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NWS EARLE
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INSTALLATION RESTORATION PROGRAM

PHASE III -- REMEDIAL INVESTIGATION/FEASIBILITY STUDY

WORK PLAN

for

Naval Weapons Station Earle,
Colts Neck, NJ

Northern Division
Naval Facilities Engineering Command
U. S. Naval Base, Philadelphia, PA

January 1991

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WESTON

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SECTION 1

INTRODUCTION

1.1 U.S. NAVY INSTALLATION RESTORATION PROGRAM

1.1.1 Program Origin

The Navy Assessment and Control of Installation Pollutants (NACIP) Program was promulgated by OPNAV NOTE 6420, SER 45/ 733503 of 11 September 1980 and by Marine Corps Order 6280.1 of 30 January 1981. The objective of the NACIP Program was to protect human health and the environment by identifying, assessing, and controlling contamination resulting from past operations involving hazardous materials on Navy lands. The NACIP Program has been replaced by the Navy's Installation Restoration Program (IRP).

1.1.2 Program Organization

The IRP has been developed as a four-phase program as follows:

- Phase I -- Preliminary Assessment (PA), formerly known as the Initial Assessment Study (IAS) -- identifies possible contamination sources through records searches, personnel interviews, and site visits. The purpose of the PA is to evaluate the seriousness of the hazardous substance release, or threat of release, and to recommend additional response actions at the site. No action need be taken if available data indicate that there is no threat or potential threat to public health or the environment. Alternatively, the best response action may be an immediate removal of the threat or potential threat. The PA, therefore, establishes the priority for scheduling a Site Inspection by characterizing a site.

- Phase II -- Site Inspection (SI), previously known as the Confirmation Study (CS) -- supplements the information gathered during the PA, eliminates from further consideration those releases that pose no threat to public health or the environment, and determines the potential need for remedial action. Additionally, the SI collects or develops additional data.

- Phase III -- Remedial Investigation/Feasibility Study (RI/FS), previously a part of the Corrective Measures (CMs) -- performs extensive on-site investigations, including physical and analytical monitoring, to quantify the extent of the problem and to develop alternatives for possible corrective measures.

- Phase IV -- Remedial Action Plan (RAP), within which remedial actions are evaluated and implemented to control and mitigate confirmed contamination.

1.2 LONG-RANGE OBJECTIVES OF THE IRP

The long-range objectives of the IRP at Naval Weapons Station Earle (NWS Earle) are to assess the extent and magnitude of contamination at past hazardous waste disposal and spill sites and to develop remedies consistent with the National Contingency Plan (NCP) for those sites that pose a threat to human health or the environment. The goals for the process of selecting the remedial alternatives are to:

- Select remedies that, based on risk analysis findings, will protect human health and the environment.
- Provide cost-effective remedies.
- Attain New Jersey and Federal potentially applicable or relevant and appropriate requirements (ARARs) as a result of remediation.
- Select remedies that use permanent solutions and alternative technologies to the maximum extent practicable.
- Consider the use of interim responses.
- Use on-site mitigation to the maximum extent possible.

This Work Plan develops the scope of work for RI as well as FS activities for the sites.

The sites that were investigated during the previously conducted Confirmation Study and that will be addressed during Phase III are listed as follows:

Site No.	Site Title
2	Ordnance Demilitarization Site
3	Landfill Southwest of "F" Group
4	Landfill west of "D" Group
5	Landfill west of Army Barricades
7	Landfill south of "P" Barricades
10	Scrap Metal Landfill near Building 589
11	Contract Ordnance Disposal Area

Site No.	Site Title
19	Paint Chip and Sludge Disposal Area adjacent to Building S-34
20	Grit Blasting Disposal Area adjacent to Building 544
22	Paint Chip Disposal Area adjacent to Building D-2
26	Explosive "D" Washout Area adjacent to Building GB-1

1.3 OBJECTIVES OF THE CURRENT IRP PHASE III EFFORT

The primary objective of the RI/FS is to further the remedial investigations of the sites at NWS Earle. This will provide information to conduct feasibility studies needed to evaluate potential alternatives. This process will determine which sites present a threat to human health or the environment and which sites do not. Plate 1 shows the locations of the sites. The numbers associated with the sites were assigned when the sites were ranked during Phase I. Other sites identified during the PA are being studied in a separate SI.

This Work Plan is designed to meet the following objectives:

- Confirm the absence or presence of contamination identified by the Confirmation Study.
- Delineate the extent of contamination, if any.
- Classify the sites into two categories:
  - No action (candidate for risk assessment).
  - Potential action (candidate for feasibility study).
- Identify what, if any, data are required to complete the risk assessments at the no action sites or to complete the RI/FSs at all remaining sites.

1.4 IRP PHASE III PLANNING DOCUMENTS

1.4.1 IRP Phase III Work Plan

This Work Plan has been developed to address the scope of work for IRP Phase III activities at NWS Earle and is based on the recommendations included in the "Draft Report for Naval Weapons Station Earle, Colts Neck, New Jersey, Installation Restoration Program Phase II - Confirmation Study," prepared by Roy F. Weston, Inc. (WESTON) in September 1986 and the "Draft Report of Current Situation and Draft Plan of Action," prepared by WESTON in 1989. These have been submitted to the Navy, the New Jersey Department of Environmental Protection (NJDEP), and the U.S. Environmental Protection Agency (EPA). This Work Plan and the subsequent planning documents will be submitted to the NJDEP and the EPA Region II office.

1.4.2 Quality Assurance Project Plan

WESTON has prepared a separate Quality Assurance Project Plan (QAPP) for field activities, sampling, analytical, and data handling aspects for the RI/FS. The QAPP is consistent with the standard procedures of WESTON's EPA-approved laboratory and the requirements of Naval Energy and Environmental Support Activity (NEESA) for analytical methods. Field sample collection and laboratory analyses will be documented in accordance with WESTON's standard chain-of-custody procedures. The QAPP addresses the following areas:

- Quality assurance (QA) objectives for data precision, accuracy, completeness, representativeness, and comparability.
- Sampling and laboratory procedures.
- Protocols for geophysical surveys, soil investigations, drilling, well construction and installation, and site management.
- Sample custody.
- Calibration procedures, references, and frequencies.
- Internal quality control (QC) checks and frequencies.
- QA performance audits, system audits, and frequencies.
- QA reports to management.
- Preventive maintenance procedures and schedules.
- Specific procedures to routinely assess data precision, representativeness, comparability, accuracy, and completeness for specific parameters.

- Corrective actions.

1.4.3 Health and Safety Plan

WESTON has also developed a separate site-specific Health and Safety Plan(HSP)/Site Security Plan. The Health and Safety Plan is consistent with the following:

- EPA Order 1440.1 - Respiratory Protection.
- EPA Order 1440.3 - Health and Safety Requirements for Employees Engaged in Field Activities.
- EPA Occupational Health and Safety Manual.
- Other appropriate EPA guidance.
- Applicable standards of the Occupational Safety and Health Administration (OSHA).
- EPA Interim Standard Operating Guide (September 1982).

The HSP includes the following elements:

- Proposed dates of investigation (tentative and final).
- Investigation objectives.
- Site-specific concerns including:
  - Apparent levels of hazards (serious, moderate, low, none, unknown) with notes.
  - Types of facilities (impoundment, dump landfill, open, enclosed, other).
  - Status of facilities (active, inactive, unknown).
  - Waste types (gas, liquid, sludge, solid, unknown, other).
  - Waste characteristics (toxic, corrosive, ignitable, volatile, radioactive, reactive, unknown, other).
  - Types/forms of hazards (dust, liquid, fume, vapor, contact, respiratory, other) and levels dangerous to life and health.
  - Levels of protection (A, B, C, D, and any modifications).

- Surveillance equipment (explosimeter, oxygen detector, Draeger pumps and tubes, organic vapor analyzer, photoionization detector).

- Histories of site activities.
- Hazard evaluations.
- Safety logistics including:
  - Team size (contractor, client, regulatory, other) and designation of team leader and safety officer.
  - Team briefing date and time.
  - Contamination control area locations (initial and alternate).
  - Command post locations (initial and alternate).
  - Hot-line locations (initial and alternate).
  - Personnel decontamination stations.
- Emergency precautions including:
  - Acute exposure symptoms and associated first aid.
  - Hospital/poison control centers (addresses, telephone numbers).
  - Emergency transportation systems (fire, police, ambulance).
  - Emergency routes for medical evacuation.

The Site Security Plan has as its objectives the protection of the community and workers from potential endangerment, the protection of site conditions from further degradation due to vandalism or criminal action, and the protection against vandalism and theft of any equipment required to be kept on site. The Site Security Plan will be incorporated with the HSP and will delineate efforts required to secure operations at the site.

1.4.4 Community Relations Plan

Community relations activities will be directed by NWS Earle. The primary contact is the Station Public Affairs Office.

SECTION 2

BACKGROUND

2.1 BASE PROFILE

2.1.1 Description of Base, History, and Current Organization

NWS Earle is located on 11,134 acres of land in the communities of Middletown, Colts Neck, and New Shrewsbury in Monmouth County, New Jersey (see Figure 2-1). Other nearby communities (within 10 miles) include Neptune, Ocean, Farmingdale, Freehold, Eatontown, Atlantic Highlands, and Holmdel. The nearest major commercial jet airport is located in Newark, 55 miles to the north. Access to the main entrance of NWS Earle is provided via U.S. Route 34.

NWS Earle was commissioned as a Naval Ammunition Depot on 13 December 1943. Its primary responsibility is to furnish ammunition to the fleet.

The major consideration in the original selection of the station's location was its proximity to New York City. The station provided ships, particularly those in convoy during World War II, the ability to take on ammunition without delay. This ability was increased by the accessibility of Raritan Bay. The advantages of an interconnected commercial rail facility with lines leading from the west, the direction from which the majority of ammunition shipments would originate, provided the location with the ability to receive shipments.

Ordnance, the station's major department, coordinates all port services and logistic support to visiting and homeported ships, conducts safety inspections, supervises ammunition loading for the United States Coast Guard, and provides an afloat firefighting capability and standby tug services.

The ammunition distribution and control division, in concert with the production planning and control division, ensures that a balanced, purified stock of ammunition is maintained in support of Navy, Coast Guard, and Marine programs.

The operations division performs all ammunition movement and ship loading. Additionally, obsolete ammunition is demilitarized. The operations division also recycles reclaimable components and renovates various types of ammunition.

The ASW and special weapons divisions plan and carry out station-level maintenance of air and anti-submarine weapons and provide shore-based support to various commanders.

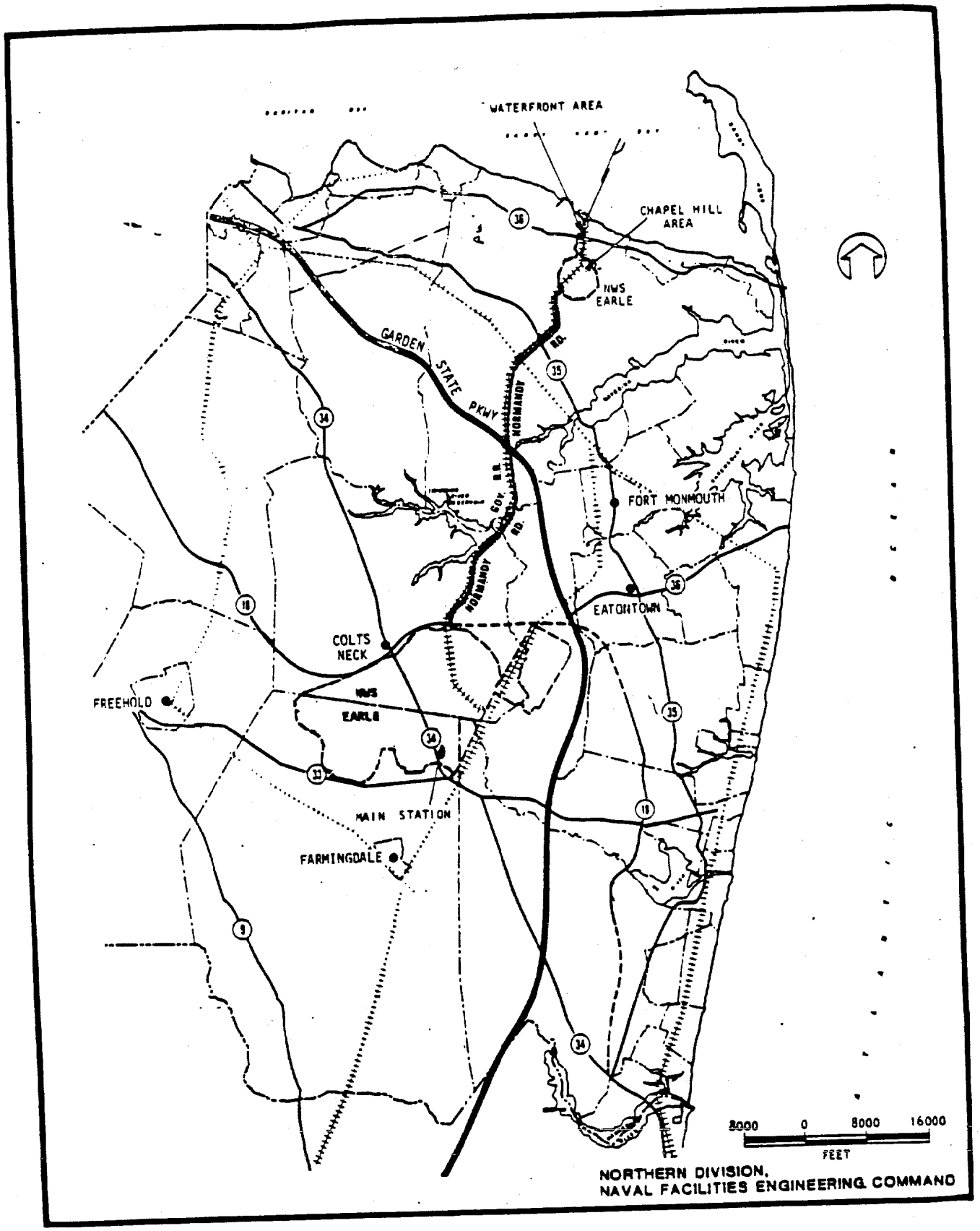

FIGURE 2-1 REGIONAL SITE MAP

The port services division operates the station fireboat, service craft, and oil pollution containment equipment in addition to providing coordination of a full range of port services for visiting and homeported vessels.

The land and associated facilities of NWS Earle are currently used to support the strategic mission of the station.

2.1.2 Physical Facilities

2.1.2.1 Wastewater Treatment

Storm drainage at NWS Earle ultimately discharges to the Swimming River, the Shark River, or the Manasquan River.

2.1.2.2 Station Water Supply and Well Inventory

NWS Earle is currently supplied with potable water from two sources: (1) west of Route 34, water is supplied by on-site production wells that feed the main water distribution system and several smaller wells that feed remote locations not connected to the main system; and (2) east of Route 34, the water supply is obtained from a hookup with the New Jersey American Water Company. The source of this water is the Swimming River surface reservoir.

The main supply wells for the station are screened in the Cretaceous Englishtown deposits, with total depths from 240 to 480 feet below ground. Well yields range to 410 gallons per minute (gpm) in the large-diameter wells. All wells combined supply 720,000 gallons per day (gpd) to the station. Current water usage is estimated to be 230,000 gpd. Figure 2-2 shows the locations of active water supply wells at NWS Earle.

Sources of information include NWS Earle personnel and the United States Geological Survey (USGS) office in Trenton, New Jersey.

2.1.3 Past Waste Management Practices

Past activities in support of munitions maintenance operations at NWS Earle have resulted in the disposal of wastes including solvents, paint strippers, and paint chips. The total quantity of the wastes is unknown; however, crude estimates are reported in the F.C. Hart IAS (Hart, 1982). In addition to the industrial wastes, outdated munitions were disposed of through controlled burning and or detonation.

Past industrial waste was disposed of along with domestic refuse. Controlled burning of the waste in trenches preceded burial at some disposal sites.

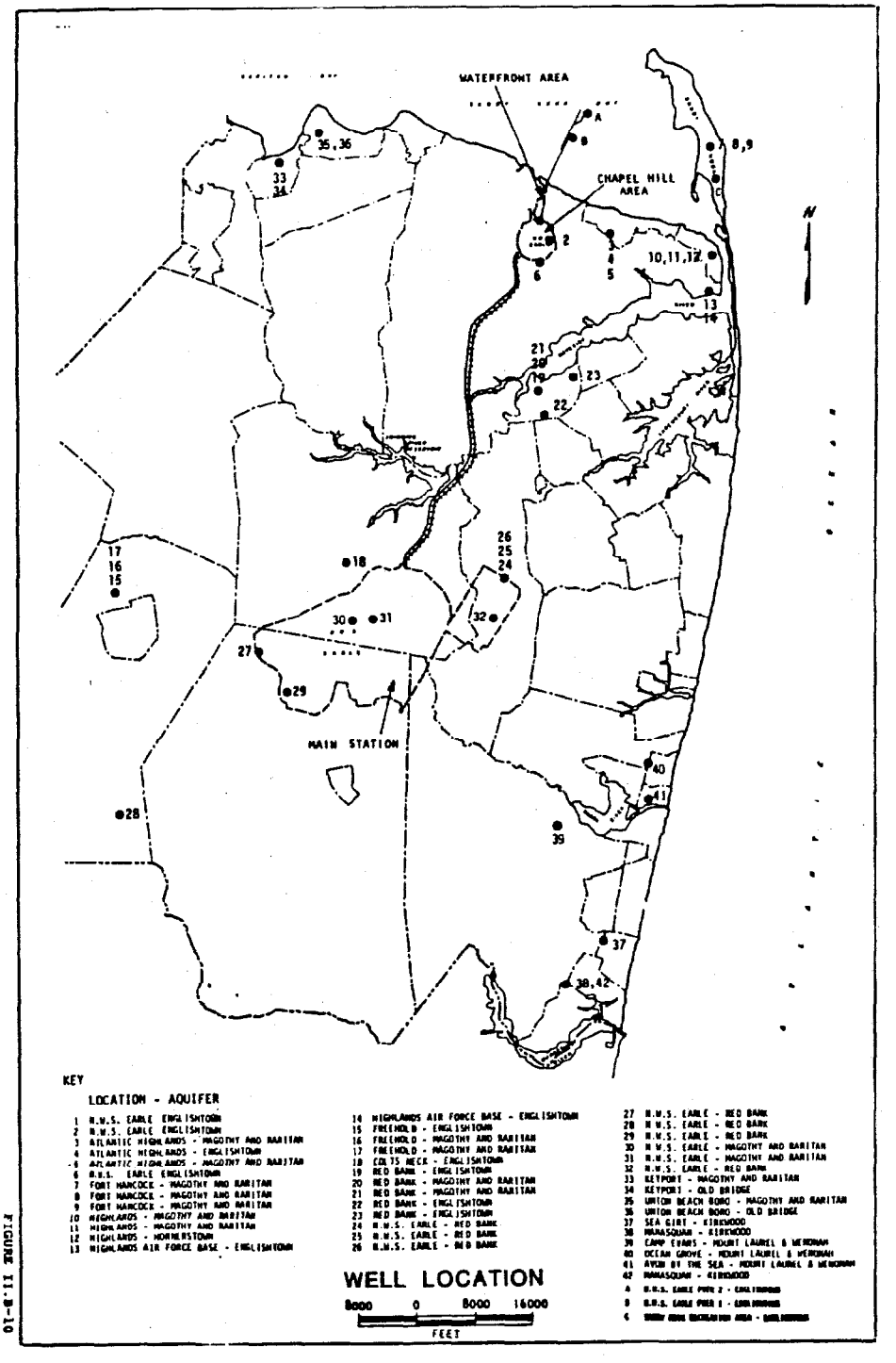

FIGURE 2-2 ACTIVE PRODUCTION WELLS

6160B

Currently, station refuse is disposed of by contract collection. The refuse is directed to the county-managed Monmouth County Reclamation Center in Tinton Falls. The center consists of a combined recycling center and landfill.

2.1.4 Previous Investigations

Previous subsurface and water quality investigations at NWS Earle have focused on identifying, evaluating, and quantifying the hazards at each site. Those investigations are reviewed separately as follows.

2.1.4.1 Phase I Study

The Phase I IAS was conducted by F.C Hart in late 1982, and the Final Report was dated February 1983. Twenty-nine past disposal sites were identified in the report, and four were recommended for further study.

After consultation and coordination with the EPA and the NJDEP, 11 sites (9 sites identified during the IAS and Site 20 and Site 22) were determined to require a CS, although none of the 11 sites was considered to pose an immediate threat to human health or the environment. Possible contaminants at the 11 sites to be investigated during Phase III are summarized in Table 2-1.

2.1.4.2 Phase II Study

The CS report for NWS Earle was submitted by WESTON in December 1986. Field work for the Phase II study was performed between October 1984 and January 1986. The Phase II field investigations included surface geophysics (ground penetrating radar and magnetometry) at selected sites, power auger borings for soil sampling and subsurface characterization, exploratory drilling and installation of 29 permanent monitor wells, groundwater and surface water sampling and analysis, and sediment sampling and analysis of selected streams and ditches. Field investigations and the results of those investigations are described in detail in the report titled "Interim Report, Confirmation Study to Determine the Existence and Possible Migration of Specific Chemicals In Situ, NWS Earle, Colts Neck, New Jersey," (WESTON, 1986)

Figure 2-3 is a map showing the locations of the sites investigated during the IRP Phase II investigation.

2.2 SITE-SPECIFIC BACKGROUND

The following summarizes the information from earlier investigations for each of the sites to be included for further work during IRP Phase III. For more information on each site, refer to the Phase II report (WESTON, 1986). Site outlines, locations of sampling points, and the locations of monitor wells installed during the Phase II investigation are shown in the site maps.

Table 2-1

Phase III Sites and Contaminants, NWS Earle, Colts Neck, NJ

Site No.	Description	Possible Contaminants
2	Ordnance demilitarization site	Ammonium picrate Trinitrotoluene C4 Black powder Nitroglycerin
3	Landfill southwest of "F" Group	Solvents Acids Alcohols Caustics Pesticides Paint thinner Paint Xylenes
4	Landfill west of "D" Group	Solvents Acids Alcohols Caustics Pesticides Paint thinner Paint Xylenes
5	Landfill west of Army barricades	Solvents Acids Alcohols Caustics Pesticides Paint thinner Paint Xylenes

Table 2-1
(continued)

Site No.	Description	Possible Contaminants
7	Landfill south of "P" barricades	Solvents Acids Alcohols Caustics Pesticides Paint thinner Paint Xylenes
10	Scrap metal landfill	Paint chips
11	Contract ordnance disposal area	Petroleum hydrocarbons Explosives
19	Paint chip/sludge disposal area	Paint Solvents
20	Grit blast disposal area	Paint chips
22	Paint chip disposal area	Paint chips
26	Explosive "D" washout area	Ammonium picrate

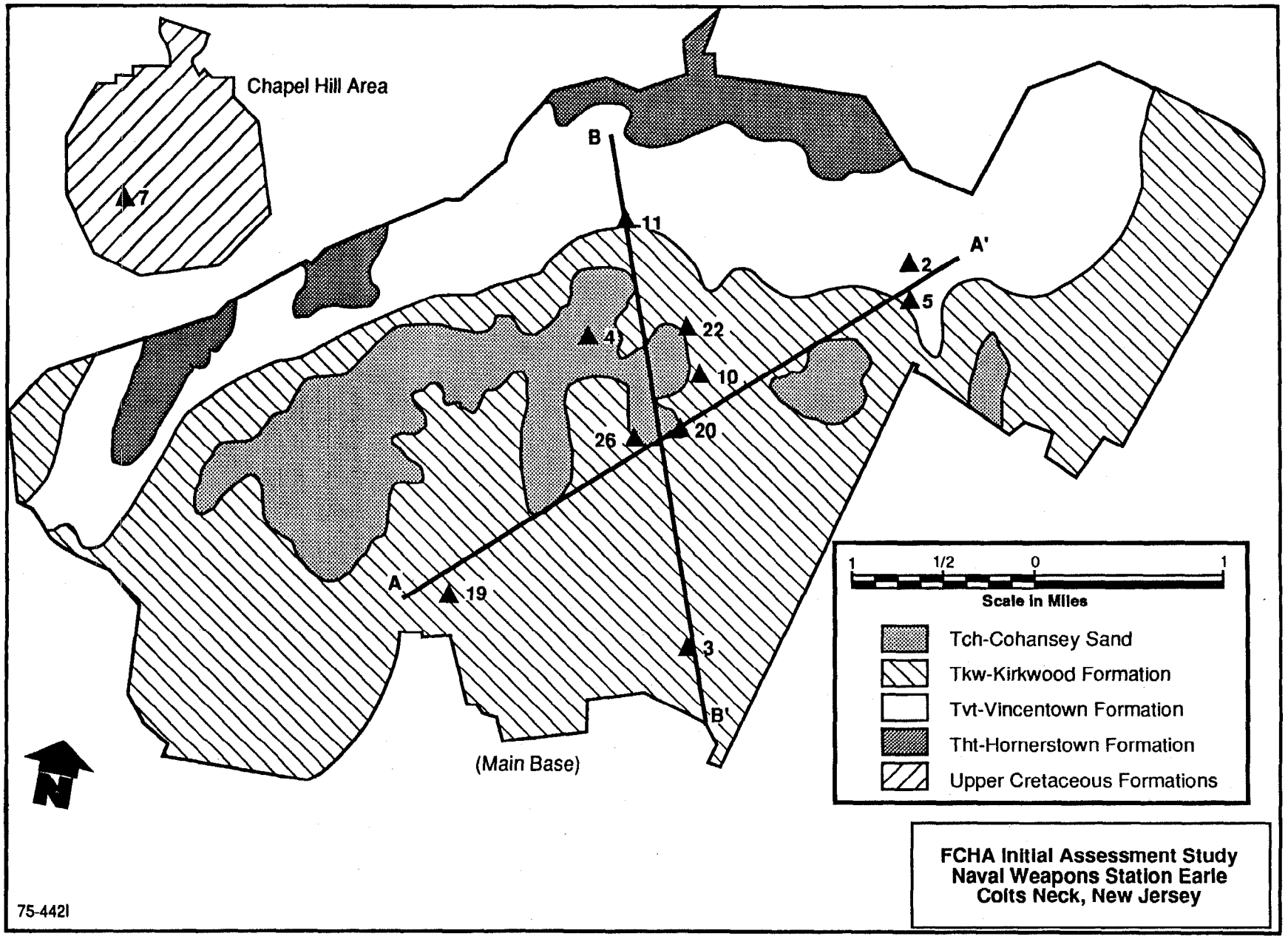

FIGURE 2-3 MAP OF SURFICIAL GEOLOGY AND SITE LOCATIONS

2.2.1 Site 2: Ordnance Demilitarization Site

Site 2 has been used for the demilitarization of ordnance materials by thermal destruction methods. Site 2 is currently used on an as-needed basis for ordnance demilitarization. It is undergoing a RCRA Part B application. Some explosives and propellants demilitarized include ammonium picrate, trinitrotoluene (TNT), C-4 (waxed RDX), black powder, and double-base propellants (nitroglycerin).

2.2.2 Site 3: Landfill Southwest of "F" Group

The IAS estimates that this 5-acre landfill may have received approximately 4,800 tons of refuse over its 9-year period of operation. Wastes disposed of there typically included municipal and industrial wastes and may have contained glass, paper, plastics, solvents, acids, alcohols, caustics, pesticide containers, paint thinner, and paint. Typical paint used at NWS Earle consists of the following chemical compounds:

- Titanium dioxide.
- Zinc oxides.
- Magnesium silicate.
- Alkyd resin solution.
- Petroleum spirits.
- Lead naphthenate.
- Cobalt naphthenate.
- Manganese naphthenate
- Xylenes.

2.2.3 Site 4: Landfill West of "D" Group

The IAS estimates that this 5-acre site may have received approximately 10,200 tons of municipal and industrial wastes similar to those disposed of at Site 3 over a period of 17 years. Disposal methods used at this site include open trench burning of some wastes before burial.

2.2.4 Site 5: Landfill West of Army Barricades

The IAS estimates that 6,600 tons of waste may have been disposed of at this 13-acre site over its 10-year period of operation. The wastes are very similar to the wastes described for Site 3.

2.2.5 Site 7: Landfill South of "P" Barricades

Site 7, located near the waterfront area in Leonardo, operated for approximately 12 years and, according to estimates, received less than 2,500 tons of refuse per year. Wastes disposed of at this 15-acre landfill typically included munitions shipping material (dunnage, etc.) and may have included glass, wood, waste paint, solvents, thinners, and some domestic refuse.

2.2.6 Site 10: Scrap Metal Landfill near Building S-589

The IAS found that this 2-acre site was used to dispose of aluminum and steel containers and spent shell cases. Paint chips and spent blasting grit from maintenance operations were also disposed of at this site.

2.2.7 Site 11: Contract Ordnance Disposal Area

The IAS found that this 2-acre site was used by an outside contractor to dispose of obsolete ordnance material using thermal destruction techniques. It was also used as a training area for firefighting exercises for approximately 3 years. The exercises were conducted in two unlined pits measuring roughly 30 feet in diameter and 2 feet in depth using oil-soaked, reject airplanes and vehicles. The area was secured at a later date (after 1977) by removing the soil and regrading the area.

2.2.8 Site 19: Paint Chip and Sludge Disposal Area Adjacent to Building S-34

The IAS found that this site was used for the periodic renovation of depth charges over a period of 20 years. Operations at this site involved the removal of loose paint and rust on the exterior of the munitions, including wire brushing aided by solvent baths, followed by a final wash with water. The quantities of waste disposed of at this site are unknown.

2.2.9 Site 20: Grit Blast Disposal Area at Building 544

Building 544 housed blasting operations for the removal of paint from mines. The paint removed from mines, along with spent grit, was disposed of in a 15- x 100-foot area behind Building 544. The IAS assumed a steady-state operation (i.e., paint applied this year will be removed over subsequent years). It estimates a volume of paint chips equivalent to roughly 53 gallons of wet paint per year was disposed of at this site. Paint chips typically contain lead and zinc.

2.2.10 Site 22: Paint Chip Disposal Area Adjacent to Building D-2

This site was used to dispose of paint chips. Approximately 50 square feet of stressed vegetation and discolored (black) soils were found behind Building D-2.

2.2.11 Site 26: Explosive "D" Washout Area (Building GB-1)

Site 26 was used for the removal and recovery of ammonium picrate (explosive "D") from 5-inch shells over a 1-year period. High-pressure hot water was used to wash out the soluble explosive (1 g in 78 mL of H_2O at 20°C). The discharge containing the explosive compound flowed into a chain of cascading tanks located within the building, allowing the water to cool, and precipitating the ammonium picrate. The discharge from these tanks flowed out of the building through an open tile pipeline into an unlined settling basin behind the building. The effluent was then allowed to evaporate from the basin or to percolate into the soil.

SECTION 3

ENVIRONMENTAL SETTING

3.1 PHYSICAL ENVIRONMENT

3.1.1 Physical Geography

NWS Earle is located in the Coastal Lowlands of Monmouth County in eastern New Jersey. This area falls within the Atlantic Coastal Plains Physiographic Province, approximately 6 miles inland from the Atlantic Ocean.

The station is divided into three physically separate areas, the largest being the Main Base (10,428 acres), and the smaller being the waterfront and Chapel Hill areas (706 acres, combined).

The Main Base lies within the Outer Coastal Plain, a relatively flat area with little topographic relief, except for the Hominy Hills. The Hominy Hills are a northeast-trending set of low hills near the center of the Main Base. Elevations there range from approximately 100 to 300 feet above mean sea level (MSL).

