter this information under the appropriate column. Refer to Section 5.2.3.

- Enter color of the material in the appropriate column.

- Describe material using the USCS. Limit this column for sample description only. The predominate material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:

  - Trace 0 - 10 percent
  - Some 11 - 30 percent
  - And 31 - 50 percent

- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.

- Enter USCS symbol - use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.

- The following information shall be entered under the Remarks Column and shall include, but is not limited by the following:

  - Moisture - estimate moisture content using the following terms - dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.

  - Angularity - describe angularity of coarse grained particles using Angular, Subangular, Subrounded, Rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.

  - Particle shape - flat, elongated, or flat and elongated.

  - Maximum particle size or dimension.

  - Water level observations.

  - Reaction with HCl - none, weak or strong.

- Additional comments:

  - Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.

  - Indicate odor and HNu or OVA reading if applicable.

  - Indicate any change in lithology by drawing in line through the lithology change column and indicate the depth. This will help later on when cross-sections are constructed.

  - At the bottom of the page indicate type of rig, drilling method, hammer size and drop and any other useful information (i.e., borehole size, casing set, changes in drilling method).

  - Vertical lines shall be drawn (as shown in Exhibit 4.6) in columns 5 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.

  - Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.2 Rock Classification

- Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent and core recovery under the appropriate columns.

- Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.

- Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.

- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.

- Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.

- Enter brokeness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.

- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:

  Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70° angle from horizontal, high angle.
  - Indicate calcareous zones, description of any cavities or vugs.
  - Indicate any loss or gain of drill water.
  - Indicate drop of drill tools or change in color of drill water.

- Remarks at the bottom of Boring Log shall include:

  - Type and size of core obtained.
  - Depth casing was set.
  - Type of Rig used.

- As a final check the boring log shall include the following:

  - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.

  - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5 foot intervals, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or "zip lock" bag for future reference, and label the jar or bag (i.e. hole number, depth, date etc.). Cuttings shall be closely examined to determine general lithology.

- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.

- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.

- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.

- Record this and any other useful information onto the boring log as provided in Exhibit 4-1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split barrel and rock core sampling methods be used at selected boring locations during the field investigation to

provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

5.6 REVIEW

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs
- Checking for conformance to the guideline
- Checking to see that all information is entered in their respective columns and spaces

6.0 REFERENCES

Unified Soil Classification System (USCS)

ASTM D2488, 1985

Earth Manual, U.S. Department of the Interior, 1974

7.0 RECORDS

Originals of the boring logs shall be retained in the project files.

EXHIBIT 4-1

BORING LOG ***NUS CORPORATION***

PROJECT: ..... BORING NO.: .....
PROJECT NO.: ..... DATE: ..... DRILLER: .....
ELEVATION: ..... FIELD GEOLOGIST: .....
WATER LEVEL DATA : .....
(Date, Time & Conditions) .....

SAMPLE NO. & TYPE OR ROD	DEPTH (ft.) OR RUN NO.	BLOWS/ 6" OR ROD (%)	SAMPLE RECOVERY /SAMPLE LENGTH	LITHOLOGY CHANGE (Depth,ft.) OR SCREENED INTERVAL	MATERIAL DESCRIPTION			BORE LOG SCRACKS	BROKENESS	REMARKS
					SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION			

REMARKS _____

BORING _____

PAGE ____ OF ____

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE GRAINED SOILS
More than half of material is LARGER than No. 200 sieve size

		FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)	GROUP SYMBOLS	TYPICAL NAMES
GRAVELS 50% (+) > 1/4" ø	CLEAN GRAVELS Low % fines	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
	GRAVELS W/FINES High % fines	Non-plastic fines (for identification procedures see ML)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures
		Plastic fines (for identification procedures see CL)	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures
SANDS 50% (+) < 1/4" ø	CLEAN SANDS Low % fines	Wide range in grain size and substantial amounts of all intermediate particle sizes	SW	Well graded sand, gravelly sands, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines
	SANDS W/FINES High % fines	Non-plastic fines (for identification procedures see ML)	SM	Silty sands, poorly graded sand-silt mixtures
		Plastic fines (for identification procedures see CL)	SC	Clayey sands, poorly graded sand-clay mixtures

FINE GRAINED SOILS
More than half of material is SMALLER than No. 200 sieve size

	FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)			GROUP SYMBOLS	TYPICAL NAMES
	Identification procedures on fraction smaller than No. 40 sieve size				
	DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)		
SILTS & CLAYS Liquid limit < 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity
SILTS & CLAYS Liquid limit > 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
	Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture			Pt	Peat and other organic soils

Boundary classifications-Soils possessing characteristics of two groups are designated by combining group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.
All sieve sizes on this chart are U.S. standard.

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE — BLOWS/FOOT
Very loose	0 - 4
Loose	5 - 10
Medium dense	11 - 30
Dense	31 - 50
Very dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC. COMPRESSIVE STR. TONS /SQ. FT.	STANDARD PENETRATION RESISTANCE — BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Very stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)

DESCRIPTIVE TERMS	SCREWDRIVER OR KNIFE EFFECTS	HAMMER EFFECTS
Soft	Easily gouged	Crushes when pressed with hammer
Medium soft	Can be gouged	Breaks (one blow) Crumbly edges
Medium hard	Can be scratched	Breaks (one blow) Sharp edges
Hard	Cannot be scratched	Breaks conchoidally (several blows) Sharp edges

ROCK BROKENNESS

DESCRIPTIVE TERMS	ABBREVIATION	SPACING
Very broken	(V. Br.)	0 - 2"
Broken	(Br.)	2" - 1'
Blocky	(Bl.)	1' - 3'
Massive	(M.)	3' - 10'

LEGEND

SOIL SAMPLES - TYPES

S - 2" O.D. Split Barrel Sample
ST - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X - NX (Conventional) Core (~ 2-1/8" O.D.)
O - NQ (Wireline) Core (~1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18 ▽ 12.6' Initial Level w/Date & Depth
12/18 ▼ 12.6' Stabilized Level w/Date & Depth

EXHIBIT 4-3

CONSISTENCY FOR COHESIVE SOILS

Consistency	(Blows per Foot)	Unconfined Compressive Strength (tons/square foot by pocket penetration	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented by thumbnail

EXHIBIT 4-4

BEDDING THICKNESS CLASSIFICATION

Thickness (Metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' - 3.3'	Thick Bedded
10 cm - 30 cm	4" - 1.0'	Medium Bedded
3 cm - 10 cm	1" - 4"	Thin Bedded
1 cm - 3 cm	2/5" - 1"	Very Thin Bedded
3 mm - 1 cm	1/8" - 2/5"	Laminated
1 mm - 3 mm	1/32" - 1/8"	Thinly Laminated
<1 mm	<1/32"	Micro Laminated

(Weir, 1973 and Ingram, 1954)

EXHIBIT 4-5

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4-64 mm
Granules	2-4 mm
Very Coarse Sand	1-2 mm
Coarse Sand	0.5-1 mm
Medium Sand	0.25-0.5 mm
Fine Sand	0.125-0.25 mm
Very Fine Sand	0.0625-0.125 mm
Silt	0.0039-0.0625 mm

After Wentworth, 1922

BORING LOG — **NUS CORPORATION**

PROJECT: HEBELKA SITE — BORING NO.: MW 3A
PROJECT NO.: 619Y — DATE: 9-21-87 — DRILLER: B. GOLLIHUE
ELEVATION: 510.07 — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA (Date, Time & Conditions): WL 26.35 - TPVC 10-16-87

	SAMPLE NO. & TYPE/ RQD	DEPTH (Ft.) / RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.) OR SCREEN INT	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK OR DRYNESS USCS	REMARKS
	S-1	0.0	3/6	1.5/1.5		STIFF	BRN	CLAYEY SILT - TR SHALE	ML	0-6" TOPSOIL MOIST 0PPM
		1.5	6					FRAG - TR ORG.		RESIDUAL SOIL.
		5.0								
	S-2	6.0	11/100/.5	0.8/1.0	5.5/6.0	M. SOFT	GRAY BRN	DEC SHALE AND SILT	VBR	DAMP 0PPM
						TO				REFUSAL @ 6' 5.5 TOP OF DEC ROCK
						M. HARD				
										AUGERED TO 15'. W/SOLID STEM AUG.
										CUTTING MOIST @ ≈8' WATER @ 11'±
										WL @ 12:10 PM WAS ≈ 9' FROM G.S.
										SET 4" PVC CAS. @ 15.0'
9-21		15.0								
9-22						M. HARD	BRN GRAY	SILTY SHALE - FEW	VBR	SEVERAL 0 PPM
								QUARTZ PCS		Fe STAINED JOINTS ON CORE
										THRUOUT RUN. JOINTS AND BREAKS
										ARE HORIZ TO LO∠. W/ VUGS ON LOWER
	9.8/10.0	①	0.8/5	7.8/10.0						PORTION 23 TO 25 OF CORE
		25.0								

REMARKS ACKER AD II RIG - SOLID STEM AUGERS USED TO ADVANCE BORING - 140 LB WT @ 30" DROP - TO TAKE 2" Φ SP. SPOON SAMPLES - SET UP OVER HOLE @ 11:10 AM. WILL SAMPLE THIS HOLE - SET 4" CASING THEN DO SHALLOW WELL. STARTED TO CORE 9-22-87 USING THE WIRE-LINE CORING METHOD.

BORING MW 3A

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BORING LOG — **NUS CORPORATION**

PROJECT: HEBELKA SITE — BORING NO.: MW 3A
PROJECT NO.: 619Y — DATE: 9-22-87 — DRILLER: B. GOLLIHUE
ELEVATION: — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA (Date, Time & Conditions):

	SAMPLE NO. & TYPE RQD	DEPTH (ft.) RUN	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS
9-22		25.0				M.HARD	GRAY	SILTY SHALE	VBR	SHALE IS VBR W/ HORIZ TO LO ∠ JNTS
								(SILTSTONE)		≈26 TO 27 2" VERT
								-FEW QUARTZ		JOINTS. IRON STAINS ON JNTS
								SEAMS		ROCK BECOMES AND BREAKS MORE LIKE
										A SILTSTONE WITH DEPTH.
	0/10.0	②	0%	8.7/10.0						
									BR	≈32 TO 33 FEW QUARTZ PIECES W/
									VBR	VUGS. SL. MICACEOUS
										VF QUARTZ GRAINS IN MATRIX - 30X MAG.
		35.0								≈34 TO 35 - 2 VERT JOINTS
						M.HARD	GRAY	SILTY SHALE (SILTSTONE)	VBR	35.0-35.5 QUARTZ PIECES
								-FEW QUARTZ	BR	
								SEAMS	VBR	BECOMES SL. CALCAR. @ 37± THIN CALCITE
										LAMINATIONS. WATER STAINED JNTS
									BR	THRUOUT RUN MORE SO 35-37±
	1.0/10.0	③	10%	9.3/10.0					VBR	39.5 → 42.0
										42.7 → 43.0 HI ∠ JNT
									BR	42.4 → 42.7 VERT JNT
		45.0							VBR	
										45.3 → 45.5 VERT JNT. & VBR
										47.5 VERT JOINT
									BR	48. HI ∠ JOINT
										SLIGHTLY CALCAREOUS MORE CALCITE
										PRESENT

REMARKS

BORING MW 3A

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* See Legend on Back

BORING LOG — **NUS CORPORATION**

PROJECT: HEBELKA SITE — BORING NO.: MW 3A
PROJECT NO.: 619Y — DATE: 9-22-87 — DRILLER: B. GOLLIHUE
ELEVATION: — FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA: (Date, Time & Conditions)

SAMPLE NO & TYPE	DEPTH (ft.)	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS
1.9/10.0	4	19%	10.0/10.0		M. HARD	GRAY	SILTY SHALE (SILTSTONE)	VBR	50.5 → 51.0 VBR
							SL. CALCAREOUS	BR	51.5 → 54.0 BR w/ SEV LO & JOINTS
	55.0								
								VBR	POOR RECOVERY w/ SOFT ZONES.
0/10	5	0%	1.8/10.0						
	65.0			66					
									68.0 - DRILLER NOTED SOFT AREA - LOSS OF 1/3 OF WATER - CHANGE IN COLOR OF DRILL WATER TO YELLOW BROWN
0/0	6	0%	1.3/10.0						POOR RECOVERY
									FEW CALCAREOUS ZONES.
	75.0			76					

REMARKS AT 75' @ 1:45 PM - PULLING TOOLS - TO REAM HOLE. AT 1:50 PM. CORED HOLE TO 75' REAMED TWICE DUE TO RUNNING SAND (FRACTURE) AT ≈ 68. REAMED 2ND TIME TO 81'. SET WELL 66'-76'.

BORING MW 3A

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* See Legend on Back

EXHIBIT 4-6

BORING LOG — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO: MW 013
PROJECT NO.: 473 Y — DATE: 7-7-87 — DRILLER: B ERICSON
ELEVATION: 1462.37 — FIELD GEOLOGIST: S.J. CONTI — PENN-DRILL
WATER LEVEL DATA (Date, Time & Conditions): 5.54' @ 8:50 AM 7-23-87 T-PVC — ACKER AD-II

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, Ft.) OR SCREEN INT.	MATERIAL DESCRIPTION: SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK OR BEDDINGS USCS	REMARKS (HNU) (HEAD SP)
	0.0	5 / 3	1.4/1.5		LOOSE	BLK BRN	CLAYEY SILT AND CINDER	ML	MOIST (0PPM)
S-1		2					TR-COAL FRAG		3/4" Φ FRAG - NEAR OLD
							TR-CC FRAG		R.R. LINE.
							(FILL)		
	5.0					RED			
S-2		1 / 1	1.3/1.5	6.0	V. LOOSE	BRN TO GRAY	SANDY SILT - TR ORG TO	SM	MOIST TO WET (0PPM)
	6.5	3					SILTY SAND - TR GRAVEL		GRAY SAND @ 6'±
									MICACEOUS LOOKS NATURAL
									DRILLER NOTE H2O
	10.0								8-10'
S-3		11 / 23	1.2/1.5		DENSE	BRN	SILTY SAND AND S.S.	GM	WET (0PPM)
	11.5	27					FRAGS. (GRAVEL)		1" Φ SIZE MAX SIZE
									SUBANGULAR TO SUBROUNDED GRAVEL
	15.0								
S-4		9 / 47	1.0/1.5		V. DENSE	BRN	SILTY FINE TO C. SAND	SM	WET (0PPM)
	16.5	43					AND GRAVEL		1" Φ SIZE MAX SIZE
									SUBANGULAR TO SUBROUNDED GRAVEL
	20.0								
S-5	20.9	17 / 50/4"	.6/.9		V. DENSE	DRAB BRN	SILTY SAND - SOME	GM	WET (0PPM)
							GRAVEL AND		MOIST
							S.S FRAGS		BECOMES MORE LIKE SANDY SILT AT BOTM OF SAMPLE

REMARKS: START @ 1:15 PM - 7-7-87 USING 4 1/4" ID HOLLOW STEMS
S-4 @ 3:30 PM ± TO ADVANCE THE BORING USING
S-5 @ 4:30 PM ACKER DRILL - MOUNTED ON FORD 8000 TRUCK

SAMPLES TAKEN USING 140 lb WT AND 30 INCH DROP.

BORING MW 013
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BORING LOG — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO.: MW013
PROJECT NO.: 473Y — DATE: 7-7-87 — DRILLER: Y. ERICSON
ELEVATION: — FIELD GEOLOGIST: S.J. CONTI
WATER LEVEL DATA:
(Date, Time & Conditions)

	SAMPLE NO. & TYPE OR RQD	DEPTH (ft) OR RUN NO	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.) OR SCREEN INT	MATERIAL DESCRIPTION: SOIL DENSITY, CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BRKNESS USCS	REMARKS (HNU)
	S-6	25.0	6 / 17	1.1/1.5		DENSE	OLIVE BLUE	SILTY SAND - SOME	GM	WET OPPM
		26.5	30				GRAY	GRAVEL - TR CLAY		C.S. IS FRIABLE FIRST CHANGE IN
								TR. SS. FRAG		COLOR. NOT ENOUGH CLAY TO BE CONFINING
										NOTE: MAY SET ZONE 2
7/7		30.0					MOTTLD			CASING @ 28'
7/8	S-7		17 / 27	1.4/1.5		V. DENSE	BRN BLUE	SILTY SAND - SOME GRAVEL	SM/GM	MOIST → WET (OPPM)
		31.5	36				GRAY	TR SS FRAG		CAUTIONS IS BLUE
								TR CLAY		GRAY & FRIABLE. SUBROUNDED GRAVEL
										NOT MUCH CLAY - BUT MAY BE SEMI-CON-
		35.0								FINING.
	S-8	35.9	30 / 50/.4	0.7/0.9		V. DENSE	BLUE GRAY	SILTY F. TO C. SAND -	SM/GM	MOIST → WET (OPPM)
								SOME GRAVEL		V. SL. TR CLAY - LESS
								TR. SS. FRAG.		THAN S-7 1" Φ FRAG - MORE
										COARSE SAND THAN ABOVE.
		40.0					BLUE			POSSIBLE 35 TO 45 SCREEN LOC. SQUEEZED
	S-9		31 / 34	1.2/1.5		V. DENSE	BRN GRAY	SILTY SAND (FINE TO M.)	SM	HOLDS TOGETHER WHEN MOIST → WET (OPPM)
		41.5	24					SOME GRAVEL - TR	SM/GM	LITTLE MORE CLAY THAN
								CLAY		S-8 SUBROUNDED GRAVEL
										VERY SLOW DRILLING 40-45 (RIG STALLS)
		45.0					BLUE			LESS CLAY LAST 3" OF SAMPLE
	S-10		13 / 34	1.2/1.5		V. DENSE	BRN GRAY	SILTY SAND (FINE TO M.)	SM/	MOIST → WET (OPPM)
		46.5	50					SOME GRAVEL - TR	?GM	1" Φ SIZE - HOLDS TO- GETHER WHEN SQUEEZ'D
								CLAY		BUT NOT COHESIVE CLASS- IFICATION
										SLOW DRILLING TO 50'

REMARKS S-6 @ 4:40 PM
S-8 @ 8:36 AM 7-8-87
S-10 @ 10:40 AM S-11 @

BORING MW013

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BORING LOG — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO.: MW 013
PROJECT NO.: 473Y — DATE: 7-8-87 — DRILLER: B. ERICSON
ELEVATION: — FIELD GEOLOGIST: S. CONTI
WATER LEVEL DATA: (Date, Time & Conditions)

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.) OR SCREEN INT	MATERIAL DESCRIPTION: SOIL DENSITY/CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK OR BROKEN ROCK USCS	REMARKS
S-11	50.0	15 / 41	1.9/1.3		V. DENSE	MOTTLED BLUE	SILTY SAND - SOME GR.	GMY	MOIST - (OPPM)
	51.3	50/3				GRAY	TR CLAY	SM	MOTTLED W/ PCS OF BLACK COAL/LIGNITE
									MORE CLAY THAN ABOVE PORTIONS OF SAMPLE - COHESIVE CLASSIF.
	55.0			55.0					
S-12		11 / 15	1.1/1.5		V. STIFF TO STIFF	GRAY ORANG BRN	SANDY CLAY / CLAYEY SAND	SC	MOIST → WET (OPPM)
	56.5	26					SOME GRAVEL		NOTE COLOR CHANGE ALSO - MORE CLAY THAN ANY SAMPLE; SUB-ROUNDED GRAINS
									FIRST COHESIVE TYPE CLASSIF.
	60.0	40							
S-13	60.9	50/.4	0.7/0.9		V. DENSE	ORANG BRN	SANDY CLAY / CLAYEY SAND - SOME	SC	MOIST → WET (OPPM)
							GRAVEL	GW	NOT AS MUCH CLAY AS S-12 BUT VERY COMPACT. SUBROUNDED GRAINS
									SET CAS. @ 62'.
	65.0								
7/13 S-14	65.8	37 / 50/3	0.7/0.8		V. DENSE	GRN ORANG	SILTY SAND - SOME GR.	SM	MOIST (OPPM)
							AND ROCK FRAG -	GW	MORE CLAY TOWARDS TOP OF SAMPLE MAX 3/4" Ø SIZE
				68.0			TR. CLAY		COLOR CHANGE AT ≈ 68' MORE SAND PER DRILLER - BOTTOM OF SEMI CONF LAYER ?
						YELLOW BRN			
	70.0								
7/14 S-15		39 / 39	1.0/1.5		V. DENSE	YELLOW BRN	CLAYEY SAND (F. TO C.) SOME	SC	MOIST → WET (OPPM)
	71.5	41					GRAVEL - TR	GC	1" MAX GRAVEL
							ROCK FRAG.		MORE GRAVEL @ 72' PER DRILLER

REMARKS: USING HOLLOW STEM TO ADVANCE BORING - WASHING OUT THRU AUGERS, UNTIL NEEDED TO OBTAIN SAMPLE
S-12 @ 1:46 pm
S-13 → 3:32 pm - LOGGED IN BY 3:47 PM
SET 6" Ø STEEL CASING TO 62' - WILL DRILL BELOW CASING AFTER GROUT SETS UP. S-14 @ 3:00 PM 7-13-87
S-15 - 7:57 AM 7-14-87

BORING MW 013
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BORING LOG — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO.: MW013
PROJECT NO.: 437Y — DATE: 7-13-87 / 7-14-87 — DRILLER: B. ERICSON
ELEVATION: — FIELD GEOLOGIST: S.J. CONTI
WATER LEVEL DATA:
(Date, Time & Conditions)

SAMPLE NO. & TYPE OR RQD	DEPTH (ft.) OR RUN NO	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.) OR SCR. INT	MATERIAL DESCRIPTION: SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	BROKENNESS ROCK OR USCS	REMARKS (HNU)
S-16	75.0	28 50/.5	0.9/1.0	75	V. DENSE	GRAY ORANG BRN	FINE TO C. CLAYEY SAND - SOME	GC	WET (0PPM)
	76.0						GRAVEL - TR		NOT AS MUCH CLAY AS S-15 - BOTM OF SAMPLE BECOMES MORE SANDY MAX 1" ⌀ PC.
							ROCK FRAG (S.S.)		
	80.0								NO SAMPLE @ 80' - DECIDED TO GO TO 85'.
	85.0	50/.4	0.4/0.4		V. DENSE	GRAY ORANG BRN	SILTY F. TO C. SAND - SOME	GW	WET (0PPM)
S-17	85.4			85			GRAVEL - TR		SUBROUNDED GRAINS
							S.S. FRAG - TR		V. SL TR CLAY - WILL SET SCREEN ≈ 75' TO 85' IN THIS BORING.
							CLAY		
							BOTM OF HOLE @ 85.0'		

REMARKS: S-17 @ 2:20 PM 7-14-87 - METHOD BEHIND 6" CASING SPUN 4" ⌀ - 5 7/8" OD SPOONS TO BOTM. USING WATER AS DRILLING FLUID

BORING MW 013

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NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-1.6	Page 1 of 3
		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Earth Sciences	
Subject DECONTAMINATION OF DRILLING RIGS AND MONITORING WELL MATERIALS		Approved D. Senovich	

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1.0 PURPOSE

2.0 SCOPE

3.0 GLOSSARY

4.0 RESPONSIBILITIES

5.0 PROCEDURES

6.0 RECORDS

1.0 PURPOSE

The purpose of this procedure is to provide reference information regarding the appropriate procedures to be followed when conducting decontamination activities of drilling equipment and monitoring well materials used during field investigations.

2.0 SCOPE

This procedure addresses only drilling equipment and monitoring well materials decontamination, and shall not be considered for use with chemical sampling and field analytical equipment decontamination.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for ensuring that project specific plans and the implementation of field investigations are in compliance with these procedures.

5.0 PROCEDURES

To insure that analytical chemical results are reflective of the actual concentrations present at sampling locations, various drilling equipment involved in field investigations must be properly decontaminated. This will minimize the potential for cross-contamination between sampling locations, and the transfer of contamination off site.

Prior to the initiation of a drilling program. all drilling equipment involved in field sampling activities shall be decontaminated by steam cleaning at a predetermined area. The steam cleaning procedure shall be performed using a high-pressure spray of heated potable water producing a pressurized stream of steam. This steam shall be sprayed directly onto all surfaces of the various equipment which might contact environmental sample. The decontamination procedure shall be performed until all equipment is free of all visible potential contamination (dirt, grease, oil, noticeable odors, etc.) In addition, this decontamination procedure shall be performed at the completion of each sampling and/or drilling location, including soil borings, installation of monitoring wells, test pits, etc. Such equipment shall include drilling rigs, backhoes, downhole tools, augers, well casings, and screens.

The steam cleaning area shall be designed to contain decontamination wastes and waste waters, and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided which is connected to a holding facility. A shallow above-surface tank may be used or a pumping system with discharge to a waste tank may be installed.

In certain cases, due to budget constraints, such an elaborate decontamination pad is not possible. In such cases, a plastic lined gravel bed pad with a collection system may serve as an adequate decontamination area. The location of the steam cleaning area shall be on site in order to minimize potential impacts at certain sites.

Guidance to be used when decontaminating equipment shall include:

- As a general rule, any part of the drilling rig which extends over the borehole, shall be steam cleaned.
- All drilling rods, augers, and any other equipment which will be introduced to the hole shall be steam cleaned.
- The drilling rig, all rods and augers, and any other potentially contaminated equipment shall be decontaminated between each well location to prevent cross contamination of potential hazardous substances.

Rinsate samples of well casing and screens may be necessary if specifically required for a given site. If required, at least 1 percent, and no more than 5 percent of steam cleaned lengths of casing and screens combined shall be sampled.

Prior to leaving at the end of each work day and/or at the completion of the drilling program, drilling rigs and transport vehicles used onsite for personnel or equipment transfer shall be steam cleaned. A drilling rig left at the drilling location does not need to be steam cleaned until it is finished drilling at that location.

6.0 RECORDS

None.

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-1.6	Page 1 of 3
		Effective Date 05/04/90	Revision 2
		Applicability EMG	
		Prepared Earth Sciences	
Subject DECONTAMINATION OF DRILLING RIGS AND MONITORING WELL MATERIALS		Approved D. Senovich	

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6.0 RECORDS

None.

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-1.7	Page 1 of 17
		Effective Date 05/04/90	Revision 1
		Applicability EMG	
		Prepared Earth Sciences	
Subject GROUNDWATER MONITORING POINT INSTALLATION		Approved D. Senovich	

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- 5.2 WELL DESIGN
- 5.2.1 Well Depth, Diameter, and Monitored Interval
- 5.2.2 Riser Pipe and Screen Materials
- 5.2.3 Annular Materials
- 5.2.4 Protective Casing
- 5.3 MONITORING WELL INSTALLATION
- 5.3.1 Monitoring Wells in Unconsolidated Sediments
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- 5.3.3 Bedrock Monitoring Wells
- 5.3.4 Drive Points
- 5.3.5 Innovative Monitoring Well Installation Techniques
- 5.4 WELL DEVELOPMENT METHODS

6.0 REFERENCES

7.0 RECORDS

1.0 PURPOSE

This procedure describes methods for proper monitoring well design, installation, and development.

2.0 SCOPE

This procedure is applicable to the construction of permanent monitoring wells at hazardous waste sites. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many regulatory agencies have specific regulations pertaining to monitoring well construction and permitting. These requirements must be ascertained during the development of the investigation and any required permits which may have to be obtained before field work begins. Innovative monitoring well installation techniques, which typically are not used, will be discussed only generally in this procedure.

3.0 GLOSSARY

Monitoring Well - A well which is properly screened (if screening is necessary), cased, and sealed which is capable of providing a groundwater level and groundwater sample representative of the zone being monitored.

Piezometer - A pipe or tube inserted into the water bearing zone, typically open to water flow at the bottom and to the atmosphere at the top, and used to measure water level elevations. Piezometers may range in size from 1/2-inch diameter plastic tubes to well points or monitoring wells.

Potentiometric Surface - The surface to which water in an aquifer would rise by hydrostatic pressure.

Well Point (Drive Point) - A screened or perforated tube (Typically 1-1/4 or 2 inches in diameter) with a solid, conical, hardened point at one end, which is attached to a riser pipe and driven into the ground with a sledge hammer, drop weight, or mechanical vibrator. Well points may be used for groundwater injection and recovery, as piezometers (i.e., to measure water levels) or to provide groundwater samples for water quality data.

4.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force to perform all phases of proper monitoring well installation and construction. He may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

Rig Geologist - The rig geologist supervises well installation and construction by the Driller, documents all phases of well installation and construction, and insures that well construction is adequate to provide representative ground water data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

5.0 PROCEDURES

5.1 EQUIPMENT/ITEMS NEEDED

Below is a list of items that may be needed while installing a monitoring well.

- Health and safety equipment as required by the site safety officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineers tape, water level indicator, retractable engineers rule electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).
- Drive point installations tools (Sledge Hammer, drop hammer, or mechanical vibrator; tripod, pipe wrenches, drive points, riser pipe, and end caps).

5.2 WELL DESIGN

The objectives for each monitoring well and its intended use must be clearly defined before the monitoring system is designed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well design, attention must be given to clearly documenting the basis for design decisions, the details of well construction, and the materials to be used. The objectives for installing the monitoring wells may include:

- Determining groundwater flow directions and velocities.
- Sampling or monitoring for trace contaminants.
- Determining aquifer characteristics (e.g., hydraulic conductivity)

Siting of monitoring wells shall be performed after a preliminary estimation of the groundwater flow direction. In most cases, these can be determined through the review of geologic data and the site terrain. In addition, production wells or other monitoring wells in the area may be used to determine the groundwater flow direction. If these methods cannot be used, piezometers, which are relatively inexpensive to install, may have to be installed in a preliminary phase to determine groundwater flow direction.

5.2.1 Well Depth, Diameter, and Monitored Interval

The well depth, diameter, and monitored internal must be tailored to the specific monitoring needs of each investigation. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. Wells of different depth, diameter, and monitored interval can be employed in the same groundwater monitoring system. For instance, varying the monitored interval in several wells, at the same location (cluster wells) can help to determine the vertical gradient and the levels at which contaminants are present. Conversly, a fully penetrating well is usually not used to quantify or vertically locate a contamination plume, since groundwater samples collected in wells that are screened over the full thickness of the water bearing zone will be representative of average conditions across the entire monitored interval. However, fully penetrating wells can be used to establish the existence of

contamination in water bearing zone. The well diameter would depend upon the hydraulic characteristics of the water bearing zone. Sampling requirements, drilling method and cost.

The decision concerning the monitored interval and well depth is based on the following information:

- The vertical location of the contaminant source in relation to the water bearing zone.
- The depth, thickness and uniformity of the water bearing zone.
- The anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume.
- Fluctuation in groundwater levels (due to pumping, tidal influences, or natural recharge/discharge events).
- The presence and location of contaminants encountered during drilling.
- Whether the purpose of the installation is for determining existence or non-existence of contamination or if a particular stratigraphic zone is being investigated.
- The analysis of borehole geophysical logs.

In most situations where groundwater flow lines are horizontal, depending on the purpose of the well and the site conditions, monitored intervals are 20 feet or less. Shorter screen lengths (1 to 2 feet) are usually required where flow lines are not horizontal, (ie., if the wells are to be used for accurate measurement of the potentiometric head at a specific point).

Many factors influence the diameter of a monitoring well. The diameter of the monitoring well depends on the application. In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling.
- Drilling methodology.
- Type of sampling device to be used.
- Costs

Standard monitoring well diameters are 2, 4, 6, or 8 inches. However, drive points are typically 1-1/4 or 2 inches in diameter. For monitoring programs which require screened monitoring wells, either a 2-inch or 4-inch diameter well is preferred. Typically, well diameters greater than 4 inches are used in monitoring programs in which open hole monitoring wells are required. In the smaller diameter wells, the volume of stagnant water in the well is minimized, and well construction costs are reduced, however, the type of sampling devices that can be used are limited. In specifying well diameter, sampling requirements must be considered. Up to a total of 4 gallons of water may be required for a single sample to account for full organic and inorganic analyses, and split samples. The water in the monitoring well available for sampling is dependent on the well diameter as follows:

Casing Inside Diameter, Inch	Standing Water Depth to Obtain 1 Gal Water (feet)	Total Depth of Standing Water for 4 Gal. (feet)
2	6.13	25
4	1.53	6
6	0.68	3

However, if a specific well recharges quickly after purging, then well diameter may not be an important factor regarding sample volume requirements.

Pumping tests for determining aquifer characteristics may require larger diameter wells; however, in small diameter wells.in-situ permeability tests can be performed during drilling or after well installation is completed.

5.2.2 Riser Pipe and Screen Materials

Well materials are specified by diameter, type of material, and thickness of pipe. Well screens require an additional specification of slot size. Thickness of pipe is referred to as "schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 (thinner wall) or 80 (thicker wall). Steel pipe thickness is often referred to as "Strength" and Standard Strength is usually adequate for monitoring well purposes. With larger diameter pipe, the wall thickness must be greater to maintain adequate strength. The required thickness is also dependent on the method of installation;-risers for drive points require greater strength than wells installed inside drilled borings.

The selection of well screen and riser materials depends on the method of drilling, the type of subsurface materials in which the well penetrates, the type of contamination expected, and natural water quality and depth. Cost and the level of accuracy required are also important. The materials generally available are Teflon, stainless steel, PVC, galvanized steel, and carbon steel. Each has advantages and limitations (see Attachment A of this guideline for an extensive discussion on this topic). The two most commonly used materials are PVC and stainless steel for wells in which screens are installed and are compared in Attachment B. Stainless steel is preferred where trace metals or organic sampling is required; however, costs are high. Teflon materials are extremely expensive, but are relatively inert and provide the least opportunity for water contamination due to well materials. PVC has many advantages, including low cost, excellent availability, light weight, and ease of manipulation; however, there are also some questions about organic chemical sorption and leaching that are currently being researched (see Barcelona et al., 1983). Concern about the use of PVC can be minimized if PVC wells are used strictly for geohydrologic measurements and not for chemical sampling. The crushing strength of PVC may limit the depth of installation, but schedule 80 materials normally used for wells greater than 50 feet deep may overcome some of the problems associated with depth. However, the smaller inside diameter of Schedule 80 pipe may be an important factor when considering the size of bailers or pumps to be used for sampling or testing. Due to this problem, the minimum well pipe size recommended for schedule 80 wells is 4 inch I.D.

Screens and risers may have to be decontaminated before use because oil-based preservatives and oil used during thread cutting and screen manufacturing may contaminate samples. Metal pipe, may corrode and release metal ions or chemically react with organic constituents, but this is considered by some to be less of a problem than the problem associated with PVC material. Galvanized steel is not recommended for metal analyses, as zinc and cadmium levels in groundwater samples may be elevated from the zinc coating.

Threaded, flush-joint casing is most often preferred for monitoring well applications. PVC, Teflon, and steel can all be obtained with threaded joints at slightly more costs. Welded-joint steel casing is also acceptable. Glued PVC may release organic contamination into the well and therefore should not be used if the well is to be sampled for organic contaminants.

When the water bearing zone is in consolidated bedrock, such as limestone or fractured granite, a well screen is often not necessary (the well is simply an open hole in bedrock). Unconsolidated materials, such as sands, clay, and silts require a screen. A screen slot size of 0.010 or 0.020 inch is generally used when a screen is necessary and the screened interval is artificially packed with a fine sand. The slot size controls the quantity of water entering the well and prevents entry of natural materials or sand pack. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material. The rig geologist shall specify the combination of screen slot size and sand pack which will be compatible with the water bearing zone, to maximize groundwater inflow and minimize head losses and movement of fines into the wells. (For example, as a standard procedure, a Morie No. 1 or Ottowa sand may be used with a 0.010-inch slot screen, however, with a 0.020-inch slot screen, the filter pack material must be the material retained on a No. 20 to No. 30 U.S. standard sieve.)

5.2.3 Annular Materials

Materials placed in the annular space between the borehole and riser pipe and screen include a sand pack when necessary, a bentonite seal, and cement-bentonite grout. The sand pack is usually a fine to medium grained well graded, silica sand. The quantity of sand placed in the annular space is dependent upon the length of the screened interval but should always extend at least 1 foot above the top of the screen. At least one to three feet of bentonite pellets or equivalent shall be placed above the sand pack. The cement-bentonite grout or equivalent extends from the top of the bentonite pellets to the ground surface.

On occasion, and with the concurrence of the involved regulatory agencies, monitoring wells may be packed naturally, i.e., no artificial sand pack will be installed, and the natural formation material will be allowed to collapse around the well screen after the well is installed. This method has been utilized where the formation material itself is a relatively uniform grain size, or when artificial sand packing is not possible due to borehole collapse.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward, to prevent bridging and to provide a better seal. However, in boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite pellet seal. Grout, most of the time, is made up of two assemblages of material, i.e., a cement-bentonite grout. A cement bentonite grout normally is a mixture of cement, bentonite and water at a ratio of one 90-pound bag of Portland Type I cement, 3-5 pounds of granular or flake-type bentonite and 6 gallons of water. A neat cement is made up of one ninety-pound bag of Portland Type I cement and 6 gallons of water.

In certain cases, the borehole may be drilled to a depth greater than the anticipated well installation depth. For these cases, the well shall be backfilled to the desired depth with bentonite pellets or equivalent. A short (1'-2') section of capped riser pipe sump is sometimes installed immediately below the screen, as a silt reservoir, when significant post-development silting is anticipated. This will ensure that the entire screen surface remains unobstructed.

5.2.4 Protective Casing

When the well is completed and grouted to the surface, a protective steel casing is often placed over the top for the well. This casing generally has a hinged cap and can be locked to prevent vandalism. A vent hole shall be provided in the cap to allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

A Protective casing which is level with the ground surface is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the riser pipe is placed 4 to 5 inches below the pavement, and a locking protective casing is cemented in place to 3 inches below the pavement. A large diameter protective sleeve is set into the wet cement around the well with the top set level with the pavement. A manhole type lid placed over the protective sleeve. The cement should be slightly mounded to direct pooled water away from the well head.

5.3 MONITORING WELL INSTALLATION

5.3.1 Monitoring Wells in Unconsolidated Sediments

After the borehole is drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing, and continue as the temporary casing is withdrawn from the borehole. In the case of hollow stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe are lowered into the borehole, all pipe and screen sections should be measured with an engineers rule to ensure proper well placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe are lowered through the temporary casing, then the sand pack can be installed. A weighted tape measure must be used during the procedure in order to carefully monitor installation progress. The sand is poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal in order to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater than 1 foot above the bottom of the casing) bridging between the temporary casing and riser pipe may occur.

After the sand pack is installed to the desired depth, (at least 1 foot above the top of the screen) then the bentonite pellet seal or equivalent, can be installed, in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack.

The cement-bentonite grout is then mixed and either poured or tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed as detailed in Section 5.2.4.

In stable formations where borehole collapse does not occur, the well can be installed as discussed above, and the use of a temporary casing is not needed. However, centralizers may have to be installed, one above, and one below the screen, to assure enough annular space for sand pack placement. A typical overburden monitoring well sheet is shown.

5.3.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large diameter boring through the upper aquifer, 1 to 3 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting the outer casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for installation of the monitoring well as detailed for overburden monitoring wells, with the exception of not using a temporary casing during installation. Sufficient time which will be determined by the rig geologist; must be allowed for setting of the grout prior to drilling through the confined layer. A typical confining layer monitoring well sheet is shown in Attachment C.

5.3.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5 feet into the bedrock. A casing (typically steel) is installed and either pressure grouted or tremie grouted in place. After the grout is cured, a smaller diameter boring is continued through the bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. However, if a screen is to be used, then the casing which is installed through the overburden and into the bedrock does not require grouting and can be installed temporary until final well installation is completed. Typical well construction forms for bedrock monitoring wells are shown in Attachment C.

5.3.4 Drive Points

Drive points can be installed with either a sledge hammer, drop hammer, or a mechanical vibrator. The screen is threaded and tightened onto the riser pipe with pipe wrenches. The drive point is simply pounded into the subsurface to the desired depth. If a heavy drop hammer is used, then a tripod and pulley setup is required to lift the hammer. Drive points typically cannot be driven to depths exceeding 10 feet.

5.3.5 Innovative Monitoring Well Installation Techniques

Certain innovative sampling devices have proven advantageous. These devices are essentially screened samplers installed in a borehole with only one or two small-diameter tubes extending to the surface. Manufacturers of these types of samplers claim that four samplers can be installed in a 3-inch diameter borehole. This reduces drilling costs, decreases the volume of stagnant water, and provides a sampling system that minimizes cross contamination from sampling equipment. These samplers also perform well when the water table is within 25 feet from the surface (the typical range of suction pumps). Two manufacturers of these samplers are Timco Manufacturing Company, Inc., of

Prairie du Sac, Wisconsin, and BARCAD Systems, Inc., of Concord, Massachusetts. Each offers various construction materials.

Two additional types of multilevel sampling systems have been developed. Both employ individual screened openings through a small-diameter casing. One of these systems (marketed by Westbay Instruments Ltd. of Vancouver, British Columbia, Canada) uses a screened port and a sampling probe to obtain samples and head measurements or perform permeability tests. this system allows sampling ports at intervals as close as 5 feet, if desired, in boreholes from 3 to 4.8 inches in diameter.

The other system, developed at the University of Waterloo at Waterloo, Ontario, Canada, requires field assembly of the individual sampling ports and tubes that actuate a simple piston pump and force the samples to the surface. Where the depth to ground water is less than 25 feet, the piston pumps are not required. The assembly is made of easily obtained materials; however, the cost of labor to assemble these monitoring systems may not be cost-effective.

5.4 WELL DEVELOPMENT METHODS

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water is removed from the well. Sequential measurements of pH, conductivity and temperature taken during development may yield information (stabilized values) that sufficient development is reached. The selection of the well development method (shall) be made by the rig geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation that the well is screened in. The primary methods of well development are summarized below. A more detailed discussion may be found in Driscoll (1986).

Overpumping and Backwashing - Wells may be developed by alternatively drawing the water level down at a high rate (by pumping or bailing) and then reversing the flow direction (backwashing) so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to remove fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods including pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels, or forcing water into the well under pressure through a water-tight fitting ("rawhiding"). Care should be taken when backwashing not to apply too much pressure, which could damage or destroy the well screen.

Surging with a Surge Plunger - A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is used to agitate the water, causing it to move in and out of the screens. This movement of water rpulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Compressed Air - Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus reducing well yield. Surging, or the "open well" method, consists of alternately releasing large volumes of air suddenly into an open well below the water level

to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Pumping the well is subsequently done with the air lift method.

High Velocity Jetting - In the high velocity jetting method, water is forced at high velocities from a plunger-type device and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered along the length of the well screen to develop the entire screened area. Jetting using a hose lowered into the well may also be effective. The fines washed into the screen during this process can then be bailed or pumped from the well.

6.0 REFERENCES

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7.0 RECORDS

A critical part of monitoring well installation is recording of significant details and events in the field notebook. The Geologist must record the exact depths of significant hydrogeological features screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (Attachment C) shall be used which allows the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials shall be recorded. Additional information (shall) include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. The documentation is very important to prevent problems involving questionable sample validity. Somewhat different information will need to be recorded.depending on whether the well is completed in overburden, in a confined layer, in bedrock with a cased well, or as an open hole in bedrock.

The quantities of sand, bentonite, and grout placed in the well are also important. The Geologist shall calculate the annular space volume and have a general idea of the quantity of material needed to fill the annular space. Volumes of backfill significantly higher than the calculated volume may indicate a problem such as a large cavity, while a smaller backfill volume may indicate a cave-in. Any problems with rig operation or down time shall be recorded and may determine the driller's final fee.

ATTACHMENT A

TABLE 7-4 RELATIVE COMPATIBILITY OF RIGID WELL-CASING MATERIAL (PERCENT)

	PVC 1	Galvanized Steel	Carbon Steel	Lo-carbon Steel	Stainless steel 304	Stainless steel 316	Teflon*
Buffered Weak Acid	100	56	51	59	97	100	100
Weak Acid	98	59	43	47	96	100	100
Miner Acid/High Solids	100	48	57	60	80	82	100
Aqueous/Organic Mixtures	64	69	73	73	98	100	100
Percent Overall Rating	91	58	56	59	93	96	100

Preliminary Ranking of Rigid Materials

1 Teflon*
2 Stainless Steel 316
3 Stainless Steel 304
4 PVC 1
5 Lo-Carbon Steel
6 Galvanized Steel
7 Carbon Steel
* Trademark of DuPont

RELATIVE COMPATIBILITY OF SEMI-RIGID OR ELASTOMERIC MATERIALS (PERCENT)

	PVC Flexible	PP	PE Conv.	PE Linear	PMM	Viton***	Silicone	Neoprene	Teflon***
Buffered Weak Acid	97	97	100	97	90	92	87	85	100
Weak Acid	92	90	94	96	78	78	75	75	100
Mineral Acid/High Solids	100	100	100	100	95	100	78	82	100
Aqueous/Organic Mixtures	62	71	40	60	49	78	49	44	100
Percent Overall Rating	88	90	84	88	78	87	72	72	100

Preliminary Ranking of Semi-Rigid or Elastomeric Materials

1 Teflon*
2 Polypropylene (PP)
3 PVC flexible/PE linear
4 Viton*
5 PE Conventional
6 Plexiglas/Lucite (PMM)
7 Silicone/Neoprene
Source: Barcelona et al., 1983
* Trademark of DuPont

ATTACHMENT B

COMPARISON OF STAINLESS STEEL AND PVC FOR MONITORING WELL CONSTRUCTION

Characteristic	Stainless Steel	PVC
Strength	Use in deep wells to prevent compression and closing of screen/riser.	Use when shear and compressive strength not critical.
Weight	Relatively heavier	Lightweight, floats in water
Cost	Relatively expensive	Relatively inexpensive
Corrosivity	Deteriorates more rapidly in corrosive water	Non-corrosive—may deteriorate in presence of ketones, aromatics, alkyl sulfides, or some chlorinated HC
Ease of Use	Difficult to adjust size or length in the field.	Easy to handle and work in the field.
Preparation for Use	Should be steam-cleaned for organics sampling	Never use glue fittings—pipes should be threaded or pressure-fitted. Should be steam cleaned if used for monitoring wells.
Interaction with Contaminants*	May sorb organic or inorganic substances when oxidized	May sorb or release organic substances.

* See also Attachment A.

ATTACHMENT C

NUS CORPORATION
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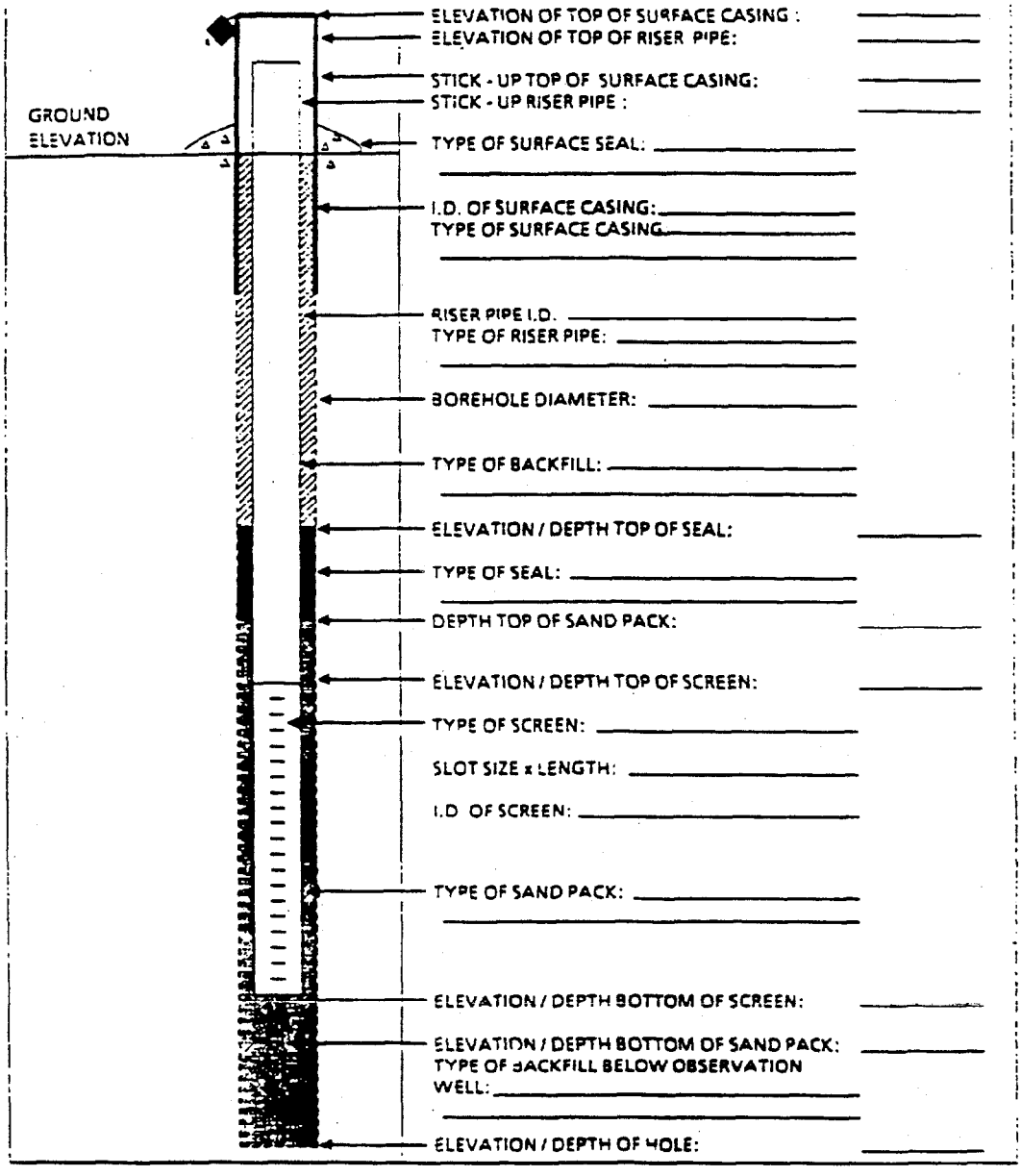
BORING NO _____

OVERBURDEN MONITORING WELL SHEET

PROJECT _____ LOCATION _____ DRILLER _____
PROJECT NO. _____ BORING _____ DRILLING METHOD _____
ELEVATION _____ DATE _____ DEVELOPMENT METHOD _____
FIELD GEOLOGIST _____



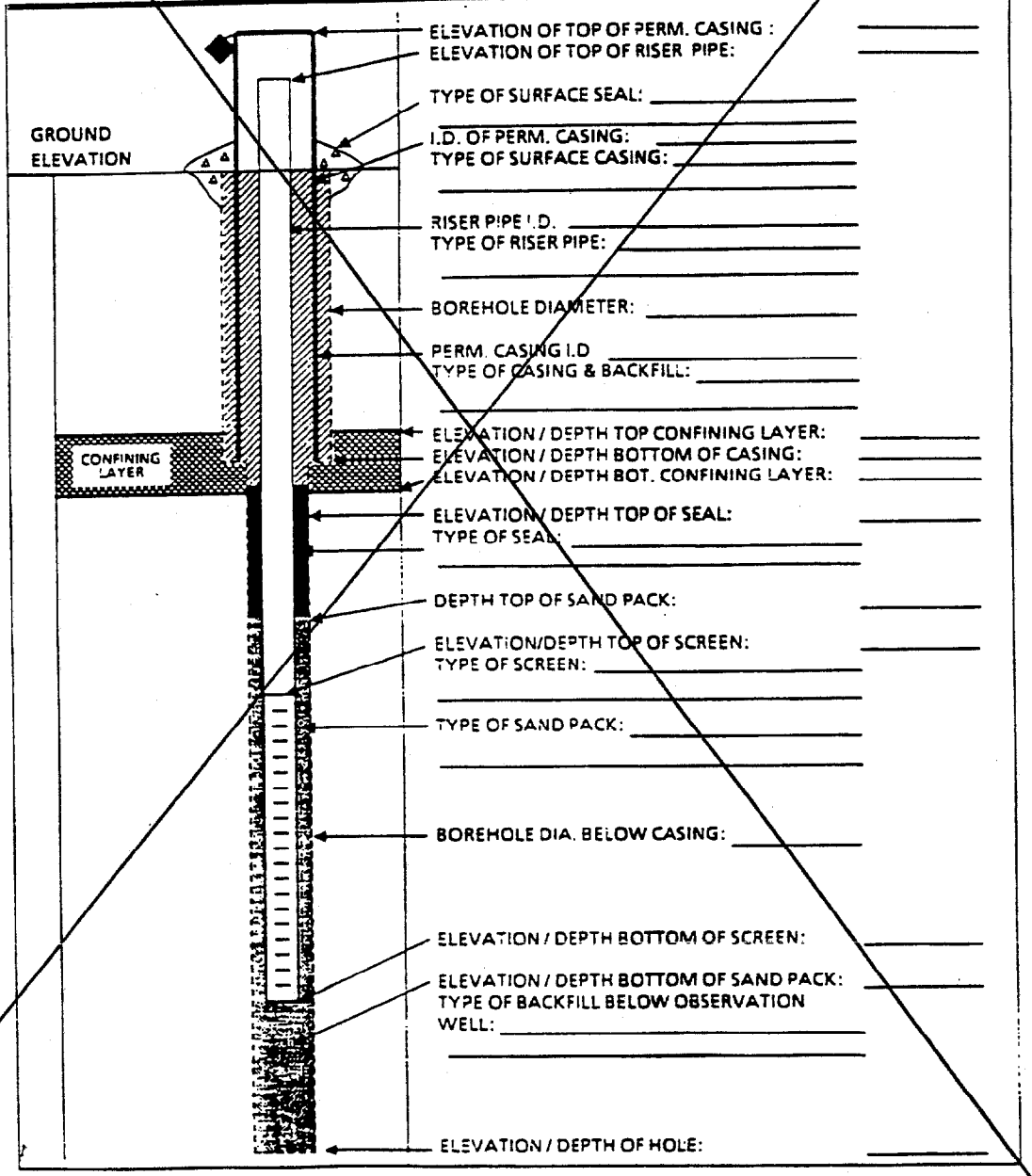
ATTACHMENT C
PAGE TWO

NUS CORPORATION

BORING NO.: _____

CONFINING LAYER
MONITORING WELL SHEET

PROJECT _____ LOCATION _____ DRILLER _____
PROJECT NO. _____ BORING _____ DRILLING METHOD _____
ELEVATION _____ DATE _____ DEVELOPMENT METHOD _____
FIELD GEOLOGIST _____



NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number GH-2.5	Page 1 of 10
		Effective Date 05/04/90	Revision 1
		Applicability EMG	
		Prepared Earth Sciences	
Subject WATER LEVEL MEASUREMENT/CONTOUR MAPPING		Approved D. Senovich	

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1.0 PURPOSE

The objective of this procedure is to provide general reference information and technical guidance on the measurement of hydraulic head levels and the determination of the direction of groundwater flow, using contour maps of the water table or the potentiometric surface of an unconfined or confined aquifer.

2.0 SCOPE

This procedure gives overall technical guidance for obtaining hydraulic head measurements in wells (frequently conducted in conjunction with groundwater sampling) and preparation of groundwater contour maps. The specific methods could be modified by requirements of project-specific plans.

3.0 GLOSSARY

Hydraulic Head - The height to which water will rise in a well.

Water Table - A surface in an unconfined aquifer where groundwater pressure is equal to atmospheric pressure (i.e., the pressure head is zero).

Potentiometric Surface - A surface which is defined by the levels to which water will rise in wells which are screened or open in a specified zone of an unconfined or confined aquifer.

Unconfined (water table) Aquifer - An aquifer in which the water table forms the upper boundary.

Confined Aquifer - An aquifer confined between two low permeability layers (aquitards).

Artesian Conditions - A common condition in a confined aquifer in which the water level in a well completed within the aquifer rises above the top of the aquifer.

Flow Net - A diagram of groundwater flow, showing flow lines and equipotential lines.

Flow Line - A line indicating the direction of groundwater movement within the saturated zone. Flow lines are drawn perpendicular to equipotential lines.

Equipotential Line - A contour line on the potentiometric surface or water table showing uniform hydraulic head levels. Equipotential lines on the water table are also called water-table contour lines.

4.0 RESPONSIBILITIES

Project Hydrogeologist - has overall responsibility for obtaining water level measurements and developing groundwater contour maps. The hydrogeologist shall specify the reference point from which water levels are measured (usually a specific point on the upper edge of the inner well casing), the number of data points needed and which wells shall be used for a contour map, and how many complete sets of water levels are required to adequately define groundwater flow directions (e.g., if there are seasonal variations).

Field Personnel - must have a basic familiarity with the equipment and procedures involved in obtaining water levels, and must be aware of any project-specific requirements.

5.0 PROCEDURES

5.1 GENERAL

Groundwater level measurements can be made in monitoring wells, private or public water wells, piezometers, open boreholes, or test pits (after stabilization). Groundwater measurements should generally not be made in boreholes with drilling rods or auger flights present. If groundwater sampling activities are to occur, groundwater level measurements shall take place prior to well evacuation or sampling.

All groundwater level measurements shall be made to the nearest 0.01 foot, and recorded in the geologist's field notebook or on the Groundwater Level Measurement Sheet (Attachment A), along with the date and time of the reading. The total depth of the well shall be measured and recorded, if not already known. Weather changes that occur over the period of time during which water levels are being taken, such as precipitation and bariometric pressure changes, should be noted.

In measuring groundwater levels, there shall be a clearly-established reference point of known elevation, which is normally identified by a mark on the upper edge of the inner well casing. The reference point shall be noted in the field notebook. To be useful, the reference point should be tied in with an established USGS benchmark or other properly surveyed elevation datum. An arbitrary datum could be used for an isolated group of wells if necessary.

Cascading water within a borehole or steel well casings can cause false readings with some types of sounding devices (chalked line, electrical). Oil layers may also cause problems in determining the true water level in a well. Special devices (interface probes) are available for measuring the thickness of oil layers and true depth to groundwater if required.

Water level readings shall be taken regularly, as required by the site hydrogeologist. Monitoring wells or open-cased boreholes that are subject to tidal fluctuations should be read in conjunction with a tidal chart (or preferably in conjunction with readings of a tide staff or tide level recorder installed in the adjacent water body); the frequency of such readings shall be established by the site hydrogeologist. All water level measurements at a site used to develop a groundwater contour map shall be made in the shortest practical time to minimize affects due weather changes, and at least during the same day.

5.2 WATER LEVEL MEASURING TECHNIQUES

There are several methods for determining standing or changing water levels in boreholes and monitoring wells. Certain methods have particular advantages and disadvantages depending upon well conditions. A general description of these methods is presented, along with a listing of various advantages and disadvantages of each technique. An effective technique shall be selected for the particular site conditions by the onsite hydrogeologist.

In most instances, preparation of accurate potentiometric surface requires that static water level measurements be obtained to a precision of 0.01 feet. To obtain such measurements in individual accessible wells, the Chalked Tape or Electrical Water Level Indicator methods have been found best, and thus are the most often utilized. Other, less precise methods, such as the Popper or Bell Sound or Bailer Line methods, may be appropriate for developing preliminary estimates of hydraulic conditions. When a large number of (or continuous) readings are required, time-consuming individual readings are not usually feasible. In such cases, it is best to use the Float Recorder or Pressure Transducer methods. When conditions in the well limit readings (i.e., turbulence in the

water surface or limited access through small diameter tubing), less precise, but appropriate, methods such as the Air Line or Capillary Tubing methods can be used.

5.2.1 Methods

Water levels can be measured by several different techniques, but the same steps shall be followed in each case. The proper sequence is as follows:

1. Check operation of recording equipment above ground. Prior to opening the well, don personal protective equipment as required.

2. Record all information specified below in the geologist's field notebook or on the Groundwater Level Measurement Sheet.

   a. Well number.
   b. Record water level to the nearest 0.01 foot (0.3 cm). Water levels shall be taken from the surveyed reference mark on the top edge of the inner well casing.
   c. Record the time and day of the measurement.

Water level measuring devices with permanently marked intervals shall be used when possible. If water level measuring devices marked by metal or plastic bands clamped at intervals along the measuring line are used, the spacing and accuracy of these bands shall be checked frequently as they may loosen and slide up or down the line, resulting in inaccurate reference points (see Section 5.2.3).

5.2.2 Water Level Measuring Devices

Chalked Steel Tape

The water level is measured by chalking a weighted steel tape and lowering it a known distance (to any convenient whole foot mark) into the well or borehole. The water level is determined by subtracting the wetted chalked mark from the total length lowered into the hole.

The tape shall be withdrawn quickly from the well because water has a tendency to rise up the chalk due to capillary action. A water finding paste may be used in place of chalk. The paste is spread on the tape the same way as the chalk, and turns red upon contacting water.

Disadvantages to this method include the following: depths are limited by the inconvenience of using heavier weights to properly tension longer tape lengths; ineffective if borehole/well wall is wet or inflow is occurring above the static water level; chalking the tape is time consuming; difficult to use during periods of precipitation.

Electric Water Level Indicators

These devices consist of a spool of small-diameter cable and a weighted probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact.

There are a number of commercial electric sounders available, none of which is entirely reliable under all conditions likely to occur in a contaminated monitoring well. In conditions where there is oil on the water, groundwater with high specific conductance, water cascading into the well, steel well casing, or a turbulent water surface in the well, measuring with an electric sounder may be difficult.

For accurate readings, the probe shall be lowered slowly into the well. The electric tape is marked at the measuring point where contact with the water surface was indicated. The distance from the mark to the nearest tape band is measured using an engineer's folding ruler or steel tape and added to the band reading to obtain the depth to water. If band is not a permanent marking band, spacing shall be checked periodically as described in Section 5.2.3.

Popper or Bell Sounder

A bell- or cup-shaped weight that is hollow on the bottom is attached to a measuring tape and lowered into the well. A "plopping" or "popping" sound is made when the weight strikes the surface of the water. An accurate reading can be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight strikes the water. This method is not sufficiently accurate to obtain water levels to 0.01 feet, and thus is more appropriate for obtaining only approximate water levels quickly.

Float Recorder

A float or an electromechanically actuated water-seeking probe may be used to detect vertical changes of the water surface in the hole. A paper-covered recording chart drum is rotated by the up and down motion of the float via a pulley and reduction gear mechanism, while a clock drive moves a recording pen horizontally across the chart. To ensure continuous records, the recorder shall be inspected, maintained, and adjusted periodically. This type of device is useful for continuously measuring periodic water level fluctuations, such as tidal fluctuations or influences of pumping wells.

Air Line

An air line is especially useful in pumped wells where water turbulence may preclude the use of other devices. A small-diameter weighted tube of known length is installed from the surface to a depth below the lowest water level expected. Compressed air (from a compressor, bottled air, or air pump) is used to purge the water from the tube, until air begins to escape the lower end of the tube, and is seen (or heard) to be bubbling up through the water in the well. The pressure needed to purge the water from the air line multiplied by 2.307 (feet of water for 1 psi) equals the length in feet of submerged air line. The depth to water below the center of the pressure gauge can be calculated by subtracting the length of air line below the water surface from the total length of the air line.

The disadvantages to this method include the need for an air supply and lower level of accuracy (unless a very accurate air pressure gauge is used, this method cannot be used to obtain water level readings to the nearest 0.01 ft).

Capillary Tubing

In small diameter piezometer tubing, water levels are determined by using a capillary tube. Colored or clear water is placed in a small "U"-shaped loop in one end of the tube (the rest of the tube contains air). The other end of the capillary tube is lowered down the piezometer tubing until the water in the loop moves, indicating that the water level has been reached. The point is then measured from the bottom of the capillary tube or recorded if the capillary tube is calibrated. This is the best method for very small diameter tubing monitoring systems such as Barcad and other multilevel samples. Unless the capillary tube is calibrated, two people may be required to measure the length of capillary tubing used to reach the groundwater. Since the piezometer tubing and capillary tubing usually are somewhat coiled when installed, it is difficult to accurately measure absolute water level elevations using this method. However, the method is useful in accurately measuring differences or changes in water levels (i.e., during pumping tests).

Pressure Transducer

Pressure transducers can be lowered into a well or borehole to measure the pressure of water and therefore the water elevation above the transducer. The transducer is wired into a recorder at the surface to record changes in water level with time. The recorder digitizes the information and can provide a printout or transfer the information to a computer for evaluation (using a well drawdown/recovery model). The pressure transducer should be initially calibrated with another water level measurement technique to ensure accuracy. This technique is very useful for hydraulic conductivity testing in highly permeable material where repeated, accurate water level measurements are required in a very short period of time. A sensitive transducer element is required to measure water levels to 0.01 foot accuracy.

Borehole Geophysics

~~Approximate water levels can be determined during geophysical logging of the borehole (although this is not the primary purpose for geophysical logging and such logging is not cost-effective if used only for this purpose). Several logging techniques will indicate water level. Commonly-used logs which will indicate saturated/unsaturated conditions include the spontaneous potential (SP) log and the neutron log.~~

Bailer Line Method

~~Water levels can be measured during a bailing test of a well by marking and measuring the bailer line from the bottom of the bailer (where water is first encountered) to the point even with the top of the well casing. This is a useful technique during bailing tests (particularly if recovery is rapid) if the bailer is heard hitting the water. However, it is not recommended for measuring static water levels because it is not usually as accurate as some of the other methods described above.~~

5.2.3 Data Recording

Water level measurements, time, data, and weather conditions shall be recorded in the geologist's field notebook or on the Groundwater Level Measurement Sheet. All water level measurements shall be measured from a known reference point. The reference point is generally a marked point on the upper edge of the inner well casing that has been surveyed for an elevation. The exact reference point shall be marked with permanent ink on the casing since the top of the casing may not be entirely level. It is important to note changes in weather conditions because changes in the barometric pressure may affect the water level within the well.

5.2.4 Specific Quality Control Procedures for Water Level Measuring Devices

All groundwater level measurement devices must be cleaned before and after each use to prevent cross contamination of wells.

Some devices used to measure groundwater levels may need to be calibrated. These devices shall be calibrated to 0.01 foot accuracy periodically. A water level indicator calibration sheet shall be completed each time the measuring device is checked. A water level indicator calibration form is shown in Attachment A. The "actual reading" column on the sheet is the actual length of the interval from the end of the indicator to the appropriate marked depth interval. In many cases, these measurements are different because the water level measuring device is connected to the end of the measuring tape or line, and may extend beyond "0" feet on the measuring line.

5.3 POTENTIOMETRIC SURFACE MAPPING

5.3.1 Selection of Wells

All wells used to prepare a flow net in a plan or map view should represent the same hydrogeologic unit, be it aquifer or aquitard. All water level measurements used shall be collected on the same day.

Before mapping, review the recorded water levels and monitoring-well construction data, site geology and topographic setting to ascertain that the wells are completed in the same hydrogeologic unit and to determine if strong vertical hydraulic gradients may be present. Such conditions will be manifested by a pronounced correlation between well depth and water level, or by a difference in water level between two wells located near each other but set to different depths or having different screen lengths. Professional judgment of the hydrogeologist is important in this decision. If vertical gradients are significant, the data to be used must be limited vertically, and only wells finished in a chosen vertical zone of the hydrogeologic unit can be used.

At least three wells must be used to provide an estimation of the direction of groundwater flow, and many more wells will be needed to provide an accurate contour map. Generally, shallow systems require more wells than deep systems for accurate contour mapping.

5.3.2 Construction of Equipotential Lines

Plot the water elevations in the chosen wells on a site map. Other hydrogeologic features associated with the zone of interest -- such as seeps, wetlands, and surface-water bodies -- should also be plotted along with their elevations.

The data should then be contoured, using mathematically valid and generally accepted techniques. Linear interpolation is most commonly used, as it is the simplest technique. However, quadratic interpolation or any technique of trend-surface analysis or data smoothing is acceptable. Computer-generated contour maps may be useful for large data sets. Contour lines shall be drawn as smooth, continuous lines which never cross one another.

Inspect the contour map, noting known features, such as pumping wells and site topography. The contour lines must be adjusted in accordance with these, utilizing the professional judgment of the hydrogeologist. Closed contours should be avoided unless a known sink exists. Groundwater mounding is common under landfills and lagoons; if the data imply this, the feature must show in the contour plot.

5.3.3 Determination of Groundwater-Flow Direction

Flow lines shall be drawn so that they are perpendicular to equipotential lines. Flow lines will begin at high head elevations and end at low head elevations. Closed highs will be the source of additional flow lines. Closed depressions will be the termination of some flow lines. Care must be used in areas with significant vertical gradients to avoid erroneous conclusions concerning gradients and flow directions.

5.4 HEALTH AND SAFETY CONSIDERATIONS

Groundwater contaminated by volatile organic compounds may release toxic vapors into the air space inside the well pipe. The release of this air when the well is initially opened is a Health/Safety hazard which must be considered. Initial monitoring of the well headspace and breathing zone

concentrations using a PID (HNU) or FID (OVA) and combustible gas meters shall be performed to determine required levels of protection.

6.0 REFERENCES

Freeze, R. A. and J. A. Cherry, 1979. Groundwater. Prentice-Hall, Englewood Cliffs, New Jersey, 604 pp.

Cedergren, H. R., 1977. Seepage, Drainage and Flow Nets (2nd edition). John Wiley and Sons, New York.

Fetter, C. W., 1980. Applied Hydrogeology. Merrill, Columbus, Ohio, 488 pp.

7.0 ATTACHMENTS

Attachment A - Groundwater Level Measurement Sheet

Attachment B - Water Level Indicator Calibration Sheet.

ATTACHMENT A

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____
Project No.: _____
Personnel: _____
Date: _____

LOCATION

Municipality: _____
County: _____
State: _____
Street or Map Location (If Off-Site) _____

WEATHER CONDITIONS

Temperature Range: _____
Precipitation: _____
Barometric Pressure: _____

Equipment No.: _____
Equipment Name: _____
Latest Calibration Date: _____

Tidally-Influenced: [ ] Yes [ ] No

Well or Piezometer Number	Date/Time	Elevation of Reference Point (Feet)*	Water Level Indicator Reading (Feet)*	Adjusted Depth (Feet)*	Groundwater Elevation (Feet)*

* All elevations to nearest 0.01 foot.

