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ROY F. WESTON, INC.

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INSTALLATION RESTORATION PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FOR 11 SITES AT NWS EARLE, COLTS NECK, NJ

VOLUME 1

RI REPORT

Prepared for

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PA

September 1993

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

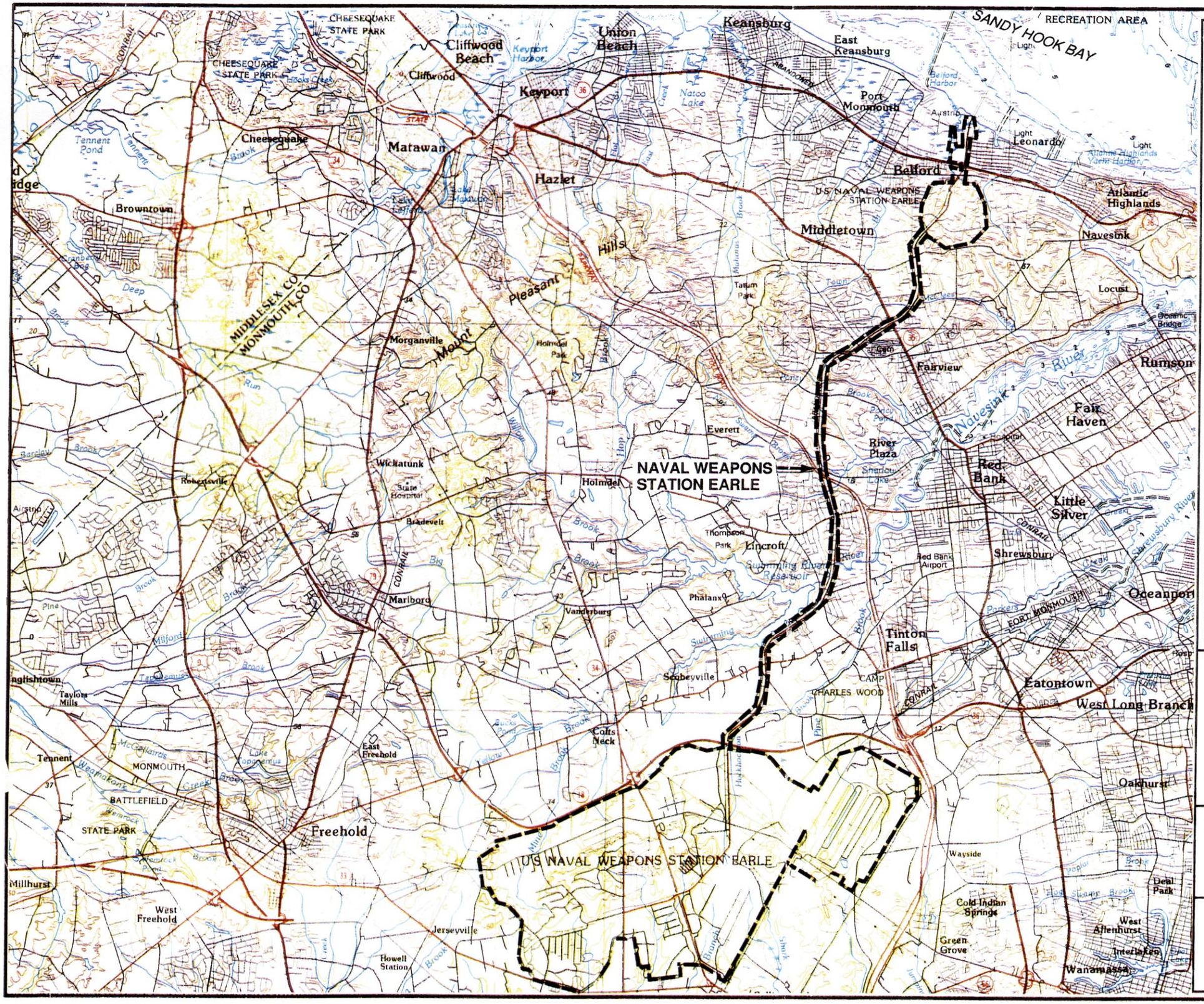
This Remedial Investigation Feasibility Study Report has been prepared by Roy F. Weston, Inc. (WESTON®) for the Naval Facilities Command (NAVFAC) to address 11 waste disposal sites at Naval Weapons Station Earle (NWS Earle), Colts Neck, New Jersey (see Figure 1-1). NWS Earle was included on the United States Environmental Protection Agency's (EPA) National Priorities List (NPL) in October 1990. This work is being conducted within the U.S. Navy Installation Restoration Program (IRP) and under a Federal Facility Agreement (FFA) between EPA and the Navy.

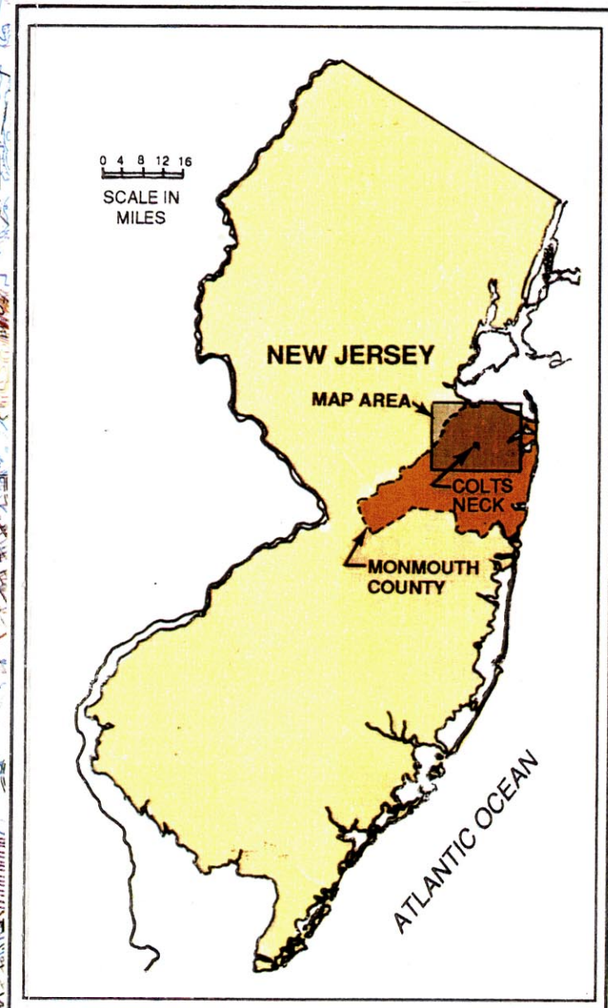
Volumes 1 and 2 of this report are the Remedial Investigation (RI) Report (Sections 1-5) and RI Report Appendices. The purpose of this RI is to identify and quantify the extent of contamination at each site. Volume 3 of the report presents the Baseline Risk Assessment which identifies potential risks to human health and the environment (Section 6). The identification of applicable or relevant and appropriate requirements (ARARs) (Section 7), and the initial screening of technologies develop appropriate standards for remediation and identify remedial technologies that can meet these standards (Section 8).

1.2 PROGRAM ORGANIZATION

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

- Phase I, Preliminary Assessment (PA) and Site Inspection (SI), formerly known as the Initial Assessment Study (IAS) — involves identification of 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 also establishes the priority for scheduling an SI.





NORTH

5000 0 5000 10000 15000

SCALE IN FEET

1000 500 0 1000 2000 3000 5000

SCALE IN METERS

Source: Base map adapted from USGS 30x60 Minute Series maps (100,000), Trenton, NJ, PA - NY quadrangle, dated 1984.

NAVAL WEAPONS STATION EARLE
COLTS NECK, MONMOUTH COUNTY
NEW JERSEY

FIGURE 1-1
REGIONAL SITE MAP

NWSEAR1A-G/DM-2/92

- Site Inspection (SI) — involves the collection or development of additional data that either eliminate from further consideration those releases that pose no threat to public health or the environment, or determine the potential need for a comprehensive RI.

- Phase II, Remedial Investigation/Feasibility Study (RI/FS) — involves conducting comprehensive on-site investigations to quantify the extent of contamination and to determine risk to human health and environment, and developing alternatives for possible corrective measures. The studies conducted during this phase were previously called confirmation and quantification studies.

- Phase III, Research and Development (R&D) — directed at research and development specifically related to waste treatment and remediation.

- Phase IV, Remedial Design/Remedial Action (RD/RA) — within which remedial actions to control and mitigate confirmed contamination are designed and implemented.

The long-range objectives of the IRP at 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.

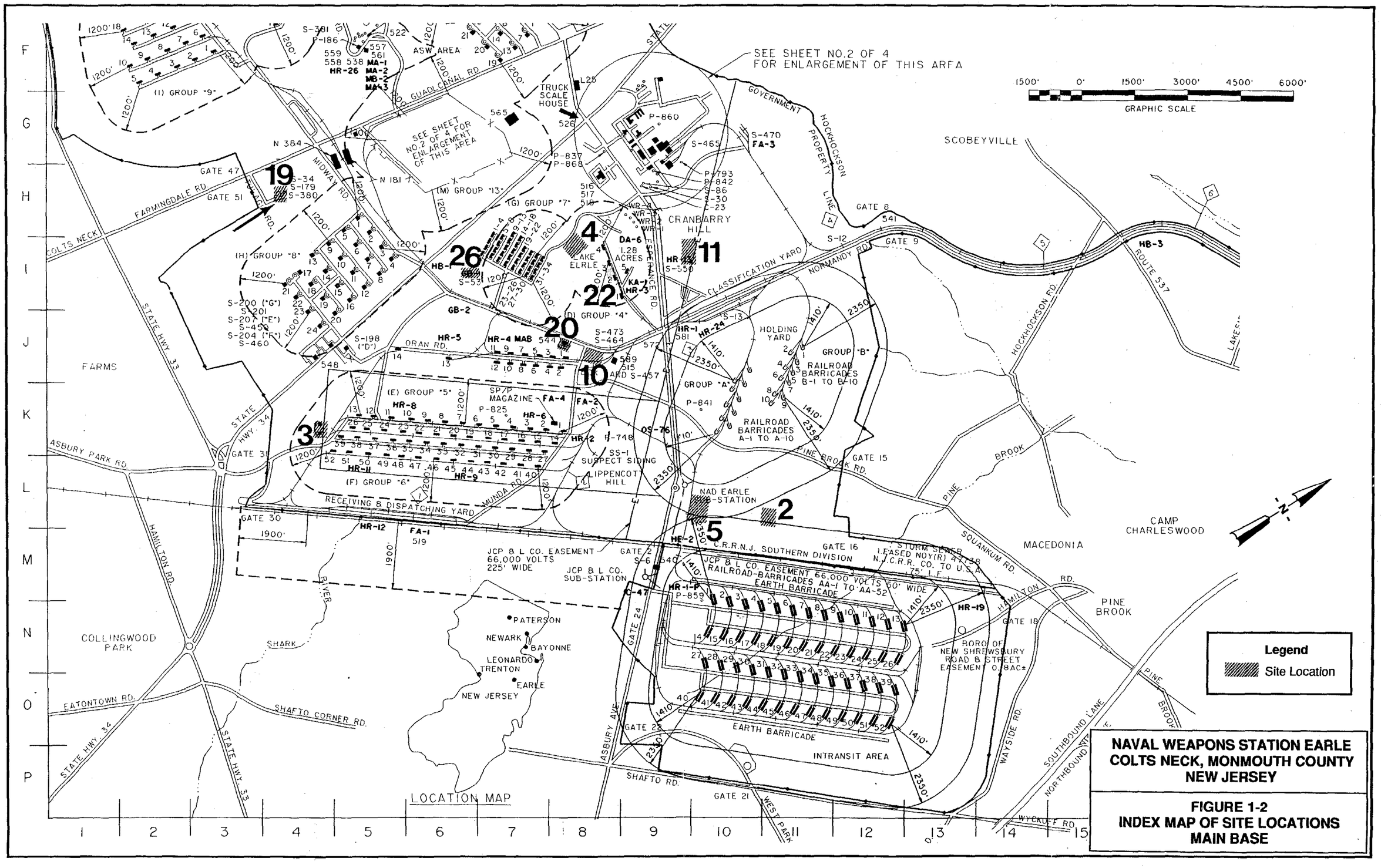
- Attain New Jersey and federal ARARs as a result of remediation.

- Select remedies that use permanent solutions and alternative technologies to the maximum extent feasible.

- Consider the use of interim responses.

- Use on-site mitigation to the maximum extent possible.

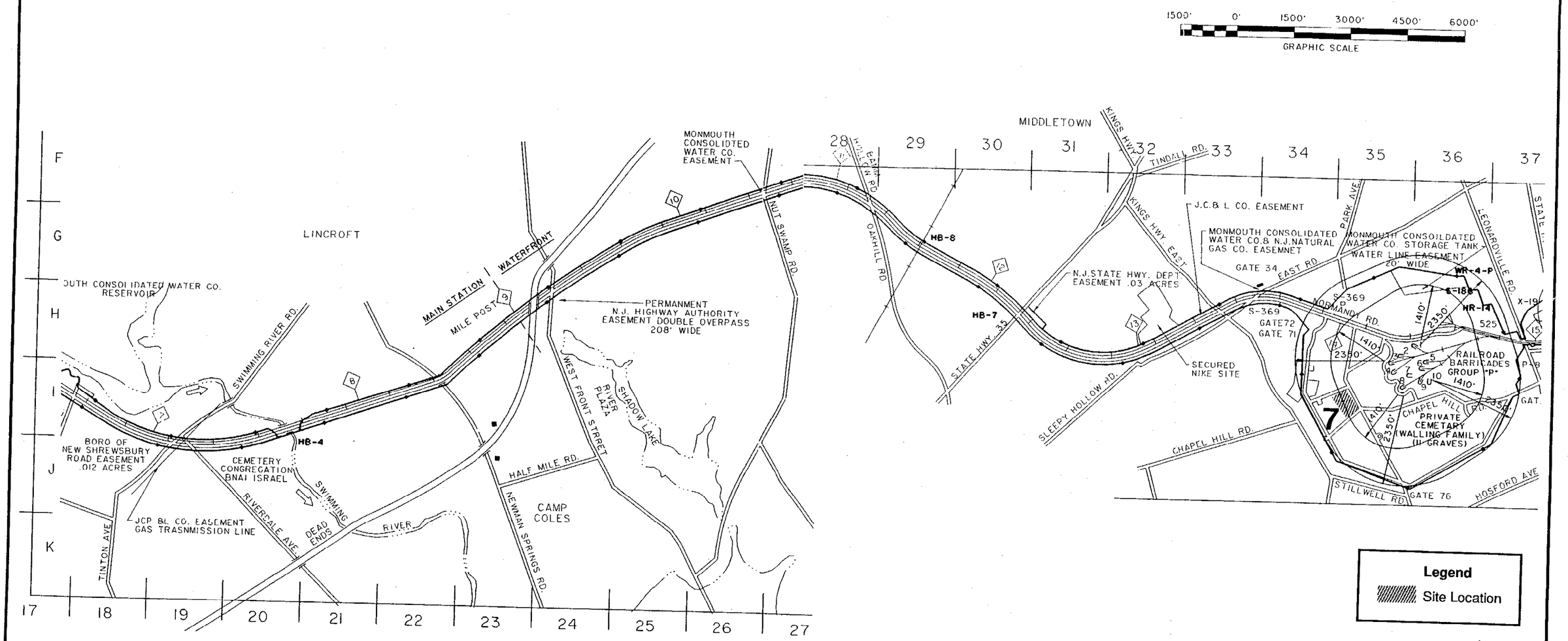
The 11 sites addressed in this report were investigated during the Confirmation Study in 1986 and sufficient data were collected to indicate that an RI was warranted at each site. The sites are shown in Figures 1-2 and 1-3 and are identified as follows:



NAVAL WEAPONS STATION EARLE
COLTS NECK, MONMOUTH COUNTY
NEW JERSEY

FIGURE 1-2
INDEX MAP OF SITE LOCATIONS
MAIN BASE

00286AB2Z



NAVAL WEAPONS STATION EARLE
COLTS NECK, MONMOUTH COUNTY
NEW JERSEY

FIGURE 1-3
INDEX MAP OF SITE LOCATIONS
WATER FRONT AREA

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
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 FEDERAL FACILITIES AGREEMENT (FFA)

In accordance with the National Contingency Plan and the Superfund Amendments and Reauthorization Act of 1986 (SARA), an FFA was signed by the EPA Region II and the Navy on January 1991. The general purposes of this Agreement are to:

- Ensure that the environmental impacts associated with past and present activities at the site are thoroughly investigated and appropriate remedial action is taken, as necessary, to protect the public health, welfare, and the environment.

- Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at the site in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the NCP, the Resource Conservation and Recovery Act (RCRA), and RCRA guidance and policy.

- Facilitate cooperation, exchange of information, and participation of the parties in such actions.

1.4 ORGANIZATION OF THE REMEDIAL INVESTIGATION REPORT

The RI Report is organized into two volumes. Volume 1 contains Sections 1 through 5, and Volume 2 contains Sections 6, 7, and 8. Section 1 provides a general introduction. Section 2 discusses the environmental setting. Section 3 discusses the history of NWS Earle and the operational history of each site, and summarizes information and data for each site obtained in the previous studies. Section 4 presents the results of the RI conducted during 1991 at each site. Section 5 discusses the significance of the findings of the RI. Section 6 includes the Baseline Risk Assessment. Section 7 contains ARAR development. Section 8 presents a preliminary screening of remedial technologies that can meet ARARs. The last two sections of this report provide the basis for the Feasibility Study (FS), which will develop site-by-site remedial alternatives.

SECTION 2
ENVIRONMENTAL SETTING

2.1 PHYSICAL ENVIRONMENT

2.1.1 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 is the Main Base (10,428 acres), and the smaller consists of 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, where elevations range from approximately 100 to 300 feet above mean sea level (MSL). All sites addressed in this report, except Site 7, are located in the Main Base area.

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). The average elevation of the waterfront area is approximately 10 feet above MSL.

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 the three physiographic areas of NWS Earle. The Highland-Mt. Pleasant Hills form the drainage divide between the Inner and Outer Coastal Plains. Average elevation is approximately

100 feet above MSL. The Chapel Hill area contains the topographic high point in the vicinity, at the High Point Chapel, approximately 200 feet above MSL. Site 7 landfill is located in the Chapel Hill area.

2.1.2 Climate and Air Quality

The Main Base area is characterized by a predominantly continental climate with significant seasonal and daily 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 17 October, and the average last frost occurs on 24 April, allowing for an average growing season of 198 days. The average annual precipitation is 44.67 inches at Long Branch (a town approximately 12 miles east of NWS Earle) and 41.82 inches at Newark (a town approximately 30 miles north of NWS Earle). The annual peak daily rainfall (1-year, 24-hour) is greater than 2.5 inches. The mean annual temperatures of Long Branch and Newark are 56.2°F and 45.2°F, respectively (see Table 2-1).

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 and generally results in little accumulation.

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

Table 2-1

Representative Meteorological Data, NWS Earle Region

Month	Temperature (°F)		
	Daily Maximum	Daily Minimum	Monthly Average
January	38	24	31
February	40	25	33
March	49	33	41
April	61	43	52
May	72	53	62
June	81	62	72
July	86	68	77
August	84	67	76
September	77	59	68
October	66	48	57
November	54	39	47
December	42	29	36

Reference: Local Climatological Data, 1989 Annual Summary with Comparative Data, NOAA, National Climatic Data Center.

(January through December 1991) was marked by warm winter months and generally low precipitation. Site groundwater levels dropped significantly between the initial monitor well installation at the start of the year to the end of the year groundwater sampling, at which point several of the originally installed wells were dry.

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 because of 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 New Jersey Department of Environmental Protection and Energy (NJDEPE) maintains and operates air quality monitoring instrumentation at Freehold and Asbury Park in Monmouth County. The NJDEPE also samples for particulates at Asbury Park, Brielle, Millstone Township, and Red Bank in Monmouth County. All of New Jersey is classified as a nonattainment 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).

2.1.3 Surface Drainage

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

The headwaters and portions of the drainage basins of three major Coastal Plain rivers, the Swimming, the Manasquan, and the Shark, are present on the Main Base (see Figure 2-1). The

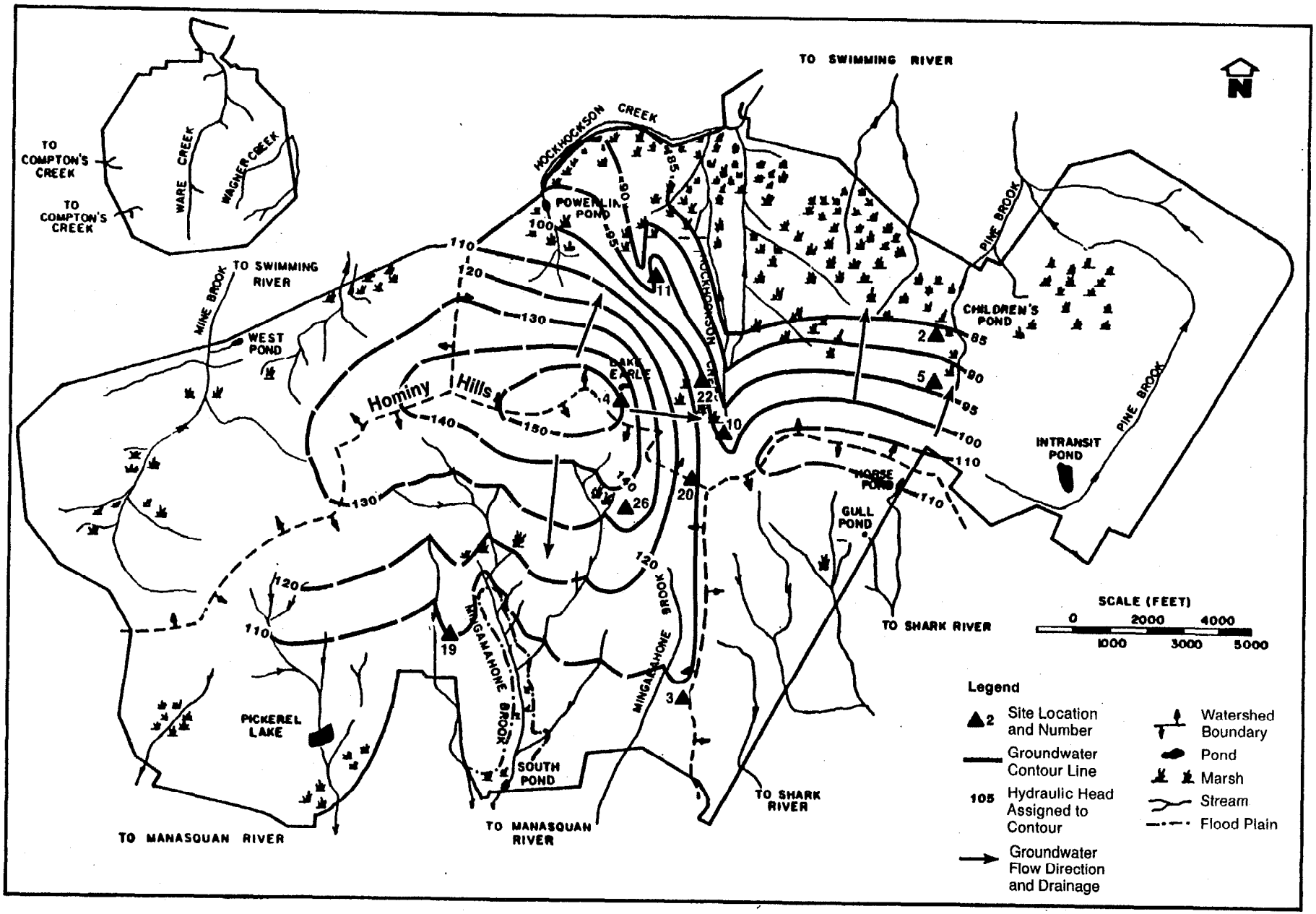


FIGURE 2–1 COMPOSITE SHALLOW GROUNDWATER–SURFACE CONTOUR AND DRAINAGE MAP FOR THE MAIN BASE,NWS EARLE

Main Base drains to the Manasquan River via either Marsh Bog Brook or Mingamahone Brook. The southeastern 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.

2.1.4 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 are described in the Soil Survey of Monmouth County, New Jersey (USDA, 1990), as follows:

- Atsion Series [At]: The Atsion Series consists of poorly drained soils on upland flats. These soils formed in acid, sandy Coastal Plain sediments. Slope ranges from 0 to 2%.

- Humaquepts [HV]: Humaquepts consist of somewhat poorly drained to very poorly drained soils on flood plains. These soils are subject to flooding several times each year. They formed in stratified, sandy or loamy sediments of fluvial origin. Slope ranges from 0 to 2%.

- Keyport Series [KeB]: The Keyport Series consists of moderately well drained soils on uplands. These soils formed in acid, clayey Coastal Plain sediments. Slope ranges from 0 to 15%.

- Lakehurst Series [LaA]: The Lakehurst Series consists of moderately well drained and somewhat poorly drained soils on uplands. These soils formed in acid, sandy, Coastal Plain sediments. Slope ranges from 0 to 2%.

- Lakewood Series [LeB]: The Lakewood Series consists of excessively drained soils on uplands. These soils formed in acid, sandy, Coastal Plain sediments. Slop ranges from 0 to 10%. Lakehurst soils are mottled in the subsoil.

- Udorthents [UA]: Udorthents consist of well-drained to somewhat poorly drained soils that have no horizonation. These soils formed in stratified or graded, sandy or loamy fill material that has as much as 35% gravel, by volume. Slope ranges from 0 to 3%. These soils have been altered in some way. In some areas the altering was filling over or excavating excessively drained to very poorly drained areas. They are strongly acid to extremely acid.

Soils in the Chapel Hill area include the Psamments and Tinton 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. The two soil associations found at Chapel Hill (waterfront area) are described in the Soil Survey of Monmouth County, New Jersey (USDA, 1990), as follows:

- Psamments [PN]: Psamments consist of excessively drained to somewhat poorly drained soils that have no horizonation. These soils formed in stratified or graded, sandy fill material. Slope ranges from 0 to 2%.

  These soils differ greatly from area to area. Thus, a typical pedon is not given. Typically, the soils are 20 to 60 inches deep or more to the original soil material or to waste fill. They are extremely acid or very strongly acid.

- Tinton Series [ToA]: The Tinton Series consists of well-drained soils on uplands and terraces. These soils formed in acid, loamy, Coastal Plain sediments that are 10 to 40% glauconite, by volume. Slope ranges from 0 to 25%.

2.1.5 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 (see Figure 2-2).

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.

The total thickness of the sediments over the crystalline bedrock basement is approximately 1,300 feet inland to more than 6,000 feet near the shore.

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, swamp, marshes,

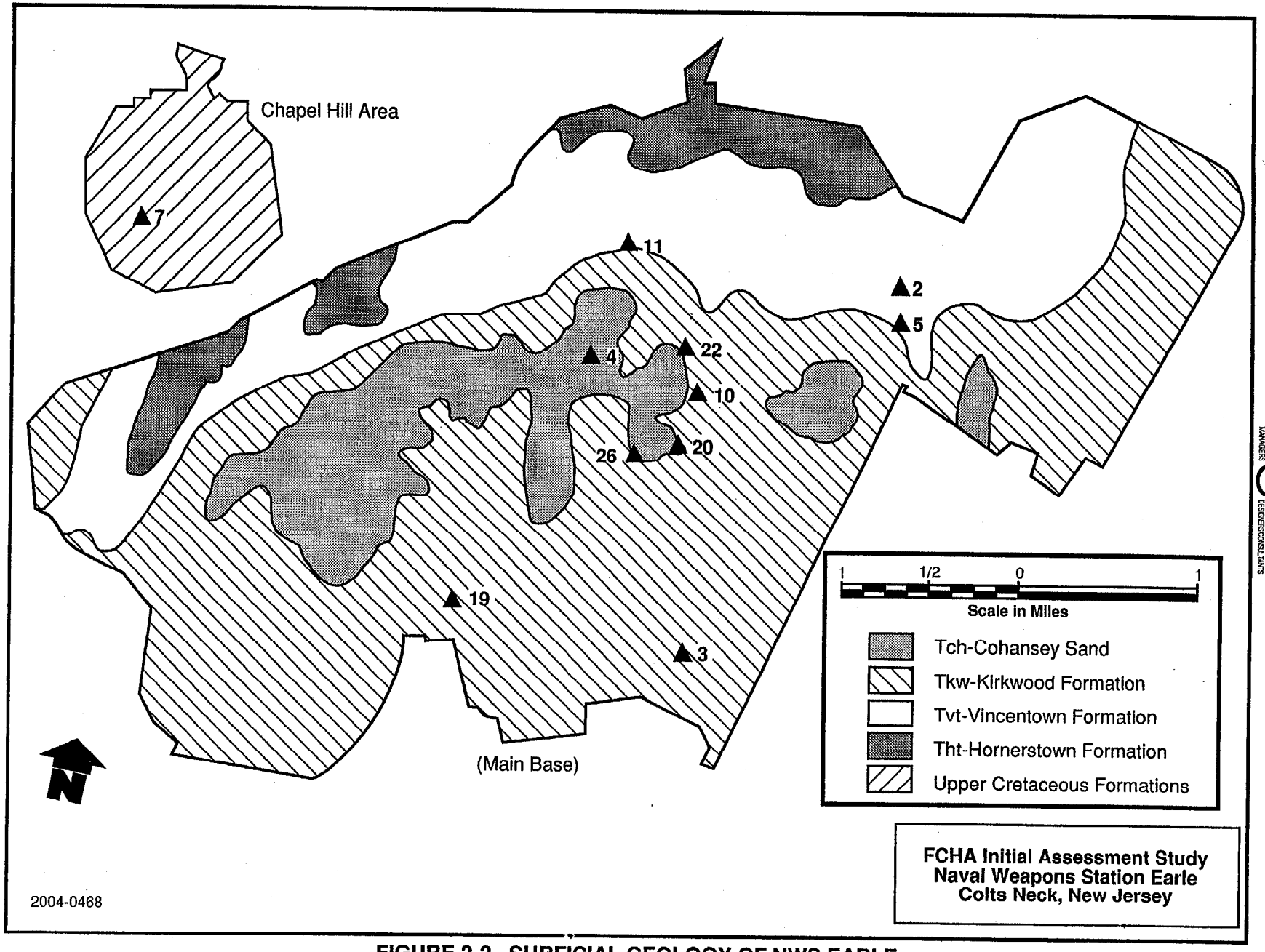


FIGURE 2-2 SURFICIAL GEOLOGY OF NWS EARLE

or backshore lagoons), while coarser textures represent higher energy zones (i.e., beachfront stream or deltaic deposits). The last major depositional event resulted from the Pleistocene glaciation.