The waterfront area is on the southern coast of Sandy Hook Bay -- an inlet on New Jersey's Atlantic coastline. This area is known as the Bayshore Lowlands. The waterfront property occupies a long strip of land perpendicular to the shore. Much of the area is swamp or tidal marsh, and there are also areas of made land (fill). Average elevation is about 10 feet above MSL. A pier extends 2 miles offshore into the bay to where the water is about 20 feet deep.

The Chapel Hill area is approximately 1 mile inland and is connected to the waterfront area by private road and rail line. It occupies a polygonal plot of land, roughly circular in outline. The Chapel Hill area falls within the Highland-Mt. Pleasant Hills area and has the most topographic relief of NWS Earle. The Highland-Mt. Pleasant Hills form the drainage divide between the Inner and Outer Coastal Plains. Average elevation is about 100 feet above MSL. The Chapel Hill area contains the topographic high point of the area, at the High Point Chapel, near 200 feet above MSL.

3.1.2 Climate and Air Quality

The Main Base area is characterized by a predominantly continental climate with significant seasonal, daily, and day-to-day temperature fluctuations. High humidity occurs frequently along the coast and less frequently inland. Freezing temperatures occur intermittently from October to April. The average first frost occurs on October 17, and the average last frost occurs on April 24, allowing for an average growing season of 198 days. The average annual precipitation is 44.67 inches at Long Branch and 41.82 inches at Newark. The annual peak

daily rainfall (1-year, 24-hour) is greater than 2.5 inches. The mean annual temperatures are 56.2°F and 45.2°F, respectively (see Table 3-1).

Because of its location near the coastline, Monmouth County is subject to easterly storms throughout late summer and early fall, causing high tides and flooding. Intense tropical hurricanes occasionally sweep the coast. The winter is characterized by storms that move along the eastern seaboard. The storms from the north are associated with high winds and precipitation in the form of snow, ice pellets, or rain; however, the snow is seldom prolonged or heavy.

Spring is a period of contrasting weather, particularly during April. Spring and autumn are periods of frost. Summer is warm and humid with occasional showers and thunderstorms. Ground fog is a frequent weather occurrence in the summer, especially during the early morning hours. Autumn is a season of comfortable temperatures (average temperature 50° to 60°F) and generally pleasant weather.

Winds are highly variable in the area of NWS Earle. The dominant winds are from the northwest during the winter and early spring. Onshore winds predominate during the spring and summer.

While the climate of a large area in and around NWS Earle can be described generally, the microclimates, or climates in small areas, may differ from the general climate of the area. For example, temperature, wind velocity, light, and humidity on the Main Base are quite different from the conditions at the waterfront due to the influence of the bay. Therefore, plants and animals that may not seem suited for the general climate may indeed be present but are restricted to the microclimate created by the unusual environmental conditions of a specific location.

The NJDEP maintains air quality monitoring instrumentation at Freehold and Asbury Park in Monmouth County. The NJDEP also samples for particulates at Asbury Park, Brielle, Millstone Township, and Red Bank in Monmouth County. All of New Jersey is classified as a non-attainment area for ozone. Carbon monoxide (CO) concentrations in Freehold exceeded the 9-ppm, 8-hour average primary standard (National and New Jersey Ambient Air Quality Standards) twice in 1980 (10.8 and 9.4 ppm CO). Monmouth County air quality complies with all other Ambient Air Quality Standards (NJDEP, 1980).

3.1.3 Surface Drainage

Located just a few miles inland, all rivers and streams draining NWS Earle ultimately discharge to the Atlantic Ocean.

The headwaters and drainage basins of three major Coastal Plain rivers, the Swimming, the Manasquan, and the Shark, are present on the Main Base. The northern half of the Main Base is in the drainage basin of the Swimming River, and tributaries include Mine Brook, Hockhockson Brook, and Pine Brook. The southwestern portion of the Main Base drains to the Manasquan River via either Marsh Bog Brook or Mingamahone Brook. The south-

Table 3-1

Representative Meteorological Data, NWS Earle Region[a]

Month	Temperature (°F) Daily Maximum	Daily Minimum	Monthly Average
January	38	24	31
February	40	25	32
March	49	34	41
April	62	43	52
May	70	53	62
June	81	63	72
July	85	69	77
August	85	68	76
September	77	61	69
October	66	48	57
November	54	39	46
December	44	31	37

[a]Daily maximum, minimum, and average temperatures by month for the 1965 to 1974 period of record at the Newark International Airport (U.S. Department of Commerce, 1978).

eastern corner of the Main Base drains to the Shark River. Both the Swimming River and the Shark River supply water to reservoirs used for public water supplies.

Surface water drainage from the waterfront area enters Sandy Hook Bay. Much of this area is under tidal influence.

Most of the surface drainage from the Chapel Hill area flows north to Sandy Hook Bay via Compton, Ware, and Wagner Creeks. A very small area at the topographically high southern end of the Chapel Hill area drains south through McClees Creek to the Navesink River.

3.1.4 Soils

The soils at NWS Earle are generally distributed in northeast/ southwest-trending belts that parallel the outcrop patterns of the underlying geologic units. More than half of the identified soil types in Monmouth County are found on the NWS Earle facility.

The dominant soil in this area is sandy and well drained. The soils typically have high iron and sulfur contents and many are acidic.

Acidic soils form from the weathering of pyrite (sulfur ore) or lignite (low-grade coal) contained in the sedimentary deposits. When exposed to air and water these materials form corrosive sulfuric acid. Severely acid soils with pH values as low as 3.5 can be developed naturally in some of the soils found at NWS Earle.

Poorly drained soils are typically organic-rich and occur in low-lying areas such as swamps, marshes, and flood plains. These poorly drained unconsolidated sediments are prone to settlement and subject to flooding and tides.

At the Main Base the most prevalent soils include the Lakewood, Lakehurst, Leon, and St. Johns Series. These range from well-drained sandy soils to very poorly drained flood plain soils adjacent to streams and swamps. Highly acid black soils have been exposed at various depths on the Main Base by construction activities. The black soils are apparently related to lignite- rich clays of the Kirkwood Formation, which crops out across the southern end of the station.

Soils in the Chapel Hill area include the Collington, Sassafras, and Colts Neck Series, which are generally well-drained sandy to loamy sand soils. Few streams and flood plains occur in the area. No black acid soils have been uncovered in the Chapel Hill area.

Tidal marsh soils and beach sands predominate in the waterfront area. The natural conditions have also been substantially altered by manmade filled land reclaimed from the marsh (i.e., the railroad trestle area near the shore) and by the presence of several (now closed) sanitary landfills. Sandy areas, such as along the shore of the bay and south and east of the pier, range from loamy sand to silt loam and are typically well drained. The tidal marsh soils, soft organic-rich silts, sands, and clays are poorly drained and are typically

flooded twice daily by the tides and occasionally by storms. The boundaries of the raised landfill areas are subject to minor erosion. Acidity problems due to black soils have not been encountered in the waterfront area.

The determination of naturally occurring levels of metals in soils at the station has not been undertaken during the previous investigations. During the preparation of this Work Plan, WESTON has performed a cursory examination of published soil analyses results from the United States Soil Conservation and Stabilization Service (SCS), the United States Geologic Survey, and the State of New Jersey. This examination did not identify naturally occurring levels.

3.1.5 Surficial Geology

The geologic setting at NWS Earle consists of a thick wedge of layered unconsolidated sediments that dip seaward (southeast). The sedimentary formations of the Coastal Plain are exposed at the surface in a banded outcrop pattern roughly parallel to the shore.

These sedimentary units are formed of interbedded sands, gravel, silt, and clay. They tend to thicken downdip (in the seaward direction) because they were deposited on the edge of the ocean basin. The coarser, more permeable deposits form aquifers, while the interbedded fine sediments form confining beds that restrict the vertical flow of water. A stratigraphic column from USGS Open File Report 84-730 is shown in Figure 3-1.

The total thickness of the sediments is on the order of 1,300 feet inland to over 6,000 feet near the shore. The crystalline bedrock surface itself dips gently to the southeast at 80 to 100 feet per mile. Successively younger units have a decreasing upward dip that drops to about 10 feet per mile for the uppermost sedimentary layers.

The sedimentary formations range in age from late Cretaceous to post-glacial. Rocks of intermediate age (post-Precambrian but pre-Cretaceous) were presumably removed by erosion prior to the deposition of the present strata.

The depositional environment of the Coastal Plain sediments represents alternating periods of marine transgressions and regressions. Finer-textured sediments represent quiet water conditions (i.e., deeper marine or backshore lagoons), while coarser textures represent higher energy zones (i.e., beachfront or streams). The last major depositional event resulted from the Pleistocene glaciation. NWS Earle falls outside the southern limit of the Wisconsin terminal morraine. Minor transgressions of the sea due to glacial melting resulted in some Pleistocene deposits at lower elevations.

The oldest formation, located at the bottom of the sedimentary sequence, is the Raritan Formation, a medium- to coarse-grained arkosic sand unit up to 400 feet thick. Despite the presence of minor interbedded kaolinitic clay layers, it is a very important regional aquifer and supplies water for many municipal wells. Due to its similarity in composition, the Raritan is commonly lumped with the next-youngest unit, the Magothy Formation. The Magothy is also dominantly sand (fine-grained, micaceous, and lignitic) and up to 175 feet

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Geologic and hydrogeologic units in the Coastal Plain of New Jersey.

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	HYDROGEOLOGIC UNIT	HYDROLOGIC CHARACTERISTICS
Quaternary	Holocene	Alluvial deposits	Sand, silt, and black mud.	Undifferentiated	Surficial material, often hydraulically connected to underlying aquifers. Locally some units may act as confining beds. Thicker sands are capable of yielding large quantities of water.
		Beach sand and gravel	Sand, quartz, light-colored, medium- to coarse-grained, pebbly.		
	Pleistocene	Cape May Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly.		
Tertiary	Miocene	Pensauken Formation		Kirkwood-Cohansey aquifer system	A major aquifer system. Ground-water occurs generally under water-table conditions. In Cape May County the Cohansey Sand is under artesian conditions.
		Bridgeton Formation			
		Beacon Hill Gravel	Gravel, quartz, light colored, sandy.		
		Cohansey Sand	Sand, quartz, light-colored, medium to coarse-grained, pebbly; local clay beds.		
		Kirkwood Formation	Sand, quartz, gray and tan, very fine- to medium-grained, micaceous, and dark-colored diatomaceous clay.	confining bed	Thick diatomaceous clay bed occurs along coast and for a short distance inland. A thin water-bearing sand occurs within the middle of this unit.
				Rio Grande w-bz[1]	
				confining bed[2]	
				Atlantic City 800-foot sand	A major aquifer along the coast.
				Composite confining bed	Alloway Clay member or equivalent
	Eocene	Piney Point Formation	Sand, quartz and glauconite, fine- to coarse-grained.	Piney Point aquifer	Yields moderate quantities of water locally.
		Shark River Formation	Clay, silty and sandy, glauconitic, green, gray and brown, fined-grained quartz sand.		Poorly permeable sediments.
		Manasquan Formation			
	Paleocene	Vincentown Formation	Sand, quartz, gray and green, fine- to coarse-grained, glauconitic, and brown clayey, very fossiliferous, glauconite and quartz calcarenite.	Vincentown aquifer	Yields small to moderate quantities of water in and near its outcrop area.
		Hornerstown Sand	Sand, clayey, glauconitic, dark green, fine- to coarse-grained.		Poorly permeable sediments.
Cretaceous	Upper Cretaceous	Tinton Sand	Sand, quartz, and glauconite, brown and gray, fine- to coarse-grained, clayey, micaceous.	Red Bank sand[2]	Yields small quantities of water in and near its outcrop area.
		Red Bank Sand			
		Navesink Formation	Sand, clayey, silty, glauconitic, green and black, medium- to coarse-grained.		Poorly permeable sediments.
		Mount Laurel Sand	Sand, quartz, brown and gray, fine- to coarse-grained, slightly glauconitic	Wenonah-Mount Laurel aquifer	A major aquifer.
		Wenonah Formation	Sand, very fine- to fine-grained, gray and brown, silty, slightly glauconitic.		
		Marshalltown Formation	Clay, silty, dark greenish gray, glauconitic quartz sand.	Marshalltown-Wenonah confining bed	A leaky confining bed.
		Englishtown Formation	Sand, quartz, tan and gray, fine- to medium-grained; local clay beds	Englishtown aquifer system	A major aquifer. Two sand units in Monmouth and Ocean Counties.
		Woodbury Clay	Clay, gray and black, micaceous silt.	Merchantville-Woodbury confining bed	A major confining bed. Locally the Merchantville Fm. may contain a thin water-bearing sand.
		Merchantville Formation	Clay, glauconitic, micaceous, gray and black; locally very fine-grained quartz and glauconitic sand.		
		Magothy Formation	Sand, quartz, light-gray, fine- to coarse-grained; local beds of dark-gray lignitic clay	Potomac-Raritan-Magothy aquifer system: upper aquifer	A major aquifer system. In the northern Coastal Plain the upper aquifer is equivalent to the Old Bridge aquifer and the middle aquifer is the equivalent of the Farrington aquifer. In the Dela. River Valley three aquifers are recognized. In the deeper subsurface, units below the upper aquifer are undifferentiated.
		Raritan Formation	Sand, quartz, light-gray, fine- to coarse-grained, pebbly, arkosic, red, white and variegated clay	conf bd; middle aquifer; conf bd	
	Lower Cretaceous	Potomac Group	Alternating clay, silt, sand, and gravel.	lower aquifer	
Pre- Cretaceous		Bedrock	Precambrian and lower Paleozoic crystalline rocks, metamorphic schist and gneiss; locally Triassic basalt, sandstone and shale	Bedrock confining bed	No wells obtain water from these consolidated rocks, except along Fall Line.

[1] Rio Grande water-bearing zone.

[2] ------ Minor aquifer not mapped in this report.

Modified from Seaber, 1965, table 3.

FIGURE 3-1 GEOLOGIC AND HYDROGEOLOGIC UNITS IN THE COASTAL PLAIN OF NEW JERSEY

thick, but the sands tend to be discontinuous and the clay interbeds more common. The Magothy and Raritan (combined) are typically described in drillers' logs as a series of alternating sand and silt beds. Together, these two units form a deep, thick, and important regional aquifer.

The next five units, from the Merchantville Formation up through the Wenonah Formation, are all part of the upper Cretaceous Matawan Group. The Merchantville Formation, a 60-foot thick, dark, micaceous, glauconitic silty clay, is often considered in combination with the succeeding Woodbury Clay, also a gray to black micaceous clay 60 or more feet thick. Together, these two clays range in thickness from 160 feet inland to 250 feet near the shore. They are generally non-water bearing and act as a single aquiclude.

The Englishtown Formation has a variable lithology that changes from a fine- to medium-grained sand inland to a clay-rich texture downdip, where it resembles the underlying Woodbury Formation and the overlying Marshalltown Formation. The Englishtown aquifer is an important source of water in Monmouth County.

The overlying Marshalltown is a relatively thin formation that consists of up to 50 feet of clayey, glauconitic quartz sand and clay.

The Wenonah Formation, at the top of the Matawan Group, is another micaceous, glauconitic sand. It tends to be fine to very fine grained and is up to 85 feet thick.

The Mount Laurel Sand is at the base of the next sedimentary sequence, the Monmouth Group, although it is sometimes grouped with the Wenonah because they tend to function as a single aquifer, 60 to 100 feet thick. The Mount Laurel is a very fine- to coarse-grained, glauconitic quartz sand.

The Navesink Formation is a sandy marl composed mostly of glauconite, quartz grains, and clay. It is an important source of water for home wells, yielding an average of 10 gpm or less.

The top of the Monmouth Group is represented by the Red Bank Sand, including the Tinton Sand, composed of up to 140 feet of medium to coarse micaceous sand plus partly pyritized lignite (important in groundwater geochemistry in that it lowers the pH and EH of the water). The unit contains a lower clay member of dark, fossiliferous, micaceous, glauconitic sandy clay.

The Hornerstown Sand is the basal Tertiary formation in Monmouth County, as well as the oldest unit in the Rancocas Group. It is a massive, green, glauconitic sand with interbedded shale. The lithology is homogeneous, and the thickness is fairly constant downdip, with an average thickness of 30 to 50 feet. The Hornerstown crops out along the northwestern boundary of the Main Base.

The Vincentown Formation is a fossiliferous quartz sand, up to 130 feet thick, that contains some coarse-grained glauconite and some clay. An upper member is a lime sand with

abundant fossil fragments. The Vincentown Formation is an important source of water for low-yield home wells, with an average range of 10 to 50 gpm. The Vincentown Formation crops out at the surface at the Main Base, covering approximately one-quarter of the station in a band along the northern border of the facility.

The Manasquan Formation at the top of the Rancocas Group (plus the overlying Shark River Marl) is clayey, glauconitic sand that varies in thickness from a few feet at the outcrop area to over 200 feet in the subsurface along the shore. Neither crop out at the Main Base but may be locally present at depth.

The Kirkwood Formation of the Miocene age is an important aquifer both regionally and locally. It crops out at the surface over two-thirds of the Main Base (the central and southern portions) as well as across the southern tier of Monmouth County.

In fact, most of the southern part of New Jersey consists of surface exposure of the Kirkwood Formation (grouped with the Cohansey Sand). Texturally, the Kirkwood consists of fine- to medium-grained quartz sand with some mica, some lignite, and some diatomaceous clay. A lower member is finer-grained, darker, and pebbly and contains some glauconite. The total thickness ranges from about 30 feet at the outcrop area on the station to 800 feet near the coast. The texture grades from fine-grained sand and silt inland (updip) to clay beds with finer strings of sand along the coast.

The Kirkwood is used locally for domestic wells and in other areas of the Coastal Plain for municipal supplies. Yields range from 15 to over 1,000 gpm, but the water is generally acidic and contains iron and sulfide.

The overlying Cohansey Sand is a light-colored medium- to coarse-grained quartz sand, occasionally pebbly, with local clay beds. In combination with the Kirkwood it forms a major unconfined aquifer throughout the New Jersey Coastal Plain. It produces brackish or salty water in some coastal areas. The Cohansey Sand crops out at the Main Base, forming the topographically prominent Hominy Hills area. No wells are known to top the Cohansey on the station. Due to its position at the top of the sedimentary sequence, the Cohansey provides recharge to the underlying aquifers, particularly the Kirkwood.

Very young Quaternary sediments consist of highly organic silt plus clay in marshy or swampy areas, beach sands along the shore, and very recent stream sands and gravels.

3.1.6 Bedrock Geology

Bedrock in the Coastal Plain area consists of the Precambrian basement complex at a depth of 1,300 to 6,000 feet below ground. The basement complex consists primarily of Precambrian metamorphic rocks such as schist and gneiss. Minor amounts of Triassic basalt and/or early Paleozoic metasediments may also be present locally.

An erosional unconformity marks the top of the bedrock surface. There is a 400 million year gap in the geologic record between the underlying Precambrian and the overlying

Cretaceous units. Some of the missing geologic material removed by weathering and erosion is still present in the form of sediments within the current strata.

The top surface of the bedrock is an undulating plain that overall dips seaward, despite the highs and lows marking this erosional surface.

3.1.7 Hydrogeology

3.1.7.1 Regional Hydrogeology

The Atlantic Coastal Plain sediments are the most important source of potable water in the region. More than 75 percent of the fresh water supply in the New Jersey Coastal Plain is from groundwater.

The Coastal Plain province is composed of a wedge-shaped deposit of alternating layers of sand and clay that thickens to the southeast and overlies a crystalline basement. These deposits store and transmit water through interconnected pore spaces.

Recharge to the groundwater system is derived from precipitation, which averages 44 inches per year. Approximately 15 to 39 inches of this precipitation recharges the groundwater reservoir annually. In addition to precipitation in the outcrop areas, recharge is also provided by vertical leakage through confining beds and by seepage from surface water bodies.

The five principal Coastal Plain aquifers are the:

- Kirkwood-Cohansey aquifer system.
- Atlantic City "800-foot sand."
- Wenonah-Mount Laurel aquifer.
- Englishtown aquifer.
- Potomac-Raritan-Magothy aquifer system.

All but the Kirkwood-Cohansey are confined, except where they crop out or are overlain by permeable surficial deposits. NWS Earle is situated over the recharge area of many of these formations.

Water quality is generally satisfactory for drinking. Minor problems due to locally high iron concentrations occur in several aquifers, including the Potomac-Raritan-Magothy. Saline water is a problem in some coastal areas with unconfined aquifers and in deep portions of some confined aquifers.

In general, in the New Jersey Coastal Plain, the deeper aquifers are used for public water supplies, while near-surface aquifers are used for shallow domestic wells.

3.1.7.2 Local Hydrogeology at NWS Earle

Four sedimentary formations of the Coastal Plain crop out at the Main Base:

- The Hornerstown Sand.
- The Vincentown Formation.
- The Kirkwood Formation.
- The Cohansey Sand.

These units and their hydrologic significance are described in detail in Subsection 3.1.5. All these units are recharged by direct precipitation at the surface. Of particular importance are the Vincentown and Kirkwood Formations because they are used extensively for residential wells in the nearby area. None of the aquifers is used for municipal wells in the area. High iron content is a problem in these aquifers.

Groundwater flow from the Main Base is generally to the east/ southeast. Two deep water supply wells located on the Main Base tap the Raritan-Magothy aquifer system at depths of approximately 800 feet below ground. The outcrop and recharge areas of this aquifer system are located several miles north and west of the Main Base; therefore, water quality in these aquifers would not be affected by activities at NWS Earle.

Surface outcrops consist of the Navesink Formation and the Mt. Laurel and Wenonah Sands at the waterfront and Chapel Hill areas. These units are used for domestic wells, but not in the vicinity of NWS Earle. Residences adjacent to the waterfront and Chapel Hill areas are supplied by municipal water systems that use both deep wells and surface reservoirs.

Groundwater flow directions are shown in the site maps. Groundwater elevations for the site monitor wells are tabulated in Table 3-2. Depths to the first saturated zone determined during drilling are found in Table 3-3.

Groundwater contour maps for the sites have been presented as Figures 3-1 to 3-9 in the Confirmation Study Report (WESTON, 1986). Stratigraphic and lithologic information obtained during the monitor well installation is found in Appendix A of the CS. Construction as-built diagrams for the wells are found in Appendix B of the CS. Analytical data are found in Appendix D of the CS.

3.1.8 Background Water Quality

New Jersey classifies its surface waterways according to potential uses based on water quality. The streams and brooks found on the main section of NWS Earle are classified as FW2. The surface waterways in the Chapel Hill area are poorly defined. In the waterfront area the tidal reaches are brackish, and the water supply is not potable. However, estuaries are highly productive areas for development of aquatic communities, and food chains in these communities are potentially sensitive to manmade contaminants.

Table 3-2

Groundwater Elevations -- July 1986,
NWS Earle, Colts Neck, NJ

Well Number	Elevation of PVC Casing (feet above MSL)	Depth to Water (feet BGS)	Elevation of Groundwater (feet above MSL)
2-1	102.56	14.33	88.23
2-2	95.98	9.80	86.18
2-3	89.87	5.65	84.22
2-4	90.06	4.15	85.91
3-1	117.05	21.52	95.53
3-2	126.00	20.83	105.17
3-3	125.53	17.41	108.12
4-1	173.00	20.00	153.00
4-2	153.36	3.10	149.26
4-3	166.40	13.80	152.60
5-1	108.77	17.14	91.63
5-2	113.96	21.83	92.13
5-3	109.78	17.68	92.10
5-4	105.65	14.86	90.79
7-1	149.73	17.23	132.50
7-2	119.68	8.59	111.09
7-3	164.15	21.14	143.01
10-1	113.99	14.83	99.16
10-2	111.35	12.35	99.00
10-3	110.90	11.33	99.57
11-1	99.07	3.28	95.79
11-2	100.97	4.00	96.97
11-3	98.37	9.29	89.08
19-1	127.75	15.41	112.34
19-2	120.51	12.84	107.67
19-3	122.47	14.43	108.04
26-1	149.89	12.26	139.63
26-2	149.64	11.15	138.49
26-3	150.48	11.56	138.92

MSL - Mean sea level
BGS - Below ground surface

Table 3-3

Summary of Stratigraphic/Hydrogeologic Conditions Encountered During Phase II Investigations, NWS Earle, Colts Neck, NJ

Site No.	Existing Monitor Well Number	Stratigraphic Unit	Depth to First Saturated Zone (feet BGS)
2	2-1	Vincentown	20
	2-2	Vincentown	10
	2-3	Vincentown	5
	2-4	Vincentown	9
3	3-1	Kirkwood	25
	3-2	Kirkwood	15
	3-3	Kirkwood	10
4	4-1	Cohansey	21
	4-2	Cohansey	10
	4-3	Cohansey	14
5	5-1	Vincentown	19
	5-2	Vincentown	19
	5-3	Vincentown	20
	5-4	Vincentown	19
7	7-1	Red Bank Sand	25
	7-2	Red Bank Sand	4
	7-3	Red Bank Sand	20
10	10-1	Kirkwood	15.5
	10-2	Kirkwood	14
	10-3	Kirkwood	16
11	11-1	Vincentown	4
	11-2	Vincentown	4
	11-3	Vincentown	9

BGS - Below ground surface

Table 3-3
(continued)

Site No.	Existing Monitor Well Number	Stratigraphic Unit	Depth to First Saturated Zone (feet BGS)
19	19-1	Kirkwood	19
	19-2	Kirkwood	20
	19-3	Kirkwood	14
26	26-1	Cohansey	14
	26-2	Cohansey	10
	26-3	Cohansey	11

BGS - Below ground surface

The most important groundwater aquifers in the area of NWS Earle occur in the Englishtown, Vincentown, and Kirkwood-Cohansey Formations. Natural groundwater quality in these formations is good and is generally suitable for drinking water purposes. Local high concentrations of nitrate/nitrite occur and are generally associated with higher population densities.

3.2 HUMAN ENVIRONMENT

3.2.1 Population

NWS Earle is situated within the municipalities of Monmouth County, New Jersey; namely the towns of Colts Neck and Middletown. The information provided here relates to the population characteristics of these towns. NWS Earle itself does not have a sizeable active duty population in comparison to the overall population:

Officers - 20
Enlisted - 394

Total 414 Navy personnel

There are no non-active duty personnel as of 22 December 1988.

There are 700 civilians employed within NWS Earle. Approximately 90 percent of these civilian employees are located on the Main Base.

An estimate of the dependents of Navy personnel at the base is (as of 31 December 1988) 229 individuals. Thus, the total daytime population on the base is estimated at between 1,000 and 1,500.

Table 3-4 presents the historical and projected population data for the municipalities associated with NWS Earle, the planning region, and the county. During the period 1960 through 1980, the county population more than doubled. This shows that the immediate vicinity of NWS Earle is considered a growth area in terms of population and fast growing in terms of economic activities. As described in the Navy report, "Addendum to Environmental Assessment for Navy Housing," Monmouth County's population growth rate is expected to be slightly higher than the State's over the next 20 years.

There are a number of small communities located along or close to NWS Earle boundaries. The closest ones are Colts Neck, Green Grove, and Freehold. The actual population data for these communities are not available at this time.

3.2.2 Land Use

The primary information sources for land use at the station and for the municipalities are the USGS topographic quadrangle maps for the area (not currently up to date), aerial photographs, and the series of maps prepared for the Monmouth County Planning Board.

Table 3-4

Population Characteristics for New Jersey, Monmouth County, and Colts Neck Township

Population[a]	New Jersey	Monmouth County	Colts Neck Township
Percent change 1950 to 1982[b]	53.8	127.5	237.1
Percent change 1970 to 1982[b]	1.0	11.0	37.7
Percent under age 5	6.3	6.2	4.3
Percent under age 18	27.0	28.6	31.6
Percent age 65 and over	11.7	11.8	7.2
Median age	32.2	32.3	32.8
Persons per household	2.84	2.9	3.48
Percent black and other non-white	16.8	10.7	3.0

[a] All data are from the 1980 Census of Population unless otherwise noted.
[b] 1982 population estimates are from the New Jersey Department of Labor.
Sources: U.S. Department of Commerce, 1982; New Jersey Department of Labor, August 1983; New Jersey Department of Labor, September 1983.

Table 3-4
(continued)

Population Estimate	1980 Census	1 July 1985 NJ Dept. of Labor
New Jersey	7,364,823	7,562,000
Monmouth County	503,173	530,900
Colts Neck Township	7,888	8,102

The following land use categories are within 1 mile of the station (approximately 11,000 acres):

- Institutional (approximately 75 percent).
- Woodland.
- Abandoned land.
- Residential (small area along the Route 34 corridor).
- Agricultural (small portion).
- Extractive (a very small section).

Current land uses at the station include:

- Buildings/offices.
- Dormitories/residences.
- Transportation (roads).
- Recreational area.
- Medical clinics/community facilities.
- Open space.
- Undeveloped.

3.2.3 Socioeconomics

The following discusses the social setting of the communities in the vicinity of the station, the economic background, and the facilities and services available within the region. With approximately 645 military personnel (including dependents) and 700 civilian personnel at the station, this is an important economic influence in the overall growth of the region. Although the station is located outside any metropolitan area, it benefits the surrounding communities.

The payroll of the military sector of the community is estimated to be $4.5 million. The civilian payroll is estimated to be $22 million. Based on total annual gross wages of all military and civilian employees, local contract and military construction project expenditures, and expenditures for educational and health care services for base personnel and their dependents, the total economic impact (TEI) of the station to the local economy in Fiscal Year 1986 was nearly $26 million. It is estimated that the station has created a total of 1,710 secondary jobs within the local communities.

Traditionally, the Colts Neck region is a farming community area. However, the region now is in rapid growth, primarily converting farming to residential use.

The transportation system in the vicinity is based primarily on highways. The main access roads to the station are U.S. Route 34 and State Route 18. Access to the waterfront and Chapel Hill areas is controlled through guarded entrances to Normandy Road, a government-owned, two-lane road. A rail line used solely by the Navy links the Main Base and the waterfront areas. This rail line runs adjacent to Normandy Road. State Routes 36 and 35 cross under Normandy Road. There is no direct uncontrolled access to Normandy

Road from these highways. The area has community facilities and services available for the population. These include state parks, golf courses, schools, public institutions, hospitals, and police and fire prevention services.

3.3 BIOLOGICAL ENVIRONMENT

The biologic resources of the station are detailed in the F. C. Hart IAS report (see Appendix A). Additional biological inventories have been performed for the environmental impact statements for the "United States Navy Family Housing Project" and the "Modernization and Expansion of Logistic Support Systems Project." Both documents were examined and reviewed at the Atlantic Highlands Municipal Library.

SECTION 4

BASIS FOR PROGRAM APPROACH

4.1 CONTAMINANTS OF CONCERN

The contaminants of concern at a site are those compounds that are detected above background levels at the site and that are likely to have a significant impact on human health or the environment at the levels detected. The determination of those compounds that are most likely to pose a significant threat is normally based on one or more of the following:

- The existing data indicate the widespread presence of the compound at a site.
- The concentrations of the detected compounds are above the applicable action levels.
- The likely environmental fates of the compounds represent potential hazards based on toxicity, mobility, and/or persistence.