ATTACHMENT B

WATER LEVEL INDICATOR CALIBRATION SHEET

Project Name _____ Date _____

Project No. _____

Equipment No. _____

Equipment Name _____

Water Level Indicator Marking (Feet)	Actual Reading* (Feet)
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	
50.0	
55.0	
60.0	
65.0	
70.0	
75.0	
80.0	
85.0	
90.0	
95.0	
100.0	

* Record readings to the nearest 0.01 foot. The actual reading may be different than marking because the water level measuring device (electrode, popper, etc.) may extend beyond the "0" feet mark on the measuring line.

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		Prepared Earth Sciences	
Subject GROUNDWATER SAMPLE ACQUISITION		Approved D. Senovich	

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1.0 PURPOSE

The purpose of this procedure is to provide general reference information on the sampling of groundwater wells. The methods and equipment described are for the collection of water samples from the saturated zone of the subsurface.

2.0 SCOPE

This procedure provides information on proper sampling equipment and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methodology.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Hydrogeologist or Geochemist - responsible for selecting and detailing the specific groundwater sampling techniques and equipment to be used, documenting these in the Project Operations Plan (POP), and properly briefing the site sampling personnel.

Site Geologist - The Site Geologist is primarily responsible for the proper acquisition of the groundwater samples. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians).

Site Manager - The Site Manager is responsible for reviewing the sampling procedures used by the field crew and for performing in-field spot checks for proper sampling procedures.

5.0 PROCEDURES

5.1 GENERAL

To be useful and accurate, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of testing in order to keep any changes in water quality parameters to a minimum.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach shall be followed prior to sample acquisition:

1. All monitoring wells shall be purged prior to obtaining a sample. Evacuation of three to five volumes is recommended for a representative sample. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical.

2. For wells that can be purged to dryness with the sampling equipment being used, the well shall be evacuated and allowed to recover prior to sample acquisition. If the recovery rate is fairly rapid, evacuation of more than one volume of water is preferred.

3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:

- A submersible pump, intake line of a surface pump or bailer shall be placed just below the water surface when removing the stagnant water and lowered as the water level decreases. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. Once this is accomplished a bailer may be used to collect the sample for chemical analysis.

- The inlet line of the sampling pump (or the submersible pump itself) shall be placed near the bottom of the screened section, and approximately one casing volume of water shall be pumped from the well at a rate equal to the well's recovery rate.

Stratification of contaminants may exist in the aquifer formation, both in terms of a concentration gradients due to mixing and dispersion processes in a homogeneous layer, and in layers of variable permeability into which a greater or lesser amount of the contaminant plume has flowed. Excessive pumping can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column at that point, and thus result in the collection of a non-representative sample.

5.2 SAMPLING, MONITORING, AND EVACUATION EQUIPMENT

Sample containers shall conform with EPA regulations for the appropriate contaminants.

The following equipment shall be on hand when sampling ground water wells:

- Sample packaging and shipping equipment - Coolers for sample shipping and cooling, chemical preservatives, appropriate packing containers and filler, ice, labels and chain-of-custody documents.

- Field tools and instrumentation - Thermometer; pH paper/meter; camera and film; tags; appropriate keys (for locked wells); engineers rule; water-level indicator; where applicable, specific-conductivity meter.

- Pumps

  - Shallow-well pumps--Centrifugal, pitcher, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable.

  - Deep-well pumps--submersible pump and electrical power generating unit, or air-lift apparatus where applicable.

- Other sampling equipment - Bailers and monofilament line with tripod-pulley assembly (if necessary). Bailers shall be used to obtain samples for volatile organics from shallow and deep groundwater wells.

- Pails - Plastic, graduated.

- Decontamination solutions - Distilled water, Alconox, methanol, acetone.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, sterilized, and reused, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well flushing and sample collection.

5.3 CALCULATIONS OF WELL VOLUME

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to know the volume of standing water in the well pipe. This volume can be easily calculated by the following method. Calculations shall be entered in the field logbook and on the field data form (Attachment A):

- Obtain all available information on well construction (location, casing, screens, etc.).

- Determine well or casing diameter.

- Measure and record static water level (depth below ground level or top of casing reference point).

- Determine depth of well (if not known from past records) by sounding using a clean, decontaminated weighted tape measure.

- Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

- Calculate one static well volume in gallons ($V = 0.163Tr^2$).

  where:

V	=	Static volume of well in gallons.
T	=	Thickness of water table in the well measured in feet, i.e., linear feet of static water.
r	=	Inside radius of well casing in inches.
0.163	=	A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.

- Determine the minimum amount to be evacuated before sampling.

5.4 EVACUATION OF STATIC WATER (PURGING)

5.4.1 General

The amount of flushing a well shall receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately the well can be pumped until the parameters such as temperature, electrical conductance, and pH have stabilized. Onsite measurements of these parameters shall be recorded on the field data form.

For defining a contaminant plume, a representative sample of only a small volume of the aquifer is required. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce significant groundwater flow from other areas. Generally three to five well volumes are considered effective for purging a well.

The site hydrogeologist, geochemist and risk assessment personnel shall define the objectives of the groundwater sampling program in the Work Plan, and provide appropriate criteria and guidance to the sampling personnel on the proper methods and volumes of well purging.

5.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment B provides guidance on the proper evacuation device to use for given sampling situations. Note that all of these techniques involve equipment which is portable and readily available.

5.4.2.1 Bailers

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers.
- No external power source needed.
- Bailers are inexpensive, and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- There is minimal outgassing of volatile organics while the sample is in the bailer.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.
- Transfer of sample may cause aeration.
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

5.4.2.2 Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, peristaltic, and pitcher pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump (therefore not suitable for well purging) that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. The pitcher pump is a common farm hand-pump.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics. In addition, the complex internal components of these pumps may be difficult to decontaminate.

5.4.2.3 Gas-Lift Samplers

This group of samplers uses gas pressure either in the annulus of the well or in a venturi to force the water up a sampling tube. These pumps are also relatively inexpensive. Gas lift samplers are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation or loss of volatile organics.

5.4.2.4 Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- They may have low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components is difficult and time-consuming.

5.5 SAMPLING

5.5.1 Sampling Plan

The sampling approach consisting of the following, shall be developed as part of the POP prior to the field work:

- Background and objectives of sampling.
- Brief description of area and waste characterization.
- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

- Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.

- Sample preservation requirements.

- Working schedule.

- List of team members.

- List of observers and contacts.

- Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

5.5.2 Sampling Methods

The collection of a groundwater sample is made up of the following steps:

1. HSO or designee will first open the well cap and use volatile organic detection equipment (HNU or OVA) on the escaping gases at the well head to determine the need for respiratory protection.

2. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data in a well sampling data sheet (Attachment A); then calculate the fluid volume in the well pipe.

3. Calculate well volume to be removed as stated in Section 5.3.

4. Select appropriate purging equipment (see Attachment B). If an electric submersible pump with packer is chosen, go to Step 10.

5. Lower purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner. Lower the purging device, as required, to maintain submergence.

6. Measure rate of discharge frequently. A bucket and stopwatch are most commonly used; other techniques include using pipe trajectory methods, weir boxes or flow meters.

7. Observe peristaltic pump intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics. Never collect volatile organics samples using a vacuum pump.

8. Purge a minimum of three-to-five casing volumes before sampling. In low permeability strata (i.e., if the well is pumped to dryness), one volume will suffice.

9. If sampling using a pump, lower the pump intake to midscreen or the middle of the open section in uncased wells and collect the sample. If sampling with a bailer, lower the bailer to sampling level before filling (this requires use of other than a 'bucket-type' bailer).

Purged water shall be collected in a designated container and disposed of in an acceptable manner.

10. (For pump and packer assembly only). Lower assembly into well so that packer is positioned just above the screen or open section and inflate. Purge a volume equal to at least twice the screened interval or unscreened open section volume below the packer before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.

11. In the event that recovery time of the well is very slow (e.g., 24 hours), sample collection can be delayed until the following day. If the well has been bailed early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record in the logbook.

12. Add preservative if required. Label, tag, and number the sample bottle(s).

13. Replace the well cap. Make sure the well is readily identifiable as the source of the samples.

14. Pack the samples for shipping. Attach a custody seal to the front and back of the shipping package. Make sure that traffic reports and chain-of-custody forms are properly filled out and enclosed or attached.

15. Decontaminate all equipment

5.5.3 Sample Containers

For most samples and analytical parameters, either glass or plastic containers are satisfactory.

5.5.4 Preservation of Samples and Sample Volume Requirements

Sample preservation techniques and volume requirements depend on the type and concentration of the contaminant and on the type of analysis to be performed. Procedure SF-1.2 describes the sample preservation and volume requirements for most of the chemicals that will be encountered during hazardous waste site investigations. Procedure SA-4.3 describes the preservation requirement for microbial samples.

5.5.5 Handling and Transporting Samples

After collection, samples shall be handled as little as possible. It is preferable to use self-contained "chemical" ice (e.g., "blue ice") to reduce the risk of contamination. If water ice is used, it shall be bagged and steps taken to ensure that the melted ice does not cause sample containers to be submerged and thus possibly become cross-contaminated. All sample containers shall be enclosed in plastic bags or cans to prevent cross-contamination. Samples shall be secured in the ice chest to prevent movement of sample containers and possible breakage. Sample packing and transportation requirements are described in SA-6.2.

5.5.6 Sample Holding Times

Holding times (i.e. allowed time between sample collection and analysis) for routine samples are given in Procedure SF-1.2.

5.6 RECORDS

Records will be maintained for each sample that is taken. The sample log sheet will be used to record the following information:

- Sample identification (site name, location, project number; sample name/number and location; sample type and matrix; time and date; sampler's identity).
- Sample source and source description.
- Purge data - prior to removal of each casing volume and before sampling, pH, electrical conductance, temperature, color, and turbidity shall be measured and recorded.
- Field observations and measurements (appearance; volatile screening; field chemistry; sampling method).
- Sample disposition (preservatives added; lab sent to, date and time; lab sample number, EPA Traffic Report or Special Analytical Services number, chain-of-custody number.
- Additional remarks - (e.g., sampled in conjunction with state, county, local regulatory authorities; samples for specific conductance value only; sampled for key indicator analysis; etc.).

5.7 CHAIN-OF-CUSTODY

Proper chain-of-custody procedures play a crucial role in data gathering. Procedure SA-6.1 describes the requirements for a correct chain-of-custody.

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7.0 ATTACHMENTS

Attachment A - Well Sampling Data Sheet
Attachment B - Purging Equipment Selection

ATTACHMENT A
SAMPLE LOG SHEET

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SAMPLE LOG SHEET

- ☐ Monitoring Well Data
- ☐ Domestic Well Data
- ☐ Other _____

Page _____ of _____
Case # _____
By _____

Project Site Name _____ Project Site Number _____
NUS Source No. _____ Source Location _____

Total Well Depth:	Purge Data				
Well Casing Size & Depth:	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Static Water Level:					
One Casing Volume:					
Start Purge (hrs.):					
End Purge (hrs.):					
Total Purge Time (min.):					
Total Amount Purged (gal.):					
Monitor Reading:					
Purge Method:					
Sample Method:					
Depth Sampled:					
Sample Date & Time:	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Sampled By:					
Signature(s):	Observations / Notes:				

Type of Sample
- ☐ Low Concentration
- ☐ High Concentration
- ☐ Grab
- ☐ Composite
- ☐ Grab - Composite

Analysis:	Preservative		Organic	Inorganic
		Traffic Report #		
		Tag #		
		AB #		
		Date Shipped		
		Time Shipped		
		Lab		
		Volume		

ATTACHMENT B
PURGING EQUIPMENT SELECTION

Purging Equipment Selection

Diameter Casing	Bailer	Peristaltic Pump	Vacuum Pump	Airlift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-inch								
Water level <25 ft		X	X	X	X			
Water level >25 ft				X				
2-inch								
Water level <25 ft	X	X	X	X	X	X		
Water level >25 ft	X			X		X		
4-inch								
Water level <25 ft	X	X	X	X	X	X	X	X
Water level >25 ft	X			X		X	X	X
6-inch								
Water level <25 ft				X	X		X	X
Water level >25 ft				X			X	X
8-inch								
Water level <25 ft				X	X		X	X
Water level >25 ft				X			X	X

Manufacturer	Model name/ number	Principle of operation	Maximum outside diameter/length (inches)	Construction materials (w/lines & tubing)	Lift range (ft)	Delivery rates or volumes	1982 price (dollars)	Comments
BarCad Systems, Inc.	BarCad Sampler	dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std. tubing	1 liter for each 10-15 ft of submergence	220-350	requires compressed gas; custom sizes and materials available; acts as piezometer
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon®, silicone Viton®	0-30	670 mL/min with 7015-20 pump head	500-600	AC/DC; variable speed control available; other models may have different flow rates
ECO Pump Corp.	SAMPLifier	portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	400-700	AC, DC, or gasoline driven motors available; must be primed
Geltek Corp.	Bailer 219-4	portable; grab (positive displacement)	1.66/38	Teflon®	no limit	1075 mL	120-135	other sizes available
GeoEngineering, Inc.	GEO-MONITOR	dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	probably 0-150	app. 1 liter for each 10 ft of submergence	185	acts as piezometer; requires compressed gas
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2800 mL/min	1500-3000	requires compressed gas; other models available; AC, DC, manual operation possible
IEA	Syringe Sampler	portable; grab (positive displacement)	1.75/43	SS, Teflon®	no limit	850 mL sample vol.	1100	requires vacuum and/or pressure from hand pump
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	portable; bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Delrin® acetal	0-150	0-7500 mL/min	990	requires compressed gas (40 psi minimum)
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	portable; helical rotor (positive displacement)	1.75/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4500 mL/min	3500	DC operated
Leonard Mold and Die Works, Inc.	GeoFilter Small Dia. Well Pump (#0500)	portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3500 mL/min	1400-1500	requires compressed gas (55 PSI minimum); pneumatic or AC/DC control module
Oil Recovery Systems, Inc.	Surface Sampler	portable; grab (positive displacement)	1.75/12	acrylic, Delrin®	no limit	app. 250 mL	125-160	other materials and models available; for measuring thickness of "floating" contaminants
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	dedicated; bladder (positive displacement)	1.66/36	PVC	0-230	0-2000 mL/min	300-400	requires compressed gas; piezometric level indicator; other materials available

Source: Barcelona et al., 1983

Manufacturer	Model name/ number	Principle of operation	Maximum outside diameter/length (inches)	Construction materials (w/lines & tubing)	Lift range (ft)	Delivery rates or volumes	1982 price (dollars)	Comments
Randolph Austin Co.	Model 500 Vari-Flow Pump	portable; peristaltic (suction)	<0.5/N/A	(not submersible) rubber, Tygon®, or Neoprene®	0-30	see comments	1200-1300	flow rate dependent on motor and tubing selected, AC operated; other models available
Robert Bennett Co.	Model 180	portable; piston (positive displacement)	1.8/22	SS, Teflon®, Delrin®, PP, Viton®, acrylic, PE	0-500	0-1800 mL/min	2600-2700	requires compressed gas; water level indicator and flow meter; custom models available
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	portable; gas drive (positive displacement)	1.9/18	PVC, nylon	0-1100	250 mL/flushing cycle	250-350	requires compressed gas; SS available; piezometer model available; dedicated model available
Solinst Canada Ltd.	5W Water Sampler	portable; grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	1300-1800	requires compressed gas; custom models available
TIMCO Mfg. Co., Inc.	Std. Bailer	portable; grab (positive displacement)	1.66/ custom	PVC, PP	no limit	250 mL/ft of bailer	20-60	other sizes, materials, models available; optional bottom-emptying device available; no solvents used
TIMCO	Air or Gas Lift Sampler	portable; gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/flushing cycle	100-200	requires compressed gas; other sizes, materials, models available; no solvents used
Tole Devices Co.	Sampling Pump	portable; bladder (positive displacement)	1.38/48	SS, silicone, Delrin®, Tygon®	0-125	0-4000 mL/min	800-1000	compressed gas required; DC control module; custom built

Construction Materials Abbreviations

PE	Polyethylene
PP	Polypropylene
PVC	Polyvinyl Chloride
SS	Stainless Steel
PC	Polycarbonate
EPDM	Ethylene-Propylene Diene (synthetic rubber)

Other Abbreviations

NA	Not Applicable
AC	Alternating Current
DC	Direct Current

NOTE: Other manufacturers market pumping devices which could be used for ground-water sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983

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1.0 PURPOSE

This procedure describes methods and equipment commonly-used for collecting environmental samples of surface water and aquatic sediment for either on-site examination and chemical testing or for laboratory analysis.

2.0 SCOPE

The information presented in this guideline is generally applicable to all environmental sampling of surface waters (Section 5.3) and aquatic sediments (Section 5.4), except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions and equipment different from those described herein.

3.0 GLOSSARY

Environmental Sample - low concentration sample typically collected offsite and not requiring DOT hazardous waste labeling or CLP handling as a high concentration sample.

Hazardous Waste Sample - medium to high concentration sample (e.g., source material, sludge, leachate) requiring DOT labeling and CLP handling as a high concentration sample.

4.0 RESPONSIBILITIES

Field Operations Leader - has overall responsibility for the correct implementation of surface water and sediment sampling activities, including review of the sampling plan with, and any necessary training of, the sampling technician(s). The actual collection, packaging, documentation (sample label and log sheet, chain-of-custody record, CLP traffic reports, etc.) and initial custody of samples will be the responsibility of the sampling technician(s).

5.0 PROCEDURES

5.1 INTRODUCTION

Collecting a representative sample from surface water or sediments is difficult because of water movement, stratification or patchiness. To collect representative samples, one must standardize sampling bias related to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important quality not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been taken. Regardless of scrutiny and quality control applied during laboratory analyses, reported data are not better than the confidence that can be placed in the representativeness of the samples.

5.2 DEFINING THE SAMPLING PROGRAM

Many factors must be considered in developing a sampling program for surface water or sediments including study objectives; accessibility; site topography; flow, mixing and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depend on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect an adsorption/desorption). The hydrologist developing the sampling plan must therefore, know not only the mixing characteristics of streams and lakes, but also must understand the role of fluvial-sediment transport, deposition, and chemical sorption.

5.2.1 Sampling Program Objectives

The objective of surface water sampling is to determine the surface water quality entering, leaving or remaining within the site. The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or in a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., spills). The major pathways for surface water contamination (not including airborne deposition are: (a) overland runoff; (b) leachate influx to the waterbody; (c) direct waste disposal (solid or liquid) into the water body; and groundwater flow influx from upgradient. The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) which encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include slopes and runoff direction, areas of temporary flooding or pooling, tidal effects, artificial surface runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation), and locations of springs, seeps, marshes, etc. In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc., shall be considered.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly non-detectable concentrations. Such dispersion does not, however, always readily occur. For example, obtaining a representative sample of contamination from a main stream immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation are: (1) move the site far enough downstream to allow for adequate mixing, or (2) collect integrated samples in a cross section. Also, nonhomogeneous distribution is a particular problem with regard to sediment-associated contaminants, which may accumulate in low-energy environments (coves, river bends, deep spots, or even behind boulders) near or distant from the source while higher-energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample itself is an important consideration. Many organic compounds are only slightly water soluble and tend to be absorbed by particulate matter. Nitrogen, phosphorus, and the heavy metals may also be transported by particulates. Samples will be collected with a representative amount of suspended material; transfer from the sampling device shall include transferring a proportionate amount of the suspended material.

5.2.2 Location of Sampling Stations

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and description of site conditions must be balanced against the costs of collection as controlled by accessibility. Bridges or piers are the first choice for locating a sampling station on a stream because bridges provide ready access and also permit the sampling technician to sample any point across the stream. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes and reservoirs, as well as those on larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder manipulation of the sampling equipment. Wading for samples is not recommended unless it is known that contaminant levels are low so that skin contact will not produce adverse health effects. This provides a built in margin of safety in the event that wading boots or other protective equipment should fail to function properly. If it is necessary to wade into the water body to obtain a sample, the sampler shall be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician shall wait for the sediments to settle before taking a sample.

Sampling in marshes or tidal areas may require the use of an all-terrain-vehicle (ATV). The same precautions mentioned above with regard to sediment disturbance will apply.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed in order to ensure, as nearly as possible, that samples are taken where uniform flow or deposition and good mixing conditions exist.

The availability of streamflow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Streamflow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gaging station is not conveniently located on a selected stream, the project hydrologist shall explore the possibility of obtaining streamflow data by direct or indirect methods.

5.2.3 Frequency of Sampling

The sampling frequency and the objectives of the sampling event will be defined by the work plan. For single-event site- or area-characterization sampling, both bottom material and overlying water samples shall be collected at the specified sampling stations. If valid data are available on the distribution of the contaminant between the solid and aqueous phases it may be appropriate to sample only one phase, although this is not often recommended. If samples are collected primarily for monitoring purposes, consisting of repetitive, continuing measurements to define variations and trends at a given location, water samples shall be collected at a pre-established and constant interval as specified in the work plan (often monthly or quarterly) and during droughts and floods. Samples of bottom material shall be collected from fresh deposits at least yearly, and preferably during both spring and fall seasons.

The variability in available water-quality data shall be evaluated before deciding on the number and collection frequency of samples required to maintain an effective monitoring program.

5.3 SURFACE WATER SAMPLE COLLECTION

5.3.1 Streams, Rivers, Outfalls and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls and drainage features at a single point vary from the simplest of hand sampling procedures to the more sophisticated multipoint sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (see below).

Samples from different depths or cross-sectional locations in the water course taken during the same sampling episode shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited. Generally, the number and type of samples to be taken depend on the river's width, depth, discharge and on the suspended sediment the river's transports. The greater number of individual points that are sampled, the more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well-mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross-section.

For larger streams, at least one vertical composite shall be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of DO, pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical composite and on the composite itself. For rivers, several vertical composites shall be collected.

5.3.2 Lakes, Ponds and Reservoirs

Lakes, ponds, and reservoirs have as much greater tendency to stratify than rivers and streams. The relative lack of mixing requires that more samples be obtained.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of DO, pH, temperature, etc., is to be conducted on each aliquot of the vertical composite. In naturally-formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites shall be composited to form a single sample. These verticals are often taken along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline which is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer which is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality since it is likely that only poor mixing will occur. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements are now made in-situ using sensors and automatic readout or recording devices. Single and multiparameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, some cations and anions, and light penetration.

5.3.3 Estuaries

Estuarine areas are by definition zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types dependent upon freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations:

- Mixed estuary - characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Being well mixed, the sampling locations are not critical in this type of estuary.

- Salt wedge estuary - characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.

- Oceanic estuary - characterized by salinities approaching full strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh-saline water mixing occurring near, or at, the shore line.

Sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides (i.e. when the tide turns). Estuarine sampling programs shall include vertical salinity measurements at 1 to 5 foot increments coupled with vertical dissolved oxygen and temperature profiles.

5.3.4 Surface Water Sampling Equipment

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Open tube
- Dip sampler
- Hand pump
- Kemmerer
- Depth-Integrating Sampler

The dip sampler and the weighted bottle sampler are used most often.

The criteria for selecting a sampler include:

- Disposable and/or easily decontaminated
- Inexpensive (if the item is to be disposed of)
- Ease of operation
- Nonreactive/noncontaminating - Teflon-coating, glass, stainless steel or PVC sample chambers are preferred (in that order)

Each sample (grab or each aliquot collected for compositing) shall be measured for:

- Specific conductance
- Temperature
- pH (optional)
- Dissolved oxygen (optional)

as soon as it is recovered. These analyses will provide information on water mixing/stratification and potential contamination.

5.3.4.1 Dip Sampling

Water is often sampled by filling a container either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible it is recommended to augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

5.3.4.2 Weighted Bottle Sampling

A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stopped glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The procedure for sampling is:

- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).
- Pull out the stopper with a sharp jerk of the sampler line.
- Allow the bottle to fill completely, as evidenced by the absence of air bubbles.
- Raise the sampler and cap the bottle.
- Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as original bottle is an approved container).

5.3.4.3 Kemmerer

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass, stainless steel or acrylic cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. "Messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

5.3.5 Surface Water Sampling Techniques

Most samples taken during site investigations are grab samples. Typically, surface water sampling involves immersing the sample container in the body of water; however, the following suggestions are made to help ensure that the samples obtained are representative of site conditions:

- The most representative samples are obtained from mid-channel at 0.6 stream depth in a well-mixed stream.
- Even though the containers used to obtain the samples are previously laboratory cleaned, it is suggested that the sample container be rinsed at least once with the water to be sampled before the sample is taken.
- For sampling running water, it is suggested that the farthest downstream sample be obtained first and that subsequent samples be taken as one works upstream. Work from zones suspected of low contamination to zones of high contamination.
- To sample a pond or other standing body of water, the surface area may be divided into grids. A series of samples taken from each grid is combined into one sample, or several grids are selected at random.
- Care should be taken to avoid excessive agitation of the water that results in the loss of volatile constituents.
- When obtaining samples in 40 ml septum vials for volatile organics, analysis, it is important to exclude any air space in the top of the bottle and to be sure that the Teflon liner faces in after the bottle is filled and capped. The bottle can be turned upside down to check for air bubbles.
- Do not sample at the surface, unless sampling specifically for a known constituent which is immiscible and on top of the water. Instead, the sample container should be inverted, lowered to the approximate depth, and held at about a 45-degree angle with the month of the bottle facing upstream.

5.4 SEDIMENT SAMPLING

5.4.1 General

Sediment samples are usually collected at the same verticals at which water samples were collected. If only one sediment sample is to be collected, the site shall be approximately at the center of water body. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center will be composed of fine-grained materials which may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations

of contaminants. The shape, flow pattern, bathometry (depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) shall be sampled while areas likely to show net erosion (high-velocity, turbulent areas) and suspension of fine solid materials shall be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained material) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water column concentrations are below detection limits). It is therefore important to minimize the loss of low-density "fines" during any sampling process.

5.4.2 Sampling Equipment and Techniques

A bottom-material sample may consist of a single scoop or core or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using on-shore or off-shore techniques.

When boats are used for sampling, life preservers must be provided and two individuals must undertake the sampling. An additional person shall remain on-shore in visual contact at all times.

The following samplers may be used to collect bottom materials:

- Scoop sampler
- Dredge samplers

5.4.2.1 Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and "cleanest" way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping in the sample along the bottom in the upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.

5.4.2.2 Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Most dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave" and permitting direct access to the secured sample without opening the closed jaws. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or Teflon scoops, thus minimizing the change of metal contamination from the frame of the device.

6.0 REFERENCES

Feltz, H. R., 1980. Significance of Bottom Material Data in Evaluating Water Quality in Contaminants and Sediments. Ann Arbor, Michigan, Ann Arbor Science Publishers, Inc., V. 1, p. 271-287.

Kittrell, F. W., 1969. A Practical Guide to Water Quality Studies of Streams. U.S. Federal Water Pollution Control Administration, Washington, D.C., 135p.

U.S. EPA, 1980. Standard Operating Procedures and Quality Assurance Manual. Water Surveillance Branch, USEPA Surveillance and Analytical Division, Athens, Georgia.

U.S. Geological Survey, 1977. National Handbook of Recommended Methods for Water-Data Acquisition. Office of Water Data Coordination, USGS, Reston, Virginia.

7.0 ATTACHMENTS

None.

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1.0 PURPOSE

This procedure describes the method for logging and sampling of test pits and trenches to determine subsurface soil and rock conditions and recover small-volume or bulk samples. The methods apply only to data collection and do not apply to the construction of excavations.

2.0 SCOPE

The procedure is applicable to the collection of bulk and small-volume samples of subsurface soils for laboratory testing which are exposed through excavating at hazardous substance sites.

3.0 GLOSSARY

Test pit or trench - A pit or trench, either machine or manually excavated, from which large quantities of soil may be removed.

4.0 RESPONSIBILITIES

Site Manager - responsible for determining, in consultation with other project personnel (geologist, geochemist), the need for test pits or trenches, their approximate locations, depths and sampling objectives.

Field Operations Leader (FOL) - responsible for finalizing the location, orientation and depth of test pits/trenches based on on-site conditions and the site geologist's advice. The FOL is ultimately responsible for the proper construction, sampling and backfilling of test pits and trenches, including adherence to OSHA regulations.

Health and Safety Officer (HSO) - responsible for air quality monitoring during test pit construction and sampling, to ensure that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The HSO may also be required to advise the FOL on other safety-related matters regarding the test pit or trench excavation and sampling, such as mitigative measures to address potential hazards from unstable trench walls, puncturing of drums or other hazardous objects, etc.

Site Geologist/Sampler - responsible for recording all information and data on test pit/trench construction and for the proper collection and logging of samples according to this procedure.

5.0 PROCEDURES

5.1 DATA COLLECTION AND SAMPLING

5.1.1 General

Test pits and trenches are usually logged as they are excavated. Records of each test pit/trench will be made on prepared forms or in a field notebook. If the log is made in a field notebook, it will be transcribed to the prepared forms. These records include plan and profile sketches of the test

pit/trench showing materials encountered, their depth and distribution in the pit/trench, and sample locations. These records will also include safety and sample screening information.

Requirements for sampling shall be determined by the Site Manager, and shall be documented in the Project Operation Plan (POP). A copy of this plan shall be maintained by the Field Operations Leader. To expedite sampling, the crew shall have sufficient tools and equipment to sample each pit. The tools and equipment must be properly decontaminated prior to use.

Entry of test pits by personnel is extremely dangerous and shall be avoided unless absolutely necessary. Pits more than 4 feet deep must be shored prior to entry, the "buddy" system must be used, and all applicable H&S and OSHA requirements followed.

The final depth and type of samples obtained from each test pit will be determined at the time the test pit is excavated. Sufficient samples are usually obtained and analyzed to quantify contaminant distribution as a function of depth for each test pit. Additional samples of each waste phase and any fluids encountered in each test pit may be collected.

In some cases, samples of soil may be extracted from the test pit for reasons other than waste sampling and chemical analysis, such as to obtain geotechnical information. Such information would include soil types, stratigraphy, strength, etc., and could therefore entail the collection of disturbed (grab or bulk) or relatively undisturbed (hand-carved or pushed/driven) samples, which can be tested for geotechnical properties. The purposes of such explorations are very similar to those of shallow exploratory or test borings, but often test pits offer a faster, more cost-effective method of sampling than borings.

5.1.2 Sampling Equipment

The following equipment is needed for taking samples for chemical or geotechnical analysis from test pits and trenches:

- Backhoe or other excavating machinery.
- Shovels, picks and hand augers, stainless steel trowels.
- Sample container - bucket with locking lid for large samples and glass bottles for chemical or geotechnical analysis samples.
- Polyethylene bags for enclosing sample; buckets.
- Remote sampler consisting of 10-foot sections of steel conduit (1-inch diameter), hose clamps and right angle adapter for conduit (see Attachment A).

5.1.3 Sampling Methods

The methods discussed in this section refer to test pit sampling from grade level. If test pit entry is required, see Section 5.1.4.

- Excavate trench or pit in several depth increments. After each increment the operator will wait while the sampler inspects the test pit from grade level to decide if conditions are appropriate for sampling. (Monitoring of volatiles by the HSO will also be used to evaluate the need for sampling.) Practical depth increments range from 2 to 4 feet.

The backhoe operator, who will have the best view of the test pit, will immediately cease digging if:

- Any fluid phase or groundwater seepage is encountered in the test pit.
- Any drums, other potential waste containers, obstructions or utility lines are encountered.
- Distinct changes of material are encountered.

This action is necessary to permit proper sampling of the test pit and to prevent a breach of safety protocol. Depending upon the conditions encountered, it may be required to excavate more slowly and carefully with the backhoe.

- Remove loose material to the greatest extent possible with backhoe.
- Secure walls of pit if necessary. (There is seldom any need to enter a pit or trench which would justify the expense of shoring the walls. All observations and samples can generally be taken from the ground surface.)
- Samples of the test pit material will be obtained either directly from the backhoe bucket or from the material once it has been deposited on the ground. The sampler or Field Operations Leader directs the backhoe operator to remove material from the selected depth or location within the test pit/trench. The bucket is brought to the surface and moved away from the pit. The sampler and/or HSO then approaches the bucket and monitors its contents with a photoionization (HNU) or OVA meter. The sample is collected from the center of the bucket or pile and placed in sample jars using a clean stainless steel trowel or spatula.
- If a composite sample is desired, several depths or locations within the pit/trench are selected and a bucket is filled from each area. It is preferable to send individual sample bottles filled from each bucket to the laboratory for compositing under the more controlled laboratory conditions. However, if compositing in the field is required, each sample bottle shall be emptied into a mixing container (e.g., stainless steel bucket) and thoroughly stirred prior to being placed into the sample jars. Composite sampling is not appropriate for samples which will undergo analysis for volatile organic compounds.

- Using the remote sampler shown in Attachment A, samples can be taken at the desired depth from the side wall or bottom of the pit. The face of the pit/trench shall first be scraped (using a long-handled shovel or hoe) to remove the smeared zone that has contacted the backhoe bucket. The sample is then collected directly into the sample jar, by scraping with the jar edge, eliminating the need to utilize samplers and minimizing the likelihood of cross-contamination. The sample jar can be capped, removed from the assembly, and packaged for shipment.

- Prepare shipping papers, labels, and chain-of-custody records, as described in SA-6.2, Sample Packaging and Shipping.

5.1.4 In-Pit Sampling

Samples can also be obtained by personnel entering the test pit/trench. This is necessary when soil conditions preclude obtaining suitable samples from the backhoe bucket (e.g., excessive mixing of soils or wastes within the test pit/trench) or when samples from relatively small discrete zones within the test pit are required. This approach may also be necessary to sample any seepage occurring at discrete levels or zones in the test pit that are not accessible with remote samplers.

In general, personnel shall sample and log pits and trenches from the ground surface, except as provided for by the following criteria:

- The project will benefit significantly from the improved quality of the logging and sampling data obtained if personnel enter a pit or trench rather than conduct such operations from the ground surface.

- There is no practical alternative means of obtaining such data.

- The Site Health & Safety Officer determines that such action can be accomplished without breaching site safety protocol. This determination will be based on actual monitoring of the pit/trench after it is dug (including, at a minimum, measurements of volatile organics, explosive gases and available oxygen).

- An experienced geotechnical professional determines that the pit/trench is stable or is made stable prior to entrance of any personnel (by grading the sidewalls or using shoring). OSHA requirements (Reference 1) must be strictly implemented.

If these conditions are satisfied, one person will enter the pit/trench. On potentially hazardous waste sites, this individual will be dressed in safety gear as required by the conditions in the pit, usually Level B. He will be affixed to a safety rope and continuously monitored while in the pit.

A second individual will be fully dressed in protective clothing including a self-contained breathing device and on standby during all pit entry operations. The individual entering the pit will remain therein for as brief a period as practical, commensurate with performance of his work. After removing the smeared zone, samples are obtained with a clean trowel or spoon. As an added precaution, it is advisable to keep the backhoe bucket in the test pit when personnel are working below grade. Such personnel can either stand in or near the bucket while performing sample

operations. In the event of a cave-in they can either be lifted clear in the bucket, or at least climb up on the backhoe arm to reach safety.

5.1.5 Geotechnical Sampling

In addition to the equipment described in Section 5.1.2, the following equipment is needed for geotechnical sampling:

- Soil sampling equipment, similar to that used in shallow drilled boring (i.e., open tube samplers), which can be pushed or driven into the floor of the test pit.
- Suitable driving (i.e., a sledge hammer) or pushing (i.e., the backhoe bucket) equipment which is used to advance the sampler into the soil.
- Knives, spatulas, and other suitable devices for trimming hand-carved samples.
- Suitable containers (bags, jars, tubes, boxes, etc.), labels, wax, etc. for holding and safely transporting collected soil samples.
- Geotechnical equipment (pocket penetrometer, torvane, etc.) for field testing collected soil samples for classification and strength properties.

Disturbed grab or bulk geotechnical soil samples may be collected for most soils in the same manner as comparable soil samples for chemical analysis. These collected samples may be stored in jars or plastic-lined sacks (larger samples), which will preserve their moisture content. Smaller samples of this type are usually tested for their index properties, to aid in soil identification and classification, while larger bulk samples are usually required to perform compaction tests.

Relatively undisturbed samples are usually extracted in cohesive soils using open tube samplers, and such samples are then tested in a geotechnical laboratory for their strength, permeability and/or compressibility. The techniques for extracting and preserving such samples are similar to those used in performing Shelby tube sampling in borings, except that the sampler is advanced by hand or backhoe, rather than a drill rig. Also, the sampler may be extracted from the test pit by excavation around the sampler when it is difficult to pull it out of the ground. If this excavation requires entry of the test pit the requirements described in Section 5.1.4 must be followed. The open tube sampler shall be pushed or driven <u>vertically</u> into the floor or steps excavated in the test pit at the desired sampling elevations. Extracting tube samples horizontally from the walls of the test pit is not appropriate, because the sample will not have the correct orientation.

A sledge hammer or the backhoe may be used to drive or push the sampler or tube into the ground. Place a piece of wood over the top of the sampler or sampling tube to prevent damage during driving/pushing of the sample. Pushing the sampler with a constant thrust is always preferable to driving it with repeated blows, to minimize disturbance to the sample. If the sample cannot be extracted by rotating it at least two revolutions (to shear off the sample at the bottom), hand excavation to remove the soil from around the sides of the sampler and slice off the sample at its bottom may be required. If this requires entry of the test pit, the requirements in Section 5.1.4 must be followed. Prepare, label, pack and transport the sample in the required manner, as described in SA-6.2, Sample Packaging and Shipping.

~~Hand-carved block samples are extracted in a similar manner to open tube samples, except that the sampling container (usually a large tube or box with no top or bottom) is not used to cut the sample. Instead, the surrounding sections of the test pit floor are carved away by hand to leave a sample slightly smaller in plan dimensions than the container, with the sample remaining connected to the test pit floor at its bottom. The container is slipped over the sample, and the annular space and top of the sample is covered with melted wax. The bottom of the sample is then sliced away from the test pit floor, the container is inverted, about 1/2 inch of soil removed, and the space filled with melted wax. Caps are then installed, taped, and dipped in hot wax for each end of the container, and the block sample is labeled and shipped in the same manner as a tube sample.~~

5.2 RECORDS

The following information will be recorded on the test pit/trench log form and in the field notebook:

- Name, work assignment number, and location of job.
- Date of digging or trenching.
- Surface elevation.
- Depth, surface area and orientation of pit or trench.
- Sample numbers.
- Method of taking samples, type and size of samples.
- Approximate water levels after stabilization (if below the water table), and location and depth of any seeps.
- Description of soil.
- Other pertinent information, such as HNU or OVA readings, weather conditions, etc.
- List of photographs.
- Name of contractor, backhoe (or other equipment) operator and sampler.
- Date and type of backfill.

6.0 REFERENCES

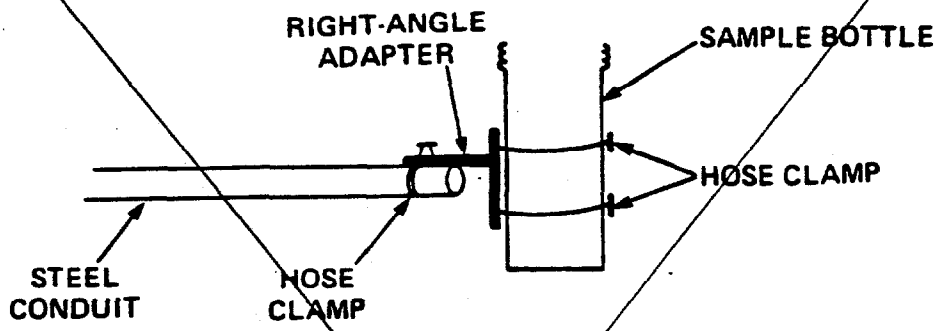
OSHA, 1979. Excavation Trenching and Shoring, 29 CFR 1926.650-653.

7.0 ATTACHMENTS

Attachment A - Remote Sampling/Sample Holder for Test Pit/Trench

ATTACHMENT A
REMOTE SAMPLE HOLDER FOR TEST PIT/TRENCH SAMPLING

REMOTE SAMPLE HOLDER FOR TEST PIT/ TRENCH SAMPLING



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		Prepared Earth Sciences	
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1.0 PURPOSE

This purpose of this procedure is to provide information on chain-of-custody procedures to be used under the NUS Program.

2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of all samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities. Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence. This procedure identifies the necessary custody records and describes their completion.

This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

3.0 GLOSSARY

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. A Chain-of-Custody Record Form is a controlled document, provided by the regional office of EPA.

The chain-of-custody form is a two-page carbon-copy type form. The original form accompanies the samples during shipment, and the pink carbon-copy is retained in the project file.

Controlled Document - A consecutively-numbered form released by EPA or Program Management Office (PMO) for use on a particular work assignment. All unused forms must be returned or accounted for at the conclusion of the assignment.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under your custody if:

- It is in your actual possession.
- It is in your view, after being in your physical possession.
- It was in your physical possession and then you locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record and maintaining custody of samples until they are relinquished to another custodian, to the shipper, or to the common carrier.

Remedial Investigation Leader - Responsible for determining that chain-of-custody procedures have been met by the sample shipper and analytical laboratory.

5.0 PROCEDURES

5.1 OVERVIEW

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is what it is represented to be. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom and, secondly, provide security for the evidence as it is moved and/or passes from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

5.2 SAMPLE IDENTIFICATION

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records, with identifying information.

5.2.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling Plan. Each sample container is identified by a sample label (see Attachment B). Sample labels are provided by the PMO. The information recorded on the sample label includes:

- **Project:** EPA Work Assignment Number (can be obtained from the Sampling Plan).
- **Station Location:** The unique sample number identifying this sample (can be obtained from the Sampling Plan).
- **Date:** A six-digit number indicating the day, month, and year of sample collection; e.g., 12/21/85.
- **Time:** A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- **Medium:** Water, soil, sediment, sludge, waste, etc.

- **Concentration:** The expected concentration (i.e., low, medium, high).
- **Sample Type:** Grab or composite.
- **Preservation:** Type of preservation added and pH levels.
- **Analysis:** VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- **Sampled By:** Printed name of the sampler.
- **Case Number:** Case number assigned by the Sample Management Office.
- **Traffic Report Number:** Number obtained from the traffic report labels.
- **Remarks:** Any pertinent additional information.

Using just the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

5.2.2 Sample Identification Tag

A Sample Identification Tag (Attachment F) must also be used for samples collected for CLP (Contract Laboratory Program) analysis. The Sample Identification Tag is a white, waterproof paper label, approximately 3-by-6 inches, with a reinforced eyelet, and string or wire for attachment to the neck of the sample bottle. The Sample Tag is a controlled document, and is provided by the regional EPA office. Following sample analysis, the Sample Tag is retained by the laboratory as evidence of sample receipt and analysis.

The following information is recorded on the tag:

- **Project Code:** Work Assignment Number.
- **Station Number:** The middle portion of the Station Location Number, (between the hyphens).
- **Month/Day/Year:** Same as Date on Sample Label.
- **Time:** Same as Time on Sample Label.
- **Designate - Comp/Grab:** Composite or grab sample.
- **Station Location:** Same as Station Location on Sample Label.
- **Samplers:** Same as Sampled By on Sample Label.
- **Preservative:** Yes or No.
- **Analyses:** Check appropriate box(es).

- **Remarks**: Same as Remarks on Sample Label (make sure the Case Number and Traffic Report numbers are recorded).

- **Lab Sample Number**: For laboratory use only.

The tag is then tied around the neck of the sample bottle.

If the sample is to be split, it is aliquoted into similar sample containers. Identical information is completed on the label attached to each split.

Blank, duplicate, or field spike samples shall not be identified as such on the label, as they may compromise the quality control function. Sample blanks, duplicates, spikes, and splits are defined in Procedure SA-6.6.

5.3 CHAIN-OF-CUSTODY PROCEDURES

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

5.3.1 Field Custody Procedures

- Samples are collected as described in the site-specific Sampling Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the sample log sheet and Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather.

5.3.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. Chain-of-Custody Record Forms used in EPA Regions I-IV are shown in Attachments A through D. The appropriate form shall be obtained from the EPA Regional Office. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as follows:

- Enter header information (project number, samplers, and project name -- project name can be obtained from the Sampling Plan).

- Sign, date, and enter the time under "Relinquished by" entry.

- Enter station number (the station number is the middle portion of the station location number, between the hyphens).
- Check composite or grab sample.
- Enter station location number (the same number as the station location on the tag and label).
- Enter the total number of containers per station number and the type of each bottle.
- Enter either the inorganic traffic report number, the organic traffic report number, or the SAS number for each station number in the remarks column.
- Enter the tag number from the bottom of the sample identification tag in the remarks column for each station location.
- Make sure that the person receiving the sample signs the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by." Receiving laboratory will sign "Received for Laboratory by" on the lower line and enter the date and time.
- Enter the bill-of-lading or Federal Express airbill number under "Remarks," in the bottom right corner, if appropriate.
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in the appropriate sample shipping package. Retain the pink copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment G is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals are provided by ZPMO on an as-needed basis.
- Place the seal across the shipping container opening so that it would be broken if the container is opened.
- Complete other carrier-required shipping papers.

The custody record is completed using black waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the sample container (enclosed with other documentation in a plastic zip-lock bag). As long as custody forms are sealed inside the sample container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

If sent by mail, the package will be registered with return receipt requested. If sent by common carrier or air freight, proper documentation must be maintained.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

5.3.3 Receipt for Samples Form

Whenever samples are split with a private party or government agency, a separate Receipt for Samples Record Form is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the party or agency shall require the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received by" space. When appropriate, as in the case where the representative is unavailable, the custody record shall contain a statement that the samples were delivered to the designated location at the designated time. This form must be completed and a copy given to the owner, operator, or agent-in-charge even if the offer for split samples is declined. The original is retained by the Field Operations Leader.

6.0 REFERENCES

U.S. EPA, 1984. User's Guide to the Contract Laboratory Program, Office of Emergency and Remedial Response, Washington, D.C.

7.0 ATTACHMENTS

Attachment A - Chain-of-Custody Record Form for use in Region I
Attachment B - Chain-of-Custody Record Form for use in Region II
Attachment C - Chain-of-Custody Record Form for use in Region III
Attachment D - Chain-of-Custody Record Form for use in Region IV
Attachment E - Sample Label
Attachment F - Sample Identification Tag
Attachment G - Chain-of-Custody Seal

ATTACHMENT A
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION I
(Original is 8-1/2 by 11)

PROJECT NAME

SAMPLERS: *(Signature)*

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CON-TAINERS							REMARKS

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks:	

ATTACHMENT B
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION II
(Original is 8 by 10-1/2)

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL PROTECTION AGENCY – REGION II
SURVEILLANCE & ANALYSIS DIVISION
EDISON, NEW JERSEY 08837

Name of User and Address		
Sample Number	Number of Containers	Description of Samples

Person Assuming Responsibility for Samples	Time	Date

Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody
Sample Number	Relinquished By:	Received By:	Time	Date	Reason for Change of Custody

ATTACHMENT C
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION III
(Original is 8-1/2 x 11-3/4")

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 3
Curtis Bldg., 6th & Walnut Sts.
Philadelphia, Pennsylvania 19106

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME														
SAMPLERS: *(Signature)*						NO. OF CON-TAINERS								REMARKS	
STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION										

Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date / Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date / Time	Received for Laboratory by: *(Signature)*	Date / Time	Remarks	

Distribution: Original Accompanies Shipment, Copy to Coordinator Field Files

3-15966

D334901

D334901

ATTACHMENT D
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION IV
(Original is 8-1/2 by 14)

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL SERVICES DIVISION
COLLEGE STATION ROAD
ATHENS, GEORGIA 30613

PROJ NO.	PROJECT NAME

SAMPLERS (Signature)

Analysis column groups: Water/Wastewater | Soil/Sed | Sldg/Waste | Misc

Analysis columns: Gal G (ext org) / Gal G (EP) / 40 ml vial (VOA) / Gal P (BOD, COD, TSS) / Pt G (phenol) / Pt G (metals, Hg) / Pt P (metals) / Pt P (S⁻⁻) / Pt P (TOC, COD) / Qt G (O&G or Pest) / ½ gal P (CN) / ½ gal P (Cl, Fl, SO4) / Qt G (ref org, EP) / 8 oz G (VOA) / Pt P (met, Hg, CN, S⁻⁻) / 8 oz G (ext org, VOA, met, Hg, CN) / 8 oz G (EP, S⁻⁻, F.P.)

STA NO	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	(analyses)	REMARKS/TAG NUMBERS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Remarks
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	

DISTRIBUTION: Original and Pink copies accompany sample shipment to laboratory. Pink copy retained by laboratory. Yellow copy retained by samplers. Blue copy extra copy as needed.

Nº 4 3526

ATTACHMENT E
SAMPLE LABEL

NUS CORPORATION PROJECT: _____

STATION LOCATION: _____

DATE: ___/___/___ TIME: _____ hrs.

MEDIA: WATER ☐ SOIL ☐ SEDIMENT ☐ _____ ☐

CONCENTRATION: LOW ☐ MED ☐ HIGH ☐

TYPE: GRAB ☐ COMPOSITE ☐

ANALYSIS	PRESERVATION
VOA ☐ BNA's ☐	Cool to 4°C ☐
PCB's ☐ PESTICIDES ☐	HNO_3 to pH <2 ☐
METALS: TOTAL ☐ DISSOLVED ☐	NAOH to pH>12 ☐
CYANIDE ☐	_____ ☐
_____ ☐	

Sampled by: _____

Case No.: _____ Traffic Report No.: _____

Remarks:

ACFILE: FORMS\BOTLABL

ATTACHMENT F
SAMPLE IDENTIFICATION TAG

☆ GPO 505-552

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA

Designate: Grab / Comp.

Time

Month/Day/Year

Station No.

Project Code

Samplers (Signatures)

Station Location

Preservative:
Yes ☐ No ☐

ANALYSES

BOD Anions Solids (TSS) (TDS) (SS)	
COD, TOC, Nutrients	
Phenolics	
Mercury	
Metals	
Cyanide	
Oil and Grease	
Organics GC/MS	
Priority Pollutants	
Volatile Organics	
Pesticides	
Mutagenicity	
Bacteriology	

Remarks:

Tag No.	Lab Sample No.
3 60966	

ATTACHMENT G
CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL

Date

Signature

NUS CORPORATION

NUS CORPORATION

CUSTODY SEAL

Date

Signature

NUS CORPORATION ENVIRONMENTAL MANAGEMENT GROUP	STANDARD OPERATING PROCEDURES	Number SA-6.2	Page 1 of 12
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		Applicability EMG	
		Prepared Earth Sciences	
Subject SAMPLE PACKAGING AND SHIPPING		Approved D. Senovich	

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1.0 PURPOSE

This procedure provides instruction for sample packaging and shipping in accordance with U.S. Department of Transportation (DOT) regulations.

2.0 SCOPE

Samples collected at hazardous waste sites usually have to be transported elsewhere for analysis. This requires that the samples be appropriately preserved to prevent or minimize chemical alteration prior to analysis, and be transported to protect their integrity, as well as to protect against any detrimental effects from leakage or breakage. Regulations for packaging, marking, labeling, and shipping hazardous materials and wastes are promulgated by the U.S. Department of Transportation and described in the Code of Federal Regulations (49 CFR 171 through 177, in particular 172.402h, Packages Containing Samples). In general, these regulations were not intended to cover shipment of samples collected at controlled or uncontrolled hazardous waste sites or samples collected during emergency responses. However, the EPA has agreed through a memorandum of agreement to package, mark, label, and ship samples observing DOT procedures. The information presented here is for general guidance.

This procedure is applicable to all samples taken from uncontrolled hazardous substance sites for analysis at laboratories away from the site.

3.0 GLOSSARY

Carrier - A person or firm engaged in the transportation of passengers or property.

Hazardous Material - A substance or material in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce ("commerce" here to include any traffic or transportation). Defined and regulated by DOT (49 CFR 173.2) and listed in Attachment A of this guideline.

Hazardous Waste - Any substance listed in 40 CFR Subpart D (¥261.20 et seq) or otherwise characterized as ignitable, corrosive, reactive, or EP toxic as specified under 40 CFR Subpart C (¥261.20 et seq) that would be subject to manifest requirements specified in 40 CFR 262. Defined and regulated by EPA.

Marking - Applying the descriptive name, instruction, cautions, weight, or specification marks or combination thereof required to be placed outside containers of hazardous materials.

n.o.i. - Not otherwise indicated.

n.o.s. - Not otherwise specified.

ORM - Other regulated material.

Packaging - The assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, multiunit tank car tanks.

Placard - Color-coded, pictorial sign depicting the hazard class symbol and name to be placed on all four sides of a vehicle transporting certain hazardous materials.

Reportable Quantity (RQ) - A parenthetical note of the form "(RQ-1000/454)" following an entry in the DOT Hazardous Materials table (49 CFR 172.101) indicates the reportable quantity of the substance in pounds and kilograms. If a spill of that amount or more of the substance occurs during transit or storage, a report must be filed with DOT according to ¥171.15-15 concerning hazardous materials incidents reports. If the material spilled is a hazardous waste, a report must always be filed, regardless of the amount, and must include a copy of the manifest. If the RQ notation appears, it must be shown either immediately before or after the proper shipping name on the shipping paper (or manifest). Most shipping papers and manifests will have a column designated "HM" which may be used for this purpose.

4.0 RESPONSIBILITIES

Field Operations Leader or Team Sampling Leader - responsible for determining that samples are properly packaged and shipped.

Sampling Personnel - responsible for implementing the packaging and shipping requirements.

5.0 PROCEDURES

5.1 INTRODUCTION

Samples collected for shipment from a site shall be classified as either environmental or hazardous material (or waste) samples. In general, environmental samples are collected off-site (for example from streams, ponds, or wells) and are not expected to be grossly contaminated with high levels of hazardous materials. On-site samples (for example, soil, water, and materials from drums or bulk storage tanks, obviously contaminated ponds, lagoons, pools, and leachates from hazardous waste sites) are considered hazardous. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples. If there is any doubt, a sample shall be considered hazardous and shipped accordingly.
- Protect the health and safety of laboratory personnel receiving the samples. Special precautions are used at laboratories when samples other than environmental samples are received.

5.2 ENVIRONMENTAL SAMPLES

5.2.1 Packaging

Environmental samples may be packaged following the procedures outlined in Section 5.4 for samples classified as "flammable liquids" or "flammable solids." Requirements for marking, labeling, and shipping papers do not apply.

Environmental samples may also be packed without being placed inside metal cans as required for flammable liquids or solids.

- Place sample container, properly identified and with a sealed lid, in a polyethylene bag, and seal the bag.
- Place sample in a fiberboard container or metal picnic cooler which has been lined with a large polyethylene bag.
- Pack with enough noncombustible, absorbent, cushioning materials to minimize the possibility of the container breaking.
- Seal large bag.
- Seal or close outside container.

5.2.2 Marking Labeling

Sample containers must have a completed sample identification tag and the outside container must be marked "Environmental Sample." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling are required.

5.2.3 Shipping Papers

No DOT shipping papers are required. However, the appropriate chain-of-custody forms must be included with the shipment.

5.2.4 Transportation

There are no DOT restrictions on mode of transportation.

5.3 DETERMINATION OF SHIPPING CLASSIFICATION FOR HAZARDOUS MATERIAL SAMPLES

Samples not determined to be environmental samples, or samples known or expected to contain hazardous materials, must be considered hazardous material samples and transported according to the requirements listed below.

5.3.1 Known Substances

If the substance in the sample is known or can be identified, package, mark, label and ship according to the specific instructions for that material (if it is listed) in the DOT Hazardous Materials Table, 49 CFR 172.101.

Unz and Company have published the following steps to help in locating a proper shipping name from the Hazardous Materials Table, 49 CFR 172.101.

1. Look first for the chemical or technical name of the material, for example, ethyl alcohol. Note that many chemicals have more than one technical name, for example, perchloroethylene (not listed in 172.101) is also called tetrachloroethylene (listed 172.101). It may be useful to consult a chemist for all possible technical names a material can have. If your material is not listed by its technical name then. . . . . .

2. Look for the chemical family name. For example, pentyl alcohol is not listed but the chemical family name is: alcohol, n.o.s. (not otherwise specified). If the chemical family name is not listed then. . . . . .

3. Look for a generic name based on end use. For example, Paint, n.o.s or Fireworks, n.o.s. If a generic name based on end use is not listed then. . . . . .

4. Look for a generic family name based on end use, for example, drugs, n.o.s. or cosmetics, n.o.s. Finally, if your material is not listed by a generic family name but you suspect or know the material is hazardous because it meets the definition of one or more hazardous classes, then. . . . . .

5. You will have to go the the general hazard class for a proper shipping name. For example, Flammable Liquid, n.o.s, or Oxidizer, n.o.s.

5.3.2 Unknown Substances

For samples of hazardous substances of unknown content, select the appropriate transportation category according to the DOT Hazardous Materials Classification (Attachment A), a priority system of transportation categories.

The correct shipping classification for an unknown sample is selected through a process of elimination, utilizing Attachment A. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample is considered radioactive and appropriate shipping regulations for "radioactive material" followed.

If a radioactive material is eliminated, the sample is considered to contain "Poison A" materials (Attachment B), the next classification on the list. DOT defines "Poison A" as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquids, mixed with air is dangerous to life. Most Poison A materials are gases or compressed gases and would not be found in drum-type containers. Liquid Poison A would be found only in closed containers; however,all samples taken from closed drums do not have to be shipped as Poison A, which provides for a "worst case" situation. Based upon information available, a judgment must be made whether a sample from a closed container is a Poison A.

If Poison A is eliminated as a shipment category, the next two classifications are "flammable" or "nonflammable" gases. Since few gas samples are collected, "flammable liquid" would be the next applicable category. With the elimination of radioactive material, Poison A, flammable gas, and nonflammable gas, the sample can be classified as flammable liquid (or solid) and shipped accordingly. These procedures would also suffice for shipping any other samples classified below flammable liquids in the DOT classification table (Attachment A). For samples containing unknown materials, categories listed below flammable liquids/solids on Attachment A are generally not used because showing that these materials are not flammable liquids (or solids) requires flashpoint testing, which may be impractical and possibly dangerous at a site. Thus, unless the sample is known to consist of materials listed as less hazardous than flammable liquid (or solid) on Attachment A, it is considered a flammable liquid (or solid) and shipped as such.

For any hazardous material shipment, utilize the shipping checklist (Attachment C) as a guideline to ensure that all sample-handling requirements are satisfied.

5.4 PACKAGING AND SHIPPING OF SAMPLES CLASSIFIED AS FLAMMABLE LIQUID (OR SOLID)

5.4.1 Packaging

Applying the word "flammable" to a sample does not imply that it is in fact flammable. The word prescribes the class of packaging according to DOT regulations.

1. Collect sample in the prescribed container with a nonmetallic, Teflon-lined screw cap. To prevent leakage, fill container no more than 90 percent full.

2. Complete sample label and sample identification tag and attach securely to sample container.

3. Seal container and place in 2-mil thick (or thicker) polyethylene bag, one sample per bag. Position sample identification tag so that it can be read through bag. Seal bag.

4. Place sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly and permanently. Mark can as indicated in Paragraph 1 of Section 5.4.2, below.

5. Place one or more metal cans (or single 1-gallon bottle) into a strong outside container, such as a metal picnic cooler or a DOT-approved fiberboard box. Surround cans with noncombustible, absorbent cushioning materials for stability during transport. Mark container as indicated in Paragraph 2 of Section 5.4.2.

5.4.2 Marking/Labeling

1. Use abbreviations only where specified. Place the following information, either hand-printed or in label form, on the metal can (or 1-gallon bottle):

   - Laboratory name and address.

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."

Not otherwise specified (n.o.s) is not used if the flammable liquid (or solid) is identified. Then the name of the specific material is listed before the category (for example, Acetone, Flammable Liquid), followed by its appropriate UN number found in the DOT Hazardous Materials table (49 CFR 172.101).

2. Place all information on outside shipping container as on can (or bottle), specifically:

   - Proper shipping name.
   - UN or NA number.
   - Proper label(s).
   - Addressee and sender.

   Place the following labels on the outside shipping container: "Cargo Aircraft Only" and "Flammable Liquid" (or "Flammable Solid"). "Dangerous When Wet" label shall be used if the solid has not been exposed to a wet environment. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" shall also be marked on the top of the outside container, and upward-pointing arrows shall be placed on all four sides of the container.

5.4.3 Shipping Papers

1. Use abbreviations only where specified. Complete the carrier-provided bill of lading and sign certification statement (if carrier does not provide, use standard industry form, see Attachment D). Provide the following information in the order listed (one form may be used for more than one exterior container).

   - "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."
   - "Limited Quantity" (or "Ltd. Qty.").
   - "Cargo Aircraft Only."
   - Net weight (wt) or net volume (vol), just before or just after "Flammable Liquid, n.o.s." or "Flammable Solid, n.o.s.," by item, if more than one metal can is inside an exterior container.
   - "Laboratory Samples" (if applicable).

2. Include Chain-of-Custody Record, properly executed in outside container.

3. "Limited Quantity" of "Flammable Liquid, n.o.s." is limited to one pint per inner container. For "Flammable Solid, n.o.s.," net weight of inner container plus sample shall not exceed one pound; total package weight shall not exceed 25 pounds.

5.4.4 Transportation

1. Transport unknown hazardous substance samples classified as flammable liquids by rented or common carrier truck, railroad, or express overnight package services. Do not transport by any passenger-carrying air transport system, even if they have cargo-only aircraft. DOT regulations permit regular airline cargo-only aircraft, but difficulties with most suggest avoiding them. Instead, ship by airline carriers that only carry cargo.

2. For transport by government-owned vehicle, including aircraft, DOT regulations do not apply. However, procedures described above, with the exception of execution of the bill of lading with certification, shall still be used.

6.0 REFERENCES

U.S. Department of Transportation, 1983. Hazardous Materials Regulations, 49 CRF 171-177.

NUS Standard Operating Procedure SA-6.1 - Sample Identification and Chain-of-Custody

NUS Standard Operating Procedure SA-1.2 - Sample Preservation

NUS Standard Operating Procedure SF-1.5 - Compatibility Testing

7.0 ATTACHMENTS

Attachment A - DOT Hazardous Material Classification (49 CFR 173.2)
Attachment B - DOT List of Class "A" Poisons (49 CFR 172.101)
Attachment C - Hazardous Materials Shipping Checklist
Attachment D - Standard Industry Certification Form

ATTACHMENT A

DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2)

1. Radioactive material (except a limited quantity)
2. Poison A
3. Flammable gas
4. Nonflammable gas
5. Flammable liquid
6. Oxidizer
7. Flammable Solid
8. Corrosive material (liquid)
9. Poison B
10. Corrosive material (solid)
11. Irritating material
12. Combustible liquid (in containers having capacities exceeding 110 gallons [416 liters])
13. ORM-B
14. ORM-A
15. Combustible liquid (in containers having capacities of 110 gallons [416 liters] or less)
16. ORM-E

ATTACHMENT B

DOT LIST OF CLASS "A" POISON (49 CFR 172.101)

Material	Physical State at Standard Temperature
Arsine	Gas
Bromoacetone	Liquid
Chloropicrin and methyl chloride mixture	Gas
Chloropicrin and nonflammable,nonliquefied compressed gas mixture	Gas
Cyanogen chloride	Gas (>13.1°C)
Cyanogen gas	Gas
Gas identification set	Gas
Gelatin dynamite (H. E. Germaine)	----
Grenade (with Poison "A" gas charge)	----
Hexaethyl tetraphosphate/compressed gas mixture	Gas
Hydrocyanic (prussic) acid solution	Liquid
Hydrocyanic acid, liquefied	Gas
Insecticide (liquefied) gas containing Poison "A" or Poison "B" material	Gas
Methyldichloroarsine	Liquid
Nitric oxide	Gas
Nitrogen peroxide	Gas
Nitrogen tetroxide	Gas
Nitrogen dioxide, liquid	Gas
Parathion/compressed gas mixture	Gas
Phosgene (diphosgene)	Liquid

ATTACHMENT C
HAZARDOUS MATERIALS SHIPPING CHECKLIST

PACKAGING

1. Check DOT 172.500 table for appropriate type of package for hazardous substance.
2. Check for container integrity, especially the closure.
3. Check for sufficient absorbent material in package.
4. Check for sample tags and log sheets for each sample, and chain-of-custody record.

SHIPPING PAPERS

1. Check that entries contain only approved DOT abbreviations.
2. Check that entries are in English.
3. Check that hazardous material entries are specially marked to differentiate them from any nonhazardous materials being sent using same shipping paper.
4. Be careful all hazardous classes are shown for multiclass materials.
5. Check total amounts by weight, quantity, or other measures used.
6. Check that any limited-quantity exemptions are so designated on the shipping paper.
7. Offer driver proper placards for transporting vehicle.
8. Check that certification is signed by shipper.
9. Make certain driver signs for shipment.

RCRA MANIFEST

1. Check that approved state/federal manifests are prepared.
2. Check that transporter has the following: valid EPA identification number, valid driver's license, valid vehicle registration, insurance protection, and proper DOT labels for materials being shipped.
3. Check that destination address is correct.
4. Check that driver knows where shipment is going.
5. Check that the driver is aware of emergency procedures for spills and accidents.
6. Make certain driver signs for shipment
7. Make certain one copy of executed manifest and shipping document is retained by shipper.

ATTACHMENT D

STANDARD INDUSTRY CERTIFICATION FORM

NO PCS	SIZE	GROSS WEIGHT	H M	D O T PROPER SHIPPING NAME	HAZARD CLASS	CODE	P G	CONTAINER NUMBERS	PLC	BULK
1	55 gal	200 lbs.	x	Nitric Acid, Fuming	Oxidizer	55-OXI	C	1	✓	
1	55 gal	450 lbs	x	Flammable liquid, n.o.s.	Flammable Liquid	55-ABF	—	2		✓
1	55 gal	250 lbs	x	Flammable liquid, n.o.s.	Flammable liquid	55-BII	B	3	✓	
1	15-A	12 lbs.	x	Bromine	Corrosive Material	55-CRI	C	4	✓	

SHIPPER'S CERTIFICATION

This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Shipper's Signature

Placards Req'd _____

Shipment Date _____ Manifest No _____

Shipper Work Order _____

Service Order No _____

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		Prepared Earth Sciences	
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6.0 REFERENCES

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1.0 PURPOSE

This procedure describes the process for keeping a site logbook.

2.0 SCOPE

The site logbook is a controlled document which records all major on-site activities during a Remedial Investigation/Feasibility Study. At a minimum, the following activities/events shall be recorded in the site logbook:

- Arrival/departure of site visitors
- Arrival/departure of equipment
- Sample pickup (chain-of-custody form numbers, carrier, time)
- Sampling activities/sample logsheet numbers
- Start or completion of borehole/trench/monitoring well installation or sampling activities
- Health and Safety issues

The site logbook is initiated at the start of the first on-site activity (e.g., initial reconnaissance survey). Entries are made for every day that on-site activities take place which involve RI/FS contractor personnel. One current site logbook is maintained per site.

The site logbook becomes part of the permanent site file maintained in the RI contractor's office. Because information contained in the site logbook may be admitted as evidence in cost recovery or other legal proceedings, it is critical that this document be properly maintained.

3.0 GLOSSARY

Site Logbook - The logbook is a bound notebook with consecutively numbered pages that cannot be removed. Upon entry of data, the logbook requires signature by the responsible site leader (see Section 5.1).

4.0 RESPONSIBILITIES

The site logbook is issued by the Regional Manager (or his designee) to the Site Manager for the duration of the project. The Site Manager releases the site logbook to the Field Operations Leader or other person responsible for the direction of on-site activities (e.g., Reconnaissance Survey Team Leader, Sampling Team Leader). It is the responsibility of this person (or his designee) to keep the site logbook current while in his possession, and return it to the Site Manager or turn it over to another field team. Following the completion of all fieldwork, the site logbook is returned to the Site Manager for inclusion in the permanent site files.

5.0 PROCEDURES

5.1 GENERAL

The cover of each site logbook contains the following information:

- Project Name
- NUS Project Number
- RI/FS Contractor and Site Manager's Name
- Sequential Book Number

- Start Date
- End Date

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information must be recorded:

- Date
- Start time
- Weather
- All field personnel present
- Any visitors present

During the day, a summary of all site activities and level of personal protection shall be recorded in the logbook. The information need not duplicate that recorded in other field notebooks (e.g., sample logbook, Site Geologist's notebook, Health and Safety Officer's notebook, etc.), but shall summarize the contents of these other notebooks and refer to the page locations in these notebooks for detailed information. An example of a site logbook page is shown in Attachment A.

The sample logsheet for each sample collected (see Procedure SA-6.6) must be referenced. If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the notebook and page number(s) on which they are recorded (see Attachment A).

All entries shall be made in black pen. No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook must be signed. It must also be signed by the Field Operations Leader or responsible site leader at the end of each day.

5.2 PHOTOGRAPHS

When movies, slides, or photographs are taken of a site or any monitoring location, they are numbered to correspond to logbook entries. The name of the photographer, date, time, site location, site description, and weather conditions are entered in the logbook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook. If possible, such techniques shall be avoided, since they can adversely affect the admissibility of photographs as evidence. Chain-of-custody procedures depend upon the subject matter, type of film, and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Adequate logbook notation and receipts may be used to account for routine film processing. Once processed, the slides of photographic prints shall be serially numbered and labeled according to the logbook descriptions.

6.0 REFERENCES

None.

7.0 ATTACHMENTS

Attachment A - Typical Site Logbook Entry

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: _____ DATE: _____

SITE LEADER: _____
PERSONNEL:

NUS	DRILLER	EPA
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenney and fire hoses were set up.

2. Drilling activities at well _____ resumes. Rig geologist was _____. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4 inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well _____.

3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well _____.

4. Well _____ drilled. Rig geologist was _____. See Geologist's Notebook, No. 2, page _____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.

5. Well _____ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."

6. EPA remedial project manger arrives on-site at 14:25 hours.

7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit _____.

8. Test pit _____ dug with cuttings placed in dump truck. Rig geologist was _____. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit _____ resulted in a very soft and wet area. A mound was developed and the area roped off.

9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel offsite, gate locked.