NWS Earle falls outside the southern limit of the Wisconsin terminal moraine. 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. Because of their similarity in composition, the Raritan is commonly considered with the next-youngest unit, the Magothy Formation. The Magothy is also predominantly sand (fine-grained, micaceous, and lignitic) and up to 175 feet thick, but the sands tend to be discontinuous and the clay interbeds more common than in the Raritan Formation. The Magothy and Raritan are both Cretaceous Age formations. Combined they 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 younger units, the Merchantville Formation up through the Wenonah Formation, are 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 overlying Woodbury Clay, also a gray to black micaceous clay 60 or more feet thick. Together, these two clays range in thickness from 120 feet inland to 250 feet near the shore. They are generally nonwater-bearing and act as a single aquitard.

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 gallons per minute (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, and the oldest unit in the Rancocas Group. It is a massive, green, glauconitic sand with interbedded clay. The lithology is homogeneous, and the thickness is fairly constant downdip, with an average thickness of 30 to 50 feet. The Hornerstown Sand 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 25% 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 more than 200 feet in the subsurface along the shore. Neither formation crops 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) and across the southern tier of Monmouth County.

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 tap the Cohansey on the station. Because of 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.

2.1.6 Hydrogeology

2.1.6.1 Regional Hydrogeology

The Atlantic Coastal Plain sediments are the most important source of potable water in the region. More than 75% 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 thicken to the southeast and overlie 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 as follows:

- 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 or semiconfined, 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. Intrusion of 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.

2.1.6.2 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.

The lithologic properties of these units are described in Subsection 2.1.5 and their hydrologic significance is described in detail in Subsection 2.1.6.1. 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 immediate to NWS Earle. High iron content is a problem in these aquifers.

Two deep water supply wells (currently out of service) located on the Main Base tap the Raritan-Magothy aquifer system at depths of approximately 800 feet below ground surface (bgs). The recharge area of this aquifer system is located several miles north and west of the Main Base. The base wells were removed from service in 1989 when, in response to increased station demand for water, an agreement was reached between NWS Earle, Colts Neck Township and the American Water Company (AWC) for the AWC to supply water to the station.

Groundwater flow across the Main Base is generally to the east/southeast. However, surface topography and drainage heavily influences local shallow groundwater flow as shown on Figure 2-1.

At the waterfront and Chapel Hill areas, surface outcrops consist of the Navesink Formation and the Mt. Laurel and Wenonah Sands. These units are used for private domestic supply 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.

Generalized area shallow groundwater flow contours are shown in the site map in Figure 2-1. Table 2-2 lists the geologic formations underlying the study sites based on descriptions from shallow boring logs at each site.

Table 2-2

Summary of Surficial Geology at Study Sites, NWS Earle, Colts Neck, NJ

Site No.	Location	Stratigraphic Unit	Depth to First Saturated Zone (ft bgs*)
2	Main Base	Vincentown	5 - 20
3	Main Base	Kirkwood	10 - 25
4	Main Base	Cohansey	10 - 21
5	Main Base	Vincentown	19 - 20
7	Chapel Hill	Red Bank Sand	4 - 25
10	Main Base	Kirkwood	14 - 16
11	Main Base	Vincentown	4 - 9
19	Main Base	Kirkwood	14 - 20
26	Main Base	Cohansey	10 - 14

*bgs - below ground surface.

2.1.7 Groundwater and Surface 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. As described in Subsection 2.1.3, the headwaters and portions of the drainage basins of the Swimming, Manasquan, and Shark Rivers are present on the Main Base. Both the Swimming and Shark Rivers supply water to reservoirs used for public water supplies. 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.

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 agricultural land use.

SECTION 3
SITE INVESTIGATIONS

3.1 FIELD INVESTIGATION OVERVIEW

The purpose of the field investigation was to obtain sufficient data to determine the nature and extent of contamination at each site and provide data for the completion of a Baseline Risk Assessment and Feasibility Study. Generally, each of the 11 sites had been investigated during the SI in 1986 which included the installation and sampling of monitor wells and surface soil sampling. While no extensive environmental impact was identified from the SI study, the sites continued to be investigated during an RI to:

- Provide more comprehensive data on soil, groundwater, surface water, and sediment impacts. The RI investigation included additional sampling points and an expanded list of parameters.
- Characterize known waste materials in the landfills and grit-blasting waste piles.
- Meet EPA data validation requirements for analytical samples.

The sampling strategy and program were developed and presented in the RI/FS Work Plan (January 1991). Modifications were made in response to field conditions. EPA and NJDEPE concurrence to these modifications was obtained verbally, then followed by written documentation. These changes to the work plan are noted in the site discussions.

The field investigation methods used during the RI study can be divided into the following categories:

- Soil and surficial waste sampling.
- Exploratory drilling and monitor well installation.
- Well elevation survey.
- Groundwater sampling.
- Surface water and sediment sampling in streams adjacent to sites.
- Test pit investigation of landfills.

All sampling and analytical work was performed according to the Quality Assurance Project Plan (QAPP) (June 1990). Sample collection, handling, preservation, numbering, custody documentation, and quality control protocol are discussed in detail in the QAPP. All target compound laboratory work was conducted and reported according to EPA contract laboratory program (CLP) protocols; full quality control protocol and reporting were also provided for the explosive compounds that are not under CLP protocol. All data were validated by an independent reviewer.

3.1.1 Soil Sampling

Soil and solid waste samples were taken with hand augers at specific shallow depths (< 2 feet) at Sites 2, 11, 19, 20, 22, and 26. The objectives of the shallow subsurface soil sampling at these sites were to characterize the following:

- Soil contamination related to explosives destruction at Sites 2, 11, and 22.
- Blasting grit waste and metals in the soils and sediments in drainageways at Sites 20, 22, and 26.

3.1.2 Exploratory Drilling and Additional Monitor Well Installation

Additional 26 permanent monitoring wells were installed as part of the RI in January 1991. The monitor wells were installed following NJDEPE monitor well construction and grouting specifications for unconsolidated formations, as outlined in the QAPP. This monitor well design conforms with NJAC 7:9-7, 8, and 9. The drilling and well construction methods used are described in the following subsections (boring logs and well construction diagrams are provided in Appendix A). A summary of the monitoring well completion data is provided on Table 3-1.

The following general procedures were followed during all drilling and well installations:

- Continuous split-spoon samples were taken for lithologic description of the boreholes.

Table 3-1
Summary of Monitor Well Completion
Site & Remedial Investigation Stages
NWS Earle, Colts Neck, NJ

Monitor Well	Date Completed	NJDEP Permit #	Well Total Depth (Ft)	Casing Diameter (In)	Screen Interval From	Screen Interval To	Static WL at Development	Comments	Survey Information Northing	Easting	El. TOC	El. GS
MW2-1	02-27-86	29-15752	30.00	4	15	30	----		521475.57	2152742.31	102.56	NS
MW2-2	02-28-86	29-15753	20.00	4	5	20	----		522229.54	2152226.07	95.98	NS
MW2-3	02-21-86	29-15754	24.00	4	4	24	----		522668.06	2152717.85	89.87	NS
MW2-4	02-28-86	29-15755	19.00	4	4	19	----		522042.71	2153154.26	90.06	NS
MW2-5	01-25-91	29-25712-3	19.28	4	4.25	19.28	5.60		522420.92	2152415.24	103.05	101.07
MW2-6	01-24-91	29-25713-1	19.80	4	4.8	19.8	3.90		522160.00	2152655.97	95.07	92.99
MW2-7	01-25-91	29-25714-0	20.00	4	5.0	20.0	6.79		522374.06	2152954.66	95.18	93.18
MW3-1	01-07-86	28-15756	23.00	4	8	23	----		510873.73	2146110.42	117.05	NS
MW3-2	01-06-86	29-15757	25.00	4	10	25	----	Dry after 5 sec. of development	511187.86	2145598.71	126.00	NS
MW3-3	01-02-86	29-15758	23.00	4	8	23	----		511283.17	2146138.03	125.53	NS
MW3-4	01-30-91	29-25715-8	14.60	4	4.60	14.60	6.42	Drill to top of clay layer	510921.89	2145914.56	123.27	121.57
MW3-5	02-05-91	29-25716-6	17.75	4	5.0	17.75	9.88		510978.98	2145713.86	126.03	124.36
MW3-6	02-11-91	29-25717-4	19.00	4	5.25	19.0	9.25		511476.37	2145754.76	126.78	124.99
MW3-7	01-29-91	29-25718-2	19.80	4	4.8	19.8	8.38		511239.73	2145910.80	125.63	123.49
MW4-1	01-09-86	29-15759	30.00	4	15	30	----		520372.72	2143727.64	173.00	NS
MW4-2	01-09-86	29-15760	18.00	4	3	18	----		519966.04	2144194.49	152.36	NS
MW4-3	01-10-86	29-15761	25.00	4	10	25	----		519414.94	2143771.72	166.00	NS
MW4-4	02-08-91	29-25708-5	35.00	4	15.0	35.0	----		519976.34	2143461.23	181.28	179.66
MW4-5	02-20-91	29-25709-3	26.00	4	11.0	26.0	15.50		520335.34	2144154.78	165.28	164.07
MW4-6	02-25-91	29-25711-5	13.70	4	3.7	13.7	2.17	Bentonite to GS w/concrete form	519595.61	2144197.10	149.75	147.64
MW5-1	02-20-86	29-15762	29.00	4	14	29	----		520101.85	2152556.65	108.77	NS
MW5-2	01-21-86	29-15763	28.00	4	13	28	----		520075.26	2152231.27	113.96	NS
MW5-3	03-03-86	29-15764	32.00	4	17	32	----		520279.67	2151923.34	109.78	NS
MW5-4	02-19-86	29-15765	27.00	4	12	27	----		520926.28	2151901.90	105.65	NS
MW5-5	01-18-91	29-25696-8	28.50	4	13.5	28.5	17.19		520720.54	2152107.72	112.05	110.28
MW5-6	01-23-91	29-25697-6	33.00	4	18.0	33.0	22.26		520532.33	2152448.17	117.30	115.93
MW5-7	01-24-91	29-25698-4	29.00	4	14.0	29.0	18.10		520362.58	2152458.41	113.97	111.96
MW5-8	02-13-91	29-25699-2	14.50	4	9.0	24.5	13.28		520009.12	2151921.68	110.30	108.32
MW7-1	03-04-86	29-15775	39.00	4	24	39	----		571753.39	2165760.50	149.74	148.65
MW7-2	03-05-86	29-15776	19.00	4	4	19	----		571999.24	2165343.22	128.15	127.08
MW7-3	01-24-86	29-15777	35.00	4	20	35	----		571389.53	2165400.20	164.14	162.74
MW7-4	02-28-91	29-25694-1	23.50	4	9.0	23.5	11.59		572094.11	2165620.79	133.90	132.09
MW7-5	02-27-91	29-25695-0	20.00	4	5.3	20.0	9.73		571889.01	2165158.27	137.23	135.14
MW10-1	01-13-86	29-15766	27.50	4	12.5	27.5	----		519453.48	2146774.29	113.99	NS
MW10-2	01-15-86	29-15767	22.00	4	7	22	----		519309.21	2147093.98	111.35	NS
MW10-3	01-14-86	29-15768	25.00	4	10	25	----		518865.96	2146856.99	110.90	NS
MW10-4	01-17-91	29-25703-4	22.50	4	7.5	22.5	9.70		519151.57	2146632.89	114.13	112.38
MW10-5	01-18-91	29-25704-2	21.00	4	6.0	21.0	8.52		519664.80	2146882.31	112.44	110.43
MW10-6	02-19-91	29-25705-1	17.00	4	2.0	17.0	2.13	Bentonite to GS w/concrete form	519451.58	2147095.32	109.11	107.14
MW10-7	01-18-91	29-25706-9	19.50	4	5.0	19.5	5.12		519489.28	2146999.71	107.44	104.61
MW11-1	12-19-85	29-15769	19.00	4	4	19	----		524179.96	2144759.79	99.07	NS
MW11-2	12-18-85	29-15770	18.00	4	3	18	----		523941.95	2144958.84	100.97	NS
MW11-3	12-18-85	29-15771	20.00	4	5	20	----		523687.09	2144532.51	98.37	NS
MW11-4	01-14-91	29-25701-8	14.50	4	4.2	14.5	0.57		523918.98	2144587.88	92.23	89.72
MW11-5	01-15-91	29-25702-6	13.70	4	3.7	13.7	1.20		524101.29	2144586.65	90.72	88.31
MW19-1	01-20-86	29-15772	25.00	4	10	25	----		512587.98	2139324.23	117.75	NS
MW19-2	01-20-86	29-15773	24.00	4	9	24	----		512587.70	2139324.75	110.51	NS
MW19-3	01-20-86	29-15774	24.00	4	9	24	----		512747.57	2139079.34	112.47	NS
MW19-4	01-15-91	29-25719-1	16.00	4	4.0	16.0	12.02	1' in high plastic glauconite clay	512869.96	2139260.84	114.57	113.06
MW19-5	01-16-91	29-25720-4	20.00	4	5.0	20.0	13.15		512514.66	2139133.26	115.16	113.61
MW19-6	02-15-91	29-25721-2	16.00	4	2.5	16.0	7.40	Bentonite to GS w/concrete form	512656.03	2138966.10	110.26	108.08
MW26-1	01-29-86	29-15939-3	24.00	4	9	24	----		517010.09	2144382.71	149.89	NS
MW26-2	01-27-86	29-15940-7	22.00	4	7	22	----		517195.55	2144352.05	149.64	NS
MW26-3	01-28-86	29-15941-5	22.00	4	7	22	----		517260.75	2144352.73	150.48	NS
MW26-4	01-15-91	29-25700-0	15.00	4	5.0	15.0	7.92		517109.10	2144400.87	151.09	149.09

- All soil borings not completed as wells were abandoned by tremie grouting to the surface with a cement/bentonite slurry.

- On the basis of soil vapor readings, and odor and visual observation, no drill cuttings were identified as potentially hazardous. Cuttings were spread on the ground around the wells in accordance with the QAPP. No HNu readings above background were observed during any of the drilling activity.

- All drilling, sampling, and other related equipment was decontaminated as detailed in the QAPP.

- Development water and purge water from the first round of new wells were containerized pending analysis. After analysis showed no significant contamination, the water was discharged to the ground.

All drilling was conducted according to standard hollow-stem auger drilling techniques. The wells were designed to monitor the shallow water table aquifer and were installed by placing 4-inch-diameter, threaded, PVC casing and 15-foot-length, 0.020-inch slot, well screen (conditions permitting) into the borehole so that the screen intercepted the groundwater table. The well screen was generally placed so that approximately 5 feet of screen was above the groundwater table. In some instances, screen length was shortened based on hydrogeologic conditions encountered during drilling.