4.1.1 Identification of Contaminants of Concern at NWS Earle

At many sites studied during the IRP Phase II investigation at NWS Earle, the general screening parameters total organic carbon (TOC), total organic halogens (TOX), explosives, and petroleum hydrocarbons were used as the primary means for confirming the presence or absence of contamination. Limited compound-specific data for the contaminant groups such as volatile organic compounds (VOCs), Priority Pollutant metals, and explosives have been determined at some sites. In the absence of definitive data the following rationale was applied to determine the contaminants of concern for NWS Earle:

- Target compound groups were identified for each of the sites under study, based on the waste types known or suspected to have been disposed on the site.
- Where compound-specific data are available for the target groups at a site, the presence, concentration, and fate have been used to identify contaminants of concern within those target groups.
- Where compound-specific data are available for one site (e.g., a landfill), the same contaminants of concern were identified by analogy at sites with similar waste types (e.g., other landfills and construction rubble dumps) but without compound-specific data.
- In the absence of compound-specific data for a target compound group at a site or analogous sites at NWS Earle, particular compounds in the target

group that are known to have been in use on Navy installations during the period of operation of the site were identified as contaminants of concern. For example, at a site where solvents are included in the waste type, VOCs were identified as the target compound group. The compounds that are identified as the contaminants of concern are listed in Table 4-1.

- Compound-specific data are available for the base-neutral/acid-extractable compounds (BNAs) for groundwater at all sites except Sites 20, 22, and 26. BNAs were identified as a target contaminant group at those sites containing waste oils or combustion by-products of waste oils and fuels and at the landfills and sites where the waste types are essentially unspecified.

The contaminants of concern at NWS Earle are summarized in Table 4-1. The list of contaminants of concern is preliminary and will be revised as compound-specific data become available.

4.1.2 Physicochemical Properties of Contaminants of Concern

The physicochemical properties of the contaminants of concern identified in Table 4-1 have been summarized in Table 4-2. A brief explanation of each property is given in the following. Each of these properties controls, to some extent, how a compound interacts with and migrates in different media; therefore, it affects both the environmental fate and the potential remediation of a compound.

- Specific Gravity - The ratio of the density of a compound in its pure form to the density of water. Compounds having a specific gravity less than 1.0 will tend to float on water. Compounds having a specific gravity greater than 1.0 will tend to sink through water until they reach an impervious or low-permeability layer.

- Vapor Pressure - The pressure exerted by a vapor in equilibrium with its liquid form. A liquid is volatile (high vapor pressure) or non-volatile (low vapor pressure).

- Log Octanol/Water Partition Coefficient - An indicator of a compound's affinity for solvent or aqueous phases. Compounds with high coefficients tend to partition to the solvent phase and have the potential to accumulate in fatty tissue.

- Molecular Weight - The weight of a molecule of a chemical expressed in atomic mass units. Compounds with large molecular weights tend to be less susceptible to biodegradation.

- Melting Point - The temperature at which a pure liquid normally freezes and the corresponding solid substance melts.

Table 4-1

Preliminary Identification of Contaminants of Concern, IRP Phase III, NWS Earle, Colts Neck, NJ

Contaminant	Site at which found at concentration greater than regulatory guidelines	*Site study group at which contaminant is possibly present
Acetone	---	1,2
Bis(2-ethylhexyl) phthalate	---	1
2-Butanone	---	1,2
Cadmium	19	1,2
Chloroform	---	1
Di-n-butyl phthalate	---	1
Lead	19	1,2
Methylene chloride	5,7,10,19	1,2
N-Nitrosodiphenylamine	10	1,3
Pentachlorophenol	5,11	1
Titanium	---	1,2
Toluene	---	1
Zinc	19	1,2

*Site study groups are described in Table 4-4.

Table 4-2

Summary of Physicochemical Properties of Contaminants of Concern, IRP Phase III, NWS Earle, Colts Neck, NJ

Contaminant of Concern	Melting Point (°C)	Boiling Point (°C)	Molecular Weight	Specific Gravity	Vapor Pressure (mm Hg)	Log Octanol/Water Partition Coefficient
Acetone	-94.6	56.48	58.08	0.7972	400 @39°C	2.57
Bis(2-ethylhexyl) phthalate	50	386.9	391.0	---	5 @387°C	9.22
2-Butanone	-85.9	79.6	72.1	0.8062	7 @20°C	---
Cadmium	Physicochemical properties depend on compounds present.					
Chloroform			92			2.69
Di-n-butyl phthalate	35	340	278.34		0.1 @115°C	3.22
Lead	Physicochemical properties depend on compounds present.					
Methylene chloride		39.8	84.9	1.326	380 @22°C	2.57
N-Nitrosodiphenylamine	66.5	152	74.1	1.005		8.73
Pentachlorophenol	266.4	310	266.4	1.978	40 @211.2°C	5.01
Titanium	Physicochemical properties depend on compounds present.					
Toluene	-95	110.6	92.13	---	28.7	2.69
Zinc	Physicochemical properties depend on compounds present.					

- Boiling Point - The temperature at which the vapor pressure of a liquid becomes equal to the atmospheric pressure and the liquid passes into the vapor phase.

Subsections 4.1.2.1 through 4.1.2.13 briefly summarize the toxicological profiles of the contaminants of concern.

4.1.2.1 2-Butanone

Production and Use

2-Butanone or methyl ethyl ketone (MEK) is used mainly as a solvent for vinyl, nitrocellulose, and acrylic coatings (TDB, 1988). Other uses include smokeless powder, cleaning fluids, adhesives, and cements (Verschueren, 1983). MEK has been used as a flavoring and/or fragrance additive in the candy and perfume industry (TDB, 1988).

Toxicity

From the information available concerning the acute and chronic toxicity of MEK in both animals and humans, it appears that MEK has a low order of toxicity. Human exposure to MEK occurs primarily through inhalation and dermal contact during manipulation of MEK-containing substances (Krasavage, et al., 1981). Little is known about the contribution of MEK through the diet or by drinking water. In subchronic inhalation studies of MEK exposure, rats exposed to 200 ppm (for 12 hr/day, 7 day/week, 24 weeks) exhibited "slight neurological effects" (Takeuchi, et al., 1983). Another study showed that 2,500 ppm (6 hr/day, 5 day/week, 90 days) caused an increase in serum glutaminic/ pyruvic transaminase levels in female rats (Cavendar, et al., 1983). Animals displayed significant toxicity at exposure levels of 5,000 ppm and higher.

The odor threshold for MEK is 10 ppm. The threshold for eye and nose irritation is 200 ppm (50 percent response) (ACGIH, 1986). MEK also was reported to cause numbness of the upper extremities (Smith and Mayers, 1944). Central nervous system (CNS) depression occurs at high concentrations, but warning factors (i.e., unpleasant odor, irritation of mucous membranes) usually prevent this exposure. MEK has been shown to augment the neuropathy attributed to coexposure with methyl n-butyl ketone or n-hexane (Altenkirch, et al., 1979).

Guidelines, Regulations, and Standards

The standard for MEK set by the Occupational Safety and Health Administration (OSHA) is 200 ppm for an 8 hr/day, 40-hour work week (FR, 1989). The ACGIH time weighted average (TWA) is also 200 ppm, which is the threshold for eye and nose irritation (ACGIH, 1986). A short-term exposure limit of 300 ppm has been recommended by ACGIH (1986).

The Office of Drinking Water, Environmental Protection Agency (1987a) issued health advisories for MEK in drinking water. The 1-day health advisory for acute exposure that

has been determined for a 10-kg child is 75,000 μg/L. The longer-term health advisory for MEK is 2,500 μg/L for the 10-kg child and 8,000 μg/L for an adult. A level of 172 μg/L MEK per day has been derived for the lifetime health advisory assuming that drinking water would contribute 20 percent of the total daily exposure. A reference dose (RfD) of 5.00 x 10^{-2} mg/L has been recommended by the EPA (1986a).

4.1.2.2 Methylene Chloride

Production and Use

Methylene chloride is commercially produced in the United States predominantly by the hydrochlorination of methanol (De Forest, 1979; Anthony, 1979). The annual U.S. production of methylene chloride was estimated to be 269,000 metric tons in 1981 (U.S. International Trade Commission, 1982). It is widely used as a paint remover, metal degreaser, and aerosol propellant (U.S. EPA, 1985b). Methylene chloride is used as a laboratory solvent and was used in the decontamination procedure for sample bottles.

Toxicity

The volatile nature of methylene chloride results in approximately 85 percent of the amount in use being lost directly to the environment by evaporation (NAS, 1978). Therefore, the most common exposure route is inhalation. An odor is apparent to most people at concentrations of 300 ppm, but is not to be relied upon as an indicator of unsafe levels (Sittig, 1985). Methylene chloride has demonstrated mutagenic properties in the Ames test (ACGIH, 1986). It also has been shown to induce hepatocellular (NTP, 1986; NCA, 1982, 1983) and alveolar/bronchiolar tumors in mice (NTP, 1986) and benign mammary tumors in rats (Burek, et al., 1980; Nitschke, et al., 1982; NTP, 1986). The typical acute presentation of methylene chloride poisoning is headache, nausea, and drowsiness (Friedlander, et al., 1978). Carbon monoxide, a metabolite of methylene chloride, induces carboxyhemoglobin and contributes to the CNS depression. CNS depression due to methylene chloride exposure has resulted in human fatality (ACGIH, 1986). Dermatitis occurs after dermal exposure (Torkelson and Rowe, 1981).

Guidelines, Regulations and Standards

The OSHA workplace standard is 500 ppm (8-hr TWA), with an acceptable ceiling concentration of 1,000 ppm (TDB, 1986). This standard is in the process of being reviewed (FR, 1989).

Health advisory drinking water guidance describing non-carcinogenic toxicology has been developed for methylene chloride by the Office of Drinking Water (U.S. EPA, 1985b). However, since methylene chloride is classified as a probable human carcinogen (EPA group B2), a lifetime health advisory is not recommended. The Drinking Water Equivalent Level (DWEL) recommended is 1.75 mg/L (ATSDR, 1987e). A drinking water concentration of 5 μg/L has been associated with a 10^{-6} excess cancer risk (IRIS, 1989).

Methylene chloride has been rated by IARC as a group 3 carcinogen (not classifiable as to its carcinogenicity to humans) (IARC, 1987).

The U.S. EPA has set an oral reference dose of 0.05 mg/kg/day based on a NOAEL of 5 mg/kg/day in a 2-year drinking water rat study. Hepatic histological alterations were the most sensitive endpoint (NCA, 1982).

4.1.2.3 Toluene

Production and Use

Toluene is obtained mainly from petroleum and is found in gasoline (ACGIH, 1986). It is used in the production of organic solvents and as a solvent for paints, rubber, and resins (U.S. EPA, 1987a; ACGIH, 1986). Direct production of toluene amounted to 5.1 billion tons in 1981 (U.S. EPA, 1987a).

Toxicity

The main exposure pathways for toluene are inhalation and dermal; therefore, data regarding oral toxicity are limited. It is known, however, that ingestion causes vomiting, diarrhea, and respiratory depression (TDB, 1988). Toluene is absorbed through the skin and respiratory tract. Dermal contact with toluene results in a defatting of the skin, causing fissured dermatitis (Key, et al., 1977; Cohen and Maier, 1974). Acute inhalation exposure shows a dose-related CNS toxicity, with symptoms ranging from fatigue, headache, nausea, muscular weakness, and confusion (Carpenter, et al., 1944; Von Oettinger, et al., 1942a,b) to loss of consciousness, convulsions, (Helliwell and Murphy, 1979), and death (Chiba, 1969; Winek, et al., 1968). Chronic exposure has lead to reversible encephalopathies. Permanent encephalopathies and brain atrophy have been observed in chronic toluene abusers (i.e., "glue sniffers" as opposed to those individuals occupationally exposed) (U.S. EPA, 1982). Reinhardt, et al. (1973) determined that the "sudden death" from habitual toluene abuse was due to its cardiac-sensitizing properties. Embyrotoxicity is significantly increased in mice administered toluene orally, but teratogenicity studies present conflicting data (U.S. EPA, 1987a). Toluene is neither mutagenic nor carcinogenic (U.S. EPA, 1987a). The U.S. EPA rates toluene as a group D carcinogen (not classified) (IRIS, 1989).

Guidelines, Regulations, and Standards

OSHA has set the 8-hour TWA for toluene at 100 ppm (FR, 1989). The EPA has proposed a Recommended Maximum Contaminant Level (RMCL) of 2.0 mg/L based upon the DWEL of 10.1 mg/L for noncarcinogenic effects, assuming 20 percent contribution from drinking water (IRIS, 1989). An oral RfD of 0.3 mg/kg/day has been set by the U.S. EPA based on a NOEL of 29 mg/kg/day from a rat inhalation study. Clinical chemistry and hematological parameters were noted as the critical effects (IRIS, 1989).

4.1.2.4 Chloroform

Production and Use

Chloroform is produced by the chlorination of either methane or methyl chloride (Ahlstrom and Steele, 1979; Deshon, 1979). It is used mainly for the production of fluorocarbon-22 (93 percent). About 3 percent is exported, and the remainder is used as a solvent and/or extraction solvent for flavorings, resins, adhesives, and various pharmaceuticals (CMR, 1986). Chloroform was formerly a widely used anesthetic (ACGIH, 1986).

Toxicity

Chloroform can enter the body by inhalation, ingestion, or skin contact. External exposure causes local irritation. When vapor concentrations are high enough, automatic closure of the eye is induced. Splashing chloroform into the eye causes a burning pain, tearing, and reddening of the conjunctiva. Corneal epithelium is usually injured or lost. Complete recovery is normally seen within 3 days (Grant, 1974).

Humans exposed experimentally to chloroform for 20 to 30 minutes have reported dizziness, headache, giddiness, and tiredness at concentrations <1,000 ppm and light intoxication at concentrations above 4,000 ppm. Clinical anesthesia is produced by 10,000 ppm chloroform (ACGIH, 1986).

In addition to depression of the central nervous system, chloroform anesthesia was associated with cardiac arrhythmias (ACGIH, 1986), cardiac arrest (IRIS, 1989), hepatic centrilobular necrosis (U.S. EPA, 1985a; Goodman and Gilman 1980; Woodsmith and Stewart, 1964), and in severe poisoning, renal tubular necrosis (ACGIH, 1986). Cardiac sensitization to endogenous catecholamines promotes the ventricular fibrillation that causes death in overdose cases. This has lead to the discontinuation of chloroform as an anesthetic (ATSDR, 1987b). Delayed death occurs due to liver necrosis (ACGIH, 1986). The mean lethal oral dose of chloroform was estimated to be approximately 44 grams. Death was due to respiratory or cardiac arrest (Gosselin, et al., 1976). Chronic oral administration of chloroform produces a dose-related increase in kidney epithelial tumors in rats and hepatocarcinomas in mice (U.S. EPA, 1980; IARC, 1979). There is weak evidence to support a correlation between bladder, colon, and rectal cancer and drinking water chlorination (ATSDR, 1987b). Chloroform is highly embryotoxic but only slightly teratogenic. The teratogenic effects seen in mice exposed to chloroform via inhalation at concentrations of 30, 100, and 300 ppm were decreased fetal development, decreased birth weight and body measurements, and low incidences of acaudate fetuses with imperforate anus (Schwetz, et al., 1981). Oral dosing of pregnant mice produce pups with low birth weight only (Balster and Borzelleca, 1982). Chloroform was not found to be mutagenic (ATSDR, 1987b).

Guidelines, Regulations, and Standards

OSHA has set a TWA level of 2 ppm for chloroform in the workplace (FR, 1989).

The American Conference of Governmental Industrial Hygienists recognized chloroform as a "suspected human carcinogen" (ACGIH, 1986), and choloroform is classified as a B^2 carcinogen by the EPA (ATSDR, 1987b) and a group 2B carcinogen by IARC (IARC, 1987). The excess carcinogenic risk level associated with 6 μg/L in drinking water is 10^{-6} (IRIS, 1989).

The oral RfD is 0.01 mg/kg/day based on a LOAEL of 12.9 mg/ kg/day from a dog study. The observed toxicity was fatty cyst formation on the liver (Hegwood, et al., 1979).

4.1.2.5 Cadmium

Production and Use

Cadmium is a moderately toxic, silvery-white metal. Its main use is electroplating. It is also used as a color pigment for glazes and enamels and as cathode material for nickel/cadmium batteries (ACGIH, 1986). Cadmium is a by-product of zinc, copper, and lead mining and smelting. These are important sources of environmental pollution. Cadmium may also be added to fertilizers (commercial phosphate fertilizers) (ATSDR, 1987a).

Toxicity

The major source of cadmium for the general population is the diet. Acute toxicity may result from ingestion of relatively high concentrations of cadmium and through contaminated beverages or food (ATSDR, 1987). However, cadmium's low gastrointestinal absorption (approximately 5 percent of the ingested amount, Rahola, et al., 1973; McLellan, et al., 1978), and strongly emetic properties usually prevent serious effects from occurring after the ingestion of a large quantity (Gosselin, 1984).

Inhalation of cadmium fumes or other heated cadmium-containing materials may produce an acute chemical pneumonitis and pulmonary edema. In the case of severe intoxication, sensory disturbances, liver injury, and convulsions may result, which, in fatal intoxications, are followed by shock and/or renal failure and cardiopulmonary depression (CEC, 1978).

Chronic exposure to cadmium through inhalation and ingestion lead to many of the same adverse effects. The principal longterm effects of low-level exposure to cadmium are chronic obstructive pulmonary disease and emphysema (inhalation only) and chronic renal tubular disease (EPA 1984a). Renal cortical cadmium concentrations of 100-400 mg/kg appear to be the critical level for kidney damage. This damage can lead to disturbances in calcium and phosphate metabolism which result in skeletal deformities and severe leg and back pain (Baselt, 1982).

Animal studies show that chronic intake of cadmium causes structural changes in the liver but does not affect hepatic function. Little evidence has been found supporting liver dysfunction in chronically exposed humans. There are data to support cadmium as a weak animal teratogen but no similar human data. The current data are inconclusive in their findings on mutagenicity. Evidence for carcinogenicity for chronic inhalation of cadmium

is positive, but negative for chronic ingestion. There are mixed data for correlating cadmium exposure with hypertension in humans (ATSDR, 1987a).

Guidelines, Regulations, and Standards

The current OSHA 8-hour TWA exposure limit for cadmium fumes is 100 $\mu g/m^3$ and 200 $\mu g/m^3$ for cadmium dust in workplace air (ATSDR, 1987a). However, these limits are under review, with the expected final values to lie between the 10 to 50 $\mu g/m^3$ range (Hazline, 1989). The current ACGIH TWA is 50 $\mu g/m^3$ (ACGIH, 1988). Both cadmium fumes and dust are considered by OSHA to be potential occupational carcinogens. Based on exposure to cadmium via inhalation, IARC (1987) has classified cadmium and certain cadmium compounds in group 2B (sufficient evidence for carcinogenicity in animals; limited evidence in humans). The U.S. EPA has put cadmium in carcinogen group B1, designating cadmium as a probable human carcinogen by inhalation (IRIS, 1989).

The proposed U.S. EPA MCGL for cadmium is 0.005 mg/L in drinking water. The lifetime health advisory for cadmium in drinking water is 5 $\mu g/L$ (ATSDR 1987a). The proposed RfD for cadmium is 0.0005 mg/kg/day. This is based on an estimate by Friberg (1950) that ingestion of 0.005 mg/kg/day (human NOAEL) would not exceed the critical renal concentration after 50 years of exposure (IRIS, 1989).

4.1.2.6 Acetone

Production and Use

Owing to high volatility, acetone is used for the cleaning and drying of precision parts (ACGIH, 1986). It is also used as a solvent for varnishes, plastics, and rubber (TDB, 1988).

Toxicity

Acetone's highly volatile nature makes the most likely exposure route inhalation. Small quantities may be absorbed through the skin. Prolonged exposure of skin to acetone will cause defatting and contact dermatitis. This condition is reversed after a few days of non-exposure (Krasavage, et al., 1981). Acute inhalation of acetone causes eye and throat irritation (ACGIH, 1986), headache, and CNS depression resulting in drowsiness and incoordination and, in serious cases, coma (Harris and Jackson, 1952; Sack, 1940). A case of 200 mL ingestion of acetone caused stupor and shallow respiration, followed shortly by coma. The patient regained consciousness (with support therapy) in about 12 hours. Chronic inhalation of acetone vapors causes irritation of the respiratory tract, coughing, and headache (ACGIH, 1986). Acetone has not been found to be teratogenic (Krasavage, et al., 1981). The Ames test showed acetone to be non-mutagenic (Clement, 1985). There is no evidence that it is an animal or human carcinogen.

Guidelines, Regulations, and Standards

OSHA has set a TWA level of 750 ppm for acetone in workplace air (FR, 1989). ACGIH (1987) has also recommended 750 ppm as a threshold limit value (TLV) (ACGIH,1987).

An RMCL in drinking water has not been established for acetone. An oral RfD of 0.1 mg/kg/day has been set by the U.S. EPA (U.S. EPA, 1986a).

4.1.2.7 N-Nitrosodiphenylamine

Production and Use

N-Nitrosodiphenylamine is a radical scavenger and is used to stabilize petroleum products (TDB, 1988). Its major use is in rubber processing as a vulcanization retarder. N-Nitrosodiphenylamine is no longer being produced in the United States (ATSDR, 1987d).

Toxicity

Data on the toxicity of N-nitrosodiphenylamine are limited. It is a known skin and eye irritant. It has a low acute toxicity in rats. N-Nitrosodiphenylamine chronically ingested by rats produced corneal opacity and epithelial hyperplasia of the bladder. This hyperplasia appears to be preneoplastic. Unlike rats, mice did not develop bladder cancer when chronically ingesting N-nitrosodiphenylamine. N-Nitrosodiphenylamine was ranked by CERCLA as being a low hazard for carcinogenicity (ATSDR, 1987d). IARC has placed it in carcinogenic group 3 (not classifiable as to human carcinogenesis) (IARC, 1987).

Guidelines, Regulations, and Standards

The U.S. EPA has established an ambient water quality criterion for N-nitrosodiphenylamine at 4.9 μg/L. This level of 4.9 μg/L in ambient water was estimated to limit excess lifetime cancer risk (upper bound) to one in 1 million (ATSDR, 1987d).

No RfD or OSHA exposure limits have been set for N-nitrosodiphenylamine (ATSDR, 1987d).

4.1.2.8 Pentachlorophenol

Production and Use

Pentachlorophenol (PCP) is a commercially produced bactericide, fungicide, and slimicide used since 1936 for the preservation of wood and wood products (Sittig, 1985; NAS, 1977). Due to its biological activity, PCP has also been employed as a herbicide, insecticide, and molluscicide (Sittig, 1985).

Toxicity

Direct human exposures to PCP have resulted during the manufacture and handling of PCP (Deichmann, 1981). PCP presents primarily an acute exposure hazard, and it is recognized as being toxic by all portals of entry (Gosselin, 1984). Dermal absorption following virtually uncontrolled industrial use has been reported as resulting in acute intoxication (Deichmann, 1981). Intoxicated individuals exhibited respiratory difficulty, hyperpyrexia, gastrointestinal upset, sweating, anorexia, and in severe cases, a rapidly progressive coma (Deichmann, 1981). PCP is also known to cause respiratory, dermal, and ocular irritation following acute exposure (Gosselin, 1984). Dermal absorption through intact skin of lethal amounts may result when PCP is in solution with organic solvents (Gosselin, 1984).

Chronic PCP exposure data in man are lacking. A number of subchronic and chronic oral animal studies over a range of concentrations (1.25 to 50 mg/kg/day) have revealed effects at various doses, including no effect (5 mg/kg/day) to reduced growth rate (10 mg/kg/day); other studies found increased liver weight (2.5 mg/kg/day), altered hemoglobin and hematocrit levels (2.5 mg/kg/day), and increased kidney weights (3 mg/kg/ day) (NAS, 1977).

The mechanism of PCP toxicity is similar to that of 2,4-dinitrophenol (Gosselin, 1984). PCP uncouples the oxidation and phosphorylation cycles in tissue (Deichmann, 1981). Fatalities resulting from the associated hyperpyrexia have been reported (Gosselin, 1984).

Guidelines, Regulations, and Standards

OSHA has established an 8-hour TWA PEL in the workplace of 0.5 ppm for PCP (FR, 1989). The U.S. EPA has calculated an oral RfD for PCP based on a chronic oral study in rats by Schwetz, et al. (1978) of 3.0×10^{-2} mg/kg/day (IRIS, 1988).

4.1.2.9 Di-n-Butyl Phthalate

Production and Use

Di-n-butyl phthalate (DBP) is an organic liquid that has a very broad range of industrial applications. DBP is used extensively in the manufacture of plastics to increase their flexibility (Sittig, 1985). It is also used in the manufacture of rocket propellant, industrial stains, cosmetics, safety glass, printing inks, adhesives, insecticides, and as an insect repellant for impregnation of clothes (Verschueren, 1983). Over 16 million pounds of DBP were produced in the U.S. in 1977 (U.S. ITC, 1978).

Toxicity

Several animal studies have found that DBP has generally low acute and chronic toxicity (Bornmann, 1956; Smith, 1953; Timofievskaya, 1972; Varonin, 1973). The acute oral LD_{50} of DBP in rats is between 8 and 16 g/kg (ACGIH, 1986). Rats showed no adverse effects when dosed orally with a solution of DBP in oil (1 mL/kg of body weight) for a period of

6 weeks. It was also shown that as much as 2,500 ppm DBP in the diet of rats in a 1year chronic study did not inhibit growth (Smith, 1953). A 2 hour exposure of mice to 250 mg/m^3 DBP in aerosol form caused irritation of the eyes and upper respiratory tract (Varonin, 1973). The LC_{50} value for DBP aerosol ranges from 2,100 $\mu g/ m^3$ for mice to 7,900 $\mu g/m^3$ for rats and 9,620 mg/m^3 for mammalian species (Sax, 1984). DBP has been shown to be virtually non-irritating to the skin of rabbits (Patty, 1981).

A worker who reportedly accidentally ingested about 10 grams of DBP experienced nausea, dizziness, and vomiting, followed by headache, conjunctivitis, lacrimation, and photophobia. Renal function was also reportedly affected, but the individual recovered from all symptoms in about 2 weeks (Cagianot, 1954). Chronic exposure to DBP and similar substances in the workplace has caused complaints of pain, numbness, and spasms in the upper and lower extremities. Extensive neurological studies have shown polyneuritis in 32 percent of the individuals examined (Milkov, 1973). DBP is currently being evaluated by the National Toxicology Program for its carcinogenic toxicological potential (NTP, 1989).

Guidelines, Regulations, and Standards

OSHA has established an 8-hour TWA PEL in the workplace of 5 mg/m^3 for DBP. The ACGIH recommends a TLV-TWA of 5 mg/m^3 for DBP. ACGIH also recommends the deletion of a short-term exposure limit (STEL), which was previously set at 10 mg/m^3, until additional toxicological data are available (ACGIH, 1986). The U.S. EPA has calculated a reference dose for DBP of 1.00×10^{-1} mg/kg/day (U.S. EPA, 1986b).

4.1.2.10 Bis(2-ethylhexyl) Phthalate

Production and Use

Bis(2-ethylhexyl) phthalate (BEHP) is an organic liquid that is added to plastic products to enhance flexibility. Approximately 300 million pounds are employed each year in the manufacture of commercial, medical, and consumer products. BEHP is also used as a hydraulic fluid and as a dielectric fluid for use in electrical capacitors (ATSDR, 1987c).

Toxicity

Numerous animal studies have found BEHP to exhibit low acute toxicity by both the oral and inhalation exposure routes (WARF Institute, 1976; Pegg, 1979; Shaffer, et al., 1945; Patty, 1967; Krauskopf, 1973). BEHP was, however, shown to exhibit greater acute toxicity during early postnatal development in rats (Dostal, et al., 1987). High-level oral exposure in animals has resulted in adverse effects targeting primarily the liver and testes. BEHP has been shown to induce functional hepatic damage characterized by morphological changes and alterations in the activity of hepatic enzyme systems (Mitchel, et al., 1985; Jacobson, et al., 1977). A study of the livers of kidney dialysis patients found liver peroxisome proliferation associated with BEHP exposure (Ganning, et al., 1984). Testicular damage in the form of decreased organ weights and histiological changes in the seminiferous tubules has been reported in animals exposed orally (Sjoberg, et al., 1985a,b; Agarwal, et al., 1984).

BEHP has also been reported to induce developmental toxicity by the oral route in the form of decreased body weight, fetal death, and malformations (Nakamura, et al., 1979; Wolkowski-Tyl, et al., 1984a,b). BEHP has been evaluated by the National Toxicology Program for carcinogenicity in which an increase in the incidence of hepatocellular carcinomas in the treated group over controls was demonstrated (NTP, 1982). Data on the toxicity of BEHP by other exposure routes (i.e., inhalation and dermal) are recognized as lacking (ATSDR, 1987c).

Guidelines, Regulations, and Standards

OSHA has established an 8-hour TWA PEL in the workplace of 5 mg/m^3 (0.3 ppm) for BEHP. NIOSH recommends reducing exposure to BEHP to the lowest feasible limit, citing it as a potential occupational carcinogen (NIOSH, 1984). BEHP is recognized by EPA as a possible human carcinogen (group B2) and by IARC as a probable human carcinogen (group 2B) (IARC, 1982; U.S. EPA, 1986). The U.S. EPA has calculated a RfD for BEHP based on a 1-year study in guinea pigs by Carpenter, et al., (1953) of 2.0×10^{-2} mg/kg/day (U.S. EPA, 1987b).

4.1.2.11 Lead

Production and Use

Lead ranks fifth among metals in industrial usage after iron, cooper, aluminum, and zinc. Lead is used principally in storage batteries and as an "antiknock" gasoline additive. Lead in the form of a monoxide, referred to as litharge, is used extensively in sulfuric acid-type batteries as the positive plate. Likewise, lead dioxide is used as the electrically conductive plate in other lead/acid storage batteries. Tetraethyl lead is the form used as a gasoline antiknock compound and is being phased out of use for environmental reasons. Lead oxides have many other uses and are found in optical, electrical, and electronic glasses; glazes; enamels; high-temperature lubricants; and dyes. These lead compounds are also used as driers in varnishes and as vulcanizing agents in plastic and rubber synthesis.

Toxicity

Lead is a general protoplasmic poison; it is cumulative, being stored in the solid portion of the body skeleton. Lead is absorbed into the body by inhalation, ingestion, and through skin contact. The ability of the body to adsorb lead and the rate at which the absorption takes place are a function of the chemical form of the lead. Lead distribution in the body is best characterized by a three-compartment model. The first compartment, circulating red blood cells, distributes the lead to the other two compartments, the soft tissue compartment, consisting of the liver and kidney, and the third compartment, the bones.

4.1.2.12 Titanium

Production and Use

Titanium is used in the manufacture of alloys, particularly ferrotitanium. This material is used in the structural materials of aircraft, marine equipment, and missiles. Titanium is used as the pigment of white paint and infrequently as a corrosion inhibitor.

Toxicity

From the information available concerning the acute and chronic toxicity of titanium in both animals and humans, it appears that titanium has a low order of toxicity. Human exposure to titanium occurs primarily through inhalation of titanium-bearing metallic dusts from machining or milling operations.

Guidelines, Regulations, and Standards

The standard for titanium oxide set by OSHA is 10 mg/m^3 for total dust (<1 percent quartz). The ACGIH exposure limit has been recommended to be 15 mg/m^3.

4.1.2.13 Zinc

Production and Use

Zinc is used in the manufacture of alloys (brass and bronze), galvanizing of iron and other metals, electroplating, and numerous electrical components.

Toxicity

Zinc is an essential growth element. The available information concerning the acute and chronic toxicity of metallic zinc in both animals and humans indicates that zinc has a low order of toxicity. Zinc compounds have a wide diversity of effects and toxicities. Principal exposure to zinc in humans occurs through inhalation of fumes from welding and ingestion of dissolved zinc compounds in water.