_____
Field Operations Leader

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		Applicability EMG	
		Prepared Earth Sciences	
Subject ONSITE WATER QUALITY TESTING		Approved D. Senovich	

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1.0 PURPOSE

This procedure describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen (DO) Concentration
- Oxidation Reduction Potential
- Certain Dissolved Constituents Using Specific Ion Elements

2.0 SCOPE

This procedure is applicable for use in an on-site groundwater quality monitoring program to be conducted during a remedial investigation or site investigation program at a hazardous or non-hazardous site. The procedures and equipment described are applicable to nearly all aqueous samples, including potable well water, monitoring well water, surface water, leachate and drummed water, etc. and are not, in general, subject to solution interferences from color, turbidity and colloidal material, or suspended matter.

This procedure provides generic information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use.

3.0 GLOSSARY

3.1 pH MEASUREMENT

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution pH.

3.2 SPECIFIC CONDUCTANCE MEASUREMENT

Ohm - Standard unit of electrical resistance (R). A siemen (or umho) is the standard unit of electrical conductance, the inverse of the ohm

Resistance - A measure of the solution's ability to oppose the passage of electrical current. For metals and solutions, resistance is defined by Ohm's law, $E = IR$, where E is the potential difference, I is the current, and R is the resistance.

Conductance - The conductance of a conductor 1 centimeter long and 1 square centimeter in cross-sectional area. Conductivity and specific conductance are used synonymously.

3.3 TEMPERATURE MEASUREMENT

None.

3.4 DISSOLVED OXYGEN MEASUREMENT

Galvanic Cell - An electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit.

Electrolytic Cell - An electrochemical cell in which electrical energy is supplied from an external source. This cell functions in much the same way as a galvanic cell, only in the opposite direction due to the external source of applied voltage.

3.5 OXIDATION-REDUCTION POTENTIAL MEASUREMENT

Oxidation - The process in which an atom or group of atoms loses electrons to achieve an increasing positive charge.

Reduction - The gaining of electrons by an atom or group of atoms and subsequent increase in negative charge.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

3.6 SPECIFIC ION ELECTRODES MEASUREMENT

Specific Ion Electrode - An electrode which develops a potential difference across a membrane in response to the concentration differences for selected ions on either side of that membrane.

4.0 RESPONSIBILITIES

Site Manager - in consultation with the Project Geochemist, is responsible for determining which on-site water quality measurements can contribute to the RI, when these measurements shall be made, and the data quality objectives (DQOs) for these measurements. The Project Operations Plan (POP) shall contain details of type, frequency and locations of the desired measurements.

Project Geochemist - primarily responsible for determining the type, frequency and locations for on-site water quality measurements as presented in the POP and for interpreting the results, including determination of which measurements are unrepresentative.

Field Operations Leader - responsible for implementing the POP, and also for deciding under what field conditions a particular on-site measurement will be unrepresentative or unobtainable.

Field Samplers/Analysts - responsible for the actual analyses that take place, including calibration, quality control and recording of results, as well as for the care and maintenance of the equipment in the field.

5.0 GUIDELINES

5.1 MEASUREMENT OF pH

5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control, is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Measurements of pH can also be used to check the quality and corrosivity of soil and solid waste samples. However, these samples must be immersed in water prior to analysis, and specific techniques are not described.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required, and the pH meter when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or basicity of the solution with the indicator compound on the paper. Depending on the indicator and the pH range of interest, a variety of different colors can be used. Typical indicators are weak acids or bases, or both. Process chemistry and molecular transformations leading to the color change are variable and complex.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to hydrogen ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to hydrogen ion concentration can be generated and measured.

5.1.3 Equipment

The following equipment is needed for taking pH measurements:

- Accumet 150 portable pH meter, or equivalent.
- Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs.
- pH indicator paper, such as Hydrion or Alkacid, to cover the pH range 2 through 12.
- Buffer solutions of pH 4, 7 and 10, or other buffers which bracket the expected pH range.

5.1.4 Measurement Techniques for Field Determination of pH

1. pH Meter

The following procedure is used for measuring pH with a pH meter (Standardization is according to manufacturers instructions):

a. The instrument and batteries shall be checked and calibrated prior to initiation of the field effort.

b. The accuracy of the buffer solutions used for field and laboratory calibration shall be checked. Buffer solutions need to be changed often due to degradation upon exposure to the atmosphere.

c. Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes as some must be stored dry.

d. Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).

e. Immerse the electrode(s) in a pH-7 buffer solution.

f. Adjust the temperature compensator to the proper temperature (on models with automatic temperature adjustment, immerse the temperature probe into the buffer solution). Alternately, the buffer solution may be immersed in the sample and allowed to reach temperature equilibrium before equipment calibration. It is best to maintain buffer solution at or near expected sample temperature before calibration.

g. Adjust the pH meter to read 7.0.

h. Remove the electrode(s) from the buffer and rinse well with demineralized water. Immerse the electrode(s) in pH-4 or 10 buffer solution (depending on the expected pH of the sample) and adjust the slope control to read the appropriate pH. For best results, the standardization and slope adjustments shall be repeated at least once.

i. Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.

j. Read and record the pH of the solution, after adjusting the temperature compensator to the sample temperature. pH shall be recorded to the nearest 0.1 pH unit. Also record the sample temperature.

k. Rinse the electrode(s) with deionized water.

l. Keep the electrode(s) immersed in deionized water when not in use.

The sample used for pH measurement shall never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

2. pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper.

5.2 MEASUREMENT OF SPECIFIC CONDUCTANCE

5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance.

5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not disassociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.2.3 Equipment

The following equipment is needed for taking specific conductance measurements:

- YSI Model 33 portable conductivity, meter, or equivalent
- Probe for above meter

A variety of conductivity meters are available which may also be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirement of the sampling program.

5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturers instructions):

- Check batteries and calibrate instrument before going into the field.
- Calibrate the instrument daily when used. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used. Attachment A may be used for guidance.
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the electrode in the sample and measure the conductivity. Adjust the temperature setting to the sample temperature.
- Read and record the results in a field logbook or sample log sheet.

If the specific conductance measurements become erratic, or inspection shows that any platinum black has flaked off the electrode, replatinization of the electrode is necessary. See the manufacturer's instructions for details.

Note that specific conductance is occasionally reported at temperatures other than ambient.

5.3 MEASUREMENT OF TEMPERATURE

5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury filled or dial-type thermometers. In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used on a collected water sample:

- Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.

- Record values in a field logbook or sample log sheet.

If a temperature meter or probe is to be used, the instrument shall be calibrated according to manufacturer's recommendations with an approved thermometer before each measurement or group of closely spaced measurements.

5.4 MEASUREMENT OF DISSOLVED OXYGEN CONCENTRATION

5.4.1 General

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The method monitoring discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible, and are free from interference caused by color, turbidity, colloidal material or suspended matter.

5.4.2 Principles of Equipment Operation

Dissolved oxygen probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, but to leave the surface of the solution undisturbed.

Dissolved oxygen probes are relatively free of interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide which are not

easily depolarized from the indicating electrode. If the gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

5.4.3 Equipment

The following equipment is needed to measure dissolved oxygen concentration:

- YSI Model 56 dissolved oxygen monitor or equivalent.
- Dissolved oxygen/temperature probe for above monitor.
- Sufficient cable to allow the probe to contact the sample.

5.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked in the laboratory before going to the field.

- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

- The instrument shall be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a water sample of known dissolved oxygen concentration (i.e., determined by Winkler method) or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubilities as a function of temperature and salinity (see Attachment B).

- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane, either by stirring the sample, or placing the probe in a flowing stream. Probes without stirrers placed in wells can be moved up and down.

- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.

- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical. Be sure to record whether the liquid was analyzed in-situ, or if a sample was taken.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

5.5 MEASUREMENT OF OXIDATION-REDUCTION POTENTIAL

5.5.1 General

The oxidation-reduction potential (ORP) provides a measure of the tendence of organic or inorganic compounds to exist in an oxidized state. The technique therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and will be dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

5.5.3 Equipment

The following equipment is needed for measuring the oxidation-reduction potential of a solution:

- Accumet 150 portable pH meter or equivalent, with a millivolt scale.
- Platinum electrode to fit above pH meter.
- Reference electrode such as a calomel, silver-silver chloride, or equivalent.

5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment shall be calibrated and have its batteries checked before going to the field.

- Check that the platinum probe is clean and that the platinum bond or tip is unoxidized. If dirty, polish with emery paper or, if necessary, clean the electrode using aqua regia, nitric acid, or chromic acid, in accordance with manufacturer's instructions.

- Thoroughly rinse the electrode with demineralized water.

- Verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of the test solution is altered. The ORP will increase when the pH of the test solution decreases and the ORP will decrease if the test solution pH is increased. Place the sample in a clean glass beaker and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added, the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions. If the ORP does not respond as above when the caustic is added, the electrodes shall be cleaned and the above procedure repeated.

- After the assembly has been checked for sensitivity, wash the electrodes with three changes of water or by means of a flowing stream of water from a wash bottle. Place the sample in a clean glass beaker or sample cup and insert the electrodes. Set temperature

compensator throughout the measurement period. Read the millivolt potential of the solution, allowing sufficient time for the system to stabilize and reach temperature equilibrium. Measure successive portions of the sample until readings on two successive portions differ by no more than 10 mV. A system that is very slow to stabilize properly will not yield a meaningful ORP. Record all results in a field logbook, including ORP (to nearest 10 mV), sample temperature and pH at the time of measurement.

5.6 SPECIFIC ION ELECTRODE MEASUREMENTS

5.6.1 General

Use of specific ion electrodes can be beneficial in the field for determining the presence and concentration of dissolved inorganic species which may be associated with contaminant plumes or leachate. Thus, electrodes can be used for rapid screening of water quality and determination of water migration pathways.

This procedure provides generic information for specific ion electrodes commonly used in groundwater quality monitoring programs and describes the essential elements of a field investigation program. Analytical methods using some specific ion electrodes have not been approved by the USEPA. In addition, calibration procedures and solutions, interferences and conditions and requirements for use for various electrodes vary greatly. Consequently, review of manufacturer's literature is mandatory prior to use.

5.6.2 Principles of Equipment Operation

All specific ion electrode measurements involve the use of a reference electrode, a pH meter, and a specific ion electrode (SIE). When the SIE and the reference electrode are immersed in a solution of the ion to be measured, a potential difference is developed between the two electrodes. This potential can be measured by a pH meter and related to the concentration of the ion of interest through the use of standard solutions and calibration curves.

Several different types of SIEs are in use: glass, solid-state, liquid-liquid membrane, and gas-sensing. All of the electrodes function using an ion exchange process as the potential determining mechanism. Glass electrodes are used for pH measurement. The glass in the tip of the electrode actually acts as a semi-permeable membrane to allow solution. Solid-state electrodes replace the glass membrane with an ionically-conducting membrane, (but act in essentially the same manner) while liquid-liquid membrane electrodes have an organic liquid ion exchanger contained in the pores of a hydrophobic membrane. Maintenance of the conducting interface, in combination with a reference electrode, allows completion of the electrical circuit and subsequent measurement of the potential difference. Gas-sensing electrodes have a membrane that permits the passage of gas only, thus allowing for the measurement of gas concentration. Regardless of the mechanism involved in the electrode, most SIEs are easy to use under field conditions. The sensitivity and applicable concentration range for various membranes and electrodes will vary.

5.6.3 Equipment

The following equipment is required for performing quantitative analyses using a specific ion electrode:

- A pH meter with a millivolt scale, or equivalent.
- The specific ion electrode for the parameter to be measured. A partial list of ions which can be measured includes cyanide, sulfide, ammonia, lead, fluoride and chloride.
- A suitable reference electrode to go with the above SIE.

Specific electrodes for other ions have also been developed, but are not widely used for field investigation efforts at this time. Note that of the specific electrodes referenced above, only fluoride and ammonia have analytical methods approved by the U.S. EPA.

5.6.4 Measurement Techniques for Inorganic Ions Using Specific Ion Electrodes

Different types of electrodes are used in slightly different ways and are applicable for different concentration ranges. Following the manufacturer's instructions, the general steps given below are usually followed:

- Immerse the electrode in water for a suitable period of time prior to sample analysis.

- Standardize the electrode according to the manufacturer's instructions, including necessary chemical additions for ionic strength adjustment, etc. Standard solutions normally differ by factors of ten in concentration. Constant stirring is needed for accurate readings.

- Immerse the electrode in the sample. Allow the reading to stabilize and record the results in a site logbook. Stir the sample at the same rate as the standards. Air bubbles near the membrane shall be avoided, since this may cause interference in millivolt readings.

(NOTE: Each SIE has substances which interfere with proper measurement. These may be eliminated using pretreatment methods as detailed by the manufacturer. It is important to know if interferences are present so that suspect readings may be noted as such.)

- If the pH meter does not read out directly, plot millivolts versus concentration for the standards and then determine sample concentration.

6.0 REFERENCES

American Public Health Association, 1980. Standard Methods for the Examination of Water and Wastewater, 15th Edition, APHA, Washington, D.C.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

U.S. Geological Survey, 1984. National Handbook of Recommended Methods for Water Data Acquisition, Chapter 5: Chemical and Physical Quality of Water and Sediment. U.S. Department of the Interior, Reston, Virginia.

7.0 ATTACHMENTS

Attachment A - Specific Conductance of KC1 Solutions at 25 degrees Centigrade

Attachment B - Variation of Dissolved Oxygen Concentration in Water as a a Function of Temperature and Salinity.

ATTACHMENT A

SPECIFIC CONDUCTANCE OF M KCl AT VARIOUS TEMPERATURES[1]

Temperature (°C)	Specific Conductance (µmhos/cm)
15	1,147
16	1,173
17	1,199
18	1,225
19	1,251
20	1,278
21	1,305
22	1,332
23	1,359
24	1,368
25	1,413
26	1,441
27	1,468
28	1,496
29	1,524
30	1,552

1 Data derived from the International Critical Tables 1-3-8.

ATTACHMENT B

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature °C	Dissolved Oxygen mg/l					
	Chloride Concentration in Water					Difference/100 mg chloride
	0	5,000	10,000	15,000	20,000	
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.016
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	9.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008

ATTACHMENT B
VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY
PAGE TWO

Temperature °C	Dissolved Oxygen mg/l					
	Chloride Concentration in Water					Difference/100 mg chloride
	0	5,000	10,000	15,000	20,000	
25	8.4	8.0	7.6	7.2	6.7	0.008
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008
30	7.6	7.3	6.9	6.5	6.1	0.008
31	7.5					
32	7.4					
33	7.3					
34	7.2					
35	7.1					
36	7.0					
37	6.9					
38	6.8					
39	6.7					
40	6.6					
41	6.5					
42	6.4					
43	6.3					
44	6.2					
45	6.1					
46	6.0					
47	5.9					
48	5.8					
49	5.7					
50	5.6					

Note: In a chloride solution, conductivity can be roughly related to chloride concenration (and therefore used to correct measured D.O. concentration) using Attachment A.

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1.0 PURPOSE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped offsite for chemical analysis.

2.0 SCOPE

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the quality of the sample prior to analysis.

Many water and soil samples are unstable, and therefore require preservation when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s) requiring analysis. While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that inevitably take place after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s) and refrigeration/ freezing. Their purpose is to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

3.0 GLOSSARY

HCl - Hydrochloric Acid
H_2SO_4- Sulfuric Acid
HNO_3 - Nitric Acid
NaOH - Sodium Hydroxide

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing one gram-atom of replaceable hydrogen or its equivalent. Thus, a one molar solution of HCl, containing one gram-atom of H, is "one-normal," while a one molar solution of H_2SO_4 containing two gram-atoms of H, is "two-normal."

4.0 RESPONSIBILITIES

Field Operations Leader - retains overall responsibility for the proper storage and preservation of samples. During the actual collection of samples, the sampling technician(s) will be directly responsible for the bottling, preservation, labeling, and custody of the samples they collect until released to another party for storage or transport to the analytical laboratory.

5.0 PROCEDURES

5.1 SAMPLE CONTAINERS

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be determined is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then the container shall be plastic. Since container specification will depend on the analyte and sample matrix types (as indicated in Attachment A) duplicate samples shall be taken when both organic and inorganic analyses are required. Containers shall be kept in the

dark (to minimize biological or photooxidation/photolysis breakdown of constituent) until they reach the analytical laboratory. The sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (1 liter of water at 4°C expands by 15 ml if heated to 130°F/55°C), however, head space for volatile organic analyses shall be omitted.

For CLP laboratories, containers will be obtained through the CLP Sample Management Office. For Responsible party actions or non-CLP laboratories, the laboratory shall provide containers that have been cleaned according to U.S. EPA procedures. Sufficient lead time shall be allowed. Shipping containers for samples, consisting of sturdy ice chests, are provided by the laboratory of the remedial investigation contractor.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded; because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing Teflon liner (if required for the container) shall be discarded.

General sample container and sample volume requirements are listed in Attachment A. Specific container requirements are listed in Attachment B.

5.2 PRESERVATION TECHNIQUES

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the Field or added in the Field. In general, aqueous samples of low concentration organics (or soil samples of low or medium concentration organics) are cooled to 4°C. Medium concentration aqueous samples and high hazard organics sample are not preserved. Low concentration aqueous samples for metals are acidified with HNO_3, while medium concentration and high hazard aqueous metal samples are not preserved. Low or medium concentration soil samples for metals are cooled to 4°C while high hazard samples are not preserved.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

5.2.1 Addition of Acid (H_2SO_4, HCl, or HNO_3) or Base

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade and shall be diluted to the required concentration with double-distilled, deionized water in the laboratory, before Field sampling commences:

Acid Base	Concentration	Normality	Amount for Acidification*
HCl	1:1 dilution of concentrated HCl	6N	5-10 ml
H_2SO_4	1:1 dilution of concentrated H_2SO_4	18N	2-5 ml
HNO_3	Undiluted concentrated HNO_3	16N	2-5 ml
NaOH	400 grams solid NaOH in 870 ml water	10N	2 ml**

* Amount of acid to add (at the specified strength) per liter of water to reduce the sample pH to less than 2, assuming that the water is initially at pH 7, and is poorly buffered and does not contain particulate matter.

** To raise pH of 1 liter of water to 12.

The approximate volumes needed to acidify one liter of neutral water to a pH of less than 2 (or raise the pH to 12) are shown in the last column of the above table. These volumes are only approximate; if the water is more alkaline, contains inorganic or organic buffers, or contains suspended particles, more acid may be required. The final pH must be checked using narrow-range pH paper.

Sample acidification or base addition shall proceed as follows:

- Check initial pH of sample with wide range (0-14) pH paper.
- Fill sample bottle to within 5-10 ml of final desired volume and add about 1/2 of estimated acid or base required, stir gently and check pH with medium range pH paper (pH 0-6 or pH 7.5-14, respectively).
- Add acid or base a few drops at a time while stirring gently. Check for final pH using narrow range (0-2.5 or 11-13, respectively) pH paper; when desired pH is reached, cap sample bottle and seal.

  Never dip pH paper into the sample; apply a drop of sample to the pH paper using the stirring rod.

5.2.2 Cyanide Preservation

Pre-sample preservation is required if oxidizing agents such as chlorine are suspected to be present. To test for oxidizing agents, place a drop of the sample on KI-starch paper; a blue color indicates the need for treatment. Add ascorbic acid to the sample, a few crystals at a time, until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume. Add NaOH solution to raise pH to greater than 12 as described in 5.2.1. If oxidizing agents are not suspected, add NaOH as directed.

5.2.3 Sulfide Preservation

Samples for sulfide analysis must be preserved by addition of 4 drops (0.2 ml) of 2N zinc acetate solution per 100 ml sample. The sample pH is then raised to 9 using NaOH. The 2N zinc acetate solution is made by dissolving 220 g of zinc acetate in 870 ml of distilled water to make 1 liter of solution.

5.2.4 Preservation of Organic Samples Containing Residual Chlorine

Some organic samples containing residual chlorine must be treated to remove this chlorine upon collection (See Attachment A). Test the samples for residual chlorine using EPA methods 330.4 or 330.5 (Field Test Kits are available for this purpose). If residual chlorine is present, add 0.008% sodium thiosulfate (80 mg per liter of sample).

5.2.5. Field Filtration

When the objective is to determine concentration of dissolved inorganic constituents in a water system, the sample must be filtered through a non-metallic 0.45 micron membrane filter immediately after collection. A filtration system is recommended if large quantities of samples must be filtered in the field. The filtration system shall consist of a Büchner funnel inserted into a single-hole rubber stopper, sized to form a seal when inserted into the top of a vacuum filter flask equipped with a single side arm. Heavy-wall Tygon tubing shall be attached to the single side arm of the vacuum filter flask and the suction port of a vacuum pump. The stem of the Büchner funnel shall extend below the level of the side arm of the vacuum filter flask to prevent any solvent from entering the tubing leading to the vacuum pump. Before filtration, the filter paper, which shall be of a size to lay flat on the funnel plate, shall be wetted with the solvent in order to "seal" it to the funnel. Slowly pour the solvent into the funnel and monitor the amount of solvent entering the vacuum filter flask. When the rate of solvent entering the flask is reduced to intermittent dripping and the added aliquot of solvent in the funnel has passed through the filter, the used filter paper shall be replaced with new filter paper. If the solvent contains a high percentage of suspended solids, a coarser-sized nonmetallic membrane filter may be used prior to usage of the 0.45 micron membrane filter. This "prefiltering" step may be necessary to expedite the filtration procedure. Discard the first 20 to 50 ml of filtrate from each sample to rinse the filter and filtration apparatus to minimize the risk of altering the composition of the samples by the filtering operation. For analysis of dissolved metals, the filtrate is collected in a suitable bottle (see Section 5.1) and is immediately acidified to pH 2.0 or less with nitric acid whose purity is consistent with the measurement to be made. Inorganic anionic constituents may be determined using a portion of the filtrate that has not been acidified.

Samples used for determining temperature, dissolved oxygen, Eh, and pH should not be filtered. Do not use vacuum filtering prior to determining carbonate and bicarbonate concentration because it removes dissolved carbon dioxide and exposes the sample to the atmosphere. Pressure filtration can be done using water pressure from the well. If gas pressure is required, use an inert gas such as argon or nitrogen.

Do not filter samples for analysis of volatile organic compounds. If samples are to be filtered for analyzing other dissolved organic constituents, use a glass-fiber or metal-membrane filter and collect the samples in a suitable container (see Section 5.1). Because most organic analyses require extraction of the entire sample, do not discard any of it. After filtering, the membrane containing the suspended fraction can be sealed in a glass container and analyzed separately as soon as practicable. Total recoverable inorganic constituents may be determined using a second, unfiltered sample collected at the same time as the sample for dissolved constituents.

6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

U.S. EPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. U.S. EPA-EMSL, Cincinnati, Ohio.

7.0 ATTACHMENTS

Attachment A - General Sample Container and Preservation Requirements CERCLA/RCRA Samples

Attachment B - Required Containers, Preservation Techniques, and Holding Times (3 sheets)

ATTACHMENT A
GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS CERCLA/RCRA SAMPLES

PT-7.06
REVISION 0

	SAMPLE TYPE & CONCENTRATION	CONTAINER[1]	SAMPLE SIZE	PRESERVATION[2]	HOLDING TIME[2]
WATER					
Organics (GC & GC/MS)	VOA	borosilicate glass	2 x 40 ml	Cool to 4°C	7 days
	Extractables Low	amber glass	2 x 2 l or 4 x 1 l	Cool to 4°C	5 days to extraction 40 days after extraction
	Medium	wide-mouth glass	4 x 32 oz	None	Same as above
Inorganics	Metals Low	high density (h.d.) polyethylene	1 l	HNO_3 to pH ≤2	6 months (Hg-30 days)
	Medium	wide-mouth glass	16 oz	None	6 months
	Cyanide Low	h.d. polyethylene	1 l	NaOH to pH >12	14 days
	Medium	wide-mouth glass	16 oz	None	
Organic/Inorganic	High Hazard	8 oz wide-mouth glass	6 oz	None	14 days
COD	--	h.d. polyethylene	0.5 l	H_2SO_4 to pH <2	28 days
TOC	--	h.d. polyethylene	0.5 l	HCl to pH <2	28 days
Oil & Grease	--	glass	1.0 l	H_2SO_4 to pH <2	28 days
Phenols	--	h.d. polyethylene	1.0 l	H_2SO_4 to pH <2	28 days
General Chemistry	--	h.d. polyethylene	1.0 l	None	---
SOIL					
Organics (GC & GC/MS)	VOA	2 x 120 ml (4 oz) wide-mouth glass	240 ml	Cool to 4°C	10 days
	Extractables Low/Medium	8 oz or 2 x 4 oz (120 ml) wide-mouth glass	6 oz	Cool to 4°C	10 days to extraction 40 days after extraction
Inorganics	Low/Medium	8 oz or 2 x 4 oz (120 ml) wide-mouth glass	6 oz	Cool to 4°C	NA
Organic/Inorganic	High Hazard	8 oz (120 ml) wide-mouth glass	6 oz	None	NA
Dioxin	All	4 oz (120 ml) wide-mouth glass	4 oz	None	NA
EP Toxicity	All	250 ml h.d. polyethylene	200 grams	None	NA
Air					
Volatile Organics	Low Medium	Charcoal Tube 7 cm long, 6 mm OD, 4 mm ID	100 l air	Cool to 4°C	NA

1. All glass containers should have Teflon cap liners or septa.
2. See Attachment B.

SAMPLE CONTAINER AND PRESERVATION REQUIRMENTS CERCLA/RCRA SAMPLES

D334901

ATTACHMENT B
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

PAGE 1

Parameter No./Name	Container[1]	Preservation[2,3]	Maximum Holding Time[4]
INORGANIC TESTS:			
Acidity	P,G	Cool, 4°C	14 days
Alkalinity	P,G	Cool, 4°C	14 days
Ammonia	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Biochemical Oxygen Demand	P,G	Cool, 4°C	48 hours
Bromide	P,G	None required	28 days
Biochemical Oxygen Demand, Carbonaceous	P,G	Cool, 4°C	48 hours
Chemical Oxygen Demand	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Chloride	P,G	None required	28 days
Chlorine, Total Residual	P,G	None required	Analyze immediately
Color	P,G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P,G	Cool, 4°C, NaOH to pH 12, 0.6g ascorbic acid[5]	14 days[6]
Fluoride	P	None required	28 days
Hardness	P,G	HNO_3 to pH 2, H_2SO_4 to pH 2	6 months
Hydrogen Ion (pH)	P,G	None required	Analyze immediately
Kjeldahl and Organic Nitrogen	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Nitrate	P,G	Cool, 4°C	48 hours
Nitrate-Nitrite	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Nitrite	P,G	Cool, 4°C	48 hours
Oil and Grease	G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Organic Carbon	P,G	Cool, 4°C, HCl or H_2SO_4 to pH 2	28 days
Orthophosphate	P,G	Filter immediately, Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle and top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle and top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Phosphorus (elemental)	G	Cool, 4°C	48 hours
Phosphorus, Total	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Residue, Total	P,G	Cool, 4°C	7 days
Residue, Filterable	P,G	Cool, 4°C	48 hours
Residue, Nonfilterable (TSS)	P,G	Cool, 4°C	7 days
Residue, Settleable	P,G	Cool, 4°C	48 hours
Residue, Volatile	P,G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P,G	Cool, 4°C	28 days
Sulfate	P,G	Cool, 4°C	28 days
Sulfide	P,G	Cool, 4°C, add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P,G	None required	Analyze immediately
Surfactants	P,G	Cool, 4°C	48 hours
Temperature	P,G	None required	Analyze immediately
Turbidity	P,G	Cool, 4°C	48 hours
METALS:[7]			
Chromium VI	P,G	Cool, 4°C	24 hours
Mercury	P,G	HNO_3 to pH 2	28 days
Metals, except Chromium VI and Mercury	P,G	HNO_3 to pH 2	6 months

ATTACHMENT B
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

PAGE 2

Parameter No./Name	Container[1]	Preservation[2,3]	Maximum Holding Time[4]
ORGANIC TESTS:[8]			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], HCl to pH 2[9]	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], adjust pH to 4-5[10]	14 days
Phenols[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
Benzidines[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction[13]
Phthalate Esters[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitrosamines[11,14]	G, Teflon-lined cap	Cool, 4°C, store in dark, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
PCBs[11] Acrylonitrile	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitroaromatics and Isophorone[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days until extraction, 40 days after extraction
Polynuclear Aromatic Hydrocarbons[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days until extraction, 40 days after extraction
Haloethers[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
Chlorinated Hydrocarbons[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
TCDD[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
PESTICIDES TESTS:			
Pesticides[11]	G, Teflon-lined cap	Cool, 4°C, pH 5-9[15]	7 days until extraction, 40 days after extraction
RADIOLOGICAL TESTS:			
1-5 Alpha, beta and radium	P, G	HNO_3 to pH 2	6 months

TABLE 1 Notes

(1) Polyethylene (P) or Glass (G).

(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4° until compositing and sample splitting is completed.

(3) When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).

(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time, and has received a variance from the Regional Administrator.

(5) Should only be used in the presence of residual chlorine.

(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

(7) Samples should be filtered immediately on-site before adding preservative for dissolved metals.

(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(9) Sample receiving no pH adjustment must be analyzed within seven days of sampling.

(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).

(12) If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxident-free) atmosphere.

(14) For the analysis of diphenylnitrosamine add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

ATTACHMENT B
REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

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		Effective Date 05/04/90	Revision 1
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		Prepared Earth Sciences	
Subject DECONTAMINATION OF CHEMICAL SAMPLING AND FIELD ANALYTICAL EQUIPMENT		Approved D. Senovich	

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7.0 RECORDS

1.0 PURPOSE

The purpose of these procedures is to provide a general methodology, protocol, and reference information on the proper decontamination procedures to be used on chemical sampling and field analytical equipment.

2.0 SCOPE

This procedure addresses chemical sampling and field analytical equipment only, and should be consulted when equipment decontamination procedures are being developed as part of project-specific plans.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Manager - responsible for ensuring that project-specific plans and the implementation of field investigations are in compliance with these guidelines.

Field Operations Leader - responsible for ensuring that decontamination procedures for all chemical sampling and field analytical equipment are programmed prior to the actual field effort and that personnel required to accomplish the task have been briefed and trained to execute the task.

5.0 PROCEDURES

In order to assure that chemical analysis results are reflective of the actual concentrations present at sampling locations, chemical sampling and field analysis equipment must be properly decontaminated prior to the field effort, during the sampling program (i.e., between sample points) and at the conclusion of the sampling program. This will minimize the potential for cross-contamination between sample points and the transfer of contamination offsite.

This procedure incorporates only those aspects of decontamination not addressed in other procedures. Specifically it incorporates those items involved in decontamination of chemical sampling and field analytical equipment.

5.1 ACCESS FOR SAMPLING

5.1.1 Bailers and Bailing Line

The potential for cross-contamination between sampling points via the use of common bailer, or its attached line, is high unless strict procedures for decontamination are followed. It is preferable, for the aforementioned reason, to dedicate an individual bailer and its line to each sample point, although this does not eliminate the need for decontamination of dedicated bailers. For non-dedicated sampling equipment, the following conditions and/or decontamination procedures should be followed.

Before the initial sampling and after each succeeding sampling point, the bailer must be decontaminated. The following steps should be followed if sampling for organic contaminants:

- Potable water rinse
- Alconox or Liquinox detergent wash
- Scrubbing of the line and bailer with a scrub brush may be required if the sample point if heavily contaminated with heavy or extremely viscous compounds
- Potable water rinse
- Rinse with 10 percent nitric acid solution*
- Deionized water rinse
- Acetone or methanol rinse
- Hexane rinse**
- Distilled/Deionized water rinse
- Air dry

If sampling for organics only, the nitric acid, acetone, methanol, and hexane rinses may be omitted. Contract-specific requirements may permit alternative procedures.

Braided nylon or polypropylene lines may be used with a bailer, however, the same line must not come in contact with the sample medium, otherwise, the line must be discarded in an approved receptacle and replaced. Prior to use, the bailer should be wrapped in aluminum foil or polyethylene sheeting.

5.1.2 Sampling Pumps

Most sampling pumps are normally low volume (less than 2 gpm) pumps. These include peristaltic, diaphragm, air-lift, pitcher and bladder pumps, to name a few. If these pumps are used for sampling from more than one sampling point, they must be decontaminated.

The procedures to be used for decontamination of sampling pumps compare to those used for a bailer except the 10 percent nitric acid solution is omitted. Each of the liquid factions is to be pumped through the system. The amount of pumping is dependent upon the size of the pump and the length of the intake and discharge hoses. Certain types of pumps are unacceptable for sampling purposes.

An additional problem is introduced when the pump relies on absorption of water via an inlet or outlet hose. For organic sampling, this hose should be Teflon. Other types of hoses leach organics into the water being sampled (especially the phthalate esters) or adsorb organics from the sampled water. For all other sampling, the hose should be Viton, polyethylene, or polyvinyl chloride (in order of preference). Whenever possible, dedicated hoses should be used.

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* Due to the leaching ability of nitric acid, on stainless steel, this step is to be omitted if a stainless steel sampling device is being used and metals analysis is required with detection limits less than approximately 50 ppb; or the sampling equipment is dedicated.

** If sampling for pesticides, PCBs, or fuels.

5.1.3 Filtering Equipment

Part of the sampling plan may incorporate the filtering of groundwater samples, and subsequent preservation. This should occur as soon after sample retrieval as possible; preferably in the field as soon as the sample is obtained. To this end, three basic filtration systems are most commonly used - the in-line disposable Teflon filter, the inert gas over-pressure filtration system, and the vacuum filtration system.

For the in-line filter, decontamination is not required since the filter cartridge is disposable, however, the cartridge must be disposed of in an approved receptacle and the intake and discharge lines must still be decontaminated.

For the over-pressure and the vacuum filtration systems, the portions of the apparatus which come in contact with the sample must be decontaminated as outlined in the paragraphs describing the decontamination of bailers. (Note: Varieties of both of these systems come equipped from the manufacturer with Teflon-lined surfaces for those that would come into contact with the sample. These filtration systems are preferred when decontamination procedures must be employed.)

5.2 FIELD ANALYTICAL EQUIPMENT

5.2.1 Water Level Indicators

Water level indicators that come into contact with groundwater must be decontaminated using the following steps:

- Rinse with potable water
- Rinse with deionized water
- Acetone or methanol rinse
- Rinse with deionized water

Water level indicators that do not come in contact with the groundwater but may encounter incidental contact during installation or retrieval need only undergo the first and last steps stated above.

5.2.2 Probes

Probes, e.g., pH or specific ion electrodes, geophysical probes, or thermometers which would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise; in those cases, the methods of decontamination must be clearly described in the FSAP. Probes that contact a volume of groundwater not used for laboratory analyses can be rinsed with deionized water. For probes which make no direct contact, e.g., OVA equipment, the probe will be wiped with clean paper-towels or cloth wetted with alcohol.

6.0 REFERENCES

None.

7.0 RECORDS

None.

APPENDIX B.1

USEPA REGION
DRAFT FINAL

GROUNDWATER SAMPLING PROCEDURE
LOW FLOW PURGE AND SAMPLING

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

GROUND WATER SAMPLING PROCEDURE
LOW FLOW PURGE AND SAMPLING

DRAFT FINAL

I. SCOPE & APPLICATION

The purpose of this standard operating procedure (SOP) is to provide information on collecting ground water samples using a pump. The procedure will in most situations provide for the collection of ground water samples with minimum turbidity. This procedure is designed to be used in conjunction with the analyses for the most common types of ground water contaminants (volatile and semi-volatile organic compounds, pesticides, PCBs, metals and inorganic compounds).

II. EQUIPMENT

- Adjustable rate, positive displacement pumps (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). Peristaltic pumps may be used only for inorganic sample collection.
- Clear plastic bottom filling bailer may be used to obtain samples of light or dense non-aqueous liquids (LNAPL, DNAPL).
- Tubing - Teflon or Teflon lined polyethylene must be used to collect samples for organic analysis. For samples collected for inorganic analysis, Teflon or Teflon lined polyethylene, PVC, Tygon or polyethylene tubing may be used.
- Water level measuring device, 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).
- Flow measurement supplies (e.g., graduated cylinder and stop watch).
- Interface probe, if needed.

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

- Power source (generator, nitrogen tank, etc.).
- Indicator parameter monitoring instruments - pH, turbidity, specific conductance, and temperature. Optional indicators - eH and dissolved oxygen.
- Decontamination supplies.
- Logbook(s).
- 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.

III. PRELIMINARY SITE ACTIVITIES

- Check well for damage or evidence of tampering, record pertinent observations.
- Lay out sheet of polyethylene for monitoring and sampling equipment.
- Remove well cap.
- Measure VOCs (volatile organic compounds) 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.
- Measure and record the depth to water (to 0.01 ft) in all wells to be sampled before any purging begins. Care should be taken to minimize disturbance of any particulate attached to the sides or at the bottom of the well.
- Measure and record (as appropriate) the depth of any DNAPL's or LNAPL's with an interface probe. Care should be given to minimize disturbance of any sediment which has accumulated at the bottom of the well. If LNAPL's or DNAPL's are present, a decision needs to be made on whether to collect samples of the free phase liquid(s) and/or the dissolved phase.

IV. SAMPLING PROCEDURE

A positive displacement type pump will be used to purge and sample monitoring wells which have a 2.0 inch I.D. or greater well casing.

Pump, safety cable, tubing and electrical lines will be lowered slowly into the well to a depth corresponding to the center of the saturated screen section of the well. It is also advisable to keep the pump intake at least two feet above the bottom of the well, to prevent mobilization of any sediment present in the bottom of the well.

Measure the water level again with the pump in well before starting the pump. Start pumping the well at 0.2 to 0.5 liters per minute. Ideally, the pump rate should cause little or no water level drawdown in the well (less than 0.3 ft. and the water level should stabilize). The water level should be monitored every three to five minutes (or as appropriate) during pumping. Care should be taken not to cause pump suction to be broken, or entrainment of air in the sample. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump (e.g., 0.1 - 0.2 l/min) to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If the recharge rate of the well is very low and the well is purged dry, then sampling shall commence as soon as the well has recharged to a sufficient level to collect the appropriate volume of samples with the pump.

During purging of the well, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, etc.) every three to five minutes (or as appropriate). The well is considered stabilized and ready for sample collection once all the field indicator parameter values remain within 10% for three consecutive readings. If the parameters have stabilized, but the turbidity is not in the range of the 5 NTU goal the pump flow rate should be decreased, and measurement of the parameters should continue every three to five minutes. Measurements should be obtained using a flow through cell (preferred method) or taken in a clean container (a glass beaker is ideal).

VOCs samples will be collected first and directly into pre-preserved sample containers. All sample containers should be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

Samples requiring pH adjustment will have their pH checked to assure that the proper pH has been obtained. For VOC samples, this will require that a test sample be collected to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If filtered metal samples are to be collected, the use of an in-line filter is preferred. A high pressure, in-line 0.45 um particulate filter will be pre-rinsed with approximately 400 ml of deionized water and attached to the discharge end of the pump's tubing. After the sample is filtered, it must be preserved immediately.

As each sample is collected, the sample will be labeled. Those samples (volatile organics, cyanide, etc.) requiring cooling 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's tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated or properly discarded.

Measure and record well depth.

Secure the well.

V. DECONTAMINATION

Sampling equipment will be decontaminated prior to use and following sampling of each 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 sample) will be decontaminated by one of the procedures listed below. Alternative procedures must be approved by the Quality Assurance Office prior to sampling event.

<u>Procedure 1</u>

- 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 five gallons of non-phosphate detergent solution through the inside of the pump.
- Pump tap water through the inside of the pump to remove all of the detergent solution.

- Pump distilled/deionized water through the pump.

Procedure 2

- The decontaminating solutions can be either be pumped from buckets through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol used in the decontamination process be used sparingly 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 (five gallons).

- Flush with tap water to remove all of the detergent solution.

- Flush with distilled/deionized water.

- Flush with isopropyl alcohol.

- Flush with distilled/deionized water.

VI. FIELD QUALITY CONTROL

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

- Field duplicate.

- Matrix spike.

- Matrix spike duplicate.

- Equipment blank.

- Trip blank (VOCs)

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 three to five minute intervals; calculate or measure 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.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

APPENDIX C

NJDEPE FIELD SAMPLING PROCEDURES

NWS EARLE, NEW JERSEY

APPENDIX C

NJDEPE FIELD SAMPLING PROCEDURES

NWS EARLE, NEW JERSEY

vehicles, custody sealed in shuttles or in the presence of authorized personnel.

C. DECONTAMINATION OF SAMPLING EQUIPMENT

An important aspect of quality control is the decontamination of field sampling equipment. Improperly cleaned and prepared sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination.

The following sampling equipment cleaning procedures (ASTM D-5088-90, "Decontamination of Equipment") are standard requirements of the NJDEPE. Also included are procedures for cleaning heavy equipment and disposal of decontamination fluids and drill cuttings. Exception to the following procedures may be evaluated and approved by NJDEPE on a case-by-case basis if justifications to do so involving site specific issues or conditions are presented and verified beforehand.

1. LABORATORY DECONTAMINATION

In certain instances laboratory decontamination can serve as a viable alternative to field decontamination when sampling a non-aqueous matrix. Some advantages include: 1) decontamination takes place in a controlled environment; 2) reduced need to transport, handle or dispose cleaning solvents, acids or wash water; 3) more attention can be focused upon sampling with field decontamination labor reduced or eliminated; 4) reduced probability of cross-contamination due to improperly field decontaminated equipment; and 5) laboratory documentation of cleaning procedures and materials used. Disadvantages may include: 1) relative cost to scope of sampling event; 2) constraints meeting demands in emergency situations; and 3) logistics.

While the option to use, or not use, laboratory decontaminated field sampling equipment for non-aqueous sampling and certain aqueous sampling equipment exists (i.e., foot check valves, filtering equipment, stainless steel clamps, automatic wastewater composite samplers), there is no option available when sampling ground water with bailers. GROUND WATER SAMPLING DEVICES are required to be laboratory cleaned, packaged and dedicated for exclusive use at one sample location for that day's sampling (see definition of "laboratory cleaned" in the glossary). Field decontamination of bailers elevates the potential of cross-contamination to unacceptable levels. The possibility of contaminating a clean well is also of concern when using improperly cleaned sampling devices.

It is recommended that extra sampling devices be available on-site in the event problems occur which prohibit the use of a particular instrument. When samples are returned to the laboratory, the bailers are also returned so they can be cleaned and prepared for the next sampling event. It is preferred that the lab performing the analysis be the same lab that prepared the sampling equipment. This cannot always be arranged; therefore, make certain the laboratory analyzing the samples will accept samples collected with field equipment not prepared at their laboratory. Also, the cleaning procedure of the laboratory preparing the sampling equipment must be in accordance with NJDEPE requirements. The procedure for laboratory decontamination of dedicated field sampling equipment can be found in Table 2-1.

After this procedure has been completed, the sampling device should be wrapped in cleaned and oven baked aluminum foil (see Chapter 2 footnote #4) or equivalent material and custody sealed for identification. A record should be kept of the date and time and this information should be labeled on the sampling device.

Sampling equipment should remain in the wrapped material until it is used in the field. It should be handled as little as possible prior to use and disposable gloves must be worn at all times when handling cleaned sampling equipment. Sampling equipment must never be stored near solvents, gasoline, exhaust emissions, or other equipment and/or materials that may impact the integrity of prepared sampling instruments.

2. FIELD DECONTAMINATION

In the event that laboratory cleaning is not an option or not feasible, a field cleaning procedure must be used in order to reduce the chances of cross-contamination between sample locations. Several criteria are used to judge whether field decontamination procedures are appropriate. These are:

- Large number of sample locations may be scheduled in a one-day sampling event.

- Matrix of sample: Dedicated sampling equipment is always the preferred option for all matrices, however, it may not be practical for soil sampling

equipment such as split spoons and hand augers. (Ground water sampling equipment must be laboratory cleaned and dedicated to a sampling point per day of sampling.)

Episode logistics: It may be impractical to lab clean and dedicate sampling equipment in a short-term emergency situation because of time and administrative constraints.

Selection of a location for a field equipment decontamination station is also important. It should be located away from any on-site source of contamination so as not to adversely impact the decontamination procedure and close enough to the sampling teams to keep equipment handling to a minimum. The decontamination station must also be set up in such a way as to not adversely impact a clean environment.

Utilization of several units of one type of sampler will allow decontamination teams to rotate equipment more effectively. Tables 2-1 and 2-2 detail the procedures for field decontamination of aqueous and non-aqueous sampling equipment respectively.

The decontamination procedures (Tables 2-1 and 2-2) developed by the NJDEPE, have the concurrence of USEPA, Region II Monitoring Management Branch and follow ASTM D-5088-90 methods. The first step, a detergent and water wash, is to remove all visible particulate matter and residual oils and grease. (This may be preceded by a steam or high pressure water wash to facilitate residual removal). This is followed by a generous tap water rinse and a distilled and deionized water rinse to remove the detergent. If aqueous sampling is to be performed, the following additional steps must be completed. An acid rinse, included if metals samples are to be collected, provides a low pH media for trace metals removal. It is followed by another distilled and deionized water rinse. If the sample is not to be analyzed for metals, the acid rinse and water rinse can be omitted. Next, a high purity solvent rinse is designated for trace organics removal. Acetone has been chosen because it is an excellent solvent, miscible in water and is not a targeted analyte in Priority Pollutant Analysis. If acetone is known to be a contaminant at a given site or Target Compound List analysis is to be performed, Methanol or another solvent may be substituted on a case by case basis <u>with approval</u> from NJDEPE. Note, methanol can not be used when sampling gasoline and its' by products. The solvent must be allowed to evaporate and then a final distilled and deionized water rinse is performed. This rinse removes any residual traces of the solvent.

All equipment utilized for sampling use must be decontaminated using <u>distilled and deionized</u> water. Through distillation, all ionized solids and a broad range of organic constituents will be removed, thus making it an ideal solvent for use when sampling for organic parameters. Deionized water is water that has been effectively freed from any existing ionic impurities. Deionized water should be used when sampling for inorganic parameters. The use of distilled and deionized water, commonly available from commercial vendors, is acceptable provided that the lot number and the associated analysis is available upon request to the NJDEPE.

Whenever sampling, regardless of how equipment has been cleaned, always start sampling in the area of the site with the lowest contaminant probability and proceed to the areas of highest known or suspected contamination. Following this procedure will add another measure of quality control keeping cross contamination interference to a minimum.

3. Decontamination of Pumps

When submersible pumps are used to evacuate stagnant ground water in the well casing, they must be cleaned and flushed prior to and between each use. This cleaning process consists of an external laboratory grade glassware detergent wash and tap water rinse, or steam cleaning of pump casing, hose and cables, followed by a 20 gallon flush of potable water through the pump. This flushing can be accomplished by the use of a clean <u>plastic</u> overpack drum or a <u>plastic</u> garbage can filled with potable water. This must be followed by a distilled and deionized rinse of the outside of the pump. For submersible pumps smaller than four inches in diameter, the recommended number of gallons required for flushing may be proportionately reduced (i.e. three inch - 15 gallons, two inch - 10 gallons). If the evacuation hose is not changed between locations, it must also be decontaminated in the same manner as the pump. <u>Exercise caution to avoid contact with the pump casing and water in the drum while the pump is running (do not use metal drums or garbage cans) to avoid electric shock</u>. Always disconnect the pump from power source before handling. Surface pumps (centrifugal and diaphragm) used for well evacuation need not be cleaned between well locations <u>only if</u> a check valve is used. New ASTM drinking water grade polyethylene tubing must be used for each well and discarded after use. The submersible pump and tubing should always be placed on clean polyethylene sheeting to avoid contact with the ground surface. All tubing must be rinsed/wiped with distilled and deionized water

to remove any residual material before entering the well (Refer to ASTM D-5088-90, "Decontamination of Equipment").

4. Decontamination of Heavy Equipment

Other equipment and material associated with sampling episodes are required to be cleaned prior to usage. Items such as drill rigs, well casing, auger flights, and backhoes all present potential sources of interference to environmental samples. These items may come in contact with the materials adjacent to the matrix being sampled or may be attached to actual sampling equipment which has been cleaned in accordance with procedures set forth in Table 2-2. Heavy equipment may potentially retain contaminants from other sources such as roadways or storage areas or have soil material from previous job sites that have not been removed. For these reasons it is most important that these items be cleaned prior to usage during a site investigation (Refer to ASTM D-5088-90).

Two options are available to accomplish cleaning of heavy equipment: steam cleaning and manual scrubbing. The use of a steam generator can remove visible debris and has several advantages. Steam generators using potable water provide a high pressure medium which is very effective for residuals removal. They are also efficient in terms of ease of handling and generate low volumes of wash solutions.

Potential disadvantages include the need for a fixed or portable power source and they may not be cost effective for use on small pieces of equipment or for one day sampling events.

A second option involves manual scrubbing of equipment using a laboratory grade glassware detergent solution followed by a thorough water rinse. This procedure can be as effective as steam cleaning or preferred in situations where steam cleaning fails to remove visible materials. Disadvantages to manual scrubbing are that it is labor intensive and it generates large volumes of wash and rinse solutions.

The following requirements for cleaning heavy equipment should be incorporated into Field Sampling - Quality Assurance Project Plans where applicable.

5. Decontamination of Backhoes/Drill Rigs

These items should be thoroughly steam cleaned or manually scrubbed upon initial arrival on-site and between drilling or excavation locations. After the initial washing, cleaning may be reduced to those areas that are in close proximity to materials being sampled. The backhoe bucket and extension arm should be cleaned between each individual sample depth and between each test pit excavation. Drill rig items such as auger flights, drill rods, and drill bits must be cleaned between sample locations. Even when Shelby tubes or split spoons are used to collect samples that will <u>not</u> undergo chemical analysis, they must also be steam cleaned or scrubbed between each sample point (Refer to ASTM D-5088-90).

6. Decontamination of Monitor Well Casing and Screen

Before installation, field cleaning of well casing must consist of a manual scrubbing to remove foreign material and steam cleaning, inside and out, until all traces of oil and grease are removed. Special attention to threaded joints may be necessary to remove cutting oil or weld burn residues. The casing should then be handled and stored in such a manner so as to prevent cross contamination prior to installation.

7. Cleaning Location

It is preferred, given site specific conditions, that cleaning of all heavy equipment take place in one central location on site. A designated area or decontamination pad should be established to conduct all cleaning and provisions for containment of wash solutions must be made. All equipment such as drill rigs, backhoes, and other mobile equipment should receive an initial cleaning prior to use at a site. The frequency of subsequent cleanings while on-site will depend on how the equipment is actually used in relation to taking environmental samples. Unless otherwise specified and approved, all wash/rinse solutions should be collected and contained on-site. The actual fate of this material will be determined after review of analytical data generated from samples and on site discharge impacts have been evaluated.

8. Disposal of Drill Cuttings

During the routine course of site investigation, where materials <u>are known</u> (via field instrumentation or visual observation) <u>or suspected</u> (historic information) to be contaminated, sampling activity (i.e., soil boring or installation of monitoring wells) will produce waste intrinsic to the site. The disposition of this material must be carried out in a manner such as not to contribute further environmental degradation or pose a threat to public health or safety.

This material may be disposed of on-site provided: 1) the surface soils in areas of disposal are known or expected to be contaminated at levels above NJDEPE soil standards in effect at that time; 2) the disposed soil/water will not erode/flow either off-site or on-site onto uncontaminated areas; 3) no potential to contaminate an uncontaminated aquifer exists, and; 4) the potential to create a health hazard to adjoining property owners through airborne exposure is non-existent. In addition, the requirements of the New Jersey Pollution Discharge Elimination System (NJPDES) must be followed for discharges to ground or surface waters.

If any of the above conditions cannot be met on-site, the materials must be placed in containers (drums, rolloffs, etc.) and stored in a secure area of the site (fenced or access by unauthorized persons prevented) or transported to a central secured location. The need to perform analyses of the secured material will be determined by NJDEPE. The material will be retained for remediation or disposal in accordance with regulations as part of the selected site remedy.

When test pits are utilized for investigation, material excavated may be returned to the hole, but, excavation below the water table is not allowed. Holes produced from soil borings are to be grouted in accordance with NJDEPE's Water Monitoring Management Program regulations unless NJDEPE determines the material can be returned to the hole. Holes not grouted will be filled with sufficient quantities of material to make up for amount of soil sampled and account for settling thus allowing the hole to return to natural grade.

When materials of a noncontaminated nature are to be disposed of on-site, the following guidelines must be considered: 1) disposed cuttings, soil or water will not erode or flow off-site; 2) disposed water will not flow through an area of contamination and thereby spread it to a clean area; or 3) NJDEPE approves the disposal procedures.

Finally, at off-site (i.e. background) locations where no contamination is expected, the primary consideration is the wish of the property owner. If acceptable to the property owner, drill cuttings and muds from well installation may be raked into adjacent soils. If the property owner requests the uncontaminated material be removed from the site, it is to be properly contained and removed to the site under investigation and disposed of or stored per decision of the NJDEPE. If drill cuttings and/or development water are expected to be contaminated, they are to be removed from the off-site location to a secure on-site location and retained for remediation or disposed of per applicable regulations.

9. Disposal of Development, Purge, Pump Test and Decon Waters

Similar to drill cuttings, an initial determination whether these waste waters should be considered contaminated should be made by evaluating field instrumentation readings or by previous analytical information. Additional field tests to assist in that determination (e.g. pH, color, other physical or chemical characterizations) must be utilized to the maximum extent possible.

Essentially, water generated that is not considered to be contaminated may be re-applied directly to the ground surface and permitted to percolate back into the ground water system. Care should be taken, however, to avoid nuisance situations where the discharge may cause undue concern on the part of property owners or the community. In such cases, it is advisable to dispose of the water into a local stormwater or sanitary sewer system, or collect and discharge the water slowly to avoid such a condition. Please note that all discharges to surface water and/or the sanitary sewer are subject to the permit requirements contained in the NJPDES regulations.

Where the water is considered to be contaminated, the water generated may be re-applied to the ground surface provided all the following conditions are met:

1. The water is not permitted to migrate off-site.

2. There is no potential for contaminating a previously uncontaminated aquifer (for example, the discharge will not be permissible if a lower aquifer is being tested and is contaminated while the upper aquifer is not).

3. The discharge will not cause an increase to ground surface soil contamination.

If the above conditions cannot be met, the water shall be collected and secured at a single location (preferably the primary site under investigation). Collected water may be subsequently re-applied to ground surface only if, based on analytical results, there are indications that the above conditions can be met. If not, arrangements for proper disposal must be accomplished prior to the event.

In addition to the above considerations, the requirements of the New Jersey Pollution Discharge Elimination System (NJPDES) must be followed for all discharges to ground water and stormwater. The NJPDES Program requires the issuance of a permit for these discharges.

It is preferable to complete discharges of development, purge, and decon waters at a single, known contaminated area on-site. This area will be selected by the NJDEPE. In cases where such an area cannot be located, as with contaminated well field projects, discharges will occur as close to the well or sampling location as reasonably possible.

D. PROCEDURES FOR QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

QA/QC samples are intended to provide control over the collection of environmental measurements and subsequent validation, review, and interpretation of generated analytical data. The various types of blank samples currently used by the NJDEPE and related QA/QC concerns such as packaging, handling, preparation and actual procurement of samples from field locations are discussed below.

The trip blank is used exclusively for volatile organic analysis (aqueous sampling only) and its purpose is to measure possible cross contamination of samples during shipping to and from the site. The trip blank is never opened and travels to the site <u>with</u> the empty sample bottles and back from the site <u>with</u> the collected samples in an effort to simulate sample handling conditions. Contaminated trip blanks may also indicate inadequate bottle cleaning or blank water of questionable quality.

The primary purpose of this type of blank is to detect additional sources of contamination that might potentially influence contaminant values reported in actual samples both quantitatively and qualitatively. The following have been identified as potential sources of contamination.

- Laboratory reagent water
- Sample containers
- Cross contamination in shipment, bottle handling and storage
- Ambient air or contact with analytical instrumentation during preparation and analysis at the laboratory
- Laboratory reagents used in analytical procedures

The purpose of a field blank is to place a mechanism of control on sample equipment handling, preparation, storage, and shipment. The field blank travels and is stored with the samples bottles, and is also representative of bottle shipment effects on sample quality. By being opened in the field and transferred over a cleaned sampling device (where applicable), the field blank is indicative of ambient conditions and/or equipment conditions that may potentially affect the quality of the associated samples.

The primary purpose of this type of blank is to provide an additional check on possible sources of contamination beyond that which is intended for trip blanks. A field blank serves a similar purpose as a trip blank regarding blank water quality and sample bottle preparation. However, it is primarily used to indicate potential contamination from ambient air as well as from sampling instruments used to collect and transfer samples from point of collection into sample containers (it may also be referred to as the field rinsate blank).

The following is a breakdown by matrix of blank sample requirements.

1. NON-AQUEOUS MATRIX

a. Field Blanks

i. Description - The performance of field blanks requires two (2) sets of <u>identical</u> bottles; one set filled with demonstrated analyte free water provided by the laboratory performing the sample analysis, and one empty set of bottles. The bottles should also be identical to those provided for aqueous sample collection. Note: Since field blanks are aqueous, the lab must provide water for volatile analysis in 40 ml septum vials. Although for <u>soil VOA sample</u> collection the lab may provide 4 oz wide mouth bottles. At the field location, in an area suspected to be contaminated, the water is passed from the full set of bottles through the dedicated or field decontaminated sampling device(s) and into the empty set of bottles. This will constitute identical bottle to bottle transfer. <u>Field blanks must be preserved in the same manner as samples and only need to be collected and analyzed for volatile organics when volatile organics constitute a parameter being</u>

investigated. On a site specific basis, QA parameter requirements may be amended at the discretion of NJDEPE. Note: for logistical purposes it is recommended that the lab provide at least one extra full 40 ml vial to perform the field blank.

ii. Frequency - For sampling events lasting more than one day, field blanks for the non-aqueous matrix should be performed at a rate of 10% of the total number of samples collected throughout the event. If, for example, 40 samples were to be collected over a six day period, then only four field blanks would be required. For one-day sampling events, with the total number of samples collected being less than 10, it is required that one field blank be collected. On a site specific basis, QA frequency requirements may be amended at the discretion of NJDEPE. However, it is not necessary to collect more than one field blank per day.

b. Trip Blanks

TRIP BLANKS ARE NOT REQUIRED FOR THE NON-AQUEOUS MATRIX unless specifically requested for Special Analytical Services (SAS) by NJDEPE.

2. Aqueous Matrix

a. Field Blanks

i. Description - Same as a.1. above with one exception: Field blanks must be analyzed for all the same parameters as samples collected that day.

ii. Field Blanks are generally not required for potable well sampling events or when a sample is collected directly from a source into a sampling container.

iii. Field Blanks may be required to detect cross contamination from ambient air during potable sampling events if known sources of contamination are within close proximity or monitoring instruments indicate the presence of contamination above background levels.

iv. Frequency - Field blanks for the aqueous matrix must be performed at a rate of one per day.

b. Trip Blanks

i. Description - Trip blanks are required for aqueous sampling events. They consist of a set of sample bottles filled at the laboratory with laboratory demonstrated analyte free water. These samples then accompany the bottles that are prepared at the lab into the field and back to the laboratory, along with the collected samples for analysis. These bottles are never opened in the field. Trip blanks must return to the lab with the same set of bottles they accompanied to the field. At a minimum trip blanks must be analyzed for volatile organic parameters. The inclusion of additional parameters or amendments to the requirements for trip blanks is at the discretion of NJDEPE. Trip blanks and associated samples shall not be held on site for more than two (2) calendar days.

ii. Frequency - Trip blanks must be included at a rate of one per sample shipment (not to exceed two (2) consecutive field days).

3. Air Matrix

Trip and field blank procedures and frequencies for the various air sampling methods available should follow the specifications of the individual analytical method utilized. QA sample requirements may be amended at the discretion of NJDEPE.

4. Blank Water Quality

The demonstrated analyte free water used in the field and trip blanks must originate from one common source and physical location within the laboratory and must be the same as the method blank water used by the laboratory performing the specific analysis. The use of commercially prepared water or water not originating from the laboratory analyzing the samples is not permitted. An exception to this requirement is allowable if:

1. it is the same water used for method blank analysis,
2. the laboratory has analyzed that water and generated data from a specific batch/lot of containers,
3. the blank sample is drawn from an unopened container from the same batch/lot thus documenting the water is free of contaminants (demonstrated analyte free).

The laboratory performing the analysis may be required to provide documentation that trip and field blank water was demonstrated analyte free if contamination is detected in blanks, or at NJDEPE's discretion. This would be verified by analytical results of method blanks run by the laboratory on the day of trip and field blank preparation and shipment. This does not, however, change requirements for the analysis of method blanks on the day of sample analysis at the laboratory.

A method blank is blank water which is carried through the entire sample preparation procedure and analysis at the laboratory. It is utilized as a check on laboratory procedures as well as possible contamination from laboratory equipment (i.e. reagents, glassware, etc.). The use of solid method blanks for volatiles and extractable organics is unacceptable to both USEPA, Region II and NJDEPE. Method blanks associated with non-aqueous samples should consist of laboratory demonstrated analyte free water (documentation available upon request) which is prepared and analyzed in the same manner as the samples.

5. Sample Handling and Holding Times

a. Handling Time

Field and trip blank samples must travel with sample containers and must arrive on-site within one day of their preparation in the lab. Blanks and their associated samples may be held on-site for no longer than two calendar days, and must arrive back in the lab within one day of shipment from the field. This constitutes a maximum of a four (4) day handling time. Blanks and all samples must be maintained at 4°C while stored on-site and during shipment. Sample bottles and blanks must be handled in the same manner prior to their return to the laboratory.

The only acceptable exception to handling time requirements is when sampling stormwater runoff. The spontaneity of storm conditions precludes any possibility for preplanning sample bottle shipment. Therefore, due to these obvious logistical constraints, trip and field blanks are not normally required.

While the exception is understandable, the storage of these sample bottles must be carefully controlled to ensure the possibility of cross contamination is kept to an absolute minimum.

b. Maximum Holding Time

The clock governing holding times for samples and blanks analyzed by Contract Laboratory Program (CLP) methodologies begins when the sample is received in the laboratory as documented on the lab's chain of custody form verified time of sample receipt (VTSR). Holding times for individual parameters are dictated by the specific analytical method being used. The holding time clock for samples and blanks analyzed by SW-846 or 40 CFR, Parts 136 and 141, begins at the time of sample collection. For NJPDES, the holding times are those cited in 40 CFR 136.3.

6. Special Analytical Services (SAS)

It is important to note that both trip and field blanks are only capable of determining that contamination of samples may have occurred from additional sources other than the actual environmental matrix being investigated and cannot identify, but may suggest, possible sources of additional contaminant contribution to the reported analytical values. NJDEPE may also implement additional types of QA/QC blanks (Special Analytical Services - SAS) when initial sampling episodes produce blank contamination that cause the generated data to become suspect. SAS has been developed to help identify the specific source(s) of blank contamination in a particular analytical fraction to aid in the assessment of reported analytical values. To date its primary purpose has been to confirm or eliminate laboratory contaminant sources in blank samples.

An example of special analytical services may be the inclusion of additional blank samples that are prepared at the same time and in the same manner as the trip and field blanks, but are designated for placement in laboratory storage areas, sample preparation areas or perhaps at ambient air ventilators or other field locations. These additional blanks are then subject to the same analysis as the samples to determine if location specific cross contamination during handling/storage may be occurring. SAS may also include the use of alternate analytical methodologies for unique, site specific parameters of concern.

7. Additional QA/QC Samples

Additional parameter blanks may be required in specific cases. NJDEPE may make such a determination during review of the site specific sampling portion of a project plan.

a. Duplicate Samples Obtained in the Field

Collection of duplicate samples provides for the evaluation of the laboratory's performance by comparing analytical results of two samples from the same location. Duplicate samples are to be included for each matrix at a minimum rate of one for every twenty samples (5% of total) and be submitted to the lab as "blind" samples. If less than twenty samples are collected during a particular sampling episode, one duplicate should be performed. Duplicate requirements may be waived or expanded depending on the particular regulatory program or remedial phase involved.

i. Aqueous Matrix Duplicates

Duplicates of water samples (potable well, monitor well, surface water) should be obtained by alternately filling sample containers from the same sampling device for each parameter. Samples for volatile organics analysis from monitor wells should be filled from the same bailer full of water whenever possible and be the first set of containers filled. When other sampling devices are used, the vials for volatile organics should be alternately filled. If heterogeneity is suspected, separate samples of each phase should be collected as the nature of phased liquids precludes homogenization. It is generally not necessary to homogenize ground water or surface water samples.

ii. Non-Aqueous Matrix Duplicates

Obtaining duplicate samples in a soil or sediment matrix requires homogenization of the sample aliquot prior to filling sample containers. Regardless, <u>volatile organic samples must always be taken from discrete locations or intervals without compositing or mixing</u>. This practice is necessary to prevent loss of volatile constituents and to preserve, to the extent practicable, the physical integrity of the volatile fraction (see Chapter 7. "Sample Collection", Section B."<u>Soils</u>" for further information on the procedures for collecting volatile organics). Homogenization of the sample for remaining parameters is necessary to generate two equally representative samples. Note that enough sample must be collected at one time in order to fill all the necessary sample containers. It may be necessary to co-locate or depth integrate collection so enough sample volume is available. A description of this process should be provided in the sampling plan. Moisture content, particle size, and adsorption properties of various soils, sediments, and waste materials may inhibit the ability to achieve complete mixing prior to filling sample containers.

Homogenization should be accomplished by filling a properly decontaminated stainless steel tray or bowl with the sample and mixing it with a decontaminated stainless steel or Teflon [R] instrument. The extent of mixing required will depend on the nature of the sample and should be done to achieve a consistent physical appearance prior to filling sample containers.

Once mixing is completed the sample should be divided in half and containers should be filled by scooping sample material alternately from each half.

Several laboratory methodologies for compositing samples published by the American Society for Testing and Materials (ASTM) have been suggested for use in the field; however, they were not specifically designed for homogenization of known or suspected hazardous materials and often must be "modified" to be useful. They tend to assume a uniform sample exists to begin with and their intent may be to calculate average grain size, predict weight to volume ratios, or to reduce the size of a sample to one more convenient for handling and analysis. They also tend to assume a much larger volume of material will be subject to the particular methodology. Therefore, these methods are not recommended for generating duplicate samples in the field.

b. Splitting Samples with Responsible Parties

When various sites are under investigation, property owners and other interested parties may desire to obtain samples for analysis which are duplicates of those obtained by NJDEPE personnel or contractors. <u>If this becomes necessary, procedures for obtaining duplicate samples described above should be followed.</u>

In order to maintain the integrity of any sample "split" between interested parties, the following procedures shall be followed:

i. Personnel authorized by NJDEPE (e.g. contractors or treatment facilities) using approved NJDEPE sampling methods shall be permitted to obtain all sample aliquots.

ii. Other interested parties must provide their own sample containers, blank samples, preservatives, sample shuttles, chain of custody forms, etc.

iii. Sampling procedures shall be witnessed by NJDEPE personnel to verify consistent handling and packaging of each set of samples.

iv. Analytical data generated by responsible parties which is submitted for purposes of challenging NJDEPE results or for informational purposes only shall first be subject to standard NJDEPE "Quality Assurance Data and Validation of Analytical Sample Deliverables" procedures prior to being evaluated and considered for inclusion in the site evaluation process.

v. Duplicate samples, trip blanks and field blanks must be included as part of those samples which are split between the two or more parties involved.

vi. All interested parties desiring to obtain split samples during planned sampling episodes must provide the Department with a minimum of two weeks notice. This is essential for planning purposes and to avoid confusion or delays in the field.

c. Performance Evaluation Samples (PE)

In certain instances when a laboratory's quality assurance performance is in question, splitting samples may not prove as useful as providing blind performance evaluations samples to a laboratory since analytical performance and accuracy differs from laboratory to laboratory. One laboratory cannot be considered a "referee" whose performance can be considered the standard against which another's can be measured. Performance evaluation samples provide information on a laboratory's performance based upon analysis of that sample which contains parameters of a known and defined concentration. Therefore, at the discretion of NJDEPE, PE samples may be required as a QA/QC check on laboratory performance for a particular sampling event or site investigation.

Performance Evaluation samples can be employed in two ways. First, the PE sample can be used to pre-qualify a laboratory. Since the current NJDEPE Laboratory Certification procedures apply only to aqueous samples, a soil PE sample is useful in pre-qualifying a laboratory for soil or sediment evaluation projects. Second, a PE sample submitted blind with a sample lot to a contract laboratory is an available method for evaluating the quality of the analytical data.

PE samples consist of pre-measured, pre-determined samples of known origin and concentration which are submitted for analysis along with a sample shipment from the field. The PE samples are provided by NJDEPE, and the contractor is responsible for their delivery to the laboratory performing the analysis along with other samples submitted for analysis that day. Data generated from the analysis of a PE sample is then compared to known concentrations as a measure of laboratory performance. Deviations from known concentrations may indicate improper calibration or other laboratory error that may have influenced the results reported for those samples collected in the field.

NJDEPE maintains a bank of PE samples that may be drawn upon for individual sampling events. Dioxin PE samples are the most frequently utilized. Others include PCBs, BNAs, VOAs and Pesticides in soil; Metals in sediment; and EPA prepared PE samples in an aqueous matrix. The particular concentration and species as well as assigned code number remain confidential until data is reviewed and validated.

d. Matrix Spike/Matrix Spike Duplicate Analyses

When performing Contract Laboratory Program (CLP) organic extractable analysis, the laboratory must be supplied with triple sample volume for each Sample Delivery Group (SDG) in order to perform matrix spike and matrix spike duplicate analyses. This does not include field or trip blanks. Blanks do not require separate matrix spike or duplicate analyses regardless of their matrix.

As stated in the CLP Statement of Work (SOW), the limits on an SDG are:

- each case of field samples, or
- each 20 field samples within a Case, or
- each fourteen calendar day period during which field samples in a Case are received (said period beginning with the receipt of the first sample in the SDG), whichever comes first.

e. Background Samples

When background samples are required for comparison of site conditions to the surrounding environment they should be collected and handled in the same manner as all other samples. Requirements for inclusion of background samples are determined on a program specific and/or case by case basis.

f. Dioxin and Furans (PCDDs/PCDFs)

When dioxin or dioxin/furan sampling is performed, quality control samples may be required to accompany environmental samples regardless of the laboratory's status in the Contract Laboratory Program.