Typical well construction began with the annulus around the well screen filled with Ricci sand, No. 1 and No. 2 sand (blended) to a point 2 feet above the screen. The sand pack was then overlain with 2 feet of bentonite pellets. The remainder of the annulus was filled to grade with a 6:1 cement:bentonite grout slurry using tremie methods. Wells were constructed through hollow-stem augers and the augers were withdrawn as the backfilling proceeded. The top of each monitor well was completed with a locking steel security casing. This casing was then immobilized with a mounded concrete seal to protect the well and to not allow stormwater runoff to collect around the well casing. The typical well construction used is shown in Figure 3-1 for

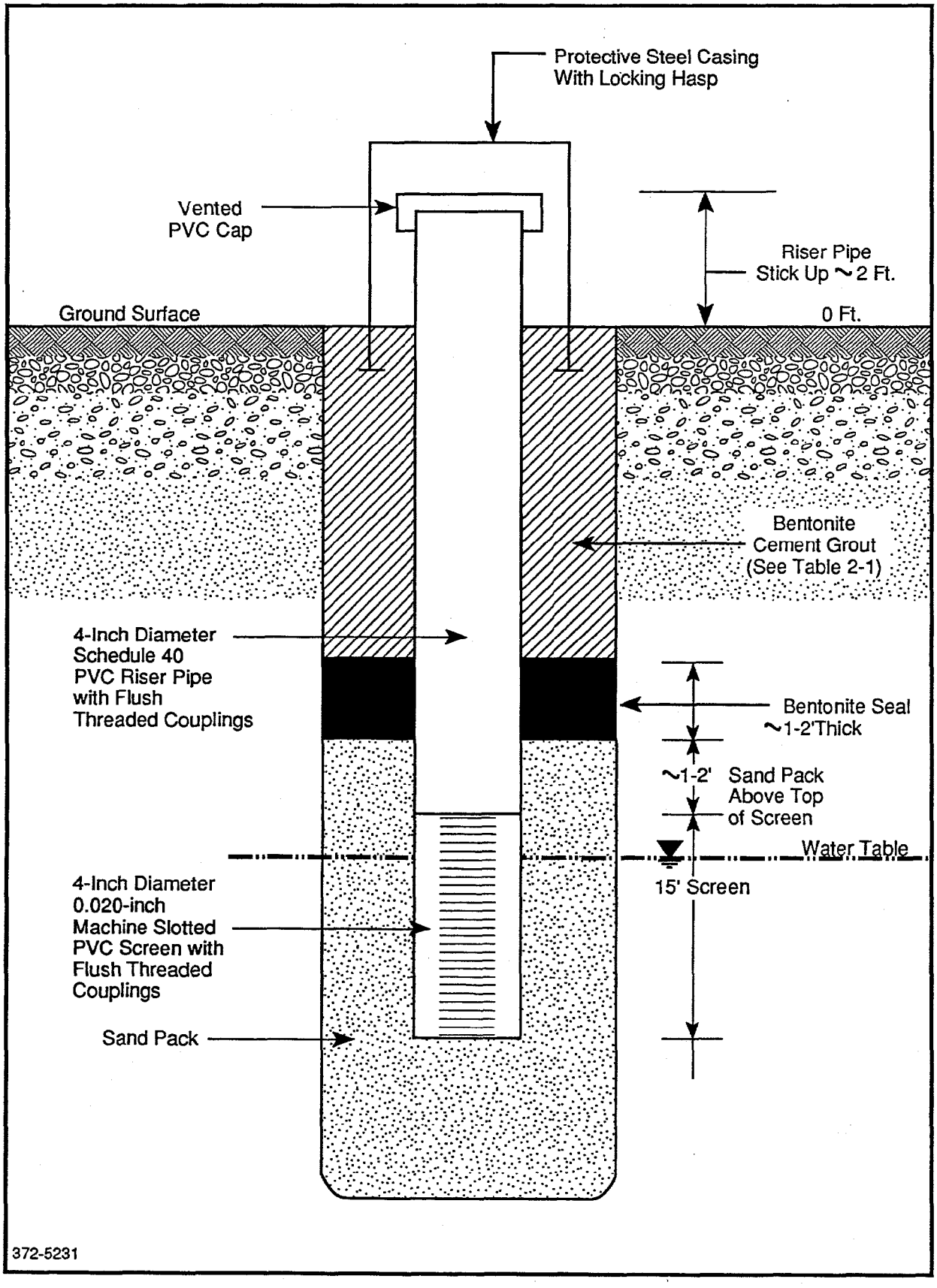


FIGURE 3-1 TYPICAL WELL CONSTRUCTION DIAGRAM

those monitor wells constructed in shallow water conditions with the water table less than 5 feet bgs. The protective casing was set partially into the bentonite seal and then anchored into an 18-inch-high steel form that was filled with a cement and bentonite grout. The annulus inside the protective casing is filled with a pure bentonite seal to the height of the form, effectively isolating any movement in the protective casing and form from the monitor well casing. Once completed, monitor wells were developed using a submersible pump. During the purge process the groundwater was monitored for temperature, pH, and conductivity. All purged water from development was containerized in 55-gallon drums. Well development was deemed complete based on three criteria: clearing of turbidity, stabilization of consecutive groundwater monitoring parameters, or 1 hour of pumping time. A summary of development data, as logged, is presented in Table 3-2. All potable water used for drilling was obtained from the fire hydrant across from Building C-23 along Esperance Road; no surface water was used during the drilling process.

3.1.3 Elevation Survey

A licensed New Jersey surveyor established all well locations and top-of-casing elevations. Table 3-1 contains this survey information and NJDEPE permit numbers. Water levels were measured to the nearest 0.01 foot at each monitoring well at the start of each sampling round. These measurements were used to establish groundwater elevations. A summary of the water level measurements is presented in Table 3-3. Existing monitor well elevations were also checked during the survey. A consistent 10.00-foot elevation discrepancy was discovered at Site 19. After checking the new benchmarks, the old well elevations were adjusted to be consistent with the new wells.

3.1.4 Aquifer Slug Tests

Slug tests were performed to obtain data to calculate hydraulic conductivities in several representative screened zones. Each test was conducted by quickly raising then lowering the water level in a well from equilibrium, and measuring its subsequent rate of rise. The rate of water level rise is a function of the hydraulic conductivity of the surrounding aquifer material.

Table 3-2
Field Tested Water Quality Parameters for Monitor Well Development
Remedial Investigation
N.W.S. Earle
Colts Neck, NJ

Monitor Well I.D. No.	Date	Purge Time	Depth To Water	Temperature C	pH	Specific Conductance mmh0s/m	Odor	Turbidity	Color	Calculated Well Volume (gallon)	Estimated Water Volume Purged (gallon)	Comments
MW26-4	2/4/91	1210a	9.92	14.5	5.5	125	N	Milky	Med. Brown	3.30		
		1220	13.54	14.0	4.8	70	N	Slight	Same			1st purge volume
		1230	13.50	14.5	4.5	62	N	Clear	Clear			2nd purge volume
		1236	13.48	14.5	4.5	58	N	Clear	Clear			3rd purge volume
MW19-4	2/4/91	1314a	13.62	17.0	4.6	93	Y	High	Green Gray	1.55		Strong putrid odor
		1340	14.00	13.0	4.3	113	Y	Med.	Green Gray			
		1354	14.00	12.0	4.7	111	Y	Med.	Green Gray			
		1407	14.00	12.0	4.8	110	Y	Slight	Green Gray		@20(total)	trace fines
MW19-5	2/4/91	1445	14.75	15.0	4.3	163	Y	Heavy	Dk Olive Green	3.41	10.6	Heavy fines, odor
		1455	15.80	14.0	4.5	154	Y	Slight	Lt Olive green		13.3	Slight odor
		1504	15.70	14.0	4.7	151	Y	Clear	Clear		12.0	Slight odor, @ 36 gals.(total)
MW10-4	2/4/91	1530a	11.70							7.02		
		1536	14.70	13.8	5.5	48	N	High	Dk Olive green			Prepurge
		1544	14.85	13.5	5.5	32	N	High	Same		8.0	1st purge volume
		1559	14.70	14.0	5.5	32	N	Med.	Same		15.0	2nd purge volume
		1605	14.70	14.0	5.5	33	N	M to Low	Same		11.0	3rd purge volume, @ 35 gals.(total)
MW10-5	2/4/91	1620a	10.52							6.81		
		1625	10.52	13.5	6.2	48	N	High	Dk Gr Green			Prepurge
		1636	14.52	13.0	6.2	32	N	High	Same		14.7	1st purge volume
		1650	14.52	12.8	6.3	32	N	Med.	Same		18.7	2nd purge volume
		1655	14.52	12.8	6.3	33	N	M to Low	Same		20.0	3rd purge volume, @ 53 gals.(total)

NOTE: a - Static water level
b - pH meter not functioning

Table 3-2
Field Tested Water Quality Parameters for Monitor Well Development
Remedial Investigation
N.W.S. Earle
Colts Neck, NJ

Monitor Well I.D. No.	Date	Purge Time	Depth To Water	Temperature C	pH	Specific Conductance mmh0s/m	Odor	Turbidity	Color	Calculated Well Volume (gallon)	Estimated Water Volume Purged (gallon)	Comments
MW10-7	2/5/91	759	10.00	11.5	5.1	60	Y	High	Dk. gr green	6.18		1st purge volume, H2S odor
		809	-----	12.0	5.0	73	Y	Med.	Med. gr green			2nd purge volume
		822	-----	12.0	4.9	77	Y	Low	Lt. gr green			3rd purge volume, H2S odor
		827	-----	12.8	4.9	67	Y	Low	Lt. gr green		100(total)	4th purge volume
MW2-5	2/5/91	929	7.60							7.59		
		940	9.02	12.5	5.1	78	N	High	Dk. milky brn			1st purge volume
		946	8.91	13.0	5.4	61	N	High	Dk. milky brn			2nd purge volume
		954	8.90	13.5	5.6	56	N	Med.	Med. milky brn			3rd purge volume
		1009	-----	13.0	5.4	39	N	Med.	Med. milky brn			4th purge volume
		1018	-----	12.5	5.4	26	N	Med.	Lt. milky brn		50(total)	5th purge volume
MW2-6	2/5/91	1030a	6.92							8.37		
		1042	15.38	13.0	6.4	350	N	High	Dk milky brn			1st purge volume
		1050	15.72	14.0	6.5	269	N	High	Dk milky brn			2nd purge volume
		1056	-----	14.5	7.2	240	N	High	Dk milky brn			3rd purge volume
		1115	-----	14.5	6.2	176	N	Med.	Med. milky brn		@38(total)	4th purge volume
MW2-7	2/5/91	1130a	8.27							7.62		
		1155	13.72	17.0	3.8	119	N	High	Dk olive brn			1st purge volume
		1203	13.89	16.5	4.2	108	N	High	Dk olive brn			2nd purge volume
		1213	14.63	17.5	4.4	82	N	Med.	Lt. brn			3rd purge volume
		1223	14.51	17.0	4.3	69	N	Low	Lt. brn		25(total)	4th purge volume

NOTE: a - Static water level
b - pH meter not functioning

Table 3-2
Field Tested Water Quality Parameters for Monitor Well Development
Remedial Investigation
N.W.S. Earle
Colts Neck, NJ

Monitor Well I.D. No.	Date	Purge Time	Depth To Water	Temperature C	pH	Specific Conductance mmh0s/m	Odor	Turbidity	Color	Calculated Well Volume (gallon)	Estimated Water Volume Purged (gallon)	Comments
MW5-7	2/5/91	1357a	20.10							5.78		
		1401	21.31	16.0	4.2	690	N	High	Dk. mky olive brn		5.0	1st purge volume
		1413	23.26	15.0	3.7	550	N	High	Dk. mky olive brn		15.0	2nd purge volume
		1420	23.00	14.5	3.7	510	N	High	Dk. mky olive brn		8.8	3rd purge volume
		1426	22.20	15.5	3.9	510	N	Med.	Milky olive brn		7.5	4th purge volume
		1432	-----	15.0	3.8	510	N	Low	Milky		10.0	5th purge volume,@ 47 gals. (total)
MW5-6	2/5/91	1447a	23.76							6.01		
		1610	25.20	17	4.5	290	N	Med.	Dk olive brn			1st purge volume
		1615	-----	16.5	4.6	290	N	Med.	Dk olive brn			Dry @ 1.5 vols.
		1620	-----	15	5.1	290	N	Med.	Dk olive brn			
		1645	-----									
MW4-6	2/26/91	931a	4.17	8.0	5.5	120	N	High		6.19		Prepurge
		934	-----	8.0	6.2	122	N	Med.				1st purge volume
		936	-----	7.5	6.6	135	N	Med.				2nd purge volume
		940	-----	7.0	6.8	140	N	Med.				3rd purge volume
		941	-----	7.0	7.0	115	N	Med.				4th purge volume
		944	-----	7.0	7.0	100	N	Med.				5th purge volume
		947	-----	7.0	7.0	95	N	Med.				6th purge volume
Mw4-5	2/26/91	1015a	17.00	7.0	7.1	110	N	High	Yellow orange	5.85		Prepurge
		1026	-----	7.5	6.2	165	N	High	Yellow orange			1st purge volume
		1030	-----	8.0	6.3	175	N	High	Yellow orange			2nd purge volume
		1039	-----	8.0	6.6	165	N	Med.	Yellow orange			3rd purge volume
		1045	-----	8.0	6.7	165	N	Low-M.	Yellow orange			4th purge volume

NOTE: a - Static water level
b - pH meter not functioning

Table 3-2
Field Tested Water Quality Parameters for Monitor Well Development
Remedial Investigation
N.W.S. Earle
Colts Neck, NJ

Monitor Well I.D. No.	Date	Purge Time	Depth To Water	Temperature C	pH	Specific Conductance mmh0s/m	Odor	Turbidity	Color	Calculated Well Volume (gallon)	Estimated Water Volume Purged (gallon)	Comments
MW4-4	2/26/91	1150a	-----	8.0	b	150	N	High		22.75		Prepurge
		1201	-----	8.5	b	128	N	High				1st purge volume
		1203	-----	9.0	b	143	N	Med.				2nd purge volume
		1208	-----	8.0	b	130	N	Med.				3rd purge volume
		1211	-----	8.0	b	132	N	Med.				4th purge volume
MW11-4	2/26/91	1523a	3.40	4.0	b	163	N	High	Brn green	7.22		Prepurge
		1528	-----	5.7	b	145	N	High	Brn green			1st purge volume
		1533	-----	6.5	b	125	N	Med.-H	Brn green			2nd purge volume
		1536	-----	6.5	b	125	N	Med.	Brn green			3rd purge volume
		1539	-----	6.7	b	122	N	Med.	Brn green			4th purge volume
MW11-5	2/26/91	1556a	3.50	7.5	b	112	N	High	Brn green	6.63		Prepurge
		1600	-----	7.0	b	145	N	High	Brn green			1st purge volume
		1602	-----	7.0	b	150	N	Med.-H	Brn green			2nd purge volume
		1605	-----	7.5	b	145	N	Med.	Brn green			3rd purge volume
		1608	-----	7.8	b	144	N	Med.	Brn green			4th purge volume
MW10-6	3/11/91	1630a	4.13	9.5	5.5	80	N	High	Brn green	8.37		Prepurge
		1637	-----	9.5	4.9	75	N	High	Brn green		70.0	1st purge volume, Glauconitic
		1639	-----	9.5	4.4	78	N	High	Brn green		20.0	2nd purge volume
		1641	-----	9.5	4.2	78	N	Med.	Brn green		20.0	3rd purge volume
		1643	-----	9.5	4.0	79	N	Med.	Brn green		20.0	4th purge volume
		1645	-----	9.5	4.0	79	N	Med.-L	Brn green		20.0	5th purge volume