Guidelines, Regulations, and Standards

Due to the wide diversity of compounds containing zinc, guidelines for the exposure limits of these compounds are difficult to condense. The Extraction Procedure Toxicity test to determine whether a waste is considered hazardous defines the hazardous level in parts per million (ppm). The State of New Jersey has set standards for the maximum permissible concentration of zinc in soils at 350 mg/kg. Water quality standards for drinking water have set the maximum permissible zinc concentration in drinking water at 5 mg/L.

4.2 PATHWAYS AND RECEPTORS

The principal media pathways for contaminant migration from a site are groundwater, surface water, air, and direct contact. The following is a discussion of each principal pathway and the most likely associated receptors with specific application to NWS Earle.

4.2.1 Groundwater

Potential groundwater receptors include local surface drainageways that receive groundwater from seepage, the station wells, and off-station wells.

Further work will be required (as described in Section 5 of this Work Plan) to locate off-station wells within 3 miles distance of the station and to identify the aquifer materials in which they are finished.

Public water supply in the area is provided by the New Jersey American Water Company, primarily from a surface water reservoir remote from the NWS Earle area.

The Main Base supply wells served as a backup to this system during the installation of the water distribution system.

4.2.2 Surface Water

Surface water present on NWS Earle includes unnamed tributaries of the Shark, Manasquan, and Swimming Rivers. In addition, several small lakes and creeks exist. Portions of the station contain wetlands soils, and in some areas these soils support standing water and swamps, at least seasonally. These areas of restricted drainage include wetlands associated with the headwaters at Hockhockson Brook. These wet areas are maintained from ponded runoff and may also receive groundwater discharge from localized shallow flow systems.

Confirmation Study investigations of the site drainageways consisted of the collection of surface water and stream bottom sediment samples at specific sites.

4.2.3 Air

At the majority of the sites, potentially contaminated vapors must move through a soil column before reaching the atmosphere, and as such, may be attenuated through adsorption/absorption before reaching the surface and being dispersed in the atmosphere. Results of the CS suggest that there is currently no overt concern for air emissions from the sites; however, air sampling has been included within this Work Plan to evaluate the potential for contaminant migration into the air.

4.2.4 Direct Contact

In general, direct contact is unlikely as a pathway for contaminant migration or significant health/environmental impact at NWS Earle. Most of the IRP sites are located in remote areas of the station or adjacent to industrial shop areas not subject to recreational use. There are no sites located in the family housing area where the civilian population is concentrated. All sites are located within the station, which is fenced and subject to controlled access. The landfills and dunnage disposal sites are fully or partially covered with clean fill.

4.3 RISK ANALYSIS

A risk analysis is a formalized means for evaluating contaminant data collected at a site in terms of the estimated risks of impact to human health or the environment. The contaminants of concern and the physical characteristics of the pathways and receptors will be updated for each site as new data are collected.

The risk analysis will include:

- Environmental fate and transport analyses, including contaminant release analyses.
- Exposure analyses.
- Toxicity analyses.

The ultimate objective of the risk analysis is to determine an upper boundary of risk to the "maximally exposed" and/or "average exposed" individual associated with measured contamination at a site. Through the risk analysis process those sites representing no significant impact to human health or the environment are identified and removed from consideration for further investigation. A more detailed risk analysis is to be performed on those sites identified as likely to represent a significant impact.

4.4 PRELIMINARY SCREENING OF POTENTIAL SITE-SPECIFIC REMEDIATION

A preliminary screening of potential remedial actions and an identification of remedial technologies are provided in this subsection of the Work Plan to serve as the basis for data gathering efforts covered by the Phase III scope of work.

Emphasis will be placed on remedial technologies that will reduce the toxicity, mobility, or volume of wastes and contaminated materials.

A number of general remedial actions (broad categories of remedial technologies) have been identified for the site study groups of NWS Earle. These remedial actions and the remedial technologies associated with them are listed in Table 4-3. The identified response

Table 4-3

General Remedial Actions and Associated Alternative Component Technologies, IRP Phase III, NWS Earle, Colts Neck, NJ

General Remedial Action	Alternative Component Technology
No action	Monitoring Upgrade site security
Diversion and collection (surface water)	Regrading/dikes and berms Revegetation Ditches and interception trenches Sedimentation ponds and basins
Containment/capping (soil/sediment/waste)	Capping techniques • Synthetic membranes • Low-permeability soils • Surface sealing - Soil/bentonite admixtures - Asphalt/concrete • Composite caps
Complete or partial removal (soil/sediment)	Excavation/dredging
In situ treatment (soil/sediment/waste/ groundwater)	Biological • Biodegradation/bioreclamation Chemical • Soil washing/extraction Physical • In situ adsorption • Supercritical extraction • Soil flushing Thermal • In situ vitrification • In situ volatilization • In situ steam stripping

Table 4-3
(continued)

General Remedial Action	Alternative Component Technology
On-site treatment (soil/sediment/waste)	Thermal • Incineration • Low-temperature thermal stripping • Pyrolysis Chemical/physical • Soil washing/extraction • Microencapsulation • Stabilization • Macroencapsulation/overpacking Biological • Land treatment/composting • Land farming
Off-site treatment (soil/sediment/waste)	Thermal • Incineration • Stabilization
Off-site disposal (soil/sediment/waste)	RCRA landfill
On-site disposal (soil/sediment/waste)	On-site RCRA landfill
Groundwater and surface water treatment (on- or off-site)	• Pumping • Physical/chemical treatment • Air stripping • Biological treatment • Coagulation/filtration • Adsorption • Ultrafiltration or membrane separation (e.g., reverse osmosis) • Ion exchange

actions and technologies are directed toward source control, treatment, and contaminant migration management, as well as "no action." Not all technologies may be appropriate for each site group category. The 11 sites included during IRP Phase III have been divided into 3 site study groups, based on the potential contaminants of concern that have been identified. Table 4-4 presents the study groups and the primary contaminants associated with them. The following discusses each type of technology and its applicability to any or all of the three site groups listed in Table 4-4.

4.4.1 No Action

Within this technology category no active remediation efforts would be conducted at a given site. This approach may be appropriate for those sites that have no significant impact on human health or the environment. No action also will be evaluated at all the sites as a basis for comparison to other technology groups.

4.4.2 Diversion and Collection

The main purposes of this technology category are to divert contaminated runoff and to collect the runoff before it mixes with uncontaminated runoff. These measures may also help prevent ponding and infiltration of water in a contaminated soil area.

Techniques in this category include dikes, berms, ponds, and ditches to collect or divert surface runoff. This approach is generally used in conjunction with other actions as part of a comprehensive remedial action program. Runoff diversion and regrading of the landfills and construction rubble dumps (CRDs) in group 1 may be appropriate to prevent the spread of surface contamination and help stabilize landfill caps. In groups 1, 2, and 3, collection and diversion could be used as measures to prevent surface contaminants from running off the sites and entering the surface water system.

4.4.3 Containment/Capping

This technology category is designed to prevent infiltration of water from the surface through contaminated soils or refuse.

Downward migration of contaminants through the soil and into the groundwater can be controlled through use of these controls. This technology is most applicable at the group 1 sites, the landfills. The waste, due to its volume, type, and structure, does not lend itself easily to in situ treatment or removal. Although capping could be employed at other sites, it is not a treatment technology and does not serve to reduce the total volume of contaminants at a site. In application at a landfill, this technology could be used in conjunction with groundwater capture and treatment unless it were shown that groundwater was not contaminated.

Table 4-4

Site Study Groups,
IRP Phase III, NWS Earle, Colts Neck, NJ

Group Type	Site Study Group	Sites in Study Group	Primary Contaminant Groups
Landfills	1	3,4,5,7,10	Volatile/semivolatile organics, heavy metals
Ordnance Maintenance	2	19,20,22	Heavy metals
Ordnance Disposal	3	2,11,26	Explosives, nitrate/ nitrogen compounds

4.4.4 Complete or Partial Removal

This technology category involves the complete or partial removal of contaminated soils, sediments, raw refuse, or waste material from the existing location. It is usually used in conjunction with either on-site treatment or off-site treatment or disposal. Removal with treatment or disposal is often quite costly at large sites such as those in group 1 or where structural constraints exist. It is particularly applicable where well-defined soil "hot spots" of limited areal extent can be defined. It may be applicable to selected sites in groups 1, 2, and 3.

4.4.5 In Situ Treatment

Soil or groundwater is typically treated in place to remove contaminants in this technology category. This approach may also be extended to waste and/or stream sediment under certain conditions. In situ treatment is advantageous because the cost and health risks associated with excavation and removal are avoided. Possible in situ technologies include biological treatment, soil flushing, and in situ volatilization. Many of these techniques are experimental or developmental, but some have been demonstrated in field-scale applications. Even those that are proven, however, may need some degree of sitespecific bench- or pilot-scale testing. In general, these technologies are most applicable to diffuse contamination with VOCs or BNAs in porous soils. If contamination is present in landfills, sources are likely to be present in concentrated pockets rather than diffused throughout the refuse mass. Therefore, applicability to the group 1 sites is unlikely.

4.4.6 On-Site Treatment

On-site treatment technologies may employ the same physical, chemical, and biological methods as in situ technologies except that treatment is performed above ground. Although the cost is higher due to the need for excavation, these technologies are often more secure in containing contamination and also more effective in reducing the total amount of contaminants present.

In addition, technologies such as low-temperature thermal stripping (LTTS) and incineration, which could not be performed in situ, are also included. On-site treatment may be applicable to any or all of the site groups where soil removal is applicable. Where removal is limited by structural or access factors, on-site treatment effectiveness is limited to the material that can be removed.

4.4.7 Off-Site Treatment

Commercially available off-site treatment, such as incineration and stabilization, can be used as effectively as on-site treatment. It also can be more cost effective in the case of small waste or soil quantities when the capital outlay for on-site equipment is not justified by the elimination of transport costs. Since the total quantity of solids requiring remediation is currently unknown, it is considered potentially applicable to all sites where on-site treatment is considered applicable.

4.4.8 On-Site Disposal

On-site disposal of the contaminated soils, sediments, and wastes on the station could potentially be an economical way of dealing with these materials. However, materials contaminated with significant levels of hazardous constituents would not be disposed of on-site unless a landfill meeting RCRA design, monitoring, and maintenance requirements were constructed at the station. The cost to construct such a facility and to obtain regulatory approvals may be prohibitive. Given the volume of potentially contaminated material present at the sites, on-site disposal is an unlikely alternative but should be considered in the event that other alternatives are not effective.

4.4.9 Off-Site Disposal

Off-site disposal at a licensed hazardous waste landfill is the most widely used method for both waste disposal and site remediation. However, this is frequently discouraged by regulatory agencies, particularly under new SARA guidelines, as it is not a treatment method and no waste reduction occurs. Of the sites at NWS Earle, Site 19 seems most amenable to this type of remediation; contaminated soil could be disposed of off site. The other site groups are either well-suited for on-site treatment (e.g., group 3) or represent too much volume to be excavated and removed (e.g., group 1).

4.4.10 Groundwater/Surface Water Treatment

Should the groundwater and surface water be contaminated, treatment of these waters is a possible alternative. Available methods include physical/chemical, thermal, and biological methods.

4.4.11 Summary

A summary of potentially applicable general remedial technologies is presented in Table 4-5. Note that the preliminary screening discussed above and summarized in Table 4-5 is based solely on the data gathered to date and will be revised as new data are gathered.

4.5 APPLICABLE, RELEVANT, AND APPROPRIATE PUBLIC HEALTH AND ENVIRONMENTAL REQUIREMENTS

The investigation and cleanup of former waste disposal sites at a Federal facility in New Jersey would fall under the jurisdiction of both State of New Jersey regulations (administered by the NJDEP) and Federal regulations (administered by EPA Region II). Potentially applicable Federal and State requirements are reviewed as follow.

4.5.1 Federal and State of New Jersey ARARs

An ARAR, as titled, is an environmental law, regulation, or guideline that is either "applicable" or "relevant and appropriate" to a remedial action. Applicable requirements are those promulgated under Federal or state laws that specifically address the chemicals/

Table 4-5

Potentially Applicable General Remedial Technologies, IRP Phase III, NWS Earle, NJ

Site Group	Group Type	Off-Site Treatment	No Action	Off-Site Disposal	Containment	Soil Removal	In Situ Treatment	On-Site Treatment
Landfill	1	---	All	All	All	---	Unknown	All
Ordnance Maintenance	2	---	All	19	19	All	---	---
Ordnance Disposal	3	---	All	All	All	---	All	All

--- indicates technology not considered applicable to any of the sites in the study group, based on data collected to date.

All indicates technology category may be applicable to all sites in the group, based on data collected to date.

contaminants of concern. Relevant and appropriate requirements are those that address problems or situations sufficiently similar to those encountered at a SARA-regulated site.

ARARs are divided into the following categories:

- Chemical-specific requirements Healthor risk-based concentration limits in various environmental media for specific chemicals/contaminants. These limits may take the form of cleanup levels, discharge levels, and/or maximum intake levels (such as for drinking water and breathing air for humans).

- Action-specific requirements - Controls or restrictions on particular types of remedial activities in related areas, such as hazardous waste management or wastewater treatment.

- Location-specific requirements - Restrictions on remedial activities which are based on the characteristics of a site or its immediate environment. An example would be restrictions on wetlands development.

The potential ARARs discussed here will be revised as more information on the sites is collected.

4.5.2 Chemical-Specific Requirements

The concentrations of Hazardous Substance List organics and inorganics detected in a drinking water source are typically compared with the Maximum Contaminant Levels (MCLs) developed under the Federal Safe Drinking Water Act (SDWA) and the New Jersey Safe Drinking Water Act (NJSDWA). If the MCLs are not available for a particular chemical, the available MCL Goals (MCLGs) and Federal Ambient Water Quality Criteria (AWQC) are typically applied. In addition, the New Jersey Water Pollution Control Act sets primary standards for various groundwater and surface water classifications. New Jersey has also established soil cleanup objectives for selected parameters. An explanation of these standards and criteria is presented as follows.

4.5.2.1 Drinking Water Standards

National Interim Primary Drinking Water Standards established under the SDWA are promulgated as MCLs that represent the maximum allowable levels of certain contaminants in public water systems. They are generally based on lifetime exposure to the contaminant for a 70-kg (154-lb) adult who consumes 2 liters (0.53 gal) of water per day. Interim health-based MCLs have been established by EPA for some of the organic and inorganic chemicals listed in Table 4-1.

The SDWA provides that the revisions to the interim primary drinking water regulations are to be developed in two steps. First, EPA establishes MCLGs and then sets revised MCLs as close to the MCLGs as feasible.

MCLGs are non-enforceable health goals at which no known or anticipated adverse effects on the health of persons occur, allowing an adequate margin of safety. MCLGs only serve as goals for EPA in the course of setting MCLs and, therefore, are initial steps in the MCL rule-making process. MCLGs have no legal impact on public water systems or the public; no public water supply system is forced to remove contaminants to this level or to take other action regarding contaminants.

Under SARA, however, remedial actions must attain a level or standard of control equivalent to the MCLGs, where such goals are relevant and appropriate. Under certain circumstances a waiver of the requirement to meet all ARARs, such as MCLGs, can be attained and a less stringent Alternate Concentration Level (ACL) may be set and approved.

On 13 November 1985 EPA published final MCLGs for eight volatile synthetic organic compounds. MCLGs for substances considered to be probable human carcinogens were set at zero, and MCLGs for other substances were set based on chronic toxicity or other data. At the same time EPA proposed MCLs and MCLGs for several inorganic and synthetic organic chemicals. In addition, the New Jersey Safe Drinking Water Act and Amendments set MCLs for drinking water in the state.

It should be emphasized that primary or secondary standards and MCLGs are established for public drinking water supplies and should not be used as standards for general surface water quality. MCLGs can be utilized as bench marks or guidelines to establish levels of concern for various contaminants in surface waters. For example, if surface water quality data near a source indicate a contaminant level in excess of an MCL or MCLG, remedial measures should be evaluated to determine whether the MCL or MCLG can be consistently met at the drinking water tap.

The State of New Jersey has also promulgated primary groundwater standards under the New Jersey Water Pollution Control Act and the New Jersey State Drinking Water Act. Groundwater quality standards have been established by the State of New Jersey to provide protection of the public health and the environment. These standards are maintained to restore, maintain and enhance the chemical, physical, and biological integrity of New Jersey's waters, protect scenic and ecologic values; and enhance the domestic, municipal, recreational, and other reasonable uses of the State's waters.

Standards for groundwater classification GW-2, which includes groundwater in the vicinity of NWS Earle, are also presented in Table 4-6.

4.5.2.2 Ambient Water Quality Criteria

Federal Ambient Water Quality Criteria documents have been published for 65 pollutants listed as toxic under the Clean Water Act. These criteria are unenforceable guidelines that may be used by states to set surface water quality standards. Although these criteria were intended to represent a reasonable estimate of pollutant concentrations consistent with the maintenance of designated water uses, states may appropriately modify these values to

Table 4-6

Statewide Groundwater Quality Criteria Where the Total Dissolved Solids (TDS, Natural Background) Concentration is Less Than or Equal to 500 mg/L: Class GW2

Primary Statewide Toxic Pollutants	
Pollutant, Substance, Or Chemical	Groundwater Quality Criteria
Aldrin/dieldrin	0.003 μg/L
Arsenic and compounds	0.05 mg/L
Barium	1.0 mg/L
Benzidine	0.0001 mg/L
Cadmium and compounds	0.01 mg/L
Chromium (hexavalent) and compounds	0.05 mg/L
Cyanide	0.2 mg/L
DDT and metabolites	0.001 μg/L
Endrin	0.004 μg/L
Lead and compounds	0.05 mg/L
Mercury and compounds	0.002 mg/L
Nitrate-nitrogen	10 mg/L
Phenol	3.5 mg/L
Polychlorinated biphenyls	0.001 μg/L

Table 4-6
(continued)

Primary Statewide Toxic Pollutants	
Pollutant, Substance, Or Chemical	Groundwater Quality Criteria
Radionuclides	Prevailing regulations adopted by the U.S. EPA pursuant to sections 1412, 1415, and 1450 of the Public Health Services Act as amended by the Safe Drinking Water Act (PL 93-523)
Selenium and compounds	0.01 mg/L
Silver and compounds	0.05 mg/L
Toxaphene	0.005 μg/L
Secondary Standards	
Ammonia	0.5 mg/L
Chloride	250 mg/L
Coliform bacteria	a) by membrane filtration, not to exceed 4 per 100 mL in more than one sample when less than 20 are examined per month, or b) by fermentation tube, with a standard 10-mL portion, not to be present in three or more portions in more than one sample when less than 20 are examined per month, or c) prevailing criteria adopted pursuant to the Federal Safe Drinking Water Act (PL 93-523)

Table 4-6
(continued)

Primary Statewide Toxic Pollutants	
Pollutant, Substance, Or Chemical	Groundwater Quality Criteria
Secondary Standards (continued)	
Color	None noticeable
Copper	1.0 mg/L
Fluoride	2.0 mg/L
Foaming agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor and taste	None noticeable
Oil and grease and petroleum hydrocarbons	None noticeable
pH (standard units)	5-9
Phenol	0.3 mg/L
Sodium	50 mg/L
Sulfate	250 mg/L
Total dissolved solids	500 mg/L
Zinc and compounds	5 mg/L

reflect location conditions. Under SARA, however, remedial actions must attain a level or standard of control equivalent to these criteria, unless a waiver has been granted.

The water quality criteria are generally represented in categories that are aligned with different surface water use designations. Concentrations are specified which, if not exceeded, should protect most aquatic life against acute toxicity or chronic toxicity (24-hour average). Specific criteria have not been established for many chemical compounds because of insufficient data.

Under the New Jersey Water Pollution Control Act, the State has set criteria for surface water based on classification. Mine Brook, Hockhockson Brook, and Pine Brook have been classified FW2 (general freshwater).

Non-point discharges from the sites to surface waters and storm water sewers may be regulated under the Sewage Infrastructure Improvement Act.

4.5.2.3 Sediment and Soil Criteria

The Extraction Procedure (EP) Toxicity test (40 CFR 261 Subpart C) provides an indication of contaminant mobility and is used to determine whether wastes are considered hazardous wastes. Under the EP Toxicity test for metals, the extraction from a representative sample of the waste is analyzed for the metals, including those listed in Table 4-1. The solid wastes are classified as non-hazardous, in terms of EP toxicity metals, if the contaminant concentrations are below the limits given in Table 4-7. These limits are 100 times higher than the primary drinking water standard. The EP toxicity criteria can be used to determine whether waste is non-hazardous in terms of EP Toxicity metals and to assess the potential impact from precipitation infiltration through the waste to shallow groundwater underlying the waste. Although the limits were developed to describe leachable metals in wastes, they may be appropriate for comparison for contaminated soils and sediments.

Acceptable levels of some organic hazardous constituents have been established in CFR 268.41 for the disposal of spent solvent wastes, based on the amount of the constituent released during the toxicity characteristic leaching procedure (TCLP) (see Table 4-7).

New Jersey cleanup levels for sediments and soils are generally determined based on background levels for inorganics and risk assessment for organics. In their absence, NJDEP has established surrogate or action levels to guide cleanups (see Table 4-8).

In addition to levels applicable to specific contaminants, levels for compound groups in soils have been established: 1 ppm total volatile organics, 10 ppm total base-neutral/acid-extractable organics, and 100 ppm total petroleum hydrocarbons, unless primarily benzene or polynuclear aromatic hydrocarbons (PAHs).

Table 4-7

Maximum Concentration of Contaminants for Characteristics of EP Toxicity

EPA Hazardous Waste Number	Contaminant	Maximum Concentration (mg/L)
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0
D012	Endrin	0.02
D013	Lindane	0.4
D014	Methoxychlor	10.0
D015	Toxaphene	0.5
D016	2,4-D	10.0
D017	2,4,5-TP	1.0

Table 4-8

NJDEP Guidelines* for Evaluating Possible ECRA Cleanup Requirements

	Contaminant	Soil (mg/kg-ppm)	Groundwater (μg/kg-ppb)
Metals	Arsenic	20	50
	Barium	400	1,000
	Cadmium	3	10
	Chromium	100	50
	Copper	170	1,000
	Lead	250 - 1,000	50
	Mercury	1	2
	Nickel	100	
	Selenium	4	10
	Silver	5	50
	Zinc	350	5,000
Organics	Total volatiles	1	10
	Total base-neutrals	10	50
	Total acid-extractables	10	50
	Total petroleum hydrocarbons	100	1,000
	Total PCBs	1 to 5	1
Other	Cyanide	12	200

*Used informally in evaluating possible cleanup requirements

4.5.3 Action-Specific Requirements

Action-specific requirements are controls or restrictions that limit the application or implementation of particular remedial activities.

4.5.3.1 Federal and State Requirements

Regulations promulgated under the Federal Resource Conservation and Recovery Act (RCRA) generally establish technology-based requirements for active or proposed hazardous waste facilities.

RCRA requirements cover groundwater protection, general landfill standards, and standards for waste piles and surface impoundments. ARARs under RCRA include certain provisions of 40 CFR 264, such as those for surface impoundments (Subpart K), waste piles (Subpart L), land treatment (Subpart M), landfills (Subpart N), and incinerators (Subpart O). Specific ARARs of concern in 40 CFR 264 depend on the remedy selected. Should wastes, such as spent activated carbon from the treatment of contaminated water, be transported off site, regulations applicable to transporters of hazardous waste (40 CFR 263) would be relevant. Transporters must obtain an EPA identification number and comply with the manifest system that documents shipment and delivery of hazardous waste. Hazardous wastes that may be generated through implementation of alternatives involving off-site treatment and disposal must go to a permitted RCRA facility. The NJDEP is responsible for implementation of the RCRA program in New Jersey.

Discharges to and contamination of groundwater in New Jersey are regulated with respect to groundwater monitoring requirements, cleanup criteria, and recordkeeping and reporting (NJAC 7:9-6). Discharges to surface water are subject to effluent standards and minimum treatment requirements (NJAC 7:9-5.1, et seq.). The State of New Jersey is authorized by EPA to administer wastewater discharge permits under the New Jersey Pollutant Discharge Elimination System (NJPDES). General information and filing requirements for NJPDES permits are described in NJAC 7:14A. Non-point discharges directly entering saltwater are regulated by the NJDEP under the Sewage Infrastructure Act.

If volatile organic substances are released to the atmosphere during remediation of contamination from NWS Earle, these emissions are regulated under NJAC 7:27-16. Other air emissions are also regulated through NJAC 7:27.

Proper disposal of residual wastes from any remedial option selected will depend on whether the waste is designated hazardous or non-hazardous. New Jersey Hazardous Waste Regulations (NJAC 7:26) define solid waste and hazardous waste and the criteria for listing hazardous waste. The regulations also stipulate that the generator must determine whether the waste is a hazardous waste (NJAC 7:26-8). RCRA Section 3001 (40 CFR 261) also defines and lists hazardous wastes and characteristics of waste that are subject to RCRA controls. Section 3001(f) of RCRA contains provisions for the delisting of waste that would otherwise be considered hazardous.

Section 3004(c) of RCRA prohibits the disposal of bulk or noncontainerized liquid hazardous waste or free liquids contained in hazardous waste in any landfill. Disposal of non-hazardous waste liquid in any RCRA-permitted landfill is prohibited unless the only reasonable alternative available is disposal in a non-RCRA landfill or an unlined impoundment that contains hazardous waste, and placement in a RCRA landfill will not present a risk of contamination of any underground drinking water source. Under the NJPDES, NJAC 7:15A-5 describes requirements for wells injecting liquid wastes. Wastewater treatment requirements in New Jersey are also described under the NJPDES in NJAC 7:14A-12 and 13.

Final remediation in the vicinity of NWS Earle may require the sealing of former residential wells in areas of contaminated groundwater. The sealing of abandoned wells is regulated under NJAC 7:9-9. If the extraction of contaminated groundwater is selected as an operable unit of site remediation, well installation as regulated under NJAC 7:9-7 would be relevant.

4.5.3.2 NJPDES Requirements

An NJPDES permit specific to remediation measures may be required for the discharge of groundwater, surface water, and/or leachate (treated or untreated) to nearby surface water or to the NWS Earle sewage treatment plant.

4.5.3.3 Additional State Requirements

In addition to the potential action-specific ARARs that appear as regulations in the State of New Jersey, other actionspecific requirements that are not regulations should be considered. These requirements are primarily based on precedents set during the implementation of previous remedial actions.

Since air stripping of volatile organics is a possible remedial option, several state memos should be consulted:

- Letter to Robert Palasits - Elizabethtown Water Co., 17 June 1985, regarding waste contaminated with trichloroethene (TCE) and tetrachloroethane (PCE).
- Memo from Milton Polakovic on air-stripping of contaminated water, 8 December 1982.
- Draft: Air stripping guidelines (memo from Assistant Commissioner Tyler).

Additional requirements on the discharge of effluent to a publicly owned treatment works (POTW) can be found in New Jersey's Guidelines Waste Discharge. Information on the discharge to surface water, which may pertain to remediation at NWS Earle, can be found in the following:

- Required information for discharges to surface waters (DSW) from Superfund sites (memo from Edward H. Post, 1 November 1983).

- Toxic Management - Regulating Point Source Discharge of Toxic Substances into New Jersey Waters.

- Indirect Discharge Permitting Procedures.

Corrective action criteria for groundwater are covered in NJ groundwater quality standards (NJAC 7:9-6).

Additional requirements on air emissions which may apply include the following:

- Draft: The Role of Risk Assessment and Risk Management in the Air Pollution Control Permit Process - Joann Held, 15 July 1986.

- Required pre-test protocol information.

- Protocol - continuous emissions monitors - DEQ.

- Guidelines for review applications for toxic substances emissions.

- Information required to determine whether equipment used in hazardous waste site cleanups complies with New Jersey Air Pollution Control Regulations (memo from William O'Sullivan, 23 March 1987).

If large volumes of sediments are found to be contaminated with volatile organics, the Preapplication Conference, Terra-Vac Corp. (memo from Joel Leon, 2 December 1986) should be consulted.

Regarding wastewater treatment, the BROS Concept Engineering Report (memo from Iclal Atay, 30 May 1986) contains specifications for the construction and decontamination of on-site wastewater treatment and storage facilities, while information concerning pretreatment facilities is contained in Pretreatment Works Requirements.

4.5.4 Location-Specific Requirements

4.5.4.1 Federal and State Requirements

Location-specific regulations promulgated by RCRA would be applicable to the siting of any on-site storage or treatment alternatives. A treatment facility cannot be located within 200 feet of a fault displaced in Holocene time (40 CFR 264.18). If located in a 100-year flood plain, the facility must be designed, constructed, operated, and maintained to avoid washout (40 CFR 18). In a normal flood plain or lowlands near surface water bodies, action must be taken to avoid adverse effects, to minimize potential harm, and to restore the site to its natural state (Executive Order 11988). The Fish and Wildlife Coordination Act provides that any alternative adversely affecting a stream or river shall also include action to protect fish and wildlife.

NJAC 7:7E-3 lists special areas, such as flood plains, wetlands, and endangered or threatened wildlife or vegetation species habitats, that involve special policy considerations. Rules governing flood hazard areas are contained in NJAC 7:13 Flood Hazard Area Regulations. The New Jersey NJAC 7:2-11 describes the location, designation, classification, and management of natural areas in the state. The Wetlands Act of 1970 (NJSA 13:9A-1, et seq.) and the Freshwater Wetlands Protection Act define wetlands and list regulated activities and permit requirements for wetlands in New Jersey.

SECTION 5

IRP PHASE III SCOPE OF WORK

The scope of work for the NWS Earle IRP Phase III study will focus on site and waste characterizations and contaminant migration off site in groundwater and surface drainage. Remedial action technologies and alternatives will be reviewed as field investigation data are gathered to support the initial remedial alternatives screening. Existing data will be incorporated throughout the IRP investigations to ensure continuity and to avoid duplication of data gathering efforts.

5.1 ORGANIZATION AND SEQUENCING OF THE IRP PHASE III EFFORT

This remedial investigation (RI) for NWS Earle will address 11 sites. Available information on site histories and waste disposal is summarized in Table 2-1 and in Subsection 2.2. Available information on stratigraphic and hydrogeologic conditions at the sites is summarized in Table 3-3.

The Phase III scope of work for NWS Earle is summarized in Table 5-1. It includes both general activities (stationwide activities or activities to be included at all sites) and site-specific activities. The activities outlined in Table 5-1 are described in detail in the following subsections. The scope of work outlined in this Work Plan is sequenced into three periods of effort, each one culminating in an Interim Technical Report with specific recommendations for the next portion of the investigation.

The first period of effort will include much of the stationwide activities, including the literature search, well inventory, aerial photography review, and topographic map review.

The second period of effort will be field data collection and sample analysis and will include initial subsurface investigations for chemical and physical characterization of the sites, including test boring investigation, soil sampling, and chemical analyses and geotechnical testing of soils. The second period of effort also will include data analysis activities leading to preliminary risk analyses and remedial alternatives screening efforts.

The third period of effort will include installation of monitor wells. These will further define chemical and/or physical characteristics and develop parameters for evaluation of specific potentially applicable remedial technologies. This effort will include groundwater, surface water, and stream sediment sampling. This period also will include hydrogeologic data analysis.

A Remedial Investigation Report will be generated after completing this effort. A follow-up effort will include the analyzes of data and evaluation of remedial action alternatives.