The quality control requirements for:

- each case of field samples received or
- each 20 field samples within a case or
- each 14 calendar day period during which field samples in a case are received (beginning with the receipt of the first sample),

whichever is the most frequent, are usually defined by the method of analysis chosen.

The NJDEPE reserves the right to choose one or more of the following quality control samples for incorporation into a sampling event. The quality control samples may be fortified field blanks, field duplicates, matrix spike/martix spike duplicates, a fortified sample for each matrix, and/or a Performance Evaluation sample (PE).

A PE sample may be:

- a sample obtained by the NJDEPE from the Environmental Measurement Soil Laboratory - Las Vegas (EMSL - LV) fortified with a known amount of native 2,3,7,8-substituted PCDDs/PCDFs or other PCDD/PCDF congeners (concentration unknown to the laboratory) or
- an uncontaminated sample obtained by the NJDEPE from EMSL - LV which is to be analyzed by the laboratory for the appropriate PCDDs/PCDFs (concentration unknown to the laboratory) or
- a known blank obtained by the NJDEPE from EMSL - LV that is to be fortified with a known amount of native material (Typically, a resultant concentration of 1 ug/Kg is used for soils/sediments and 10 ng/L is used for water).

E. SAMPLE PRESERVATION REQUIREMENTS

Certain analytical methodologies for specific analytes require chemical additives in order to stabilize and maintain sample integrity. Generally this is accomplished under two scenarios:

- Preservative may be added to the sampling bottles by the laboratory prior to shipment into the field or,

- Preservatives are added in the field immediately after the samples are collected.

Many laboratories provide pre-preserved bottles as a matter of convenience and to help ensure that samples will be preserved immediately upon collection. A problem associated with this method arises if not enough sample is collected, resulting in too much preservative in the sample. More commonly encountered problems with this method include the possibility of insufficient preservative provided to achieve the desired pH level or the need for additional preservation due to chemical reactions caused by the addition of sample liquids to pre-preserved bottles. NJDEPE approves the use of pre-preserved bottles. However, field sampling teams must always check the pH level and be prepared to add additional preservatives to samples if necessary.

When samples are preserved after collection, special care must be taken. The transportation and handling of concentrated acids into the field requires additional preparation and adherence to appropriate preservation procedures. All preservation acids used in the field should be trace metal grade or higher.

The following guidelines are recommended to achieve safe and accurate preservation of samples in the field.

1. Sampling teams must be properly equipped to conduct preservation of samples in the field. To accomplish this task the following items are necessary:

- Graduated pipets
- Pipet bulbs
- Preservatives in glass containers with their content and concentration clearly labeled
- pH paper
- Carrying case clearly labeled and constructed of appropriate material to facilitate safe transportation of preservatives in vehicles and in

the field.

2. Sampling teams must also be properly equipped with appropriate health and safety equipment. Use of and immediate access to the following items are strongly recommended:

- Protective goggles
- Disposal gloves
- Lab apron
- First aid kit
- Portable eye wash station
- Containerized tap water for immediate flushing if spillage occurs onto clothing

3. A level surface area should be designated to conduct preservation activities. A clean sheet of plastic sheeting should be placed over the area and secured.

4. Personnel assigned to conduct preservation activities must be familiar with specified preservation requirements and verify that the necessary pH level has been achieved. To accomplish this task, a small amount of the preserved sample aliquot should be placed into a separate clean beaker or the container lid. The liquid should then be checked with pH paper so as to indicate that the desired pH level has been achieved. Under no circumstances should the test sample aliquot be returned into the container retaining the sample for analysis.

Volatile organics being analyzed for 602, 603, 624 and 1624 (drinking water and wastewater analysis) must be preserved with HCl. Preservation requirements for other individual parameters are referenced in the charts found in Appendix 2-1. These charts also indicate any additional preservation required upon arrival of samples at the laboratory as cited in the specific methodologies. The source of preservatives is also of concern. They may be provided in bulk by the laboratory performing the analysis or purchased from a commercial laboratory supply vendor. All preservative containers must be labeled with respect to contents, concentration, laboratory grade and the date of purchase or preparation. Again, under no circumstances should the test sample aliquot be returned into the container retaining the sample for analysis.

5. Preservation must take place <u>immediately</u> upon sample collection <u>except</u> when samples are to be <u>filtered</u>. Samples requiring filtration must be processed immediately after collection. Filtered samples are then preserved <u>immediately following</u> the filtration process.

6. Samples must be placed into a cooler and maintained at 4° C immediately upon collection and preservation.

TABLE 2-1

AQUEOUS SAMPLING
EQUIPMENT DECONTAMINATION
(Laboratory and Field)

A. All field sampling equipment must be laboratory cleaned, wrapped, and dedicated to a particular sampling point or location during a sampling episode. In instances where this is not feasible, permission for field cleaning must be obtained from the NJDEPE prior to the collection of any samples and be referenced in the approved site specific field sampling quality assurance project plan.

B. The field sampling equipment cleaning and decontamination procedures are as follows:

1. Laboratory grade glassware detergent plus tap water wash
2. Generous tap water rinse
3. Distilled and deionized (ASTM Type II) water rinse
4. 10% nitric acid rinse* (trace metal or higher grade HNO3 diluted with Distilled and deionized (ASTM Type II) H_2O)
5. Distilled and deionized (ASTM Type II) water rinse*
6. Acetone (pesticide grade) rinse**
7. Total air dry or pure nitrogen blow out**
8. Distilled and deionized (ASTM Type II) water rinse**

* Only if sample is to be analyzed for metals.
** Only if sample is to be analyzed for organics.

C. Wherever possible, sampling devices should be numbered in a manner that will not affect their integrity and wrapped in a material (e.g., aluminum foil) that has been cleaned and oven baked at 105° C or cleaned in the same manner as the equipment (see footnote #4, Appendix 2-1). Equipment should be custody sealed and information concerning decontamination methodology, date, time, and personnel should be recorded in the field log book.

D. The use of distilled and deionized water commonly available from commercial vendors may be acceptable for sampling equipment decontamination. NJDEPE may require specific lot numbers from containers or analytical verification that the distilled and deionized water meets ASTM Type II specifications.

E. Hexane is not a necessary solvent for dioxin, PCB, or other chlorinated organic sampling. The cleaning procedure outlined above is adequate for all sampling episodes.

F. In those instances where acetone is a parameter of concern another solvent may be used. All substitutes must be approved by NJDEPE.

G. Decontamination should be carried out over a container and the material properly disposed off-site. Decontamination wastes must be disposed of properly.

representative of actual field conditions for a particular time or location. Additionally, contaminants in one aliquot of sample may be masked when this portion is composited with other, cleaner aliquots.

If compositing is ever allowed in site specific instances, it should occur in the laboratory for hazardous samples, and in the field for wastewater or stormwater samples. Samples should be composited on a weight/weight or volume/volume basis under controlled conditions.

Note: For discussion on duplicate, split, and other QA/QC sample collection requirements see Chapter 2.

3. Laboratory Procurement

The analytical needs associated with the collection of samples should be clearly defined in the site specific sampling plan. Important information regarding the data quality objectives, analytical methods to be employed, turnaround times, deliverables, and funds available must be specified. When choosing a lab, these factors act as a guide. Additional considerations include:

- whether the lab has maintained the required certifications and approvals for specific parameters for which samples are to be analyzed

- whether the lab is available to perform the analysis requested.

- whether the lab has the capacity to handle all the samples that will be delivered.

- whether the lab can perform the analysis within the time frame specified (if applicable).

- the lab's proximity to the site or capability to pick up and deliver as needed.

4. Quality Assurance Samples

When advising the chosen laboratory of the required analyses, specifications regarding quality control samples should be relayed. The lab should be informed as to the rate of inclusion of trip and field blanks, how this water should be provided (e.g., identical sets of filled and empty bottles for field blank collection), the requirements for the quality and origin of the blank water (e.g., the same as the method blank) and the analysis desired (see Chapter 2).

The laboratory's procedure for bottle preparation and storage, blank preparation and mechanism for transport and maintenance of temperature should be evaluated and the associated paperwork should be reviewed for adequacy.

Quality assurance considerations must be addressed prior to sampling. If upon initiation of the sampling it is discovered that one or several quality assurance considerations have not been properly addressed, no sampling should occur. In such a situation, with personnel and equipment on standby in the field, the importance of effective communication with the lab is illustrated.

5. Sampling/Quality Assurance Plans

Since sampling situations vary widely and no universal sampling procedure can be recommended, it is important that a sampling plan or quality assurance project plan be developed per regulatory authority requirements. Most regulatory programs require receipt of proper approvals before sampling begins. In these circumstances, sampling must never begin without an approved quality assurance project plan which details the laboratory QA, field QA and the sampling operations and project organization.

6. Assuring Health and Safety

The health and safety of sampling and support personnel is the most important priority during collection operations. Appropriate portable monitoring devices which have been properly calibrated should be used by properly trained personnel to monitor site conditions. A complete Health and Safety Plan should be developed based on information gathered during the file search and instrument reading from the pre-sampling site visit. This Plan should detail potential hazards, instruments to be used and their calibration and use, level of protection to be worn by personnel during various on-site activities, emergency services locations and phone numbers, etc. To assure health and safety in unknown situations (e.g., sites with little available historic information or in initial entry situations) a worst case scenario should always be assumed until instruments confirm otherwise.

For example, for test pit excavation sampling and sampling of containerized materials, level B personal protection should be utilized. The results of continuous air monitoring may determine that downgrading personnel protection is acceptable.

7. Post Sampling Activities

There are several steps to be taken, even after the transfer of the sample into the sample bottle, that are necessary to properly complete collection activities. Once the sample is transferred into the appropriate container, the bottle should be capped and, if necessary, the outside of the bottle should be wiped with a clean paper towel to remove excess sampling material. The bottle should not be submerged in water in an effort to clean it. Rather, if necessary, a clean paper towel moistened with distilled and deionized water may be used.

The sample should be preserved immediately (4°C or appropriate reagent), properly labeled, packaged for transportation and custody sealed. Information such as sample number, location, collection time and sample description should be recorded in the field logbook. Associated paperwork (e.g., Chain of Custody forms, Sample Analysis Request forms) should then be completed and should stay with the sample. The samples should be packaged in a manner that will allow the appropriate storage temperature to be maintained during shipment to the lab. Samples should be delivered to the lab so the proper temperature level is assured and analytical holding times are not exceeded.

B. SOIL SAMPLING

This recommended protocol outlines procedure, equipment and other considerations specific to the collection of representative soil samples from surface and subsurface locations. When properly followed, these guidelines serve to maintain sample integrity by preserving physical form and chemical composition to as great an extent as possible. In addition to this section, the reader should refer to the following in order to attain a more complete understanding of the requirements associated with soil sampling: Chapter 2. "Quality Assurance"; Chapter 6. "Sample Equipment"; and Chapter 15. "Personnel Protection".

1. Selection of Sampling Equipment

Particular attention should be paid to the soil type being investigated in order to select the most appropriate sampling device. New Jersey's soil types range from the principally unconsolidated sandy soils of the southern coastal plain to the more heterogeneous soils in the north. Generally, the northern region's rocky soil increases the difficulty obtaining a representative sample. Therefore, when sampling outside the coastal plain, extra consideration for the selection and advancement of the sampling device should be factored into planning.

Further, in certain site-specific circumstances, the parameters being investigated or the reagents being used for decontamination may influence the device's type and style of construction. Specifically, the sensitive chemical/physical nature displayed by the volatile organic fraction requires special consideration in sample equipment selection. Sampling devices (e.g., bucket auger) which may churn or otherwise alter or destroy certain physical attributes of the soil (i.e., pore space, vapor pressure, etc.) can cause an unwanted release of volatiles to ambient air. These devices are least recommended for volatile organic sample collection. The recommended device (e.g., soil corer or split spoon) should be used to produce a relatively undisturbed soil core from which soil characteristics (i.e., silt/clay) can be visually identified. The device should also be able to present the soil in such a fashion as to lend reasonable accessibility to field screening instruments (e.g., PID/FID) which in turn will assist in a reasonable interpretation of potential contamination across a measurable segment of the soil horizon. The optimum device will yield a sample which has been minimally disturbed, where any biased sample may be easily identified and whose depth can be determined for future reference. For further clarification, discussion with the regulatory authority is recommended. Correct selection of sampling equipment will not only save time and expense, but will allow for collection of the most representative sample possible.

Typical soil sampling devices and accessories include but are not limited to the following:

- scoop or trowel
- bucket/hand auger
- soil coring device
- silver bullet sampler
- waste pile sampler
- split spoon sampler
- Shelby tube sampler
- mixing bowl or tray
- spatula

All of the above devices must be of stainless steel construction. The only exception to this rule is the split spoon sampler which is commonly constructed of carbon steel.

2. Equipment Preparation

After selection of the proper device, consideration must be given to equipment decontamination. When the decontamination procedure is properly performed (Chapter 2. Table 2-2), the potential for cross contamination can be significantly reduced. Care must be taken if a parameter of concern (i.e. acetone) is part of the decontamination process, or, if the potential for washing out elements and equipment damage by the reagents used during decontamination is a possibility (i.e. nitric rinse on components of a sampling device constructed of bronze or carbon steel). When these site-specific questions arise, discussion with the regulatory authority may be prudent before a sampling plan is finalized (also note Chapter 2. Section C. "Decontamination of Sampling Equipment" and ASTM D-5088-90).

All soil sampling devices used for chemical analysis must be decontaminated prior to use and in between sample locations. Once the equipment has been cleaned, it must be wrapped in aluminum foil which has either been cleaned in the same manner as the sampling device, or cleaned and oven baked as described in Chapter 2. - Footnote number 4.

Additionally, any heavy equipment necessary for the advancement of any sampling device must be steam cleaned prior to and between sample locations. This would include but is not limited to power augers and respective accessories, drill rig, auger flights, drill rods, backhoe buckets etc.

Depending on site conditions or sampling requirements, soil may have to be collected from beneath concrete pads, floors or asphalt paved areas. In these instances, the equipment used to expose the earthern surface must also be steam cleaned or cleaned by a laboratory grade glassware detergent and water wash followed by a distilled and deionized water rinse if the equipment will contact the sample directly. Similar to the treatment of heavy equipment, this procedure must be performed prior to each sample acquisition. Particular attention should be paid to the lubricating water associated with concrete coring equipment. If a potable water source is not available and the potential integrity of the sample is in jeopardy, analysis of the lubricating water used may be necessary.

It can not be overstated that costly and lengthy cleanup or permit decisions are based on the outcome of soil samples collected in relatively short order. Therefore, initial attention to equipment selection and its preparation can offer a significant reduction in oversight expense while providing the most professional results.

3. Soil Logs

During the collection of soil samples, soil logging should be performed in order to develop a description of the subsurface lithology. It is important that each person logging the samples does so in a knowledgeable and consistent manner to insure that strata and contaminant distribution can be correlated from borehole to borehole.

Soil logs must follow one of the following classification systems:

1. Burmeister
2. Unified Soil Classification Systems (USCS)
3. United States Dept. of Agriculture System (USDA)

When logging soils at a site, the same classification system must be used during the entire investigation. Soil descriptions must provide at a minimum the following information in the required format of the classification system chosen:

1. Color - soil colors should be determined with the use of a color chart (i.e. Munsell).
2. Soil Texture - this is the amount of sand, silts and clays in a soil.
3. Particle Shape - shape of individual soil particles.
4. Mottles - blotches or spots of contrasting color interspersed with the dominant soil color.
5. Structure - shape of the natural soil aggregates.
6. Consistence - degree of resistance to breaking or crushing; descriptions will vary with moisture condition.
7. Horizon Thickness - layers of soil with distinct changes of above features.

It is essential that boreholes are accurately logged in order to provide information which is useful in the determination of geological conditions and ultimately in the assessment of contaminant distribution and evaluation of remedial alternatives.
In addition to soil type and physical characteristics, depth to ground water, field instrument measurements, presence of odor, vapors, discoloration and presence of free product must be recorded in the soil log for documentation purposes. Finally, all soil locations

should be photographed.

4. Surface Sample Collection

Determination of the sample location is the first step in sample collection. If a sampling plan has been developed, confirm the locations before sampling by taking the appropriate measurements. If a sampling plan is not available, or relocation due to refusal is necessary, take measurements from fixed objects and record. This will assure that if resampling for further investigation is necessary, the sample locations can be identified at a later date. Next, at the desired location, clear all inconsequential surface debris (e.g., vegetation, rocks, etc.). Donning disposable gloves and using a stainless steel trowel or scoop, collect an adequate portion of soil from a depth of 0-6" for initial investigations. All analytical parameters, <u>except</u> the volatile organic fraction, must be homogenized either in-situ or in a stainless steel bowl or tray before being placed into the sample container.

* Volatile Organic Sampling Depth and Technique

When sampling for the volatile organic fraction at the surface (defined as 0 - 2'), certain specific considerations must be taken. First, the sampling device used must be able to provide a soil core from which a 24" profile can be observed (assuming 100% recovery). Then, disregarding the six inch interval closest to the surface, field screen the core with a properly calibrated PID or FID. Use the procedure described below (5. "Subsurface Sample Collection", 4th paragraph) for soil scoring and instrument recording. The six inch interval registering the highest FID/PID measurement must be subsampled from an undisturbed portion of the core and laboratory analyzed for volatile organics.

If field screening is not conducted, surface depth for volatile organic collection must be based on soil type using the following guidelines:

1. Sample at six to twelve (6 - 12) inches if the soil consists of 50% or more silt/clay.
2. Sample at eighteen to twenty-four (18 - 24) inches if soil consists of 15 - 50% silt/clay.
3. If surface soil consists of less than 15% silt/clay, sample the six (6) inch interval above the water table or a six (6) inch interval within the next lower soil horizon consisting of 15% or more silt/clay, or at nine and one-half - ten (9.5-10) feet, whichever is encountered first.

In all cases, samples must be collected in discrete six inch increments. If more or less than a six inch increment is collected because of poor sample recovery or other field logistical problems, an explanation must be provided in the soil log.

Care must be taken in collecting and handling the sample for volatile analysis. The sample should be transferred into the sample bottle as quickly as possible, without mixing and only with the aid of stainless steel tools. This will assure that the volatile fraction is not lost or compromised. It is also recommended that for volatile organics analysis of soils, the laboratory performing the analysis be instructed to provide wide mouth bottles (4 ounce) for sample collection. The sample should be packed tightly, but not at the risk of creating more volatile loss than necessary. Small rocks or vegetation should be avoided to the extent most practical. Following this procedure will reduce disturbance of the sample and will aid in the prevention of volatile loss.

5. Subsurface Sample Collection

As with the surface samples, all down-hole devices must be thoroughly decontaminated. Once the desired depth is reached, a decontaminated sampling device (e.g., split spoon or Shelby tube) may be advanced by the drill rig. The advancement of any downhole sampling device must follow ASTM #D1586-84 for disturbed (split spoon) samples, or, ASTM #D1586-83 for undisturbed (Shelby tube) samples. Upon retrieval the split spoon should be opened, its contents logged, and then proceeding in the appropriate manner (see paragraph 4 below) transfer the sample into a sample bottle using a decontaminated stainless steel spatula or spoon. If a Shelby tube is utilized it should be properly sealed and prepared for shipment.

When using a split spoon sampling device, the retaining basket must be in place. This will prevent the representative interval contained within the spoon from falling back into the bore hole while mechanically raising the spoon to the surface.

Once retrieved, remove the drive shoe and drive head and strike the spoon to open being cautious to retain all soil in only one split barrel. When mud rotary well construction is being employed in conjunction with split spoon sampling, the top one to two inches of soil in the spoon should be discarded. This is necessary to minimize the impacts of drilling fluid on the sample's analytical results. Immediately collect the volatile fraction (if a parameter of concern) from a discrete

six inch interval. Once this is completed, proceed to mix the remaining sample in a stainless steel mixing bowl or tray before filling the remaining sample containers. Do not collect any sample that has fallen outside of the spoon as unwanted contamination may be introduced.

An air-monitoring device (FID or PID) may be required to record the presence of any volatiles (See Chapter 8 for more information on these instruments). To obtain the most representative monitor reading, use a decontaminated stainless steel spoon, knife or other appropriately constructed device and make a cross sectional slice(s) of the soil core, or, score a longitudinal line the length of the core deep enough to expose a porous surface. Simultaneously place the probe of the monitoring device into the opened area being careful not to touch the sample, or, move the probe slowly above the lateral scoring and record the results. If the probe of an air monitoring device is simply moved above the soil core without breaking the smooth compact surface, instrument readings may be biased low.

Continuous split spoon sampling often calls for field screening of headspace for all collected intervals with only one or two worst case samples being selected for laboratory analysis based on the outcome of headspace readings. While a variety of methods may be employed to obtain a satisfactory result, there are some important points to consider: 1) The sample collected for screening is collected after all other parameters are secured; 2) the headspace sample must be placed in an air tight container (most preferred: zip-lock plastic bag, least preferred: aluminum foil over glass soil jar held in place with rubber bands or screw cap lid); 3) when penetrating the container with a PID or FID probe, keep infiltration of ambient air to an absolute minimum and; 4) warm the sample to induce volatilization prior to monitoring. The value of this seemingly routine procedure is becoming increasingly recognized as a critical component of site investigation. Therefore, it cannot be overstated that the technique utilized be performed with strict attention to detail in order maintain and achieve consistent results.

In addition to soil classification logs, accurate field logs are essential to the evaluation and interpretation of analytical results. A field log for each sampling point should be prepared and include:

- date/time/weather
- sampler/geologist/soil scientist name(s)
- sample point identification (same number used in sampling plan summary table)
- sketch showing the sampling point location (including reference distances)
- depth to water and/or bedrock (refusal) when encountered
- soil profile with Unified Soil Classification System (USCS), Burmeister, or USDA classification system textual classification and blow counts
- sample recovery (and portion submitted for analysis)
- sampling equipment used
- field measures of any monitoring devices, their calibration, and settings
- general comments (e.g., odor, staining, etc.)

When sampling is completed the tailings from the unused portion of the sample should be placed back down the bore hole. This will reduce the surface spreading of potentially contaminated soil taken at depth. In many cases it may also be required to seal bore holes at or near the water table with non-shrinking impermeable material. These holes may otherwise act as a conduit for contamination.

Soil borings may require permits from the NJDEPE. All borings must be performed in accordance with the procedures and regulatory requirements pursuant to the Subsurface and Percolating Water Act, N.J.S.A. 58:4A-4.1 et. seq. This law requires that a permit be obtained prior to drilling a boring greater than 25 feet below grade.

6. Test Pits

Test pit excavation is useful in the identification of waste material buried on site and to determine the soil horizons or any apparent band of soil contamination. However, this method of accessing a sample is limited. Due to the amount of disturbance involved, test pit samples are not reproducible and are not considered to represent the undisturbed formation. Additionally the depth of the evacuation is limited by equipment, visual observation, distance and the integrity of the trench walls. The health and safety hazard associated with test pits is great. Because the trench walls may be unstable, no personnel should enter any test pit that is deeper than three (3) feet. Care must be taken in working near the backhoe. All personnel must be alert to the machine's movement and be prepared for any potential release from the excavation. During test pit operations, the potential exists to leave contaminated soils at the surface where it may not have been present before excavation. Consideration must be given to potential exposures from the contaminated surface

soils. Finally, in areas where surface soil contamination is a problem, this contamination may be carried deeper by excavation and backfilling. In such a situation test pits should not be used.

For these reasons, test pits should only be used as a biased sampling approach when attempting to locate specific hot spots of contamination or to locate specific buried waste. To most efficiently collect representative soil samples at depth, a drill rig should be used.

If, in a specific instance, it is determined that test pits will be utilized to access samples at depth, the backhoe used must be equipped with a protective shield and its operator properly trained in the use of level B respiratory and dermal protection. The backhoe bucket and arm must be thoroughly decontaminated by steam cleaning or standard cleaning procedures for non-aqueous sampling equipment prior to use and between each test pit location.

The operator should be directed to excavate until the sampler indicates that the desired depth has been reached. All excavated material should be placed on a tarp or plastic sheeting. If the pit is shallow (less than three feet) the sampler can enter the pit and collect the soil sample using a decontaminated trowel. As the pit gets deeper, the sampler may collect the soil directly from the bucket of the backhoe in an area where the sample material is not in contact with the bucket. The sample should be transferred from the bucket into the sample container using a decontaminated stainless steel trowel following appropriate collection techniques for volatiles and homogenization of remaining sample parameters in a decontaminated stainless steel mixing bowl or tray.

C. SAMPLING CONTAINERIZED MATERIAL

Sampling containerized materials presents a unique obstacle to field personnel, whether the container involved is a fiber drum or vacuum truck. Container staging, identification and opening are all issues to be considered. Health and safety precautions associated with sampling containerized materials are generally more stringent. Quality assurance guidelines for waste samples, as opposed to environmental samples are unique and each site should be considered individually. When sampling waste materials, high levels of contaminants can be expected. Therefore trip and field blanks may be inappropriate. However, if residual or low-level waste/chemicals are expected (e.g., sampling contaminated soils in drums or containers) trip and field blanks may be appropriate. Quality assurance requirements will be determined by a NJDEPE representative on a site by site basis.

1. Drums, Bags, Sacks, Fiberdrums and Similar Small Containers

Prior to the initiation of the sampling event, all containers should be inventoried. All available information concerning each container should be recorded in the field logbook including the type of container, total capacity estimate, actual capacity (if container is open), markings, labels, color, origin, condition, etc. Photographs should be taken to provide a permanent record.

Depending on the location and position of the containers, it may be necessary to upright and/or relocate them prior to sampling. DRUMS CONTAINING LIQUID WASTE CAN BE UNDER PRESSURE OR VACUUM. A BULGING DRUM SHOULD NOT BE MOVED OR SAMPLED UNTIL THE PRESSURE CAN BE SAFELY RELIEVED. Containers that can be moved should be positioned so that the opening or bung is upright (if the integrity of the container will allow). Containers should not be stacked.

Next, the containers should be marked with an identification number of present and future reference. Enamel spray paint is often suitable for this purpose. Again, photographs of the numbered containers can prove valuable in documenting the containers' condition.

The procedure used to open a container will depend directly upon the container's condition. The sampling team leader should determine which drums will be opened using a remote opening device or penetrating apparatus. If such devices are used, an experienced operator must be employed and specific procedures for assuring health and safety must be clearly defined. All containers should be opened with utmost care. For drums, the bung opening should be loosened slowly with a non-sparking bung wrench. If the bung is badly rusted or frozen, it may be necessary to use a non-sparking hydraulic penetrating device. During container opening operations organic vapor concentrations should be monitored with portable instrumentation. Results should be recorded in the field logbook.

The integrity of the drums may dictate that overpacking is necessary prior to sampling, therefore overpack drums should be available.

contaminants of concern

- disposable dedicated surgical gloves to be changed prior to collection of each sample.

- container for sample

Once the sample location has been determined, sample collection can begin. Wearing a new pair of disposable gloves, sweep all residue in the area to be sampled onto a decontaminated or dedicated dust pan or directly into the sample container. A decontaminated or dedicated spatula may be used to aid in transferring the sample into the sample bottle.

4. Rinsate Samples

This method of sampling is utilized to determine if surfaces contain hazardous waste residual after being cleaned. It is normally associated with drum storage pads, floors of buildings and the inside of waste tanks.

Rinsate samples are performed by collecting the water from the last rinse when cleaning a tank or surface area. This water, which is normally potable water, is then analyzed and compared against a blank consisting of the same type of water.

F. COLLECTION OF SEDIMENT AND LIQUID SAMPLES FROM STREAMS, RIVERS, CHANNELS, SEWERS, PONDS, LAKES, LAGOONS, ESTUARIES AND MARINE WATERS

This recommended protocol outlines procedures and equipment for the collection of representative liquid samples and sediment/sludge samples from standing lakes, ponds and lagoons, and flowing streams, rivers, estuaries, marine waters, channels, sewers and leachate seeps.

The collection of samples from these sources presents a unique challenge. Often sampling can be quite easy and routine (e.g. collecting a surface water sample from a two foot deep stream). Other times, the nature of the site specific condition may dictate that special equipment is needed to access the sample, that health and safety is critical, that proper timing is essential due to tidal fluctuations and/or that flow rate is a factor for consideration.

Prior to sample collection, impoundment characteristics (size, depth, flow) should be recorded in the field log book. Sampling should proceed from downstream locations to upstream locations so that disturbances related to sampling do not affect sampling quality. Additionally if sediment samples will be collected at the same locations as liquid samples, the liquid samples must be collected first.

If the sampling plan calls for the samples to be collected from the shore of one of these impoundments, obtaining it should not be difficult. However health and safety considerations must be addressed. The person collecting the sample should be fitted with a safety harness with a rope secured to an immobile object on shore. Backup personnel should be available to assist in collection and shall be prepared and able to pull the samplers to safety if unstable banks are encountered.

To more adequately characterize the content and/or quality of one of these impoundments, samples may need to be collected from the shoreline, often at various depths. If the content of the channel or impoundment is suspected to be highly hazardous, the risk to sampling personnel must be weighed against the need to collect the sample. Again, each person on the barge or in the boat must be equipped with a life preserver and/or lifeline.

1. Liquids

The sampling of liquids in lakes, ponds, lagoons, streams, rivers, estuaries, marine waters, channels, sewers and leachate seeps is generally accomplished through the use of the following samplers:

- laboratory cleaned sample bottle
- pond sampler
- weighted bottle sampler
- Wheaton dip sampler
- Kemmerer Depth Sampler
- Bacon Bomb Sampler

The factors that will contribute to the selection of the sampler include the width, depth and flow of the location being sampled, and whether the sample will be collected from the shore or a vessel.

For flowing liquids, an additional concern must be addressed. A determination of tidal influences should be made and this influence's effect on the sample collection should be detailed in the sampling plan. At a minimum, the stage of the tide at the time of sample

collection should be recorded. Consideration should be given to sampling at varied tidal stages.

Samplers may encounter situations where rate of flow affects their ability to collect a sample. For fast flowing rivers and streams it may be nearly impossible to collect a mid-channel sample at a specific point. Low flowing streams and leachate seeps present the opposite problem. In these cases the sampler should attempt to find a location where flow is obstructed and a pool is created. If this is not possible, the only way to obtain a sample may be to dig into the sediment with a decontaminated trowel to create a pooled area where the liquid will accumulate.

a. Onshore

If the banks are not sloped the sampling personnel may be able to collect the liquid directly into the sample bottle. In some instances where the liquid to be sampled cannot be reached, a pond sampler, by virtue of its extension capabilities, may be necessary. In this case, assemble the pond sampler ensuring adequate extension to obtain the sample without placing the sampling personnel in danger of falling into the impoundment being sampled. For a stream, channel or river, collect the sample from mid-depth. For standing liquid, collect the sample from just below the surface or at mid-depth. Once the sample is obtained, transfer it directly into the sample bottle. Decontaminate the sampling device before taking the next sample.

b. Offshore

Using the decontaminated sample bottle or pond sampler if necessary, collect a liquid sample. If the liquid has stratified, a sample at each strata should be collected. One of the depth samplers listed will allow collection of discrete representative liquid samples at various depths. Proper use of the sampling device chosen includes slow lowering and retrieval of the sample, immediate transfer of the liquid into the sampling container, and logbook notation of the depth at which the sample was collected. After collection, decontaminate the sampling device before taking the next sample.

c. Stream Sampling

The selection of stream sampling is based on the following criteria:

- to bracket a stream segment traversing a particular geomorphologic zone or land use area;
- to bracket known or potential point and nonpoint sources of pollution;
- streams or stream segments sensitive to water quality changes or consistently exceeding a water quality standard;
- at lake or reservoir inlets and outlets to define the rates of nutrient deposition;
- at the confluence of a tributary to the mainstream river;
- in segments of the river determined to be representative of larger segments.

Sample collection will be in accordance with the following procedures:

i. Composite Sampling

The characterization of a water column generally requires the representation of a cross section of a water body. This characterization is most often achieved with a composite sample procedure.

Water samples can be collected by either wading in the stream using a hand-held sample container or by lowering a depth-integrating sampler (a mechanism designed for holding and submerging the bottle) into the stream from the bridge. When wading, position the sample container upstream relative to stream flow and the wader. When using a depth-integrating sampler the sample should be collected on the upstream side of the bridge, unless stream or site conditions preclude sampling from the upstream side. These methods will minimize the possibility of sample contamination.

The number of individual samples in a composite varies with the width of the stream being sampled. Horizontal intervals should be at least one foot wide. Determine the number of stream intervals by using a tag line, bridge markers or visual inspection. At the interval (or vertical) of apparent maximum discharge determine the equal transit rates (or constant rates of speed) at which the sampling apparatus is to be lowered and then raised at all succeeding verticals. Lower and raise the sampling apparatus at a rate which, when all the verticals through the water column are sampled, will provide an adequate sample volume. Contact with the stream bed should be avoided to decrease the

possibility of resuspended material entering the sample container. The contents of the sample container are then emptied into the churn splitter for rinsing of the churn.

The transit rate, number of verticals and the number of passes at each vertical are influenced by the volume of water required for the parameters to be analyzed and the mixing characteristics of the stream. A narrow or shallow stream may require each vertical to be sampled more than once, but all verticals must be sampled the same number of times. The compositing of the verticals in the churn splitter creates a single cross-sectional representation of the stream. The composited sample must now be split into the necessary subsamples as explained below. Samples collected for organic analysis, organic carbon, pesticides, herbicides and bacteria should not be composited in the churn splitter nor collected in any plastic device because of the potential for contamination. These parameters require glass samplers and containers. The CHURN SPLITTER is a 1/4 in. thick polyethylene cylinder, 8 inches in diameter and 10.5 inches deep, holds a volume of 8.6 liters and has a lid. The valve and spout are polypropylene. The stirring disc is a 3/8 in. thick polypropylene disc 9 15/16 inches in diameter with 16 apertures; 9 as scallops in the outer edge, and 8 in a inner circle. The handle, a 1 in. diameter by 18 in. long polypropylene rod, is welded perpendicular to the center of the disc and supported by four ribs. A small "lip" on the disc aligns with the valve and a guide notch and rib are provided to maintain the correct alignment.

The SAMPLE SPLITTING PROCEDURE requires a total sample volume of 3 to 8 liters of which 1 to 6 liters are suitable for composited water column subsamples. The remaining two or more liters may be used for filtered subsamples if required by the analytical schedule. If not, they may be discarded. This size churn splitter does not reliably produce representative composited water column subsamples when it contains less than 2 liters. Before collection of the representative sample of the streamflow, determine the total volume needed. Add to this volume at least 10% to cover filter losses and rinse water. Collect approximately one liter of water and thoroughly rinse the churn splitter.

When the required volume plus 10% for waste is collected in the splitter, place all subsample containers within easy reach so that once started, the stirring can be continuous. The sample should be stirred at a uniform rate of approximately 9 inches per second. If faster or slower churning rates are used, maximum errors of 45% to 65% are possible. As the volume of sample in the splitter decreases the round trip frequency should be increased so that the churning disc velocity is constant. The disc should touch bottom, and every stroke length should be as long as possible without breaking the water surface. If the stroke length, and or disc velocity, is increased beyond the recommended rate, there is a sudden change of sound and churning effort which is accompanied by the introduction of excessive air into the mixture. This is undesirable because excessive air may tend to change the dissolved gases, bicarbonate, pH and other characteristics. On the other hand, inadequate stirring may result in non-representative subsamples. The sample in the splitter shall be stirred at the uniform churning rate for about 20 strokes prior to the first withdrawal to establish the desired churning rate of 9 inches per second and to insure uniform dispersion of suspended matter. The sample containers are to be rinsed with churned sample water prior to filling them.

NOTE: Bottles that have preservatives should not be rinsed, i.e. acid-rinsed bottles for metals sampling and hexane-acetone rinsed bottles for pesticides samples, or those pre-preserved by the laboratory.

When all composited water column subsamples have been obtained, the remaining portion of sample is used for filtered samples. Rinse the bottles for filtered samples with filtered water first. When all of the necessary filtered subsamples have been obtained, the mixing tank, churning disk and filtered apparatus shall be rinsed thoroughly with distilled/deionized water.

NOTE: The churn splitter lid should be kept on at all times except when pouring samples, in order to protect samples from dust contamination.

ii. Grab Sampling

This alternative to composite sampling is used when natural stream conditions (i.e. uniform mixing, high velocity make compositing unnecessary, when requested parameters require special handling or when non-representative samples are desired. Prerinse the sample container with water from the site. Position the appropriate sample container upstream below the surface and allow the container to fill as required. The grab sample may also be performed as a dip or surface sample when the stream velocity is too high for sampler penetration to any significant depth, when there is large floating and submerged debris, or when the stream is very shallow.

iii. Point Sampling

Point sampling is used to obtain a water sample from a specific depth in the liquid column. A Kemmerer sampler or similar device is lowered to the appropriate depth and a weighted messenger is sent down the suspension line to trigger the closing mechanism. The sample may be composited with other point samples or placed directly into the sample containers prerinsed with water from the same point in the water column. A point sample may also be taken in shallow waters by holding a sample container with the top still on below the surface at the desired depth, removing the top and allowing the container to fill to the required volume then replacing the top and removing the container from the liquid.

2. Lake Sampling

The sampling of lakes is performed with methods similar to those of stream sampling. Surface samples should be taken at a depth of one meter. If temperature recordings at varied depths indicate a stratification of the lake, point (discrete) samples shall be taken in the observed layers using a Kemmerer sampler. These samples may be composited or analyzed individually. A PVC sampler may be used to lower a bottle through a vertical or several verticals which may then be composited depending on the purpose of the sampling program. Care should be taken when sampling from a boat that water is not disturbed by the wake of the boat.

3. Estuarine and Marine Sampling

The sampling of estuaries and marine waters is performed with the methods used in the sampling of streams and lakes. Stratification in estuaries is observed with the recording of specific conductivities/salinities along a vertical to the estuary bed. Sampling schedules must consider tidal stages and currents. Sampling from a boat should be performed as far from the stern as possible and only after the turbulence from the wake has subsided. The site should be approached from downstream.

4. Bacteriology

Bacteriology samples are to be collected directly into the special bacteriological container. Sample collection devices (i.e. composite samplers, sewage samplers, etc.) are not to be used for bacteriological sampling unless otherwise stated. The following methods are to be employed:

When sampling a stream, lake, bay or wastewater discharge, a grab sample is obtained in the following manner:

Take a bacteriological sample container and remove the covering and closure (protect from contamination). Grasp the container at the base with one hand and plunge the container (opening down) into the water to avoid introducing surface scum. DO NOT RINSE THE CONTAINER. Position the mouth of the container into the current away form the hand of the collector and away from the sampling platform or boat. The sampling depth should be 15 to 30 cm (6 to 12 inches) below the water surface. If the water body is static, an artificial current can be created by moving the container horizontally in the direction it is pointed and away from the sampler. Tip the container slightly upwards to allow air to exit and the container to fill. After removal of the container from the water, pour out a small portion of the sample to allow an air space of 2 to 3 cm (1 inch) above the sample for proper mixing of the sample before analysis. Tightly close and label the container.

When collecting a sample at a depth greater than an arm's reach, use a Kemmerer or weighted container sampler. The devices are lowered into the water in the open position, and a water sample is collected in the device. The Kemmerer sampler is closed by a drop messenger. The Kemmerer sampler should not be used to collect bacteriological samples without obtaining data that supports its use without sterilization.

5. Sediments and Sludges

The sampling of sediments/sludges in lakes, ponds, lagoons, streams, rivers, channels, sewers and leachate seeps is generally accomplished through the use of one of the following stainless steel or PTFE samplers:

- scoop or trowel
- sampling trier
- bucket auger
- soil coring device/silver bullet sampler
- Veihmeyer sampler
- waste pile sampler
- split spoon sampler
- Ponar dredge

The factors that contribute to the selection of a sampler include the width, depth, flow and bed characteristics of the impoundment or stream to be sampled, and whether the sample will be collected from

the shore or a vessel.

a. Sediment

Sediments (aka "bottom material") is a heterogeneous media and therefore care must be taken when designing an adequate sampling plan to ensure collection of representative samples. There are numerous factors such as particle size, organic content, stream flow, resuspension rate, biological activity, and physical/chemical properties which affect the concentration and distribution of contaminants in a sediment system.

The goals of sediment sampling are: 1) identify areas of highest contamination/impact; 2) to delineate the full spatial extent of contamination/impact and/or 3) determine ambient conditions. The areas of greatest contamination will occur in depositional areas in aquatic systems and these areas must be specifically targeted by the sampling plan except in ambient monitoring where a spatial composite would be appropriate. The sampling team should specify the location of samples, the collection protocol, and the type(s) of sampling apparatus in the sampling plan. The plan should be thoroughly reviewed prior to implementation.

An adequate assessment of sediment quality involves four components:

1. The concentration of contaminants (Bulk chemistry)
2. Potential for contamination of the environment [elutriate, Extration Procedure (EP) and Toxicity Characteristis Leaching Procedure (TCLP)].
3. A measure of bioavailability and toxicity of environment samples (Tissue analysis toxicity testing)
4. Assessment of resident biota (Community bioassessment International Joint Commission 1988, Chapman 1989, USEPA 1989).

These four components provide complementary data and no single component can be used to predict the measurements of the other components. For instance, sediment chemistry provides information on the extent of contamination but not on biological effects. Sediment toxicity tests provide direct evidence of sediment toxicity but cannot discriminate among contaminants nor predict actual in-situ responses. In-situ responses of resident biota, measured by infauna community analysis, provides direct evidence of contaminant-related effects, but only if confounding effects not related to pollution can be excluded. Sediment evaluation must be based on several techniques to provide strong evidence for the identification, delineation, and ranking of pollution induced degradation.

It is imperative that in sediment sampling, all data be collected considering the overall needs of the assessment. As noted, bulk chemistry data may need to be supplemented with additional information such as total organic carbon, pH, and particle grain size in addition to site specific analytical parameters. This information is not only necessary to fully characterize each sediment sample, but will also assist in any subsequent modeling and assessment efforts.

If the contamination event or the greatest contamination occurred in the past, it is likely that recent actions have resulted in the deposition of a layer of relatively uncontaminated sediment on top of the sediments of concern. Commonly used dredges collect only near-surface sediments and will result in data biased low. In these situations, sediment corers may be the most appropriate sampling device. Additionally, the analysis of the sediment can include fractioning of the various layers found in the sediment cores (i.e., oxic an anoxic zones).

Particular attention should be paid to chemicals that are very persistent in the aquatic environment, have high bioaccumulation potential, have high toxicity to aquatic organisms, and have a high frequency of detection.

Surface water data should be included in the overall hazard assessment for sediments. However, in aquatic systems that contain quiescent waters such as lakes, wetlands, ponds, and intermittent or slow moving streams, the release of contaminants from the sediment may play a significant role in surface water quality. Lake stratification and associated anoxia may affect the exchange of contaminants at the water sediment interface. Under these conditions it may be necessary to collect seasonal samples or discrete samples at various depths. Elevated concentrations of contaminants in the water column are indicative of a higher degree of concern associated with contaminated sediments.

Note: When sampling for both surface water and sediment at the same location, always collect the surface water sample first. If the samples being collected are from a flowing stream, always start from a downstream location and proceed upstream. If samples are being collected from a landfill seep, collect the

sediment sample first and then create a small excavation. This will allow for the partial submersion of leachate sample containers. After the excavation disturbance has had time to fill with leachate, proceed with sampling.

Once contaminants of concern for sediments have been identified, further evaluation of the ecosystem in question should be performed. It must be emphasized that the screening levels criteria can only evaluate the potential for biological effects to occur. In the environment, may factors such as bioavailibility, species composition, natural physical and chemical characteristics will determine whether actual adverse effects become expressed.

In collecting sediment samples from any source, care must be taken to minimize disturbance and sample washing as it is retrieved through the liquid column above. Sediment fines may be carried out of the sample during collection if the liquid above is flowing or deep. This may result in collection of a non-representative sample due to the loss of contaminants associated with these fines. While a sediment sample is usually expected to be a solid matrix, sampling personnel should avoid placing the sample in the bottle, and decanting off the excess liquid. Decantation promotes the loss of water soluble compounds and volatile organics present in the sediment. If the sample is collected properly, any liquid that makes it into the bottle is representative of sediment conditions.

As with aqueous sampling, a determination of tidal influences on the impoundment being sampled should be made and its effect on sample collection should be detailed in the sampling plan. At a minimum, the stage of the tide at the time of sample collection should be recorded. Consideration should be given to sampling at varied tidal stages.

i. Onshore

If liquid flow and depth are minimal and sediment is easy to reach, a trowel or scoop may be used to collect the sediment. However, where the liquid above the sediment collection point is flowing or is greater than four (4) inches in depth, a corer or other device that eliminates sample washings should be used to collect the sample in an attempt to minimize washing the sediment as it is retrieved. One of the coring devices listed in Chapter 6 will allow the collection of an undisturbed core of sediment. If homogenization is not required, a decontaminated trowel constructed of appropriate material should be utilized to transfer the sample from the corer directly into the bottle. After collection decontaminate the sampling device before collecting the next sample.

ii. Offshore

In some instances, the dimensions of the impoundments or channel dictate that a barge or boat must be used. The device used for the sample collection in this case will, again, depend upon the depth and flow of the liquid above the sample location and the bed characteristics of the impoundment. Generally, trowels or scoops cannot be used in an offshore situation. Instead, cores or dredges are more efficient means for sample collection. The barge or boat should be positioned just upstream (if it is a flowing impoundment) of the desired sample location. As the corer or dredge is lowered it may be carried slightly downflow, depending on the force of the flow. Upon retrieval transfer the contents of the corer or dredge directly into the sample bottle using a decontaminated trowel of appropriate construction. Decontaminate both the corer or dredge and the trowel before collecting the next sample.

iii. Procedure

Sediment samples collected from the surface layer of a lake bottom or stream bottom may be obtained using an Eckman dredge, Ponar dredge or hand scoop. If deeper sediment samples are required, a core sampler should be used. Loss of contaminates should be avoided by utilizing plastic bottles when sampling for metals and using brown borosilicate glass containers with Teflon[R] lined lids for organics.

If compositing or homogenization of sediment samples is necessary, the optimal methods will depend on the study objectives. Important considerations include: loss of sediment integrity and depth profile; changes in chemical speciation via oxidation and reduction or other chemical interactions; chemical equilibrium disruption resulting in volatilization, sorption, or desorption; changes in biological activity; completeness of mixing; and sampling container contamination. Several studies of sediment toxicity suggest it is advantageous to subsample the inner core area since this area is most likely to have maintained its integrity and depth profile and not be compromised by contact with the sampling device. Subsamples from the depositional layer of concern, for example, the top 1 or 2 cm should be collected with the appropriate sampling tool. Remember, samples are frequently of a

mixed depth but a 2 cm sample is the most common depth obtained.

For some studies it is advantageous or necessary to composite or mix single sediment samples. Composites usually consist of three to five grab samples. Subsamples collected with a decontaminated appropriate sampling scoop should be placed in a decontaminated appropriate bowl or pan. The composite sample should be stirred until texture and color appear uniform. Due to the large volume of sediment which is often needed for toxicity or bioaccumulation assays and chemical analyses, it may not be possible to use subsampled cores because of sample size limitations. In those situations, the investigator should be aware of the above considerations and their possible biased affect on assay results as they relate to in-situ conditions.

If samples are to be analyzed from a certain particle size fraction or if the laboratory has maximum particle size limitations (generally 2 mm) the samples must be sieved before transfer to the sample bottles. Properly decontaminated, sieves of the appropriate construction (i.e., metal for organics and plastics or PFTE for metals) must be used. All sediment samples should arrive at the laboratory within the specified analytical method holding time, at 4° Celsius and in the appropriate containers.

b. Sludge

All sludge samples shall be representative for the chemical and physical characteristics of the sludge removed from the treatment unit process immediately preceding ultimate management. For example, if a treatment works discharges dewatered filter cake for land application, then sampling activity must focus on the output sludge stream from the dewatering device (that is, vacuum filter, bed press, etc.)

Sampling locations shall be as follows unless alternate sampling locations are approved by the Department

- Sampling points for liquid sludges shall be at taps on the discharge side of the sludge pumps.

- For treatment works utilizing drying beds, one quarter cup sludge samples should be taken at five foot intervals across the bed surface. Neither the weathered surface nor sand should be included in the sample.

- For treatment works processing a dewatered sludge cake, sampling of the sludge should be taken from the point of sludge cake discharge.

- For treatment works with a heat treated sludge, samples shall be taken from taps on the discharge side of positive displacement pumps after decanting for the heat treatment unit.

When a treatment works generates several different types of sludge (for example primary, secondary or advanced wastewater treatment sludges) each of which is removed separately for ultimate management, separate composite samples shall be collected and analyzed.

The sample collection, handling and preservations techniques set out in Appendix 2-1 shall be followed for all sludge analyses. Samples requiring preservation shall be preserved at the time of collection. If a preservative cannot be utilized at the time of collection (that is, incompatible preservation requirements), it is acceptable to initially preserve by icing the entire sample during compositing and immediately ship it to the laboratory at the end of the sampling period. Upon receipt in the laboratory, the sample shall be properly preserved.

All samples shall be chilled at four degrees Celsius during compositing and holding. For dewatered or dried sludge samples, preservation shall consists of chilling to four degrees Celsius. Use of a chemical preservative is generally not useful due to failure of the preservative to penetrate the sludge matrix.

G. FLOW MEASUREMENTS

During the course of site investigations it is often necessary to assess the quality and quantity of liquids flowing in channels. While the quality of liquid is determined through sampling and analysis, determinations of quantity of flow are made through the use of field measurements. Flow information should be gathered when samples are collected to allow a full characterization of the channel. Flow measurements also may be made without the collection of samples when assessing the channel's potential as a migratory pathway for pollutants.

Flow is the amount of liquid going past a reference point during a period of time. It can be calculated by measuring both the average velocity and the area

through which the liquid is moving. Flow is reported as volume per unit time and is expressed in units such as cubic feet per second (CFS), gallons per minute (GPM) and million gallons per day (MGD).

Flow is measured by a flow metering system. The "primary element" is the measuring structure that contains the liquid. The "secondary element" is used to make measurements from the primary element and convert them to flow.

Flow methods fall into two broad categories: open-channel flow and closed-pipe (pressure conduit) flow. In open-channel flow the liquid has a free surface; in closed-pipe flow the water completely fills the conduit.

1. Open-Channel Flow Measurement

The open-channel primary element creates a known relationship between flow and depth. Under these conditions, the channel width is known and the velocity does not need to be measured. The secondary element is used to measure depth at a specific measurement point.

All open-channel primary elements create observable flow profile characteristics by manipulating the channel slope and size. The flow is constricted and made to drop through a steep and precisely dimensioned section (the primary element) before flow through the regular channel is resumed. A known and repeatable relationship between depth and flow results.

Starting some distance upflow of the primary element, the liquid will be relatively deep and slow moving. As it passes through the primary element, it will become much shallower and faster. Downflow from the primary element the liquid will return to a deeper and slower condition.

The flow is "subcritical" in the upflow and downflow reach and "supercritical" when it is moving shallower and faster. A hydraulic lift occurs as the flow changes between subcritical and supercritical. In all cases the approach flow must be subcritical and the change from subcritical to supercritical must be clearly evident.

The depth of the liquid in the primary element is measured at a particular location in the channel. The depth-to-flow relationship is only accurate at the measuring point. The depth can be measured directly from the throat or it can be measured at a stilling well.

A stilling well is a small, circular well, connected to the throat or to an upstream measuring point of the flume or weir, generally through a small-diameter pipe. The stilling well provides a calm pooling area where the depth can be accurately measured. The water level in the stilling well is the same as in the flume or weir at the measuring point. The stilling well should only connect to the flume or weir at the measuring point for the device being used. Stilling wells are not affected by wave action, foam or floating or partially submerged debris. Frequent cleaning may be necessary to keep the well and the connection to the flume or weir clean to ensure accurate measurements.

The accuracy of both the primary and secondary elements should be checked. Observe the flow through the primary element for certain characteristic flow conditions described in the following sections. Check the secondary element by comparing the depth reading with and independent depth measurement. Convert depth measurements to flow using hydraulic equations for the measuring device and evaluate the calculated flows with those indicated by the measuring device or the attached totalizer, recording disk, or discharge meter.

2. Open-Channel Flow Meters

a. Palmer-Bowlus Flumes

This type of flume is designed to be installed in an existing channel providing the channel is on an acceptable slope and the flows do not exceed the flume's capacity. The flume is sized by the dimension of the channel. For example, a six-inch Plamer-Bowlus flume is used in a six-inch channel. Smaller Palmer-Bowlus flumes of the "quick-insert" type are often used due to the ease with which their inflatable collar is inserted into the exit section of a pipe.

When installed, a Palmer-Bowlus flume is preceded by a section of straight pipe (about 25 pipe diameters long) and on an acceptable (subcritical) slope. The point of measurement for a Palmer-Bowlus flume is located at a distance D/2 upstream from the top of the flume, where D is the size of the flume.

The depth-to-flow relationships for Palmer-Bowlus flumes are available in tabular form. The depth, H, IS THE VERTICAL DISTANCE BETWEEN THE FLOOR OF THE FLUME AND THE WATER SURFACE AT THE MEASURING POINT. The distance from the channel bottom to the floor of the flume is approximately D/6. This dimension may vary considerably due to the way the flume is installed or

H. GROUND WATER SAMPLING PROCEDURES

1. SCOPE

These procedures describe recommended methods as well as minimally acceptable methods for obtaining representative ground water samples for organic, inorganic, residue, nutrient, bacteriological and other general chemical analysis. Ground water monitoring wells, homeowners' private supply wells, industrial or municipal supply wells are the potential sources of these samples. These procedures are to be followed by Department personnel, contractor personnel or anyone submitting data from wells to the NJDEPE. Analytical data derived from samples obtained in a way which does not meet the minimum criteria outlined herein will not be accepted as representative. All ground water monitoring wells should be constructed in accordance with current NJDEPE specifications or to any NJDEPE approved changes to these specifications. Reference should also be made to ASTM D5092-90, "Well Design and Construction", along with well specifications available from the Department's Water Allocation Bureau. Monitoring well specifications for Bedrock Formations, Unconsolidated Formations, and Confined Formations are provided in Appendix 7-1 of this section.

2. SAMPLING EQUIPMENT

The equipment utilized for specific ground water sampling episodes can vary greatly dependent on the following factors:

a. type of well (i.e. monitoring well, supply well)
b. depth of well
c. diameter of well casing
d. depth to water
e. contaminants likely to be encountered
f. analytes of interest
g. length of open hole (bedrock well)
h. slot size of screen, screen type and length of screen
i. expected recharge rate of well

Equipment to be utilized for ground water sampling generally falls into two categories; that used to evacuate water in the well casing and that used to collect a discrete sample for analysis. However, in some instances, the device utilized for evacuation may be the same device utilized for sample collection.

Types of equipment available for ground water sample collection include the following:

a. Bottom-fill Bailer (single or double check valve)
b. Peristaltic pump
c. Bladder pump
d. Packer pump
e. Inertial pump
f. Syringe Sampler

Site-specific sampling conditions will dictate the ideal sampling equipment. Generally, sampling equipment which minimizes agitation, air content, gas exchange, and depressurization is preferred.

Sampling devices must be cleaned, preferably by the laboratory performing the analysis, utilizing recommended equipment cleaning procedures (refer to Chapter 2 of this manual). The sampling device should be dedicated to the individual well location for one day of sampling and wrapped in cleaned, oven baked or autoclaved aluminum foil. The sampling device should remain wrapped in this manner and stored in an area where contamination will not occur prior to its use. Down hole devices should not be transported in the same vehicle storing gasoline or gasoline powered equipment. ANY DEVIATION FROM THE ABOVE PROCEDURES MUST BE APPROVED IN WRITING BY THE NJDEPE PRIOR TO IMPLEMENTATION OF THE SAMPLING EVENT.

Types of equipment available for well evacuation include:

a. Centrifugal pump/Diaphragm pump
b. Submersible pump
c. Peristaltic pump
d. Bladder pump
e. Packer pump
f. Gas displacement pump
g. Gas piston pump
h. Inertial pump
i. Bottom-fill bailer

In addition to an evacuation and sampling device, other equipment necessary for a sampling episode may include:

a. Water level indicator
   * steel line and chalk
   * electric tape (i.e., interface probe, slope indicator, M-scope)
b. Sample containers (proper size and composition)
c. Preservatives, as needed
d. Ice or ice packs
e. Field instrumentation (i.e., PID, FID)
f. Field and trip blanks
g. Bound field logbook
h. Sample analysis request forms

i. Chain of custody forms
j. Chain of custody seals
k. Sample labels
l. Appropriate personal safety equipment (i.e., disposable gloves)
m. Appropriate hand tools
n. Keys to locked wells
o. Metal filtering devices
p. pH paper, narrow range
q. Field measurement instrumentation (temp., specific conductance, pH etc)
r. Plastic sheeting, ties and bags
s. Calcuator, wristwatch, timer
t. Sample shuttle (cooler)
u. Indelible marker
v. Calibrated bucket for purge water measurement
w. Distilled and deionized water
x. Laboratory grade glassware detergent
y. Paper towels
z. Stainless steel clamps

3. Sampling Plan

Prior to the implementation of any sampling episode, the specific objectives of the program must be established (refer to Chapter 1 of this manual). Objectives of a ground water sampling program should be specified in the sampling plan and may include:

a. determining the potability of a private or municipal supply well
b. investigating the presence or absence of contamination in a given study area
c. investigating the magnitude (i.e. the vertical and horizontal extent) of a known or suspected contaminant plume.
d. determining ground water flow direction
e. evaluating the hydrogeological characteristics of the aquifer(s).
f. identifying potential receptors and receptor pathways

The design of a ground water sampling program can be affected by the presence, location, pumping schedule(s) and rate(s), and construction of existing wells. In cases of suspected contaminant sources, there may be no monitor wells available to sample. In this case, private wells may be used to help define the presence or absence of contamination. However, this should not be a standard practice. Private supply wells should only be used to evaluate potability and to gather preliminary data. These wells should not be used as a substitute for properly located and constructed monitor wells.

4. Quality Assurance

Ground water remedial investigations and associated laboratory analytical costs demand that sample integrity be maintained during sample collection. Laboratory analysis, no matter how sophisticated, may only be representative if the sample supplied to the analyst has retained its integrity. There are many areas to which specific attention must be paid: some relate to well drilling and development procedures, well construction materials, or heavy equipment decontamination and are discussed elsewhere in this manual. Issues addressed in this section include the decontamination procedure and the construction materials used for sampling equipment.

a. Equipment Cleaning and Decontamination

For each sampling event, all field measurement and sampling equipment that will enter the well must be cleaned prior to its entry into the well. Field measurement equipment such as water level indicators should be cleaned in the following manner:

i. wipe with a paper towel to remove visual debris
ii. tap water and laboratory grade glassware detergent wash
iii. tap water rinse
iv. distilled and deionized water rinse

Sampling equipment must be cleaned by the appropriate methodology discussed in Tables 2-1 and 2-2 of this manual. The requirement for dedicated equipment shall apply to all bailers and leader wire used for collecting samples when data will be submitted to the NJDEPE. Additionally, bailers and sample bottles must be physically separated from pumps and generators during transport and storage. Pumps and equipment not amenable to laboratory cleaning may be field cleaned utilizing approved methodologies discussed in Chapter 2 of this manual (see also ASTM D-5088-90 "Decontamination of Equipment").

b. Composition of Construciton Materials for Sampling Equipment

The composition of materials comprising ground water sampling equipment is critical to the collection of valid monitoring information particularly when volatile organic, pH sensitive or valence reduced chemical constituents are being evaluated. The construction materials which come in contact with the sample are as

critical as the composition of the laboratory sample containers. Recommended materials for bailers, pump parts, tubing, other sampling devices and associated apparatus in decreasing order of preference are: PTFE (Teflon[R]), stainless steel 316, stainless steel 304, polypropylene, linear polyethylene, PVC, Viton, conventional polyethylene.

The majority of NJDEPE regulatory programs require that the bailers be constructed of PTFE or stainless steel. Additionally, any other devices contacting the water to be sampled should be constructed of PTFE or stainless steel. The reader is cautioned that exceptions to this requirement should be confirmed and approved by the regulatory program having project oversight authority.

Tubing utilized in well evacuation may consist of materials other than PTFE, but may not be utilized for sample collection and it is recommended that it should be dedicated for use in each individual well for that particular sampling event.

c. Quality Control Blanks

In an attempt to identify external variables affecting ground water sample integrity, the NJDEPE has initiated a program of quality control blanks. The quality control blank sample program is a two track approach using both a trip and field blank. The trip blank acts as a check on potential contamination sources in sample container preparation, method blank water, and sample transport. The field blank serves as a check on the cleanliness of the sampling equipment, potential atmospheric contamination and the effects of sampling procedures on the analytes of interest.

It is the NJDEPE's policy that all ground water sample data that will be submitted for review and validation must be accompanied by field and trip blank data. ANY DEVIATION FROM THIS POLICY MUST BE APPROVED BY THE NJDEPE IN WRITING PRIOR TO THE COMMENCEMENT OF ANY SAMPLE COLLECTION.

For more information on blank samples (handling time restrictions, preparation methods, frequencies, etc.) refer to Chapter 2 of this manual.

5. Sampling Procedures

a. Sampling Monitor Wells

(See also, c. "Well Purging or Evacuation Procedures" and d. "Ground Water Sampling Procedures")

Evacuation of the water column in a monitor well is required prior to sample collection. This removes the standing water column and induces ground water flow from the surrounding formation into the well. The only exception to this standard procedure is if the objective of the sampling event is to determine the presence of dense or light phase non-aqueous phase liquids.

Access to monitor wells may be difficult and the wells themselves hard to locate in the field. Obtain information on the location, access, permission, etc. before visiting the site. Monitor wells usually have a friction cap or screw cap, and should be locked. Therefore, keys to unlock the wells and tools for removing the caps are often necessary.

If several monitor wells must be sampled, proper identification of each well is essential. The well permit number assigned by the NJDEPE or any other assigned number should be known. If numbers are not assigned, a precise field description of each well location is essential to avoid confusion of sample results. When several monitor wells of known or suspected contamination will be sampled, the least contaminated well should be sampled first, and thereafter sampled in ascending order of contamination. Well head readings using photo or flame ionization detectors (PID or FID) can aid in determining the order in which wells should be sampled by providing information on levels of contamination.

b. Field Measurements

i. Water Level Measurements

Well depths and water table depths can be determined by various measuring devices. A commonly used device is the electronic water level indicator. These units have a tape divided into incremental measurements of .01 feet and two conductors forming a probe. When ground water is encountered the circuit is complete and a light, meter or audible buzzer is activated. The depth to ground water is then measured from this point to the

reference mark on the inner casing of the monitor well.

Water indicator paste/gel acts as colormetric test method when the paste comes in contact with water. It is applied to the bottom few feet of a measuring tape or rod. The tape or rod is then lowered into the well and remains for less than one minute. The wetted tape/stick gives the depth to the top of the liquid and the color change section indicates the depth to water. This procedure is good to ± 0.02 feet.

The least recommended device is a measuring tape with a stainless steel metal cup on the end which makes a "pop" sound when hitting the water surface, hence the name "popper".

Wells with a non-aqueous phase liquid layer on the surface pose a problem when measuring the level of ground water. Electronic water level indicators will not work in this material, so alternate methods must be used. These include water indicator paste, bailers and interface probes.

Once the surface level of the non-aqueous phase liquid layer has been determined, a clear bailer is lowered into the well and slowly into the product, being careful not to submerge the bailer. The bailer is raised and the product thickness measured. Once the product thickness is known, the depth to water may be determined. This method has inaccuracies due to the operation of the bailer.

A more accurate and easier device to use is the interface probe. This probe uses an optical sensor to determine if the probe is in liquid and a conductivity sensor to determine if the probe is in water. When using this probe, each phase can be measured independently. The hydrocarbon-air interface reading should be taken first going from the air to the hydrocarbon surface to prevent dripping hydrocarbons from enhancing the thickness reading. The hydrocarbon-water reading is best taken going up from the water to the hydrocarbon layer to prevent hydrocarbons from coating the conductivity probe which would also enhance the hydrocarbon thickness reading. This is best done by lowering the probe quickly through the hydrocarbon layer minimizing the contact time of the probe in the hydrocarbon phase.

The key to accurate readings by any method is proper collection of the measurements from the same survey point, preferably by the same person and tape to avoid any procedural differences. Readings should be made three to four times. All well measurements should be performed the same day and prior to evacuation of any wells which may influence ground water elevations in the area of the investigation.

Water level elevation equipment should be properly decontaminated to avoid cross contamination. In certain circumstances sensitive components of an interface probe may be compromised by the use of standard decontamination solvents. Alternative solvents may be used upon approval of NJDEPE.

Once a well has been located and properly identified, the field measurements listed below should be noted in a field logbook. Be certain that the proper well is being selected. The misidentification of a sampling point in the field will result in erroneous data that may affect important decisions.

ii. Physical Measurements

- diameter of protective outer casing
- security and integrity of the well
- well number & well permit number
- inner diameter and construction material of the inner well casing
- total depth of the well from the top of the inner casing or surveyor's mark, if present (measured to 0.01 foot)
- depth from the top of the casing to water (recorded to 0.01 foot)
- thickness of floating product, if any
- calculation of the linear feet of water in the well by subtracting the depth to water from the total depth of the well. Note: water levels should be obtained from all wells prior to sampling the first well, thus avoiding interference problems. This also allows one to determine if any well is damaged or may pose a problem for sampling. The capacity of common casing diameters are as follows:

Casing Diameter (ft.)	Gallons/Linear foot
2 inch (0.1667)	0.1632
4 inch (0.3333)	0.6528
6 inch (0.5000)	1.4688
8 inch (0.6667)	2.6112
10 inch (0.8333)	4.0800
12 inch (1.0000)	5.8752

The amount of water within the well casing is calculated by multiplying the linear feet of water by the volume per foot for the proper diameter casing.

Example:

Total depth of well casing:	100 ft.
Depth to water:	-20 ft.
Linear feet of water:	80 ft.
2 inch casing:	x 0.1632
amount of water in casing:	=13.06 gal.

The amount of standing water in the casing should then be multiplied by three (3) to determine the minimum volume to be purged from the well prior to sample collection. The total volume purged should not exceed five (5) times the amount of standing water in the well.

Alternately, one can use this formula to determine the gallons in any diameter well:

Number of gallons = $5.8752 \times C^2 \times H$
Where: C = casing diameter in feet
H = height of water column in feet

iii. Physio-Chemical Parameters

In addition, to the physical measurements taken above and other information that may identify the well, physio-chemical information including specific conductance, pH, and temperature should be recorded during well evacuation and before and after sample collection.

c. Well Purging or Evacuation Procedures

i. Theory

Obtaining representative ground water samples from monitor wells is required for all ground water pollution investigations in New Jersey. The length of time for ground water conditions to become representative at and near the monitor well (the stabilization period) will vary depending on site hydrogeologic conditions, drilling methods and monitor-well development methods. Ground water flow velocities are typically less than one foot per day and natural flushing rates are generally slow. If a monitor well is drilled, installed and developed so that a 14-foot radius around the well was left as unrepresentative, and a natural ground water flow rate was one foot per day, it would take 14 days for representative ground water to reach the well. Sampling a monitor well immediately after development will generally not be representative of the static ground water quality conditions at the horizontal and vertical location of the monitor well's intake interval. Therefore, all newly constructed and developed monitor wells must be allowed to stabilize and equilibrate with the aquifer for a minimum of two weeks prior to sampling.

Monitor well development is required to: remove drilling fluid residues remaining in the borehole or surrounding aquifer, remove imported drilling water lost to the aquifer during the drilling procedure, remove ground water in the borehole or surrounding aquifer which has been affected by the drilling process or drilling or well construction materials, restore the hydraulic properties of the formation immediately surrounding the monitor well, and allow ground water to freely flow to the monitor well.

Installation and construction of monitor wells may themselves alter the quality of ground water in the surrounding aquifer. Site-specific subsurface conditions should be used to determine the appropriate well development techniques. Many times it is a combination of the techniques mentioned below which will be necessary to produce a properly developed monitor well. Also discussed are certain outcomes inherent to the well development techniques which can be mitigated by following the 14 day stabilization period.

- High velocity air jetting, air lift or surge block development methods may introduce air into the aquifer surrounding the monitor well, and this air has the potential for altering ground water quality, particularly for volatile organics.

- Overpumping of a monitor well for development may draw ground water to the monitor well from considerable distances and draw ground water of quality not representative of the horizontal and vertical location required by the monitor well, especially in an isotropic and/or bedrock aquifers.

- Organic drilling fluid residues and inorganic residues of bentonite have been found to remain in and near wells, even after proper development, and these residues have been found to affect water quality including chemical oxygen demand of ground water samples for up to 100 days after completion of development.

- Non-aqueous phase liquid contaminants may be pushed away or drawn to a monitor well location during development, depending on the development method, resulting in non-representative ground water samples being obtained.

- Suspended sediment in ground water of a monitor well which is not completely removed by development and not allowed to settle out may affect the quality of ground water samples obtained from the well. Therefore, a period of time is required to allow a sand/gravel pack to settle around a monitor well screen.

Ground water pollution investigations in New Jersey often base expensive site related investigatory and remedial action decisions on initial (first sampling event after development) ground water sample analyses. Therefore, before ground water samples are collected, a complete understanding of the monitor well's design, construction and hydrogeological setting is necessary in order to properly interpret any analytical results.

The well evacuation procedure allows representative ground water to enter the well. Air sensitive parameters such as dissolved oxygen, pH, temperature, Eh and specific conductance are best analyzed with the use of a flow through cell, eliminating sample exposure and influence by air. However, monitoring of these air sensitive parameters for well stability may not be a reliable indicator as to when to collect a representative sample. Therefore, if a constant monitor is not used during well purging, a sample should be collected within 2 hours after 3 to 5 volumes of water have been purged from the well. The volume evacuated and evacuation rate should be recorded after each purge and sample episode and repeated for subsequent sampling events. This procedure will give consistent results for each well.