NOTE: a - Static water level
b - pH meter not functioning

Table 3-2
Field Tested Water Quality Parameters for Monitor Well Development
Remedial Investigation
N.W.S. Earle
Colts Neck, NJ

Monitor Well I.D. No.	Date	Purge Time	Depth To Water	Temperature C	pH	Specific Conductance mmh0s/m	Odor	Turbidity	Color	Calculated Well Volume (gallon)	Estimated Water Volume Purged (gallon)	Comments
MW19-6	3/1/91	1206a	9.90	16.0	4.4	210	N	High		3.97		Prepurge
		1218	-----	17.0	3.8	220	N	High				1st purge volume
		1225	-----	15.0	3.9	140	N	High				2nd purge volume
		1239	-----	15.5	3.9	121	N	Med.				3rd purge volume
		1248	-----	12.0	3.7	121	N	Med.				4th purge volume
		1300	-----	13.0	3.8	110	N	Med.				5th purge volume
MW3-6	3/1/91	1350	11.05	10.0	5.9	285	N	High		5.17		1st purge volume
		1359	-----	10.0	5.9	250	N	High				2nd purge volume
		1404	-----	10.5	6.0	229	N	High				3rd purge volume
		1407	-----	10.5	6.0	220	N	Med.				4th purge volume
		1416	-----	11.5	5.9	205	N	Med.				5th purge volume
MW5-8	3/4/91	1026	15.69	13.5	4.5	200	N	High		5.73		1st purge volume
		1031	-----	12.5	4.8	202	N	High				2nd purge volume
		1036	-----	13.0	4.8	170	N	High				3rd purge volume
		1040	-----	13.1	4.8	155	N	High				4th purge volume
		1045	-----	13.2	4.8	145	N	High				5th purge volume
		1048	-----	13.2	4.8	138	N	High				6th purge volume
MW5-5	3/4/91	1123	18.69	13.5	5.2	350	N	High		6.38		1st purge volume
		1128	-----	13.0	5.0	280	N	High				2nd purge volume
		1131	-----	13.0	5.0	255	N	High				3rd purge volume
		1134	-----	13.0	5.0	245	N	High				4th purge volume
		1139	-----	13.0	5.0	241	N	High				5th purge volume
		1143	-----	13.1	4.9	235	N	High				6th purge volume

NOTE: a - Static water level
b - pH meter not functioning

Table 3-2
Field Tested Water Quality Parameters for Monitor Well Development
Remedial Investigation
N.W.S. Earle
Colts Neck, NJ

Monitor Well I.D. No.	Date	Purge Time	Depth To Water	Temperature C	pH	Specific Conductance mmh0s/m	Odor	Turbidity	Color	Calculated Well Volume (gallon)	Estimated Water Volume Purged (gallon)	Comments
MW7-4	3/4/91	1425	13.51	13.5	4.9	152	N	High		6.49		1st purge volume
		1431	-----	12.0	4.7	135	N	High				2nd purge volume
		1436	-----	12.0	4.6	125	N	High				3rd purge volume
		1442	-----	12.1	4.5	120	N	High				4th purge volume
		1448	-----	12.0	4.5	115	N	High			@35(total)	5th purge volume
MW7-5	3/4/91	1519	11.83	12.0	4.6	200	N	High		5.31		1st purge volume
		1522	-----	12.0	4.6	208	N	Med-high				2nd purge volume
		1525	-----	12.0	4.7	219	N	Med-high				3rd purge volume
		1528	-----	12.0	5.0	245	N	Med-high				4th purge volume
		1531	-----	12.0	5.0	240	N	Med-high				5th purge volume
		1551	-----	12.0	4.9	230	N	Med-high			39(total)	6th purge volume
MW4-3		903	12.02	8.0	4.2	45	N	Low	Clear	8.44		1st purge volume
		910	-----	10.0	4.0	42	N	Low	Orange brown			2nd purge volume
		918	-----	10.0	4.0	42	N	Low	Brown			3rd purge volume
		926	-----	10.0	4.0	42	N	Low	Brown		@40(total)	4th purge volume
MW4-4	2/26/91	1150	25.30	8.0	b	150	N	High	Tan brown	6.31		1st purge volume
		1201	-----	8.5	b	128	N	High	Tan brown			2nd purge volume
		1203	-----	9.0	b	143	N	Med.	Tan brown			3rd purge volume
		1208	-----	8.0	b	130	N	Med.	Tan brown		@25(total)	4th purge volume
		1211	-----	8.0	b	132	N	Med.	Tan brown			

NOTE: a - Static water level
b - pH meter not functioning

Table 3–3
Summary of Groundwater Elevation Data
Remedial Investigation
N.W.S. Earle, Colts Neck, NJ

Monitor Well	Well Total Depth (Ft)	Casing Diameter (In)	Well Elevation (TOC)	Depth to Water (TOC) 6/26/91	Depth to Water (TOC) 10/22/91	Depth to Water (TOC) 11/19/91	Groundwater Elevation (MSL) 6/26/91	Groundwater Elevation (MSL) 10/22/91	Groundwater Elevation (MSL) 11/19/91
MW2–1	30	4	102.56	12.65	14.48	14.54	89.91	88.08	88.02
MW2–2	20	4	95.98	8.36	9.65	----	87.62	86.33	----
MW2–3	24	4	89.87	5.23	5.40	5.37	84.64	84.47	84.50
MW2–4	19	4	90.06	3.59	4.13	4.09	86.47	85.93	85.97
MW2–5	19.28	4	93.05	8.60	9.66	9.17	93.05	83.39	83.88
MW2–6	19.8	4	95.07	7.89	8.82	8.82	87.18	86.25	86.25
MW2–7	20	4	95.18	9.38	9.64	9.87	85.80	85.54	85.31
MW3–1	23	4	117.05	10.62	22.30	22.57	106.43	94.75	94.48
MW3–2	25	4	126.00	10.82	Dry	Dry	115.18	Dry	Dry
MW3–3	23	4	125.53	10.78	14.72	Dry	114.75	110.81	Dry
MW3–4	14.6	4	123.27	14.00	Dry	Dry	109.27	Dry	Dry
MW3–5	17.75	4	126.03	11.89	15.04	17.34	114.14	110.99	108.69
MW3–6	19	4	126.76	11.55	13.86	14.24	115.23	112.90	112.54
MW3–7	19.8	4	125.63	12.29	19.71	20.59	113.34	105.92	105.04
MW4–1	30	4	173.00	19.00	21.34	21.63	154.00	151.66	151.37
MW4–2	18	4	152.36	2.77	3.74	3.98	149.59	148.62	148.38
MW4–3	25	4	166.00	12.63	15.24	15.51	153.37	150.76	150.49
MW4–4	35	4	181.28	24.35	27.57	27.99	156.93	153.71	153.29
MW4–5	26	4	165.28	15.44	17.15	17.32	149.84	148.13	147.96
MW4–6	13.7	4	149.75	3.80	4.12	4.11	145.95	145.63	145.64
MW5–1	29	4	108.77	17.92	18.22	18.41	90.85	90.55	90.36
MW5–2	28	4	113.96	19.77	22.57	22.78	94.19	91.39	91.18
MW5–3	32	4	109.78	15.52	18.28	18.50	94.26	91.50	91.28
MW5–4	27	4	105.65	12.86	15.31	15.45	92.79	90.34	90.20
MW5–5	28.5	4	112.05	18.93	22.49	21.68	93.12	89.56	90.37
MW5–6	33	4	117.30	24.23	26.93	27.11	93.07	90.37	90.19
MW5–7	29	4	113.97	20.57	23.48	23.47	93.40	90.49	90.50
MW5–8	24.5	4	110.30	15.57	18.35	18.51	94.73	91.95	91.79
MW7–1	39	4	149.74	16.47	18.22	18.44	133.27	131.52	131.30
MW7–2	19	4	128.15	8.72	9.47	9.98	119.43	118.68	118.17
MW7–3	35	4	164.14	19.21	22.68	23.09	144.93	141.46	141.05
MW7–4	23.5	4	133.90	14.08	17.30	17.55	119.82	116.60	116.35
MW7–5	20	4	137.23	12.43	14.66	14.78	124.80	122.57	122.45
MW10–1	27.5	4	113.99	12.85	15.15	15.39	101.14	98.84	98.60
MW10–2	22	4	111.35	10.30	12.69	13.00	101.05	98.66	98.35
MW10–3	25	4	110.90	9.43	11.75	12.02	101.47	99.15	98.88
MW10–4	22.5	4	114.13	12.32	14.74	15.05	101.81	99.39	99.08
MW10–5	21	4	112.44	11.67	13.94	14.15	100.77	98.50	98.29
MW10–6	17	4	109.11	7.73	5.12	8.34	101.38	103.99	100.77
MW10–7	19.5	4	107.44	8.12	9.32	10.39	99.32	98.12	97.05
MW11–1	19	4	99.07	3.02	2.98	3.11	96.05	96.09	95.96
MW11–2	18	4	100.97	3.89	4.10	3.92	97.08	96.87	97.05
MW11–3	20	4	98.37	8.56	9.09	9.11	89.81	89.28	89.26
MW11–4	14.5	4	92.23	4.36	4.17	4.42	87.87	88.06	87.81
MW11–5	13.7	4	90.72	3.59	3.70	3.65	87.13	87.02	87.07
MW19–1	25	4	117.75	14.69	15.36	15.26	103.06	102.39	102.49
MW19–2	24	4	110.51	12.12	12.76	12.72	98.39	97.75	97.79
MW19–3	24	4	112.47	13.69	14.31	14.27	98.78	98.16	98.20
MW19–4	16	4	114.57	15.37	Dry	Dry	99.20	Dry	Dry
MW19–5	20	4	115.16	16.64	17.30	17.22	98.52	–17.30	97.94
MW19–6	16	4	110.28	11.10	11.68	11.70	99.16	–11.68	98.56
MW26–1	24	4	149.89	10.37	13.33	13.23	139.52	136.56	136.66
MW26–2	22	4	149.64	9.92	13.05	13.36	139.72	136.59	136.28
MW26–3	22	4	150.48	10.49	12.70	14.03	139.99	137.78	136.45
MW26–4	15	4	151.09	11.23	14.22	14.63	139.86	136.87	136.46

Slug tests were conducted at 22 well locations (see Table 3-4) at the 11 sites where groundwater was being addressed. Several wells were slug tested to determine the range of hydraulic conductivities in various unconsolidated materials beneath the site. The wells were selected for slug testing based on sample descriptions from the boring logs.

Before initiating each test, water elevation measurements were taken to determine the static potentiometric head. A pressure transducer was then lowered into the well to measure water level fluctuations through the test. The pressure transducer was connected to a central data collection and processing unit (In-Situ Model SE1000 Well Hermit) that records and stores water elevation measurements for subsequent analysis.

A slug of a known volume was instantaneously added to the well. Once the water level in the well was equilibrated, the slug was lifted to lower the water level approximately 3 feet. The data logger was activated simultaneously and the subsequent rising water level was measured relative to the initial water level at time t_0. The rate of water level rise is a function of the permeability of the surrounding soil, and varies with the zone the well is monitoring. Slug test data were analyzed using the Bouwer and Rice method. Results of the analysis are presented collectively in Appendix B and discussed, site by site, in Section 4.

3.1.5 Groundwater Sampling

Three rounds of groundwater sampling were conducted during the remedial investigation. The first round was performed in March 1991, followed by confirmatory rounds in October and November 1991. Groundwater depths and elevations for all wells in each of the three rounds are provided on Table 3-3. All 26 new and 27 pre-existing monitor wells were included in the sampling rounds. As specified in the RI Work Plan, the first round of samples were analyzed for the full target list of organic compounds (TCL), target analyte list of inorganics (TAL), and explosive compounds. Sites associated with explosives destruction (Sites 2, 11, and 21) were also sampled for analysis of explosive compounds. The second and third sampling rounds were limited to select parameters, at a minimum volatile organic compounds (VOCs) and Primary and

Table 3-4

Summary of Slug Test Results,
NWS Earle, Colts Neck, NJ

Well ID No.	Hydraulic Conductivity (ft/day)	Lithology
MW02-01	13.21	Very fine to coarse quartz sand with glauconite and silt
MW02-05	1.31	
MW02-06	0.12	
MW02-07	0.49	
MW03-03	2.03	Very fine to coarse quartz sand with glauconite and silt, some interbedded clay layers
MW03-06	1.56	
MW04-04	1.27	Fine to coarse quartz sand and silt
MW05-02	0.90	Very fine to coarse quartz sand with glauconite and silt
MW05-06	1.83	
MW05-07	0.59	
MW07-02	2.76	Silt to medium sand, micaceous, grading upward to semi-indurated sand
MW07-03	0.75	
MW10-04	0.72	Very fine to coarse sand and glauconite, some clay stringers
MW10-05	1.98	
MW10-07	4.97	
MW11-02	1.01	Silt to medium quartz sand, some glauconite and interbedded thin clay layers
MW11-04	2.45	
MW19-04	1.96	Silt to coarse quartz sand, some glauconite and interbedded clay stringers
MW19-05	3.00	
MW26-01	1.09	Fine to coarse quartz sand, little gravel
MW26-03	5.43	
MW26-04	2.01	

Secondary Drinking Water Metals[1] and additional analytes, based on the nature of the sites and initial results. Wells were purged of at least three well volumes prior to sampling. Specifics on equipment used, protocols followed, and decontamination procedures are provided in the QAPP.

3.1.6 Surface Water and Sediment Sampling

Small perennial streams are associated with Sites 4, 10, and 19. The streams, sediment and surface water of the streams were sampled to identify and quantify possible off-site migration of contaminants in the stream beds.

Sediments from the stream beds were collected using trowel/scoop or soil auger. If the trowel/scoop method was used, the sediment was placed directly in sample jars using a decontaminated trowel or scoop. Complete sampling procedures are found in the QAPP.

3.1.7 Test Pit Waste Characterization

Test pit investigations were conducted at landfill Sites 3, 4, 5, 7, and 10. The objective of this task was to obtain a physical description of landfill cover and waste material and to obtain samples for chemical analyses.

A backhoe was used to excavate four to seven test pits at each landfill to a maximum depth of 10 feet bgs. Cover material was stockpiled separately from underlying waste. The test pits allowed visual observations of subsurface conditions. The test pits were described and logged in the field notebook and included descriptions of color, texture, moisture, depth to water, and odor or staining, if present.

All sampling used the backhoe bucket and a shovel as needed. Two samples were selected at each site for full TCL and TAL analyses. These grab samples were taken from potentially impacted soils that were in contact with the waste and leachate, where observed. Upon

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[1] Primary Drinking Water Metals include Ag, As, Ba, Cd, Cr, Hg, Pb, and Se. Secondary Drinking Water Metals include Cu, Fe, Mn, Na, Zn.

completion, excavated materials were sequentially backfilled into the test pit and compacted with the backhoe bucket. The backhoe bucket was 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 were consistent with procedures for soil and water sampling specified in the QAPP. Test pit logs are presented in Appendix A.

3.1.8 Sampling QA/QC Requirements

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

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 on Tables 5-4 and 5-5 of the RI/FS Work Plan, January 1991.

3.1.9 Data Analysis

The raw data have been reduced to produce data tables, groundwater level maps, and isoconcentration maps for soil and groundwater chemical data. Data are presented on a site-specific basis in Section 4 of this report. Data analysis methods are described in the section in which each analysis is presented.

3.2 FIELD INVESTIGATION BY SITE

The following subsections discuss the implementation of the RI at each of the 11 sites. A brief discussion of the Phase II findings is presented for each site. Phase II analytical results are summarized in Appendix C.