Table 5-1

RI/FS Activity Matrix, NWS Earle, Colts Neck, NJ

	Site 2	Site 3	Site 4	Site 5	Site 7	Site 10	Site 11	Site 19	Site 20	Site 22	Site 26
Historical Aerial Photograph Interpretaion	●	●	●	●	●	●	●	●	●	●	
Geophysics					●						
Sediment/Soil Sampling	●		●			●	●	●	●	●	●
New Monitor Well Installation	●	●	●	●	●	●	●	●			●
Surface Water Sampling			●			●					
Monitor Well Sampling	●	●	●	●	●	●	●	●			●
Slug Test	●	●	●	●	●	●	●	●			●
Additional Geologic Characterization	●	●	●	●	●	●	●	●			

● Proposed Activity

241-1480

Site-specific requirements for soil borings and soil sampling are listed in Table 5-2. Site-specific requirements for groundwater and surface water sampling and analyses are listed in Table 5-3. Site-specific work scopes are discussed in Subsection 5.3 through 5.13. Tables 5-4 and 5-5 present lists of sample analysis and required QC samples.

5.2 GENERAL WORK REQUIREMENTS

This discussion outlines general methodologies to be followed while performing the IRP Phase III study at NWS Earle.

5.2.1 Planning Documents

The Quality Assurance Project Plan (QAPP) and Health and Safety Plan (HSP) have been prepared to outline specific procedures to be used during the RI.

5.2.2 Literature Search

Prior to conducting field work and ongoing during the Phase III investigation, a literature search will be performed to correlate and evaluate existing regional, stationwide, and site-specific data. The literature search will develop data to supplement the information provided in this Work Plan and earlier reports and to further identify and define migration pathways. The geographic area included in the literature search will be the area within a 3-mile radius of the site boundaries. The literature search will include but not be limited to the following items:

- Geographic setting.
- Physiography, including topography, drainage, vegetation, and soils.
- Geology, including structure, stratigraphy, lithology, and hydrogeology.
- Well inventory, including all identifiable active supply wells (domestic, community supply, industrial, and other uses) within a 3-mile radius of the sites.
- Groundwater and surface water quality.
- Surface water, including types, flow rate (where documented), uses, and classification.
- Biology and ecology, including flora, fauna, and sensitive areas.
- Natural resources.
- Human environment, including population, demographics, and land uses.

Table 5-2

Summary of Analytical Requirements for Soil and Sediment Analyses, NWS Earle, Colts Neck, NJ

Site Number	Site Name	Sediment Samples	Sediment Analytes	Subsurface Soil Sampling Locations	Depth Interval (feet)	Soil Analytes
2	Ordnance Demilitarization	3 3	TAL metals+CN Explosives*	6	1-2	TAL metals+CN, explosives
3	Landfill SW of F Group	0	None	0	0	None
4	Landfill West of D Group	4 4	TCL organics TAL metals+CN	0	0	None
5	Landfill West of Army Barricades	0	None	0	0	None
7	Landfill South of P Barricades	0	None	0	0	None
10	Scrap Metal Landfill Near Building 589	3 3	TCL organics TAL metals+CN	0	0	None
11	Contract Ordnance Disposal Area	0	None	9 9	0.5-1.5 0.5-1.5	Explosives TPH

*Explosives compounds include nitrate/nitrite; picric acid; nitrocellulose; nitroglycerin; 2,4,6-trinitrotoluene; 2,4-dinitrotoluene; 2,6-dinitrotoluene; tetryl; 1,3,5-trinitrobenzene; 1,3-dinitrobenzene; HMX; and RDX.

QC samples (matrix spikes and duplicates) will be taken at a rate of 10 percent minimum per sampling event. Field blanks will be taken daily for each event.

Grab samples will be taken of impacted soils, leachate, or perched water from Sites 3,4,5,7, and 10 for full scan TCL and TAL analyses during a later stage test pit investigation.

Table 5-2
(continued)

Site Number	Site Name	Sediment Samples	Sediment Analytes	Subsurface Soil Sampling Locations	Depth Interval (feet)	Soil Analytes
19	Paint Chip and Sludge Disposal Area	3 12 6	TAL metals+CN Pb and Cd TPH	4 20 4 hand auger borings in drainageway	0-0.5 0.5-1.0 1-2	TAL metals+CN, Cd and Pb VOCs, TPH
20	Blasting Grit Disposal Area (near Building 589)	5 2	TAL metals+CN BNAs, Pest/PCBs	1	1-2	VOCs
22	Paint Chip Disposal Area (adjacent to Building D-2)	5 6 2	TAL metals+CN TPH BNAs, Pest/PCBs	4 4	0-1 1-2	TAL metals+CN, BNAs, Pest/PCBs VOCs
26	Explosive D Washout Area (adjacent to Building GB-1)	2 1	TAL metals+CN VOCs	8	0-0.5/2-3	Explosives*

*Explosives compounds include nitrate/nitrite; picric acid; nitrocellulose; nitroglycerin; 2,4,6-trinitrotoluene; 2,4-dinitrotoluene; 2,6-dinitrotoluene; tetryl; 1,3,5-trinitrobenzene; 1,3-dinitrobenzene; HMX; and RDX.

QC samples (matrix spikes and duplicates) will be taken at a rate of 10 percent minimum per sampling event. Field blanks will be taken daily for each event.

Grab samples will be taken of impacted soils, leachate, or perched water from Sites 3,4,5,7, and 10 for full scan TCL and TAL analyses during a later stage test pit investigation.

Table 5-3

Phase III Remedial Investigation Sampling Plan, NWS Earle, Colts Neck, NJ

Site Number	Site Name	Number of Existing Wells	Number of Proposed Wells	Initial Round Groundwater Analytes	Surface Water Samples	Surface Water Analytes
2	Ordnance Demilitarization	4	3	TCL organics	0	None
		4	3	TAL metals+CN		
		4	3	Explosives*		
3	Landfill SW of F Group	3	4	TLC organics	0	None
		3	4	TAL metals+CN		
4	Landfill West of D Group	3	4	TLC organics	4	TPH
		3	4	TAL metals+CN	4	VOCs
5	Landfill West of Army Barricades	3	4	TCL organics	0	None
		3	4	TAL metals+CN		
7	Landfill South of P Barricades	3	2	TCL organics	0	None
		3	2	TAL metals+CN		
10	Scrap Metal Landfill Near Building 589	3	4	TCL organics	3	TPH
		3	4	TAL metals+CN	3	VOCs

*Explosives compounds include nitrate/nitrite; picric acid; nitrocellulose; nitroglycerin; 2,4,6-trinitrotoluene; 2,4-dinitrotoluene; 2,6-dinitrotoluene; tetryl; 1,3,5-trinitrobenzene; 1,3-dinitrobenzene; HMX; and RDX.

QC samples (matrix spikes and duplicates) will be taken at a rate of 10 percent minimum per sampling event. Field blanks will be taken daily for each event.

Table 5-3
(continued)

Site Number	Site Name	Number of Existing Wells	Number of Proposed Wells	Initial Round Groundwater Analytes	Surface Water Samples	Surface Water Analytes
11	Contract Ordnance Disposal Area (adjacent to Building S-34)	3 3 3	2 2 2	TCL organics TAL metals+CN Explosives*	0	None
19	Paint Chip and Sludge Disposal Area	3 3	3 3	TCL organics TAL metals+CN	0	None
20	Blasting Grit Disposal Area (near Building 589)	0	0	None	0	None
22	Paint Chip Disposal Area (adjacent to Building D-2)	0	0	None	0	None
26	Explosive D Washout Area (adjacent to Building GB-1)	3 3 3	1 1 1	TCL organics TAL metals+CN Explosives	0	None

*Explosives compounds include nitrate/nitrite; picric acid; nitrocellulose; nitroglycerin; 2,4,6-trinitrotoluene; 2,4-dinitrotoluene; 2,6-dinitrotoluene; tetryl; 1,3,5-trinitrobenzene; 1,3-dinitrobenzene; HMX; and RDX.
QC samples (matrix spikes and duplicates) will be taken at a rate of 10 percent minimum per sampling event. Field blanks will be taken daily for each event.

Table 5-4

Summary of Analytical QC Requirements for Soil and Sediment Analyses, NWS Earle, Colts Neck, NJ

Parameter	Sampling Points	MS/MSD	Field Blanks	Total Number of Samples
Explosives	30	4	3	37
Metals (including cyanide)	39	2	2	43
Lead/cadmium	32	4	4	40
VOCs (TCL)	17	4	4	25
BNAs (TCL) and pesticides/ PCBs (TCL)	16	4	2	22
Total petroleum hydrocarbons	25	0	4	29

Table 5-5

Summary of Analytical QC Requirements for Surface Water and Groundwater Analyses, NWS Earle, Colts Neck, NJ

Parameter	Sampling Points	MS/MSD	Duplicate Samples	Trip Blanks	Field Blanks	Total Number of Samples
*Explosives	16	2	2	0	2	22
Metals (TAL)	55	6	6	0	11	78
CN	55	6	6	0	11	78
VOCs (TCL)	55	6	6	11	11	89
BNAs	55	6	6	0	11	78
Pest/PCBs	55	6	6	0	11	78
TPH	7	0	1	0	1	9
VOCs (SW)	7	2	2	1	1	11

*Explosives require daily shipment -- sample three sites in 2 days.
Exact number of QC samples required may vary based on actual schedule and shipping conditions.

5.2.3 Review of Aerial Photographs

A thorough search of available maps and aerial photographs, will be conducted. Sources will include the National Cartographic Information Center (Durham, New Hampshire, and Denver, Colorado), the Agricultural Stabilization and Conservation Service Center (Salt Lake City, Utah), the EROS Data Center (Sioux Falls, South Dakota), and private aerial photography services in the area. If available, stereo pairs will be used. In addition, new aerial photography of the station area may need to be flown. The aerial photograph review will have the following objectives:

- Delineate the historical extent and types of waste disposal activities at the individual IRP sites.
- Identify historical drainage patterns and past land uses that may have been modified in developing the area.

5.2.4 Topographic Mapping

Topographic mapping is not currently planned for the sites. Detailed mapping requirements will be identified in the RI Report, based on the results of the RI and initial screening of remedial alternatives.

5.2.5 Field Investigation Methods

The field investigation methods to be employed during the Phase III study can be divided into the following categories:

- Surface geophysics.
- Source test pit area subsurface investigations, including test borings, soil chemical sampling, mechanical testing, and piezometric analyses.
- Exploratory drilling and monitor well installation.
- Groundwater sampling.
- Surface water sampling
- Sediment sampling.

5.2.5.1 Surface Geophysical Surveys

Surface geophysical surveys are planned for drilling and test pit sites using limited magnetometer surveys at specific locations where buried objects could be encountered during field operations and at Site 7 to locate full buried tanks.

The magnetic surveys will be performed using a Scintrix Fluxgate magnetometer, or equivalent instrument. Magnetometers respond to ferromagnetic minerals and ferrous metals; thus, debris consisting of nonferrous materials will not be identified.

5.2.5.2 Test Borings

Test borings will be performed at Sites 2, 19, 22, and 26. The objectives of the test boring programs at these sites are to:

- Characterize soil contamination at depth.
- Develop geotechnical information for site soils to be used in evaluating migration pathways and remedial action alternatives.

Site-specific sampling locations and laboratory analyses for soils requirements are summarized in Table 5-2.

Test borings below 2 feet will be completed using hollow-stem drilling augers and split-spoon sampling. Split-spoon samples will be taken at 2.0-foot intervals from ground surface to approximately 15 feet in depth, or total depth, as determined by site-specific requirements. Test borings at Sites 2 and 19 will be completed at first water encountered. Samples at Site 22 will be taken with a bucket auger at depths of less than 2 feet.

5.2.5.3 Exploratory Drilling and Additional Monitor Well Installation

The following general procedures will be followed during all test borings:

- All soil borings will be tremie grouted to the surface with a cement/bentonite slurry.
- Drill cuttings identified as potentially hazardous will be containerized in new unused drums. Specific procedures are included in the QAPP.
- All drilling, sampling, and other related equipment will be decontaminated as detailed in the QAPP.
- All completed wells will be permanently marked with the NJDEP ID number and site number.

Twenty-seven new permanent wells will be installed at NWS Earle. The monitor wells will be installed following NJDEP monitor well construction and grouting specifications for unconsolidated formations. This monitor well design will conform with NJAC 7:9-7, 8, and 9. The following describes drilling and well construction methods to be used.

At a minimum, all drilling will be conducted according to standard hollow-stem auger and hydraulic rotary drilling techniques. Wells intended to monitor the water table aquifer will

be installed by placing 4-inch diameter, threaded, PVC casing and 15-foot length well screen with a 0.020-inch slot opening inside the 8-inch hollow-stem augers. The well will terminate at a depth of 10 feet below the groundwater table and will extend 5 feet above the groundwater table. The annulus around the well screen will be filled with Ottawa No. 1 sand, or equivalent, to a point 2 feet above the screen. The sand pack will then be overlain with 2 feet of bentonite pellets. The remainder of the annulus will be filled to grade with a 6:1 cement:bentonite slurry using tremie methods. The augers will be withdrawn as the backfilling proceeds. The top of the monitor well will be completed with a locking steel security casing. This casing will be immobilized with a mounded concrete seal to protect the well and to not allow storm water runoff to collect around the well casing. All water used for drilling must be potable; no surface water will be used during the drilling process.

5.2.5.4 Piezometric Analyses

Water level measurements made will be made throughout the field investigation. The following standard procedures will be followed during all water level studies:

- Reference stakes will be installed to mark permanent surface water and sediment sampling locations. Stake elevations will be established in streams adjacent to the sites.

- New and existing monitor wells will be available for groundwater level measurements.

5.2.5.5 Groundwater Sampling

Three rounds of groundwater sampling are planned during the Phase III study, the first to be performed no sooner than 2 weeks after installing the new monitor wells. Included in the groundwater sampling will be all the existing and new monitor wells at the 11 sites.

Parameters to be analyzed are listed in Table 5-3. All groundwater samples collected will be field tested for pH, specific conductance, and temperature.

The first round of samples will be analyzed for the full target list of organic compounds, (TCL), target analyte list of inorganics (TAL), and explosives (see Table 5-3). The second and third sampling round will be limited to select parameters based on the initial results. Standard EPA protocols, including purging of at least three well volumes prior to sampling, will be followed. Specifics on equipment to be used, protocols to be followed, and decontamination procedures are provided in the QAPP.

5.2.5.6 Surface Water and Sediment Sampling

The stream sediment sampling program is designed to identify and quantify expected contaminants in the stream beds.

Sampling Methodology

Standard EPA protocols for sample collection and handling will be followed during all surface water and sediment sampling. Sediments from the stream beds will be collected using trowel/scoop, sample trier, or soil auger. If the trowel/scoop method is used, the sediment will be placed directly in sample jars using a decontaminated trowel or scoop.

Sample Management

Once the samples have been collected and the sediment samples have been placed in their containers, the samples will be placed in a cooler and packed with vermiculite. Ice will be placed around the samples to keep them cool. A chain of custody record, as described in the QAPP, will be maintained from collection through shipping and relinquished upon receipt of the samples at the laboratory.

Documentation

A field logbook will be maintained to document pertinent information regarding the sediment sampling. Specifics to be documented at each sampling location include sampling location via the use of sketches, landmarks, and markers; sediment sampling depth; and description of sampled material.

Sampling Equipment Decontamination

Any sampling equipment to be used at multiple sampling locations will be decontaminated between locations using the decontamination procedures described in the QAPP.

5.2.5.7 Test Pits

A test pit investigation will be conducted at landfill Sites 3, 4, 5, 7, and 10. The objective of this task is to obtain a physical description of landfill cover and waste material and to obtain samples for chemical analyses.

A backhoe will be used to excavate four to six test pits at each landfill to a maximum depth of 10 feet below ground surface (BGS). Cover material will be stockpiled separately from underlying waste. The test pits will allow visual observations of subsurface conditions. The test pits will be described and logged in the field notebook and will include color, texture, moisture, depth to water, and odor or staining if present.

All sampling will be conducted using the backhoe bucket and a shovel as needed. Two samples will be selected at each site for full TCL and TAL analyses. These grab samples will be taken of impacted soils, leachate, or perched water. At least one sample will be of solids; the other sample will be of liquids, if encountered. Upon completion, excavated materials will be sequentially backfilled into the test pit and compacted with the backhoe bucket. The backhoe bucket will be steam cleaned before excavation of the first pit, between sampling locations, and following completion of the last pit.

Sample handling, documentation, analytical, and QA/QC procedures will be consistent with procedures for soil and water sampling specified in the QAPP. The information and data gleaned from the test pit investigation will be evaluated, and incorporated into the RI Report.

5.2.5.8 Sampling QA/QC Requirements

Field QA/QC samples will be collected and analyzed as part of all field sampling activities. The field QA/QC samples will be approximately 10 percent of the total number of field samples and will include trip blanks, ambient blanks, field equipment blanks, and field duplicates/replicates.

The distribution of field QA/QC samples is detailed in the QAPP, as are field QA/QC procedures (e.g., decontamination, sample handling). Duplicate, replicate, trip blank, and field blank requirements are identified in Tables 5-4 and 5-5.

5.2.6 Data Analysis

Raw data will be tabulated to produce data tables, groundwater level maps, well hydrographs, and isoconcentration maps for soil and groundwater chemical data. Data will be represented on a site-specific basis for interpretation and evaluation for later use in the risk analysis and feasibility study efforts.

5.3 SITE 2 SCOPE OF WORK

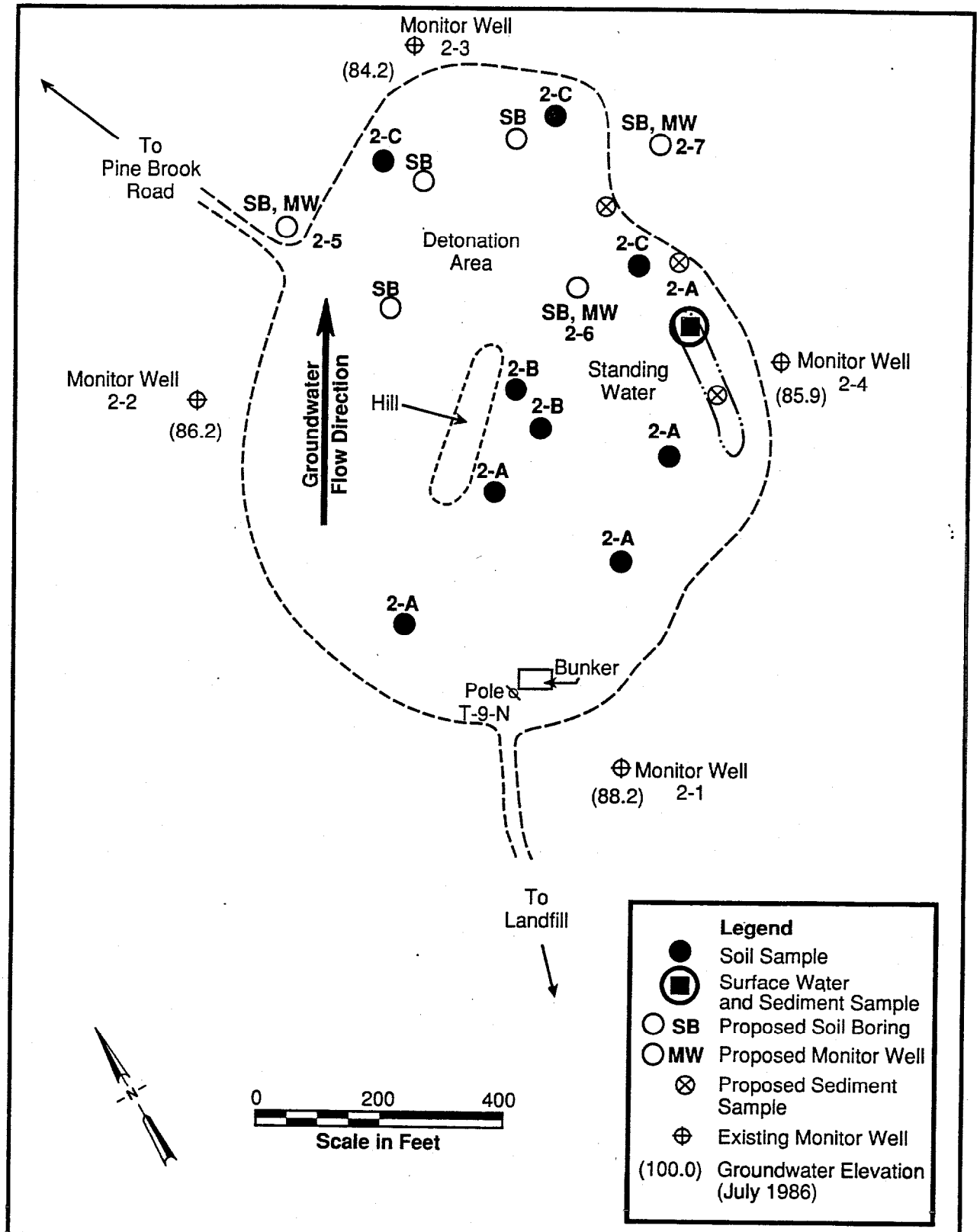
5.3.1 Field Investigation Overview

Site 2 has been and is currently being used to demilitarize ordnance. Common explosives demilitarized at this site include ammonium picrate, TNT, RDX, black powder, and nitroglycerin. The CS tested for the presence of these explosives, as well as for nitrate/nitrite (possible residue after detonation). No contamination from these explosives was detected at the CS sampling locations (see Figure 5-1). Tables 5-6 and 5-7 summarize the chemical analyses undertaken during the CS and highlight contaminants detected at concentrations above regulatory standards.

Currently, one monitor well is located downgradient from the site. Two additional monitor wells are to be located at the site perimeter to confirm that there are no contaminants migrating off site. One additional monitor well will be located within the detonation area to directly monitor the source area.

5.3.1.1 Surface Soil Sampling

Surface soils sampled during the CS were composited and analyzed for explosives. Analyses show none detected.



Well 2-1	N 521475.574	E 2152742.308	El. 102.56	W.L. 88.23
Well 2-2	N 522229.543	E 2152226.069	El. 95.98	W.L. 86.18
Well 2-3	N 522668.058	E 2152717.850	El. 89.87	W.L. 84.22
Well 2-4	N 522042.714	E 2153154.258	El. 90.06	W.L. 85.91

75-442a

FIGURE 5-1 SITE 2 - ORDNANCE DEMILITARIZATION SITE MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

Table 5-6

Analytical Results for Surface Water Samples Collected in July 1986 -- Site 2, NWS Earle, Colts Neck, NJ

Analyte	2-A (1st hour)	2-A (6th hour)	2-A (blank)	Regulatory Limit
Total organic halogens (μg/L)	40.0	35.0	NR	NRC
Total organic carbon (mg/L)	4.13	4.13	NR	NRC
Nitrate/nitrite (mg/L)	1.0(1.0)**	1.0	ND	NRC
Base/neutral/acid compounds (μg/L)	ND	ND	NR	NRC
Explosives				
HMX (μg/L)	ND	ND	ND	NRC
RDX (μg/L)	ND	ND	ND	NRC
2,4,6-TNT (μg/L)	ND	ND	ND	NRC
Nitroglycerin (mg/L)	ND	ND	ND	NRC
Picric acid (μg/L)	ND	ND	ND	NRC
Soluble metals (mg/L)				
Antimony	ND	ND	NR	NRC
Arsenic	ND	ND	NR	0.050

** Duplicate sample
ND - Not detected
NR - Analysis not requested
NRC - No specific regulatory concentration

Table 5-6
(continued)

Analyte	2-A (1st hour)	2-A (6th hour)	2-A (blank)	Regulatory Limit
Soluble metals (mg/L)				
Beryllium	ND	ND	NR	NRC
Cadmium	ND	ND	NR	0.0101
Chromium	0.016	0.017	NR	0.050
Copper	0.021	0.022	NR	NRC
Lead	0.014	0.014	NR	0.050
Mercury	ND	ND	NR	0.002
Nickel	0.04	0.04	NR	NRC
Selenium	ND	ND	NR	0.010
Silver	ND	ND	NR	0.050
Thallium	ND	ND	NR	NRC
Zinc	0.018	0.045	NR	NRC
pH (lab measured)	4.20	4.20	NR	---
Chloride (mg/L)	ND	ND	NR	NRC
Specific conductance (μmho/ cm)	36.1	35.8	NR	NRC

** Duplicate sample
ND - Not detected
NR - Analysis not requested
NRC - No specific regulatory concentration

Table 5-7

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 2, NWS Earle, Colts Neck, NJ

Analyte	2-1	2-1B	2-2	2-3	2-4	Regulatory Limit
Total organic halogens (μg/L)	20.0	1.00	35.0	18.0	27.0	NRC
Total organic carbon (mg/L)	2.39	1.58	2.25	4.12	2.25	NRC
Nitrate/nitrite (mg/L)	ND	ND	ND	0.70	0.20	10
Base/neutral/acid compounds (μg/L)	ND	ND	ND	ND	ND	
Explosives						
HMX (μg/L)	ND	ND	ND	ND	ND	NRC
RDX (μg/L)	ND	ND	ND	ND	ND	NRC
2,4,6-TNT (μg/L)	ND	ND	ND	ND	ND	NRC
Nitroglycerin (mg/L)	ND	NR	ND	ND	ND	NRC
Picric acid (μg/L)	ND	ND	ND	ND	ND	NRC
Soluble metals (mg/L)						
Antimony	ND	ND	ND	ND	ND	NRC
Arsenic	ND	ND	ND	ND	ND	0.050
Beryllium	ND	ND	ND	ND	ND	NRC
Cadmium	ND	ND	ND	ND	ND	0.010

*Field measured
ND - Not detected
NR - Analysis not requested

A - Duplicate sample
B - Field blank
NRC - No specific regulatory concentration

Table 5-7
(continued

Analyte	2-1	2-1B	2-2	2-3	2-4	Regulatory Limit
Soluble Metals (mg/L)						
Chromium	0.023	0.014	ND	ND	ND	0.050
Copper	0.024	0.014	ND	ND	ND	NRC
Lead	ND	ND	ND	ND	ND	0.050
Mercury	ND	ND	ND	ND	ND	0.002
Nickel	0.03	0.04	ND	ND	ND	NRC
Selenium	ND	ND	ND	ND	ND	0.010
Silver	0.004	ND	ND	ND	ND	0.050
Thallium	ND	ND	ND	ND	ND	NRC
Zinc	0.016	ND	0.03	0.04	0.02	NRC
pH	5.10	6.10	4.90	4.80	4.90	---
pH*	5.3	NR	7.0	5.2	6.8	---
Chloride (mg/L)	7.00	ND	8.60	5.00	7.60	NRC
Specific conductance (μmho/cm)	40.6	1.12	50.1	47.2	38.6	NRC
Specific conductance* (μmho/cm)	40	NR	40	40	30	NRC
Temperature (°C)	20	NR	14	16	14	NRC

*Field measured
ND - Not detected
NR - Analysis not requested

A - Duplicate sample
B - Field blank
NRC - No specific regulatory concentration

5.3.1.2 Soil Borings

Six soil borings will be taken at a depth of 1 to 2 feet using hand auger methods around the detonation area. These borings have been tentatively located as shown in Figure 5-1. Their actual locations will be adjusted in the field as required. Samples will be analyzed for TAL metals, cyanide, and explosives (see Table 5-2).

5.3.1.3 Sediment Sampling

Three sediment samples will be obtained in the drainage depression on the eastern side of the site (see Figure 5-1) and analyzed for TAL metals, cyanide, and explosives.

5.3.1.4 Groundwater Sampling

All existing and new monitor wells at the site will be sampled in accordance with the QAPP. Groundwater pH and specific conductance will be determined in the field.

5.4 SITE 3 SCOPE OF WORK

5.4.1 Field Investigation Overview

Site 3 is a 5-acre landfill used from 1960 through 1968 and is currently closed. Materials disposed at the site include municipal-type solid waste and waste from station industrial operations. Potential contaminants are listed in Table 2-1. The site was investigated during the CS by installing and sampling three monitor wells. Table 5-8 summarizes the chemical analyses during the CS. The groundwater samples taken during the CS exhibit a pH below the groundwater standard. No other contaminants were detected above regulated limits.

5.4.1.1 Test Pit Investigation

Consistent with the requirements summarized in Subsection 5.2.5.7, a series of four to six test pits will be completed at the site to obtain a physical description of the waste materials and surrounding soils. Two samples will be taken for TCL organics and TAL inorganics analyses, and the grab sample will be taken of impacted soils, leachate, or perched water. At least one sample will be solids; the other will be liquids, if encountered.

5.4.1.2 Soil Borings

Continuous split-spoon soil sampling will be conducted during monitor well installation. Soil samples will be collected on a continuous basis and logged for lithology.

5.4.1.3 Monitor Wells

Four additional monitor wells will be installed. The approximate monitor well locations are shown in Figure 5-2. The locations of these wells will be adjusted in the field depending on

Ta. . 5-8

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 3, NWS Earle, Colts Neck, NJ

Analyte	3-1	3-2	3-3	3-3A	3-3B	Regulatory Limit
Total organic halogens (μg/L)	28.0	12.0	25.0	35.0	17.0	NRC
Total organic carbon (mg/L)	7.10	4.44	3.60	3.39	2.15	NRC
Volatile organic compounds (μg/L)	ND	ND	ND	ND	ND	10
Petroleum hydrocarbons (mg/L)	1.00	ND	ND	ND	ND	1
Pesticides (μg/L)	ND	ND	ND	ND	ND	Compound specific
Nitrate/nitrite (mg/L)	ND	ND	0.20	NR	ND	10
Base/neutral/acid compounds (μg/L)	ND	ND	ND	ND	ND	100
Soluble metals (mg/L)	ND	ND	ND	ND	ND	---
Antimony	ND	ND	ND	ND	ND	NRC
Arsenic	ND	ND	ND	ND	ND	0.050
Beryllium	ND	ND	ND	ND	ND	NRC
Cadmium	0.008	ND	ND	ND	ND	0.010
Chromium	0.017	0.013	ND	ND	ND	0.050
Copper	0.015	0.016	ND	ND	ND	NRC
Lead	ND	ND	ND	ND	ND	0.050

ND - Not detected
NR - Analysis not requested

A - Duplicate sample
B - Field blank
NRC - No specific regulatory concentration

Table 5-8
(continued)

Analyte	3-1	3-2	3-3	3-3A	3-3B	Regulatory Limit
Soluble Metals (mg/L)						
Mercury	ND	ND	ND	ND	ND	0.002
Nickel	0.05	0.05	ND	ND	ND	NRC
Selenium	ND	ND	ND	ND	ND	0.010
Silver	ND	ND	ND	ND	ND	0.050
Thallium	ND	ND	ND	ND	ND	NRC
Zinc	0.226	0.087	0.11	0.20	ND	NRC
pH	2.90	3.80	4.70	NR	7.10	**
pH*	3.9	--	5.5	NR	NR	**
Chloride (mg/L)	8.80	5.80	7.80	NR	ND	NRC
Specific conductance (μmho/cm)	609	103	54.3	NR	2.48	NRC
Specific conductance* (μmho/cm)	290	100	40	NR	NR	NRC
Temperature (°C)	17	18	17	NR	NR	NRC

ND - Not detected
NR - Analysis not requested
NRC - No specific regulatory concentration
*Field measured
A - Duplicate sample
B - Field blank
** pH standard for groundwater is a range between 5 and 9. Soil and water in the NWS Earle area commonly have natural pH below the standard.