Every reasonable effort must be made to keep pumping rates low to avoid overpumping or pumping the well to dryness. To accomplish this, pump rates may be adjusted and pumping times extended in order to remove the required three to five well volumes. In no case should the time of sampling exceed 24 hours after purging. The evacuation rate of a monitor well should not exceed that of the development of the well thus altering the hydrogeological properties of the aquifer in the vicinity of the well.

In some situations evacuation of three to five volumes may not be practical in wells with slow recoveries. If a well has been pumped to near dryness at a rate less than 0.5 gallons per minute, the well should be allowed to recover to a volume sufficient for sampling. If necessary, sampling within the two hour limit may be exceeded to allow the well to recover sufficiently for sampling.

There are several reasons why the well should not be pumped below the level at which the ground water enters the well. In certain formations, water entering the well at the top of the screened area will fall into the pumped dry well. This cascading effect may aerate the ground water to be sampled, thus resulting in the loss of volatile organic compounds. Secondly, pumping to dryness can cause dehydration of the saturated zone; again volatiles may be lost due to aeration within this zone. Additionally, other contaminants may adsorb to formation materials where a dehydrated zone is created. As a result, those samples collected upon the recharge of a well pumped to dryness may not correctly characterize ground water quality due to one or more of the above effects.

There are certain circumstances where a well will not be screened across the water table, such as the following:

a. wells screened for collection of depth discrete ground water samples,
b. bedrock wells with several water-bearing zones,
c. very slow recovering wells.

In these circumstances, the well must not be pumped as to allow the ground water level to fall below the zone where water enters the well. If a well is evacuated to dryness or below the well screen, samples should not be collected until the entire screen is covered by formation water. This should also be documented since the sample's integrity may be severely altered.

ii. Evacuation Methods

There are many methods that may be used for well evacuation. Not all methods are acceptable under all conditions. The selection of an evacuation method is usually dictated by the depth to water. The preferred and most commonly used methods involve the use of a centrifugal or peristaltic pump (when the depth to water is less than twenty-five feet) and a submersible pump (when the depth to water is greater than twenty-five feet).

It is paramount to ensure that the evacuation procedure does not cause cross contamination from one well to the next. Therefore, the preferred method employs dedicated tubing (new dedicated linear polyethylene ASTM drinking water grade) and pumps. Since in many cases it may not be practical to dedicate a pump to a specific well, it is permissible to decontaminate this equipment between wells, if approved methods are used (refer to Chapter 2 of this manual). Tubing should

always be dedicated to each individual well. Cleaned equipment entering the well should not be allowed to contact the ground or any other potentially contaminated surfaces (i.e. gasoline pumps). If this should occur, the item should not be placed in the well or utilized for evacuation.

Prior to evacuation check the well for floating product. During evacuation, the pump intake or tubing shall be kept at a maximum distance of six feet below the water level. The pump intake or tubing shall be lowered as the water level decreases to maintain this distance. In instances where the total depth of standing water in well casing is less than six feet, begin evacuation near the top of the water column and lower as stated above. Following this procedure will ensure that all static water will be removed prior to sampling.

Note: The disposal or discharge of floating product or hydrocarbons, and the discharge of highly contaminated water may require special purge water collection and disposal procedures.

Regardless of the evacuation procedure used, the evacuation rate should not exceed that of well development. This will cause a "redevelopment" of the well resulting in a turbid sample. Information on the various methods of evacuation is provided as follows:

Finally, the following information should be recorded in the field log for each monitoring well sampled.

Before Purging

- Date, time, and weather conditions.
- Well number & well permit number.
- PID or FID reading taken from the well immediately after the cap is removed.
- Check for free product, measure thickness if present.
- pH, dissolved oxygen, temperature, & specific conductivity.
- Total depth of well from the top of inner casing or surveyors mark if present.
- Depth from the top of inner casing to the top of screen.
- Depth from the top of inner casing to water.
- Estimated water volume in well.

After Purging

- Start and end time for purging.
- Purge method.
- Purge rate(s).
- Total volume purged.
- pH, dissolved oxygen, temperature, & specific conductivity.

After Sampling

- Start and end time for sampling.
- pH, dissolved oxygen, temperature, & specific conductivity.
- Sampling method.

Any comments concerning field observations during the ground water sampling event, i.e. slow recharge, turbidity, odor, sheens, PID or FID readings, etc. shall also be reported.

iii. Evacuation Procedure Using Suction Lift Pumps/Centrifugal Pumps

Suction lift pumps (i.e. diaphragm and centrifugal) are pumps utilized at the ground surface with polyethylene tubing inserted into the well. They are used to evacuate the well prior to sampling. The tubing must be new and dedicated to a particular monitor well and as the tubing is inserted into the well, it must be cleaned with distilled and deionized water. The tubing should be equipped with a decontaminated foot check valve to avoid having aerated water from the pump fall back into the well.

If a foot check valve is not used, care must be taken to ensure that the entire pump impeller chamber is drained after being used and then thoroughly decontaminated as specified in Chapter 2 of this manual. Also, when removing tubing without a foot check valve after evacuation, the pump must continue to operate to avoid purged water remaining in the tubing and pump chamber from falling back into the well.

The limitation posed by this type of pump is its suction capability. Generally the water level must be within twenty-five feet of the ground surface.

Note: Care must be taken as to the source of the water used in priming the centrifugal pump; ONLY potable water should be used.

Note: These pumps may only be used for well evacuation, not for ground water sampling.

iv. Evacuation Procedure Using Portable Submersible Pumps

When the depth to water is greater than twenty-five feet and if the diameter of the well casing will allow, a portable submersible pump should be utilized.

The pump must be carefully lowered into the well, trailing a discharge hose, electrical cables and a security cable constructed of approved material (i.e. single-strand stainless steel or polyethylene). The security cable should support most of the weight of the pump. These items can be bundled together at ten foot intervals with plastic electrician's ties or stainless steel clamps. Duct or electrical tape must not be used at a level that will be submerged into the water column. It is important that the hose and electrical line be fed so they do not jam between the pump and the casing. Similarly, the hose and electrical line must be pulled up ahead of the pump during removal.

Once the end of the purged line is fitted with a gate valve in the closed position, lower the sumbersible pump to the appropriate depth. The pump can then be turned on and the gate valve adjusted to provide the correct flow rate. During evacuation, it may be necessary to lower the pump as the static ground water level drops.

If a portable gasoline generator is used, it should be placed downwind and at some distance away from the well so fumes from the generator will not affect sample quality. The generator should not be operating while a sample is being collected.

The pump should be fitted with dedicated tubing for the discharge of evacuation water. As with the suction lift pumps, submersible pumps should be equipped with a check valve to avoid having water from the pump fall back into the well. If the same submersible pump is to be used for more than one well, then the pump should be decontaminated between well locations as specified in Chapter 2 of this manual to ensure that no cross contamination from the previous well occurs.

Submersible pumps are susceptible to clogging. Turbid ground waters or poorly developed monitor wells are likely to impede the evacuation process. Care should be taken not to let the pump draw from the bottom of the well where silts and sands may be taken up by the pump.

v. Evacuation Procedures Using Peristaltic Pumps

A peristaltic pump is a self priming suction lift pump which consists of a rotor with ball bearing rollers and is operated at the ground surface. One end of dedicated tubing is inserted into the well and the other end is attached to a flexible tube which has been threaded around the rotor, out of the pump and connected to a discharge tube. PTFE, polyethylene or silastic tubing are preferred for use with a peristaltic pump.

Other materials may be acceptable, particularly for threading through the pump, but must be approved in writing by the NJDEPE on a case by case basis. The bottom length of tubing should be equipped with a foot check valve to avoid having water from the pump and the tubing fall back into the well.

Use of a peristaltic pump for well evacuation is limited to its suction capabilities. Generally, a peristaltic pump cannot be used to evacuate wells with a depth to water greater than twenty-five feet. Also, due to the volume present in large diameter and high yield wells, peristaltic pumps are not recommended.

vi. Evacuation Procedure Using Air Lift Pumps

This method is generally used for well development and is not recommended for well evacuation prior to sampling. If logistics dictate that air lift pumps are the only alternative to evacuation, then the procedure can only be applied to wells screened below the water table. Tubing connected to air lift pumps must be placed above the well screen since air may become trapped in the screen and/or filter pack. Entrapped air can alter the oxidation-reduction potential of the aquifer material around the well bore which can affect the chemical composition of ground water samples. In addition, only oil-free compressors should be used.

vii. Evacuation Procedures Using Bladder Pumps (Gas Squeeze Pumps)

A bladder pump consists of a stainless steel cylindrical housing that encloses a flexible membrane. Below the bladder, a screen is attached to filter any material that may clog the check valves that are located above and below the bladder. The pump works as follows: Water enters the membrane through the lower check valve, compressed gas is injected through a separate line to the space between the bladder and the pump housing. As the bladder is squeezed, the water in the bladder closes the lower check valve and goes out

through the upper check valve. As the air pressure is released, the upper check valve closes and water enters the pump through the lower check valve. There is no contact of compressed gas with the sample water.

The bladder pump is utilized much like the portable submersible pumps, except that no electrical lines are lowered down the well. The source of gas for the bladder is either bottled gas or an on-site oil-less air compressor. Disadvantages include the large gas volumes needed, especially for greater depths and the potential for bladder rupture and slow evacuation rates.

The preferred material of construction for bladder pumps and any tube, joint or other fixture that remains in contact with the ground water is PTFE (Teflon^R) or stainless steel.

viii. Evacuation Procedure Using Packer Pumps

Packer pumps consist of two expandable bladders that when inflated isolate a section of the well bore between them. They deflate for vertical movement within the well. The advantage of this type of pump is that a smaller volume of water is required for evacuation prior to sampling. Also several zones within a single well can be sampled.

Packer pumps are constructed of rubber and can be used with submersible, gas lift and suction pumps. Exposures to high level contamination may deteriorate the rubber with time.

The use of packer pumps for evacuation must be approved by the NJDEPE on a case by case basis. The sampler must be sure the zone being sampled and packered is isolated from the other zones.

ix. Evacuation Procedures Using Gas Piston Pumps

The gas piston pump provides continuous sample withdrawal at depths greater than is possible with most other methods. The pump consists of a stainless steel alternating chamber between two pistons. Pressurization of the alternating chamber activates the piston which allows water entry during the suction stroke and forces the water to the surface during the pressure stroke.

The use of gas piston pumps for evacuation must be approved by the NJDEPE on a case by case basis.

x. Evacuation Procedures Using Gas Displacement Pumps

Gas displacement pumps work by gas forcing water out of a discharge line. They consist of a cylinder with a check valve and two lines, an air supply line and a water discharge line, connection to the top.
As the pump is lowered into the water, the pump fills by hydrostatic pressure. When air pressure is applied, the check valve seats and water is forced out the discharge line. When the air pressure is released, the pump chamber fills and the cycle repeats.

The use of gas piston pumps for evacuation must be approved by the NJDEPE on a case by case basis.

xi. Evacuation Procedures Using Inertial Pumps

The inertial pump consists of a single tube or pipe with a foot check valve at one end. The foot check valve allows water to enter the pipe but stops the water from draining out of the pipe.

The pump is operated by raising and lowering the tube over a short distance with rapid strokes. This causes the water inside the pump to be moved up a distance due to its inertia. This can be accomplished manually or automatically utilizing a powered unit. The advantages of this type of pump is its ease of operation and its inexpensive cost.

There are several disadvantages to this type of pump. Its manual operation is labor intensive although mechanical devices are available. The tubing and foot assembly must be dedicated to a well. Use in slow recharge wells may cause the water level to drop significantly and result in aeration of the water column during the physical act of purging the well. Conversely, the inertial pump device may be overwhelmed in a rapidly recharging well leading to insufficient evacuation of the water column.

The use of inertial pumps for evacuation must be approved by the NJDEPE on a case by case basis.

xii. Evacuation Procedures Using Hand Bailing Techniques

Hand bailing may be utilized if no other method of evacuation can accomplish the task and the procedure is approved by NJDEPE. However, bailing is the <u>least recommended</u> procedure for well purging due to the potential to aerate the well water or possibly introduce contaminants during the bailing procedure. Specifically, bailing is the least recommended method

of purging when samples are to be collected for volatile organic analysis.

If hand bailing is the method of evacuation, it must be performed with a laboratory cleaned and dedicated PTFE or stainless steel bailer. An additional laboratory cleaned and dedicated bailer will be required for sample collection.

Note: Hand bailers come in a variety of sizes and volumes to accommodate most well casing diameters.

The bailer must be slowly lowered into the well exercising care not to aerate the ground water to be sampled. The preferred method of lowering the bailer is by using a Teflon^R coated stainless steel cable attached to a low gear ratio winch connected to a tripod standing over the well. This is the most reproducible method of bailing a well. If this apparatus is not available, the bailer may be lowered by hand using a Teflon^R coated stainless steel leader. (Due to the manufacturing oils associated with braided stainless steel cable, Teflon^R coated stainless steel is required for the bailer leader contacting ground water, unless, decontaminated single strand stainless steel cable is utilized.) Lower the bailer until it is submerged and retrieve the bailer and transfer the water into a container or other device to measure the volume being evacuated. The bailer utilized for well evacuation along with any other equipment entering the well for sample collection must be handled with new surgical gloves to preclude any potential contamination. It is always a good practice to have extra laboratory cleaned bailers available at the site.

d. Ground Water Sampling Procedures

After evacuation of the required volume of water from the well, sampling can begin. If the well is a quick recharger, sampling of the well should occur as soon as possible after evacuation, preferably immediately. In most cases, the time lapse between evacuation and sampling should not exceed two hours. When several wells will be sampled of known or suspected contamination, the least contaminated well should be sampled first, and the wells then sampled in ascending order of contamination. Well head readings can aid in determining sample order by providing information on contaminant levels in the wells. Attention to decontamination procedures must be strictly followed. Information on the various methods of sample collection is provided as follows:

i. Sampling Procedures Using Bottom Fill Bailers

Bailers come in a variety of sizes and volumes to accommodate most well casing diameters. The preferred materials of construction are PTFE (i.e. Teflon^R) and stainless steel. The use of bailers constructed of other materials for ground water sample collection must be approved by the NJDEPE on a case by case basis.

The bailer must be cleaned and wrapped using approved methodologies, preferably by the laboratory performing the analysis. The bailer must be slowly lowered into the well exercising care not to aerate the ground water to be sampled. The preferable method of lowering the bailer is by the use of a Teflon^R coated stainless steel cable attached to a low gear ratio winch connected to a tripod standing over the well. If this apparatus is not available, the bailer may be lowered by hand using a recommended length of three to six feet of Teflon^R coated stainless steel leader wire attached to the bailer and to an appropriate length of dedicated polypropylene rope.

Due to the manufacturing oils associated with braided stainless steel cable and its difficulty to decontaminate, Teflon^R coated stainless steel is required for the bailer leader contacting ground water. Care should be taken if using stainless steel cable clamps when securing the leader to the bailer. The integrity of the Teflon^R may be compromised by compression while tightening the clamps, thus exposing the braided wire. Also, all cut ends of leaders must have an end cap so as to eliminate exposure of the stainless wire.

Slowly lower the bailer down the well until it is submerged and then retrieve the bailer and transfer the sample to the appropriate containers. Caution must be used in transferring the water from the bailer to the sample container. The transfer of the sample has the greatest susceptibility for sample aeration.

Note: The first bailer recovered after well evacuation must be utilized for sample collection.

Some bailer manufactures have small stopcocks with an attached sample line. The valve is inserted into the bottom of the bailer, pushing the check valve up and supplying water to the sample line. The sample flow for the volatile compounds may then be reduced to eliminate aeration of the sample. The valve should be in the open position when inserting into the bailer. After inserting, it may then be closed. This procedure will eliminate an air bubble rising up inside the

bailer through the sample, thereby causing aeration.

The order in which samples should be collected from each well, regardless of sampling device, is as follows:

1. Volatile organics (VOA) √
2. Purgeable organic carbons (POC)
3. Purgeable organic halogens (POX)
4. Total organic halogens (TOX)
5. Total organic carbon (TOC)
6. Base neutrals/acid extractables √
7. TPHC/Oil & Grease
8. PCBs/pesticides √
9. Total metals √
10. Dissolved metals √
11. Phenols
12. Cyanide √
13. Sulfate and chloride √
14. Turbidity √
15. Nitrate and ammonia √
16. Preserved inorganics
17. Radionuclides
18. Non-preserved inorganics
19. Bacteria

This collection order takes into consideration the volatilization sensitivity of ground water samples. Additional information on the order of sample collection can be found in the RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD), September 1986.

The bailer and any other equipment entering the well must be laboratory cleaned and handled with new surgical gloves to preclude any potential contamination sources. Surgical gloves must be changed between each sample location. Clean sampling equipment and any other objects entering the well should not be allowed to contact the ground or any other potentially contaminated surfaces (i.e. gasoline pumps). If this should occur, that item should not be placed in the well or utilized for sampling. It is always a good practice to have extra laboratory cleaned bailers available at the site. Additionally, bailers and sample bottles must be physically separate from pumps or generators during transport and storage.

Note: Dedicating a bailer and leaving it in a well for long term monitoring is not recommended due to the potential risk of contamination resulting from excessive handling (would be necessary to remove bailer first in order to purge the well therefore increasing the risk of contamination).

ii. Sampling Procedures Using Peristaltic Pumps

A peristaltic pump is a self priming suction lift pump which consists of a rotor with ball bearing rollers and is operated at the ground surface. One end of the dedicated tubing is inserted into the well and the other end is attached to a flexible tube which has been threaded around the rotor, out of the pump and connected to a discharge tube. PTFE and polyethylene are the preferred materials for the tubing associated with a peristaltic pump. Other materials may be acceptable, particularly for threading through the pump, but must be approved by the NJDEPE on a case by case basis. The sample moves totally within the sample tube and no part of the pump contacts the liquid. If Teflon tubing was used for well evacuation, the same length of tubing may be used for sample collection at that well. If another approved material was used for well evacuation, a new dedicated length of Teflon tubing may be required for sample collection.

The tubing should be equipped with a foot check valve to avoid having water from the pump and the tubing fall back into the well. A foot check valve is not required if the pump is not shut off in between evacuation and sampling of the well however, a foot valve is still desirable in case of pump failure.

Use of a peristaltic pump for well sampling is limited to its suction capabilities. Generally, a peristaltic pump cannot be used to sample wells with a depth to water greater than twenty-five feet.

Note: This pump cannot be used to collect samples for volatile organics or base neutral/acid extractable organics due to the pressure gradients to which the sample is exposed.

iii. Sampling Procedures Using Bladder Pumps (Gas Squeeze Pumps)

A bladder pump consists of a stainless steel cylindrical housing that encloses a flexible membrane. Below the bladder, a screen is attached to filter any material that may clog the check valves that are located above and below the bladder. The pump works as follows: Water enters the membrane through the lower check valve, compressed gas is injected through a separate line to the space between the bladder and the pump housing. As the bladder is squeezed, the water in the bladder closes the lower check valve and goes out through the upper check valve. As the air pressure is released, the upper check valve closes and water enters the pump through the lower check valve. There is no

contact of compressed gas with the sample water.

The bladder pump is utilized much like the portable submersible pumps, except that no electrical lines are lowered down the well. The source of gas for the bladder is either bottled gas or an on-site oil-less air compressor. Some disadvantages include the large gas volumes needed, especially for lower depths and potential bladder rupture. The preferred material of construction for bladder pumps and any tube, joint or other fixture that remains in contact with the ground water is PTFE or stainless steel.

All pumps and fixtures must be laboratory cleaned prior to installation or use and dedicated to a particular well.

Note: The same bladder pump may be used for well evacuation and sample collection provided that Teflon® tubing is used.

Note: Bladder pumps are acceptable to use for the collection of samples for volatile organics and base neutral/acid extractable analysis. Care must be taken to regulate the flow rate during sample collection to avoid surging caused by cycling within the pump.

iv. Sampling Procedures Using Packer Pumps

Packer pumps consist of two expandable bladders that when inflated isolate a section of the well bore between them. They deflate for vertical movement within the well. The advantage of this type of pump is that a smaller volume of water is required for evacuation prior to sampling. Also several zones within a single well can be sampled because the length of the standing water in the column is reduced.

Packer pumps are constructed of rubber and can be used with submersible, gas lift and suction pumps. Exposures to high level contamination may deteriorate the rubber with time.

The use of packer pumps to isolate portions of the well for sampling must be approved by the NJDEPE on a case by case basis as materials of construction may not be appropriate for certain analysis.

v. Sampling Procedures Using Inertial Pumps

The inertial pump consists of a single tube or pipe with a foot check valve at one end. The foot check valve allows water to enter the pipe but stops the water from draining out of the pipe.

The pump is operated by raising and lowering the tube over a short distance with rapid strokes. This causes the water inside the pump to be moved up a distance due to its inertia. This can be accomplished manually or automatically utilizing a powered unit.

The advantages of this type of pump is its ease of operation and its inexpensive cost.

The disadvantages of this type of pump is that its manual operation is labor intensive and the pump must be dedicated to a well. Depending upon the static water level within the well, care must be taken during evacuation and sampling so as not to aerate the water column. Introduction of ambient air may compromise the volatile organic fraction.

The use of inertial pumps for sampling must be approved by the NJDEPE on a case by case basis.

vi. Sampling Procedures Using Syringe Samplers

The sample container is pressurized or evacuated and lowered into the well. Opening the container and or releasing the pressure allows the sample to enter the device. These systems are not widely used or commercially available. The use of Syringe Samplers must be approved by the NJDEPE on a case by case basis.

e. Filtering Ground Water Samples

In order to assure the quality of data generated from the analysis of ground water samples, critical sample handling procedures must be addressed. Of chief importance is sample filtration. Because the objectives of specific monitoring programs may vary, it is difficult to establish a standard for filtering that will apply to all situations.

The NJDEPE requires metals analysis to be performed on unfiltered ground water samples pursuant to the requirements of the Safe Drinking Water Act and the Clean Water Act. The reason for this is to obtain a representative sample as it actually occurs in the aquifer and to maintain consistency between sample handling for inorganic and organic analysis. If a particular case demands consideration of dissolved metals, both filtered and non-filtered samples should be collected for analysis. The regulatory document i.e., NJPDES, ACO, or approved quality assurance project plan should be consulted for monitoring requirements.

The differences obtained as a result of sample handling (filtered vs. non-filtered) are dependent on the type of association between the specific inorganic ion and the particulate matter. Studies show that when an inorganic ion is not closely associated with particulate matter (i.e., sodium), the differences between total and dissolved concentrations are small and random.

Ideally, the sample can be split into two portions, one for filtration and the other for immediate preservation and subsequent analysis for total metals concentration. By analyzing the two fractions separately, differences between dissolved and total metals can be compared.

The decision whether to filter metal(s) samples will be based on the physical quality of the samples, the objective of the monitoring program and the policy of the Program within the NJDEPE controlling the specific event. If filtering is allowed and chosen, it is imperative that it be performed in a manner that will preserve the integrity of the sample and allow consistent reproduction of technique.

i. Considerations for Total Metals Sampling

Analyzing for total metals concentrations provides an element of consistency when comparing data and evaluating water quality. Also, both the National Primary Drinking Water Standards (NPDWS) and the National Secondary Drinking Water Standards (NSDWS) for metals are based on total metals concentration. An assessment of water quality must take this into account.

The difference between dissolved and total metals can be attributed to the absorption or adsorption of various metals species onto fine grained particles (i.e., silt, clay). There has been a general assumption that water and soil are the only distinct constituents of an aquifer system; there is also a false assumption that water and completely solvated solutes are the only constituents of the system that are mobile. In fact, components of the solid phase in the colloidal size range may be mobile in subsurface environments. The colloidal state refers to a two phase system in which one phase in a very finely divided state is dispersed through a second. In ground water, colloidal particles are generally smaller than one micrometer (1 μm) in diameter. Since the clay fraction is defined as being two micrometer (2 μm) and smaller, not all clay is strictly colloidal, but even the larger clay particles have colloid-like properties.

There are two distinct types of colloidal matter, inorganic and organic, which exist in an intimate intermixture. The inorganic fraction is present almost exclusively as clay minerals of various kinds; the organic portion is represented by humus. These colloidal particles can adsorb organic and inorganic contaminants and stabilize them in the mobile phase of the aquifer. Association of contaminants with mobile colloidal particles may enhance the transport of highly adsorbed pollutants, or deposition of colloidal particles in porous media may decrease permeability and reduce contaminant transport.

An objective of many sampling episodes is to assess water movement in an aquifer. Total metals concentrations are useful in case there is a change in the aquifer (i.e., pH) that would cause adsorbed ions to become dissolved, thus raising the concentration.

Note:
- Unfiltered sample results should be reported as total metals.
- Acidification of an unfiltered sample will dissolve some particulate matter, thus raising the original metals content by releasing adsorbed metals into solution.

ii. Trace Metals Sampling Protocols

The following guidelines will apply to samples collected for trace metal analysis of ground water:

* For new investigations, that is, when ground water quality is uncertain, samples must be unfiltered for the initial round of samples. Unfiltered samples will represent "worst case" with respect to metal content. Thus, if no significant levels are detected, further sampling for metals normally will not be required.

* If metal concentrations significantly above ground water standards are confirmed, two samples may then be collected from each well: one sample filtered according to the NJDEPE procedures and a second unfiltered sample.

Note:
- Filtered samples are not allowed by the Safe Drinking Water Act program.

iii. Considerations for Dissolved Metals Sampling

The effect of filtration on inorganic ion content must be considered. The aeration that occurs during filtration may reduce the oxidation-reduction potential

of the water through the introduction of oxygen. This in turn may change the valence state of some inorganic ions which then could lead to the loss of analytes through precipitation (i.e., oxidation of ferrous ion to ferric ion after aeration). This same effect occurs during sample transport if the sample is not immediately preserved. For this reason transport of the sample to a laboratory for subsequent filtration and preservation is not permitted.

In addition, the filtering apparatus itself may adversely affect the quality of the sample. The filter paper and filter cake that accumulates during filtration could absorb dissolved metal ions resulting in lower than actual dissolved metals concentration in the filtrate. Also, the filtration apparatus and procedures, especially if performed by an unskilled technician, are an additional source of error potentially affecting the quality of the sample. In general, handling between collection and analysis should be minimized.

Note:

- If the results of metals analyses are to be reported as dissolved metals concentration, samples must be field filtered immediately after sampling and prior to preservation.

iv. Filtering Procedures for Dissolved Metals Analysis

A device made of polyethylene, polypropylene or borosilicate glass should be used when filtering ground water samples for metals. The apparatus should be pre-cleaned by rinsing with a 10% HNO_3 solution, followed by a demonstrated analyte-free deionized water rinse, and should be cleaned in the same manner between samples. Also, a field blank must be collected for this apparatus.

When filtration is performed, it must be done immediately upon sample collection and prior to preservation. The sample may not be transported to the laboratory for filtration and preservation nor may it be preserved prior to filtration. The sample should be collected, filtered, preserved, placed on ice and shipped to the laboratory for analysis.

Filtration is best accomplished using an in-line filter apparatus equipped with an ungridded, 0.45 micron pore-diameter cellulose acetate filter. If the use of an in-line filter is impractical, pressure filtration may be performed. Vacuum filtration of ground water samples, a third alternative, is the least preferred method of filtration. Care must be taken to strictly follow the manufacture's recommended procedures if vacuum filtration is used. All filter apparatus should be laboratory cleaned and dedicated. Disposable filters are acceptable. Caution must be used when filtering samples as to prevent the "filter cake" from becoming too thick during filtration. After filtration, samples must be preserved immediately with nitric acid to a pH less than 2.

f. Sampling for Light, Non-Aqueous Phase Liquids (LNAPLS)

LNAPLS are generally considered to be low density, immiscible organics including gasoline, petrochemicals and other chemicals which have specific gravities less than water. They are likely to be present in aquifers as a separate phase because of low solubility in water. These chemicals tend to float on the water surface in a water table environment and commonly occupy the capillary fringe zone above the water table. For this reason, if product (LNAPL) is suspected to be floating on the water table, all shallow wells installed in the area under investigation must be screened <u>across</u> the water table.

In a confined aquifer, these chemicals are found along the upper surface of the permeable material and also within the overlying confining layer. When immiscible organics with a specific gravity greater than water are the contaminants of concern or if contaminants are suspected in more than one stratified layer in the well column, sampling procedures must be modified. It may be necessary to lower the bailer used for sample collection to a particular depth in the well, or to utilize a double check valve bailer.

Sampling procedures for LNAPL differ substantially from those for other pollutants. If more than one distinct LNAPL layer is present in a well, each layer should be sampled. Samples should be analyzed for chemical composition (i.e., for volatile organics and base-neutral extractables, etc.) and physical parameters (e.g., specific gravity, water solubility, vapor pressure of the liquid, and Henry's Law Constant, etc.).

After the well is initially constructed it should be developed and pumped to remove stagnant water, then it should sit idle for at least two weeks to allow the water level to fully stabilize and the floating layer to stabilize.

Measurement of the thickness of the floating layer may be accomplished by using a water indicator paste/gel with a weighted steel tape to determine the depth to the top of the floating layer and to the water surface. The difference between these two readings is the thickness of the floating layer. Measurement of the thickness of the floating layer may also be accomplished by using an interface probe or clear Teflon bailer, if the product thickness is less than the length of the bailer. Electric water level sounders will not work properly for these determinations.

Prior to the purging of ground water from the well, a sample of the floating layer may be obtained using a bailer which fills from the bottom. Care should be taken to lower the bailer just through the floating layer but not significantly down into the underlying ground water. Samples should be analyzed to determine the chemical composition of the LNAPL and its physical properties (e.g., specific gravity, water solubility, equilibrium vapor pressure of the liquid and Henry's Law Constant, etc.). After following typical evacuation procedures discussed previously in this section, a sample of formation water may be obtained from the well.

g. Sampling for Dense, Non-Aqueous Phase Liquids (DNAPLs)

DNAPLs include chlorinated solvents and other chemicals which have specific gravities greater than water. They are likely to be present in aquifers as a separate phase because of low solubility in water. DNAPL chemicals tend to migrate downward through the unsaturated zone and the saturated zone due to their high density. If the volume of DNAPL chemical introduced into the subsurface is larger than the retention capacity of the vadose and saturated zones, a portion of the DNAPL will spread out as a layer of free liquid on the bottom of the aquifer or on lower permeability beds within the aquifer.

Measurement of the thickness of DNAPLs (and LNAPLs) must be performed prior to purging (evacuating) the well. Measurement of the DNAPL may be accomplished by using a water indicator paste/gel with a weighted steel tape (if no LNAPL is present) to determine the depth of the top of the DNAPL and the bottom of the well. The difference between these two measurements is the thickness of the DNAPL in the well. An interface probe may also be used to measure DNAPL in the well. An interface probe may also be used to measure DNAPL thickness.

Prior to purging a monitor well, a sample of the DNAPL may be obtained using a dual check valve bailer or a bladder pump. If both LNAPLs and DNAPLs are present in a well it may be necessary to purge the well of one casing volume of water prior to sampling the DNAPL provided that efforts are made not to disturb the DNAPL in the bottom of the well. This can be accomplished by setting the pump intake of the submersible or suction-lift pump several feet above the DNAPL.

Samples should be analyzed to determine the chemical composition of the DNAPL and its physical properties (e.g., specific gravity, water solubility, equilibrium vapor pressure of the liquid and Henry's Law Constant, etc.). After the well is purged, a sample of the ground water may be obtained for laboratory analysis.

h. Sampling Domestic Wells

(See also, J. "POTABLE WATER SAMPLING" - 2. "INDIVIDUAL WATER SUPPLY SYSTEMS")

An important step in sampling a domestic well is to obtain as much information as possible from the homeowner. This should include: depth of the well, well yield, formation in which the well is completed, screen depth and length, well construction material, diameter of casing and when and by whom the well was installed. This information should be verified if possible by obtaining drilling logs, etc. With this information, determine the number of gallons to be evacuated (see section 5. "Sampling Procedures" b. "Field Measurements").

When collecting a sample from an operating domestic well, it is essential to evacuate the plumbing and water storage tank. Running the water for a minimum of fifteen minutes before collection is a good rule of thumb, however, longer is desirable. Listen for the pump or the electric circuit to the pump to come on, indicating that the plumbing is being evacuated. Inquire as to whether any treatment units are installed on the system. Softening, iron removal, turbidity removal, disinfection, pH adjustment are often used; these may give misleading analyses depending on the parameters of interest. Home carbon filters for the removal of organics are also increasingly popular. Basement and outside faucets may by-pass such treated water (note: sample cold water faucet).

A brief inspection of the system should be performed to locate the well, pump, storage tanks and any treatment systems. Samples should be taken as close to the pumping well as possible and prior to any storage tanks or treatment systems. If a sample must be taken following a treatment unit, the type, size and purpose of the unit should be noted on samples sheets and in the field logbook.

Home faucets, particularly kitchen faucets, usually have a screen installed on the discharge. The screen must be removed prior to sampling for bacteria, or for volatile organics, since the screen tends to aerate the water and some organics may be lost. Also, when sampling for bacteria, do not take a sample from a swivel faucet since the joint may harbor a significant bacterial population.

Note: Homeowners' plumbing systems should not be tampered with in any way, except for removal of the faucet screen with permission of the homeowner.

For long term monitoring projects which utilize domestic wells, a specific tap or faucet should be designated as the target sample access point for accurate reproducibility of future samples.

i. Sampling Industrial Wells

When sampling industrial wells, it is desirable to sample as close to the well source as possible. Samples should be taken directly from the well head whenever possible. This will eliminate treatment interferences, possible changes in quality within the lines, mixing of water from other wells, etc.

Large capacity wells which are "on-line" during the visit can be sampled immediately. Wells which are "off-line", must be pumped to waste prior to sampling. Fifteen minutes or more is suggested. Access to municipal well systems well houses, etc. requires the assistance of a water department employee. Prior notification is essential.

I. SAMPLING OF MUNICIPAL AND INDUSTRIAL WASTEWATERS

Sampling of municipal and industrial wastewaters is performed for a number of reasons: to determine compliance with Federal, State or local standards, to verify reported self-monitoring data, to assist in determining discharger or user fees based upon wastewater strength, to verify the sampling technique and monitoring points of regulated parties, and to aid in determining the sources of prohibited or unwanted wastes. The most difficult type of sampling to perform is the collection of background information for future use; sometimes the correct information will be obtained, sometimes it will be missed. The collection of background information is critical. Information that may be gathered includes flow, totalizer readings, pH, TSS, treatment plant configuration and operating status.

When sampling wastewaters, one must take into consideration that good sample results are dependent on a number of factors, including sample representativeness, proper sampling technique and proper preservation. A location for sample collection should be chosen where uniform wastewater quality and thorough mixing exist. Wastewater influent samples should be collected at a point prior to any recycle, supernatant or return lines; wastewater effluent samples should be collected after the final treatment process. Take into consideration that the representativeness of samples may depend on timing; for example, influent samples collected at a municipal treatment plant with a substantial collection system may represent discharges into the system that occurred hours ago. In addition, be cognizant that many sampling locations present safety hazards, ranging from confined spaces, heights, unsteady equipment or surroundings, to airborn pollutants, biological hazards that may include infectious disease agents, ticks, poison ivy and snakes to chemical hazards such as corrosive liquids, heavy metals and potentially explosive atmospheres.

Samples may be collected as grabs or composites, depending on the purpose of the sampling, regulatory requirements or site conditions. Grab samples are single samples collected at neither a set time or flow. It may be advantageous to collect grab samples if wastewater flow is not continuous, if the wastewater's character varies or is not consistent, or if there is a need or desire to determine if a composite sample of the wastewater would obscure extreme conditions of the waste. In addition, some parameters, specifically dissolved oxygen or other dissolved gases, total and fecal coliform and other bacteria, pH, temperature, oil and grease and petroleum hydrocarbons, purgeable organics, and available and residual chlorine sulfite may only be collected as grab samples.

CHAPTER 10.

SOIL GAS SURVEYS

A. INTRODUCTION

Ground water contamination by volatile organic compounds (VOCs) is an extensive problem throughout the country resulting from the spillage and improper disposal of chemicals from a large variety of commercial and industrial processes.

The most common techniques applied to the investigation and delineation of volatile organics in ground water are typically performed by the use of soil borings and monitoring wells. Samples from these types of investigations provide the best method of detecting volatile organics in ground water both qualitatively and quantitatively. However, they also have some disadvantages. The combination of soil borings, well installation, and respective sampling and laboratory analysis can be very expensive. The levels of contamination are not known until after the installation, sampling and the receipt of analytical data from the laboratory. Additionally, numerous installations are required to sufficiently delineate the contamination.

Virtually all volatile organics which have become ground water contaminants are present to varying degrees in the soil as a gas due to their high vapor pressure and low aqueous solubility. The methods of sampling and measuring the levels of volatile organics in soil gas can aid in defining the extent of subsurface contamination. By measuring the volatile components migrating to the surface, the source and area plume extent can be estimated. The advantages of the soil gas survey are that a more thorough assessment of the site can be performed at a reduced cost with instantaneous analytical results. The survey can also aid in the decision process of future soil samples and well locations to optimize their data. It should be noted that a soil gas survey is not intended to be a substitute for conventional methodology, but instead, as a screening tool to enable conventional methods to be used more effectively.

This section will give guidance to the theory, applications and some of the common methodologies employed for performing soil gas investigations.

B. THEORY

Subsurface contamination by volatile contaminants produces a concentration gradient in soil gas that decreases in a direction away from the major source or body of contamination.

For volatile organics in ground water to be detected in the vadose zone, they must move upward from the saturated zone, through the capillary fringe, and into the area where the gas samples are obtained. Volatile organics evaporate out of the groundwater and into the vadose zone by molecular diffusion. The concentration of volatile organics in soil is a function of their concentration in the ground water, aqueous solubility and vapor pressure.

Ideally, an upward vertically decreasing volatile organic concentration gradient is found in the soil gas. This is caused by the vertical migration of volatiles from the contaminated ground water table to the ground surface. A horizontal concentration gradient will also be present with decreasing concentrations of volatile organic vapors in the soil gas from the source of contamination. In some cases, the concentration gradient between the water table and ground surface in soil gas may be distorted by hydrologic and geologic variables such as perched water or impermeable layers. Diffusion of contaminants will generally occur around geologic and hydrologic barriers unless they are of great lateral extent as compared to the area of the plume.

C. SOIL GAS GENERATION

Soil gas may be generated by biological, chemical and physical decomposition of spilled, stored, or dumped wastes. Waste characteristics such as type, source, quantities, and the geologic and geographic location of entry into the subsurface can affect the rate of decomposition and gas production.

1. Biological Decomposition

Biological decomposition is important in most active and closed landfills containing organic wastes which decompose due to anaerobic microbial degradation.

Generally the amount of gas generated in a landfill is directly related to the amount of organic matter present.

Rapid decomposing wastes such as food, sewage sludges, and garden wastes, result in high initial yields of gas generation shortly after burial. Waste material such as cardboard, paper, wood, leaves and some textiles decompose at a reduced rate. Materials which do not contribute to gas production include rocks, plastics, ash, glass, ceramics, metals and man-made textiles.

Waste type and in situ characteristics and conditions can affect biological decomposition. Factors which enhance anaerobic decomposition include moderate temperatures, adequate buffer capacity, neutral pH, high moisture content and sufficient nutrients such as nitrogen and phosphorus. Biological decomposition is decreased by soluble metals, microbial toxicants, sulfureous environment, and acidic or basic pH. Under anaerobic conditions, organic wastes are primarily converted by microbial action into carbon dioxide and methane. Also, trace amounts of hydrogen, ammonia, aromatic hydrocarbons, halogenated organics, and hydrogen sulfide may be present.

2. Chemical Decomposition

Gas production from chemical decomposition results from the mixing of incompatible materials. Reactive or ignitible wastes can cause explosions or heat producing reactions resulting in a rapid production of gases and increased temperatures. In acidic conditions a strong oxidizing agent can react with organic wastes to produce ammonia and carbon dioxide.

Under typical conditions, soil gas production from chemical reactions is not expected to occur. These reactions are more likely to occur from liquids stored or spilled from underground tanks and pipelines.

3. Physical Decomposition

Gas production from physical decomposition is from the processes of volatilization and combustion. Volatilization can result in subsurface gas generation from contaminated ground water, spills or leaking underground tanks and pipes. Volatilization of a compound will be dependent upon the compound's vapor pressure. The greater a compound's vapor pressure, the greater its ability to volatilize.

Combustion processes, such as underground fires in landfills, can result in the release of subsurface gases. In a landfill, combustion can convert waste material into carbon dioxide, carbon monoxide and trace toxic components.

Combustion processes can also create an environment conducive to accelerate chemical reaction rates and biological decomposition rates. The increased rates create a greater potential of subsurface gas generation and release.

D. SITE SPECIFIC CHARACTERISTICS

Subsurface conditions at a site for a soil gas investigation must be evaluated to discover likely gas migration routes. Various structures and construction at a site may produce areas of preferred pathways for soil gas migration or impede gas flow.

1. Chemical and Physical Properties of the Contaminant

During the planning and preparation for conducting a soil gas survey, site specific parameter characteristics should be evaluated. This will aid in the recognition of the variability of the site specific parameters so accurate interpretations of the results, can be made. The degree of preparation will have a direct bearing on the success or failure of an investigation. On-site chemical and physical properties of the contaminant which should be evaluated include:

a. Concentration

The known or estimated concentration of the ground water contaminant will dictate the vertical concentration gradient of soil gas established in the vadose zone. The diffusion of vapors from areas of high concentrations to lower concentrations is the mechanism of greatest importance for gas transport in the unsaturated zone. Therefore, if the known or suspected concentrations of contaminants in ground water is low, the compound will be difficult to detect in the vadose zone. To counter this, samples should be taken at greater depths in the vadose zone. A greater concentration of sampling locations can then be established or an alternate tracer compound can be selected.

b. Density

The density of a compound is defined as the amount of substance per unit volume (g/cm^3). The density of the contaminant as compared to water will determine the contaminant migration in the aquifer. Compounds with densities greater than 1 will tend to move downward in the aquifer (sinkers), those with densities greater than 1 will float on the surface of the aquifer (floater). Floaters with low water solubility and high volatility are good candidates for vapor detection due to the setup of a steep vapor concentration gradient in the vadose zone.

c. Dielectric Constant

The dielectric constant is the relationship between two charges and the distance of separation of the two charges to the force of attraction. In clay, this constant reflects the degree to which they will shrink or swell. Liquids with high dielectric constants, such as water, will cause clays to swell. Those liquids will low dielectric constants will cause clays to shrink and crack increasing permeability exposure to concentrated organic liquid. This will decrease the travel time of these organic liquids to reach the groundwater in clayey soils. Also vapors migrating to the surface would not be as restricted as in normal circumstances.

d. Henry's Law Constant

Henry's law constant is expressed as a ratio of partial pressure in the vapor to the concentration in the liquid. It is a coefficient that reflects the air water partitioning of an organic compound. Those compounds with Henry's law constants greater than 0.05 k Pa M^3/mole, or, 1 microgram per liter soil gas/micrograms per liter water ratio would be good candidates for soil gas detection.

e. Molecular Weight

The molecular weight of a compound is the sum total of the atoms which compose the molecule. High molecular weight compounds characteristically decompose through biodegradation at a much slower rate and would therefore persist in the unsaturated and saturated zones the longest.

f. Boiling Point

The boiling point of a compound is defined as the temperature at which the external pressure of the liquid is in equilibrium with the saturation vapor pressure of the liquid. Generally, compounds with lower boiling points also have higher vapor pressures. It is these compounds which are best suited for soil gas detection.

g. K_{oc}

The K_{oc} of a compound is a coefficient that relates the partitioning of the organic compound between the adsorbed phase and the soil solution relative to the organic carbon fraction. This coefficient reflects the affinity of an organic compound to adsorb out of solution onto organic soil material. The affinity for organic compounds to adsorb onto soil in the unsaturated zone is dependent upon the presence of organic material in the soil. Generally the organic carbon content in the vadose zone decreases with depth, so the greatest influence will be at or near the surface.

h. Vapor Pressure

Vapor pressure is the pressure of a confined liquid such that the vapor collects above it. Groundwater contaminants with high vapor pressures will be present in the soil vapor and are therefore excellent targets for soil gas analysis. those compounds with vapor pressures of 1mm Hg at 20° or higher are the best target analytes for soil gas analysis.

i. Water Solubility

Water solubility is the extent to which a compound dissolves in water. These compounds would partition primarily in the water phase. Compounds with high water solubilities would move through the unsaturated zone quickly depending upon the amount of rainfall and the hydraulic conductivity of the soil. The detection of highly water soluble compounds would also depend on recent precipitation and wetting fronts which would dissolve the compound and cause it to migrate downward.

2. Properties of the Vadose Zone

a. Air Filled Porosity

The air filled porosity is a ratio of the volume of air in the soil pores to the total volume of soil. This is an indicator of soil aeration and is inversely related to the degree of saturation. As the air filled porosity increases, the diffusion of vapors migrating to the surface increases establishing a vertical soil gas profile. As the air filled porosity decreases with increases in water content due to wetting fronts and soil texture (water holding capacity), vapors moving into low air filled porosity zones could potentially be resolubilized.

b. Volumetric Water Content

This parameter is the ratio of the volume of water in a porous volume to the total volume. The presence of moisture in the soil can serve to decrease the rate of vapor migration. This can occur because as the volume of soil water increases, the soil airspace decreases, thereby increasing the vapor path length. Partitioning of the contaminant into vadose zone liquid water can decrease the amount of contaminant available for transport. However, there are some instances in which increased soil moisture may enhance vapor migration. One such instance occurs when soil has been dried extensively and the majority of soil water has evaporated from the surface of soil particles. This situation provides for more extensive absorption of VOC onto the soil. Under these conditions when the soil is rehydrated, the VOCs which are hydrophobic, are displaced by water molecules and migrate in the vapor state. Carried to the extreme, the presence of perched water between a VOC source and a sampling point may indicate minimal contamination. Dealing with soil moisture can be a problem in the interpretation of soil gas data.

c. Soil Texture

Soil texture is the measure of the percentages of various particle size groups in a volume of soil, typically sand, silt and clay. As the soils become poorly sorted with increased clay content, the pore space is decreased, the water content increases and the rate of vapor diffusion decreases. The rate of diffusion of vapors in the vadose zone will be dictated by the most retarding layer.

d. Soil Organic Material

The amount and depth of organic material in the soil will depend upon the vegetation, climate, and the rate of decomposition. Organic material will have high surface areas and exchange properties ideal for adsorption of organic compounds. The K_{OC} value of a soil designates the ability of the organic material to adsorb organic compounds out of solution.

e. Depth of the Vadose Zone

This will determine the distance vapors must migrate from the ground water to an area for sampling. The greater the depth of the vadose zone, the greater the chance for soil texture changes, the greater distance the concentration gradient must be established and the deeper soil gas probes would be required to be placed for detection of the vapors. Conversely, if the thickness of the vadose zone is small there is a greater chance of dilution of the soil gas by ambient air and a severe alteration of the concentration gradient.

f. Temperature and Temperature Gradients

Soils with elevated temperatures or great temperature gradients existing from the surface will allow thermal diffusion to readily occur. The effect of a temperature gradient is to induce flow and distillation from warmer to cooler regions. Vapors migrating to the surface during warm summer months will then have to move against a temperature gradient when entering the surface soil horizon. To the other extreme, if surface soil temperatures are reduced to freezing, vapors could be trapped, concentrate and then move laterally under the frozen soil. Soil temperature may also have an impact on microbial growth with warmer temperature increasing microbial action.

g. Microbial Degradation

If conditions permit, microbial degradation can lead to significant degradation of organic compounds. The amount of degradation will depend upon the number of species available and the degree of difficulty in breaking down the compounds. Degradation can reduce the amount of contaminant which will reduce the vapor concentration gradient.

h. Barriers

Barriers either man-made or natural are obstructions which will impede the movement of vapor. The obstacles can be structures, blacktop, cement, landfill caps, clay layers, frozen soil or any other obstacle for vapor migration. The location and extent of the barrier will dictate the direction of movement of the soil vapor around the obstacle.

i. Conductive Zones

Conductive zones can be natural, such as old stream beds and gravel lenses, or man made, for example bedding around pipelines. Since vapor will move along the path of least resistance, it will tend to travel these routes. This has been most notable for methane moving along sewer lines and into homes.

3. Hydrologic and Hydrogeologic Properties

a. Ground water Flow

The direction, velocity and gradient of groundwater will control to a great extent, the shape and extent of the plume. In proximity to pumping wells or other influences, alteration of the groundwater direction will occur by creating a cone of depression. These characteristics will also help make the initial decision to locate soil gas sampling points.

b. Water Table Oscillations

Changes in the depth of the water table can have a large impact on the vertical transport of contaminants. Drops in the water table with floating product will leave a "smear" of product in the vadose zone and therefore a greater availability for vapor transport.

c. Lithology Of The Aquifer

When the contaminant enters the aquifer, its migration will become dependent upon the sediments and rock that make up the aquifer. Changes in ground water flow may occur due to soil texture changes, depositional characteristics of the unit, jointing and fracturing. Contaminants will migrate along these pathways which may become difficult to track.

d. Background Water Quality

The greater the contamination of ground water with various contaminants, the greater the difficulty in delineating a particular contaminant in question. At some locations several plumes may exist that are partially or completely overlapping from different spills. In such cases, greater instrument sensitivity would be required to separate the contaminant of interest from the "contaminant soup".

e. Rainfall, Barometric Pressure, Temperature and Wind

All of these "weather effects" will have varying degrees of influence on soil gas. Low Barometric pressure and increasing winds will increase the outgassing of soil vapors in the soil pores at or near the surface. To eliminate this effect soil gas probes can be located several feet below the soil surface. Rainfall that occurs may cause leaching of the soil vapor, water table oscillations, decreased air filled porosity and altered concentration gradients. Rainfall may also make it very difficult to compare soil gas testing results before and after a rainfall event.

Temperature, both daily and seasonal, will influence the migration of soil gas. Increased temperature will induce the movement of gas due to the increased biological activity in landfills or drying of the soils.

The key to limiting these effects is to acquire all the samples in the shortest period of time possible under the same meteorological conditions. This leads to reducing the effects of meteorological changes and therefore, a greater confidence in the correlation can be made.

4. Spill Characteristics

Extensive knowledge of characteristics of the spill such as location, duration, volume and age can provide a greater insight as to the best locations for soil gas sampling.

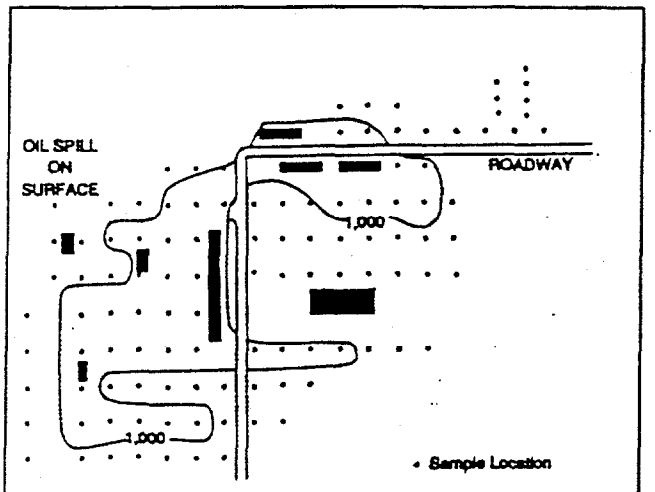
E. SITE MONITORING NETWORKS

The sampling network should be constructed to obtain all necessary and required information with a minimal

expenditure of time and resources. The development of the network should be based on background information obtained regarding physical and chemical properties of the contaminant, properties of the vadose zone and hydrologic and hydrogeologic properties of the area. All this information should be used to design a sampling strategy specific to the characteristics at the site. Some of the designs used include:

1. Grids

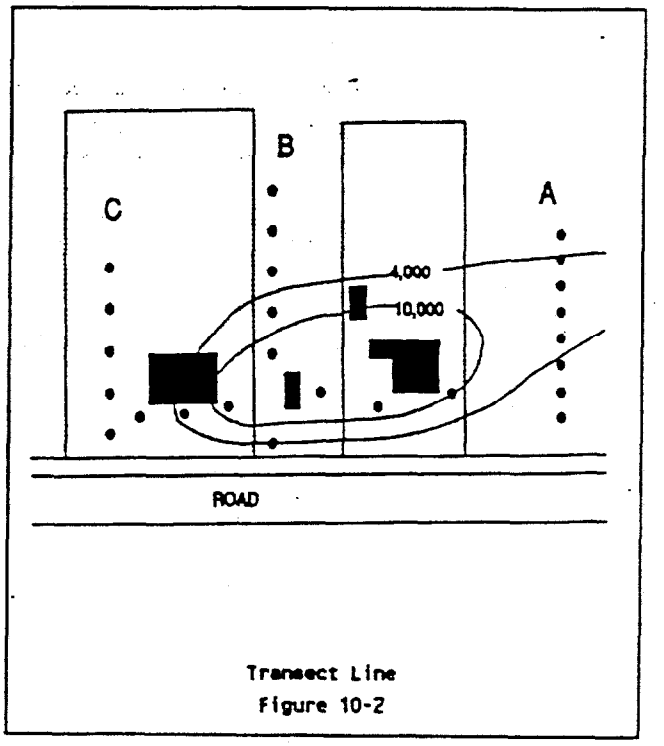
Grids consist of sampling points set on perpendicular lines at equal distances along the line from each other. The grid size will depend upon the site characteristics and objectives. An example of a grid utilized in a soil gas survey design is shown in Figure 10-1.



Soil Gas Grid
Figure 10-1

2. Transect Lines

This network is most commonly used to find a source area of contamination. Sampling points are placed on a line between the area of impact and a suspected source area. This significantly decreases the number of sampling points from using grids. An example of using a transect line investigatory technique is shown in Figure 10-2.



Transect Line
Figure 10-2

3. Biased

In this approach, sample points are placed near a suspected source in an area of contamination to find "hot spots" for further delineation or remediation. This type of network is used once a source area is defined.

4. Random

Random networks use a grid with numbers designating the nodes or areas. The sample points are then selected by a random number generator to designate which areas are targeted for sampling. This type of network is used in areas where no information is known or no contamination is suspected.

5. Combined

This type is the most common network used, usually a combination of the four previous networks to detect, define and discover sources and impacted areas of contamination.

The interval between sampling points will be dependent upon the objective of the investigation. Reducing the soil gas sampling interval will not necessarily provide better resolution of the ground water plume. It has been stated in the literature (16) that as a rule of thumb, the soil gas probes should be placed 2 - 3 times

the depth of ground water. Spacing less than this may be a measure of the small scale difference in the vadose zone rather than changes in the parameter of interest. Soil gas sampling is not a high - resolution mapping technique and should not be used as such.

F. HEALTH AND SAFETY

Prior to mobilizing for any soil gas investigation, health and safety concerns must be answered. Of greatest concern would be to locate any underground utilities. These include but are not limited to the following:

- Electric
- Sewer Lines
- Telephone Lines
- Cable TV
- Water Lines
- Natural Gas Lines

This is by no means an all encompassing list of utilities which may be present at a site targeted for a soil gas investigation. A check must be performed for any commercial processes at a site to determine the presence of any unlisted buried utilities.

To locate the utilities, various methods or sources of information should be investigated. One of the most common is using a metal detector. If utilities are non-metallic, sources such as construction blueprints, "as built plans" or other drawings must be consulted.

One source in New Jersey, "The Garden State Underground Plant Location Service", can be contacted at 1-800-272-1000. They will contact all utility companies which may have services in the area of investigation. They are a subscription service, so some utility companies may not be in the network. The location service will identify those subscribing companies, but the other potential utilities must be contacted by the investigator.

Above all, if it is suspected that a utility line is present, move the sample location. A few feet in a soil gas survey won't have a great impact on the results in lieu of possible injury or death.

G. SAMPLING METHODOLOGIES

There are numerous methodologies for the collection of soil gas samples. The most common types will be discussed in this section. They include sorbent collectors, ground probes and air piezometers. A discussion of each methodology follows:

1. Passive Sorbent Samplers

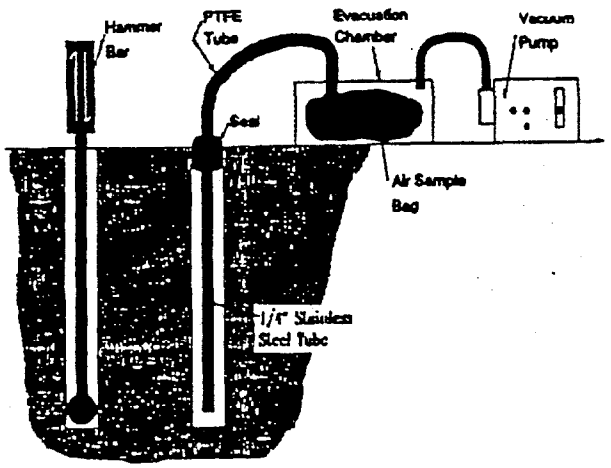
The most common sorbent sampler used is known as a "Petrex Tube". This collector consists of activated charcoal chemically fused to the tip of a Curie-point ferromagnetic wire and inserted in a glass tube. The collector is then buried at a depth of 2 - 4 feet in an inverted position (open end of tube down) with the glass tube acting as a flux chamber for an optimal period of time as determined by "loading checks" of replicate probes. Other types of passive collectors have been used, and are being further developed, which use sorbent media housed in a collector or flux chamber. These can be buried or placed on the surface such as the EMFLUX^R system. Sample analysis is by thermal desorption onto a MS or GC.

This type of collector provides an integrated sample that compensates for any short term fluxes in soil gas concentrations. This method is recommended when the ground water contaminants are not known and concentration are low.

2. Pipe Probes

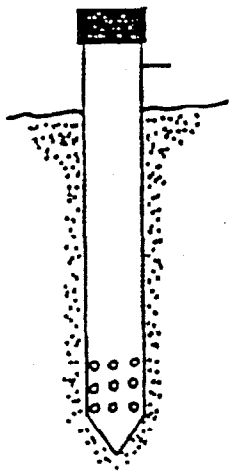
Pipe probes are soil gas collection methodologies which involves the use of a hollow tube to obtain a sample. The probes can be passively placed into a predrilled hole or driven to their desired depth.

Passive pipe probes (Figure 10-3) are used by first making a hole with the use of a bucket auger or slide hammer and removed. The probe, designed with predrilled holes on the sealed leading end or open end, is inserted into the hole to allow soil gas entry. The annular space at the surface is then sealed with an inert impermeable material, such as clay. It is recommended that the drill cuttings not be used since this will not provide an effective seal. Once sealed, the probe is evacuated and a sample withdrawn for analysis.



Passive Probe
Figure 10-3

Driveable pipe probes (Figure 10-4) consist of a tube which has a drive tip and perforations on the leading end to allow soil gas to enter the probe. The trailing end has a drive cap to protect it when the tube is driven into the ground. A sample port of manifold for gas extraction is also located on the trailing end.

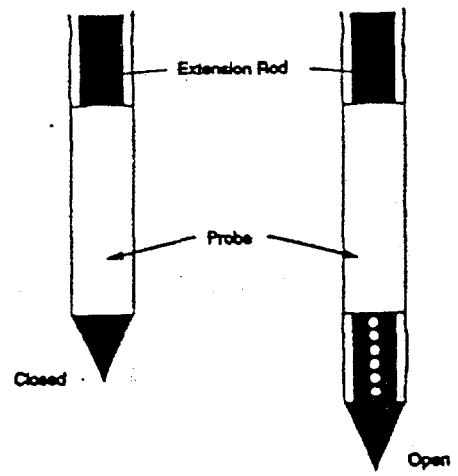


Drive Probe
FIGURE 10-4

The probes are driven to the targeted depth by a slide or electric hammer. Once the probe is at the desired depth, soil gas will enter the tube through the perforations. A gas sample may then be extracted through the sample port.

Differences in the probes can be made to vary the length to attain greater depths, and to decrease the inside volume of the probe. A decreased probe volume will cut down on the volume needed to purge the system, thereby giving a more representative sample of the gas present at the sampling depth.

Another type of probe which is available is the retractable probe (Figure 10-5). This probe is used for obtaining soil gas samples at discrete depths with fewer failures due to hole clogging. This probe consists of two parts, an outer tube and a small inner tube with sample parts connected to the drive point. The probe is driven to the desired depth and the probe is pulled up about 6 inches. This action opens the probe for soil gas sampling to commence.



Retractable Probe
Figure 10-5

3. Air Piezometers

Air piezometers (Figure 10-6) can be installed to obtain data of subsurface gas concentrations at depths or areas inaccessible by other monitoring techniques. Single or multiple probes may be installed into a single borehole. In areas where contamination is at

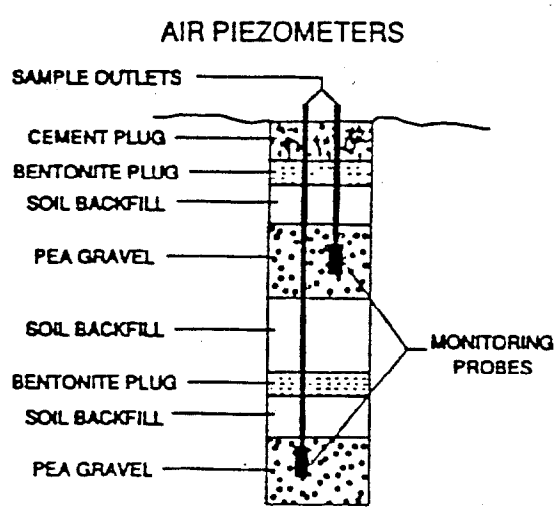
greater depths, multiple depth probes may be installed in the borehole to obtain a vertical profile of soil gas concentrations.

Location and depth of gas piezometers should be based on any natural high permeability zones. The zones may be dry sand and gravel, in close proximity to the waste source, aligned with off-site structures, or engineered channels (utility lines). Areas of stressed vegetation may possibly be due to gas migration. An increased number of piezometers may be necessary at locations where site characterizations or anomalies can create significantly different subsurface conditions of gas migrations.

Air piezometers are recommended for projects if more than one soil gas sampling event is to occur to monitor subsurface gas conditions (underground storage tanks, landfills). Their installation will decrease the number of man-hours required to complete the task.

The construction of the piezometers may vary. They can be predrilled small diameter PVC pipe, slotted well screen or commercially available soil gas well points manufactured by companies specializing in soil gas equipment.

Depending upon depth and construction, installation of gas piezometers may require the use of a drill rig, power auger or hand auger.



Air Piezometer
FIGURE 10-6

The installation of a soil gas piezometer should be as follows:

1. Drill borehole to desired depth.
2. Set probe at desired depth and backfill with pea gravel (approx. 2').
3. Place soil backfill on top of pea gravel.
4. Place a 2 foot bentonite plug to inhibit gas migration.
5. Place soil backfill on top of the bentonite plug.
6. Repeat steps 1-4 for each additional probe to be set in a well.
7. Place a 3 foot cement plug at the surface.
8. Install a protective casing to prevent piezometer damage.

4. Soil Gas Sample Collection

The collection of the soil gas sample for analysis will vary depending upon probe design and analytical methodology. The most common types of collection methods are as follows:

a. Whole Air

One technique involves the employment of a container to hold the air. The most common technique is using a tedlar bag with an evacuation chamber. A tedlar bag is connected to the soil gas probe and placed in an air tight container. The air surrounding the bag in the container is pumped out, creating a vacuum which allows the bag to fill. The advantage to this method is the air sample never passes through the pump thus eliminating a source of contamination.

A second technique uses Glass bombs which are glass cylinders with openings at each end. The air sample is collected by connecting one end of the bomb to the probe and the other to a pump. The pump then draws the sample through the bomb. Again, the air sample does not go through the pump prior to collection.

The key advantage of these techniques is that multiple injections of the sample can be performed after removal of the probe while moving onto the next location. The sample can also be cryogenically trapped and analyzed at a later date by laboratory based instruments.

The holding time for samples in tedlar bags and glass bombs is 48 hours.

b. Sorbents

Soil gas samples can be collected on sorbents dependent upon the species of interest. Some of the sorbents used are charcoal, tenax, carbotrap, polyurethane foam (PUF) and carbon molecular sieve (CMS). A sorbent tube is connected to the soil gas probe and a sample is pumped through the tube while the sorbent strips the analytes from the air. The tube is then usually analyzed by thermal desorption or extraction by a laboratory based instrument.

5. Analytical Methodologies

The method selected to analyze the soil gas samples must be consistent with the collection methodology to achieve the objectives of the investigation. Some basic criteria for selection of the proper analytical method includes:

- Sensitivity: Is Ppb, Ppm or percent concentration required? Is the relative concentration or the absolute concentration required?
- Selectivity: Will the analytical methodology identify the pollutant species or will a total value satisfy the data objectives?
- Cost: Is the analytical methodology cost effective?

Based on these criteria, an analytical methodology can be chosen which will achieve the objectives of the soil gas investigation. Some of the methods used in soil gas sampling are as follows:

a. Detector Tubes

This analytical method is the most inexpensive, has good selectivity and the sensitivity is usually high. Also, the user must be aware of the influences other gases and humidity will have on the method.

b. Direct Reading Instruments

Depending upon the instrument, these units can be cost effective for obtaining analytical data which has PPM sensitivity and limited selectivity.

c. Portable Gas Chromatographs

These instruments, though more expensive, can be very sensitive (sub PPB) and selective to the contaminant. This is due to the ability to select the type of detector and column most amenable to the contaminants of concern.

d. Based Systems

These units will have the highest cost ratio per sample analysis, but generally will have the greatest sensitivity and selectivity for pollutant analysis.

6. Quality Assurance/Quality Control

Quality control must be an integral part of any sampling plan. Without attention to detail the project becomes suspect and the data meaningless. Quality control checks required for any project will be dependent on the sampling and analytical methods selected. The following list of quality control considerations is applicable to most soil gas measurement programs:

a. Adhere to sampling procedures

Doing so provides consistency of data throughout the investigation. Examples include purge volumes, sample depths and techniques used.

b. Collection of Equipment Blanks

Equipment blanks should be run daily prior to use of the equipment. This must include all probes, syringes and sample containers (bags, bombs). Equipment blanks will prevent the occurrence of false positives from contamination in the sampling system.

c. Background Measurements

This allows for comparison of all measurements detected in the contamination zone and ensures that discrepancies which arise are the result of the sampling method.

d. Duplicates

Duplicate samples determine the variability associated with the sampling procedure. They should be performed at a minimum rate of one per every twenty samples. Duplicates should be taken from the same probe since different probe locations may yield order of magnitude variation in results.

e. Decontamination

Probes should be purged with air. If the field blanks determine the probes are still contaminated after flushing, they must be cleaned with alconox, given a tap water rinse, distilled/deionized water rinse and then be allowed to air dry.

f. Equipment Calibration

Equipment must be calibrated as per the manufacturer's requirements. Calibration standards should be run at a minimum of 1 per 10 samples. If area counts, retention times or concentrations differ by more than 10 - 20%, recalibration is required.

g. Limitations of the analytical methodology

Depending upon the analytical methodology selected, the limitations and influences that the soil gas matrix will have on the instrument must be understood. This is especially true for the survey instruments which are influenced by humidity, oxygen or flow rates. With a greater understanding of analytical methodology limitations, a better assessment and interpretation of the data can be achieved.

7 Soil Gas Interpretation

Soil gas measurements are an approximation of the contaminant of interest in the underlying ground water. There is a considerable amount of interpretation that must be incorporated before the selection of a down gradient monitor well or approximating the boundaries of groundwater contamination plumes.

Because of site and compound specific considerations, soil gas surveys should be planned with a thorough knowledge of the site: It's history and other factors as previously discussed may impact the results which are important to the survey. A preliminary site reconnaissance can be valuable when determining the shallowest depth which will provide the most adequate sensitivity, appropriate sampling and analytical methods, purge volumes while optimizing other operational details.

When selecting the target contaminant(s), the persistence of that contaminant in the subsurface must be evaluated. VOC's can be altered or eliminated by biological or chemical transformation. Examples include microbial degradation of TCE by sequential dehalogenation to CIS-1,2-DCE, trans-1,2-DCE and vinyl chloride, or the reduction of organic hydrocarbons by oxidation.

When using survey instruments for measuring total volatiles, the nature of the volatiles cannot be discriminated. Influences such as humidity, oxygen content and the presence of naturally occurring volatiles will complicate the measurements. Although each naturally occurring compound may be present in small amounts, when combined, these compounds can have a significant influence on the total volatile organic level. Caution should be exercised in using total volatile organics as an indicator of pollutant levels present, especially at sites where they are abundant. The use of total volatile organic levels as a measurement of degree of contamination should only be performed in situations where naturally occurring volatile compounds will not influence the results. This can be accomplished by the use of instrumentation that can differentiate between the contaminants of interest and the naturally occurring compounds. Determining the background levels of naturally occurring compounds can be performed by characterizing their potential influence on the soil gas results. Table 10-1 lists some naturally occurring volatiles released from biological sources.

In the analysis of soil gas, the phase or "mode of occurrence" can be estimated by the differing properties of the components comprising the contaminant. For example, the relative concentrations of benzene to xylene can be an indicator if the sample was collected above an area of free product or dissolved hydrocarbons. Since benzene has a higher solubility in water, it is readily stripped out of the liquid hydrocarbon as it is flushed with water.

In contrast to the major fuel component, the xylenes have the lowest solubility in water and have a higher K_{oc} value. Xylenes do not migrate easily in a dissolved or liquid phase. Therefore, their occurrence is more closely associated with the presence of the liquid hydrocarbons.

The relative concentrations of these components can also be used to differentiate between different sources and spills of different composition (diesel, heating oil, gasolene).

Combining the knowledge of the site, soil characteristics and contaminant interface will aid in the correct interpretation of results from some of the most common interferences to the mapping of ground

water contamination. One of the most common reasons for false negatives is due to barriers including perched water, buried foundations, clay lenses and disturbed soils. Conversely, false positives are usually a result of site specific factors, the most common being the presence of unknown, near surface source areas that may be mistakenly identified as ground water contamination.