3.2.1 Site 2 Scope of Work

3.2.1.1 Introduction

Site 2 has been and is currently being used to demilitarize ordnance. Common explosives in the ordnance demilitarized at this site include ammonium picrate, TNT, RDX, black powder, and nitroglycerin. The 1986 Phase II investigation tested for the presence of these explosives in surface soils, and for nitrate/nitrite (possible residue after detonation). No contamination from these explosives was detected at the sampling locations (see Figure 3-2). Tables 5-6 and 5-7 in Appendix C summarize the chemical analyses of samples collected during the Phase II study.

The locations of four new monitor wells, surface and subsurface soil samples and sediment samples for Site 2 are presented in Figure 3-2.

3.2.1.2 Monitor Well Installation and Sampling — Site 2

During the Phase III RI, two additional monitor wells were installed at the site perimeter to confirm that no contaminants are migrating off-site. One additional monitor well was located within the detonation area to directly monitor the potential source area.

The three new monitor wells (MW02-05 to MW02-07) were installed to depths ranging from 19 to 20 feet. Each well has a 15-foot screen length.

In round one, all seven existing and new monitor wells at Site 2 were sampled for analysis of TCL organics, TAL inorganics, and explosive compounds. Groundwater pH and specific conductance were determined in the field.

3.2.1.3 Subsurface Soil Sampling — Site 2

Five subsurface soil samples were taken at a depth interval of 1 to 2 feet in loose sandy soils (Figure 3-2). Samples were analyzed for TAL inorganics, cyanide, and explosives.

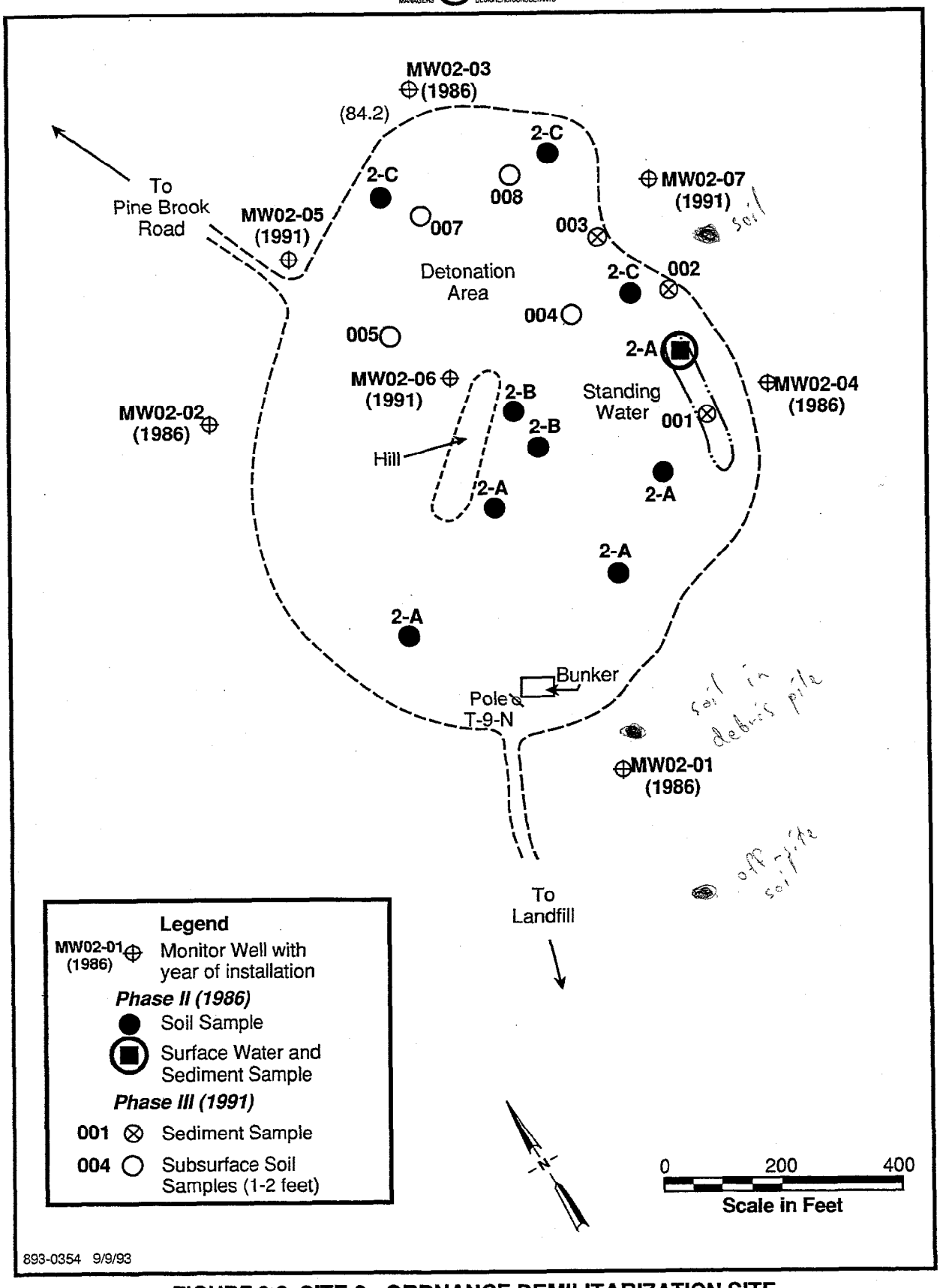

FIGURE 3-2 SITE 2 - ORDNANCE DEMILITARIZATION SITE MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.1.4 Sediment Sampling — Site 2

Three sediment samples were obtained in the drainage depression on the eastern side of the site (see Figure 3-2) and analyzed for TAL inorganics, cyanide, and explosives.

3.2.2 Site 3 Scope of Work

3.2.2.1 Introduction

Site 3 is a 5-acre landfill that was used from 1960 through 1968 and is currently closed. Materials disposed of at the site include municipal-type solid waste and waste from station industrial operations. The site was investigated during the Phase II SI study (1986) by installing and sampling three groundwater monitor wells. The groundwater samples taken exhibited a relatively low pH. No contaminants were detected above regulated limits.

The locations of the new monitor wells and test pits undertaken during the RI are presented in Figure 3-3.

3.2.2.2 Test Pit Investigation — Site 3

Seven test pits were completed at the site to obtain a physical description of the waste materials and surrounding soils. A total of two samples of "soils" in contact with the waste were taken from two of the test pits and analyzed for TCL organics and TAL inorganics. No water was observed in the pits.

3.2.2.3 Monitor Well Installation and Sampling — Site 3

Four additional monitor wells were installed during the RI, three hydraulically downgradient from the landfill and the fourth upgradient. Well depth was defined by an underlying silt/clay layer, pervasive throughout the site, ranging from 14.6 to 19.8 feet deep.

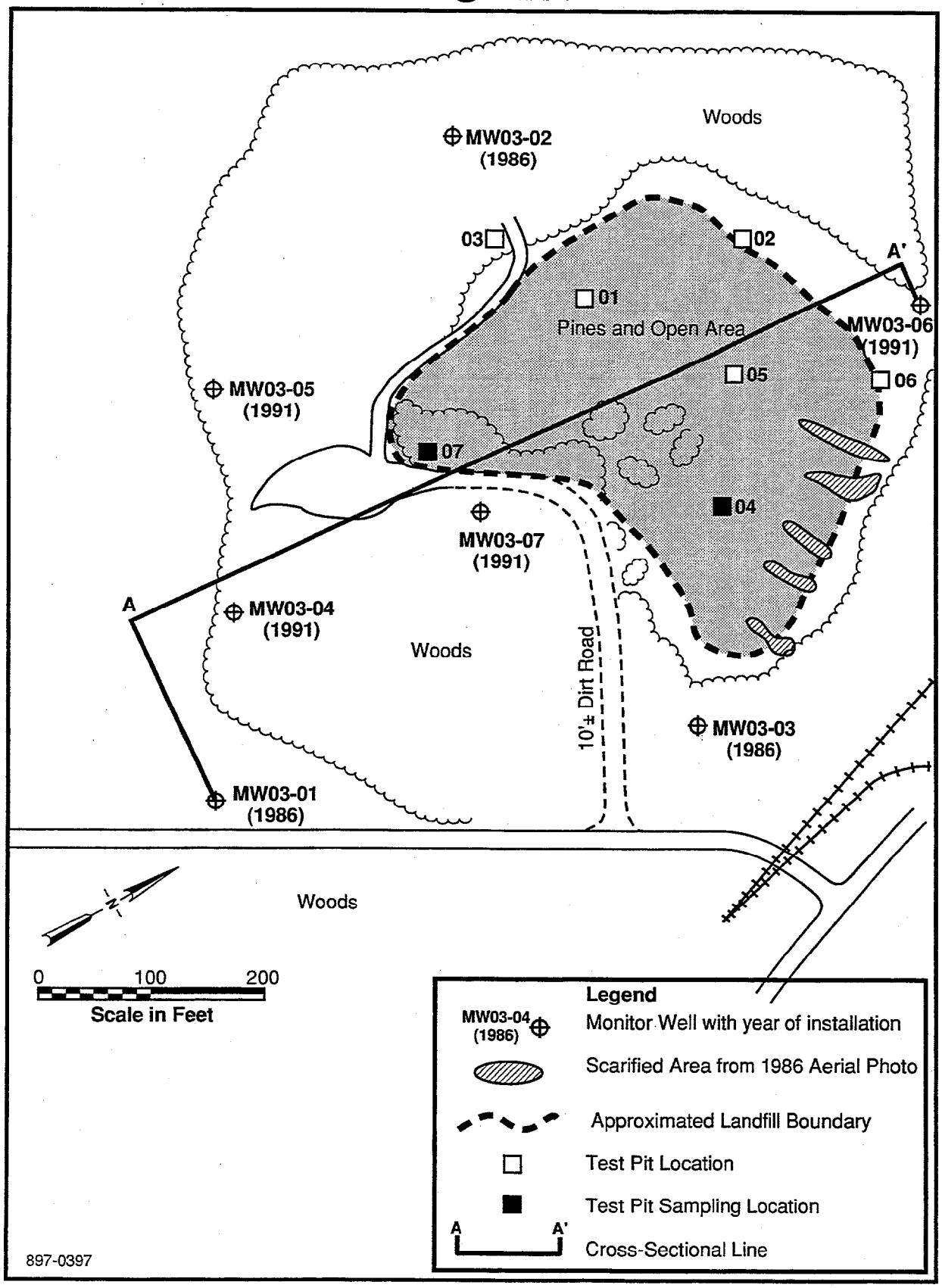

FIGURE 3-3 SITE 3 - LANDFILL SOUTHWEST OF "F" GROUP MONITOR WELL LOCATIONS, NWS EARLE, NJ

The placement of these wells was intended to identify contaminants migrating from the landfill area via groundwater and determine if any were entering the landfill from off-site areas.

In March 1991, all new and existing wells at Site 3 were sampled initially for full TCL/TAL analysis. Subsequently, samples for more limited analyses (VOCs, drinking water metals, and inorganic landfill indicator parameter) were taken in October and November 1991. A very dry summer and fall 1991 resulted in a significant lowering of groundwater levels. During the time of the second and third sampling rounds, three wells at Site 3 were dry and were not sampled (MW03-02, MW03-03, and MW03-04).

3.2.3 Site 4 Scope of Work

3.2.3.1 Introduction

Site 4 is a 5-acre landfill that was used from 1943 to 1960. Materials disposed of at this site include municipal-type solid waste and waste from station industrial operations. A small stream originates from springs adjacent to the site (see Figure 3-4). The site investigated during the Phase II SI study included the installation and sampling of three monitor wells and the collection and analysis of surface water samples. Table 5-9 in Appendix C summarizes the chemical analyses performed during the Phase II SI. 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. Water from a spring at this site indicated the presence of an amine tentatively identified as N-nitrosodiphenylamine.

The Phase III RI for Site 4 included the installation of three new monitor wells, surface water and sediment sampling, and test pit excavation. Current and past sampling locations are presented in Figure 3-4.

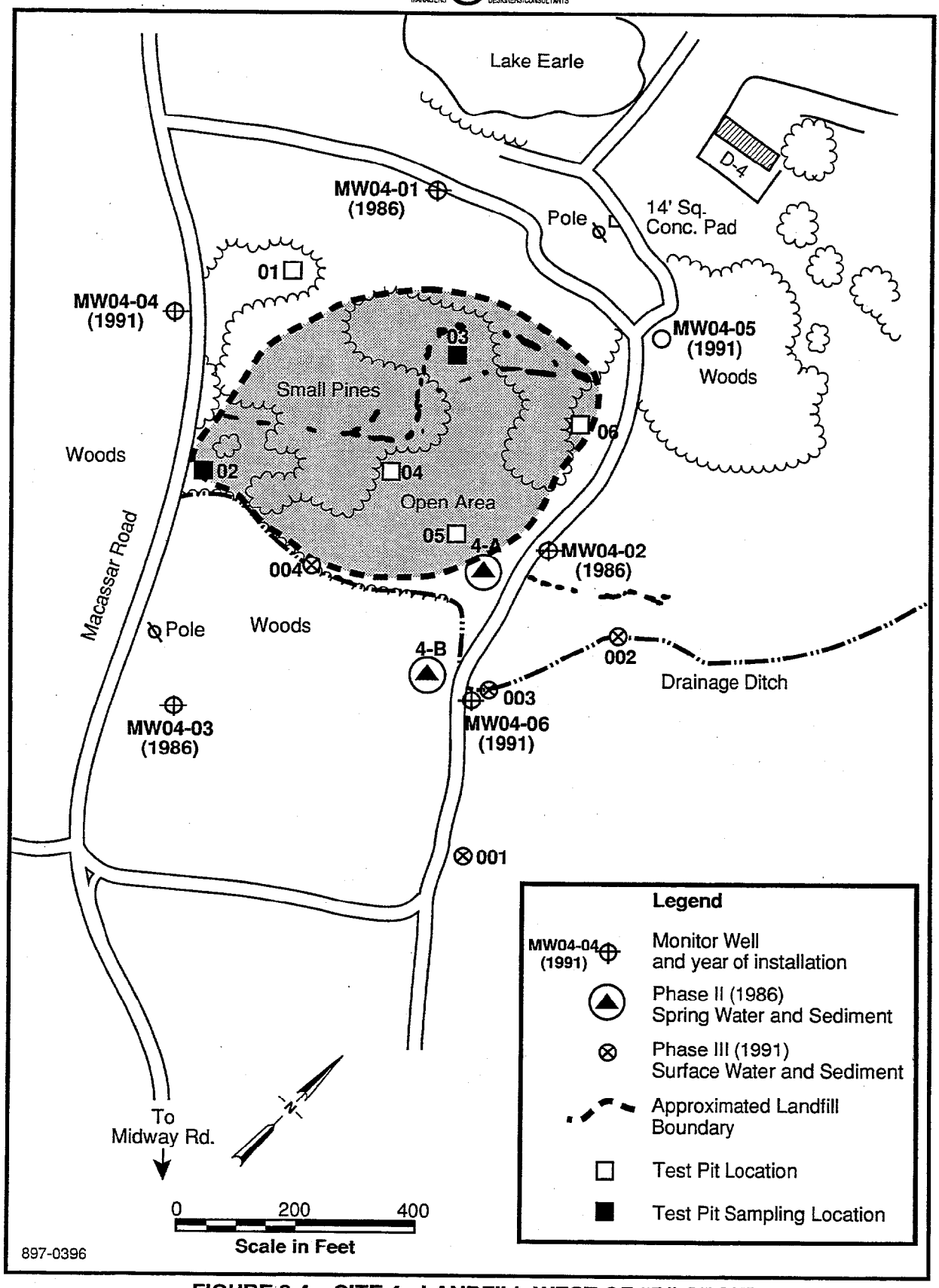

FIGURE 3-4 SITE 4 - LANDFILL WEST OF "D" GROUP MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.3.2 Test Pit Investigation — Site 4

In January 1991, six test pits were completed at the site to obtain a physical description of the waste materials and surrounding soils (Figure 3-4). Two soil samples were taken for TCL organics and TAL inorganics analyses. Test pit logs are presented in Appendix A.