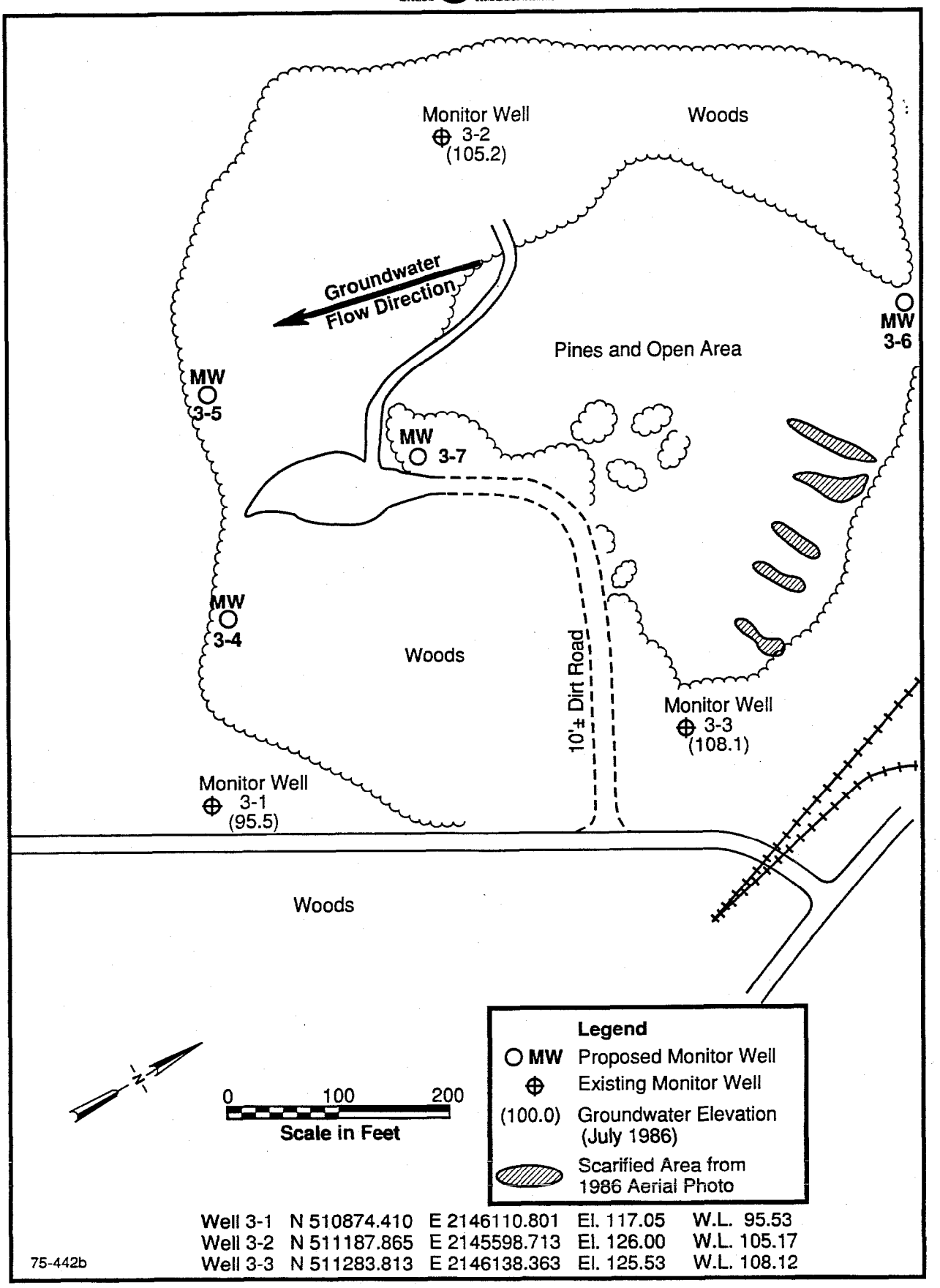


FIGURE 5-2 SITE 3 - LANDFILL SOUTHWEST OF "F" GROUP MONITOR WELL LOCATIONS, NWS EARLE, NJ

site conditions and topographical constraints. The placement of these wells will permit the identification of contaminants migrating from the landfill area.

The monitor wells will be of will be set 10 feet into the water table to an approximate depth of 25 to 30 feet. The construction methods are presented in Subsection 5.2.5.3 and in the QAPP.

5.4.1.4 Groundwater Sampling

A representative groundwater sample will be collected from each on-site monitor well. The analytical parameters are listed in Table 5-2.

5.5 SITE 4 SCOPE OF WORK

5.5.1 Field Investigation Overview

Site 4 is a 5-acre landfill used from 1943 to 1960. Materials disposed at this site include municipal-type solid waste and waste from station industrial operations. Potential contaminants are listed in Table 2-1. The site was investigated during the CS through the installation and sampling of three monitor wells and the collection and analyses of surface water samples. Table 5-9 summarizes the chemical analyses performed during the CS. Groundwater and surface water analyses indicate that bis(2-ethylhexyl) phthalate (BEHP) was detected in monitor well 4-1 at 53 μg/L. This compound was not detected elsewhere at Site 4 (see Table 5-9).

Water from a spring at this site indicates the presence of an amine tentatively identified as N-nitrosodiphenylamine (see Table 5-10).

5.5.1.1 Test Pit Investigation

Consistent with the requirements summarized in Subsection 5.2.5.7, a series of four to six test pits will be completed at the site to obtain a physical description of the waste materials and surrounding soils. Two samples will be taken for TCL organics and TAL inorganics analyses, and the grab sample will be taken of impacted soils, leachate, or perched water. At least one sample will be solids; the other will be liquids, if encountered.

5.5.1.2 Monitor Wells

Four additional groundwater monitor wells will be installed at this site. These new monitor wells will be placed hydraulically upgradient and downgradient of the site (see Figure 5-3). The boreholes will be advanced using hollow-stem augers, and the monitor wells will be screened across the water table. The water table is at a depth of approximately 22 feet. Split-spoon samples will be collected during the boring phase of the well installations. Construction methods are presented in Subsection 5.2.5.3 and the QAPP.

Table 5-9

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 4, NWS Earle, Colts Neck, NJ

Analyte	4-1	4-2	4-3	Regulatory Limit
Total organic halogens (μg/L)	17.0	18.0	17.0	NRC
Total organic carbon (mg/L)	1.94	4.74	2.15	NRC
Volatile organic compounds (μg/L)	ND	ND	ND	10
Petroleum hydrocarbons (mg/L)	ND	ND	ND	1
Pesticides (μg/L)	ND	ND	ND	Compound specific
Nitrate/nitrite (mg/L)	ND	ND	ND	10
Base/neutral/acid compounds (μg/L)	ND	ND	100	
Bis(2-ethylhexyl) phthalate	53	ND	ND	
Soluble metals (mg/L)				
Antimony	ND	ND	ND	NRC
Arsenic	ND	ND	ND	0.050
Beryllium	ND	ND	ND	NRC
Cadmium	ND	ND	ND	0.010

*Field measured
ND - Not detected
NR - Analysis not requested
NRC - No specific regulatory concentration

Table 5-9
(continued)

Analyte	4-1	4-2	4-3	Regulatory Limit
Soluble metals (mg/L)				
Chromium	ND	ND	ND	0.050
Copper	ND	ND	ND	NRC
Lead	ND	ND	ND	0.050
Mercury	ND	ND	ND	0.002
Nickel	ND	ND	ND	NRC
Selenium	ND	ND	ND	0.010
Silver	ND	ND	ND	0.050
Thallium	ND	ND	ND	NRC
Zinc	0.06	0.03	0.06	NRC
pH	4.50	6.50	4.50	---
pH*	5.0	6.0	5.0	---
Chloride (mg/L)	6.80	6.40	6.40	NRC
Specific conductance (μmho/cm)	77.8	72.3	56.0	NRC
Specific conductance* (μmho/cm)	60	160	40	NRC
Temperature (°C)	14	17	14	NRC

*Field measured
ND - Not detected
NR - Analysis not requested
NRC - No specific regulatory concentration

Table 5-10

Analytical Results for Spring Water Samples Collected in July 1986 -- Site 4, NWS Earle, Colts Neck, NJ

Analyte	4-A (1st hour)	4-A (6th hour)	4-B (1st hour)	4-B (6th hour)	Regulatory Limit
Total organic halogens (μg/L)	31.0	26.0	9.00	11.0	NRC
Total organic carbon (mg/L)	53.4	50.3	8.23	6.30	NRC
Volatile organic compounds (μg/L)	ND	ND	ND	ND	10
Petroleum hydrocarbons (mg/L)	45.8	44.0	ND	ND	1
Nitrate/nitrite (mg/L)	ND	ND	ND	ND	10
Base/neutral/acid/compounds (μg/L)					
N-Nitrosodiphenylamine	ND	60	ND	ND	100
Soluble metals (mg/L)					
Antimony	ND	ND			NRC
Arsenic	ND	ND	ND	ND	0.050
Beryllium	ND	ND	ND	ND	NRC
Cadmium	ND	ND	ND	ND	0.010
Chromium	0.012	0.017	0.012	0.014	0.050

*Field measured
ND - Not detected
NR - Analysis not requested

Table 5-10
(continued)

Analyte	4-A (1st hour)	4-A (6th hour)	4-B (1st hour)	4-B (6th hour)	Regulatory Limit
Soluble metals (mg/L)					
Copper	0.014	0.014	0.014	0.016	NRC
Lead	ND	ND	ND	ND	0.050
Mercury	ND	ND	ND	ND	0.002
Nickel	0.04	0.04	0.03	0.03	NRC
Selenium	ND	ND	ND	ND	0.010
Silver	ND	ND	ND	ND	0.050
Thallium	ND	ND	ND	ND	NRC
Zinc	0.017	0.039	0.027	0.018	NRC
pH	6.70	6.60	4.90	4.80	---
pH*	NR	NR	NR	NR	---
Chloride (mg/L)	8.80	9.00	6.00	5.60	NRC
Specific conductance (μmho/cm)	663	653	57.7	55.8	NRC
Specific conductance* (μmho/cm)	NR	NR	NR	NR	NRC
Temperature (°C)	NR	NR	NR	NR	NRC

*Field measured
ND - Not detected
NR - Analysis not requested

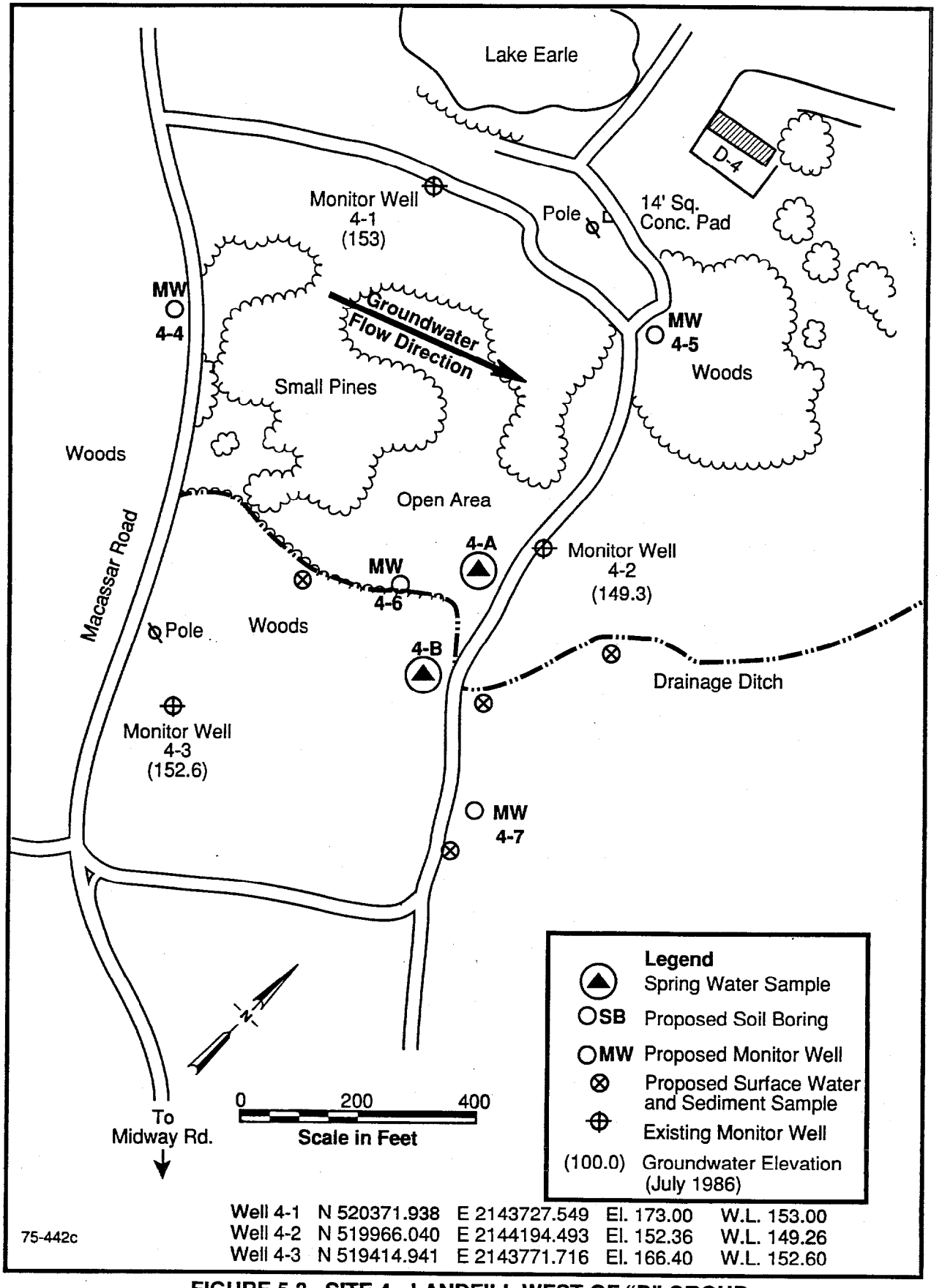


FIGURE 5-3 SITE 4 - LANDFILL WEST OF "D" GROUP MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

5.5.1.3 Groundwater Sampling

A representative groundwater sample will be collected from each new and existing monitor well. The methods and protocols for the sample collection, preservation, and custody are detailed in the QAPP. The samples will be analyzed for TCL organics, TAL metals, and cyanide, as specified in Table 5-2.

5.5.1.4 Surface Water and Sediment Sampling

Surface water samples will be taken at three spring locations and the swale along the eastern edge of the site (see Figure 5-3). The sampling protocols are defined in the QAPP. The analyses for these samples include TCL organics, TAL metals, and cyanide and are specified in Table 5-2.

5.6 SITE 5 SCOPE OF WORK

5.6.1 Field Investigation Overview

Site 5 is a former landfill used from 1968 to 1978. The materials disposed at this site include municipal-type solid waste and waste from station industrial operations. Potential contaminants are listed in Table 2-1. The site was investigated during the CS by installing and sampling four monitor wells.

The analyses of groundwater samples indicate that pentachlorophenol is present at a maximum concentration of 150 μg/L in well 5-3 (see Table 5-11). Methylene chloride was detected at J value limits in the water samples, with the exception of the blank, which detected methylene chloride at 420 μg/L. The high level of methylene chloride, and possibly the contaminant observed in the water samples, is attributed to laboratory contamination rather than to the presence of this compound at the site.

The three wells that contain pentachlorophenol are close to the railroad tracks. The railroad track ties are a possible source of this contamination. Specific activities for this site and their approximate locations are shown in Figure 5-4.

5.6.1.1 Test Pit Investigation

Consistent with the requirements summarized in Subsection 5.2.5.7, a series of four to six test pits will be completed at the site to obtain a physical description of the waste materials and surrounding soils. Two samples will be taken for TCL organics and TAL inorganics analyses, and the grab sample will be taken of impacted soils, leachate, or perched water. At least one sample will be solids; the other will be liquids, if encountered.

Table 5-11

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 5, NWS Earle, Colts Neck, NJ

Analyte	5-1	5-1B	5-2	5-3	5-4	Regulatory Limit
Total organic halogens (μg/L)	241	NR	68.0	41.0	29.0	NRC
Total organic carbon (mg/L)	6.44	NR	1.18	7.45	4.85	NRC
Volatile organic compounds (μg/L)						
Methylene chloride	8 J	420	8 J	7 J	5 J	
Acetone	110	5 J	6 J	12	ND	
2-Butanone	12	7 J	6 J	8 J	9 J	
Petroleum hydrocarbons (mg/L)	ND	NR	ND	ND	ND	1
Pesticides (μg/L)	ND	ND	ND	ND	ND	Compound specific
Nitrate/nitrite (mg/L)	ND	NR	ND	0.20	ND	10
Base/neutral/acid compounds (μg/L)						100
Pentachlorophenol	81		NR	10 J	150	ND

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration

ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits.

Table 5-11
(continued)

Analyte	5-1	5-1B	5-2	5-3	5-4	Regulatory Limit
Soluble metals (mg/L)						
Antimony	ND	NR	ND	ND	ND	NRC
Arsenic	ND	NR	ND	ND	ND	0.050
Beryllium	ND	NR	ND	ND	ND	NRC
Cadmium	ND	NR	ND	ND	ND	0.010
Chromium	ND	NR	ND	ND	0.019	0.050
Copper	ND	NR	ND	ND	0.022	NRC
Lead	ND	NR	ND	ND	ND	0.050
Mercury	ND	NR	ND	ND	ND	0.002
Selenium	ND	NR	ND	ND	0.04	NRC
Selenium	ND	NR	ND	ND	ND	0.010

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration

ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits.

Table 5-11
(continued)

Analyte	5-1	5-1B	5-2	5-3	5-4	Regulatory Limit
Soluble metals (mg/L)						
Silver	ND	NR	ND	ND	ND	0.050
Thallium	ND	NR	ND	ND	ND	NRC
Zinc	0.017	NR	0.016	0.033	0.035	NRC
pH	4.25	NR	4.25	4.20	4.40	---
pH*	5.1	NR	4.5	5.0	5.1	---
Chloride (mg/L)	10.5	NR	9.80	13.7	8.60	NRC
Specific conductance (μmho/cm)	72.3	NR	68.6	142	76.0	NRC
Specific conductance* (μmho/cm)	50	NR	50	80	70	NRC
Temperature (°C)	16	NR	15	16	18	NRC

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration

ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits.

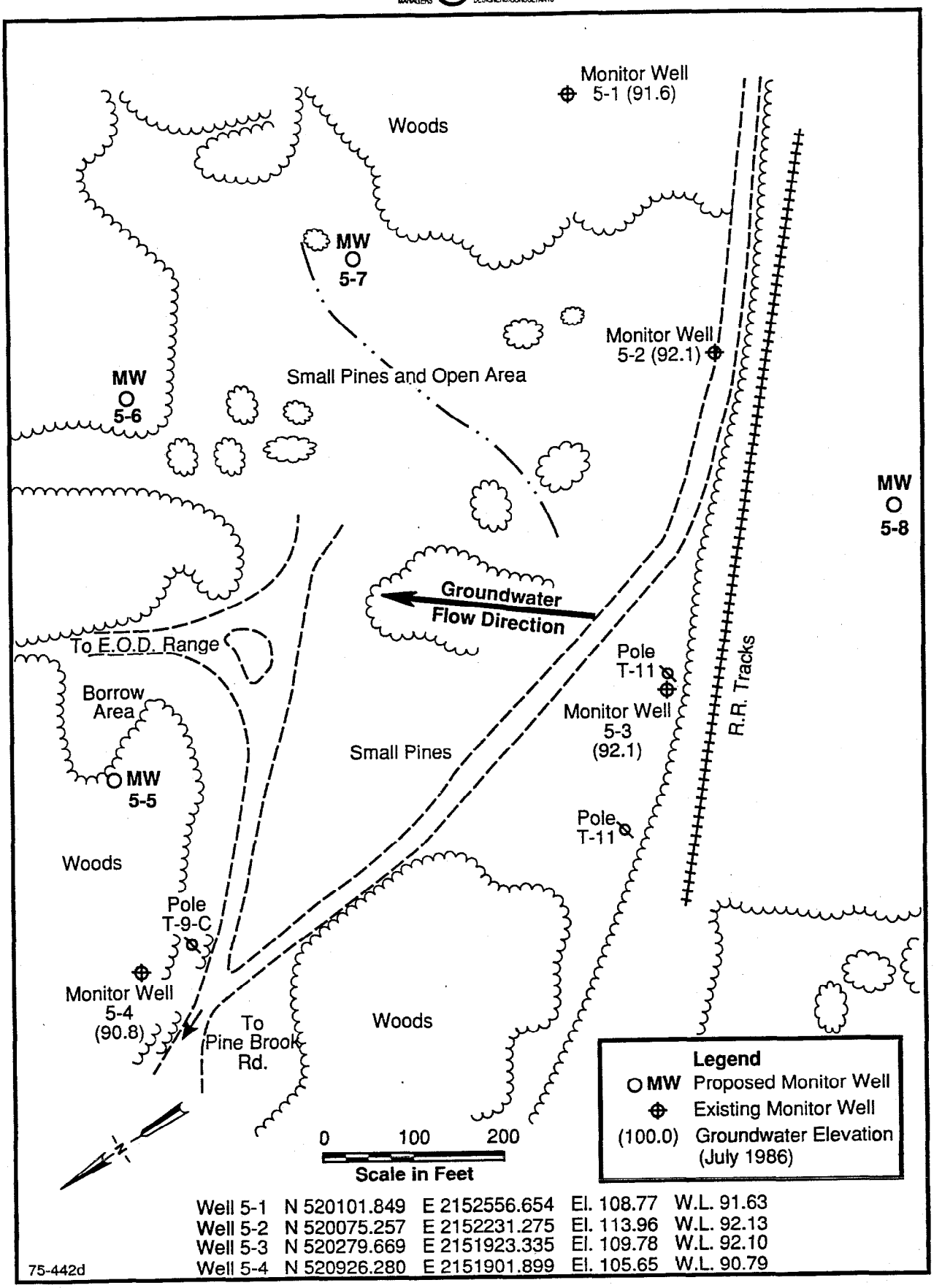


FIGURE 5-4 SITE 5 - LANDFILL WEST OF ARMY BARRICADES MONITOR WELL LOCATIONS, NWS EARLE, NJ

5.6.1.2 Monitor Wells

Four additional monitor wells will be installed at this site at locations shown in Figure 5-4. The monitor wells will be approximately 23 to 29 feet deep and screened across the groundwater table. The monitor wells will be used to provide further definition of groundwater flow and groundwater flow direction, as well as to further delineate the contaminants identified in monitor wells 5-1, 5-2, and 5-3. Well 5-8 will be located upgradient of the railroad tracks to establish background.

5.6.1.3 Groundwater Sampling

Representative groundwater samples will be collected from each new and existing on-site monitor well and analyzed for TCL organics, TAL metals, and cyanide. The sampling protocols specified in the QAPP will be followed. The analytical parameters are listed in Table 5-2.

5.7 SITE 7 SCOPE OF WORK

5.7.1 Field Investigation Overview

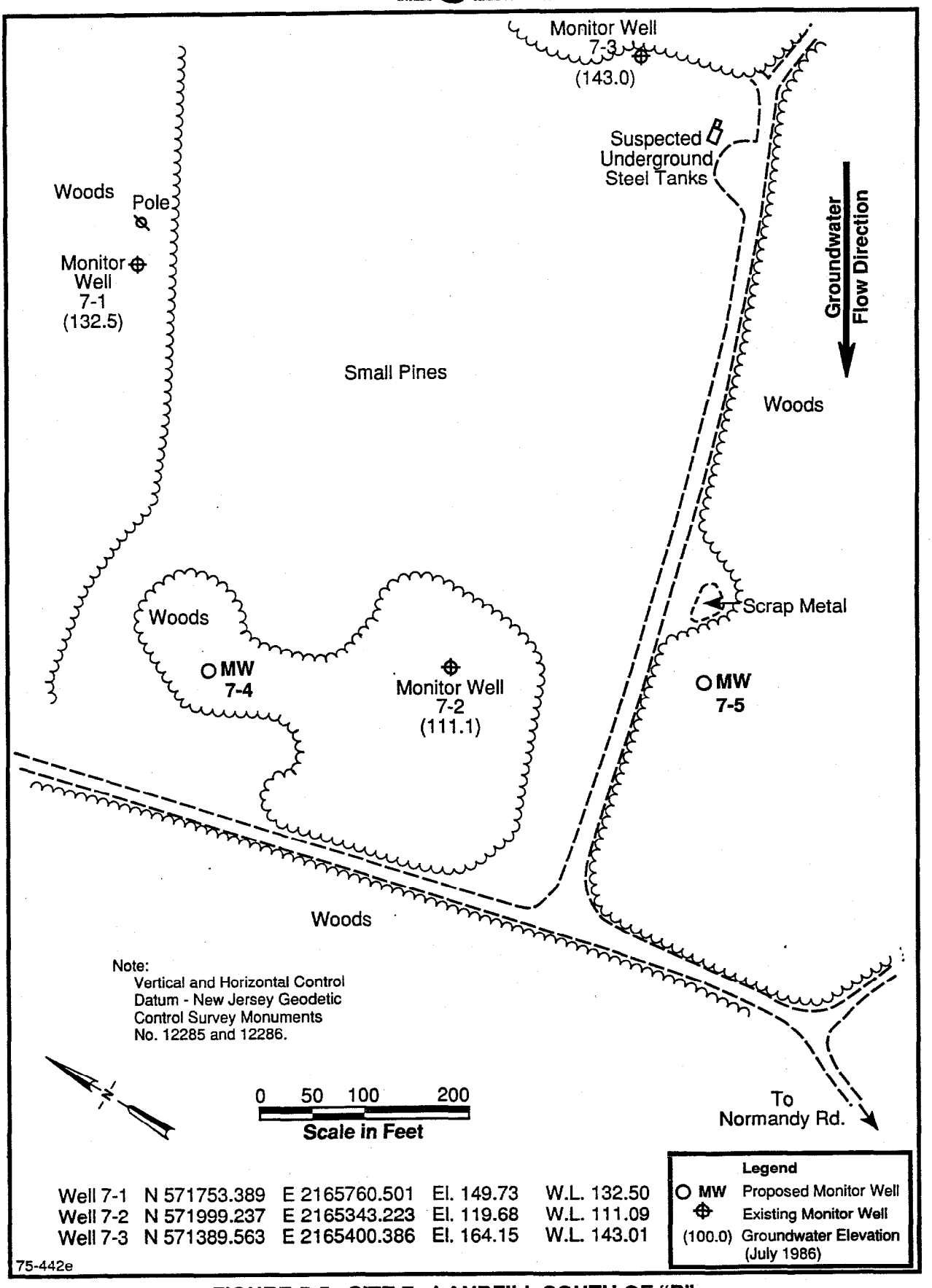
Site 7 is a former landfill used from 1965 to 1977. The materials disposed at this site include municipal-type solid waste and waste from waterfront industrial operations. Potential contaminants are listed in Table 2-1. The site was investigated during the CS by installing and sampling three monitor wells. As shown in Figure 5-5, groundwater flow is to the southwest; only one monitoring well (7-2) is located downgradient of the site. The existing wells were sampled and found to contain estimated levels (7 J, 9 J, and 6 J for monitor wells 7-1, 7-2, and 7-3, respectively, see Table 5-12) of methylene chloride. The levels of methylene chloride were highest in the field blank (11 μg/L), indicating that the methylene chloride levels observed are an artifact of laboratory decontamination.

5.7.1.1 Underground Tank Evaluation

Underground heating fuel storage tanks associated with former base housing are reportedly located at the northern end of the site. A magnetometer survey will be conducted to locate the tanks. If found, they will be excavated and sampled under standard NJDEP guidelines for site closure of UST installations. Excavation and closure will be handled separately from this RI.

5.7.1.2 Monitor Wells

Two downgradient wells will be drilled using hollow-stem augers. Soil samples will be collected at 2-foot intervals from the surface to the finished well depth; 15-foot screens will be installed 10 feet into the water table, which occurs between 8 and 20 feet BGS.



Well 7-1	N 571753.389	E 2165760.501	El. 149.73	W.L. 132.50
Well 7-2	N 571999.237	E 2165343.223	El. 119.68	W.L. 111.09
Well 7-3	N 571389.563	E 2165400.386	El. 164.15	W.L. 143.01

FIGURE 5-5 SITE 7 - LANDFILL SOUTH OF "P" BARRICADES MONITOR WELL LOCATIONS, NWS EARLE, NJ

Table 5-12

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 7, NWS Earle, Colts Neck, NJ

Analyte	7-1	7-2	7-2B	7-3	Regulatory Limit
Total organic halogens (μg/L)	23.0	18.0	12.0	18.0	NRC
Total organic carbon (mg/L)	1.73	6.51	1.42	2.15	NRC
Volatile organic compounds (μg/L)					NRC
Methylene chloride	7 J	9 J	11	6 J	
Acetone	22	380	141	ND	
Petroleum hydrocarbons (mg/L)	ND	ND	ND	ND	1
Pesticides (μg/L)	ND	ND	ND	ND	Compound specific
Nitrate/nitrite (mg/L)	ND	ND	ND	0.20	10
Base/neutral/acid compounds (μg/L)		ND	ND	ND	100
Di-n-butyl phthalate	54	ND	ND	ND	
Soluble metals (mg/L)					
Antimony	ND	ND	ND	ND	NRC
Arsenic	ND	ND	ND	ND	0.050
Beryllium	ND	ND	ND	ND	NRC

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration
ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits.

Table 5-12
(continued)

Analyte	7-1	7-2	7-2B	7-3	Regulatory Limit
Soluble Metals (mg/L)					
Cadmium	ND	ND	ND	ND	0.010
Chromium	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	0.050
Mercury	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	0.050
Thallium	ND	ND	ND	ND	NRC
Zinc	0.03	0.03	ND	0.09	NRC
pH	4.70	4.20	6.70	4.70	---

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration
ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits.

Table 5-12
(continued)

Analyte	7-1	7-2	7-2B	7-3	Regulatory Limit
pH*	5.5	--	NR	6.0	---
Chloride (mg/L)	12.3	32.6	11.1	ND	NRC
Specific conductance (μmho/cm)	63.3	235	1.23	90.6	NRC
Specific conductance* (μmho/cm)	40	--	NR	60	NRC
Temperature (°C)	14	--	NR	16	NRC

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration
ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits.

5.7.1.3 Test Pit Investigation

Consistent with the requirements summarized in Subsection 5.2.5.7, a series of four to six test pits will be completed at the site to obtain a physical description of the waste materials and surrounding soils. Two samples will be taken for TCL organics and TAL inorganics analyses, and the grab sample will be taken of impacted soils, leachate, or perched water. At least one sample will be solids; the other will be liquids, if encountered.

5.7.1.4 Groundwater Sampling

A representative groundwater sample will be collected from each of the three existing and two new monitor wells and analyzed for TCL organics and TAL metals. The sampling protocols followed will be consistent with those specified in the QAPP. The analytical parameters are listed in Table 5-3.

5.8 SITE 10 SCOPE OF WORK

5.8.1 Field Investigation Overview

Site 10 is a 2-acre scrap metal landfill used from 1953 to 1965 for the disposal of demilitarized munitions and spent munitions casings. The site was investigated through the construction of monitor wells and the sampling of groundwater and surface water. The analyses of these samples (see Tables 5-13 and 5-14) indicate that methylene chloride was present at 16, 9 J, and 9 J for wells 10-1, 10-2, and 10-3, respectively. An amine (tentatively identified as N-nitrosodiphenylamine) was present in surface water, but not groundwater, at levels above the 10^{-6} cancer risk value. Mercury was detected in one stream sample (0.3 mg/L) but was not confirmed in the subsequent sample taken approximately 6 hours later from the same location. Di-n-butyl phthalate was detected at a concentration of 70 μg/L in surface water sample 10-B (1st hour). This concentration is above the NJDEP ECRA guideline of 50 μg/L for BNA compounds. The same sampling point was below the limit 6 hours later (see Table 5-14).

5.8.1.1 Test Pit Investigation

Consistent with the requirements summarized in Subsection 5.2.5.7, a series of four to six test pits will be completed at the site to obtain a physical description of the waste materials and surrounding soils. Two samples will be taken for TCL organics and TAL inorganics analyses, and the grab sample will be taken of impacted soils, leachate, or perched water. At least one sample will be solids; the other will be liquids, if encountered.