Another useful tool generated by soil gas surveys is the "fuel fingerprint". This technique encompasses the comparison of soil gas chromatograms with those of pure product which can then be used to identify volatile petroleum products in soil gas. Fuel fingerprinting however, is limited due to the enormous differences in volatilization, migration and degradation which affect individual fuel products. This method is most successfully used at sites where recent spills have occurred creating free product layers in shallow aquifers.

Generally, to determine the occurrence of recent spills and ground water contamination, vertical soil gas concentration gradients can be used. The success of this method will depend upon the characteristics of the soil, contaminant and age of the spill.

The most common mistake associated with interpretation of soil gas data is to extend the interpretation beyond the scope of the survey design. For example, the relationship between volatile concentrations obtained in a soil gas survey rarely match the ground water contours. Differences in the ground water contaminant plume and the soil gas concentrations will vary as a result of varying soil conditions at a site. Quantitative relationships between soil gas data and ground water contamination are also difficult to interpret due to the varying soil conditions. Correlation coefficients between ground water contamination and soil gas results can have a difference in orders of magnitude. The lack of a statistical correlation between soil gas and ground water does not indicate that soil gas results are unindicative of ground water contamination, but the variability of each set are different. A good example of the difference in variability is when duplicate ground water analysis are suspect if results are not within two percent whereas adjacent VOA soil gas concentrations can vary by a factor of 4 to 5 and still be indicative of the same subsurface contamination.

Soil gas sampling and its analysis are designed as a screening tool to be used in conjunction with water quality data. It will always be necessary to confirm the predictions of contamination identified by a soil gas survey through the analysis of soil borings or monitoring wells. Soil gas surveys can be used as one tool in an array of investigative techniques for a phased approach to site characterization.

The successful use of soil gas surveying in determining subsurface contamination is dependent upon collection and analysis as well as planning and data interpretation. A soil gas survey should be conducted on the basis of successfully interpreting the data, not on the feasibility of collecting the data.

CHAPTER 13.

DOCUMENTATION

Proper documentation of all site activities is a crucial part of the field investigation process. Documentation must be maintained to trace the possession and handling of samples from the time of collection through analysis and disposition. Documentation procedures include: sample labels, sample seals, field log books, chain of custody records, sample analysis request forms, and laboratory sample logs. The details of all activities, whether part of the site inspection or a sampling episode, must be recorded in a field log book. When samples are collected, documentation in the form of sample analysis request forms must be completed. Proper completion of these forms and the field log book are necessary to support potential enforcement actions that may occur from the results of sample analysis.

A. FIELD LOG BOOKS

Field log books must be bound and should have numbered, water resistant pages. All pertinent information regarding the site and sampling procedures must be documented. Notations should be made in log book fashion, noting the time and date of all entries. Information recorded in this notebook should include, but not be limited to, the following: name and exact location of site of investigation; date and time of arrival and departure; affiliation of persons contacted; name of person keeping log; names of all persons on site; purpose of visit; all available information on site (processes or products, waste generation, nature of spilled material); composition and concentration of substance, if known; description of sampling plan; field instrument calibration information; location of sampling points (including justification) number of samples taken, volume of samples taken; preservation; method of sample collection and any factors that may affect its quality; date and time of sample collection and any factors that may affect its quality; name of collector; all sample identification numbers; description of samples; weather conditions on the day of sampling and up to forty-eight hours previous and any field observations.

B. DOCUMENTING SAMPLING POINTS

Sampling points should be documented as to their exact location for purposes of future sampling. This is accomplished through the use of a monument, measuring tape and compass. A monument should be chosen at each site to act as a stationary reference point from which all sampling points can be measured using a compass and measuring tape.

If a building or other stationary structure exists, its corner may act as this reference point. If no such monument already exists, it will be necessary to create your own. A piece of wood, approximately 2 in. by 2 in. should be hammered into the ground to almost ground level, making it difficult to remove and thus assuring its permanence. The stake should then be marked with flagging tape or fluorescent paint.

When establishing a sampling point, follow this procedure:

- Standing at the monument, facing sampling point, use the compass hairlines to determine degree of direction.

- Line of sight should run from the monument, through both hairline needles on the compass, to the sampling point.

- When first establishing the sampling point, record the degree and direction reading from the compass in the field notebook, along with the distance measurement, from the monument to the exact sampling point.

- In the future, field investigating teams should have no difficulty finding the exact locations from which previous samples were taken when they are provided with the monument and compass data.

C. PHOTO-DOCUMENTATION

All sampling points should be documented on film. A film record of a sampling event allows positive identification of the sampling point. Photographs are the most accurate and convenient demonstration of the

field personnel's observations. Photographs taken to document sampling points should include two or more reference points to facilitate relocating the point at a later date.

Keeping a record of photographs taken is crucial to their validity as a representation of an existing situation. Therefore, for each photograph taken several items should be noted in the field notebook:

1. Date
2. Time
3. Photographed by (signature)
4. Name of site
5. General direction faced and description of the subject taken
6. Sequential number of the photograph and the roll number

Photo-documentation is invaluable if the sampling and subsequential analytical data ends in litigation, enforcement, or cost recovery actions. Video coverage of a sampling episode can be equally or even more valuable than photographs because it can be used to prove that samples were taken properly as well as where they were taken. It can be used as a record of site conditions and can give those who have not been on-site an idea of the circumstances.

D. SAMPLE COLLECTION PAPERWORK

1. SAMPLE LABELS

Sample labels are an important part of proper documentation as their use not only reduces the possibility of confusing sample containers, but also provides the information necessary during handling to complete chain-of-custody forms. Sample containers should be pre-labeled before sample collection and the labels themselves protected from the sample matrix with a clear tape covering. Sample labels should include the well or sample number; parameter sampled; date; time sampled; sampler's initials; preservative; and site name or location.

2. CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

When samples are collected for laboratory analysis, additional documentation procedures are required. The Chain of Custody (COC) form is intended as a legal record of possession of the sample. The COC should be initiated at the lab at sample container receipt, remains with the sample at all times and bears the name of the person assuming responsibility for the samples. This person is tasked with ensuring secure and appropriate handling of the bottles and samples. When the form is completed, it should indicate that there were no lapses in sample accountability.

In order to assure that the proper analysis is performed on the samples, additional information may be required by the lab performing the analysis and/or the regulatory agency involved. Such as identification of samples by number, location and time collected and desired analysis. This information should act as a confirmation to lab contacts made prior to the sample event initiation.

In order to reduce the amount of paperwork necessary to adequately document sample collection, the NJDEPE has combined the "Chain of Custody" form with the "Sample Analysis Request Form". The format of this document may vary, depending upon the source of the sample bottles.

There are two (2) versions of the combined form:

a. External Chain of Custody and Sample Analysis Request Form WITH shipping container.

This document is intended to be initiated by the laboratory performing the analysis and to accompany the samples until they return to the laboratory for analysis (Figure 13-1).

b. External Chain of Custody and Sampling Analysis Request Form WITHOUT shipping container.

This form can be used in cases where chain of custody is initiated by the sample collector (Figure 13-2).

Both forms are currently utilized within the Site Remediation Programs to ensure handling and legitimate transfer of samples.

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EXTERNAL CHAIN OF CUSTODY AND SAMPLE ANALYSIS REQUEST FORM
(with Shipping Container)

INSTRUCTIONS: *Use 1 form per sample.*
Enter all dates and times on this form in the following format: (24 hr. clock, day/month/year)

Name of Laboratory: _____

Name/Title of Individual Preparing Sample Bottle(s) and Shipping Container: *(Print)*
Name _____ Title _____
Time/Date Sample Shipping Container Sealed: _____ / _____ Laboratory Affixed Seal No. _____

SAMPLING INFORMATION

Division _____ Bureau _____ Phone (____) _____
Time/Date Sample Shipping Container Opened: _____ / _____
Time/Date Sampling Initiated: _____ / _____ Time/Date Sampling Terminated: _____ / _____

Sample Location:
Company: _____
Address: _____

Physical Location of Sample: _____
DEPE Field Sample Number: _____

REQUESTED ANALYSIS(ES)

Parameter	Method	Container Preserv.	Container Volume	Container Qty	Description of Sample Matrix

Preservative Added: *(Check one)* ☐ Laboratory ☐ Field ☐ N/A
Contract No.: _____ Task No.: _____ Report Format: _____
Samples are: *(Check one)* ☐ Emergency ☐ Non-emergency

EXTERNAL CHAIN OF CUSTODY

Relinquished	Received	Time/Date	Reason for Change of External Custody
XXXXXXXXXXXXXXXXXXXX			Break Seal/Sample

Name/Title of Individual Resealing Shipping Container: *(Print/Sign)*
Name: _____ Title: _____
Time/Date Sample Shipping Container Resealed: _____ / _____ DEPE Affixed Seal No. _____
Name/Title of Individual Breaking Shipping Container Seal and Accepting Responsibility at the Laboratory for the Sample:
(Print/Sign) Name: _____ Title: _____
Time/Date Sample Shipping Container Opened: _____ / _____
Time/Date Internal Chain of Custody Initiated on DEPE Form 077 (Internal Chain of Custody) _____ / _____

Distribution: *White - Original (sent with report)* *Green - Contractor Spare, retain with report file* *Yellow - Sample Custodian* *Pink - DEPE Field Sampling Personnel* *Gold - Sample Preparation/Shipment*

Figure 13-1

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EXTERNAL CHAIN OF CUSTODY AND SAMPLE ANALYSIS REQUEST FORM
(without Shipping Container)

INSTRUCTIONS: *Use 1 form per sample.*
Enter all dates and times on this form in the following format: (24 hr. clock, day/month/year)

Name/Title of Individual Preparing Sample Bottle(s) and Shipping Container:

(Print/Sign) Name: _____

Title: _____

Time/Date Sample Bottle Prepared: _____ / _____

Time/Date Sample Shipping Container Sealed: _____ / _____

DEP Affixed Seal Number: _____

SAMPLING INFORMATION

Division _____ Bureau _____ Phone (____) _____

Time/Date Sample Shipping Container Opened: _____ / _____

Time/Date Sampling Initiated: _____ / _____ Time/Date Sampling Terminated: _____ / _____

Sample Location:

Company: _____

Address: _____

Physical Location of Sample: _____

DEP Field Sample Number: _____

REQUESTED ANALYSIS(ES)

Parameter	Method	Container Preserv.	Container Volume	Container Qty	Description of Sample Matrix

Preservative Added: *(Check one)* ☐ Laboratory ☐ Field ☐ N/A

Contract No.: _____ Task No.: _____ Report Format: _____

Samples are: *(Check one)* ☐ Emergency ☐ Non-emergency

INTERNAL CHAIN OF CUSTODY

Relinquished	Received	Time/Date	Reason for Change of External Custody
XXXXXXXXXXXXXXXXXXXX			Break Seal/Sample

Name/Title of Individual Resealing Shipping Container: *(Print/Sign)*

Name: _____ Title: _____

Time/Date Sample Shipping Container Resealed: _____ / _____ DEP Affixed Seal No. _____

Name/Title of Individual Breaking Shipping Container Seal and Accepting Responsibility at the Laboratory for the Sample:

(Print/Sign) Name: _____ Title: _____

Time/Date Sample Shipping Container Opened: _____ / _____

Time/Date Internal Chain of Custody Initiated on DEP Form 077 (Internal Chain of Custody) _____ / _____

Distribution: *White - Original (sent with report)* *Pink - DEP Field Sampling Personnel*
Green - Contractor Spare, retain with report file *Gold - DEP Field Sampling Personnel (Duplicate)*
Yellow - Sample Custodian

Figure 13-2

CHAPTER 14.

SAMPLE SHIPMENT

A. INTRODUCTION

Samples collected during a planned sampling episode or in response to a hazardous material incident often must be transported elsewhere for analysis. The NJDEPE requires compliance with DOT regulations governing the shipment of hazardous materials. These regulations (49 CFR Parts 171 through 179) describe proper marking, labeling, packaging and shipment of hazardous materials, substances and wastes. In particular, part 172.402(h) of 49 CRF is intended to cover shipment of samples of unknown materials destined for laboratory analysis.

B. EXPLANATION OF THE HAZARDOUS MATERIALS TABLE

The Department of Transportation divides all substances in its Hazardous Materials Table (Table 14-1 in this Section) 49 CFR Part 172.01, into sixteen different Hazard Classes. Substances in a particular class share certain unique characteristics. If the identity of the material to be packaged/shipped is known, it can be located on the Hazardous Materials Table and the specific packaging/shipping requirments will be indexed, perusal. For example, when packaging a quantity of 1-4 Dimethylcyclohexane for shipping, reference to the Hazardous Materials Table shows that its Hazard Class is "Flammable Liquid" and that specific requirements for packaging can be found in Part 173 Section 119 of 49 CFR. But, as is often the case when shipping environmental samples, the identity of the substance to be shipped is often unknown. So, with this in mind, DOT has ranked sixteen Hazard Classes in order of degree of hazard (see Table 1), with packaging requirements becoming less stringent moving down the list. It is the job of the environmental scientist to evaluate available information and determine into which of these sixteen classes the sample falls.

C. GENERAL CATEGORIZATION OF UNKNOWN HAZARDOUS WASTES

The following illustrates the typical thought process that should be used when trying to categorize an unknown hazardous waste. Unless known or demonstrated otherwise through the use of radiation survey instruments, the sample is considered radioactive and appropriate shipping regulations for "radioactive material" are to be followed. If the presence of radioactive material has been eliminated through survey instruments, the sample is considered to contain "Poison A" materials (see Table 14-2), the next classification on the list. DOT defines "Poison A" as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquid, mixed with air is dangerous to life.

Most poison A materials are gases or compressed gases and would not be found in drum-type containers. Liquid poison A's would be found only in closed containers. All samples taken from closed drums do not have to be shipped as poison A's, which provides for a "Worst case" situation. Based upon information available, a judgment must be made whether a sample from a closed container is a Poison A.

If poison A is eliminated as a shipment category, the next two classifications are "flammable" or "nonflammable' gases. Since few gas samples are collected, the next applicable category would be "flammable liquid". With the elimination of radioactive material, poison A, flammable gas, and nonflammable gas, the sample can be classified as flammable liquid (or solid) and shipped accordingly. These procedures would also suffice for shipping any other samples classified below flammable liquids in the DOT classification table.

The special case of ORM-E samples also deserves attention, as many environmental samples fall into this category. ORM stands for Other Regulated Materials. ORM-E, according to 49 CFR Part 173.500, is a material that is not included in any other hazard class and includes both Hazardous Waste and Hazardous Substances as defined in 49 CFR Part 171.8. In general, environmental samples collected offsite (for example, from streams, ponds, or wells) and which are not expected to be grossly contaminated are packaged as ORM-E. Samples collected on site from monitoring wells as well as soil, surface water, and sediment samples that do not "appear" to be grossly contaminated are usually packaged as ORM-E. Sludges, oil waste and unknown drum samples should be packaged in accordance

to Flammable Liquid/Solid regulations. It must be emphasized that best judgement is to be used here and when in doubt, it is recommended that the more conservative, safe option is chosen.

D. PACKAGING AND SHIPPING REQUIREMENTS

Specific regulations covering packaging and shipping requirements for Hazard Categories "ORM-E", "Flammable Liquid/Solid", and "Poison A" follow, as these are the most frequently encountered situations. For any other hazard categories, refer to 49 CFR, Parts 171-179.

1. SAMPLES CLASSIFIED AS ORM-E

a. Packaging

i. Place sample container, properly identified and with a sealed lid, in a polyethylene bag.

ii. Place sample in a fiber board container or metal picnic cooler which has been lined with a large polethylene bag.

iii. Pack with enough noncombustible, absorbent, cushioning material to minimize the possibility of the container breaking.

iv. Seal Large bag

v. Seal or close outside container.

b. Marking/Labeling

i. Use abbreviations only where specified.

ii. Place the following information on outside of shipping container:

- Proper shipping name (i.e.,"Hazardous Substance, Liquid, N.O.S.") N.O.S. = Not otherwise specified.
- Category of Hazardous Materials (i.e., ORM-E)
- UN or NA number (i.e., NA 9188)
- Proper label(s) ("Laboratory Samples", "This End Up")
- Addressee and addressor

iii. Print "Laboratory Samples" and "This End Up" or "This Side up" clearly on top of shipping container. Put upward pointing arrows on all four sides of container.

c. Shipping Papers

i. Use abbreviations only where specified.

ii. Complete carrier-provided bill of lading and sign the certification statement. If the carrier does not provide one, use a standard industry form. One form may be used for more than one exterior container. Provide the following information in the order listed.

- "Hazardous Substance, liquid, N.O.S. NA 9188. ORM-E." or "Hazardous Substance, solid, N.O.S. NA 9188. ORM-E."
- "Limited Quantity" (or "Ltd.Qty.").
- New weight or net volume
- Further descriptions such as "Laboratory samples" or "Cargo Aircraft Only" (if applicable) are allowed if they do not contradict required information.

iii. Include chain-of-custody record, properly executed, inside container if legal use of samples is required or anticipated.

d. Transportation

i. Transport unknown hazardous substance samples classified as ORM-E by rented or common carrier truck, railroad, or express overnight package services.

2. SAMPLES CLASSIFIED AS FLAMMABLE LIQUID OR SOLID

The following procedure is designed to meet the requirements for a "limited quantity" exclusion for shipment of flammable liquids and solids, as set forth in Part 173.118 of 49 CFR. By meeting these requirements, the DOT constraints on packaging are greatly reduced. Packaging, according to the limited quantity exclusion, requires notification on the

shipping papers.

a. Packaging

i. Collect sample in a glass container (16 ounces or less) with a nonmetallic, Teflon[R]-lined screw cap. To prevent leakage, fill container no more than 90 percent full at 130°F. If an air space in the sample container would affect sample integrity, place that container within a second container to meet 90 percent requirement.

ii. Complete sample identification tag and attach securely to sample container.

iii. Seal container and place in 2-mil thick (or thicker) polyethylene bag, one sample per bag. Position identification tag so it can be read through bag. Seal bag.

iv. Place sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite or diatomaceous earth) between the bottom and sides of the can and bag to prevent breakage and to absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to hold can lid securely, tightly, and permanently.

v. Place one or more metal cans into a strong outside container, such as a metal picnic cooler or a DOT approved fiberboard box. Surround cans with noncombustible, absorbent, cushioning material for stability during transport.

vi. Limited quantities of flammable liquids, for the purpose of the exclusion, are defined as one pint or less (49 CFR Part 173.118(a)(2)).

vii. Limited quantities of flammable solids, for the purpose of this exclusion, are defined as one pound net weight in inner containers and no greater than 25 pounds net weight in the outer container (49 CFR Part 173.153(a)(1)).

b. Marking/Labeling

i. Use abbreviations only where specified.

ii. Place the following information on the outside of shipping container:

- Proper shipping name (i.e., "Flammable Liquid, n.o.s.")**
- UN or NA number (i.e., UN 1993)
- Proper label(s) ("Laboratory Samples", "This End Up")
- Addressee and addressor

** Not otherwise specified (n.o.s.) is not used if the flammable liquid, or solid, is identified. Then the name of the specific material is listed before the category (for example, Acetone, Flammable Liquid) followed by its appropriate UN number found in the DOT hazardous materials table Part (172.101).

iii. Print "Laboratory Samples" and "This End Up" or "This Side Up" clearly on top of shipping container. Put upward pointing arrows on all four sides of container.

c. Shipping Papers

i. Use abbreviations only where specified.

ii. Complete carrier-provided bill of lading and sign the certification statement. If the carrier does not provide one, use standard industry form. One form may be used for more than one exterior container. Provide the following information in the order listed.

- "Flammable Liquid, n.o.s. UN1993" or "Flammable Solid, n.o.s. UN1325."
- "Limited Quantity" (or "Ltd. Qty.").
- Net weight or net volume (weight or volume may be abbreviated) just before or just after "Flammable Liquid, n.o.s. UN1325" or "Flammable Solid, n.o.s. UN1325".
- Further descriptions such as "Laboratory Samples: or "Cargo Aircraft Only" (if applicable) are allowed if they do not contradict required information.

iii. Include chain-of-custody record, properly executed, inside container if legal use of samples is required or anticipated.

d. Transportation

i. Transport unknown hazardous substance samples classified as flammable liquids by rented or common carrier truck, railroad, or express overnight package services.

ii. Do not transport by any passenger-carrying air transport system, even if they have cargo only aircraft. DOT regulations permit regular airline cargo only aircraft, but difficulties with most passenger carrying airlines suggest avoiding them. Instead, ship by airlines that only carry cargo.

3. Samples Classified as Poison "A"

a. Packaging

i. Collect samples in a polyethylene or glass container with an outer diameter narrower than the valve hole on a DOT specification No. 3A1800 or No.3AA1800 metal cylinder. To prevent leakage, fill container no more than 90 percent full (at 130°F).

ii. Seal sample container.

iii. Complete sample identification tag and attach securely to sample container.

iv. Attach string or flexible wire to neck of the sample container; lower it into metal cylinder partially filled with noncombustible, absorbent cushioning material (for example, diatomaceous earth or vermiculite). Place only one container in a metal cylinder. Pack with enough absorbing material between the bottom and sides of the sample container and the metal cylinder to prevent breakage and absorb leakage. After the cushioning material is in place, drop the end of the string or wire into the cylinder valve hole.

v. Replace valve, torque to 250 ft/lb (for 1-inch opening), and replace valve protector on metal cylinder, using Teflon tape.

vi. Place one or more cylinders in a sturdy outside container.

b. Marking/Labeling

i. Use abbreviations only where specified.

ii. Place the following information, either hand printed or in label form, on the side of the cylinder or on a tag wired to the cylinder valve protector.

- "Poisonous Liquid, n.o.s. NA1955" or "Poisonous Gas, n.o.s. NA1955."
- Laboratory name and address.
- DOT label "Poisonous Gas" (even if sample is liquid) on cylinder.

iii. Put all information on metal cylinder on outside container.

iv. Print "Laboratory Sample" and "Inside Packages Comply With Prescribed Specifications" on top and/or front of outside container. Mark "This Side Up" on top of container and upward-pointing arrows on all four sides.

c. Shipping Papers

i. Use abbreviations only as specified.

ii. Complete carrier-provided bill of lading and sign the certification statement. If the carrier does not provide one, use a standard industry form. One form may be used for more than one exterior container. Provide the following information in the order listed.

- "Poisonous Liquid, n.o.s. NA1955."
- Net weight or net volume (weight or volume may be abbreviated), just before or just after "Poisonous Liquid, n.o.s. NA 1955". Include a chain-of-custody record, properly executed, in container or with cylinder if legal use of samples is required or anticipated.

d. Transportation

Transport unknown hazardous substance samples classified as poison A only by ground transport or Government-owned aircraft. Do not use air cargo, other common carrier aircraft, or rented aircraft.

TABLE 14-1

DOT PRIORITY RANKING OF HAZARDOUS MATERIALS

Category	Definition	Application regulations for packaging and transport
General		49 CFR 173.1-173.34, 177
1. Radioactive Materials	49 CFR 173.389	49 CFR 173.390-173.398
2. Poison A	49 CFR 173.326	49 CFR 173.327-173.337
3. Flammable Gas	49 CFR 173.300	49 CFR 173.300-173.316
4. Nonflammable Gas	49 CFR 173.300	49 CFR 173.300-173.316
5. Flammable Liquid	49 CFR 173.115	49 CFR 173.116-173.119, 173.121-173.149a
6. Oxidizer	49 CFR 173.151	49 CFR 173.152-173.239a
7. Flammable Solid	49 CFR 173.150	49 CFR 173.152-173.239a
8. Corrosive Material (Liquid)	49 CFR 173.240	49 CFR 173.241-173.299a
9. Poison B	49 CFR 173.343	49 CFR 173.344-173.379
10. Corrosive Material (Solid)	49 CFR 173.240	49 CFR 173.241-173.299a
11. Irritating Materials	49 CFR 173.381	49 CFR 173.381-173.385
12. Combustible Liquid (in containers exceeding 100 gal capacity)	49 CFR 173.115	49 CFR 173.116-173.118a, 173.121-173.149a
13. Other Regulated Material (ORM) - B	49 CFR 173.800	49 CFR 173.510, 173.800-173.862
14. ORM-A	49 CFR 163.605	49 CFR 173.510, 173.605-173.655
15. Combustible Liquid (in containers having capacities of 110 gal or less)	49 CFR 173.115	49 CFR 173.116-173.118a, 173.121-173.149a
16. ORM-E	49 CFR 173.1300	49 CFR 173.510

TABLE 14-2

DOT LIST OF CLASS "A" POISONS (49 CFR 172.101)

Material	Physical state at standard temperature
Arsine	Gas
Bromoacetone	Liquid
Chloropicrin and methyl chloride mixture	Gas
Chloropicrin and nonflammable, nonliquified compressed gas mixture	Gas
Cyanogen chloride	Gas (13.1°C)
Cyanogen gas	Gas
Gas identification set	Gas
Germane	-
Grenade (with Poison "A" gas charge)	-
Hexaethyl tetraphosphate/compressed gas mixture	Gas
Hydrocyanic acid (Prussic) Solution	Liquid
Hydrocyanic acid, liquified	Gas
Insecticide liquified gas containing Poison "A" or Posion "B" material	Gas
Methyldichloroarsine	Liquid
Nitric oxide	Gas
Nitrogen peroxide	Gas
Nitrogen tetroxide	Gas
Nitrogen dioxide, liquid	Gas
Parathion/compressed gas mixture	Gas
Phosgene (diphosgene)	Liquid

REFERENCES

Blackman, Benson, Fisher and Hardy, "Enforcement and Safety Procedures for Evaluation of Hazardous Waste Proposal Sites", in Management of Uncontrolled Hazardous Waste Sites, Denver, USEPA National Enforcement Investigation Center, 1980.

Office of the Federal Register, 49 CFR parts 171-179, Washington, D.C., US Government Printing office, 1986.

Office of Research and Development, Characterization of Hazardous Waste Sites- A Methods Manual - Volume 2: Available Sampling Methods, 2nd Edition, Las Vegas, Nevada, 1984.

B. MONITOR WELL REQUIREMENTS FOR UNCONSOLIDATED AQUIFERS

Revised 3/92

1. State well permits are required for each monitoring well installed and the well must be constructed by a New Jersey-licensed well driller of the proper class.

2. The State well permit number must be prominently displayed and permanently affixed to each monitoring well. Each well must have a site specific well identification number permanently affixed (e.g., MW-1).

3. Copies of the site-specific well specifications and State approved well permit must be maintained at the drilling site by the driller.

4. Minimum screen and riser pipe inner diameter is 2 inches.

5. The use of glues or solvents is prohibited in the installation of well screens, riser pipes and well casing.

6. Any borehole that is to have a casing installed and grouted, must be a minimum of 4 inches greater than the immediate casing it surrounds.

7. In order to prevent any induced interconnection between the overburden/weathered bedrock and competent bedrock, the well screen shall not extend across the aforementioned interface.

8. Wells must have a filter pack installed.

9. No more than 25 feet of well screen shall be installed and no more than 5 feet of filter pack shall be placed above the top of the well screen.

10. Acceptable well grouting procedures:

    a. The following materials shall be acceptable for the grouting of the annular space between the casing and the oversize borehole.

        i. Portland Neat Cement - In accordance with Table 1

        ii. Portland Cement/High Grade Bentonite - In accordance with Table 2

        iii. High Grade Bentonite - In accordance with Table 3

Table 1 - Portland Cement

Type of Cement	Pounds of Cement	Gallons of Water	Target Density lbs/gal	Acceptable Density Range lbs/gal	Water to Cement Ratio
I & II	94	5.2	15.6	15.9 to 16.3	0.46
III	94	6.3	14.8	14.2 to 15.5	0.56

Table 2 - Portland Cement/High Grade Bentonite
Only Portland Cement Types I or II

Pounds of Bentonite	Pounds of Cement	Gallons of Water	Target Density lbs/gal	Acceptable Density Range lbs/gal	Water to Cement Ratio
5.0	94	8.3	13.9	13.4 to 14.5	0.74

Table 3 - High Grade Bentonite
Numbers Based on 15 to 30% Solids by Weight

Pounds of Bentonite	Target Gallons of Water**	Acceptable Range of Water (gallons)**	Target Density lbs/gal*	Acceptable Density Range lbs/gal*
50	18	14-34	9.8	9.2 to 10.2

* Accurate Measurement of materials prior to mixing is imperative as air entrainment during the physical mixing of the slurry tends to decrease the density of the mixture.

** Bentonite Products and additives should be mixed in accordance with manufacturers specifications.

b. When using straight bentonite - Bentonite shall not be used for grouting in those instances where it will come in contact with ground water having a pH less than 5.0 and/or a Total Dissolved Solids content in excess of 1,000 ppm.

c. Where the grouting material extends through zones of salt water, a salt/water resistant grout material shall be used.

11. Grout Placement

a. Pressure Grouting - The grout shall be pumped, through a tremie pipe, in one continuous operation, from the bottom to the top of the annular space. The tremie/grout pipe may be slowly raised as the grout is being placed but the discharge end of the pipe shall remain submerged in the grout at all times until grouting is complete.

b. When grouting the annular space around a well casing or riser pipe, the grout must extend up to the ground surface.

c. When grouting the annular space directly above a filter pack, the grout should be discharged horizontally from the tremie pipe.

12. Potable water must be used for mixing grouting materials and drilling fluids.

13. The driller must maintain an accurate written log of all materials encountered, record construction details for each well, and record the depth of each water bearing zone. This information must be submitted to the Bureau of Water Allocation as required by N.J.S.A. 58:4A-14.

14. The protective steel casing shall be installed to a minimum depth of 3 feet below grade, equipped with a locking cap and securely set in concrete, as shown in the diagram. The locking cap must be made of steel. Flush-mount monitoring wells are acceptable provided they have manholes, locking caps, and seals to prevent leakage of surface water into the well.

15. Top of the innermost casing (excluding cap) must be surveyed to the nearest 0.01 foot by a New Jersey-licensed surveyor. The survey point shall be the highest point of the casing. The survey point must be marked on each well.

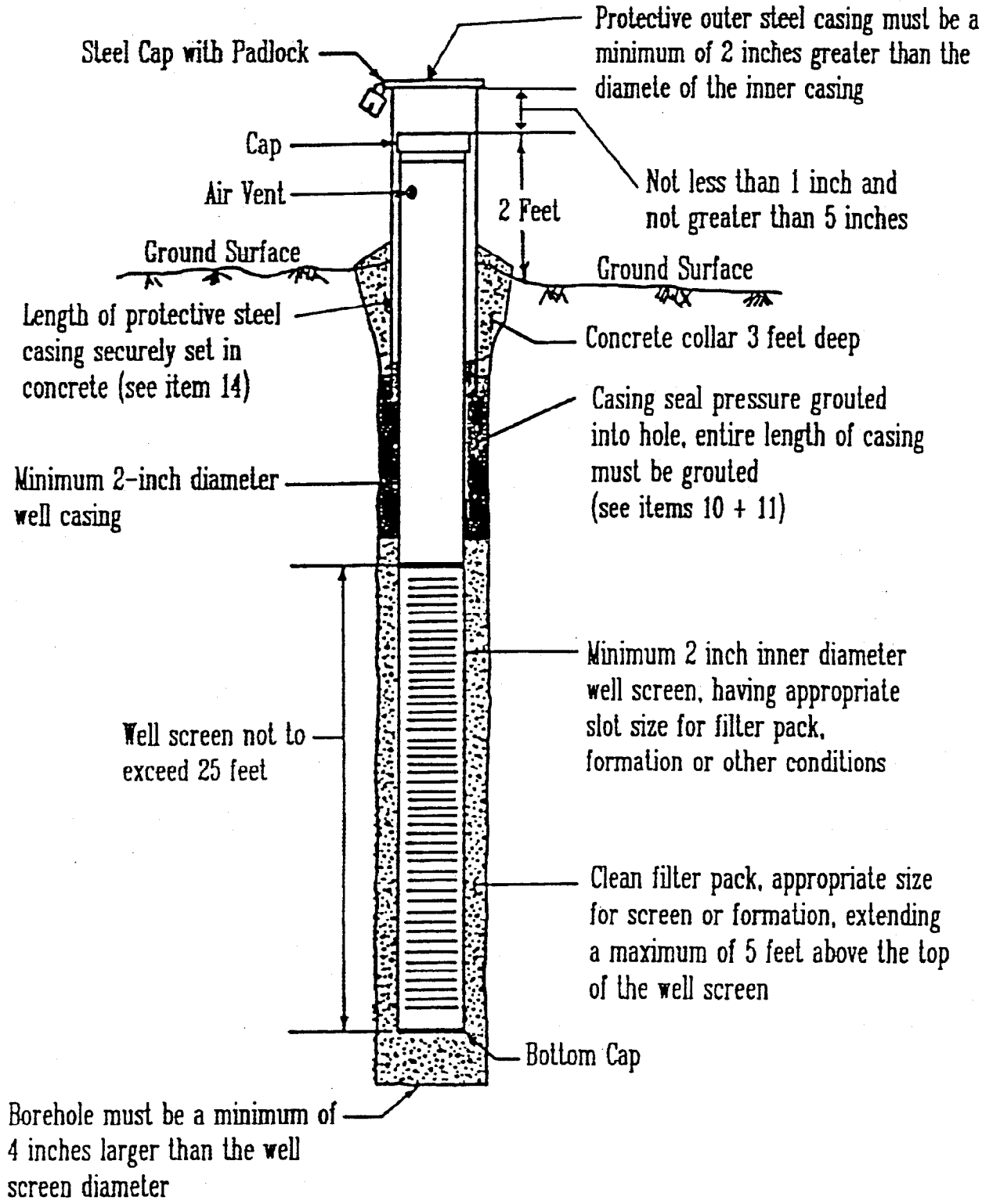
16. Wells should be developed to a turbid-free discharge.

Notice is Hereby Given of the Following:

The Department does not review well locations or depths to ascertain the presence of, nor the potential for, damage to any pipeline, cable, or other structures.

The permittee (applicant) is solely responsible for the safety and adequacy of the design and construction of monitoring well(s) required by the Department.

The permittee (applicant) is solely responsible for any harm or damage to person or property which results from the construction or maintenance of any well; this provision is not intended to relieve third parties of any liabilities or responsibilities which are legally theirs.



Unconsolidated Aquifer Well

C. MONITOR WELL REQUIREMENTS FOR CONFINED UNCONSOLIDATED AQUIFERS

Revised 3/92

1. State well permits are required for each monitoring well installed and the well must be constructed by a New Jersey-licensed well driller of the proper class.

2. The State well permit number must be prominently displayed and permanently affixed to each monitoring well. Each well must have a site-specific well identification number permanently affixed (e.g., MW-1).

3. Copies of the site-specific well specifications and State approved well permit must be maintained at the drilling site by the driller.

4. Minimum screen and riser pipe inner diameter is 2 inches.

5. The use of glue or solvents is prohibited in the installation of well screens, riser pipes and well casing.

6. Any borehole or outer casing that is to be seated into a confining layer, that is to have a casing installed and grouted, must be a minimum of 4 inches greater than the immediate casing it surrounds.

7. In order to prevent any induced interconnection between the overburden/weathered bedrock and competent bedrock, the well screen shall not extend across the aforementioned interface.

8. Wells must have a filter pack installed.

9. No more than 25 feet of well screen shall be installed and no more than 5 feet of filter pack shall be placed above the top of the well screen.

10. Under no circumstances shall the filter pack extend into a confining layer.

11. Acceptable well grouting procedures:

    a. The following materials shall be acceptable for the grouting of the annular space between the casing and the oversize borehole.

        i. Portland Neat Cement - In accordance with Table 1

        ii. Portland Cement/High Grade Bentonite - In accordance with Table 2

        iii. High Grade Bentonite - In accordance with Table 3

Table 1 - Portland Cement

Type of Cement	Pounds of Cement	Gallons of Water	Target Density lbs/gal	Acceptable Density Range lbs/gal	Water to Cement Ratio
I & II	94	5.2	15.6	15.9 to 16.3	0.46
III	94	6.3	14.8	14.2 to 15.5	0.56

Table 2 - Portland Cement/High Grade Bentonite
Only Portland Cement Types I or II

Pounds of Bentonite	Pounds of Cement	Gallons of Water	Target Density lbs/gal	Acceptable Density Range lbs/gal	Water to Cement Ratio
5.0	94	8.3	13.9	13.4 to 14.5	0.74

Table 3 - High Grade Bentonite
Numbers Based on 15 to 30% Solids by Weight

Pounds of Bentonite	Target Gallons of Water**	Acceptable Range of Water (gallons)**	Target Density lbs/gal*	Acceptable Density Range lbs/gal*
50	18	14-34	9.8	9.2 to 10.2

* Accurate Measurement of materials prior to mixing is imperative as air entrainment during the physical mixing of the slurry tends to decrease the density of the mixture.

** Bentonite Products and additives should be mixed in accordance with manufacturers specifications.

b. When using straight bentonite - Bentonite shall not be used for grouting in those instances where it will come in contact with ground water having a pH less than 5.0 and/or a Total Dissolved Solids content in excess of 1,000 ppm.

c. Where the grouting material extends through zones of salt water, a salt/water resistant grout material shall be used.

12. Grout Placement

a. Pressure Grouting - The grout shall be pumped, through a tremie pipe, in one continuous operation, from the bottom to the top of the annular space. The tremie/grout pipe may be slowly raised as the grout is being placed but the discharge end of the pipe shall remain submerged in the grout at all times until grouting is complete.

b. When grouting the annular space around a well casing or riser pipe the grout must extend up to the ground surface.

c. When grouting the annular space directly above a filter pack, the grout should be discharged horizontally from the tremie pipe.

13. Potable water must be used for mixing grouting materials and drilling fluids.

14. The driller must maintain an accurate written log of all materials encountered, record construction details for each well, and record the depth of each water bearing zone. This information must be submitted to the Bureau of Water Allocation as required by N.J.S.A. 58:4A-14.

15. The outermost steel casing shall be installed to a minimum depth of 3 feet below grade, equipped with a locking cap and securely set in concrete, as shown in the diagram. The locking cap must be made of steel. Flush-mount monitoring wells are acceptable provided they have manholes, locking caps, and seals to prevent leakage of surface water into the well.

16. Top of the innermost casing (excluding cap) must be surveyed to the nearest 0.01 foot by a New Jersey licensed surveyor. The survey point shall be the highest point of the casing. The survey point must be marked on each well.

17. Wells should be developed to a turbid-free discharge.

Notice is Hereby Given of the Following:

The Department does not review well locations or depths to ascertain the presence of, nor the potential for, damage to any pipeline, cable, or other structures.

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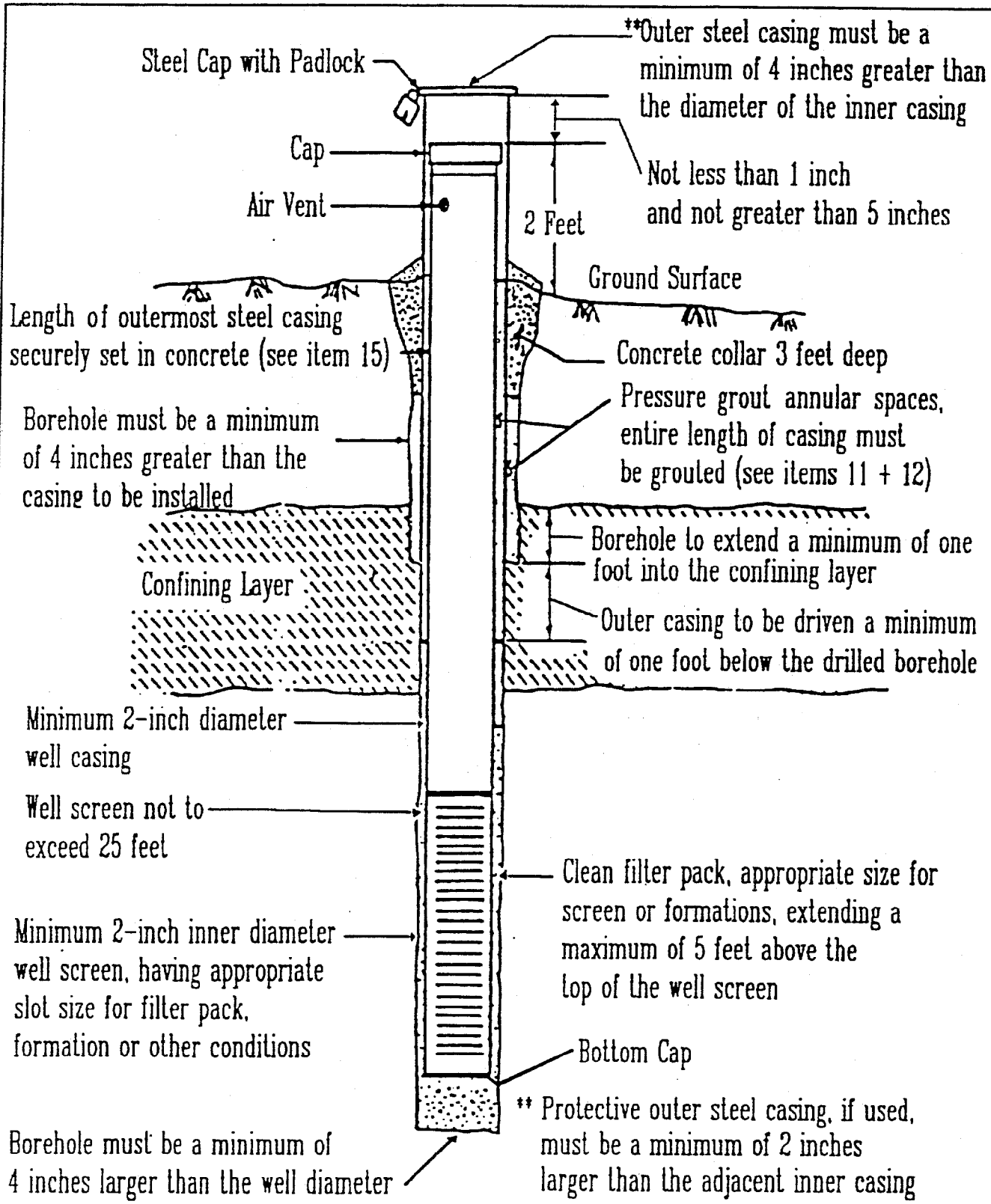
The permittee (applicant) is solely responsible for any harm or damage to person or property which results from the construction or maintenance of any well; this provision is not intended to relieve third parties of any liabilities or responsibilities which are legally theirs.



Confined Unconsolidated Aquifer Well

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APPENDIX D

HEALTH AND SAFETY PLAN

NWS EARLE, NEW JERSEY

Health and Safety 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 0147

JUNE 1995

HEALTH AND SAFETY 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 NO. 82
LESTER, PENNSYLVANIA 19113-2090

SUBMITTED BY:
HALLIBURTON NUS CORPORATION
993 OLD EAGLE SCHOOL ROAD, SUITE 415
WAYNE, PENNSYLVANIA 19087-1710

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0147

JUNE 1995

SUBMITTED BY:

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HEALTH AND SAFETY MANAGER
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ATTACHMENT 1 - COLD AND HEAT STRESS

ATTACHMENT 2 - TICK CONTROL

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1.0 INTRODUCTION

This Health and Safety Plan (HASP) is designed to provide minimum practices and procedures for Halliburton NUS and subcontractor personnel engaged in Remedial Investigation (RI) activities at the locations identified in Section 2.0 of this document. This document represents investigative activities to take place at several satellite locations within Naval Weapons Station (NWS) Earle, New Jersey. This plan has been developed to conform to the requirements of OSHA Standard 29 CFR 1910.120 - "Hazardous Waste Operations and Emergency Response", and other requirements, as applicable, under OSHA General Industry (29 CFR 1910), Construction Industry (29 CFR 1926) standards as applicable, and State requirements where applicable. This plan is based on available information regarding possible contaminants and physical hazards that may exist at the site or as a result of onsite activities. If more information concerning the nature and/or concentrations of contaminants, or if additional information concerning potential physical hazards becomes available, this HASP will be modified accordingly. It will be the Halliburton NUS Project Manager's (PM) responsibility to communicate any such information to the Clean Health and Safety Manager (HSM) who will, in turn, determine the need for modifying the HASP.

1.1 KEY PROJECT PERSONNEL AND ORGANIZATION

The purpose of this plan is to assign responsibilities, establish personnel protection standards and mandatory safety practices and procedures, and provide for contingencies that may arise while operations are being conducted at the site.

This section identifies personnel and positions, and establishes the responsibility for site safety and health for Halliburton NUS and subcontractor personnel.

The Halliburton NUS Project Manager (PM) is responsible for requesting the generation of this HASP and the overall direction and implementation of health and safety for this project.

The Halliburton NUS Field Operations Leader (FOL) under the direction of the PM is responsible for:

- Implementation of this HASP with the assistance of an appointed Site Safety Officer (SSO);
- Management of field activities;
- Execution of the work plan;
- Enforcement of safety procedures, as they apply to the work plan.

The SSO supports site activities by advising the FOL on all aspects of health and safety on site. These duties and activities may include, but are not limited to:

- Coordinating safety and health activities with the FOL;
- Selection, application, inspection, and maintenance of Personal Protective Equipment (PPE);

- Establishing, monitoring, and/or modification of work zones and control points;
- Implementation of the monitoring program for onsite activities;
- Confirms team members training and medical status with regard to site activities;
- Implements supporting elements of the health and safety program such as Hazard Communications and Respiratory Protection;
- Coordinates emergency services.

These requirements and activities set forth in this HASP are monitored by the CLEAN HSM for compliance with federal standards and the Health and Safety Management Plan. This monitoring and evaluation establishes the preliminary basis by which the effectiveness of this document and its implementation may be assessed.

1.2 APPLICABILITY

The provisions of the plan are mandatory for all onsite employees engaged in hazardous material management activities including, but not limited to, initial site reconnaissance, preliminary field investigations, mobilization, project operations, and demobilization.

PERSONNEL ASSIGNMENTS

Site Name: Naval Weapons Station Earle
Client Contact: Environmental
Base Contact: Gus Hermanni Phone Number: (908) 866-2624

Navy Regional Project Manager (RPM) - John Kolicius Phone Number: (215) 595-0567
Extension: 157

Address: Earle, New Jersey

Effective Date: TBA

Purpose of Site Visit: The following activities have been identified as part of Contract Task Order (CTO) 147 for NWS Earle. These activities will be conducted at 27 satellite locations and will consist of the installation of monitoring wells, soil borings, evaluation of existing wells, multi-Media Sampling, and land surveying as identified in Section 3.0 of this document. These activities will be conducted to determine if the contamination or potential contamination exists, and the vertical and horizontal extent of that contamination.

Proposed Dates of Work: TBA

Project Team:

Halliburton NUS Personnel:	Discipline/Tasks Assigned:
Richard Gorrell	Project Manager
Keith Simpson/Stan Conti	Field Operation Leader (FOL)/Geologist
Keith Simpson	Site Safety Officer (SSO)
TBA	Geologist/Sampler

Non-Halliburton NUS Personnel:

TBA	

Plan Preparation:

Prepared by: Thomas M. Dickson

Reviewed and Approved by:

Halliburton NUS Navy CLEAN
Health and Safety Manager: Matthew M. Soltis, C.S.P

Reviewed:

Halliburton NUS
Project Manager: Richard Gorrell

Follow Up Report:

Responsible Person: Keith Simpson (Must fill out Follow-Up Report)

Additional individuals and responsibilities may be supplemented to this HASP, as specialized skills for supporting field activities may be required.

2.0 SITE/PROJECT BACKGROUND

2.1 AUTHORITY

This RI is part of an overall Installation Restoration (IR) Program administered by the Department of the Navy. The purpose of the IR program is to identify, assess, characterize, and clean up or control contamination from past hazardous waste disposal operations and hazardous material spills at Navy and Marine Corps Facilities. This activity and the IR is governed under the Defense Environmental Restoration Program (DERP) which establishes responsibility under the Superfund Amendments Reauthorization Act (SARA) of 1986.

The general objectives of the RI at NWS Earle is to include general site characterization efforts as described in the Work Plans for each site.

These efforts involve individual tasks as identified in Section 3.0 of this HASP, to accomplish the general objectives. These individual tasks, executed over a specified period of time, will not vary, but be a continuous application building on the original effort and information base.

2.2 SITE DESCRIPTIONS

This effort is to assess past hazardous waste disposal practices and the impact to human and environmental health and welfare associated with the sites identified in the following text.

A summary of individual site background information including a general description of the sites identified in Table 2-1 are as follows.

2.2.1 SITE 1 (ORDNANCE SITE)

This site consists of a 6-acre open field which was formally used for burning ordnance material for several decades. Operations were discontinued in 1975. During site abandonment the area was plowed, and a layer of diesel fuel soaked hay was burned on site to remove residual ordnance. This procedure was carried out three times. A U.S. Army communications station and tower were located near the center of the site for several years. The site is currently cleared of all structures.

2.2.1.2 <u>Site 1 (Ordnance Demilitarization Site) Activities</u>

Activities planned for Site 1 include the following:

- Soil borings/monitoring well installation
- Hydropunch
- Multi-media sampling
  - Soils-surface and subsurface
  - Groundwater
- Site Mapping

Additional wells may be considered if indicated.

TABLE 2-1

SITE NAMES FOR NWS EARLE, NEW JERSEY

Site No.	Site Name
Site 1	Ordnance Demilitarization Site
Site 2	Active Ordnance Demilitarization Site
Site 3	Landfill Southwest of "F" Group
Site 4	Landfill West of "D" Group
Site 5	Landfill West of Army Barricades
Site 6	Landfill West of Normandy Road
Site 7	Landfill South of "P" Barricades
Site 9	Landfill Southeast of "P" Barricades
Site 10	Scrap Metal Landfill
Site 11	Contract Ordnance Disposal Area
Site 12	Battery Storage Area
Site 13	Defense Property Disposal Office Yard
Site 14	Mercury Spill
Site 15	Sludge Disposal Site
Site 16	Epic Site F/Round House Site
Site 17	Landfill
Site 19	Paint Chip and Sludge Disposal Area
Site 20	Grit Blasting Area at Building 544
Site 22	Paint Chip Disposal Area
Site 23	Paint Disposal Area
Site 24/25	Closed Pistol Ranges
Site 26	Explosive "D" Washout Area
Site 27	Projectile Refurbishing Area
Site 29	PCB Spill Site
EPIC Site L	MSC Van Parking Lot
EPIC Site Q	Fire Fighting School

2.2.1.3 Potential Contaminants

Based on the information retrieved to this point, the potential contaminants at this site may include TPH and metals. The concentrations and magnitudes of specific contaminants at the investigation sites are limited. Elevated levels of volatile organic compounds (VOCs) and explosives, RDX and 2,4 - DNT.

2.2.2 SITE 2 (ACTIVE ORDNANCE DEMILITARIZATION SITE)

The Active Ordnance Demilitarization Site 2 is an 11-acre site that has been used for the demilitarization and disposal of ordnance since 1973. The ordnance consists of explosives and propellants such as ammonium picrate, TNT, RDX, Composition 4, black powder, and propellants. The site is characterized as a shallow, open, non-vegetated, oval-shaped sand-pit. The perimeter of the site is defined by a berm, which is surrounded by woods.

2.3.1 Site 2 Activities

Activities planned for Site 2 include the following:

- Multi-media sampling
  - Soils-surface
  - Groundwater
- Site Mapping

2.3.2 Potential Contaminants

The potential contaminants which have been previously identified indicates very low concentrations of explosives. In addition to nitrite and aluminum, higher concentrations of chromium, cadmium and iron were also detected. High iron concentrations are attributable to naturally-occurring conditions.

2.4 SITE 3 (LANDFILL SOUTHWEST OF "F" GROUP)

The Landfill southwest of "F" Group is a 5-acre site that was used for the disposal of domestic and industrial wastes. The domestic wastes consisted of paper, glass, and plastics. The reported industrial wastes consisted of paints and paint thinners, solvents, varnished, shellac, acids, alcohols, caustics, pesticide containers and rinse waters, wood and small amounts of asbestos.

2.4.1 Site 3 Activities

Activities planned for Site 3 include the following:

- Soil-gas survey
- Multi-media sampling
  - Surface Soil
  - Groundwater
- Test pits
- Site Mapping

The test pits will be 20 feet long and 10 feet deep. During excavation all material removed will be screened with a PID/FID to determine if a significant source of volatiles may be present

2.4.2 Potential Contaminants

Elevated levels of arsenic, volatile and semivolatile were found. Low level of pesticide compounds were detected. Also, metals were detected above background levels. The concentration is not high enough to indicate that the landfill is generating a highly concentrated leachate.

2.5 SITE 4 (LANDFILL WEST OF "D" GROUP)

The Landfill west of "D" group is a 5-acre site that from 1943 to 1960 was used for the disposal of station domestic and industrial wastes. Activity at this site included the burning of wastes in trenches prior to burial. The industrial wastes consisted of demolition wastes, pesticide containers and rinse waters, discarded containers of paint, paint thinners, varnishes, shellacs, acids, alcohols, caustics, and asbestos. The site is characterized as an open area that is surrounded by woodlands. the site is moderately vegetated with grasses and some scrub pines although there are a few bare areas with no vegetation.

2.5.1 Site 4 (Landfill West of "D" Group) Activities

Activities planned for Site 4 include the following:

- Monitoring well installation
- Hydropunch
- Multi-media sampling
  - Groundwater
  - Surface water
  - Sediment
- Site Mapping

2.5.2 Potential Contaminants

One semivolatile compound [bis(2-ethylhexyl)phthalate], the pesticide 4,4-DDT and TPH were detected in the test pits.

2.6 SITE 5 (LANDFILL WEST OF ARMY BARRICADES)

The landfill west of army barricades is a 13-acre site that was used for the disposal of domestic and industrial wastes. The domestic wastes consisted of paper glass and plastics. The industrial wastes consisted of waste wood, pesticide containers and rinse waters, and discarded containers of paint, paint thinner, solvents, varnishes, shellacs, acids, alcohols and caustics. The site is an open area surrounded by woodlands.

2.6.1 Site 5 (Landfill West of Army Barricades) Activities

Activities for Site 5 include the following:

- Hydropunch
- Multi-media sampling
  - Groundwater
- Site Mapping

Depending on the results of the additional monitoring wells may be considered.

2.6.2 Potential Contaminants

Contaminants of concern include beryllium, chromium, cadmium, chloroform and to a lesser extent, lead. Volatile organics including DCE, TCE, and benzene were also detected. Results from landfill parameters indicated elevated levels of sulfate.

2.7 SITE 6 (LANDFILL WEST OF NORMANDY ROAD)

This landfill site occupies approximately 4 acres located in the Waterfront area. The site is reported to contain dunnage lumber, glass, paper, packing material and small amounts of paint and solvent. Currently, the majority of the landfill surface is paved or covered with buildings. The landfill surface is 10 to 15 feet higher than the marsh area and the toe of the landfill is covered with vegetation.

2.7.1 Site 6 (Landfill West of Normandy Road) Activities

Activities planned for Site 6 include the following:

- Multi-media sampling
  - Surface water and sediments
  - Groundwater
- Site Inspection (groundwater seeps)
- Site Mapping

2.7.2 Potential Contaminants

Low levels of organics, metals, and pesticides were detected in soil samples. Elevated levels of metals, pesticides, semivolatiles and PCBs were detected in sediment samples. Elevated levels of metals and one semivolatile were detected in groundwater.

2.8 SITE 7 (LANDFILL SOUTH OF "P" BARRICADES)

The landfill south of "P" barricades is a 5-acre site that was used for the disposal of municipal-type solid waste and waste from Waterfront industrial operations. The disposed materials consisted of munitions shipping wastes (dunnage and packing), shop wastes from the Waterfront Public Works Shop, and the Munitions Handling Laboratory glass, wood, and small quantities of waste paints, thinners, and solvents), and domestic refuse. The site is now covered with loose sand quarried from the surrounding area. The site is a open area and with small pines and is surrounded by woodlands. It is vegetated with grasses and some scrub pines, except for a few scared areas where no vegetation exists.

2.8.1 Site 7 Activities

Activities planned for Site 7 include the following:

- Multi-media sampling
  - Soil (surface)
  - Groundwater
- Site Mapping

2.8.2 Potential Contaminants

Volatiles and chemicals associated with laboratory contamination (methylene chloride and acetone) were detected. Elevated levels of metals including chromium, arsenic and lead were detected. Results of the landfill parameters indicated elevated levels of COD, chlorides, and sulfates.

2.9 SITE 9 (LANDFILL SOUTHEAST OF "P" BARRICADES)

The landfill southeast of "P" barricades is an isolated 3 acre fill area in the Waterfront area. Past activities at the site are reported to have included the disposal of dunnage lumber and construction debris. Lumber was stacked, burned,(using a petroleum ignition source) and covered. The area is vegetated and physically stable reforestation with pine species was completed several years ago. In addition, the area is surrounded on all sides by mature hardwood stands. There are some scarred areas where vegetation is sparse. The landfill cover is thin and waste is exposed in some areas.

2.9.1 Site 9 (Landfill Southeast of "P" Barricades) Activities

Activities planned for Site 9 include the following:

- Test pit excavation
- Multi-media sampling
  - Surface water and sediments
- Site Mapping

Test pits will be located in the vicinity of where the small pine trees, which is likely to make the edge of the landfill.

2.9.2 Potential Contaminants

Analysis of the subsurface soils indicated low levels of TPH, VOCs, pesticides, and cyanide in test pit samples. These concentrations were extremely low and therefore were not identified as a primary chemical of concern.

2.10 SITE 10 (SCRAP METAL LANDFILL)

The scrap metal landfill is a 2-acre site that was used for the disposal of demilitarized munitions and spent munitions cases. The disposed material consisted primarily of aluminum and steel containers. Spent grit and paint chips for the ammunition re-work operations were buried. Since site closure, the cover material has eroded and 40-mm shell cases are uncovered. The

site is an open area surrounded by wet lands. It is accessible via a dirt road from the southwest. It is vegetated with grasses and scrub pines, except for an open area in the middle where no vegetation exists.

2.10.1 Site 10 (Scrap Metal Landfill) Activities

Activities planned for Site 10 include the following:

- Multi-media sampling
  - Groundwater from existing wells
- Site Mapping

Depending on the results of the additional monitoring wells may be considered.

2.10.2 Potential Contaminants

Methylene chloride, metals, semivolatile, and organics were detected.

2.11 SITE 11 (CONTRACT ORDNANCE DISPOSAL AREA)

Site 11 is a 2-acre site which was used for disposal of obsolete ordnance material and fire fighting training. These activities occurred in 2 unlined pits approximately 20 feet long. Reject vehicles were soaked with fuel oil, ignited and extinguished. Unburned fuel and waste oil was allowed to evaporate or soak into the soil. The site is a fan shaped open area surrounded by woods on all sides.

2.11.1 Site 11 (Contract Ordnance Disposal Area) Activities

Activities planned for Site 11 include the following:

- Multi-media sampling
  - Groundwater from existing wells
- Site Mapping

2.11.2 Potential Contaminants

Elevated levels of metals in the groundwater. One soil boring had high concentrations of oil and grease. Minimal semivolatiles and volatiles were detected in the wells. Due to the minimal amount of soil contamination the field activities will focus on groundwater.

2.12 SITE 12 (BATTERY STORAGE AREA)

Site 12 occupies a paved area next to the loading dock behind Building R-10. This area was used as a transient staging area for forklift batteries being sent off-site to be reclaimed. 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, surface soil, or straining is present at the site. Infiltration of precipitation is precluded by an asphalt parking lot which covers the site. Surface runoff is directed to a storm water collection basin which discharges through a concrete culvert to a drainage swale and eventually to the marsh north of Site 6.

2.12.1 Site 12 (Battery Storage Area) Activities

Activities planned for Site 12 include the following:

- Multi-media sampling
  - Surface soils
  - Sediments
  - Surface water
- Site Mapping

2.12.2 Potential Contaminants

Sample analysis also indicated that semivolatiles, VOCs, metals, and pesticides were present in the water and sediment samples taken at the site. These concentrations were considered low and therefore were not identified as a primary chemical of concern.

2.13 SITE 13 (DEFENSE PROPERTY DISPOSAL OFFICE YARD)

Site 13 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 burial of material, including cars, trucks, electronic equipment, clothing/shoes, sheet metal, furniture, scrap metal and batteries. In addition, batteries were broken open at the site during lead recovery activities, and acid was drained onto the ground. Fill material is present at the ground surface at several places across the site. The site is flat, and has little topographic relief. Runoff from the site drains to the marsh to the north of the site, and west to a perennial drainage which flows to Hockhockson Brook. Currently, a fence exists around the site, although this fence is not located at the edge of the landfill, and the extent of fill material at the site has not been clearly defined by previous investigations.

2.13.1 Site 13 (Defense Property Disposal Office Yard) Activities

Activities planned for Site 13 include the following:

- Monitoring well installation
- Test pits
- Multi-media sampling
  - Surface water and sediment
  - Sediment
- Site Mapping

2.13.2 Potential Contaminants

Laboratory analysis from previous investigation efforts determined that low levels of semivolatiles (PAHs), pesticides, metals and PCBs were present in the soil and sediment samples. Metals were present in surface water, although no semivolatiles, pesticides, or PCBs were detected.

The primary contaminants of concern for this site will be the metals, as the other compounds were detected in relatively low concentrations.

2.14 SITE 14 (MERCURY SPILL)

A small quantity of mercury (reportedly ranging in volume from that of a thermometer to as much as several ounces) was spilled inside Building C-33, the Defense Property Disposal Warehouse, in 1970. The location of the spill within the building was not documented. According to the Weston Phase II Draft SI (1993) it is probable that the mercury was cleaned up by vacuuming after the spill. The warehouse has solid concrete floors precluding the mercury spill from effecting soil below the building. The floors of the warehouse have been coated with a concrete protecting material since the spill and it is unlikely that any residue from the spill remains.

2.14.1 Site 14 (Mercury Spill) Activities

To determine if any traces of mercury remain on the warehouse floor surface, the floor of the warehouse will be swept and the sweepings will be collected and analyzed. Because the location of the mercury spill is unknown, the sweepings from the entire warehouse floor will be included. A sample will be taken from this material and will be analyzed for mercury.

2.14.2 Potential Contaminants

The primary contaminant associated with the activities at this site is mercury.

2.15 SITE 15 (SLUDGE DISPOSAL SITE)

Site 15 occupies a small area along the railroad tracks near the main entrance to the water front area which was used for disposal of an unknown amount of oily bilge sludge in the 1970's. It is estimated that over 5,000 gallons of sludge, which may have ranged from 1 to 25% oil may have been disposed of at the site. The exact location of the sludge disposal activities was not apparent during site inspections. The site is near a railroad grade which is built up approximately 6 feet above the surrounding ground surface. A small drainage swale runs parallel to the railroad bed on the north side, and surface water from the site and the adjacent paved parking area flows towards this drainage. This drainage is not influenced by groundwater and contains water only after precipitation.

2.15.1 Site 15 (Sludge Disposal Site) Activities

Activities planned for Site 15 include the following:

- Soil borings (using a hand auger)
- Monitoring well installation
- Multi-media sampling
  - Soils (surface and subsurface)
  - Groundwater
  - Surface and sediment
- Site Mapping

Each auger bucket removed from the boring will be continuously monitored with a PID/FID and the sample at each boring will be collected from the interval with the highest PID/FID readings and/or evidence such as soil staining or discoloration.

2.15.2 Potential Contaminants

The potential contaminants associated with Site 15 include semivolatiles which were present in subsurface soil at the site. In addition, metals were found in groundwater samples.

Metals associated with this site will represent the primary chemicals of concern, as the other substances identified were present in low concentrations.

2.16 SITE 16 (EPIC SITE F - ROUND HOUSE)

Site 16 and EPIC Site F is considered as one site, due to the close proximity (overlapping) of these two areas. This area is a 8-acre site, which is composed of a heavy equipment storage yard, and two railroad car storage yards which have been active since the late 1940's. Building C-50 is known as the Roundhouse and is used for maintenance and repair of locomotives and rail cars. Building C-19 is the forklift maintenance and repair shop.

Site 16 is located north of Building C-19. 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 north of Building C-19. Investigations at these areas are concerned with petroleum hydrocarbon contamination of soil, groundwater, surface water and sediment.

An underground fuel line is located in the area north of Building C-19 and was used to transport diesel fuel from an underground fuel storage tank located at the northeast corner of Building C-50, to a dispensing station near Building C-19. This portion of the site was investigated during the 1992 SI field activities, as described below. A leak in the fuel line was discovered in 1977 and use of the pipeline was discontinued after the leak was discovered and excavated.

Waste oils from locomotive maintenance were stored in a holding tank at the southeast side of Building C-50. This tank has since been removed under the U.S.T. program. Water from locomotive steam-cleaning operations in the past may have discharged water to sewer drains, and to an oil-water separator on the northeast side of Building C-50. Water discharge from this oil-water separator is reported to have been sent to a drainage ditch along the east side of the railroad tracks, although a buried leach field may be present near the oil-water separator. A similar leach field was used in conjunction with a oil-water separator at NWS Earle and may be present at this site, although no drawings have been produced which confirm the existence of a leach field. The location of the oil-water separator leach field, if present, is unknown but may be expected to have been installed on the down slope side of the separator. In 1989 the oil-water separator failed and the ditch on the east side of Building C-50 was excavated and disposed of as hazardous waste. Rinse water is currently collected and sent off-site for disposal. The center of the tracks near Building C-50 is stained with thick oil, possibly from the locomotive engines awaiting maintenance.

Building C-19 is used as a fork-lift maintenance and repair facility and batteries may have been stored behind this building awaiting disposal. Currently, high pressure parts washing is performed on the concrete pad north of Building C-19. This wash water is not contained. The railroad storage yard to the west is used for rail car storage, and for heavy equipment storage.

2.16.1 Site 16 (EPIC Site F - Roundhouse Area) Activities

Activities planned for these co-joining sites include the following:

- Soil gas
- Soil borings/Monitoring Well Installation
- Test Pit Operation
- Multi-media sampling
  - Soils (surface and subsurface)
  - Groundwater
  - Sediments
- Site Mapping

2.16.2 Potential Contaminants

The potential contaminants associated with these sites include elevated levels of TPH, PAHs, and VOCs. These contaminants represent largely petroleum based products associated with the activities of the two sites.

2.17 SITE 17 (LANDFILL)

This landfill site occupies 3 acres adjacent to a tidal marsh and is reported to have been used for the disposal of wood, forklift vehicles, empty paint cans and construction debris. The landfill surface is paved and is 10 to 15 feet higher in elevation than the marsh area. The toe of the landfill is covered with vegetation. Infiltration is limited by pavement and overland flow drains toward the salt marsh north of the site. Groundwater flow is to the north-northwest, towards the marsh.

2.17.1 Site 17 (Landfill) Activities

Activities planned for Site 17 include the following:

- Multi-media sampling
  - Soils (surface)
  - Groundwater
  - Surface water/sediments
- Site Mapping
- Site Inspections (Seeps and erosion)

2.17.2 Potential Contaminants

Previous analytical results indicate VOCs, semi-volatiles (PAHs), and pesticides were detected only in sediment samples. Metals, acetone, landfill parameter indications, and pesticides in limited quantities were present in groundwater.

These contaminants were only detected in limited quantities and therefore present an anticipated reduced hazard.

2.18 SITE 19 (PAINT CHIP AND SLUDGE DISPOSAL AREA)

Site 19 is an ordnance maintenance area where paint chips and paint sludge generated during paint operations were discharged to a topographic depression near Building S-34. Paint slurries and solvent residues were discharged into the open drainage swale. Past construction activities and building construction at the site may have removed a significant portion of the contaminated material. The site is a circular area approximately 300 feet in diameter that is surrounded by woodlands. Half the site is paved; the other half is gravel.

2.18.1 Site 19 (Paint Chip and Sludge Disposal Area) Activities

Activities planned for Site 19 include the following:

- Soil borings/Monitoring Well Installation
- Multi-media sampling
  - Soils (surface and subsurface)
  - Groundwater
  - Surface water and sediments
- Site Mapping

2.18.2 Potential Contaminants

Cadmium, lead, and zinc were detected at elevated concentrations in soil. Methylene chloride and acetone were detected in groundwater samples. Elevated levels of metals were detected at monitoring wells.

2.19 SITE 20 (GRIT BLASTING AREA AT BUILDING 544)

The grit blasting area at Building 544 is a small area behind Building 544 which houses blasting operations for the removal of paint from ordnance. A leaching field is reported to be present behind this building. Past disposal activities at this leaching field are unknown. Activities at the site included the disposal of paint chips and spent grit from site operations. The spent grit was staged in an open pit southwest of Building 544. This material has been removed. A gravel accesses the site from Midway Road.

2.19.1 Site 20 (Grit Blasting Area at Building 544) Activities

Activities planned for Site 20 include the following:

- Soil borings (hand auger)
- Multi-media sampling
  - Soils (surface and subsurface)
  - Surface water/sediments
- Site Mapping

2.19.2 Potential Contaminants

Elevated levels of semivolatile compounds and metals were detected from samples along the drainage. Only very low levels of volatiles (possible lab artifacts) were detected in surface soil samples

2.20 SITE 22 (PAINT CHIP DISPOSAL AREA)

The paint chip disposal area is behind Building D-2 and previously consisted of approximately 50 square feet of stressed vegetation and discolored soils. This discolored soils resulted from past grit blasting and painting operations. This is no longer visible. The ground surface is predominantly sand and gravel. Traces of paint stains were barely evident in the surface materials and were limited to black and red staining on the surface.

2.20.1 Site 22 (Paint Chip Disposal Area) Activities

Because of the minimal concentrations of compounds detected no sampling activities are planned for Site 22. However, site mapping will be conducted.

2.20.2 Potential Contaminants

All samples were below NJDEPE ECRA guidelines.

2.21 SITE 23 (PAINT DISPOSAL AREA)

This site near Building D-5 has been used since the early 1970's for repainting and stenciling torpedoes, aerial bombs, and other large ordnance. Recent SI work at the site found a small amount of paint residue present at the site inside the fence line, west of Building D-5. A earthen berm about 20 ft high surrounds the north, east and west sides of the site. A drainage ditch and a small marsh are present west and north of the building within the bermed area. The site is partially paved, and overland runoff flows radially across the site into shallow drainage depressions which surround the site on three sides. The drainage flow towards the marshlands which contains standing water. A tributary of Hockhockson Brook is located approximately 500 ft to the southwest of the site.