3.2.3.3 Monitor Well Installation and Sampling — Site 4

Three additional groundwater monitor wells were installed at Site 4, ranging in depth from 13 to 35 feet. Monitor well MW04-06 was the shallowest and used only 10 feet of screen because of shallow water table conditions (Figure 3-4). A fourth well originally proposed was not installed because of shallow water table conditions and access problems. A rearrangement of the three new well locations was performed with EPA and NJDEPE concurrence.

A groundwater sample was collected from each new and existing monitor well. The first round of samples was analyzed for full TCL organics and TAL inorganics. The second and third rounds included VOCs, drinking water metals, and landfill indicator parameters.

3.2.3.4 Surface Water and Sediment Sampling — Site 4

Surface water samples were taken at three spring locations and the swale along the eastern edge of the site (Figure 3-4). Surface water samples were analyzed for TCL organics. Sediment samples were analyzed for full TCL organics and TAL inorganics.

3.2.4 Site 5 Scope of Work

3.2.4.1 Introduction

Site 5 is a former landfill that was used from 1968 to 1978. The materials disposed of at this site include municipal-type solid waste and waste from station industrial operations. The site was investigated during the Phase II SI study by installing and sampling four monitor wells. Site 5

is located southwest of Site 2, hydraulically upgradient from Site 2. Railroad tracks border Site 5 on the southeast side. These wells were shown to contain pentachlorophenol in the Phase II sampling results. The railroad track ties were identified as a possible source. Well MW05-08 was located upgradient of the railroad tracks to establish background.

Locations for monitor wells and sampling locations for the Phase II SI (1986) and Phase III RI (1991) investigations are presented in Figure 3-5.

3.2.4.2 Test Pit Investigation — Site 5

In January 1991, four test pits were completed at the site to obtain a physical description of the waste materials and surrounding soils. Two soil samples were taken for full TCL organics and TAL inorganics analyses.

3.2.4.3 Monitor Well Installation and Sampling — Site 5

Four additional monitor wells were installed at Site 5. The monitor wells ranged from 14 to 33 feet deep and were screened across the groundwater table. The screen length was 15 feet for each of the new monitor wells.

In March 1991, groundwater samples were collected from each new and existing on-site monitor well and analyzed for TCL organics, TAL metals, and cyanide. Analytes in subsequent October and November 1991 samplings were VOCs, drinking water metals, and landfill indicator parameters.

3.2.5 Site 7 Scope of Work

3.2.5.1 Introduction

Site 7 is a former landfill that was used from 1965 to 1977. The materials disposed of at this site include municipal-type solid waste and waste from waterfront industrial operations. The site

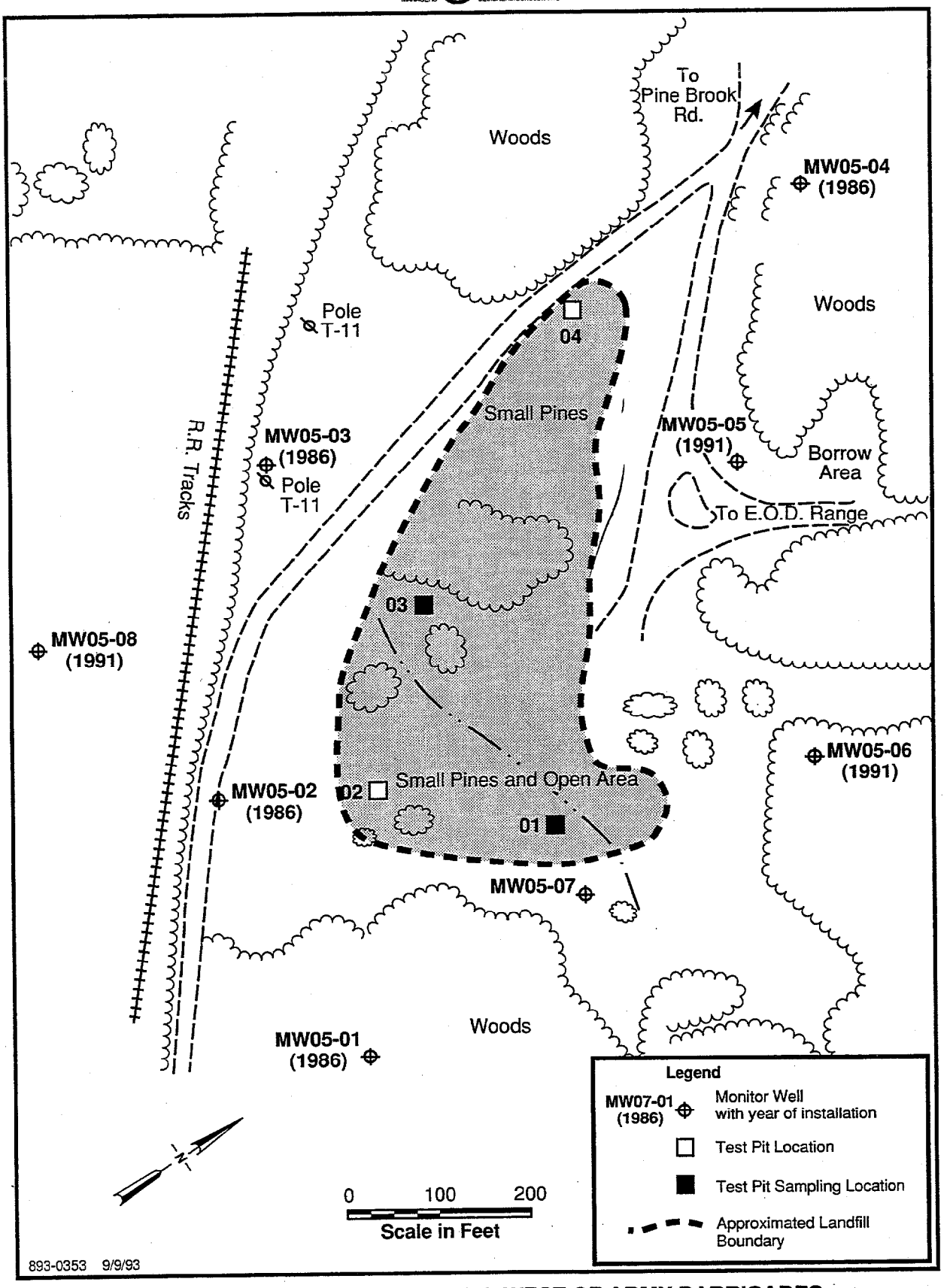

FIGURE 3-5 SITE 5 - LANDFILL WEST OF ARMY BARRICADES MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

was investigated during the Phase II SI study by installing and sampling three monitor wells. Groundwater flow is to the southwest. During the Phase III RI, two additional monitor wells were completed, both downgradient on the landfill perimeter.

Locations of test pits as well as new and existing monitor wells are presented in Figure 3-6.

3.2.5.2 Monitor Well Installation and Sampling — Site 7

The two new monitor wells, MW07-04 and MW07-05, were completed to depths of 23.5 and 20 feet, respectively.

In March 1991, groundwater samples were collected from each of the three existing and two new monitor wells and analyzed for TCL organics and TAL metals. All wells were sampled during each of the three sampling events; samples for select analysis were obtained in October and November.

All new and existing wells were sampled during each of the three sampling rounds. During round one, the sampling parameters included TCL organics, TAL inorganics (including cyanide), and pesticides/PCBs. Analyses in both rounds two and three included VOCs, drinking water metals, and landfill indicator parameters.

3.2.5.3 Test Pit Investigation — Site 7

In January 1991, a series of four to six test pits were completed at the site to obtain a physical description of the waste materials and surrounding soils. Two soil samples were taken for TCL organics and TAL inorganics analyses.

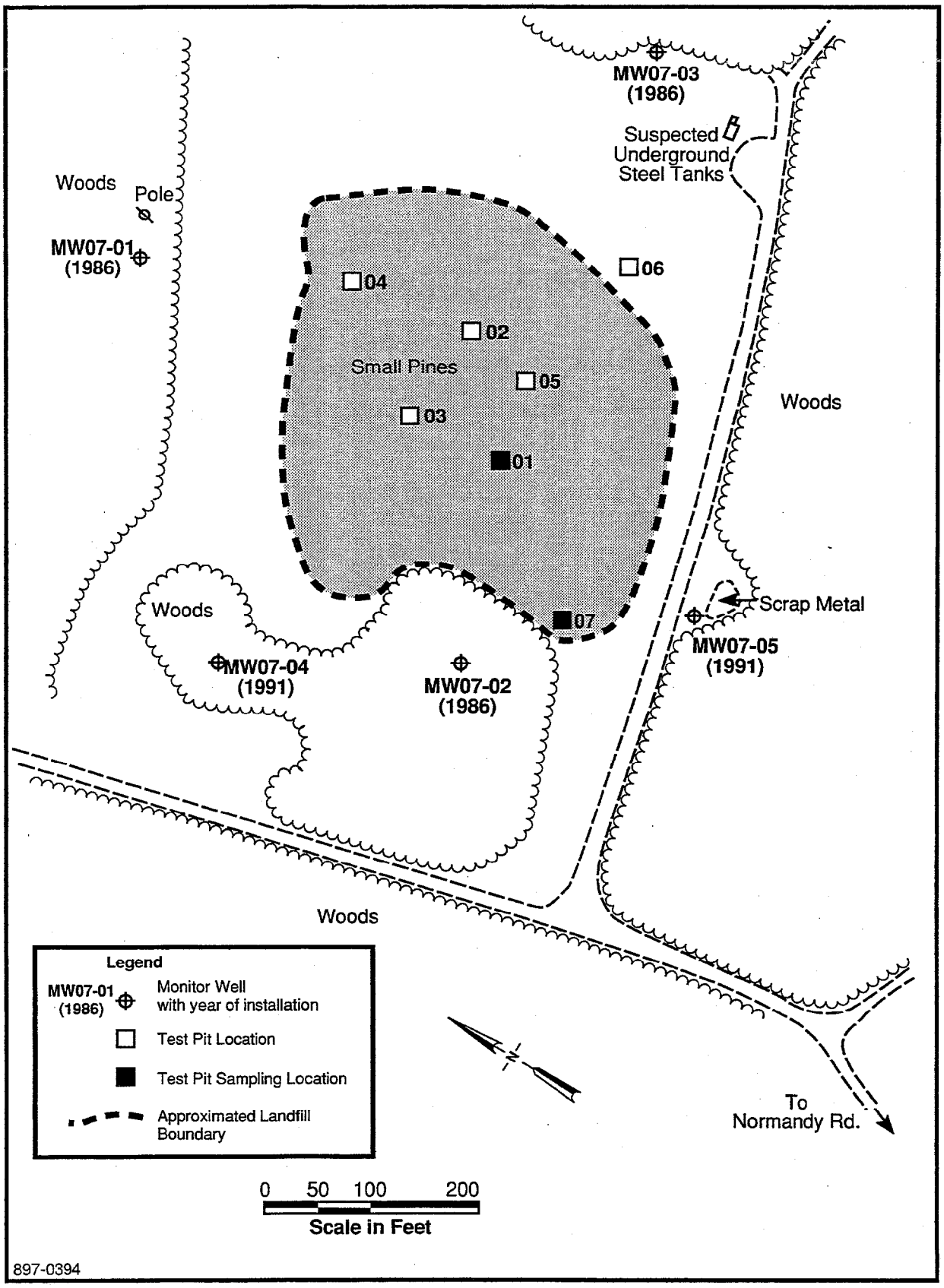

FIGURE 3-6 SITE 7 - LANDFILL SOUTH OF "P" BARRICADES MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.6 Site 10 Scope of Work

3.2.6.1 Introduction

Site 10 is a 2-acre scrap metal landfill that was used from 1953 to 1965 for the disposal of demilitarized munitions and spent munitions casings. The Phase II SI included 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, Appendix C) indicate that methylene chloride was present at 16, 9 J, and 9 J for wells MW10-01, MW10-02, and MW10-03, respectively. An amine (tentatively identified as N-nitrosodiphenylamine) was present in surface water, but not groundwater. Mercury was detected in one stream sample (0.3 mg/L), but was unconfirmed 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 (first hour). The same sampling point was below the limit 6 hours later (see Appendix C, Table 5-14).

Locations of previously existing and new monitor wells, test pits, surface water samples, and sediment samples are presented in Figure 3-7.

3.2.6.2 Monitor Wells — Site 10

Four new monitor wells were completed on-site. Three monitor wells (MW10-05, MW10-06, and MW10-07) were placed hydraulically downgradient of the site. The fourth monitor well (MW10-04) was placed upgradient. Because of the lower ground surface elevation and elevated water table adjacent to the stream, monitor well MW10-06 uses a modified well construction. This construction allows a shallower screen depth to screen across the water table while limiting the potential effects of frost heave. All four new wells used 15 feet of screen length.

In March 1991, groundwater samples were collected from four of the new and three existing monitor wells and analyzed for full TCL organics and TAL inorganics. In October and November 1991 (rounds two and three, respectively), the sampling parameter list was modified. Subsequent analytes were VOCs, drinking water metals, and landfill indicator parameters.