5.8.1.2 Monitor Wells

Four monitor wells are planned for this site. Three monitor wells will be placed hydraulically downgradient of the site. The fourth monitor well will be placed upgradient (see Figure 5-6). The monitor wells will be screened across the water, which occurs at approximately 15 feet.

Table 5-13

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 10, NWS Earle, Colts Neck, NJ

Analyte	10-1	10-2	10-2A	10-3	Regulatory Limit
Total organic halogens (μg/L)	67.0	36.0	108	20.0	NRC
Total organic carbon (mg/L)	4.62	5.73	4.92	3.81	NRC
Volatile organic compounds (μg/L)					10
Methylene chloride	16	9J	14	9J	
Acetone	ND	7J	ND	10	
2-Butanone	ND	10	ND	11	
Petroleum hydrocarbons (mg/L)	ND	ND	ND	ND	1
Nitrate/nitrite (mg/L)	0.10	ND	ND	0.10	10
Base/neutral/acid compounds (μg/L)	ND	ND	ND	ND	100
Soluble metals (mg/L)					
Antimony	ND	ND	ND	ND	NRC
Arsenic	ND	ND	ND	ND	0.050
Beryllium	ND	ND	ND	ND	NRC
Cadmium	0.006	ND	ND	ND	0.010

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration
ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits

Table 5-13
(continued)

Analyte	10-1	10-2	10-2A	10-3	Regulatory Limit
Soluble metals (mg/L)					
Chromium	ND	ND	ND	ND	0.050
Copper	0.03	ND	ND	ND	NRC
Lead	ND	ND	ND	ND	0.050
Mercury	ND	ND	ND	ND	0.002
Nickel	0.014	ND	ND	ND	NRC
Selenium	ND	ND	ND	ND	0.010
Silver	ND	ND	ND	ND	0.050
Thallium	ND	ND	ND	ND	NRC
Zinc	0.09	1.01	0.82	0.08	NRC
pH	4.40	4.25	4.30	4.35	---
pH*	4.4	4.3	NR	4.0	---
Chloride (mg/L)	20.1	8.20	8.50	11.0	NRC
Specific conductance (μmho/cm)	161	125	122	135	NRC
Specific conductance* (μmho/cm)	140	105	NR	85	NRC
Temperature (°C)	13	16	NR	16	NRC

*Field measured
NR - Analysis not requested
B - Field blank
NRC - No specific regulatory concentration
ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits but greater than instrument detection limits

Table 5-14

Analytical Results for Surface Water Samples Collected in July 1986 -- Site 10, NWS Earle, Colts Neck, NJ

Analyte	10-A (1st hour)	10-A (6th hour)	10-B (1st hour)	10-B (6th hour)	Regulatory Limit
Total organic halogens (μg/L)	10.0	15.0	43.0	29.0	NRC
Total organic carbon (mg/L)	3.93	4.03	4.34	4.85	NRC
Volatile organic compounds (μg/L)	ND	ND	ND	ND	NRC
Petroleum hydrocarbons (mg/L)	ND	ND	ND	ND	1
Nitrate/nitrite (mg/L)	ND	ND	ND	ND	10
Base/neutral/acid compounds (μg/L)					100
N-nitrosodiphenylamine	ND	ND	31	30	
Di-n-butyl phthalate	ND	2 J	70	42	
Soluble metals (mg/L)					
Antimony	ND	--	ND	ND	NRC
Arsenic	ND	--	ND	ND	0.050
Beryllium	ND	--	ND	ND	NRC
Cadmium	ND	--	ND	ND	0.010

ND - Not detected
NR - Analysis not requested
*Field measured
-- Sample not analyzed
NRC - No specific regulatory concentration

Table 5-14
(continued)

Analyte	10-A (1st hour)	10-A (6th hour)	10-B (1st hour)	10-B (6th hour)	Regulatory Limit
Soluble metals (mg/L)					
Chromium	ND	--	ND	ND	0.050
Copper	ND	--	ND	ND	NRC
Lead	ND	--	ND	ND	0.050
Mercury	0.3	--	ND	ND	0.002
Nickel	ND	--	ND	ND	NRC
Selenium	ND	--	ND	ND	0.010
Silver	ND	--	0.004	ND	0.050
Thallium	ND	--	ND	ND	NRC
Zinc	ND	--	ND	ND	NRC
pH	6.70	6.70	6.60	6.60	---
pH*	NR	NR	NR	NR	---

ND - Not detected
NR - Analysis not requested
*Field measured
-- Sample not analyzed
NRC - No specific regulatory concentration

Table 5-14
(continued)

Analyte	10-A (1st hour)	10-A (6th hour)	10-B (1st hour)	10-B (6th hour)	Regulatory Limit
Chloride (mg/L)	6.80	7.20	7.20	6.80	NRC
Specific conductance (μmho/cm)	74.6	78.8	81.6	81.3	NRC
Specific conductance* (μmho/cm)	NR	NR	NR	NR	NRC
Temperature (°C)	NR	NR	NR	NR	NRC

ND - Not detected
NR - Analysis not requested
*Field measured
-- Sample not analyzed
NRC - No specific regulatory concentration

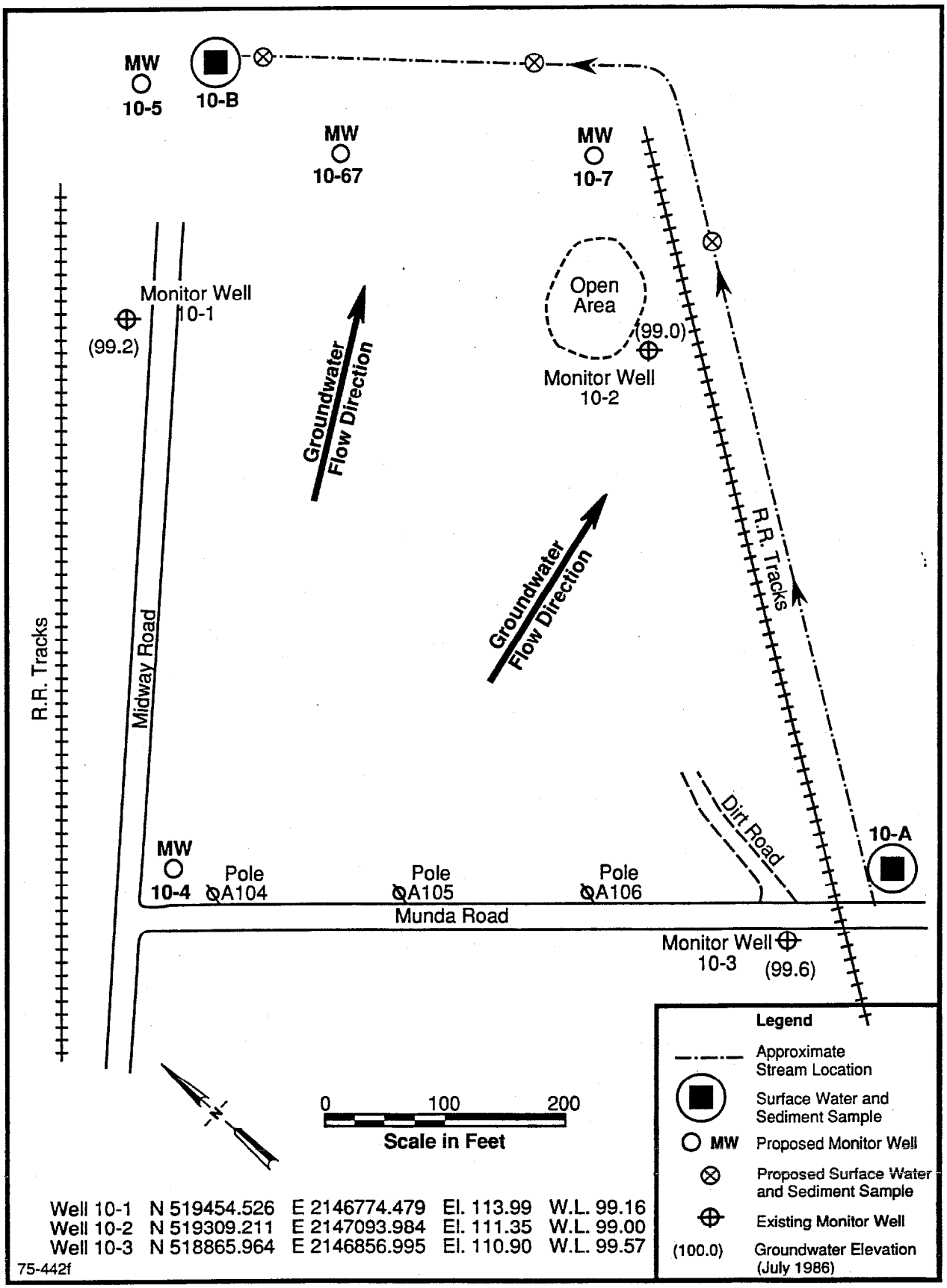


FIGURE 5-6 SITE 10 - SCRAP METAL LANDFILL MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

A representative groundwater sample will be collected from four of the new and existing on-site monitor wells and analyzed for full TCL organics and TAL metals. The wells will be sampled in accordance with the sampling standards set forth in the QAPP. The analytical parameters are listed in Table 5-3.

5.8.1.3 Surface Water and Sediment Samples

Surface water and sediment samples will be collected at one upstream and two downstream locations in the drainage shown on Figure 5-6. Samples will be analyzed for constituents shown on Tables 5-2 for sediment and 5-3 for water.

5.9. SITE 11 SCOPE OF WORK

5.9.1 Field Investigation Overview

Site 11 is a fan-shaped 2-acre site used by contractors for the disposal of obsolete ordnance material (dates uncertain) and from 1974 to 1977 for occasional firefighting training exercises.

Site 11 was investigated through four soil borings and installing and sampling three monitor wells during the CS. Groundwater flow direction was determined. Sample analyses summarized in Table 5-15 indicate that one soil boring had oil and grease (O&G) levels of 37,300 mg/kg. Pentachlorophenol was detected at 120 μg/L in monitor well 11-1 (see Table 5-16).

Nine soil borings will be constructed surrounding the one sampling location that had the elevated O&G levels to determine the areal distribution of the O&G contamination and suspected petroleum hydrocarbons residues that may be associated with the O&G. Sampling will determine both the vertical and horizontal distribution of the petroleum hydrocarbons.

One additional monitor well is to be constructed immediately downgradient of the contaminated soil area. Topographically determined surface water flow directions contradict the determined flow direction. Upgradient well 11-1 contains pentachlorophenol. Evaluation of the piezometric surface with the data from the new monitor well will resolve this potential discrepancy. Additional work to determine the extent of the pentachlorophenol contamination may be proposed after this analysis. Specific activities for this site and their approximate locations are shown in Figure 5-7.

5.9.1.1 Geophysical Survey

A magnetometer will be used at the site to detect buried metallic objects where soil borings or monitor wells will be drilled. This survey is very limited in scope and will be used to avoid encountering buried metallic objects during drilling.

Table 5-15

Analytical Results for Soil Samples Collected in March 1986 -- Site 11, NWS Earle, Colts Neck, NJ

Sample Number	Oil and Grease (Method 413.3) (mg/kg)
11-A	
(6" - 9")	37,300
(2' - 2.5')	76.3
11-B	
(6" - 9")	112
(2' - 2.5')	15.5
11-C	
(6" - 9")	2.60
(2' - 2.5')	1.75
11-D	
(6" - 9")	8.20
(2' - 2.5')	3.70
Detection Limit	1.0

Oil and grease has no specific regulatory concentration.

Table 5-16

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 11, NWS Earle, Colts Neck, NJ

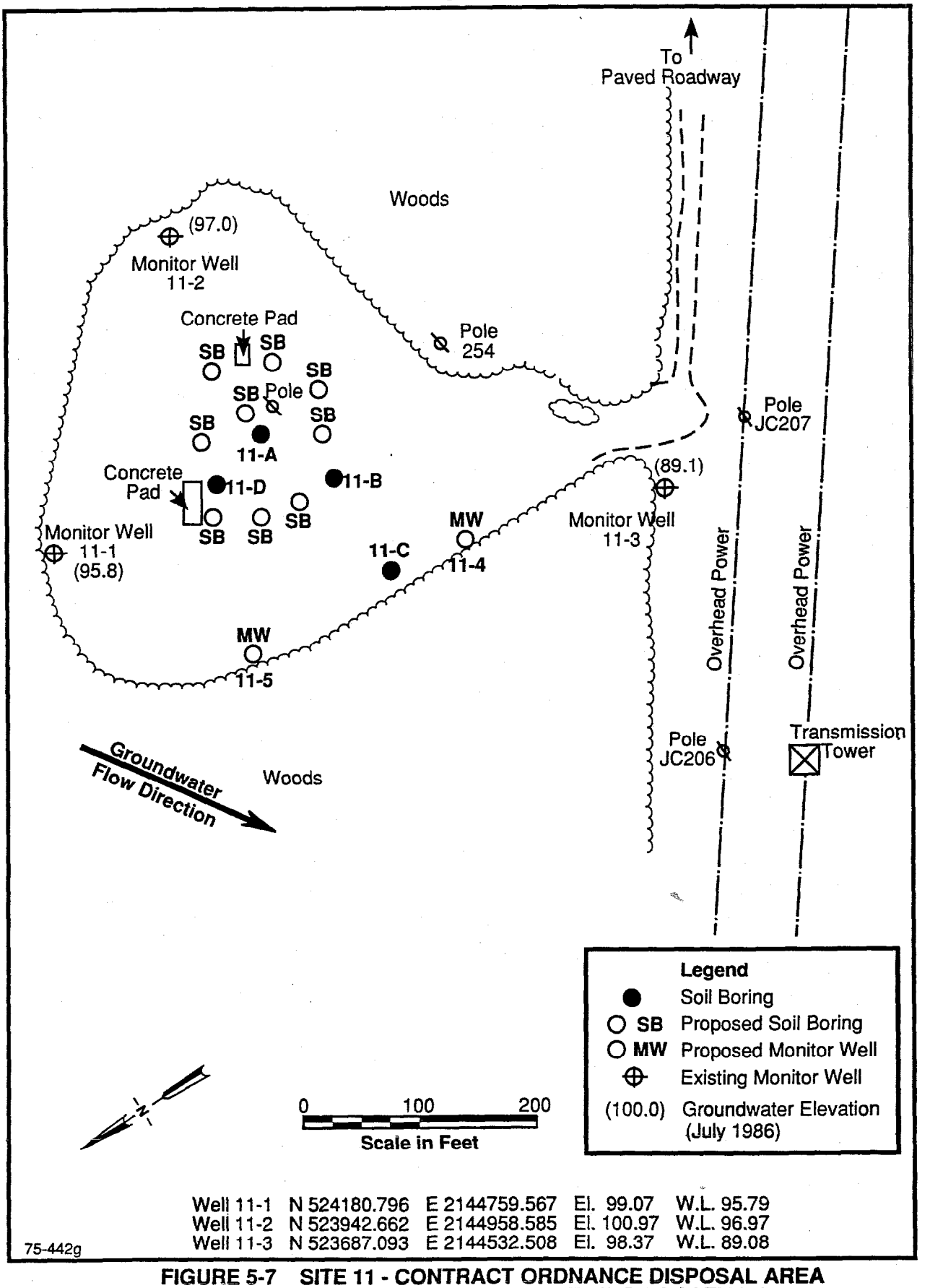
Analyte	11-1	11-2	11-2B	11-3	11-3A	Regulatory Limit
Total organic halogens (μg/L)	202	60.0	13.0	169	123	NRC
Total organic carbon (mg/L)	11.9	3.91	0.977	7.66	8.77	NRC
Base/neutral/acid compounds (μg/L)						100
Pentachlorophenol	120	ND	ND	ND	ND	
Oil and grease (mg/L)	ND	ND	ND	ND	ND	NRC
Nitrate/nitrite (mg/L)	0.30	ND	ND	ND	ND	10
Explosives						
HMX (μg/L)	ND	ND	ND	ND	ND	NRC
RDX (μg/L)	ND	ND	ND	ND	ND	NRC
2,4,6-TNT (μg/L)	ND	ND	1.85	ND	NR	NRC
Nitroglycerin (mg/L)	ND	ND	ND	ND	NR	NRC
Picric acid (μg/L)	ND	ND	ND	ND	ND	NRC
Soluble metals (mg/L)						
Antimony	ND	ND	ND	ND	ND	NRC
Arsenic	ND	ND	ND	ND	ND	0.050

*Field measured
ND - Not detected
NR - Analysis not requested
A - Duplicate sample
B - Field blank
NRC - No specific regulatory concentration

Table 5-16
(continued)

Analyte	11-1	11-2	11-2B	11-3	11-3A	Regulatory Limit
Soluble Metals (mg/L)						
Beryllium	ND	ND	ND	ND	ND	NRC
Cadmium	ND	ND	ND	ND	ND	0.010
Chromium	ND	ND	ND	ND	ND	0.050
Copper	ND	ND	ND	ND	ND	NRC
Lead	ND	ND	ND	ND	ND	0.050
Mercury	ND	ND	ND	ND	ND	0.002
Nickel	ND	ND	ND	ND	ND	NRC
Selenium	ND	ND	ND	ND	ND	0.010
Silver	ND	ND	ND	ND	ND	0.050
Thallium	ND	ND	ND	ND	ND	NRC
Zinc	0.03	0.07	0.010	0.06	0.04	NRC
pH	4.50	3.95	7.30	4.25	4.95	---
pH*	5.0	4.5	NR	4.7	NR	---
Chloride (mg/L)	6.20	9.60	ND	7.60	8.50	NRC
Specific conductance (μmho/cm)	53.6	77.7	1.78	64.6	63.7	NRC
Specific conductance* (μmho/cm)	40	70	NR	50	NR	NRC
Temperature (°C)	20	20	NR	18	NR	NRC

*Field measured
ND - Not detected
NR - Analysis not requested
A - Duplicate sample
B - Field blank
NRC - No specific regulatory concentration



Well 11-1	N 524180.796	E 2144759.567	El. 99.07	W.L. 95.79
Well 11-2	N 523942.662	E 2144958.585	El. 100.97	W.L. 96.97
Well 11-3	N 523687.093	E 2144532.508	El. 98.37	W.L. 89.08

75-442g

FIGURE 5-7 SITE 11 - CONTRACT ORDNANCE DISPOSAL AREA MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

5.9.1.2 Soil Borings and Sampling

Nine hand auger borings to a depth of 1.5 feet will be completed at locations shown in Figure 5-7. Soil samples, from 0.5- to 1.5-foot intervals will be analyzed for explosive compounds and total petroleum hydrocarbons (see Table 5-2).

5.9.1.3 Monitor Wells

Two additional downgradient groundwater monitor well are proposed for this site. Well locations are shown in Figure 5-7 and will be located north of existing well 11-3. This well will be completed to an approximate depth of 20 feet.

5.9.1.4 Groundwater Sampling

A representative groundwater sample will be collected from the two new and existing monitor wells. The wells will be purged and sampled according to the protocols set forth in this Work Plan and the QAPP. The analytical parameters are listed in Table 5-3.

5.10 SITE 19 SCOPE OF WORK

5.10.1 Field Investigation Overview

Site 19 is an ordnance maintenance area where paint chips and wastewater from operations were discharged to a topographically low area close to Building S-34. Site 19 was investigated through the installation of soil borings and monitor wells during the CS. Analyses were performed on the soil, surface water, sediment, and groundwater samples collected at the site (see Tables 5-17 through 5-20). Levels of cadmium up to 31,900 mg/kg were found in the soil of a swale that received paint chips and associated maintenance waste. The levels of lead and zinc in soil sample 19-B were 1,560 and 776 mg/kg, respectively. These values exceed the ECRA soil standards of 1,000 mg/kg for lead and 350 mg/kg for zinc.

Groundwater flow directions were determined for the site. The gradient is close to being flat. The upgradient monitor well (19-1) contains 0.007 mg/L of cadmium (below the drinking water MCL of 0.010 mg/L), but was the highest value in the Site 19 wells (see Table 5-19). A monitor well will be constructed upgradient of well 19-1 to determine whether this represents an elevated background value associated with this particular geologic formation.

Methylene chloride appears in sediment sample analyses, including the blanks (see Table 5-20). The methylene chloride levels are suspected to be a laboratory artifact. Soil borings, both in the swale and outside the swale, will be constructed to define the extent and character of the potential contaminants.

Table 5-17

Analytical Results for Soil Samples Collected in January 1986 -- Site 19, NWS Earle, Colts Neck, NJ

Sample Number	TOX (μg/kg)	VOCs (μg/kg)		Petroleum Hydrocarbons (mg/kg)	Priority Pollutant Metals (mg/kg)	
19-A composite	0.320	Chloromethane	3 J	ND	Ag	<0.251
		Acetone	460		As	1.53
		2-Butanone	67		Be	<0.637
		Dilution Factor	1.3		Cd	26,800
		Detection Limit	13		Cr	59.6
					Cu	4.84
					Hg	<0.285
					Ni	1.4
					Pb	49.5
					Sb	<0.005
					Se	<0.637
					Tl	<0.251
					Zn	289

ND - Not detected
J - Estimated concentration less than quantification limit but greater than instrument detection limit.

Table 5-17
(continued)

Sample Number	TOX (μg/kg)	VOCs (μg/kg)		Petroleum Hydrocarbons (mg/kg)	Priority Pollutant Metals (mg/kg)	
19-B composite	2.15	Chloromethane	4 J	751	Ag	<0.222
		Methylene chloride	12		As	4.53
		Acetone	14		Be	<0.561
		2-Butanone	7 J		Cd	31,900
		Dilution Factor	1.1		Cr	639
		Detection Limit	11		Cu	13.5
					Hg	<0.300
					Ni	2.5
					Pb	1,560
					Sb	0.747
					Se	<0.637
					Tl	<0.222
					Zn	776

ND - Not detected
J - Estimated concentration less than quantification limit but greater than instrument detection limit.

Table 5-18

Analytical Results for Surface Water Samples Collected in July 1986 -- Site 19, NWS Earle, Colts Neck, NJ

Analyte	19-A (1st hour)	19-A (6th hour)	19-A (dup)	19-A (blank)	19-B (1st hour)	19-B (6th hour)	Regulatory Limit
Total organic halogens (μg/L)	65.0	9.00	29.0	NR	49.0	36.0	NRC
Total organic carbon (mg/L)	17.3	30.0	17.0	0.962	22.6	19.3	NRC
Volatile organic compounds (μg/L)	ND	ND	ND	ND	ND	ND	NRC
Petroleum hydrocarbons (mg/L)	ND	ND	ND	ND	ND	4.20	ND
Nitrate/nitrite (mg/L)	ND	ND	ND	ND	ND	ND	
Base/neutral/acid compounds (μg/L)	ND	ND	ND	ND	ND	ND	NRC
Soluble metals (mg/L)							
Antimony	ND	ND	ND	ND	ND	ND	NRC
Arsenic	ND	ND	ND	ND	ND	ND	0.050
Beryllium	ND	ND	ND	ND	ND	ND	NRC
Cadmium	ND	ND	ND	ND	ND	ND	0.010
Chromium	0.014	0.016	0.021	0.018	0.014	0.014	0.050
Copper	0.018	0.017	0.018	0.019	0.017	0.018	NRC
Lead	ND	ND	ND	ND	ND	ND	0.050

*Field measured
ND - Not detected
NR - Analysis not requested
NRC - No specific regulatory concentration

Table 5-18
(continued)

Analyte	19-A (1st hour)	19-A (6th hour)	19-A (dup)	19-A (blank)	19-B (1st hour)	19-B (6th hour)	Regulatory Limit
Soluble metals (mg/L)							
Mercury	ND	ND	ND	ND	ND	ND	0.002
Nickel	0.03	0.04	0.04	0.04	0.04	0.03	NRC
Selenium	ND	ND	ND	ND	ND	ND	0.010
Silver	ND	ND	ND	ND	ND	ND	0.050
Thallium	ND	ND	ND	ND	ND	ND	NRC
Zinc	0.027	0.028	0.033	ND	0.122	0.014	NRC
pH	5.20	5.20	5.10	6.00	4.80	4.80	---
pH*	NR	NR	NR	NR	NR	NR	---
Chloride (mg/L)	15.0	13.2	14.6	ND	14.6	13.8	NRC
Specific conductance (μmho/cm)	56.6	53.7	55.6	1.03	61.9	55.2	NRC
Specific conductance* (μmho/cm)	NR	NR	NR	NR	NR	NR	NRC
Temperature (°C)	NR	NR	NR	NR	NR	NR	NRC

*Field measured
ND - Not detected
NR - Analysis not requested
NRC - No specific regulatory concentration

Table 5-19

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 19, NWS Earle, Colts Neck, NJ

Analyte	19-1	19-2	19-3	Regulatory Limit
Total organic halogens (μg/L)	63.0	71.0	50.0	NRC
Total organic carbon (mg/L)	4.01	6.95	4.92	NRC
Volatile organic compounds (μg/L)				10
Methylene chloride	14	13	8J	
Acetone	ND	ND	16	
2-Butanone	ND	ND	10	
Petroleum hydrocarbons (mg/L)	ND	ND	ND	1
Nitrate/nitrite (mg/L)	0.80	ND	ND	10
Base/neutral/acid compounds (μg/L)	ND	ND	ND	100
Soluble metals (mg/L)				
Antimony	ND	ND	ND	NRC
Arsenic	ND	ND	ND	0.050

*Field measured
ND - Not detected
NR - Analysis not requested
A - Duplicate sample
B - Field blank
J - Estimated concentration less than quantification limits but greater than instrument detection limits.
NRC - No specific regulatory concentration

Table 5-19
(continued)

Analyte	19-1	19-2	19-3	Regulatory Limit
Soluble metals (mg/L)				
Beryllium	ND	ND	ND	NRC
Cadmium	0.004	0.007	0.006	0.010
Chromium	0.015	ND	ND	0.050
Copper	ND	ND	ND	NRC
Lead	0.006	ND	ND	0.050
Mercury	ND	ND	ND	0.002
Nickel	0.02	0.016	ND	NRC
Selenium	ND	ND	ND	0.010
Silver	ND	ND	ND	0.050
Thallium	ND	ND	ND	NRC
Zinc	0.09	0.09	0.06	NRC
pH	3.85	3.95	4.10	---

ND - Not detected
NR - Analysis not requested
* - Field measured
A - Duplicate sample
B - Field blank
J - Estimated concentration less than quantification limits but greater than instrument detection limits.
NRC - No specific regulatory concentration

Table 5-19
(continued)

Analyte	19-1	19-2	19-3	Regulatory Limit
pH*	4.3	4.6	4.5	---
Chloride (mg/L)	7.60	11.4	10.5	NRC
Specific conductance (μmho/cm)	189	103	80.5	NRC
Specific conductance* (μmho/cm)	160	70	60	NRC
Temperature (°C)	20	17	17	NRC

ND - Not detected
NR - Analysis not requested
* - Field measured
A - Duplicate sample
B - Field blank
J - Estimated concentration less than quantification limits but greater than instrument detection limits.
NRC - No specific regulatory concentration

Tab. 5-20

Analytical Results for Sediment Samples Collected in July 1986 -- Site 19, NWS Earle, Colts Neck, NJ

Analyte	19-A (1st hour)	19-A (6th hour)	19-A (dup)	19-A (blank)	19-B* (1st hour)	19-B* (6th hour)	Regulatory Limit**
Total organic halogens (μg/kg)	ND	ND	ND	NR	NR	NR	NRC
Volatile organic compounds (μg/kg)							1
Methylene chloride	8 J	NRP	75	7 J (μg/L)	210	NRP	
Acetone	7 J	230	53	2J	1,200	730	
Chloroform	ND	ND	25	ND	37	ND	
2-Butanone	ND	ND	ND	ND	240	ND	
Toluene	ND	2J	ND	ND	170	ND	
Dilution factor	1.46	1.48	1.55	1.0	13.1	11.1	
Detection limit	15	15	16	10	130	110	
Petroleum hydrocarbons (mg/kg)	82.8	14.9	129	ND	445	681	100
Total metals (mg/kg)							
Antimony	<14.1	<14.4	<13.0	<0.05	<100	<123.5	NRC
Arsenic	<2.82	<2.89	<2.76	<0.01	<19.9	<25.0	20

ND - Not detected
NR - Analysis not requested
NRP - Not reported; see lab report
*Sample 19-B sediment had high water content
J - Estimated concentration less than quantification limits but greater than instrument detection limits.
NRC - No specific regulatory concentration
**ECRA limits

Table 5-20
(continued)

Analyte	19-A (1st hour)	19-A (6th hour)	19-A (dup)	19-A (blank)	19-B* (1st hour)	19-B* (6th hour)	Regulatory Limit**
Total metals (mg/kg)							
Beryllium	<14.1	<14.4	<13.0	<0.05	<100	<123.5	1
Cadmium	<0.7	<0.7	<0.7	<0.0025	<5	<6.25	3
Chromium	<28.2	<28.8	<26.0	<0.1	<200	<247.0	100
Copper	<14.1	<14.4	<13.0	<0.05	<100	<123.5	170
Lead	5.83	4.65	6.86	<0.005	<94.7	<96.0	250 - 1,000
Mercury	<0.250	0.423	<0.250	<0.250	<0.250	<0.250	1
Nickel	<28.2	<28.8	<26.0	<0.1	<200	<247	100
Selenium	<1.41	<1.44	<1.38	<0.005	<9.95	<12.54	
Silver	<2.82	<2.89	<2.75	<0.01	286	<25.0	5
Thallium	<2.82	<2.89	<2.76	<0.01	<19.9	<25.0	NRC
Zinc	<14.1	<14.4	<13.0	<0.05	214	<331	350

ND - Not detected
NR - Analysis not requested
NRP - Not reported; see lab report
*Sample 19-B sediment had high water content
J - Estimated concentration less than quantification limits but greater than instrument detection limits.
NRC - No specific regulatory concentration
**ECRA limits

One additional monitor well will be located at the terminus of the drainage swale. This well will be sampled to determine whether any contamination of the uppermost aquifer has occurred. A second monitor well is to be constructed downgradient of the area of highest soil contamination. This well will be located on the site side of the poorly defined stream shown in Figure 5-8.

Grain size and moisture content determinations of the swale soils will be undertaken to evaluate remedial actions considered for use on the site. Specific activities for this site and their approximate locations are shown in Figure 5-8.

5.10.1.1 Soil Sampling

Twenty-four subsurface soil samples will be collected in the area surrounding Building S-34. As shown in Table 5-2, 4 soil samples will be analyzed for TAL metals and cyanide; the remaining 20 soil samples will be analyzed for cadmium and lead. In addition, four hand auger borings will be collected in the drainageway exiting the site and will be analyzed for VOCs and TPH.

5.10.1.2 Monitor Wells

Site 19 requires the installation of three groundwater monitor wells hydraulically downgradient of Site 19 and downslope of the solvent/paint sludge discharge pipe. These monitor wells will be screened across the groundwater table.

Representative groundwater samples will be collected from monitor wells and analyzed for TCL organics and TAL inorganics. The groundwater samples will be collected according to the protocols set forth in this Work Plan and the QAPP. The analytical parameters are listed in Table 5-2.

5.10.1.3 Sediment Sampling

Sediment samples will be collected at several locations around the site and will be analyzed for the parameters listed in Table 5-2.

5.11 SITE 20 SCOPE OF WORK

5.11.1 Field Investigation Overview

Site 20 is an ordnance maintenance area where waste sand blasting media were disposed. The field investigation conducted during the CS obtained soil samples from the site at locations that appeared to have the highest potential for containing paint chip contaminants. The analyses of the samples shown in Table 5-21 indicate that no contamination above the NJDEP ECRA soil guidelines was detected. The site is not considered contaminated.