2.21.1 Site 23 (Paint Disposal Area) Activities

Activities planned for Site 23 include the following:

- Soil borings which will be converted to monitoring wells.
- Multi-media sampling
  - Soils (subsurface)
  - Surface water/sediment
  - Groundwater
- Site Mapping

2.21.2 Potential Contaminants

Sample analysis indicated that low levels of VOCs and metals were present in soil samples, low levels of organics and one pesticide were detected in sediment, an elevated metals were detected in sediments. Groundwater contained low levels of organics and some elevated levels of metals.

The primary contaminants of concern are metals, as other compounds detected were in low concentrations.

2.22 SITES 24 AND 25 (PISTOL FIRING RANGES)

Sites 24 and 25 are closed pistol ranges which are no longer used for target practice. Due to the similar nature of the sites, their similar history, and the close proximity of the pistol ranges, these sites will be combined and addressed by the RI as a single site. Activities at the site consisted of target practice using lead and copper-jacketed bullets which were fired into the impact berm (natural sand bank). It has been estimated that approximately 250 pounds of lead may be present at each site (Weston 1993). Preserved wooden posts are present at the site, and make up the firing platform. The impact berms are approximately 70 ft high and are composed of sand. No drainage swales are present at either site and precipitation infiltrates through the soil.

2.22.1 Site 24/25 (Pistol Firing Ranges) Activities

Activities planned for Sites 24/25 include the following:

- Soil boring
- Multi-media sampling
  - Soils (subsurface)
- Site Inspections (seeps/erosion)
- Site Mapping

2.22.2 Potential Contaminants

The primary contaminant of concern for these sites is lead.

2.23 SITE 26 (EXPLOSIVE "D" WASHOUT AREA)

The explosive "D" washout area is located behind Building GB-1. For one year in the late 1960's, 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. The site is approximately 200 by 200 feet in size, is situated between Macassar and Midway Roads. There are two railway lines adjacent to the site that run northeast. The ground surface at the site is relatively flat. The percolation pit is in the center and measures approximately 30 feet in diameter and 10 feet in depth. A tile lined open pipe runs from Building GB-1 to the pit.

2.23.1 Site 26 (Explosive Contaminants) Activities

Activities planned for Site 26 include the following:

- Soil-gas survey
- Soil borings/monitoring well installation
- Multi-media sampling
  - Soils (subsurface)
- - Groundwater
- Site Mapping

2.23.2 Potential Contaminants

Lead was detected at elevated levels in the settling basin. Picric acid was detected in one sample. TCE was detected at elevated levels near the percolation pit. Other volatile organic compounds, such as dichloroethanes, were also present. Low concentrations of several explosive compounds were detected.

2.24 SITE 27 (PROJECTILE REFURBISHING AREA)

Site 27, located near Building E-14, has been used for shot-blasting, repainting, and re-stenciling of projectiles. Some of the waste material stored at the site includes oil-contaminated rags, paint chips, blasting shot and toluene. A portion of the site surface near the southeast corner of Building E-14 is characterized by accumulation of paint sludge. A railroad siding and small drainage swale are present on the east side of the site. Drainage at the site moves to the shallow depression immediately down-slope and approximately 15 feet in distance from the area of paint sludge. Surface water infiltration occurs within this drainage depression.

2.24.1 Site 27 (Projectile Refurbishing Area) Activities

Activities planned for Site 27 include the following:

- Soil boring
- Multi-media sampling
  - Soil (subsurface)
- Site Mapping

2.24.2 Potential Contaminants

Analysis of soil samples detected low levels of pesticides, metals, PCBs, VOCs and semivolatiles. Elevated levels of lead and copper were detected. Sediment samples contained some elevated levels of metals and pesticides and low levels of metals, volatiles and semivolatiles.

2.25 SITE 29 (PCB SPILL SITE)

This site is located in a storage yard north of Building C-16 and was the location of a PCB spill from a transformer in 1981. Within five days after the spill all discolored soil (over 120 ft^3) was disposed of offsite. Confirmatory sampling at the spill site was not performed. NWS Earle is planning to build a one story, brick building at the site which will function as a new hazardous waste storage facility. A railroad spur and wet lands are located to the east of the site and Saipan Road is located along the west side of the site.

2.25.1 Site 29 (PCB Spill Site) Activities

Activities planned for Site 29 include the following:

- Multi-media sampling
  - Soils (subsurface)
  - Groundwater
- Site Mapping

2.25.2 Potential Contaminants

Small amounts of pesticides, VOCs, and PCBs were detected during the 1992 SI field investigation at concentrations below New Jersey soil criteria. One sample (S001) contained concentrations of TPH (28,000 mg/kg) above acceptable criteria. Elevated levels of benzene (30 ppb) and DCE (25 ppb) were reported in one well. Total lead and total chromium were present above state clean up criteria.

2.26 EPIC SITE L - MSC VAN PARKING AREA

Epic Site L is comprised of a 15.7 acre area near Asbury Avenue and Pine Brook Road. Approximately one third of the site is currently used for storage of new and old telephone poles, railroad ballast stone, and miscellaneous metal, plastic, and wood scrap material. The remaining a majority of the site is a power line easement. Storage at the site is currently limited to a few small scrap piles, a telephone pole storage area, and small asphalt and concrete piles. However, materials have been stored at the site for 25 to 30 years, and past storage practices are not known.

2.26.1 EPIC Site L (MSC Van Parking Area) Activities

Activities planned for EPIC Site L include the following:

- Multi-media sampling
  - Soils (surface)
- Site Mapping

2.26.2 Potential Contaminants

No previous sampling has occurred at this site. Sampling at this site will focus on determining if soils have been impacted by ongoing storage activities which have occurred in the past.

2.27 EPIC SITE Q (FIRE FIGHTING SCHOOL)

This site occupies a 5.5 acre area at the extreme southwestern corner of NWS Earle. The fire fighting school has been in use since 1975 and is used by a variety of state and county groups to practice fire fighting. The station is operated by the Military Sealift Command, which reports having all necessary operating permits and is inspected on a regular basis by the NJDEPE. An oil water separator and retention pond is present at the site and the facility has a permit for disposal of the water from the separator to the pond. The pond is monitored and is maintained at or below discharge limits. Fire fighting takes place on a concrete pad, which prevents the infiltration of flammable material into the soil.

2.27.1 EPIC Site Q (Fire Fighting School) Activities

Activities planned for EPIC Site Q include the following:

- Monitoring well installation
- Sampling
  - Groundwater
- Site mapping

2.27.2 Potential Contaminants

The site was identified by reviewing aerial photographs of the NWS Earle facility to detect areas of potential environmental concern (NEESA, 1992). No previous groundwater sampling has occurred at this site.

Groundwater will be analyzed for TCL, VOAs, semi-volatiles, and TPH.

3.0 SCOPE OF WORK

This section outlines the work to be performed at the NWS Earle by Halliburton NUS and subcontractor personnel and, therefore, defines the work covered by this HASP. If site work other than that listed below must be performed, Halliburton NUS will revise this HASP accordingly to reflect those changes. Each task identified in this HASP has been evaluated to identify potential hazards, physical and chemical, associated with that specific task. The evaluation of each task will be accompanied by the appropriate control measures for the hazards identified (see section 6.0).

Field operations to be performed at NWS Earle during the RI include mobilization of equipment, borehole drilling, monitoring well installation/construction, soil-gas surveying, soil and groundwater sampling, well development, test pit excavation, water-level measurements, ground surveying, equipment decontamination and waste handing.

Work performed in conjunction with this Health and Safety Plan (HASP) will include the following activities

- Mobilization/demobilization - The Field Operations Leader (FOL) will coordinate the mobilization activities upon arrival at the station. The FOL will also make any equipment purchases required to conduct the field investigation. The equipment required for the field activities will be loaded in Pittsburgh and driven to the site by the FOL and a technician/geologist. After field activities are completed, the FOL will demobilize the equipment and drive back to Pittsburgh. Additional project personnel will be utilized in the field as necessary to efficiently perform all contractor oversight and investigation/sample collection work.

- Subsurface Investigation - Current specifications call for drilling, monitoring well installation, soil borings, and multi-media sampling to function as a preliminary investigation that is expected to provide the majority of the information necessary to assess the extent of contamination. The general objective of the subsurface investigation is to delineate the horizontal and vertical extent of potential site contaminants at each site or study area.

- Media sampling - Surface and subsurface soil, surface and groundwater, and sediments include the media to be sampled as part of the planned activities. This information will be utilized to determine and characterize the extent, level, and the potential threat to human and environmental health and welfare from the contamination associated with the selected sites.

- Surveying/Site Maps - The contractor shall conduct a survey of all monitoring well locations following installation.

- Restoration of Boring Locations - This activity will return all identified work zones to their former condition. The accomplishment of this task will ensure all potentially contaminated material possibly brought to the surface through intrusive activities such as soil borings and monitoring well installation are collected for

proper disposal. Inspection and documentation of this task will be the responsibility of the FOL or SSO. This is especially crucial for those areas which may be travelled or frequented by the general public.

- Test Pit Operations - Test pits will be excavated at landfill sites to visually define and characterize the extent of fill at these locations. Test pit excavations will not be sampled, although the contents of the fill will be described. All excavated material removed from the test pit will be placed on a tarp or plastic sheet to prevent contamination of surface soil. After test pit activities are completed, the excavated material will be used as backfill and a wooden stake will be positioned at each end of the pit for determining location during site survey work. All test pits will be filled in immediately after a test pit log is completed.

- Decontamination Activities - Decontamination activities for personnel, heavy equipment, and sampling equipment will take place in overall support of this scope of work. This along with a functioning site control program will be employed to stop the spread of onsite contaminants outside the exclusion zones. Applied decontamination procedures, effective evaluation of this process, and work zone closure procedures will ensure that any contaminants encountered and associated with the task have been adequately contained, removed, and disposed of in accordance with accepted procedures.

- Waste Handling Procedures - All development and purge liquids, decontamination and steam-cleaning fluids, drill cuttings and used Personal Protective Equipment (PPE) will be collected, containerized, labeled, and stored on site in DOT approved (Specification 17-C), 55 gallon drums. 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 of the drums upon project completion and will determine whether off site disposal and/or treatment is required after receiving analytical results from the sampling.

A more detailed description of each of these tasks can be found in either the "Sampling and Analysis Plan" (SAP) or the Work Plan.

4.0 HAZARD ASSESSMENT

This section describes the chemical and physical hazards that are associated either directly or indirectly with the tasks and operations described in Section 3.0 of this HASP. Measures to control the hazards presented below can be found throughout this document with emphasis on the following Sections:

5.0 - Air Monitoring
6.0 - Personal Protective Equipment
7.0 - Standard Work Practices
8.0 - Decontamination
9.0 - Training
11.0 - Site Control

4.1 PRIMARY SITE CONTAMINANTS

The primary contaminants associated with this scope of work, identified at the majority of the sites, and associated with and the tasks identified in Section 3.0, are metals. Metals which including aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc, have been detected in previous samples in various concentrations. The assessment as a primary contaminant is based on concentrations and dispersion characteristics at various sites and through the media sampled.

4.2 ADDITIONAL CHEMICAL HAZARDS

Additional contaminants which may be present at higher concentration at isolated sites include semi-volatile compounds such as Polynuclear Aromatic Hydrocarbons (PAHs), Total Petroleum Hydrocarbons (TPHs), phthalate esters, and some aromatic hydrocarbons including benzene, toluene, ethylbenzene, and xylene (BTEX). BTEX compounds, although detected were represented in much smaller concentrations. All of these contaminants have not been detected at each site as identified in Section 2.0. Therefore, as site activities change locations, a preview of anticipated contaminants and conditions peculiar to that site should be reviewed prior to the commencement of onsite activities.

In addition, various areas of the sites may be designated as storage areas used to store items that will be required to perform many of the tasks while at the site. These items may include; fuel for machinery and generators, and chemicals for decontamination of equipment and personnel. Many of these products may present various hazards to site workers. At the time that this HASP was developed, it was unknown exactly what products will be stored at each of the sites. Once a subcontractor is selected and the materials are identified, appropriate measures (obtaining MSDS, proper storage methods, instituting standard work practices, revising this HASP, and establishing a site hazard communication program) will be initiated. It is unlikely that workers will be overexposed to these additional chemicals as they are handled under controlled conditions.

Information concerning safe exposure limits, warning properties, air monitoring (detection, identification, and quantification), chemical/physical properties, and health effects information on these substances can be found in Table 4-1.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Acetone	67-64-1	I.P. 9.69 eV, High response with PID and 10.2 eV lamp	60 % Relative Response with FID	Air sample using a charcoal tube and carbon disulfide desorption, OSHA 69,07 / NIOSH 1300	1000 ppm, OSHA; 750 ppm ACGIH with 1000 ppm STEL; 250 ppm, NIOSH	Adequate - Can use air purifying respirator with organic vapor cartridge up to 5000 ppm **Recommended glove:** Natural rubber	**Boiling Pt:** 133°F **Melting Pt:** NA **Solubility:** Miscible **Flash Pt:** 0°F **LEL/LFL:** 2.5% **UEL/UFL:** 13% **Vapor Density:** NA **Vapor Pressure:** 180 mm **Specific Gravity:** 0.79 **Incompatibilities:** Oxidizers, acids **Appearance and odor:** Colorless liquid with a fragrant mit-like odor.	Exposure to this chemical may result in irritationto the eyes, nose, throat. Overexposure may cause headache, dizziness. Contact with the skin may cause dermatitis. Target organs are listed as the respiratory system (lungs) and skin.
Benzene	71-43-2	I.P. 9.24 eV, 100% response with PID and 10.2 eV lamp	150% response with FID	Air sample using charcoal tube and carbon disulfide desorption, OSHA 07	1 ppm OSHA 10 ppm ACGIH 0.1 ppm NIOSH	Inadequate - OSHA accepts the use of air-purifying respirators with organic vapor cartridge up to 10 ppm despite the inadequate warning properties **Recommended glove:** nitrile	**Boiling Pt:** 80°C **Melting Pt:** 5.5°C **Solubility:** 0.07% **Flash Pt:** -11°C **LEL/LFL:** 1.3% **UEL/UFL:** 7.9% **Vapor Density:** 2.77 **Vapor Pressure:** 75 mm **Specific Gravity:** 0.88 **Incompatibilities:** Strong oxidizers, perchlorates, acids **Appearance and Odor:** Colorless to a light yellow liquid with an aromatic order.	Over exposure may result in irritation to the eyes, nose, throat, and respiratory system. CNS effects include giddiness, lightheadedness, headaches, staggered gait, fatigue, and lassitude and depression. Additional effects may include nausea. Long duration exposures may result in respiratory collapse. Regulated as an OSHA carcinogen. May cause damage to the blood forming organs and may cause leukemia.
Chlorobenzene	108-90-7	I.P. 9.07 eV, High response with PID and 10.2 eV lamp	200% response with FID	Air sample using charcoal sorbent tube and carbon disulfide desorption with gas chromatography-flame ionization detector, OSHA 07, NIOSH 1003	75 ppm TWA, OSHA, NIOSH; 10 ppm TWA, ACGIH	Adequate - Can use air-purifying respirator with organic vapor cartridge up to 500 ppm **Recommended glove:** nitrile	**Boiling Pt:** 131°C **Melting Pt:** -45°C **Solubility:** 0.05% **Flash Pt:** 29°C **LEL/LFL:** 1.3% **UEL/UFL:** 9.6% **Vapor Density:** 3.88 **Vapor Pressure:** 10 mm @ 22°C **Specific Gravity:** 1.11 **Incompatibilities:** Strong oxidizers **Appearance and Odor:** Colorless liquid with an almond-like odor.	Regulated primarily because of it potential to cause sleepiness and incoordination. Irritating to the eyes, nose, and skin. May cause liver, kidney, and lung damage.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Dinitrotoluene	25321-14-6	Particulate form - unable to be detected by PID/FID	Not detectable in the solid form	None available	OSHA NIOSH 1.5 mg/m^3; skin ACGIH 0.15 mg/m^3; skin NIOSH IDLH 50 mg/m^3	In the particulate form - Can use air-purifying respirator with organic vapor cartridge up to 50 ppm **Recommended glove:** nitrile	**Boiling Pt:** 572°F;300°C **Melting Pt:** 158°F;70°C **Solubility:** Insoluble **Flash Pt:** 404°F;207°C **LEL/LFL:** Not available **UEL/UFL:** Not available however, airborne in the form of a dust this substance will support combustion **Vapor Density:** 6.27 **Vapor Pressure:** 1 mm **Specific Gravity:** 1.32 **Incompatibilities:** Strong oxidizers, caustics, metals such as tin and zinc **Appearance and Odor:** Orange to yellow crystalline solid with characteristic odor.	Overexposure to this substance may result in anemia, methemoglobinemia, cyanosis, and liver damage. This substance may result in an irritant and possible allergic reaction.
1-2-Dichloroethylene	540-59-0	I.P. 9.65 eV, High response with PID and 10.2 eV lamp	50% response with FID	Air sample using charcoal tube and carbon disulfide, OSHA 07	200 ppm TWA, OSHA, ACGIH, and NIOSH	Limited data available. Should use pressure-demand supplied air respirator above exposure limits. **Recommended glove:** nitrile	**Boiling Pt:** 47°C **Melting Pt:** -13.8°C **Solubility:** 0.4% **Flash Pt:** 2.2°C **LEL/LFL:** 5.6% **UEL/UFL:** 12.8% **Vapor Density:** 2.0 **Vapor Pressure:** 180-260 mm **Specific Gravity:** 1.27 @ 32°C **Incompatibilities:** Strong oxidizers, alkalis, potassium hydroxide, and copper. When heated to decomposition temperatures will emit toxic fumes of phosgene. **Appearance and Odor:** Colorless liquid with an acrid odor.	Overexposure may result in CNS depression potential to cause sleepiness, hallucinations, distorted perceptions, and stupor (narcosis). Systemically, symptoms may result in nausea, vomiting, weakness, tremors, and cramps. May also irritate the eyes, skin, and mucous membranes. Chronic exposures may result in dermatitis, liver, kidney, and lung damage.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
1,1,2- Trichloroethane	79-00-5	I.P. 11.0 eV	105% response with FID	Air sample using charcoal sorbent tube and carbon disulfide desorption with gas chromatography-flame ionization detector; OSHA 07, NIOSH 1003	OSHA, NIOSH, ACGIH 10 ppm TWA, IDLH ~100 ppm	Adequate - Can use air-purifying respirator with organic vapor cartridge up to 500 ppm Recommended glove: Nitrile	**Boiling Pt:** 114°C **Melting Pt:** -35°C **Solubility:** 0.6% **Flash Pt:** N/A **LEL/LFL:** None established **UEL/UFL:** None established **Vapor Density:** Not available **Vapor Pressure:** 40 mm @ 20°C **Specific Gravity:** 1.44 **Incompatibilities:** Strong oxidizers, caustics, and chemically active metals **Appearance and Odor:** Colorless liquid with a sweet chloroform-like odor.	Overexposure to this substance may cause irritation to the eyes, skin, and mucous membranes of the respiratory and gastrointestinal tract. CNS effects may include sleepiness, incoordination, depression similar to a narcotic. Chronic exposure may cause liver, kidney and lung damage.
1,1,2,2-Tetrachloroethane	79-34-5	I.P. 11.1 eV	100% response with FID	Air sample using charcoal tube and carbon disulfide desorption, OSHA 07, or NIOSH method 1003	1 ppm TWA OSHA, ACGIH, and NIOSH Overall exposure to this substance may be contributed through skin absorption IDLH ~100 ppm	Odor threshold for this substance has been determined to be at airborne concentrations of approximately 1.5 ppm, which is considered adequate. **Recommended glove:** Nitrile	**Boiling Pt:** 47°C **Melting Pt:** -36 to -43.8°C **Solubility:** 0.3% **Flash Pt:** N/A **LEL/LFL:** N/A **UEL/UFL:** N/A **Vapor Density:** Not available **Vapor Pressure:** 9mm @ 86°F **Specific Gravity:** 1.59 @ 25°C **Incompatibilities:** Strong oxidizers, alkalis, fuming sulfuric acid, and chemically active metals. When heated to decomposition temperatures will emit toxic fumes of chlorine. **Appearance and Odor:** Colorless to pale yellow liquid with a pungent chloroform like odor.	Overexposure may result in CNS depression potential to cause sleepiness, hallucinations, distorted perceptions, and stupor (narcosis). Systemically, symptoms may result in nausea, vomiting, weakness, tremors, and cramps. May also irritate the eyes, skin, and mucous membranes. Chronic exposures may result in dermatitis, enlarged tender liver, kidney, and lung damage.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Methylene chloride	75-09-2	I.P. 11.32 eV, High response with PID and 11.7 eV lamp	100% response with FID	Air sample using charcoal or Anasorb CMS sorbent tube and carbon disulfide desorption with gas chromatography-flame ionization detector; OSHA 59 or 80, NIOSH 1005	500 ppm TWA, OSHA 1,000 ppm ceiling, OSHA 50 ppm TWA, ACGIH Lowest feasible concentration, NIOSH 50 ACGIH	Inadequate - Must use a supplied air respirator (airline respirator with emergency escape cylinder or a Self-Contained Breathing Apparatus - SCBA) **Recommended gloves:** Butyl rubber or nitrile	**Boiling Pt:** 39.8°C **Melting Pt:** -96°C **Solubility:** 2% **Flash Pt:** N.A. **LEL/LFL:** 15.5% **UEL/UFL:** 66.4% **Vapor Density:** 2.93 **Vapor Pressure:** 380 mm @ 22°C **Specific Gravity:** 1.33 **Incompatibilities:** Strong oxidizers, caustics, metals (i.e. aluminum, magnesium, potassium, sodium, lithium), and concentrated acids **Appearance and Odor:** Colorless liquid with a chloroform-like odor. (Note: A gas above 104°F). Odor Threshold of 160 ppm.	Regulated primarily because of its ability to cause sleepiness, fatique, weakness, lightheadedness, numbness of the limbs, altered cardiac rate and incoordination. These signs and symptoms may be accompanied by nausea, gastric and pulmonary irritation leading possibly to pulmonary edema. In addition to the narcosis log term effects may include liver injury. Listed as possessing carcinogenic properties by NTP, IARC, and ACGIH.
Vinyl chloride	75-01-4	I.P. 9.99 eV, High response with PID and 10.2 eV lamp	40% response with FID	Air sample using charcoal or Anasorb CMS sorbent tube and carbon disulfide desorption with gas chromatography-flame ionization detector; NIOSH 1007, OSHA 75	1.0 ppm TWA, OSHA 5.0 ppm Ceiling, OSHA 5 ppm TWA, ACGIH Lowest Feasible Concentration; NIOSH	Inadequate - Must use an open-circuit, self-contained breathing apparatus, pressure demand type, with full facepiece. Refer to 29 CFR 1910.1017(g) for specific requirements based on atmospheric concentrations of vinyl chloride. **Recommended gloves:** Silver shield, nitrile, or Viton	**Boiling Pt:** -13.9°C **Melting Pt:** -160°C **Solubility:** slight **Flash Pt:** -8°C **LEL/LFL:** 4% **UEL/UFL:** 22% **Vapor Density:** 2.15 **Vapor Pressure:** 2600 mm @ 25°C **Specific Gravity:** N.A. **Incompatibilities:** Oxidizers, copper, aluminum, peroxides, iron, steel, **Appearance and Odor:** Colorless gas or liquid (below 56°F) with a pleasant odor **at high concentrations.** Odor Threshold of 10-20 ppm.	A severe skin, eye, and mucous membrane irritant. Narcotic effect causing weakness, abdominal pains, GI bleeding, and pallor skin or cyanosis. Regulated primarily because of its depresant effects on the CNS and its association with the formation of malignant tumors originating from blood lymphatic vessels in the liver and kidneys (angiosarcoma and nephroblastoma). Listed as a carcinogen by NTP, IARC and ACGIH.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Xylene All isomers o-,m-, p-	1330-20-7	I.P. 8.56 eV, High response with PID and 10.2 eV lamp	110% response with FID	Air sample using charcoal tube and carbon disulfide desorption, OSHA 07	100 ppm TWA 150 ppm STEL OSHA, ACGIH, & NIOSH IDLH 900 ppm	Adequate - Can use air-purifying respirator with organic vapor cartridge up to 1,000 ppm **Recommended gloves:** Viton, Silver shield, nitrile, or neoprene	**Boiling Pt:** 269-281°F **Melting Pt:** -13/-54/56°F **Solubility:** Insoluble **Flash Pt:** 63-81°F **LEL/LFL:** 1.0% **UEL/UFL:** 7.0% **Vapor Density:** 3.66 **Vapor Pressure:** 7-9 mmhg @ 70°F **Specific Gravity:** 0.86-0.88 **Incompatibilities:** Strong oxidizers **Appearance and odor:** Colorless liquid with an aromatic odor. Odor Threshold of 20 ppm.	Regulated primarily because of its potential to irritate the eyes and respiratory system. In addition, effects may include CNS changes (i.e. dizziness, excitement, drowsiness, incoherent, staggering gait), difficulty in breathing, pulmonary edema, and possibly respiratory failure.
Aluminum	7429-90-5	Particulate form - unable to be detected by PID/FID	Not detectable	NIOSH Method 7013 and 7300	OSHA 15 mg/m^3 Total dust 5 mg/m^3 Respirable fraction NIOSH 10 mg/m^3 Total dust 5 mg/m^3 Respirable fraction ACGIH 10 mg/m^3	Particulate form - No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** this is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 2450°C **Melting Pt:** 660°C **Solubility:** Insoluble **Flash Pt:** Nonflammable **LEL/LFL:** Nonflammable **UEL/UFL:** Nonflammable It should be noted that finely divided powders or dust when airborne becomes moderately flammable/explosive when exposed to heat, flame, or powerful oxidizers **Vapor Density:** Not available **Vapor Pressure:** 1mm @ 1284°C **Specific Gravity:** 2.702 @ 25°C **Incompatibles:** Acids, alkalis, oxidizers, halogens and halocarbons, alcohols **Appearance and odor:** silvery gray ductile, lusterous metal	Inhalation of finely divided powders or dusts may result in difficulty in breathing, coughing, and has been reported to cause pulmonary fibrosis. This malady known as "Shavers disease" is a form of benign pneumoconiosis.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Antimony	7440-36-0	Particulate form - unable to be detected by PID/FID	Not detectable	No recommendation found	OSHA NIOSH ACGIH 0.5 mg/m^3 IDLH 50 mg/m^3 (asSb)	Metallic taste resulting from exposure **Recommended Air Purifying Cartridges:** Organic vapors and acid gases with a HEPA filter **Recommended gloves:** this is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 1635°C **Melting Pt:** 630°C **Solubility:** Insoluble **Flash Pt:** Nonflammable **LEL/LFL:** Nonflammable **UEL/UFL:** Nonflammable **Vapor Density:** N.A. **Vapor Pressure:** 1mm @ 886°C **Specific Gravity:** 6.684 @ 25°C **Incompatibles:** Acids, oxidizers, halogens **Appearance and odor:** silvery gray, lusterous metal	This substance is considered a poison by ingestion, irritating to the skin and mucous membranes causing inflammation to the nose,mouth, and throat. Chronic exposure may result in some forms of dermatitis. Ingestion may result in a metallic taste, vomiting, colic, and diarrhea. Chronic exposure may result in addition to those stated above indigestion, loss of appetite and weight, and diarrhea. Sores in the mouth along with a sore throat help distinguish this form of poisoning from other forms of metallic poisoning such as lead and arsenic. Inhalation at excessive concentrations may result in difficulty in breathing, headaches and a bloody discharge from the nose, and chemical pneumonitis.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Arsenic	7440-38-2	Particulate form - This substance is unable to be detected by PID/FID	Particulate form - This substance is unable to be detected by PID/FID	NIOSH Method #7900 or Method #7300	OSHA Organic compounds 0.5 mg/m^3 Inorganic compounds 0.01 mg/m^3 NIOSH ceiling 0.002 mg/m^3 ACGIH 0.2 mg/m^3	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. This substance may be presented as a pesticide, therefore a cartridge suitable for pesticides (MSA-GMP) **Recommended Gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** sublimation @ 612°C **Melting Pt:** 814°C @ 36 atm **Solubility:** Insoluble in water;soluble in nitric acid **Flash Pt:** Nonflammable, however, airborne in the form of a dust this substance will support combustion **LEL/LFL:** Nonflammable **UEL/UFL:** Nonflammable **Vapor Density:** N.A. **Vapor Pressure:** 1 mm @ 372°C (sublimes) **Specific Gravity:** 5.73 **Incompatibilities:** Oxidizers, halogens,zinc, lithium, azides, and acetylides **Appearance and odor:** Gray to black, brittle, crystalline, amorphous, odorless.	Overexposure to this substance through inhalation or ingestion may result in ulceration of the nasal septum, GI disturbances resulting in violent purging and vomiting,hoarse voice, sore throat, excessive salivation, peripheral neuropathy (numbness and burning sensations beginning at the extremities followed by motor weakness), respiratory irritation leading to possible pulmonary edema. Skin or eye contact may result in irritation, conjunctiva, dermatitis, and hyperpigmentation (darkening of thr areas exposed) of the skin. This substance has been judged to be a Human carcinogen by NTP, and IARC.
Barium	7440-39-3 as Ba 10022-31-8 as Ba $(NO_3)_2$ 10361-37-2 as Ba Cl_2	Particulate form - This substance is unable to be detected by PID/FID	Particulate form - This substance is unable to be detected by PID/FID	NIOSH Method # 7056	OSHA NIOSH ACGIH 0.5 mg/m^3	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 1640°C (decomposes) **Melting Pt:** 725°C **Solubility:** Varies between compounds 9/38% **Flash Pt:** N.A. (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 10 mm @ 1049°C **Specific Gravity:** 3.5 **Incompatibilities:** Acids, oxidizers **Appearance and odor:** Silver to white, odorless	Overexposure to this substance results in the solubilization in the water or stomach acids. Symptoms include vomiting, colic, diarrhea (watery sometimes bloody), slow to irregular pulse, transient hypertension, convulsive tremors, and muscular paralysis resulting in stiffness immobility, leg cramps, twitching, and impairment of speech and swallowing. Overexposure to some compounds via inhalation may result in respiratory distress, dyspnea, and baritosis (a benign pneumoconiosis). Direct contact to the skin or eyes may result in irritation.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Beryllium	7440-41-7 as Be	Particulate form - This substance is unable to be detected by PID/FID	Particulate form - This substance is unable to be detected by PID/FID	NIOSH Method #7102 and Method # 7300	OSHA 0.002 mg/m^3; ceiling 0.005 mg/m^3 NIOSH 0.0005 mg/m^3 ACGIH 0.002 mg/m^3	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 2970°C **Melting Pt:** 1278°C **Solubility:** Insoluble **Flash Pt:** N.A.(Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 0 mm **Specific Gravity:** 1.85 **Incompatibilities:** Halocarbons, strong oxidizers, acids and caustics **Appearance and odor:** gray to white hard light metal, brittle	Overexposure to this substance may result in respiratory symptoms including difficulty in breathing, coughing, rales, chest pain, possibly pulmonary edema, weakness, fatique, headache, weight loss. Direct contact may result in irritant action on the skin (dermatitis), eyes (conjunctivae), and mucous membranes. This substance has been identified as a potential human carcinogen.
Cadmium	7440-43-9	Substance is not volatile. Unable to be easily detected by PID or FID.	Not detected by FID.	Air sample using a mixed cellulose-ester filter / acid desorption and analysis by atomic absorption-flame; NIOSH 7300 or 7048.	0.2 mg/m^3 TWA; OSHA ACGIH IDLH 9 mg/m^3	The use of an air purifying, full face-piece respirator with a high efficiency particulate air filter.	**Boiling Pt:** 767°C **Melting Pt:** 320.9°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** N.A. **Vapor Pressure:** 1 mm @ 394°C **Specific Gravity:** 8.65 @ 32°C **Incompatibilities:** Strong oxidizers, elemental sulfur, sellenium, tellerium, zinc, nitric acid, and hydrazoic acid **Appearance and Odor:** Metal: Silver-white, blue-tinged lustrous, odorless solid. Fume: yellow-brown, finely divided particulate dispersed in air.	Overexposure to this substance may result in irritation to the respiratory tract, dyspnea, tightness in the chest, coughing, possibly pulmonary edema. Overexposure to fumes causes symptoms characteristic of the flu (headaches, chills, muscle aches, nausea, vomiting, diarrhea). Chronic exposure may result in damage to the lungs, kidneys and liver. This substance has been identified as a confirmed animal; potential human carcinogen by IARC and NTP.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Chromium Compounds	7440-47-3 (Element)	Properties vary depending upon the specific compounds. Not detectable by PID.	Not detectable by FID.	Air sample using mixed cellulose - ester filter / acid desorption and analysis by atomic absorption; NIOSH 7024.	0.5 mg/m^3 TWA OSHA & NIOSH. 0.05 mg/m^3 TLV; ACGIH. IDLH 250 mg/m^3	The use of a air purifying, full face-piece respirator with a high efficiency particulate filter.	**Boiling Pt:** 2642°C **Melting Pt:** 1900°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** N.A. **Vapor Pressure:** 0 mm **Specific Gravity:** 7.14 **Incompatibilities:** Strong oxidizers, peroxides, and alkalis **Appearance and Odor:** Appearance and odor vary depending upon the specific compound.	Health hazards are characterized normally through chronic exposure manifesting as histologic fibrosis of the lungs and ulceration of the nasal septum and skin. IARC, NTP and ACGIH list various chromium compounds as possessing carcinogenic properties.
Cobalt	7440-48-4 as Co	Particulate form - This substance is unable to be detected by PID/FID	Particulate form - This substance is unable to be detected by PID/FID	NIOSH Method # 7027 and Method # 7300	OSHA NIOSH ACGIH 0.02 mg/m^3 0.05 mg/m^3 TWA NIOSH 0.1 mg/m^3 TWA OSHA 0.02 mg/m^3 TWA ACGIH IDLH 20 mg/m^3	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 3100°C **Melting Pt:** 1493°C **Solubility:** Insoluble in water; soluble in nitric acid **Flash Pt:** N.A.(Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 0 mm **Specific Gravity:** 8.92 **Incompatibilities:** Strong oxidizers, and ammonium nitrate **Appearance and odor:** Silver-gray to black solid, odorless	Overexposure to this substance through ingestion may result in symptoms of nausea, and vomiting. Symptoms manifested through inhalation may include wheezing, coughing, dyspnea, increased by reduced pulmonary volume by nodular fibrosis. Direct contact may result in irritation leading to dermatitis of the skin. Irritation to the eyes may result largely from mechanical damage.

TABLE 4-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Copper	7440-50-8 (Cu) 1317-38-0 (CuO)	Substance is not volatile. Unable to be detected by PID or FID.	Not detected by FID.	Air sample using a mixed cellulose ester filer / inductively coupled plasma/atomic emission spectroscopy; NIOSH 7300.	0.10 mg/m^3 TWA; OSHA and NIOSH. 0.2 mg/m^3 TWA; ACGIH. IDLH 100 mg/m^3	The use of an air-purifying full-face respirator with a high efficiency particulate air filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 2324°C **Melting Pt:** 1083°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** N.A. **Vapor Pressure:** 1 mm @ 1628°C **Specific Gravity:** 8.94 **Incompatibilities:** Oxidizers, alkalis, sodium azide, acetylene, bromates, chlorates, iodates, and acids. **Appearance and Odor:** Metal: Reddish, lustrous malleable, odorless solid. Fume: Finely divided black particulate dispersed in air.	Irritation to the nose, throat, and respiratory tract. Metallic taste Discoloration of skin (potential dermatitis) and hair. Chronic exposure may result in dermatitis and damage to the liver and kidneys. Overexposure to fumes causes symptoms characteristic of the flu (headaches, chills, muscle aches, nausea, vomiting, diarrhea). Ingestion may cause burning in the mouth, throat, and stomach. Metallic taste with colicky abdominal pain. Individuals with Wilson's disease are at greater risk of chronic exposure as a result of the bodies tendency to absorb and retain copper.
Lead	7439-92-1	Substance is not volatile. Unable to be detected by either PID or FID.	Unable to be detected by FID.	Air sample using a mixed cellulose ester filter / HNO_3 or H_2O_2 desorption / Atomic absorption; NIOSH 7082 or 7300.	0.05mg/m^3 TWA; OSHA 0.15mg/m^3 TWA; ACGIH 0.10mg/m^3 TWA; NIOSH IDLH 100 mg/m^3	The use of a air purifying, full-face respirator with high efficiency particulate air filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 1740°C **Melting Pt:** 327°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** N.A. **Vapor Pressure:** 0 mm **Specific Gravity:** 11.34 **Incompatibilities:** Strong oxidizers, peroxides, sodium acetylide, zirconium, and acids **Appearance and Odor:** Metal: A heavy ductile, soft gray solid.	Overexposure to this substance via ingestion or inhalation may result in metallic taste in the mouth, dry throat, thirst, Gastrointestinal disorders (burning stomach pain, nausea, vomiting, possible diarrhea sometimes bloody or black, accompanied by severe bouts of colic), CNS effects (muscular weakness, pain, cramps, headaches, insomnia, depression, partial paralysis possibly coma and death. Extended exposure may result in damage to the kidneys, brain, and blood.

TABLE 4-1
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NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Manganese	7439-96-5 as Mn	Particulate form - This substance is unable to be detected by PID/FID	Particulate form - This substance is unable to be detected by PID/FID	NIOSH Method # 173 and Method # 7300	OSHA Ceiling 5 mg/m^3 as a fume 1 mg/m^3 NIOSH 1 mg/m^3 for dust and fume 3 mg/m^3 as a STEL ACGIH 5 mg/m^3 for dust 1 mg/m^3 for fume IDLH 500 mg/m^3	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 1900°C **Melting Pt:** 1260°C **Solubility:** Insoluble **Flash Pt:** N.A.(Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals. This substance is considered a combustible solid.) **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 1 mm @ 1292°C **Specific Gravity:** 7.20 **Incompatibilities:** Strong oxidizers, halogens, and nitrates. Will react with water to produce hydrogen gas. **Appearance and odor:** Silvery solid or reddish-gray, odorless	Overexposure to this product may result in Central Nervous System and pulmonary effects by inhalation. Symptoms may include disturbances in gait and speech, sleepiness, mental confusion, stolid, masklike face, muscular twitching varying from tremors to coarse rhythmical movements of the extremities accompanied by cramps. Symptoms are described as postencephalitic Parkinsonism. Additionally dry throat, tightness in the chest, dyspnea, rales, flu-like symptoms low back pain, and vomiting.
Mercury	7439-97-6	Jerome Mercury Vapor Analyzer	Particulate form - This substance is unable to be detected by PID/FID	NIOSH Method # 6009	OSHA NIOSH ACGIH as alkyl compounds 0.01 mg/m^3; STEL 0.03 mg/m^3 IDLH 10 mg/m^3	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for Metallic mercury with HEPA filter. Preferably, with an end-of-service life indicator. **Recommended gloves:** This is in the liquid form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 356.9°C **Melting Pt:** -38.89°C **Solubility:** Insoluble **Flash Pt:** N.A. **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 0.0012 mm @ 25°C **Specific Gravity:** 13.6 **Incompatibilities:** Acetylene, ammonia, chlorine dioxide, azides, calcium, sodium carbide, lithium, rubidium, and copper **Appearance and odor:** Silvery-white heavy mobile liquid, odorless	This substance is corrosive to all points of contact. Systemic symptoms include irritability, wakefulness, muscle weakness and tremors, increased reflexes, gingivitis, anorexia, headache, tinnitus, hypermotility, GI disturbances (nausea, vomiting), diarrhea (sometimes bloody), liver changes, dermatitis, and fever. Symptoms experienced via inhalation include to those above coughing, chest pain, dyspnea, bronchial pneumonitis, and excessive salivation.

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NWS EARLE, NEW JERSEY

Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Nickel	7440-02-0	Particulate form - This substance is unable to be detected by PID/FID	Particulate form - This substance is unable to be detected by PID/FID	NIOSH Method # 173 and Method # 7300	OSHA as Ni metal and insoluble compounds 1 mg/m^3 NIOSH 0.015 mg/m^3 ACGIH 1 mg/m^3 IDLH 10 ppm	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 2730°C **Melting Pt:** 1455°C **Solubility:** Insoluble acid **Flash Pt:** N.A.(Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 1 mm @ 1810°C **Specific Gravity:** 8.90 **Incompatibilities:** Strong acids, halogens, sulfur, wood and other combustibles, nickel nitrate, and oxidizers **Appearance and odor:** Silvery white, hard, malleable ductile metal, odorless	Symptoms of overexposure to this product may include headaches, vertigo, delerium, extreme weakness, GI disturbance and pain including nausea vomiting and diarrhea, coughing, hyperpnea, cyanosis, weakness, allergic dermatitis, nickel itch, pulmonary asthma, chest pains tightness, dyspnea, dry cough, and conjunctivitis. This substances has been identified as a Human carcinogen by NTP and IARC.
Silver	7440-22-4	Substance is not volatile and thus is unable to be detected by PID or FID.	Unable to be detected by FID.	Air sample using a mixed cellulose ester filter / Atomic absorption or plasma emission spectroscopy; NIOSH 5(s182), OSHA ID121.	0.01mg/m^3 TWA; OSHA, ACGIH and NIOSH IDLH 10 mg/m^3	The use of a air purifying, full-face respirator with a high efficiency particulate air filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 2212°C **Melting Pt:** 962°C **Solubility:** Insoluble **Flash Pt:** Not applicable (Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** N.A. **Vapor Pressure:** 0 mm **Specific Gravity:** 10.49 **Incompatibilities:** Acetylene, acetylene compounds, ammonia, peroxides, bromoazide, chlorine, trifluoride, ethylene imine, oxalic acid, nitric acid, and tartaric acid **Appearance and Odor:** Metal: white lustrous solid.	Overexposure to this substance may result in gastrointestinal, upper respiratory, and skin irritation. Discoloration of the eyes, skin and hair.

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Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Zinc	7440-66-6	Nondetectable (particulate)	Nondetectable (particulate)	NIOSH method 7030 or 7300	OSHA 10 mg/m^3 Total dust 5 mg/m^3 Respirable fraction NIOSH 5 mg/m^3 15 mg/m^3 as a TWA ceiling ACGIH 10 mg/m^3 These TWAs are based on zinc oxide dust	No identifiable warning properties to indicate presence and thereby detection **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** This is in the particulate form. Therefore any glove suitable to prevent skin contact (Nitrile has been the one most widely used for the other substances).	**Boiling Pt:** 908°C **Melting Pt:** 419.8°C **Solubility:** Insoluble **Flash Pt:** N.A.(Airborne dust may burn or explode when exposed to heat, flame, or incompatible chemicals) **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 0 mm **Specific Gravity:** 7.14 **Incompatibilities:** Strong acids, halogens, catalytic metals, combustibles, oxidizers, nitryl fluoride **Appearance and odor:** Bluish-white, lusterous metal, odorless	Inhalation of fumes may result in metal fume fever. This condition is characterized by metallic taste, dryness of the throat, coughing with generalized aching and flu-like symptoms. Effects through ingestion may include coughing, difficulty in breathing, and sweating. A human skin irritant. Irritation to the eyes may result from mechanical action.
Chlordane	57-74-9	Substance is not volatile (VP=.00001 mmHg) no I.P. exists, therefore detection by PID is poor.	Substance is non-combustible, therefore a FID will have no response to chlordane.	Air sample using Chromosorb-102 sorbent tube with mixed cellulose-ester filter or a xad-2 sorbent tube with filter. Toluene desorption and analysis by gas chromatography-electron capture detector, NIOSH 5510 or OSHA 67.	0.5 mg/m^3 TWA; OSHA, NIOSH and ACGIH. Skin IDLH 100 mg/m^3	Adequate - can use an air purifying respirator with an organic vapor & high efficiency air filter cartridges. **Recommended gloves:** PTFE Teflon for pure product. Nitrile acceptable for incidental contact.	**Boiling Pt:** 175°C **Melting Pt:** N.A. **Solubility:** Insoluble **Flash Pt:** N.A. **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 0.00001 mm **Specific Gravity:** 1.56 @ 15.5°C **Incompatibilities:** Strong oxidizers and alkaline reagents **Appearance and Odor:** Amber-colored, viscous liquid with a pungent, chlorine like odor.	Earliest signs of overexposure manifest as hypersensitivity of the central nervous system characterized by hyperactive reflexes, muscle twitching, tremors, incoordination, ataxia, and clonic convulsions. Cycles of excitement and depression may be repeated over and over. Chronic health hazard information similar to those for DDT.

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Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
DDT and the major metabolites; DDD and DDE.	50-29-3 72-54-8 72-55-9	Substance is not volatile no I.P. exists therefore, detection by PID poor.	Substance non-combustible, therefore a FID will have no response to DDT.	Air sample using a binder free, glass fiber filter and isoctane desorption / gas chromatography-electron capture detector, NIOSH 3(S274)	1 mg/m^3 TWA, OSHA & ACGIH; 0.5 mg/m^3 TWA, NIOSH IDLH 500 mg/m^3	Adequate - Can use air purifying respirator with high efficiency particulate air filter (HEPA) **Recommended glove:** Nitrile acceptable for incidental contact.	**Boiling Pt:** 110°C **Melting Pt:** 108°C **Solubility:** Insoluble **Flash Pt:** 72°C-77°C **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** Low **Specific Gravity:** 0.99 **Incompatibilities:** Strong oxidizers and alkalis **Appearance and Odor:** Colorless crystals or off-white powder with a slight aromatic odor	Large doses are followed by vomiting due to gastric irritation, diarrhea may follow. Numbness and parethesias of the lips tongue and face associated with malaise, headache, sorethroat, fatique and weakness. Coarse tremors (usually first of the neck, head, and eyelids). This may be accompanied by confusion, apprehension, and depression. Convulsions may result and death may occur from respiratory failure. DDT is absorbed and retained in the fat of humans. Chronic exposure may result in damage to the liver, kidneys and Peripheral Nervous System. DDT is recognized as possessing carcinogenic properties by IARC and NTP

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Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Aroclor-1260 (Polychlorinated Biphenyl, PCB)	11096-82-5	Substance is not volatile (VP=0.00006 mmHg), no I.P. exists, therefore PID will not detect substance	Substance is non combustible and as a result will not be detected by FID	Air sample using a Florisil sorbent tube with glass fiber filter. Hexane desorption and gas chromatography-electron capture detector, NIOSH 5503	0.5 mg/m^3 TWA, OSHA, ACGIH 0.001 mg/m^3 TWA, NIOSH	Inadequate - However due to the low volatility it is assumed unless adgitated this substance does not present a volatile vapor or gas respiratory threat. For dusty conditions where this material may cling to particulates, use a HEPA filter. **Recommended glove:** Silver shield or Viton (for pure product). Nitrile will be acceptable for incidental contact.	**Boiling Pt:** distallation range 365-390°C **Melting Pt:** N.A. **Solubility:** Insoluble **Flash Pt:** Not applicable **LEL/LFL:** Not applicable **UEL/UFL:** Not applicable **Vapor Density:** N.A. **Vapor Pressure:** 0 mm **Specific Gravity:** 1.566 @ 15.5°C **Incompatibilities:** Strong oxidizers **Appearance and Odor:** Colorless to pale yellow, viscous liquid or solid (below 50°F) with a mild, hydrocarbon odor	Regulated primarily because of its potential to cause liver damage and chloracne. This substance is irritating to the eyes and skin. Recognized a possessing carcinogenic properties by NIOSH, and NTP.
Benzo(a)pyrene	50-32-8	Volatility is minimal. No I.P. exist, therfore PID will not detect substance	Substance is noncombustible and as a result will not be detected by FID	Air sample using a glass fiber or silver membrane filter analysis by ga chromatography/ infrared or other spectrophotometric method or colorimeter; NIOSH 1(186)	0.2 mg/m^3 TWA, OSHA 0.1 mg/m^3 TWA, NIOSH	Adequate - use a full-face air-purifying respirator with dust/mist cartridge up to 10 $mg/m^3 \approx 1$ ppm **Recommended glove:** Nitrile	**Boiling Pt:** 312°C **Melting Pt:** 179°C **Solubility:** Insoluble **Flash Pt:** N.A. **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** 10 mm @ 312°C **Specific Gravity:** N.A. **Incompatibilities:** N.A. **Appearance and Odor:** Yellow odorless crystals.	Regulated primarily as a result of potential carcinogenic properties. Listed by NTP, IARC and ACGIH as carcinogenic.

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Substance	CAS No.	Air Monitoring/Sampling Information			Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Bis(2-ethylhexyl) phthalate	117-81-7	No information found	This is a combustible liquid therefore the FID should detect it however the relative response ratio is unknown	NIOSH Method # 5020	OSHA NIOSH ACGIH 5 mg/m^3 STEL 10 mg/m^3	Irritating, tingling sensation **Recommended APR Cartridge:** Suitable for dust and fume. Organic vapor acid gases with HEPA filter. **Recommended gloves:** Nitrile has been the one most widely used for the other substances and is acceptable for this substance. Other options include butyl rubber or neoprene	**Boiling Pt:** 386°C **Melting Pt:** freezes -14°C **Solubility:** Insoluble **Flash Pt:** 215°C **LEL/LFL:** 0.3% @ 245°C **UEL/UFL:** N.A. **Vapor Density:** N.A. **Vapor Pressure:** <0.01 mm **Specific Gravity:** 0.99 **Incompatibilities:** Nitrates, strong oxidizers, acids, and caustics. **Appearance and odor:** Colorless, oily liquid, odorless	This substance is a mild skin, eye, mucous membrane irritant, and mild gastric disturbance.
Creosote / cresol [Fluoranthene, pyrene, phenanthrene, anthracene, chrysene, benz(a)anthracene, dibenz(a,h)anthracene]	8001-58-9 1319-77-3 206-44-0 85-01-8 120-12-7 218-01-9 56-55-3 53-70-3	Creosol, a major constituent of creosote has I.P. of 8.97 eV.	Response factor unknown but given the substances flammability detection by FID can be anticipated	Air sampling for cresol (a major constituent of creosote) by silica gel or xad-7 sorbent tube. Acetone desorption and analysis by gas chromatography - flame ionization detector or high-pressure liquid chromatography, NIOSH 2001, OSHA 32	5 ppm TWA, OSHA, ACGIH 2.3 ppm TWA, NIOSH IDLH 250 ppm	Adequate - use a full-face air-purifying respirator with organic vapor / dust/mist cartridge up to 250 ppm. Odor Threshold of creosol is 0.00005-0.0079 ppm **Recommended gloves:** Viton, butyl rubber, neoprene, or nitrile	**Boiling Pt:** 191-203°C **Melting Pt:** 10.9-35.5°C **Solubility:** Insoluble **Flash Pt:** 81°C **LEL/LFL:** N.A. **UEL/UFL:** N.A. **Vapor Density:** 3.72 **Vapor Pressure:** 1 mm @ 38-53°C **Specific Gravity:** 1.030-1.038 **Incompatibilities:** Nitric acid, oleum, chlorosulfonic acid, oxidizers **Appearance and Odor:** Yellowish or colorless, flammable, oily liquid (often brownish because of impurities or oxidation)	Regulated based on effects on central nervous system, and respiratory system. Acute exposures may result in difficulty breathing, respiratory failure and skin and eye burns. Chronic exposure may damage the liver, kidneys, lungs and skin.

4.3 PHYSICAL HAZARDS

In addition to the chemical hazards presented above, certain physical hazards may also be encountered by Halliburton NUS and subcontractor personnel. The most significant of these hazards include:

- Contact with Energized Sources
- The potential for a worker to become struck by or entangled in heavy machinery
- The lifting of heavy objects
- Overexposure to noise in excess of 85dBA
- Uneven/unstable walking and working surfaces
- Ambient temperature extremes
- Inclement weather
- Water hazards
- Natural hazards

These items will be discussed individually, as follows. It should be noted these hazards are predominantly of a potential concern for intrusive activities.

4.3.1 Contact with Energized Sources

One of the hazards associated with the execution of soil boring activities, monitoring well installations, and test pit operations, is the potential for encountering energized sources (i.e. pressurized lines, water lines, telephone lines, buried utility lines). Due to the obvious ramifications associated with this hazard, extreme caution and strict adherence to procedures to detect, identify, and take evasive action shall be followed during any subsurface work in the completion of this scope of work. Efforts will be made by the FOL through local and/or agency contacts, and as-built drawings (where available), to identify potential underground energized locations. Positive readings or identification from any of these sources will require the relocation of a soil boring/well point, or test pit location.

Energized sources such as overhead powerlines can also present a potential hazard to this operation as projecting booms and masts may contact these overhead sources. To avert this hazard, booms and masts will be restricted to no closer than 20 feet from these energized sources.

4.3.2 Heavy Machinery

Several of the tasks that will be performed at the site will involve the use of heavy machinery such as drill rigs (portable and truck mounted), Geoprobe Unit, backhoes, and vehicles used to transport personnel and equipment from site to site. The potential exists for workers to be struck by or entangled in rotating machinery during various tasks including soil borings, monitoring well installation, and/or during test pit operations.

In addition, many of the locations cited for investigations are active facilities and will have associated levels of traffic including foot, vehicular, and equipment which may contribute to this potential hazard.

To avert hazards of this type several control measures will be implemented to protect site personnel and the general public. These measures may include, but are not limited to, the following:

- Persons working in close proximity to or in the operation of the drill rig, geoprobe, or other motorized equipment will be required to secure all loose clothing or protective equipment to avoid possible entanglement.

- Persons working in close proximity to a backhoe while performing excavations will be required to keep a minimum distance of the boom plus 3 feet when working in the area of the boom swing. No one will approach an excavation any closer than 2 feet from the edge. All excavations will proceed in accordance with 29 CFR 1926. 650 Subpart P. Additional control measures concerning excavation safety can be obtained in Section 7.0.

- Personnel engaged in activities along thruways will employ barricades with flashing caution lights and high visibility vests with reflective strips. Where necessary traffic control elements such as flagmen, warning signs, etc. will be employed at the SSO's discretion.

- All mechanized equipment brought onsite to complete this scope of work will be inspected initially prior to the commencement of onsite activities and then periodically thereafter. These inspections will be performed by the SSO and will include the following:

  - All safety guards are in place
  - All safety-restraints (i.e. seatbelts) are in place and functioning properly as required by Federal regulations
  - All mobile equipment is equipped with a backup alarm and emergency stop device
  - Only trained, experienced, and otherwise authorized personnel are permitted to operate heavy machinery. All drivers will be required to have their Commercial Drivers License
  - Traffic control measures and regulations will be established and adherence required.
  - All maintenance performed on the equipment will employ manufacturers recommended parts, and be inspected prior to returning to services by the SSO.

- Effective site control/operation elements as discussed in Section 10.0 will further facilitate the protection of site personnel and the general public.

4.3.3 Lifting Heavy Objects

The potential exists for workers to be injured while lifting or maneuvering heavy objects during the performance of various tasks. This hazard may manifest itself during the soil boring/well installation activity; workers have the potential to over-exert themselves while maneuvering the augering devices and during sample extraction. In addition, various tasks may require lifting heavy pieces of equipment. If objects are improperly lifted, debilitating back strain and/or other injuries can result. To minimize hazards of this type workers should obtain help from others, employ proper lifting techniques, and use machinery, where possible, to assist when handling heavy objects. In addition, efforts will be employed to educate site personnel in areas such as proper lifting techniques under work practices to minimize hazards as part of the site-specific training. Ergonomic supports for the back may be employed for individuals prone to back problems. Determination for this will be based on information supplied to the SSO on the medical data sheet.

4.3.4 Overexposure to Noise in Excess of 85dBA

Since several of the tasks to be performed require the use of heavy machinery, and in locations where hazards of this type may exist, workers have the potential to be exposed to noise in excess of 85 dBA. Excessive noise exposure can cause permanent hearing loss. The use of hearing protection shall be required of all personnel while performing activities which require the use of heavy or motorized equipment or machinery. Hearing protection will also be required in any location within an operating facility identified as a high noise hazard area.

The SSO will be responsible for determining through accepted quantitative measurements of potential noise sources whether additional measures are required, or if downgrading the level of hearing protection is appropriate. Any potential source shall be considered a high hazard source and will require the implementation of the previously identified control measures until the SSO can determine otherwise. It shall also be the responsibility of the SSO to ensure the application, use, and maintenance of occupational noise protective measures, proceed in accordance with 29 CFR 1910.95.

4.3.5 Uneven Walking/Working Surfaces

Uneven topography, previous construction efforts, and current onsite activities (excavations) at the various sites may present uneven walking/working surfaces. In addition, work performed in previous investigation efforts may have resulted in additional uneven walking/working surfaces and or piles of debris. These hazards can cause workers to lose their footing which can result in injuries such as strained muscles, sprains, damaged ligaments, cuts and/or abrasions. Workers should be aware of these hazards and avoid such areas as much as possible.
In order to control these hazards, the Standard Work Practices specified in Section 7.0 of this HASP (as well as the other requirements stated in this document) will be implemented and enforced throughout site operations. These may include requirements for good housekeeping, FOL/SSO evaluation of the next site, and the removal, elimination, or barricading of these hazards, as they present themselves. This preliminary effort and evaluation of planned worksites should reduce this potential hazard. All areas slated for work will be evaluated by the FOL or SSO as stated above. Information obtained from this preliminary evaluation will be passed on to the field crew in the safety briefing prior to moving into the next area.

4.3.7 Ambient Temperature Extremes

Ambient temperature extremes (hot or cold working environments) may exist during performance of this work depending on the project schedule. Work performed when ambient air temperatures are below 50°F may result in varying levels of cold stress (frost nip, frost bite, and/or hypothermia) depending on environmental factors such as temperature, wind speed, and humidity;and contributing physiological factors such as metabolic rate and moisture content of the skin; and other factors such as work load and the protective clothing being worn. The concepts and procedures for the recognition, evaluation and control of cold stress are presented in Attachment 1.

Work performed when ambient temperatures exceed 70°F may result in varying levels of heat stress (heat rash, heat cramps, heat exhaustion, and/or heat stroke) depending on factors similar to those presented above for cold stress, also presented in Attachment 1).

These conditions can be debilitating and, when extreme, can be fatal. An understanding of the importance in preventing heat/cold stress, coupled with the worker's awareness of the signs and symptoms of overexposure, can significantly reduce the potential for adverse health effects.

This awareness is typically a part of each employees 40-hour hazardous waste operations training. If this hazard is present during site operations, each worker will be provided with information necessary to protect themselves and site management will be instructed as to methods they may employ in combatting this hazard which include items such as, but not limited to, permit frequent breaks in mild temperature rest areas, and having hot or cold fluids, as applicable, available for consumption. In extreme cases, biological monitoring may be performed and data compared to the most recent recommendations of the American Conference of Governmental Industrial Hygienist. This monitoring will be performed and documented by the SSO as conditions dictate.

4.3.8 Inclement Weather

As all work will be conducted outdoors, inclement weather such as electrical storms, high wind conditions, etc. may be encountered. As these conditions may vary, it will be at the discretion of the FOL or SSO whether or not to terminate work temporarily while these conditions exist. As a minimum requirement, all site activities will be temporarily suspended in the event of an electrical storm.

4.3.9 Water Hazards

There are sampling points proposed within the sampling plan only accessible by boat or along waters edge. To avoid potential hazards associated with working on waters edge or over water (drowning) the field team shall employ life lines, safety harnesses, and U.S Coast Guard approved flotation devices when working on or within two feet of the water. As stated earlier some of these devices or a combination of, may be used for other reasons within this scope of work, however the objective, when on or near water, is quick effective personnel extraction. All activities on water or at waters edge will be terminated should inclement weather conditions arise. This will be at the discretion and direction of the FOL and/or the SSO.

4.3.10 Natural hazards (ticks, snakes, and other indigenous creatures)

Natural hazards such as poisonous plants, bites from poisonous or disease carrying animals or insects (e.g. snakes, ticks, mosquitos) cannot be avoided in this type of environment. However in an effort to offset the impact of this hazard, field personnel will have access to commercially available insect repellents. Nesting areas in and about sampling points shall be avoided and another point selected within the same vicinity. Lastly, within recent years a marked increase in Lyme's Disease has been reported. For this operation this is a significant point as ticks have been shown to be the primary vectors. In an effort to control this hazard, close attention will be given during operations and decontamination with regard to personal hygiene to detect and remove ticks once they adhere to the body. Instructions directed at prevention, detection, control methods, and removal are presented in Attachment 2. Although this is not viewed as a prevalent hazard due to the time of year this operation will take place, it is worthy to be mentioned for information purposes.

5.0 AIR MONITORING

This section presents requirements for the use of real-time air monitoring instruments during site activities involving potential for exposure to site contaminants. It establishes the types of instruments to be used, the frequency of which they are to be used, techniques for their use, action levels for upgrading/downgrading levels of protection, and methods for instrument maintenance and calibration.

5.1 INSTRUMENTS AND USE

5.1.1 HNu PI-101 Photoionization Detector

A HNu PI-101 photoionization detector (PID) with a 11.7 eV lamp will be used to monitor potential source areas and to screen the breathing zones of employees during soil boring, sampling, excavation, or any intrusive activities which may increase the potential for exposure. The PID has been selected because it is capable of detecting organic gases and vapors and some inorganic gases and vapors. Detection is based on the contaminants ionization potential in comparison to the lamp energy, which has to be equal to or greater than the ionization of the contaminant. Based on the potential chemical associated with this scope of work, it is assessed, that detection of the more volatile gaseous and vaporous substances will be detected.

Prior to the commencement of any field activities, the background levels of the site must be determined and noted. Daily background readings must be taken away from areas of potential contamination to obtain accurate results. These readings, any influencing conditions (i.e., weather, temperature, humidity) and location will also be documented in the Health and Safety Logbook as a matter of reference. This instrument will be employed as a screening tool for those substances that are detected within the limitations of the instrument. This instrument will be employed at those sites, based on previous sample information, for contaminant screening of volatile organic and inorganic gases and vapors such as TPH, and VOA compounds.

5.1.2 OVA-Model 128 Flame Ionization Detector

The use of an Organic Vapor Analyzer (OVA) Flame Ionization Detector may also be utilized to screen potential source emissions and the breathing zones of employees during the execution of the scope of work or during any intrusive activities which may release airborne emissions of an organic vapor nature. The OVA has been selected because it may detect the presence of long chain hydrocarbons such as the PAHs more efficiently than a photoionization detector (PID) system. Both instruments are suitable for use, and are offered here as an either or, based on the field technicians knowledge and level of comfort in using these instruments.

If positive readings are indicated by either the HNu PI-101, or the OVA, colorimetric tube (Draeger tubes) will be used to determine if benzene, methylene chloride, or vinyl chloride is in the contaminant that is detected. Exposure to these substances is unlikely given the low percentages and low concentrations detected as per the previous sample information. This position is also supported based on the low probability of free product being present at the sites. This action will be employed as a precautionary measure for this and its associated compounds as they are suspected to be present on a site specific case by case scenario.

5.1.3 Draeger (Colorimetric) Tubes

Draeger tubes shall be employed in conjunction with the HNu (or the OVA, which ever is selected for use) in this portion of the air monitoring program supporting site activities. This action is taken for two reasons. First, in order to meet the requirements of 29 CFR 1910.120 (h), which is to identify and quantify airborne

hazard potentials. The use of the HNu and OVA in the survey mode will not identify airborne substances, only detect them at very low levels. However, using the Draeger tubes in conjunction with these instruments permits a semi-quantitative result with positive identification (within the restrictions of the limitations of the specific tube(s) used). Secondly, certain long duration term Draeger tubes can be employed using a low flow air sampling pump to monitor high hazard tasks or personnel. This allows for documented corroboration, based on potential exposure, of the levels of protection used for a given task.

Draeger tube 0.5/c for benzene will be used due to the presence of petroleum hydrocarbons which can interfere with other benzene tubes. An action level of any color change to the white indicating layer portion of the benzene will be interpreted as indicating benzene presence. In addition benzene tubes 2a and 5a may be employed to measure potential airborne concentrations. This application will employ a pretube or prelayer to detect other aromatics of a concern and to determine the level of interference. Discoloration of the pretube will indicate the presence of associated compounds such as toluene, ethylbenzene, or xylene in the absence of benzene.

In addition, methylene chloride 100/a, and vinyl chloride 1/a will be employed in the areas where these contaminants have been previously identified. Methylene chloride 50/a-L, or vinyl chloride 10/a-L may be used for long term monitoring applications.

5.1.4 Mini-Ram Particulate Monitor

The particulate meter may be employed to supplement visual observations regarding the extent or level of airborne particulates. As it is assessed the primary contaminant of concern is metals (particulate form), this monitoring information will also supplement potential exposure information and evaluate the effectiveness of control measures such as wetting down areas to control these airborne emissions. Action levels based on task specific activities are addressed in Section 5.3.

Any positive instrument responses (HNu, OVA, Mini-Ram) observed above background levels will be considered to indicate contaminant release. As such, the following actions will be taken:

- Monitor work areas continuously, concentrating on worker breathing zones (BZ) areas (head and face regions) when positive source results are reported. If readings are observed at these areas to be at background levels, continue monitoring and work efforts.

- If sustained (15 minutes) or repeated intermittent readings in the workers BZ are above background, workers are to retreat to an unaffected area, upgrade the level of protection to Level C with an Air Purifying respirator and organic vapor cartridges with High Efficiency Particulate Air Filters. Additional analysis (colorimetric tubes) will be used in response to positive indications of the HNu or OVA to confirm that the contaminant is not benzene, methylene chloride, or vinyl chloride as determined by the specific contaminants for that site. Further actions will be dependant upon results of colorimetric tube analysis and levels of contaminant concentration as indicated by the HNu (refer to Section 5.3 - Action Levels).

5.2 AIR MONITORING REQUIREMENTS - HNu, OVA, and Particulate Monitor

Air monitoring with the HNu PI-101, OVA (if used), and Particulate Monitor will be initiated at potential sources of contaminant emissions. The following potential sources are anticipated.

- All intrusive activities (i.e. Well installation, test pit operations, soil boring/well installation, and sampling)
- Decontamination procedures
- Any time chemical odors are perceived

5.2.1 Air Monitoring Frequency

The following schedule will be followed, but not limited to, for air monitoring activities as specified for each activity.

AIR MONITORING TYPE AND FREQUENCY

TASKS	ATMOSPHERIC HAZARD(S)	MONITORING TYPE & FREQUENCY
Monitoring Well Installation/Soil boring Sites: 1, 13, 15, 15, 16, 19, 20, 23, 24/25, 26, 27, Epic Site Q Test Pit Excavation Sites: 9, 13	Toxic Particulates	**PID/OVA** - potential sources initially then periodically as conditions dictate, breathing zone based on positive results at potential source areas. **Visual Observation/Particulate Monitor** - for dusty conditions as many of the contaminants will be presence in the particulate form or bound to particulates **Draeger tubes** - as conditions and results dictate (Benzene, and Methylene chloride)
Inspecting existing wells/ Water level measurements Sites: All study areas Soil gas survey Sites: 3, 16, 26	Toxic	**PID/OVA** - during the initial opening of the well casing, then periodically as conditions dictate **Draeger tubes** - as conditions and results dictate
Building Inspection/Site Reconnaissance Sites: All Sites	None anticipated	Instruments may be employed in the detection of hot spots, however, their use in this application is not to characterize exposure.
Land surveying Sites: All Sites	None anticipated	None required
Sampling Surface water Sites: 4, 6, 12, 13, 15, 17, 19, 20, 23 Groundwater Sites: All well locations, All study areas Subsurface soil Sites: All study areas Surface soil Sites: All study areas Sediment Sites: 4, 6, 9, 12, 13, 15, 16, 17, 19, 20, 23	This is a task driven specification	As this is an intrusive activity, monitoring may be used to detect hot spots and respective airborne concentrations.
Restoration of Work zones and boring locations Sites: All locations	None anticipated	**PID/FID** - These instruments may be employed as a screening tool to detect residual contaminants as a result of onsite activities. **Visual Observation** for indicating signs of contaminants.
Decontamination Activities	None anticipated	**PID/FID** - These instruments may be employed as a screening tool to detect residual contaminants as a result of onsite activities. **Visual Observation** for indicating signs of contaminants.

5.3 ACTION LEVELS

The following action levels will apply to this project:

INSTRUMENT	ACTION LEVEL	RESULTANT ACTION
HNu PHOTOIONIZATION DETECTOR	Any sustained readings above established background levels in workers' breathing zones	Retreat to an unaffected area and allow the work area to ventilate. If readings do not subside back to background levels, don air purifying respiratory protection (with organic vapor/HEPA filter cartridges) and perform colorimetric (detector tube) analysis to confirm that readings are not associated with benzene, methylene chloride, or vinyl chloride exposure as associated with the site specific contaminants. If colorimetric tube analysis indicates that the contaminant is **not** these substances continue work in Level C Protection, and continue monitoring. If colorimetric analysis indicates that the contaminant is one of these substances continue to monitor to quantify. If the PELs or TLVs for methylene chloride or vinyl chloride is approached, retreat to an unaffected area, and contact the PM or HSM for further instructions.
	≤ 50 ppm	If benzene has been determined to be absent, or in concentrations less than 50 ppm, continue work using an air-purifying respirator equipped with organic vapor cartridges and observe workers for symptoms of overexposure. Any measurement using these tubes should include any percent error as identified by the manufacturer.
	Greater than 50 ppm	Cease work and proceed to an unaffected area, obtain further direction from the PM and HSM.
OVA Detector	any sustained reading greater than background	Same actions as for the HNu Photoionization detector.
	≤ 50 ppm	Same actions as for the HNu Photoionization detector.
	Greater than 50 ppm	Same actions as for the Hnu Photoionization detector.
Draeger Colormetric Tubes	HNu or OVA positive result in the breathing zone	Identify and quantify the level of benzene, methylene chloride, or vinyl chloride.
	Positive results greater than 1 ppm	Don air-purifying respirator equipped with organic vapor cartridges (if excessive dusty conditions are observed, utilize in conjunction with High Efficiency Particulate Air filter (HEPA).
	Positive results greater than 50 ppm	Evacuate work area, take evasive action (plug or cover) to control airborne emissions.
Particulate Monitor	0.01 mg/m^3 above background in the workers breathing zone	Level D
	0.01 mg/m^3 - 0.5 mg/m^3	Level C - Don air purifying respirator with GMCH cartridges; implement dust suppression procedures
	>0.5 mg/m^3	Temporarily suspend activities, Notify PM

5.4 INSTRUMENT MAINTENANCE AND CALIBRATION

Air monitoring instruments will be maintained and pre-field calibrated by the equipment supplier. Field calibration will be performed daily on the PID and Particulate monitor prior to the initiation of work. An additional calibration will be performed at the end of the day to determine any significant instrument drift. The OVA will require field checks for operation and calibration on a weekly basis. Should significant instrument drift be detected this frequency will be increased. This frequency was established based on this instruments ability to hold its calibration and the manufacturers recommendation. The Draeger tube pump apparatus will be calibrated quarterly to ensure the volume per stroke or depression of the bellow is accurate. The application of low flow air pumps and long term tubes will require calibration on an as use basis. All calibration efforts must be documented. Figure 5-1 is provided for documenting these calibration efforts. This information may instead be recorded in a field Health and Safety Logbook, provided that all of the information specified in Figure 5-1 is recorded. This required information includes the following:

- Dates calibration was performed
- Individual calibrating the instrument
- Instrument name, model, and serial number
- Any relevant instrument settings and resultant readings (before and after) calibration
- Identification of the calibration standard (lot no., source concentration, supplier)
- Any relevant comments or remarks

Field maintenance will consist of daily cleaning of the instruments using a damp towel or rag to wipe off the instrument's outer casing and overnight battery recharging.

5.5 RECORDKEEPING

All instrument readings above and including background levels must be recorded using Figure 5-2, or in a field book or field Health and Safety Logbook. This recordkeeping should also indicate any corrective actions taken. In addition, results of any colorimetric analysis must be recorded in the log book. Instrument calibration efforts and results must also be recorded, as specified in Section 5.4. Lastly, information concerning potential influencing factors on instrument responses (i.e. weather, activities, interferences) shall also be recorded.

5.6 MONITORING CAPABILITIES

It has been assessed that not all the contaminants which may be associated with this site can be detected with the limited battery of monitoring instruments selected for this operation. However the strategy, where possible, is to control the particulate or particulate laden (pesticides) contaminants through dust suppression methods, as much as possible. If this doesn't work to the satisfaction of the SSO, respiratory equipment suitable to offer protection
will be employed as a second line of defense for these contaminants.

Those contaminants judged most mobile (volatile compounds) and which do present a potential threat during intrusive activities may be detected, and to a limited degree identified, as necessary.

FIGURE 5-1

DOCUMENTATION OF FIELD CALIBRATION

Site Name: Naval Weapons Station Earle

Project No.: 0494

Date of Calibration	Insturment Name and Model	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks/Comments
				Pre-Calibration	Post-Calibration	Pre-Calibration	Post-Calibration		

FIGURE 5-2

DIRECT-READING INSTRUMENT RESPONSE DATA

Site Name: Naval Weapons Station Earle

Project No.: 0494

Page 1 **of** ____

Date and Time(s)	Instrument Operator Name	Instrument Used	Instrument Reading and Duration	Location (e.g., Borehole vs. Breathing Zone)	Operation(s) Being Performed	Personnel in Vicinity at time at Readings and Level of PPE Worn
Example: *2-12-94/14:30*	*Joe Field*	*HNu 101*	*15 ppm/15 min.*	*Breathing Zone*	*Installation of Well No. 12*	*Jim Technician/Level B* *George Jones/Level B*

FIGURE 5-2
DIRECT-READING INSTRUMENT RESPONSE DATA
Page ____ of ____

Date and Time(s)	Instrument Operator Name	Instrument Used	Instrument Reading and Duration	Location (e.g., Borehole vs. Breathing Zone)	Operation(s) Being Performed	Personnel in Vicinity at time at Readings and Level of PPE Worn

6.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

This section presents requirements for the use of personal protective equipment for each of the activities being conducted as defined in Section 3.0 of this HASP. This section includes anticipated levels of protection for each of the activities, the criteria used for selecting various levels of protection, and criteria for modifying levels of protection based on monitoring instrument readings and personal observations.

6.1 ANTICIPATED LEVELS OF PROTECTION

All work is anticipated to initiate and for the most part be performed in a Level D Protection, as defined in Appendix B of OSHA Standard 29 CFR 1910.120 -"Hazardous Waste Operations and Emergency Response". Several activities, in modification to this level of protection, will require the use of chemical resistant coveralls, rainsuits, gloves, and boot covers as presented in the task breakdown which follows. Where activities overlap, the more protective requirements will be applied. Additionally, it is possible that work may be upgraded to Level C protection (air-purifying respirators equipped with organic vapor cartridges in possible conjunction with HEPA filters if excessive dusty conditions are observed) and depending on the results of air monitoring as discussed in Section 5.0 of this HASP. However, upgrading the level of protection for Halliburton NUS personnel will be at the discretion of the FOL and SSO in conjunction with monitoring results and information, activities, and site conditions.

6.1.1 Minimum Requirements (All Tasks)

Minimum requirements include steel-toe and steel shank work boots, with standard field dress consisting of long pants and long-sleeved shirts. Hard hats and safety glasses will be worn when overhead or eye hazards exist based on the task or if working in and around the machinery. It will be at the discretion of the FOL or the SSO based on tasks, site conditions, and other influencing factors, when additional items specific to conditions are employed, providing action levels or the requirements of this plan are not compromised. In addition to the minimum requirements established above, site-specific conditions or requirements at active operating facilities may influence these requirements. It shall be the responsibility of the FOL or SSO to make contact with the these various operating facilities to determine location specific requirements prior to the commencement of work at that location.

6.1.2 Mobilization/Demobilization and Building Inspection/Site Reconnaissance and Land Surveys

As mobilization/demobilization, site reconnaissance, building inspection, and surveying present limited potential for contacting the suspected hazardous materials associated with some more intrusive tasks, the minimum requirements will be adhered to for this task. Disposable boot covers, surgeons gloves will be worn, as necessary, at the discretion of the SSO. This discretion shall include the fact that many of these facilities are operating and have general public traffic.

Survey activities on or near waters edge (closer than 2 feet) will require tag lines connected to safety harness, USCG approved flotation vest, or a combination of to facilitate extraction, if necessary. It shall be at the discretion of the SSO to determine if additional items of protection, or equivalent protection in lieu of that recommended above is suitable and adequate for the task at hand.

6.1.3 Monitoring Well Installation/Soil Boring Operations

Tyvek coveralls or reusable rainsuits for muddy or wet conditions (as necessary), disposable boot covers and nitrile outer gloves over nitrile or latex, inner surgeon gloves. These gloves may be employed over cotton work gloves as conditions dictate to protect against the potential of cold stress. In addition, hard hat and safety glasses will be worn when working in close proximity to machinery. If the potential for saturation of work clothes exists the use of PVC, rainsuits, or PE-coated Tyvek can substituted in place of Tyvek. Additional personal protective items shall include hearing protection during the operation of mechanized equipment as specified in section 4.3.4

6.1.4 Multi-Media Sampling

Hard hats, when necessary, safety glasses, steel-toe, steel shank work boots, disposable boot covers, Tyvek coveralls (as necessary), nitrile inner gloves (layered as necessary). Nitrile outer gloves, tyvek coveralls, taped ankle and wrist seams will be required at the discretion of the SSO. PVC, rainsuits, or PE-coated Tyvek coveralls are to be worn whenever there is a potential for saturation of work clothes.

6.1.5 Restoration of Soil Boring Locations

The investigative effort may lead field teams into areas frequented by the general public or the facilities employees. In order to protect the general public and the facilities employees once exclusion zones are removed field teams will ensure the area is returned to the former condition, if not better. To do this the following procedures for PPE will serve in this task. The minimum requirements include standard field dress, steel-toe, steel shank work boots, safety glasses, and hard hats. Tyvek coveralls will be optional based on site conditions, observations by site personnel, and the discretion of the FOL or SSO.

6.1.6 Decontamination Activities

The requirements for decontamination activities will include the minimum requirements for all tasks (See Section 6.1.1) and the use of PE-coated tyvek, rainsuits, or PVC with nitrile outer and inner gloves when the potential for saturation of work clothing exists, and splash shield as necessary, or as directed by the FOL or SSO. This will be the required level of protection when performing large scale decontamination activities such as cleaning augers and drill flights. (For additional information concerning decontamination requirements see Section 8.0.) The general rule of thumb for respiratory protection will be the same level as, or one below that of the field personnel who were using the equipment.

6.2 PPE SELECTION CRITERIA

Based on the relative low concentrations, volatility and dispersion of potential vapors via natural ventilation (i.e. wind currents), vapor concentrations in worker breathing zones are not anticipated to be at levels which would warrant respiratory protection. However, the potential exists for dust emissions containing site contaminants to be generated. These dust emissions can be inhaled or ingested and result in exposure. If dust emissions are observed and cannot be controlled (i.e. via area wetting techniques), the use of full-face air-purifying respirators equipped with a combination High Efficiency Particulate Air (HEPA) filter and Organic Vapor mist cartridge will be implemented. Initiation of this action will be determined by either the FOL or SSO.

Nitrile outer and/or inner nitrile gloves were selected to provide protection against the potential site contaminants (Petroleum products) that could be encountered, and to minimize the potential for contaminant ingestion as a result of incidental hand to mouth contact. Hard hats, safety glasses, and work boots were selected to provide protection against some of the physical hazards associated with the proposed operations and disposable boot covers were selected to help minimize the spread of contamination. Tyvek coveralls were selected to minimize the potential for contamination of street clothes and PVC PE-coated tyvek, or rainsuits, coveralls were selected for use in the event that activities have the potential to result in the saturation of work clothes.

6.3 PPE MODIFICATION CRITERIA

This section presents criteria for upgrading and downgrading chemical protective clothing and/or respiratory protection. Where uncertainties arise, the more protective requirement will apply.

6.3.1 Chemical Protective Clothing Modification Criteria

Tyvek coveralls and boot covers must be worn anytime there is a reasonable potential for contamination of street clothes. Polyvinyl chloride (PVC), rainsuits, or PE-coated Tyvek coveralls must be worn anytime there is a reasonable potential for saturation of work clothes. Nitrile or neoprene gloves must be worn anytime there is a reasonable potential for contact with site contaminants. Modification to these requirements is anticipated only if additional discovery of site contaminants are identified. Based on this information each additional substance identified will be dealt with individually.

6.3.2 Respiratory Protection Modification Criteria

Full-face air-purifying respirators equipped with high-efficiency particulate air (HEPA) filters must be worn anytime dusty conditions are observed and these emissions cannot be suppressed with water spray. In addition, respiratory protection will be utilized anytime action levels specified in Section 5.3 are exceeded.

6.4 PPE LIMITATIONS

Information concerning limitations of the PPE to be used, user limitations and work mission duration will be discussed and addressed as part of the site-specific training conducted by the SSO.

6.5 PPE MAINTENANCE AND STORAGE

All additional stocks of PPE employed for the completion of this task will be stored in the trailer and will be issued according to this plan based on that days planned site activity. PPE requirements for that days activity will be introduced as part of the safety briefing for that day. All storage will be maintained by the SSO and FOL to ensure adequate stock for planned operations.

6.6 PPE INSPECTION PROCEDURES

The SSO will be responsible for conducting periodic inspections of the chemical protective clothing application and use, and respiratory protection equipment maintenance, storage, and use.

Respirators will be cleaned using a disinfectant, issued by the manufacturer, after each use. Once cleaned the respirators will be stored in sealable plastic bags with the facial seal in the upright position to avoid facial seal distortion. Cartridges will be exchanged after each use.

This effort will be an integral part of an overall evaluation of this program. Discrepancies noted as a result of this inspection will be corrected, and addressed as part of the following days safety briefing to ensure field teams are educated to the requirements governing this activity and to prevent reoccurrence.

7.0 STANDARD WORK PRACTICES

The following standard work practices will apply to all site personnel as applicable to the work being performed at this site.

7.1 GENERAL REQUIREMENTS (ALL TASKS)

- Work areas shall be physically cordoned off (using items such as caution tape, hazard cones, etc.) to clearly identify the work area, and to aid in restricting access of unauthorized persons.
- Walking and/or working areas will be kept free from clutter to the extent possible.
- Objects or debris that cannot be manually handled comfortably shall either be handled by more than one person or with mechanical lifting devices.
- Eating, drinking, chewing gum or tobacco, taking medication, and smoking are prohibited in the exclusion or decontamination zones, or any location where there is a possibility for contact with site contaminants exists.
- Upon leaving the exclusion zone, hands and face must be thoroughly washed with soap and potable water. Any protective outer clothing is to be decontaminated and removed as specified in this HASP, and left at a designated area prior to entering the clean area.
- Contact with potentially-contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided. Monitoring equipment must not be placed on potentially contaminated surfaces.
- No facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is permitted on personnel required to wear respiratory protective equipment.
- All personnel must be presented the contents of a site-specific Health and Safety Plan from the project Health and Safety Officer prior to commencing work on site. All site personnel must understand all components of this HASP prior to commencement of onsite activity.
- All personnel must satisfy medical monitoring procedures.
- Any new analytical data must be promptly conveyed via telephone to the HSTL and PM.
- Areas must be designated for chemical storage. Acids, bases, oxidizers, and flammable materials shall all be stored separately according to their hazard class. Storage areas must be labeled as to the contents within the storage area. Where larger volumes (>1 gallon) are stored spill response materials will be contained and maintained in the same area.
- All compressed gas cylinders must be stored and used in an upright position, properly secured and protected from damage, segregated, and labelled as empty or full.
- All site personnel must be complete a medical datasheet, to be maintained on site.

- Site personnel must immediately notify Halliburton NUS Health Sciences of all incidents for OSHA recordkeeping purposes.

- If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the FOL and SSO for further direction.

- Site personnel are not to undertake any activity which would be considered a confined-space entry without first being trained in the proper procedures.

7.2 DRILLING OPERATIONS

- No drilling or any other operation which will bring a drill mast or any other projecting device within 20 feet in any direction of overhead power lines will be permitted. Prior to any subsurface investigations the FTL shall ensure, the locations of all underground utilities will be identified and marked prior to initiating any subsurface activity.

- Hand signals with the driller will be established prior to the commencement of drilling activities.

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. All personnel working in a close proximity must be aware of the location of this emergency stop device and its operation. This device will be tested initially (and then periodically) to insure its operational status. The driller and the helper shall not simultaneously handle moving augers or flights unless there is a standby person to activate the emergency stop device.

- The driller must never leave the controls while tools are rotating unless all personnel are clear of the rotating equipment.

- A long handled shovel or the equivalent shall be used to clear away drill cuttings from the hole and rotating equipment. Hands or feet shall **not** be used for this purpose.

- A remote sampling device must be used to sample drill cuttings near rotating tools. The driller shall shutdown operations if the sampler must near the tools to obtain samples.

- All personnel working in the vicinity of the drill rig while its operating shall secure all loose clothing.

- Only manufacturer approved equipment may be used in conjunction with site equipment (i.e. pins for auger flights etc.). Pins or other protruding items from rotating equipment shall not be permitted.

- No person shall climb a drill mast while equipment is rotating.

- No person shall climb a drill mast without use of ANSI approved fall protection (i.e. belts, lanyards and a fall protection slide rail) or portable ladders which meet OSHA's requirements.

7.3 TEST PITTING

- Entrance into a test pit is forbidden in all circumstances. Personnel must use remote

samplers to collect samples from the backhoe bucket.

- Container sampling can occur during test-pitting operations only with prior approval and written procedures from the Project Safety Officer.
- Personnel must not lean over test pits.
- All Personnel must stand upwind of the test pits and away from the reach of the backhoe, tires, and outriggers.
- Personnel may not approach a test pit closer than 2 feet from the edge. Unstable pits must be sloped at the sided to prevent cave-in.
- Open pits must staffed by site personnel at all times.
- The backhoe operator must be instructed not to undermine the excavation.
- The Site Safety Officer shall frequently inspect test pits for slide or cave-in potential.
- All work areas must be kept free of ground clutter.

8.0 DECONTAMINATION

This section describes the steps site personnel will follow to prevent the spread of site contaminants into areas that may affect unprotected, unsuspecting site personnel or the public. It includes requirements for decontamination of personnel, heavy equipment, and sampling equipment.

8.1 PERSONNEL DECONTAMINATION

The decontamination of personnel and their protective clothing will be performed in three stages.

- Stage 1 includes removing contamination from reusable protective clothing and/or clothing by washing with a detergent and water. These efforts will involve washing and rinsing these items in a sequence that begins at the highest level to the lowest level (i.e.: from the head down towards the feet).

- Stage 2 will include removal of protective clothing, discarding disposable clothing into a drum conspicuously marked "Potentially contaminated Clothing" and/or storing reusable protective clothing in the contamination reduction zone. Stage 2 efforts involve a structured, segregated process carefully removing PPE items beginning with the outermost item and progressing inward.

- Stage 3 will consist of workers washing their hands and face with potable water and soap each time they leave the exclusion zone, before performing any type of hand-to-mouth activity.

All decontamination fluids and solid waste generated will be containerized, labeled, and staged pending analysis of the material and hence the ultimate disposal fate. Based on the results of the analyses, this material will be determined to be either hazardous or nonhazardous thereby directing the final disposal. The decontamination area will be physically identified with rope or flagging and well equipped to be conducive for completion of proper decontamination activities, and supporting work efforts within the exclusion zones.

8.2 HEAVY EQUIPMENT DECONTAMINATION

Heavy decontamination will consist of the use of high pressure steam cleaning. The Halliburton NUS FOL will inspect all heavy equipment prior to being released from the site, or to the next soil boring location and will document in the field logbook approval to move to the clean area. Inspections will consist of visual observation of all potentially exposed surfaces of the equipment, including such surfaces that may not be readily accessible, to determine if all potentially contaminated soils/debris has been removed. At no time will equipment be released from the decontamination station until all potentially contaminated soils/debris has been removed.

8.3 SAMPLING EQUIPMENT DECONTAMINATION

Decontamination of sampling tools may involve the use of a number of reagents including deionized water, detergents (Alconox), methanol, and/or nitric acid. Requirements for decontaminating sampling equipment are presented in the Field Sampling Plan. Methanol and nitric acid will only be used in well ventilated

areas and personnel will employ the necessary PPE while handling these substances. Material Safety Data Sheets for the decontamination solutions used will be presented during site specific training, and maintained onsite for reference.

8.4 CLOSURE OF THE PERSONNEL DECONTAMINATION STATION

All disposable clothing and plastic sheeting and other RI generated waste materials generated during this operation will be containerized, labeled, and staged onsite to await pending disposal. Based upon available information regarding the characteristics of the site and contaminant levels, used PPE and decontamination-generated liquid wastes disposal will be based on sampling results. Pending these results, this material will be staged in a central location as identified by the PM. Reusable protective equipment will be cleaned, dried, and prepared for future use. (If gross contamination has occurred, the item will be properly disposed of.)

All wash tubs, pail containers, brushes, etc., will be thoroughly washed, rinsed, and dried prior to removal from the site. The FOL or the SSO will be responsible for inspecting and clearing equipment to leave the site.

8.5 PPE REQUIREMENTS FOR DECONTAMINATION OPERATIONS

All equipment decontamination efforts will require the use of chemical protective clothing as described below:

- PVC, rainsuits, or PE coated Tyvek coveralls
- Nitrile outer gloves
- Nitrile inner gloves (surgeons)
- Rubber boots (or rubber boot covers)
- Splash shield (if respirator not worn)
- Respiratory protection (if needed*)

* The same level of respiratory protection worn for the work assignment, will be worn when decontaminating the equipment used for that assignment. This requirement is further described in Section 5.0.

8.6 EMERGENCY DECONTAMINATION PROCEDURES

In addition to routine decontamination procedures, emergency procedures will establish the protocol to be followed in the event of a medical emergency. This procedure will be established and conducted based on the severity of the injury including procedures for potential loss of life, and injury requiring first-aid. (NOTE: An emergency first aid instruction poster has been attached to this HASP. This shall be posted at the site at a convenient location.)

Potential loss of life:

- Delay decontamination (if necessary), or modify it to perform as much decontamination of the injured person as possible.

- Stabilize victim

- Wrap the victim in blankets, or plastic sheeting to reduce the potential of contamination to medical personnel.

- All medical support will be informed of the suspected hazards associated with the task. All receiving facilities however must be alerted to the potential hazards. Clearance from the hospital for accepting potentially contaminated personnel will be obtained by the SSO prior to the commencement of onsite activities.

Injury:

In situations where the contamination is extremely toxic or corrosive

- Implement immediate decontamination procedures

- For heat related disorders, remove all protective clothing, wash as appropriate, treat for heat stress. Extremely toxic or corrosive contamination is not expected to be encountered based upon known site characteristics.

8.7 DECONTAMINATION EVALUATION

The decontamination process effectiveness will be judged in the following manner.

- Visual observation - Discoloration, stains, visible dirt, and alterations of the fabric due to chemical contact will be the primary method used to determine effectiveness.

The following methods may be used if gross contamination is encountered:

- Monitoring Instrumentation - Instruments used to detect site contaminants may be employed to scan garments and equipment for the presence of site contaminants after decontamination procedures have been employed.

- Decontamination Solution Analyses - An analyses of the solution (final rinse) and the presence of contaminants may suggest additional cleaning is required. This information may be useful in the ultimate disposal of the fluids generated.

- Sample Analyses - sample analyses may indicate the level of contamination and therefore the potential for contamination. Once again this information may be useful in the ultimate disposal.

It is suggested that a combination of methods be used to determine the effectiveness of the decontamination of the process used.

9.0 TRAINING

9.1 INTRODUCTORY AND REFRESHER TRAINING

9.1.1 Requirements for Halliburton NUS Personnel

All Halliburton NUS personnel must complete 40 hours of introductory hazardous waste site training, and a minimum of three days actual field experience under direct supervision of an experienced supervisor, prior to performing work at the site. Additionally, Halliburton NUS personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training within the past 12 months before being cleared for site work.

Documentation of Halliburton NUS introductory and refresher training will be maintained onsite. Copies of certificates or other official documentation will be used to fulfill this requirement.

9.1.2 Requirements for Subcontractors

All Halliburton NUS subcontractor personnel who may be exposed to safety or health hazards associated with the hazardous waste at this site will have completed a 40-hour introductory hazardous waste site training, and a minimum of three days actual field experience under direct supervision of an experienced supervisor or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) and, if appropriate 8 hours of refresher training meeting the requirements of 29 CFR 1910.120(e)(8) prior to performing field activities at the site. Figure 9-1 may be used for the documentation of this training.

9.1.3 Subcontractor Exception

Workers who will not enter the exclusion zone or contamination reduction zone will not be required to have this training, although such personnel will be advised of the hazardous nature of the project and the importance of not driving into unauthorized areas of the site and not leaving their vehicle without a proper escort.

9.1.4 Requirements for Supervisory Personnel

All personnel operating in the supervisory capacity will have had management and Supervisory Training which satisfies 29 CFR 1910.120(e)(4). Documentation of this training will be maintained onsite.

9.2 SITE-SPECIFIC TRAINING

Halliburton NUS will provide site-specific training to all Halliburton NUS employees and subcontractor who will perform work at this project. This training will only be provided once and personnel who do not attend will not be permitted to perform work at the site. Site-specific training will include:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site

FIGURE 9-1
OSHA TRAINING CERTIFICATION

The following statements must be typed on company letterhead and signed by an officer of he company:

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Donald Blackert, P.G.
Project Manager
Halliburton NUS Corporation
Foster Plaza VII, 661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: Hazardous Waste Site Training - NWS Earle, New Jersey

Dear Mr. Blackert:

The employees listed below have had introductory hazardous waste site training or equivalent work experience as required by 29 CFR 1910.120(e). In addition, those employees listed below who have received their introductory training more than 12 months ago have also received 8 hours of refresher training in accordance with 29 CFR 1910.120 (e)(8).

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE

Should you have any questions, please contact me at (555) 555-5555.

Sincerely,

(Name of Company Officer)

FIGURE 9-2
SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of working at NWS Earle, New Jersey and that I have received site-specific training which included the elements presented below:

- Names of personnel and alternates responsible for site safety and health
- Safety, health and other hazards present on site
- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- The contents of the health and safety plan
- Review of relevant MSDSs
- Emergency Action Plan (evacuation routes, assembly points)

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 (PRINT CLEARLY)	SIGNATURE	DATE

Training Conducted By:_____ Date:_____

- Use of personal protective equipment
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- The contents of the health and safety plan
- Review of relevant MSDSs
- Emergency Action Plan (evacuation routes, assembly points)

9.2.1 Site-Specific Training Documentation

Halliburton NUS and subcontractor personnel will be required to sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. This statement will also indicate individuals involved in this project have been given an opportunity to ask questions and these questions have been answered to their satisfaction. Figure 9-2 will be used to document site-specific training.

9.3 SAFETY BRIEFINGS

As operations move from site to site, information concerning site-specific conditions or hazards, evacuation routes, specific contaminants, etc. will have to be conveyed to the field crews. In addition, as problems or difficulties in this HASP or its implementation are recognized, corrective actions will need to be installed.

To accomplish these objectives, periodic safety briefings will provide a forum for discussion, evaluation, and education. The FOL or SSO will be responsible for conducting these meetings as frequently as site activities dictate based on these items identified above.

10.0 MEDICAL SURVEILLANCE

10.1 REQUIREMENTS FOR Halliburton NUS PERSONNEL

All Halliburton NUS personnel participating in project field activities will have had a physical examination meeting the requirements of Halliburton NUS' medical surveillance program and will be medically qualified to perform hazardous waste site work using respiratory protection in accordance with 29 CFR 1910.120 (f) and 1910.134 (b)(10).

Documentation for medical clearances will be maintained onsite, and made available upon request.

10.2 REQUIREMENTS FOR SUBCONTRACTORS

Subcontractor personnel who will be potentially exposed to safety and/or health hazards related to the hazardous waste at this site will be required to obtain a certificate of their ability to perform hazardous waste site work and to wear respiratory protection. The "Subcontractor Medical Approval Form" (Figure 10-1) can be used to satisfy this requirement providing it is properly completed and signed by a licensed physician.
Subcontractors who have a company medical surveillance program meeting the requirements of paragraph (f) of OSHA 29 CFR 1910.120 can substitute Figure 10-1 with a letter, on company letterhead, containing all of the information indicated in Figure 10-1. Figures 9-1 concerning training requirements and 10-1 defining the medical surveillance criteria and those individuals meeting that criteria may be combined into a single letter.

10.2.1 Subcontractor Exception

Subcontractors who will not enter the exclusion zone during operation, and whose activities involve no potential for exposure to site contaminants, will not be required to meet the requirements for medical surveillance as stipulated in Section 10-2.

10.3 REQUIREMENTS FOR ALL FIELD PERSONNEL

Each field team member (including subcontractors) shall be required to fill out a Medical Data sheet prior to the commencement of onsite activities. All Medical Data Sheets will be maintained onsite during the course of this operation. These data sheets will be used to supply an attending physician with immediate information concerning allergies, medical histories and restrictions in the event the injured individual cannot provide this information him/herself. In addition, individuals visiting the site, even for brief periods, will be asked to fill out this form as part of the site indoctrination.

FIGURE 10-1
SUBCONTRACTOR MEDICAL APPROVAL FORM

For employees of _____
Company Name

Participant Name: _____ Date of Exam: _____

Part A

The above-named individual has:

1. Undergone a physical examination in accordance with OSHA Standard 29 CFR 1910.120, paragraph (f) and found to be medically -

   ( ) qualified to perform work at the NWS Earle, New Jersey work site
   ( ) not qualified to perform work at the NWS Earle, New Jersey work site

   and,

2. Undergone a physical examination as per OSHA 29 CFR 1910.134(b)(10) and found to be medically -

   ( ) qualified to wear respiratory protection
   ( ) not qualified to wear respiratory protection

My evaluation has been based on the following information, as provided to me by the employer.

( ) A copy of OSHA Standard 29 CFR 1910.120 and appendices.
( ) A description of the employee's duties as they relate to the employee's exposures.
( ) A list of known/suspected contaminants and their concentrations (if known).
( ) A description of any personal protective equipment used or to be used.
( ) Information from previous medical examinations of the employee which is not readily available to the examining physician.

Part B

I, _____, have examined _____
Physician's Name (print) Participant's Name (print)
and have determined the following information:

1. Results of the medical examination and tests (excluding finding or diagnoses unrelated to occupational exposure):

   _____

   _____

   _____

FIGURE 10-1

SUBCONTRACTOR MEDICAL APPROVAL FORM
PAGE TWO

2. Any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health:

_____

_____

_____

3. Recommended limitations upon the employee's assigned work:

_____

_____

_____

_____

I have informed this participant of the results of this medical examination and any medical conditions which require further examination of treatment.

Based on the information provided to me, and in view of the activities and hazard potentials involved at the NWS Earle, New Jersey work site, this participant

( ) may
( ) may not

perform his/her assigned task.

Physician's Signature _____

Address _____

Phone Number _____

NOTE: Copies of test results are maintained and available at:

_____
Address

11.0 SITE CONTROL

This section outlines the means by which Halliburton NUS will delineate work zones and use these work zones in conjunction with decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site. It is anticipated that a three zone approach will be used during work at this site; exclusion zone, contamination reduction zone, and support zone.

11.1 EXCLUSION ZONE

The exclusion zone will be considered those areas of the site of known or suspected contamination. In many cases, however, significant amounts of surface contamination will not be encountered in the proposed work areas of this site until/unless contaminants are brought to the surface by soil boring, test pit operations, or some other intrusive activities. Furthermore, once such activities have been completed and surface contamination has been removed, the potential for exposure is again diminished and the area can then be reclassified as part of the contamination reduction zone. Therefore, the exclusion zones for this project will be limited to those areas of the site where active work is being performed and/or anywhere there is believed to be the potential for inhalation, contact, and/or ingestion exposure to site contaminants.

Zone structure for this operation will encompass the size necessary to conduct operations which is regarded as an area of 25 feet around the point of operation. This size construction estimate was for test pit operations, drilling, and soil boring operations and is not applicable for sample excursions. Therefore size restriction may be altered in specific instances based on available room, site topography, task, or restricting circumstances at the discretion of the FOL or SSO. Additional alterations which may effect zone structure and operation is as follows. First of which is the nature of the hazards or the perceived hazards involved and the level of protection which will be utilized. Subdivision of work zones may also occur where circumstances the FOL and SSO permit. This will permit the stocking of resources within a restricted area to support the operation. This subdivision will also allow personnel to support operations without the confining restriction of exclusion zone requirements.

All zones identified in this operation as exclusion zones once work is completed will require the area to be restored to its former condition prior to relinquishing access to the base personnel or the onsite facilities' employees. Once efforts are employed to clean and restore the area of all debris and work materials, cuttings, etc., the FOL or SSO will be responsible for clearing the area to be released to the base personnel and/or facilities' employees as applicable. This effort and approval will documented to reflect this evaluation and approval.

11.2 CONTAMINATION REDUCTION ZONE

The contamination reduction zone (CRZ) will be a buffer area between the exclusion zone and any area of the site where contamination is not suspected. The personnel and equipment decontamination area established for this project will take place in the CRZ. This area will serve as a focal point in supporting exclusion zone activities. In addition, this area will serve as the access and control points to the exclusion zone. Closure of this zone will require the same procedures as employed for the exclusion zone above as these zones are opened and closed as the operation moves from site to site.

11.3 SUPPORT ZONE

The support zone for this project will include a staging area where site vehicles will be parked, equipment will be unloaded, and where food and drink containers will be maintained. In all cases, the support zones

will be established at areas of the site where exposure to site contaminants would not be expected during normal working conditions or foreseeable emergencies.

11.4 SITE PREPARATION

In an effort to minimize as many foreseeable hazards as possible site preparation, in addition to subsurface clearance and access control will be performed by the FOL prior to the initiation of onsite activities in any new area. Physical hazards, potential chemical hazards, which cannot be removed, identified, or barricaded to prevent possible exposure will be identified as per the safety briefing prior to the commencement of activities in that area. As part of this preparation procedure the FOL and the SSO shall identify evacuation routes, assembly points, means of communication for that site, and emergency routes for medical assistance. Access to all zones shall be established to support emergency response access and efforts in all areas identified in Section 2.0.

Staging areas for each site or a central location for RI generated wastes will be constructed prior to the commencement of activities. All material generated will be located at that area and segregated based on site location and material (i.e. PPE, drill cuttings, well development fluids). All resource equipment will be placed in the CRZ in preparation to support all exclusion zone activities. This shall include all emergency services equipment as applicable.

11.5 SITE MAP

Once the areas of contamination, access routes, topography, dispersion routes are determined a site map illustrating the particulars of each site, where these planned activities will take place, will be generated and adjusted as site conditions change. These maps will be posted in the trailer/office to illustrate up to date collection of contaminants and adjustment of Zones and access points and be used for safety briefings to inform personnel of zone demarcations and restrictions.

11.6 BUDDY SYSTEM

Personnel engaged in onsite activities will practice the "buddy system" to insure the safety of all personnel involved in this operation.

11.7 MATERIALS SAFETY DATA SHEET (MSDS) REQUIREMENTS

Halliburton NUS will provide MSDS's for all chemicals brought on site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application of the substances onsite. The MSDS's will then be maintained in a central location (i.e. temporary office) and will be available for anyone to review upon request.

11.8 COMMUNICATION

As personnel will not always be working in close proximity to one another during field activities, a supported means of communication may be necessary. For this purpose 2-way radio communication will be used.

External communication will be done so utilizing the telephones at predetermined and approved locations near each site or through cellular communications. External communication will primarily be used for the purpose of resource and emergency resource communications.

If site locations telecommunications are employed the Base contact (Gus Hermanni) and the FOL will determine and arrange for telephone communications, prior to the commencement of activities at each of the sites.

All communication equipment will have NWS Earle approval prior to use.

11.9 SITE/ZONE SECURITY

Primary site security will be accomplished at the gate whereby access is only granted to base personnel and civilian employees. Initial work zone security will be accomplished by all site personnel involved in this operation. Zone identification, demarcation, zone/access control points shall be monitored by site personnel, and a list of personnel cleared to enter the area of investigation shall initiate a secondary defense. Lastly, the FOL and the SSO shall have the power to temporarily terminate all operations should this line of security be compromised. No one shall enter an exclusion zone unless they have met the requirements of this plan, and are approved for site clearance. Violations in this area concerning facility employees or base personnel will be deliberated by the Base representative.

12.0 SPILL CONTAINMENT PROGRAM

12.1 SCOPE AND APPLICATION

It is not anticipated that bulk hazardous materials (over 55-gallons) will be handled at a given time as part of this scope of work. It is also not anticipated that such spillage would constitute a danger to human health or the environment. However, as the job progresses the potential for accumulating decontamination fluids or drill cuttings in the central staging area exists. Once characterized these fluids can be removed from this area and disposed of. As these fluids remain uncharacterized while in the staging area, a spill containment program will be developed and instituted as part of this HASP.

12.2 POTENTIAL SPILL AREAS

Potential spill areas will be monitored in an ongoing attempt to prevent and control further potential contamination of the environment. Currently, there is limited areas vulnerable to this hazard including the area used for the central staging area for potentially contaminated soils and decontamination fluids. Additionally, the handling, loading and unloading areas present limited potential for leak or spill. At this junction it is anticipated all decontamination fluids generated, as a result of this scope of work, will be containerized, labeled, and staged to await chemical analyses. The results of these analyses will determine whether the fluids will be disposed of in an agreed manner as nonhazardous, or go offsite as hazardous to a treatment facility. During the turn around for the chemical analyses there exists a possibility to accumulate multiple drums of fluid.

12.2.1 55-GALLON DRUMS

All drums containing liquids will be staged within a centralized area.

12.3 LEAK AND SPILL DETECTION

To establish an early detection of potential spills or leaks, a periodic walk around by personnel staging or disposing of drums will be conducted during working hours to visually determine that containers are not leaking. If a leak is detected the drum contents will be transferred using a hand pump into a new 55-gallon drum. The leak will be collected and contained using absorbents such as Oil-dry, vermiculite, or sand, stored at the staging area in a drum conspicuously marked. This material too, will be containerized for disposal pending analyses. All inspections will be documented in the Project Logbook.

12.4 PERSONNEL TRAINING AND SPILL PREVENTION

All personnel will be instructed on the procedures for spill prevention, containment, and collection of hazardous materials in the site specific training. The FOL and the SSO will serve as the Spill Response Coordinator for this operation should the need arise.

12.5 SPILL PREVENTION AND CONTAINMENT EQUIPMENT

The following represents the minimum equipment which will be maintained at the staging area at all times for the purpose of supporting this Spill Prevention/Containment Program.

- Sand, clean fill, vermiculite, or other noncombustible absorbent (oil-dry);

- Drums (55-gallon U.S. DOT 17-E or 17-H
- Shovels, rakes, and brooms
- Hand operated drum pump with hose
- Labels
- Drum Patch kit

12.6 SPILL CONTROL PLAN

This section describes the procedures the Halliburton NUS field crew members will employ upon the detection of a spill or leak.

1) Notify the SSO or FOL immediately upon the detection of a leak or spill.

2) Employ the personnel protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the drum or raising the leak to the highest point. Spread the sorbent material in the area of the spill covering completely.

3) Transfer the material to a new drum, collect and containerize the absorbent material. Label the new drum appropriately. Await analyses for treatment or disposal options.

4) Solid spills will be recontainerized with 2-inches of top cover, and await for test results for treatment or disposal options.

It is not anticipated that a spill will occur in which the field crews cannot handle. Therefore the the notification of offsite Emergency Response Support will be carried out by the FOL or SSO, once they have designated this as an emergency situation (See Section 13.3.1).

13.0 EMERGENCY RESPONSE PLAN

13.1 INTRODUCTION

In the event of any onsite emergencies, site personnel will be immediately evacuated to a safe place of refuge and the appropriate offsite response agencies will be notified. Halliburton NUS and subcontractor personnel will not provide or take an active role in emergency response support. This approach has been selected based on the types of emergencies most likely to be encountered during performance of this work and the fact that offsite emergency response organizations will provide the most effective response to these emergencies. Specifically, fire/explosion and personal injury/illness resulting from exposure to physical hazards are the emergencies most likely to be encountered. The local fire department and ambulance service will be best suited for handling these emergencies and are located within a reasonable distance from the various sites to ensure adequate response time. In light of this approach, this emergency response plan has been prepared to conform to the requirements of OSHA Standard 29 CFR 1910.38(a), as permitted by OSHA 29 CFR 1910.120(l)(1)(ii).

13.2 PRE-EMERGENCY PLANNING

Pre-emergency planning activities associated with this project include the following:

- Coordinating activities with NWS Earle Emergency Services personnel to ensure that Halliburton NUS emergency response activities are compatible with existing facility emergency response procedures.

- Establishing and maintaining information at the project staging area (support zone) for easy access in the event of an emergency. This information will include the following and it will be the responsibility of the Halliburton NUS FOL to ensure the information is available.

  - An inventory of chemical substances used on site, with corresponding Material Safety Data Sheets.

  - Site personnel records regarding medical treatment concerns (medical data sheets).

  - A log book identifying personnel present on site each day.

- Identifying a chain of command for emergency response.

- A signed copy of this HASP.

13.3 EMERGENCY RECOGNITION AND PREVENTION

13.3.1 Recognition

These situations will generally be recognizable by visual observation. An injury or illness will be considered an emergency if it requires treatment other than first-aid (i.e. requires treatment by a medical professional). Emergency situations those determined by the FOL or SSO to be outside of the capabilities of the field crews will require initiation of the emergency notification procedures as identified in Section 13.9 of this document.

13.3.2 Prevention

Halliburton NUS will prevent emergencies by ensuring compliance with the site-specific health and safety plan.

13.4 SAFE DISTANCES AND PLACES OF REFUGE

In the event that a site must be evacuated, all personnel will immediately stop activities and report to a previously identified location for that area. This place of refuge will be determined at each site, and communicated to the field crew, prior to the commencement of activities at that unit. Upon reporting to the refuge location, personnel will remain there until directed otherwise by the Halliburton NUS FOL. The FOL or SSO will take roll at this location, using the log book, to confirm the location of all site personnel.

13.5 EVACUATION ROUTES AND PROCEDURES

An evacuation must be initiated whenever; a fire/explosion occurs, readings on monitoring instrumentation indicate levels of contamination greater than instituted action levels, personnel show signs or symptoms of overexposure to potential site contaminants. In the event of an evacuation, personnel will proceed immediately to the support zone, unless doing so would further jeopardize the welfare of workers. If so, personnel will proceed to an alternate location and remain there until instructed otherwise by the Halliburton NUS FOL.

Evacuation procedures will be discussed prior to the initiation of any work at each site. Evacuation from the site is dependent upon the location at which work is being performed at the site. Conditions to consider in this scenario is the extenuating circumstances or influence of the operating facility and the potential impact or influence of in-house emergency situations.

13.6 DECONTAMINATION PROCEDURES/EMERGENCY MEDICAL TREATMENT

Decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. Decontamination will not be performed if the action which initiates an evacuation would further endanger the lives of workers if workers were to perform decontamination procedures. However, it is unlikely that such an event could occur at this site that would require workers to evacuate the site without first performing decontamination procedures.

13.7 EMERGENCY ALERTING AND RESPONSE PROCEDURES

Since Halliburton NUS personnel will be working in close proximity to each other, hand signals and voice commands, and 2-way radio will be sufficient to alert site personnel of an emergency.

13.8 PPE AND EMERGENCY EQUIPMENT

A first-aid kit and stretcher will be maintained on site and immediately available for use in the event of an emergency.

13.9 EMERGENCY CONTACTS

Prior to performing work at any of the sites, all personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. Phone communications shall be provided for onsite, but if not, phones are located in any of the many buildings surrounding the sites and are generally less than 2 miles away from any site in which work will be performed. A listing of the emergency phone numbers and facility locations will be posted and made available to all personnel working on site in case emergency medical treatment needed.

EMERGENCY REFERENCE
Hudson County - Jersey City/Bayonne, New Jersey

Fire Department, police, and ambulance	911
Poison Control Center	1(800)962-1253
National Response Center	1(800)424-8802
Chemtrec	1(800)424-9300
Hospitals: Jersey City Medical Center	 (201)915-2000
NJDEPE 24-hour Emergency	(609)292-7172
Base Contact: Gus Hermanni	Telephone: (908) 866-2624
Donald Blackert, P.G. Project Manager	(412)921-8351
Matthew M. Soltis, C.S.P., Manager of Health Sciences	(412)921-8912
Thomas M. Dickson, SSO	(412)921-8457

13.10 EMERGENCY ROUTE TO HOSPITAL

Specific base procedures for emergency notification and the use of outside support will be indoctrinated into this HASP prior to final approval of this HASP.

14.0 PERMIT-REQUIRED CONFINED SPACE ENTRY

No personnel, under any circumstances, are to enter confined spaces. Therefore, it is not applicable to specify procedures for such operations in this Health and Safety Plan.

15.0 MATERIALS AND DOCUMENTS

The Halliburton NUS FOL shall ensure the following materials/documents are taken to the project site and utilized as required.

- Incident Reports
- Medical Data Sheets
- Material Safety Data Sheets for decon solutions and other substances brought to the site
- Follow-Up Reports (to be completed by the Field Team Leader)
- OSHA Job Safety and Health Poster (posted in site trailer)
- Training Documentation Form (Blank)
- First Aid Supply Usage Form
- Emergency Reference Form (Figure 13-1, extra copy for posting)
- User manuals for OVA, Draeger Tubes, and HNu
- Office supplies/phone books, etc.

ATTACHMENT 1

COLD AND HEAT STRESS

COLD STRESS

Cold Stress

The cold stress TLVs are intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body temperature from falling below 36°C (96.8°F) and to prevent cold injury to body extremities (deep body temperature is the core temperature of the body determined by conventional methods for rectal temperature measurements). For a single, occasional exposure to a cold environment, a drop in core temperature to no lower that 35°C (95°F) should be permitted. In addition to provisions for total body protection, the TLV objective is to protect all parts of the body with emphasis on hands, feet, and head from cold injury.

Introduction

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is the fall in the deep core temperature of the body. The clinical presentations of victims of hypothermia are shown in Table 1. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F); lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering depends when the body temperature has fallen to 35°C (95°F). This must be taken as a sign of danger to the workers and exposure to cold should be immediately terminated for any workers when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Since prolonged exposure to cold air, or to immersion in cold water, at temperatures well above freezing can lead to dangerous hypothermia, whole body protection must be provided.

1. Adequate insulating dry clothing to maintain core temperatures above 36°C (96.8°F) must be provided to workers if work is performed in air temperatures below 4°C (40°F). Wind chill cooling rate and the cooling power of air are critical factors. [Wind chill cooling rate is defined as heat loss from a body expressed in watts per meter squared which is a function of the air temperature and wind velocity upon the exposed body.] The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required. An equivalent chill temperature chart relating the actual dry bulb air temperature and the wind velocity is presented in Table 2. The equivalent chill temperature should be used when estimating the combined cooling effect of wind and low air temperatures on exposed skin or when determining clothing insulation requirements to maintain the deep body core temperature.

2. Unless there are unusual or extenuating circumstances, cold injury to other than hands, feet, and head is not likely to occur without the development of the initial signs of hypothermia. Older workers or workers with circulatory problems require special precautionary protection against cold injury. The use of extra insulating clothing and/or a reduction in the duration of the exposure period are among the special precautions which should be considered. The precautionary actions to be taken will depend upon the physical condition of the worker and should be determined with the advice of a physician with knowledge of the cold stress factors and the medical condition of the worker.

TABLE 1
PROGRESSIVE CLINICAL PRESENTATIONS OF HYPOTHERMIA*

Core Temperature		Clinical Signs
°C	°F	
37.6	99.6	"Normal" rectal temperature
37	98.6	"Normal" oral temperature
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35	95.0	Maximum shivering
34	93.2	Victim conscious and responsive, with normal blood pressure
33	91.4	Severe hypothermia below this temperature
32	86.0	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated but react to light; shivering ceases
31	87.8	
30	86.0	Progressive loss of consciousness; muscular rigidity increases; pulse and blood pressure difficult to obtain; respiratory rate decreases
29	84.2	
28	82.4	Ventricular fibrillation possible with myocardial irritability
27	80.6	Voluntary motion ceases; pupils nonreactive to light; deep tendon and superficial reflexes absent
26	78.8	Victim seldom conscious
25	77.0	Ventricular fibrillation may occur spontaneously
24	75.2	Pulmonary edema
22	71.6	Maximum risk of ventricular fibrillation
21	69.8	
20	68.0	Cardiac standstill
18	64.4	Lowest accidental hypothermia victim to recover
17	62.6	Isoelectric electroencephalogram
9	48.2	Lowest artificially cooled hypothermia patient to recover

* Presentations approximately related to core temperature. Reprinted from the January 1982 issue of American Family Physician, published by the American Academy of Family Physician.

Evaluation and Control

For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32°C(-25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below -1°C (30.2°F) regardless of wind speed.

At air temperatures of 2°C (35.6°F) or less, it is imperative that workers who become immersed in water or whose clothing becomes wet be immediately provided a change of clothing and be treated for hypothermia.

TLVs recommended for properly clothed workers for periods of work at temperatures below freezing are shown in Table 3.

Special protection of the hands is required to maintain manual dexterity for the prevention of accidents:

1. If fine work is to be performed with bare hands for more than 10-20 minutes in an environment below 16°C (60.8°F), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be utilized. Metal handles of tools and control bars should be covered by thermal insulating material at temperatures below -1°C (30.2°F).

2. If the air temperature falls below 16°C (60.8°F) for sedentary, 4°C (39.2°F) for light, -7°C (19.4°F) for moderate work and fine manual dexterity is not required, then gloves should be used by the workers.

To prevent contact frostbite, the workers should wear anti-contact gloves.

1. When cold surfaces below -7°C (19.4°F) are within reach, a warning should be given to each worker by the supervisor to prevent inadvertent contact by bare skin.

2. If the air temperature is -17.5°C (0°F) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4°C (39.2°F). The workers should wear cold protective clothing appropriate for the level of cold and physical activity:

1. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment.

2. If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use may be of a type impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outer wear should be changed as it becomes wetted. The outer garments should include provisions for easy ventilation in order to prevent wetting of inner layers of sweat. If work is done at normal temperatures or in a hot environment before entering the cold area, the employee should make sure that clothing is not wet as a consequence of sweating. If clothing is wet, the employee should change into dry clothes before entering the cold area. The workers should change socks and any removable felt insoles at regular daily intervals or use vapor barrier boots. The optimal frequency of change should be determined empirically and will vary individually and according to the type of shoe worn and how much the individual's feet sweat.

TABLE 2
COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS EQUIVALENT TEMPERATURE
(under calm conditions)*

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148

(Wind speeds greater than 40 mph have little additional effect)	**LITTLE DANGER** In < hr with dry skin. Maximum danger of false sense of security	**INCREASING DANGER** Danger from freezing of exposed flesh within one minute.	**GREAT DANGER** Flesh may freeze within 30 seconds.
	Trenchfoot and immersion foot may occur at any point on this chart.		

* Developed by U.S. Army Research Institute of Environmental Medicine, Natick MA.

TABLE 3
THRESHOLD LIMIT VALUES WORK/WARM-UP SCHEDULE FOR FOUR-HOUR SHIFT*

Air Temperature - Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx)	°F (approx)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm Breaks)	1	(Norm Breaks)	1	75 min	2	55 min	3	40 min	4
-29° to -31°	-20° to -24°	(Norm Breaks	1	75 min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	2	30 min	5	Non-emergency work should cease		Non-emergency work should cease	
-38° to -39°	-35° to -39°	40 min	4	30 min	1	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease	
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease	
-43° & below	-45° & below	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease					

NOTES:

1. Schedule applies to moderate to heavy work activity with warm-up breaks of ten (10) minutes in a warm location. For Light-to-Moderate Work (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/M^2; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m^2. In general, the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

NOTE: External temperatures in excess of those stated above shall be regarded as inclement weather. Work continuation, termination, or alteration of the work schedule will be at the discretion of the FTL and on site health and safety representative. The heat and cold stress related sections of this are applicable to the season when work will be completed.

* Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labor.

3. If exposed areas of the body cannot be protected sufficiently to prevent sensation of excessive cold or frostbite, protective items should be supplied in auxiliary heated versions.

4. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work should be modified or suspended until adequate clothing is made available or until weather conditions improve.

5. Workers handling evaporative liquid (gasoline, alcohol, or cleaning fluids) at air temperatures below 4°C (39.2°F) should take special precautions to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling. Special note should be taken of the particularly acute effects of splashes of "cryogenic fluids" or those liquids with a boiling point that is just above ambient temperature.

Work - Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) or below -7°C (19.4°F), heated warming shelters (tents, cabins, rest rooms, etc.) should be made available nearby. The workers should be encouraged to use these shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter. When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation or a change of dry work clothing provided. A change of dry work clothing should be provided as necessary to prevent workers from returning to work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects.

For work practices at or below -12°C (10.4°F) ECT, the following should apply:

1. The worker should be under constant protective observation (buddy system or supervision).

2. The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods should be taken in heated shelters and opportunity for changing into dry clothing should be provided.

3. New employees should not be required to work fulltime in the cold during the first days of employment until they become accustomed to the working conditions and required protective clothing.

4. The weight and bulkiness of clothing should be included in estimating the required work performance and weights to be lifted by the worker.

5. The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats should not be used. The worker should be protected from drafts to the greatest extent possible.

6. The workers should be instructed in safety and health procedures. The training program should include as a minimum instruction in:

   a. Proper rewarming procedures and appropriate first aid treatment.
   b. Proper clothing practices.
   c. Proper eating and drinking habits.
   d. Recognition of impending frostbite.
   e. Recognition of signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur.
   f. Safe work practices.

Special Workplace Recommendations

Special design requirements for refrigerator rooms include:

1. In refrigerator rooms, the air velocity should be minimized as much as possible and should not exceed 1 meter/sec (200 fpm) at the job site. This can be achieved by properly designed air distribution systems.

2. Special wind protective clothing should be provided based upon existing air velocities to which workers are exposed.

Special caution should be exercised when working with toxic substances and when workers are exposed to vibration. Cold exposure may require reduced exposure limits.

Eye protection for workers employed out-of-doors in a snow and/or ice-covered terrain should be supplied. Special safety goggles to protect against ultraviolet light and glare (which can produce temporary conjunctivitis and/or temporary loss of vision) and blowing ice crystals should be required when there is an expanse of snow coverage causing a potential eye exposure hazard.

Workplace monitoring is required as follows:

1. Suitable thermometry should be arranged at any workplace where the environmental temperature is below 16°C (60.8°F) so that overall compliance with the requirements of the TLV can be maintained.

2. Whenever the air temperature at a workplace falls below -1°C (30.2°F), the dry bulb temperature should be measured and recorded at least every 4 hours.

3. In indoor workplaces, the wind speed should also be recorded at least every 4 hours whenever the rate of air movement exceeds 2 meters per second (5 mph).

4. In outdoor work situations, the wind speed should be measured and recorded together with the air temperature whenever the air temperature is below -1°C (30.2°F)

5. The equivalent chill temperature should be obtained from Table 2 in all cases where air movement measurements are required; it should be recorded with the other data whenever the equivalent chill temperature is below -7°C (19.4°F).

Employees should be excluded from work in cold at -1°C (30.2°F) or below if they are suffering from diseases or taking medication which interferes with normal body temperature regulation or reduces tolerance to work in cold environments. Workers who are routinely exposed to temperatures below -24°C (-11.2°F) with wind speeds less than five miles per hour, or air temperatures below -18°C (0°F) with wind speeds above five miles per hour, should be medically certified as suitable for such exposures.

Trauma sustained in freezing or subzero conditions requires special attention because an injured worker is predisposed to cold injury. Special provisions should be made to prevent hypothermia and freezing of damaged tissues in addition to providing for first aid treatment.

Note: This information has been adopted from the **1992-1993 "Threshold Limit Values** for Chemical Substances and Physical Agents and **Biological Indices"** by the American Conference of Governmental Industrial Hygienists (ACGIH).

HEAT STRESS

Heat Stress

The SSO shall visually monitor personnel to note for signs of heat stress. Field personnel will also be instructed to observe for symptoms of heat stress and methods on how to control it. One or more of the following control measures can be used to help control heat stress:

- Provide adequate liquids to replace lost body fluids. Personnel must replace water and salt lost from sweating. Personnel must be encouraged to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.
- Replacement fluids can be commercial mixes such as Gatorade®.
- Establish a work regime that will provide adequate rest periods for cooling down. This may require additional shifts of workers.
- Cooling devices such as vortex tubes or cooling vests can be worn beneath protective garments.
- Breaks are to be taken in a cool rest area (77°F is best).
- Personnel shall remove impermeable protective garments during rest periods.
- Personnel shall not be assigned other tasks during rest periods.
- Personnel shall be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

The heat stress of personnel onsite may be monitored utilizing biological monitoring.

One of the following biological monitoring procedures may be utilized by the SSO to monitor heat stress concerns.

- Heart rate (HR) shall be measured by the pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33 percent), while the length of rest period stays the same. If the pulse rate is 100 beats/minute at the beginning of the next rest period, the following work cycle should be shortened by 33 percent. The length of the initial work period will be determined by using the table below.

PERMISSIBLE HEAT EXPOSURE THRESHOLD LIMIT VALUES

Work-Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous	80.0°F	80.0°F	77.0°F
75% Work - 25% Rest, Each Hour	87.0°F	82.4°F	78.6°F
50% Work - 50% Rest, Each Hour	88.5°F	85.0°F	82.2°F
25% Work - 75% Rest, Each Hour	90.0°F	88.0°F	86.0°F

- Body temperature shall be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 99°F. If it does, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. However, if the oral temperature exceeds 99.7°F at the beginning of the next rest period, the following work cycle shall be further shortened by 33 percent. OT should be measured at the end of the rest period to make sure that it has dropped below 99°F. At no time shall work begin with the oral temperature above 99°F.

NOTE: External temperatures in excess of those stated above shall be regarded as inclement weather. Work continuation, termination, or alteration of the work schedule will be at the discretion of the FTL and on site health and safety representative. The heat and cold stress related sections of this are applicable to the season when work will be completed. A Standard Operating Procedure for heat stress control is also included in this Appendix.

HEAT RELATED EMERGENCIES SIGNS, SYMPTOMS, AND EMERGENCY CARE

Because some physically demanding field work is expected to take place during summer months, heat stress and exhaustion are potential problems. Therefore a "Heat Related Emergency" pamphlet is attached to this safety plan.

Heat Rash

Also known as prickly heat, this condition affects the skin. It occurs in situations where the skin remains wet most of the time. The sweat ducts become plugged and a skin rash soon appears.

Signs and Symptoms

1. Skin rash will appear on affected areas of the body.
2. Tingling or prickling sensation will be felt on the affected areas.

Emergency Care

1. Shower after working in the heat
2. Dry the skin thoroughly
3. Change underwear as needed
4. Stay in cool place after work hours.
5. Avoid repeated exposure to heated environment until condition improves, when possible.

Heat Cramps

Heat cramps are muscle pains, usually in the lower extremities, the abdomen, or both, that occur after profuse sweating with accompanying salt depletion. Heat cramps most often afflict people in good physical condition, who overwork in conditions of high temperature and humidity. Untreated, heat cramps may progress to heat exhaustion.

Treatment for heat cramps is aimed at eliminating the exposure and restoring the loss of salt and water.

Signs and Symptoms

1. Cramps in the extremities and abdomen that begin suddenly during vigorous activity. Heat cramps can be mild with only slight abdominal cramping and tingling in the extremities, but more commonly present intense and incapacitating pain in the abdomen and extremities.

2. Respiration rate will increase, decreasing after the pain subsides.

3. Pulse rate will increase

4. Skin will be pale and moist.

5 Body temperature will be normal

6. Generalized weakness will be noted as the pain subsides.

7. Loss of consciousness and airway maintenance are seldom problems with this condition.

Emergency Care

1. Move the worker to a cool environment. Have him lie down if he feels faint.

2. If the person is nauseated, avoid giving him anything orally until the nausea subsides.

3. If the person is not nauseated he may be given one or two glasses of an electrolyte solution. Have the person drink slowly. The use of salt tablets is not recommended because they may cause nausea.

4. Avoid massaging the cramping muscles. This rarely helps and may actually aggravate the pain.

5. As the salt and water level is replenished, the worker's pain will subside. He may wish to return to work; however, this is NOT recommended for a period of 12 hours. Further exertion may lead to heat exhaustion or heat stroke.

Heat Exhaustion

Heat exhaustion is a more severe response to salt and water loss, as well as an initial disturbance in the body's heat-regulations system. Like heat cramps, heat exhaustion tends to occur in people working in hot environments. Heat exhaustion may progress to heat stroke. Treatment for heat exhaustion is similar in principle to that for heat cramps.

Signs and Symptoms

1. Heat exhaustion may be accompanied present by a headache, fatigue, dizziness, or nausea with occasional abdominal cramping. More severe cases of heat exhaustion may resulting partial or complete temporary loss of respiration nd circulation due to cerebral ischemia.

2. Sweating will be profuse.

3. Pulse rate will be rapid and weak.

4. Respiration rate will be rapid and shallow.

5. The skin will be pale and clammy

6. The body temperature will be normal or decreased.

7. The person could be irritable and restless.

Emergency Care

1. Monitor the person's airway and level of consciousness. If this is a true medical emergency, prompt intervention by Emergency Medical Services is recommended.

2. Move the person to a cool environment. Take off as much of his clothing as possible and place him in a supine position with his legs elevated.

3. Sponge the person with cool water. If you fan the person, avoid chilling. When the body shivers, this energy is released in the form of heat and actually can increase the body temperature.

Heat Stroke

Heat stroke is caused by a severe disturbance in the body's heat-regulating system and is a profound emergency: The mortality rate ranges from 25 to 50 percent. It is most common in men over 40, especially alcoholics. It can also occur to people of any age having too much exposure to the sun or prolonged confinement in a hot atmosphere. Heat stroke comes on suddenly. As the sweating mechanism fails, the body temperature begins to rise precipitously, reaching 106°F (41°C) or higher within

10 to 15 minutes. If the situation is not corrected rapidly, the body cells -- especially have very vulnerable cells to the brain--are literally cooked, and the central nervous system is irreversibly damaged. The treatment for heat stroke is aimed at maintaining vital functions and causing as rapid a decrease of body temperature as possible.

Signs and Symptoms

1. The person's pulse will be strong and bounding.
2. The skin will be hot, dry, and flushed.
3. The worker may experience headache, dizziness, and dryness of mouth
4. Seizures and coma can occur.
5. Loss of consciousness and airway maintenance problems can occur.

Emergency Care

1. Establish an open airway.

2. Move the person to a cool environment. Take off as much clothing as possible, and place him in a semi-reclining position with the head elevated.

3. Use any means to cool the worker. Improvise with whatever is available. A bathtub filled with cold water and ice cubes is effective. Remember, speed is essential; delay may result in permanent brain damage. Vigorous efforts to cool the worker must continue until the body temperature is below 102° F (38.9°C).

4. This is a true medical emergency--prompt intervention by Emergency Medical Services is recommended.

These are only guidelines for heat related emergencies. Actual training in emergency medical care or basic first aid is recommended.

Cold Stress

The cold stress TLVs are intended to protect workers from the most severe effects of cold stress (hypothermia) and cold injury and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body temperature from falling below 36°C (96.8°F) and to prevent cold injury to body extremities. For a single, occasional exposure to a cold environment, a drop in core temperature to no lower than 35°C (95°F) is permitted. In addition to provisions for total body protection, the TLV objective is to protect all parts of the body with emphasis on hands, feet, and head from cold injury.

For more information concerning cold stress effects and control measures see Attachment 2.

Heat Stress

As this scope of work will require the use of various types of personal protective equipment (PPE) as a

means of protection from both chemical and physical hazards, the potential for heat related disorders during the proposed field dates is significant. To combat this problem the FOL and the SSO shall initiate heat stress monitoring, and effect the appropriate control efforts, in accordance with Halliburton NUS Standard Operating Procedures HS-09 "Heat Stress Control", (a copy of which is attached to this HASP as Appendix 3), and the ACGIH recommended control measures, (also included in Attachment 3).

ATTACHMENT 2
TICK CONTROL

Lyme disease - A newly recognized infectious disease characterized by fever, joint pain, and a distinctive red annular rash. Transmission of this disease is accomplished via a vector in this case ticks. Once the infected tick attaches to the host(field personnel) it passes the bacteria (spirochete) via the bloodstream. From introduction of the bacteria to the onset of the signs and symptoms of the disease may vary from individual to individual however generally ranges from 1 to 4 weeks for initial symptoms. Initial treatment would indicate those individuals infected have responded well to treatment with penicillin. In addition, ticks affectively vector many other maladies such as Rocky Mountain Spotted Fever, Tularemia, and Tick paralysis.

Identification and Control

Several species of hard-backed ticks exist in a variety of climates, however, reward flourish during the early spring and summer. Typically, ticks exist in warm moist climates, heavily vegetative, and attach to their host through contact as the host passes by through grasses and underbrush. Tick identification may be accomplished through their markings and structure.

Tick Control Climatic factors are probably the most important in natural control of ticks. As the timing of the field activities is not coordinated with the climatic and natural control of this hazard additional control measures must be implemented.

Control Measures Every effort should be made to discover the presence of ticks on the body and clothing by careful examination, especially of the head, promptly after exposure to tick infested areas. Tyvek uniforms will be worn for all movement through the brush (potential tick infested areas). These uniforms will be discarded between excursions into the infested areas. These uniforms will be stored away from other garments to avoid potential infestation. Commercially produced repellents have been found to be fairly effective when applied to the outer garments prior to engaging in field activities. For this reason these compounds will be employed. Additional precautions such as securing outer garments at the pants legs, wrists, and neck to avoid the opportunity of attachment. Field personnel shall assist one another in the detection of ticks inspection of one another on exposed portions of the body.

Tick Removal Should ticks successfully attach, they can be encouraged to release their mouthparts (means of attachment) by gently pulling the tick straight out. Excessive means should not be used to remove the tick. Once removed a topical medication such as Tincture of iodine should be applied onto the area of the hole evacuated by the mouthparts. Care should be taken not to get the blood of crushed ticks into the eyes or into scratches or breaks in the skin. Prompt removal of discovered ticks will reduce the chance of serious consequences.

APPENDIX E

QUALITY ASSURANCE PROJECT PLAN

Appendix E
Quality Assurance Project 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 0147

June 1995

D-11-93-8

APPENDIX E
QUALITY ASSURANCE PROJECT PLAN
FOR
NAVAL WARFARE STATION (NWS) 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:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0147

JUNE 1995

SUBMITTED BY:	APPROVED FOR SUBMISSION BY:
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1.0 PROJECT DESCRIPTION

As requested by the U.S. Navy, Halliburton NUS has prepared this Quality Assurance Project Plan (QAPP) for a field investigation being performed in support of an Remedial Investigation/Feasibility Study (RI/FS) at the Naval Weapons Station (NWS) Earle, Colts Neck, New Jersey. The 27 sites being investigated at NWS Earle include the following:

- Site 1, Ordnance site
- Site 2, Active Ordnance Demolition Range
- Site 3, Landfill Southwest of "F" Group
- Site 4, Landfill West of "D" Group
- Site 5, Landfill West of Army Barricades
- Site 6, Landfill
- Site 7, Landfill South of "P" Barricades
- Site 9, Landfill
- Site 10, Scrap Metal Landfill
- Site 11, Contract Ordnance Disposal Area
- Site 12, Battery Storage Location
- Site 13, Landfill
- Site 14, Mercury Spill Site
- Site 15, Sludge Disposal Site
- Site 16, EPIC Site F, Roundhouse
- Site 17, Landfill
- Site 19, Paint Sludge Disposal Area
- Site 20, Grit Blast Disposal Area
- Site 22, Paint Sludge Disposal Site
- Site 23, Paint Disposal Area
- Site 24, Firing Range
- Site 25, Firing Range
- Site 26, Explosive "D" Washout Area
- Site 27, Projectile Refurbishing Area
- Site 29, PCB Spill Area
- Site L, EPIC Site L

- Site Q, EPIC Site Q
- Site BG, Background Sample Location

Halliburton NUS 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 Energy and Environmental Support Activity (NEESA) approval. QA/QC procedures for the chemical analyses will satisfy NEESA requirements for Level C QC. These requirements are detailed in the NEESA guidance document, "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program" (NEESA 20.2-047B).

2.0 FIELD INVESTIGATION SCOPE OF WORK

The field investigation will be performed to support the RI/FS Halliburton NUS is conducting at 27 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 27 sites, including physical features and site history, are provided in Section 1.0 of the Work Plan. A summary of previous investigations conducted at 15 of the 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.

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. Sampling protocols to be used during this field investigation are provided in Section 6.0 of this QAPP. As required by NEESA, 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 27 sites.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Halliburton NUS will be responsible for the overall management of the project, including all field sampling activities. Personnel from the Navy will support Halliburton NUS in a number of areas during the project.

4.1 PROJECT ORGANIZATION

The key firms and personnel involved in the RI/FS, 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 19113-2090
(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

Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710
(215) 971-0900

John J. Trepanowski, P.E., Program Manager

Halliburton NUS Corporation
Foster Plaza VII
661 Andersen Drive
Pittsburgh, PA 15220
(412) 921-7090

Daryl Hutson, Deputy Program Manager
Russel E. Turner, Project Manager
Debra A. Scheib, Quality Assurance Manager
Tom Dickson, 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 Halliburton NUS 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:

$$Range = OR - DR$$

$$RPD = \frac{[OR - DR]}{1/2\ (OR + DR)} \times 100\%$$

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 NEESA (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:

$$\%R = \frac{E}{T} \times 100\%$$

where: E = experimental result

T = true value (theoretical result)

and T = $\frac{\text{(sample aliq.)(sample conc.)} + \text{(spike aliq.)(spike conc.)}}{\text{Sample aliq + spike aliq.}}$

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 NEESA-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 it 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.

5.9 BOTTLE WARE

NEESA 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 27 sites identified in Section 1.0 of the Work Plan.

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 NEESA methodology for target compound list (TCL) volatile organic compounds, pesticides, PCBs, semivolatile organic compounds, target analyte list (TAL) metals, cyanide, total petroleum hydrocarbons (TPH), ammonia (as N), nitrate-nitrite (as N), total organic carbon (TOC), biochemical oxygen demand (BOD 5-day), chemical oxygen demand (COD), chloride, sulfate, phosphate (as P), 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.

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
- Borehole Drilling and Soil Sampling
- Monitoring Well Construction/Installation/Sampling
- Surface Water/Sediment Sampling
- Test Pit Excavation
- Soil Gas Survey
- Hydropunch Groundwater Sampling
- Drum Sampling

6.4 SAMPLE DESIGNATION

The sample designation for the NWS Earle site is 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 during 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 Halliburton NUS 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 of 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°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 manufacturer's 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 this Work Plan.

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 Halliburton NUS chemist will review the analytical data packages using method-specific quality control criteria, the quality control criteria set forth in the NEESA 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 is suitable 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/FS 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 Halliburton NUS 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 NEESA 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 NEESA 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 NEESA-approved or have worked for the Navy on a recent project, be eligible to perform the required analysis under NEESA protocols, and must have site-specific approval prior to commencement of work.

13.0 PREVENTIVE MAINTENANCE

Halliburton NUS 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 manufacturer's instructions and Halliburton NUS 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 the Safe Drinking Water Act 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, 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 at this time. 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.

Naval Energy and Environmental Support Activity (NEESA), June 1988. Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program. NEESA, Port Hueneme, California. NEESA 20.2-047B.

New Jersey Department of Environmental Protection and Energy, May 1992. Field Sampling Procedures Manual.

U.S. EPA, September 1986. Test Methods for Evaluation of Solid Waste - Physical/Chemical Methods SW846.

U.S. EPA, March 1983. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79/020.

40 CFR 136, September 11, 1992. [Sec. 136.3(a)].