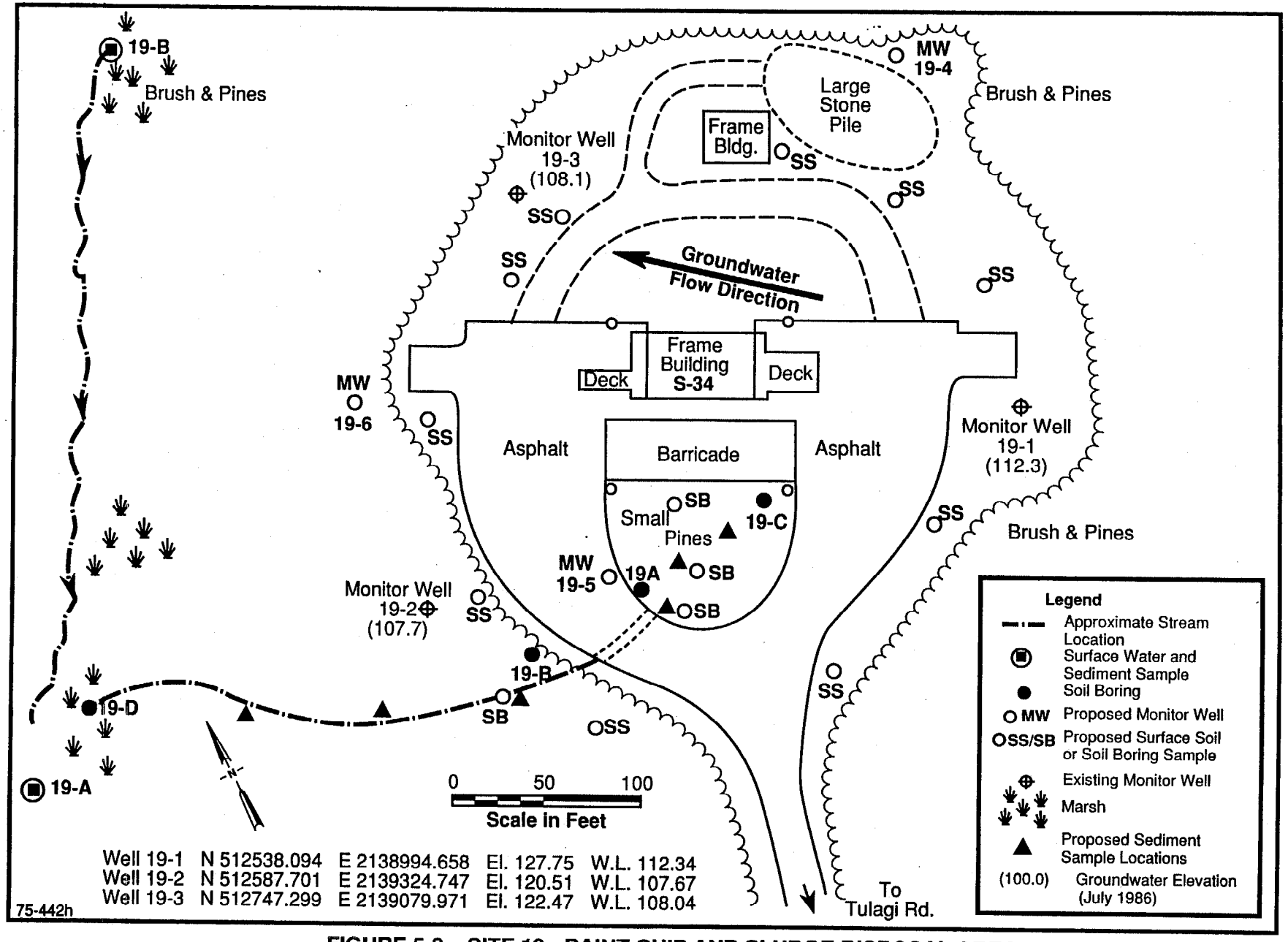


FIGURE 5-8 SITE 19 - PAINT CHIP AND SLUDGE DISPOSAL AREA MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

Table 5-21

Analytical Results for Soil Samples Collected in March 1986 -- Site 20, NWS Earle, Colts Neck, NJ

	Analyte				
		EPTOX (mg/L)			
Sample Number	Petroleum Hydrocarbons (mg/kg)	Zn	Cr	Pb	Ti
20-A					
(0.5' - 1')	ND	ND	ND	ND	ND
(2.5' - 3')	ND	ND	ND	ND	ND
20-B					
(0.5' - 1')	65.7	ND	ND	ND	ND
(2.5' - 3')	ND	ND	ND	ND	ND
20-C					
(0.5' - 1')	2.20	ND	ND	1.64	ND
(2.5' - 3')	ND	ND	ND	ND	ND
20-D*					
(0.5' - 1')	ND	<0.05	<0.50	0.051	0.41
(2.5' - 3')	ND	<0.05	<0.50	0.05	0.039
20-E*					
(0.5' - 1')	ND	<0.05	<0.50	0.072	<0.003
(2.5' - 3')	ND	<0.05	<0.50	0.057	0.024
Detection Limits	0.50	0.50	0.50	0.50	
Regulatory Limits	100	350	100	100	NRC

*Samples collected July 1986
ND - Not Detected
NRC - No specific regulatory concentration

5.11.1.1 Sediment Sampling

Seven sediment and one subsurface soil sample will be collected along the drainage ditch and blasting grit piles at Site 20 (see Figure 5-9). As shown in Table 5-2 five sediment samples will be analyzed for TAL metals and cyanide, and two samples will be analyzed for BNAs and pesticides/PCBs. In addition, one subsurface soil sample will be collected and analyzed for VOCs.

5.12 SITE 22 SCOPE OF WORK

5.12.1 Field Investigation Overview

Site 22 is an ordnance maintenance area where waste sand blasting media were disposed. The field investigation conducted during the CS obtained soil samples from the site at locations that appeared to have the highest potential of containing paint chip contaminants. The analyses of the samples shown in Table 5-22 indicate that no contamination above the NJDEP ECRA soil guidelines was detected.

5.12.1.1 Soil Sampling

Soil samples will be collected at four locations identified as "stained or discolored areas" shown in Figure 5-10. Samples will be analyzed for those parameters listed in Table 5-2 including TAL metals including cyanide, BNAs, pesticides/PCBs, and VOCs.

5.12.1.2 Sediment Sampling

Sediment samples will be collected at six locations with the drainage ditches shown in Figure 5-10. Sample will be analyzed for those parameters listed in Table 5-2, which include TAL metal and cyanide, TPH, BNAs, and pesticides/PCBs.

5.13 SITE 26 SCOPE OF WORK

5.13.1 Field Investigation Overview

Site 26 was the location of a munitions recycling operation. The explosive (ammonium picrate) was washed from large-diameter shells and recovered through thermal precipitation in a water solution. Site 26 was investigated through the construction of three monitor wells during the CS. Groundwater samples from these wells were analyzed for picric acid and pH (see Table 5-23). These were considered the most likely by-products that could remain at the site from the ammonium picrate recycling activities. Picric acid was not detected, and pH was within the levels expected for groundwater in the Colts Neck area.

5.13.1.1 Monitor Wells

The groundwater flow gradient is flat, as currently determined. A monitor well is proposed which, based on current flow direction, will be located downgradient of the end of the tile drain as shown in Figure 5-11.

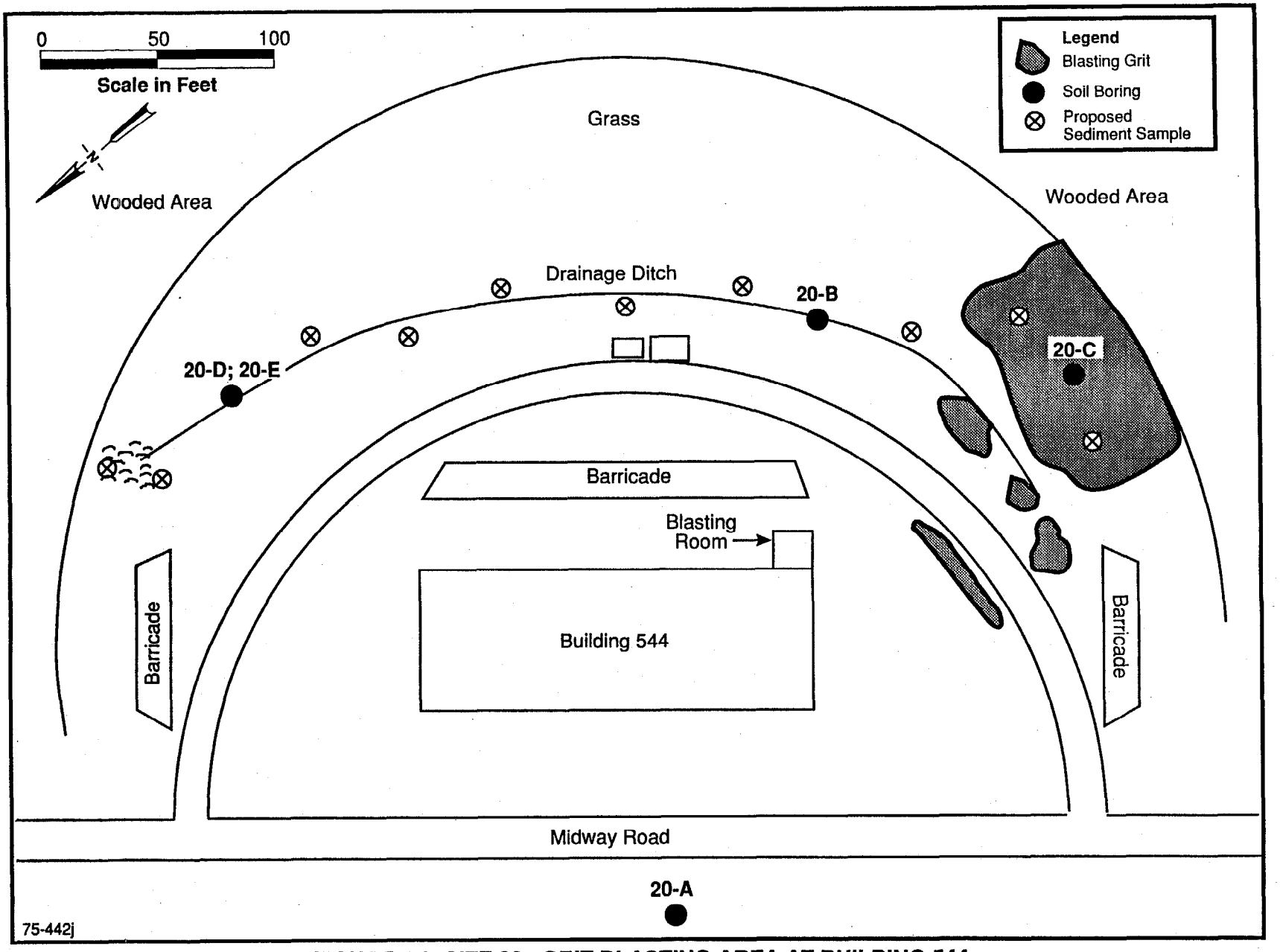


FIGURE 5-9 SITE 20 - GRIT BLASTING AREA AT BUILDING 544 SAMPLING LOCATIONS, NWS EARLE, NJ

WESTON

Table 5-22

Analytical Results for Soil Samples Collected in March 1986 -- Site 22, NWS Earle, Colts Neck, NJ

	Analyte				
		EPTOX (mg/L)			
Sample Number	Petroleum Hydrocarbons (mg/kg)	Zn	Cr	Pb	Ti
22-A					
(0.5' - 1')	ND	ND	ND	ND	ND
(2.5' - 3')	ND	ND	ND	ND	ND
22-B					
(0.5' - 1')	ND	ND	ND	ND	ND
(2.5' - 3')	ND	ND	ND	ND	ND
22-C					
(0.5' - 1')	4.20	ND	ND	ND	ND
(2' - 2.5')	39.0	ND	ND	ND	ND
22-D*					
(0.5' - 1')	ND	ND	ND	ND	ND
(2' - 2.5')	ND	ND	ND	ND	ND
Detection Limits	0.50	0.50	0.50	0.50	
Regulatory Limits	100	350	100	100	NRC

*Samples collected July 1986
ND - Not detected
NRC - No specific regulatory concentration

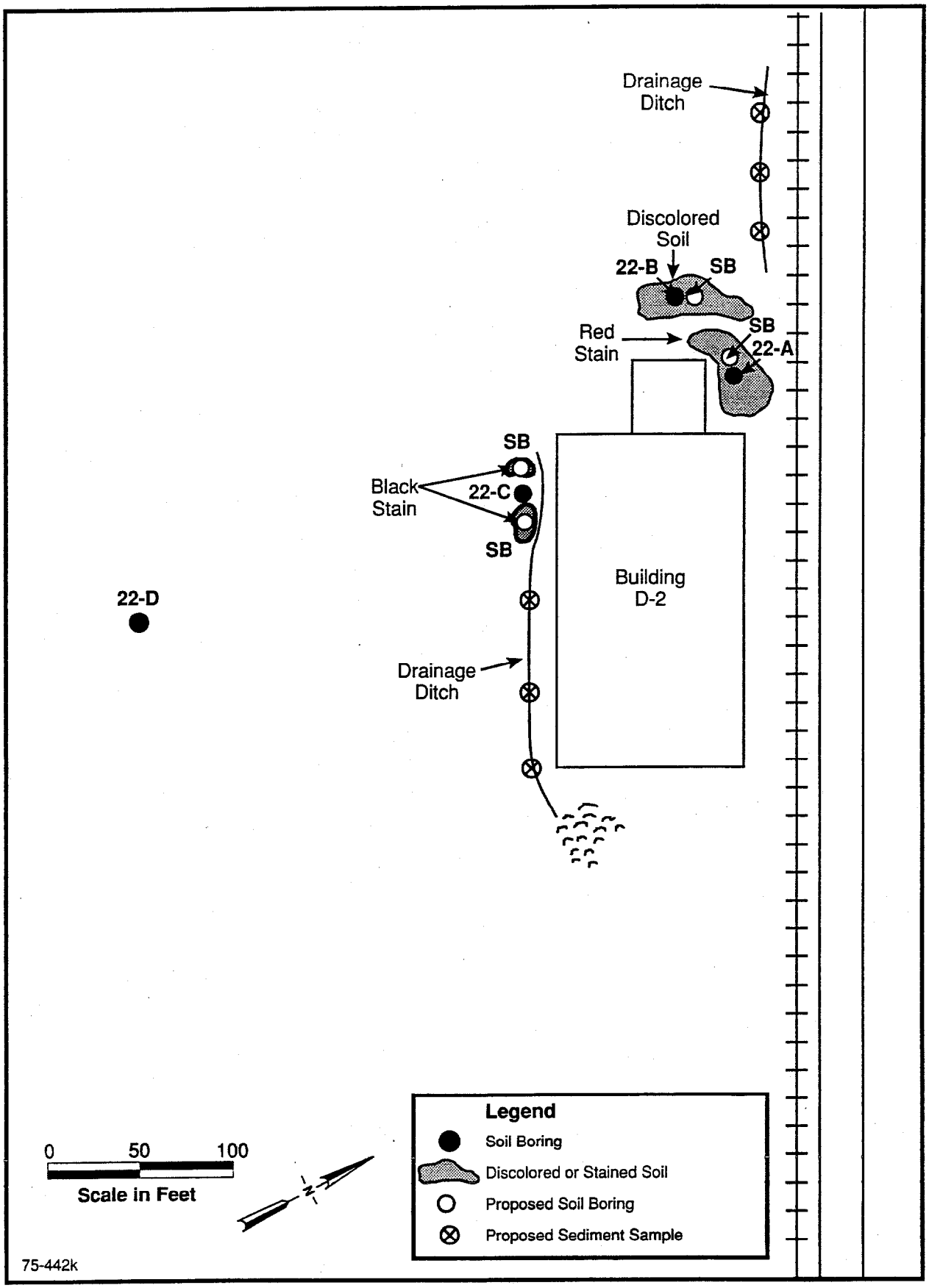


FIGURE 5-10 SITE 22 - PAINT CHIP DISPOSAL AREA SAMPLING LOCATIONS, NWS EARLE, NJ

Table 5-23

Analytical Results for Groundwater Samples Collected in July 1986 -- Site 26, NWS Earle, Colts Neck, NJ

Analyte	26-1	26-1B	26-2	26-2A	26-2B	26-3	Regulatory Limit
Picric acid	ND	ND	ND	ND	ND	ND	NRC
Field measured parameters							
pH	4.8	NR	4.0	NR	NR	4.5	---
Temperature (°C)	18	NR	17	NR	NR	17	NRC
Specific conductance (μmho/cm)	60	NR	225	NR	NR	50	NRC

ND - Not detected
NR - Analysis not requested
A - Duplicate sample
B - Field blank
NRC -No specific regulatory concentration

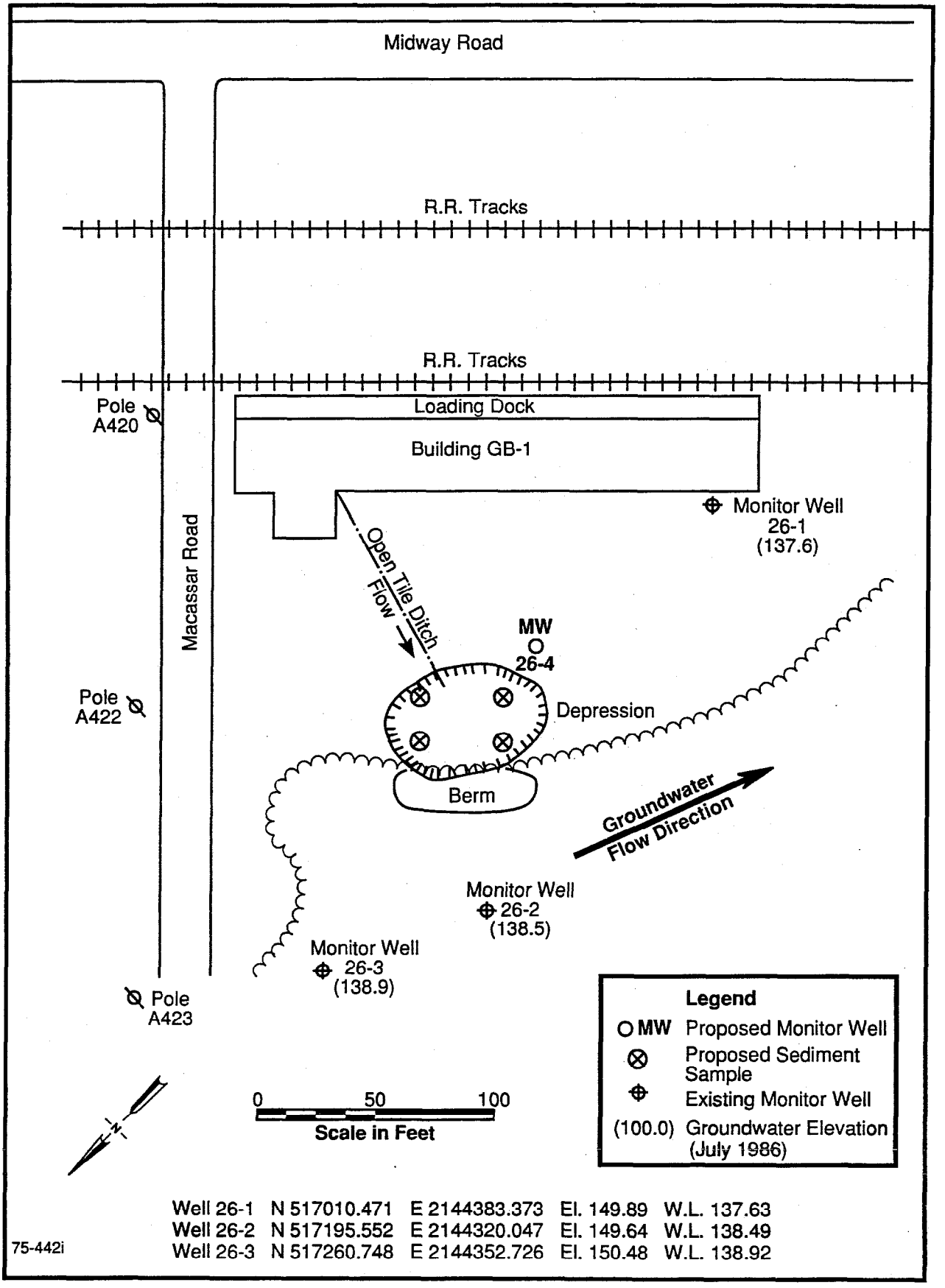


FIGURE 5-11 SITE 26 - EXPLOSIVE "D" WASHOUT AREA MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

5.13.1.2 Soil Borings

Four soil sampling locations will be located within the settling basin. Soil samples will be collected at depths of 0 to 0.5 and 2 to 3 feet. The soil samples will be analyzed for explosive compounds (see Table 5-2).

5.13.1.3 Groundwater Sampling

Groundwater samples will be collected from existing and new wells according to protocols described in this Work Plan and the QAPP. Analyses will be performed for TCL organics and TAL inorganics (see Table 5-3).

SECTION 6

REPORTING

6.1 WESTON ANALYTICS INFORMATION MANAGEMENT SYSTEM

Laboratory data will be reported in tabular form using the Wal- lace system. The laboratory data reports will include sample analytical results, second-column confirmation results, report- able field and laboratory QA/QC sample analytical results (as specified in Subsection 1.10 in the NWS Earle QAPP), method limits of detection, and sample practical quantitation limits (PQLs).

Laboratory data will be formatted to the Navy's specification and delivered in both dBASE III+ files and in printout form.

6.2 FINAL REPORT

A Final Report is planned to summarize and document the find- ings of the work undertaken and to present conclusions and recommendations for the sites.

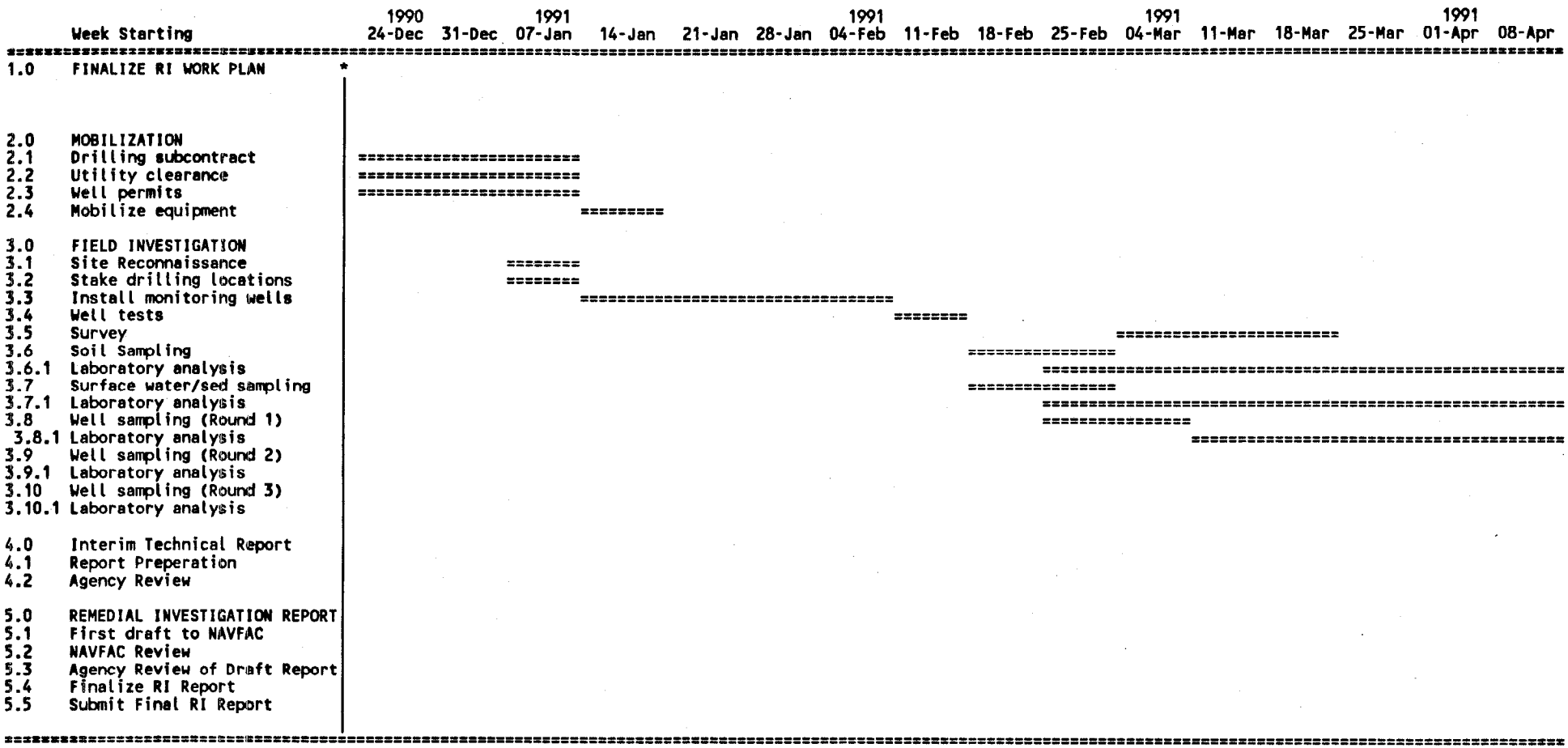
SECTION 7

SCHEDULE

The schedule for the activities described in this Work plan is shown in Figure 7-1.

FIGURE 7-1

SCHEDULE FOR COMPLETION OF THE REMEDIAL INVESTIGATION
NWS EARLE, COLTS NECK, N.J.
TASK 2 SITES



	Week Starting	15-Apr	22-Apr	29-Apr	1991 06-May	13-May	20-May	27-May	1991 03-Jun	10-Jun	17-Jun	24-Jun	1991 01-Jul	08-Jul	15-Jul	22-Jul	29-Jul
1.0	FINALIZE RI WORK PLAN	*															
2.0	MOBILIZATION																
2.1	Drilling subcontract																
2.2	Utility clearance																
2.3	Well permits																
2.4	Mobilize equipment																
3.0	FIELD INVESTIGATION																
3.1	Site Reconnaissance																
3.2	Stake drilling locations																
3.3	Install monitoring wells																
3.4	Well tests																
3.5	Survey																
3.6	Soil Sampling																
3.6.1	Laboratory analysis	==========	==========	==========	==========	==========											
3.7	Surface water/sed sampling																
3.7.1	Laboratory analysis	==========	==========	==========	==========	==========											
3.8	Well sampling (Round 1)																
3.8.1	Laboratory analysis	==========	==========	==========	==========	==========	==========	==========									
3.9	Well sampling (Round 2)																
3.9.1	Laboratory analysis																
3.10	Well sampling (Round 3)																
3.10.1	Laboratory analysis																
4.0	Interim Technical Report																
4.1	Report Preperation								==========	==========	==========	==========					
4.2	Agency Review												==========	==========	==========	==========	
5.0	REMEDIAL INVESTIGATION REPORT																
5.1	First draft to NAVFAC																
5.2	NAVFAC Review																
5.3	Agency Review of Draft Report																
5.4	Finalize RI Report																
5.5	Submit Final RI Report																

	Week Starting	1991 05-Aug	12-Aug	19-Aug	26-Aug	1991 02-Sep	09-Sep	16-Sep	23-Sep	30-Sep	1991 07-Oct	14-Oct	21-Oct	28-Oct	1991 04-Nov	11-Nov	18-Nov
1.0	FINALIZE RI WORK PLAN	*															
2.0	MOBILIZATION																
2.1	Drilling subcontract																
2.2	Utility clearance																
2.3	Well permits																
2.4	Mobilize equipment																
3.0	FIELD INVESTIGATION																
3.1	Site Reconnaissance																
3.2	Stake drilling locations																
3.3	Install monitoring wells																
3.4	Well tests																
3.5	Survey																
3.6	Soil Sampling																
3.6.1	Laboratory analysis																
3.7	Surface water/sed sampling																
3.7.1	Laboratory analysis																
3.8	Well sampling (Round 1)																
3.8.1	Laboratory analysis																
3.9	Well sampling (Round 2)	==========															
3.9.1	Laboratory analysis			==========													
3.10	Well sampling (Round 3)											==========					
3.10.1	Laboratory analysis													==========			
4.0	Interim Technical Report																
4.1	Report Preperation																
4.2	Agency Review																
5.0	REMEDIAL INVESTIGATION REPORT																
5.1	First draft to NAVFAC																
5.2	NAVFAC Review																
5.3	Agency Review of Draft Report																
5.4	Finalize RI Report																
5.5	Submit Final RI Report																

	Week Starting	25-Nov	02-Dec (1991)	09-Dec	16-Dec	23-Dec	30-Dec	06-Jan (1992)	13-Jan	20-Jan	27-Jan	03-Feb (1992)	10-Feb	17-Feb	24-Feb	02-Mar (1992)	09-Mar
1.0	FINALIZE RI WORK PLAN	*															
2.0	MOBILIZATION																
2.1	Drilling subcontract																
2.2	Utility clearance																
2.3	Well permits																
2.4	Mobilize equipment																
3.0	FIELD INVESTIGATION																
3.1	Site Reconnaissance																
3.2	Stake drilling locations																
3.3	Install monitoring wells																
3.4	Well tests																
3.5	Survey																
3.6	Soil Sampling																
3.6.1	Laboratory analysis																
3.7	Surface water/sed sampling																
3.7.1	Laboratory analysis																
3.8	Well sampling (Round 1)																
3.8.1	Laboratory analysis																
3.9	Well sampling (Round 2)																
3.9.1	Laboratory analysis																
3.10	Well sampling (Round 3)																
3.10.1	Laboratory analysis	==========	==========	==========	==========	==========	==========	==========	==========								
4.0	Interim Technical Report																
4.1	Report Preperation																
4.2	Agency Review																
5.0	REMEDIAL INVESTIGATION REPORT																
5.1	First draft to NAVFAC								==========	==========	==========	==========	==========	==========			
5.2	NAVFAC Review														==========	==========	==========
5.3	Agency Review of Draft Report																
5.4	Finalize RI Report																
5.5	Submit Final RI Report																

	Week Starting	16-Mar	23-Mar	30-Mar	06-Apr (1992)	13-Apr	20-Apr	27-Apr	04-May (1992)	11-May	18-May
1.0	FINALIZE RI WORK PLAN	*									
2.0	MOBILIZATION										
2.1	Drilling subcontract										
2.2	Utility clearance										
2.3	Well permits										
2.4	Mobilize equipment										
3.0	FIELD INVESTIGATION										
3.1	Site Reconnaissance										
3.2	Stake drilling locations										
3.3	Install monitoring wells										
3.4	Well tests										
3.5	Survey										
3.6	Soil Sampling										
3.6.1	Laboratory analysis										
3.7	Surface water/sed sampling										
3.7.1	Laboratory analysis										
3.8	Well sampling (Round 1)										
3.8.1	Laboratory analysis										
3.9	Well sampling (Round 2)										
3.9.1	Laboratory analysis										
3.10	Well sampling (Round 3)										
3.10.1	Laboratory analysis										
4.0	Interim Technical Report										
4.1	Report Preperation										
4.2	Agency Review										
5.0	REMEDIAL INVESTIGATION REPORT										
5.1	First draft to NAVFAC										
5.2	NAVFAC Review										
5.3	Agency Review of Draft Report	==========	==========	==========	==========						
5.4	Finalize RI Report					==========	==========	==========			
5.5	Submit Final RI Report								****		