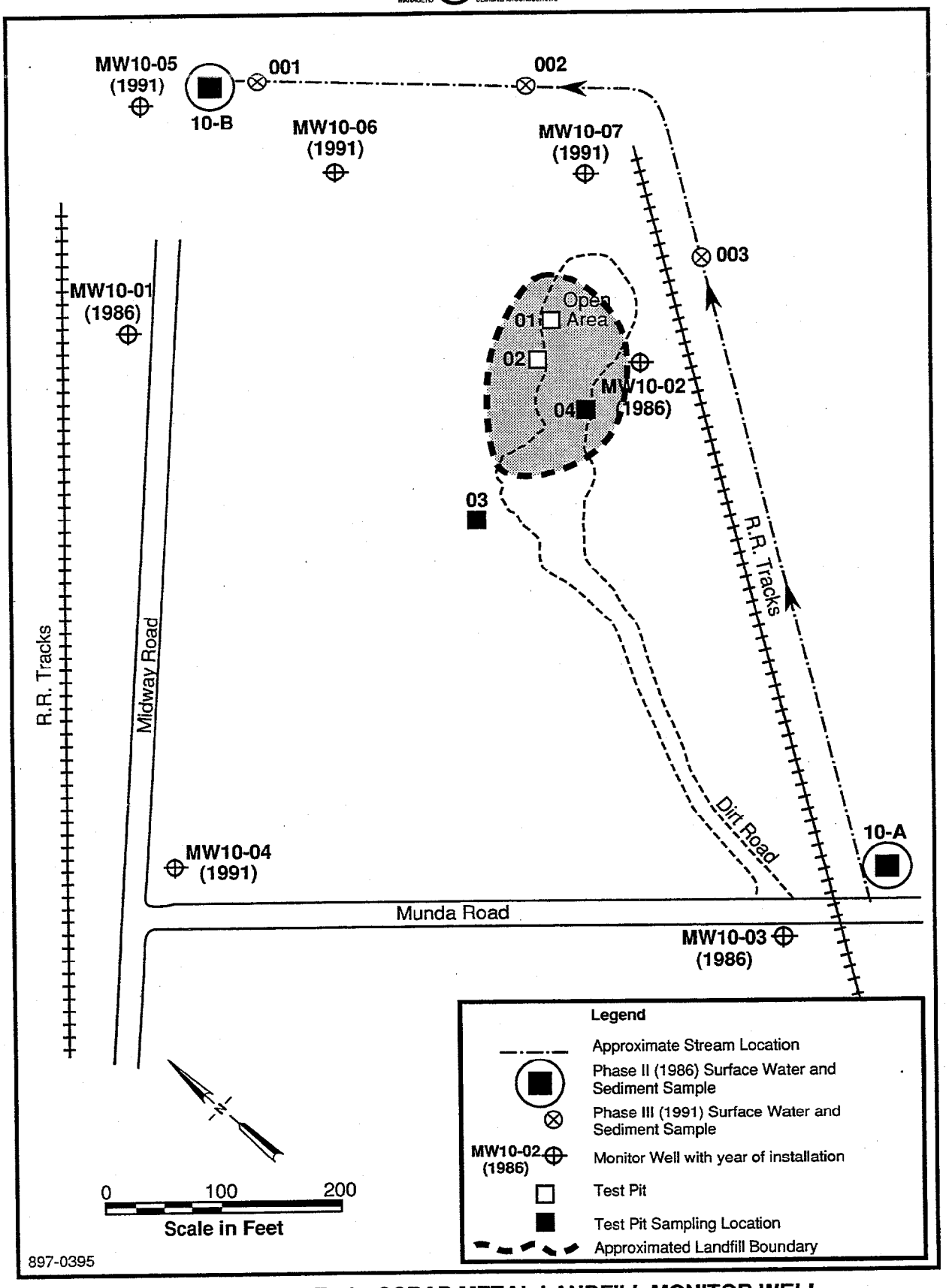

FIGURE 3-7 SITE 10 - SCRAP METAL LANDFILL MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.6.3 Test Pit Investigation — Site 10

Consistent with the requirements summarized in Subsection 5.2.5.7 of the Work Plan, January 1991, a series of four test pits was completed at the site to obtain a physical description of the waste materials and surrounding soils. Two soil samples were taken for full TCL organics and TAL inorganics analyses.

3.2.6.4 Surface Water and Sediment Samples — Site 10

Surface water and sediment samples were taken at three locations in the stream to the northeast of the site. The first two were downstream of the site and the third was collected upstream of the site where the stream is physically separated from site runoff by the railroad grade. Sediment analytes were TCL organics and TAL inorganics. Surface water samples were analyzed for TPH and VOCs.

3.2.7 Site 11 Scope of Work

3.2.7.1 Introduction

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 fire-fighting training exercises.

Site 11 was investigated through four soil borings and the installation and sampling of three monitor wells during the Phase II SI study. Sample analyses summarized in Table 5-15, Appendix C, indicate that one soil boring sample had oil and grease (O&G) levels of 37,300 mg/kg. Pentachlorophenol was detected at 120 µg/L in monitor well MW11-01.

While the Phase III RI work was in progress, the NWS Earle wildlife biologist noted the presence of a grasslike plant, Beak-rush (*Rhynchospora Knieskernii*). Beak-rush was identified in 1989 in a study conducted in 1989 by the Fish and Wildlife Commission and is listed as a

Federal Threatened Species. The presence of Beak-rush will be discussed further in the Baseline Risk Assessment.

Locations of new and existing monitor wells and surface soil samples are presented in Figure 3-8.

3.2.7.2 Subsurface Soil Sampling — Site 11

Eight hand auger borings to a depth of 1.5 feet were completed around the Phase II sampling area at locations shown in Figure 3-8. Soil samples from 0.5- to 1.5-foot intervals were analyzed for explosive compounds, total petroleum hydrocarbons (TPH), and nitrate/nitrite.

3.2.7.3 Monitor Well Installation and Sampling — Site 11

During the Phase III RI two additional downgradient groundwater monitor wells were constructed on-site. Well locations are shown in Figure 3-8, north of existing well MW11-03. Well completion was limited to approximate depths of 15 feet with 10 feet of screen because of running sands encountered during drilling.

Representative groundwater samples were collected during three sampling events from the two new and existing monitor wells. The wells were purged and sampled according to the protocols set forth in the RI/FS Work Plan, January 1991, and the QAPP, June 1990. Analytes during the first groundwater sampling round (March 1991) are TCL organics, TAL inorganics (including cyanide) and explosives. The analyte sample list was changed in rounds two and three to VOCs and drinking water metals. During round three, monitor well MW11-05 was also sampled for explosives.

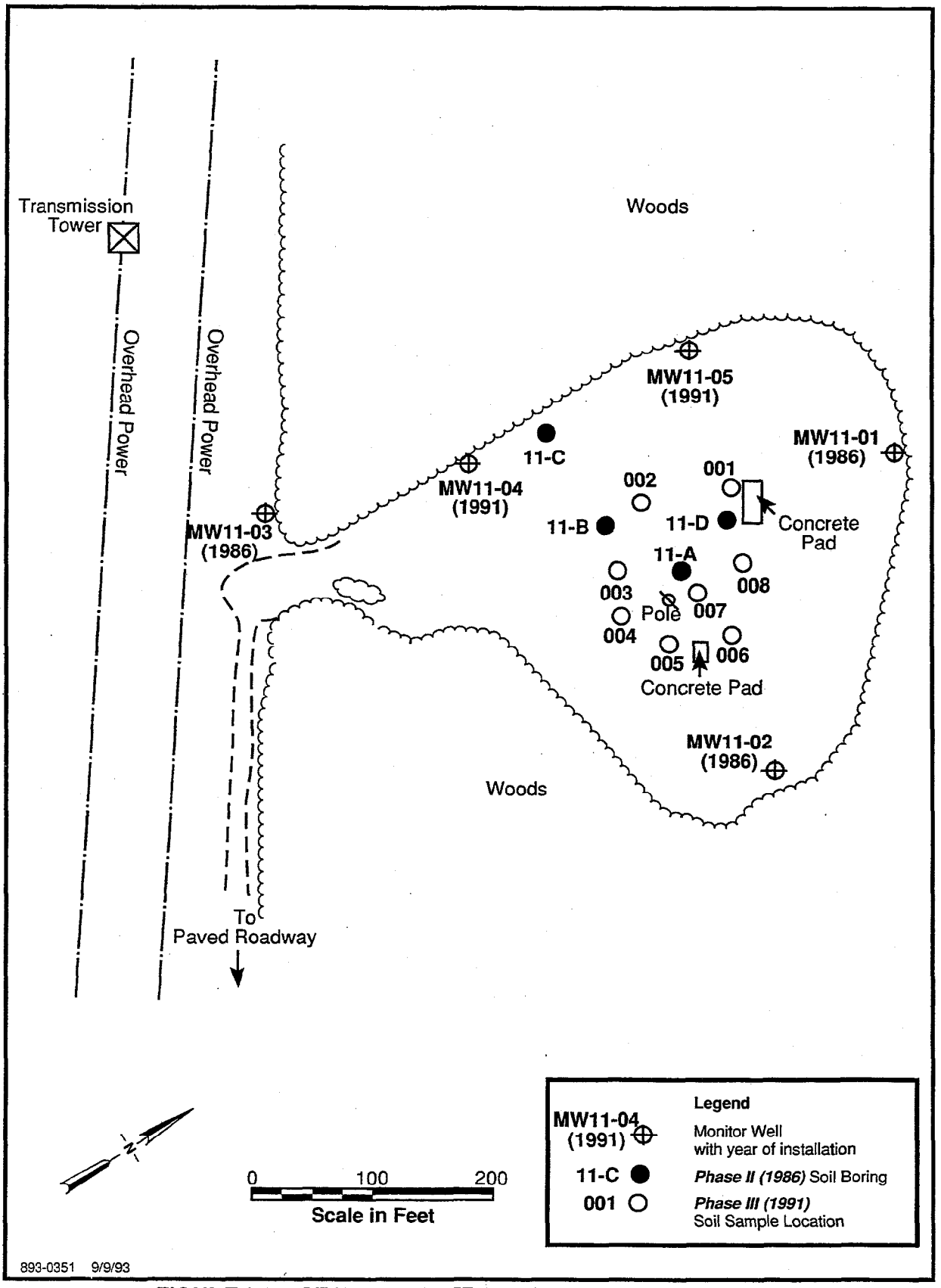

FIGURE 3-8 SITE 11 - CONTRACT ORDNANCE DISPOSAL AREA MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.8 Site 19 Scope of Work

3.2.8.1 Introduction

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 initially investigated through the installation and sampling of soil borings and monitor wells during the SI. Analyses were performed on the soil, surface water, sediment, and groundwater samples collected at the site. 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 Environmental Responsibility and Cleanup Act (ECRA) soil standards of 1,000 mg/kg for lead and 350 mg/kg for zinc.

The Phase II study also determined groundwater flow directions for the site. The upgradient monitor well (19-1) contains 0.007 mg/L of cadmium (below the drinking water maximum contaminant level (MCL) of 0.010 mg/L).

One additional monitor well was located at the terminus of the drainage swale. This well was sampled to determine whether any contamination of the uppermost aquifer has occurred. A second monitor well was constructed downgradient of the area of highest soil contamination. This well, MW19-06, was located on the site side of the stream shown in Figure 3-9. A third well was located on the northeast perimeter of the site. New and existing monitor well locations as well as other sampling locations are presented in Figure 3-9.

3.2.8.2 Soil Sampling — Site 19

Twenty-four subsurface soil samples were collected from the upper 0 to 2 feet of soil using a hand auger in the area surrounding Building S-34 and along the drainageway. As shown, four soil samples were analyzed for TAL inorganics; the remaining 20 soil samples were analyzed

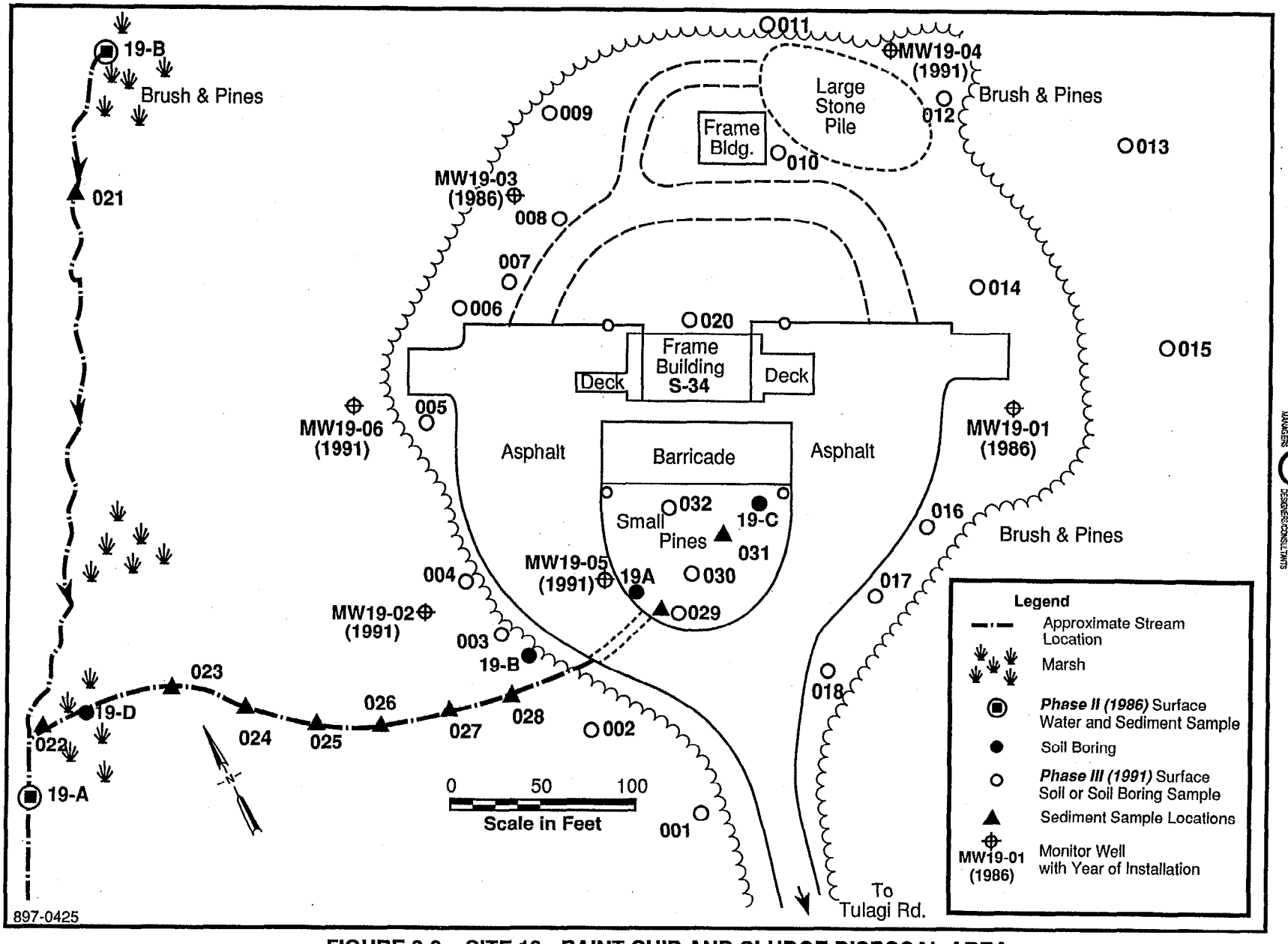

FIGURE 3-9 SITE 19 - PAINT CHIP AND SLUDGE DISPOSAL AREA MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

for cadmium and lead. Four hand auger borings were collected in the drainageway exiting the site and analyzed for VOCs and TPH.

3.2.8.3 Sediment Sampling — Site 19

Sediment samples were collected at 13 locations in the drainageway leading from the site and stream adjacent to the site and analyzed for full and selected TAL inorganics.

3.2.8.4 Monitor Well Installation and Sampling — Site 19

Three groundwater monitor wells were installed hydraulically downgradient of Site 19 and downslope of the solvent/paint sludge discharge pipe. These monitor wells were screened across the groundwater table.

During the first sampling round groundwater samples were collected from monitor wells and analyzed for TCL organics and TAL inorganics. In rounds 2 and 3, the sampling analytes were VOCs and drinking water metals. Monitor wells MW19-02 and MW19-06 were also sampled for explosives in round 3.

3.2.9 Site 20 Scope of Work

3.2.9.1 Introduction

Site 20 is an ordnance maintenance area where waste sand blasting media were disposed of. The field investigation conducted during the Phase II SI study obtained soil samples from the site at locations that appeared to have the highest potential for containing paint chip contaminants. The waste material (grit) is staged in an open pile on the site (see Figure 3-10) and surface drainage has washed some material toward a marsh area northeast of the site. The analyses of the Phase II samples are shown in Appendix C, Table 5-21.

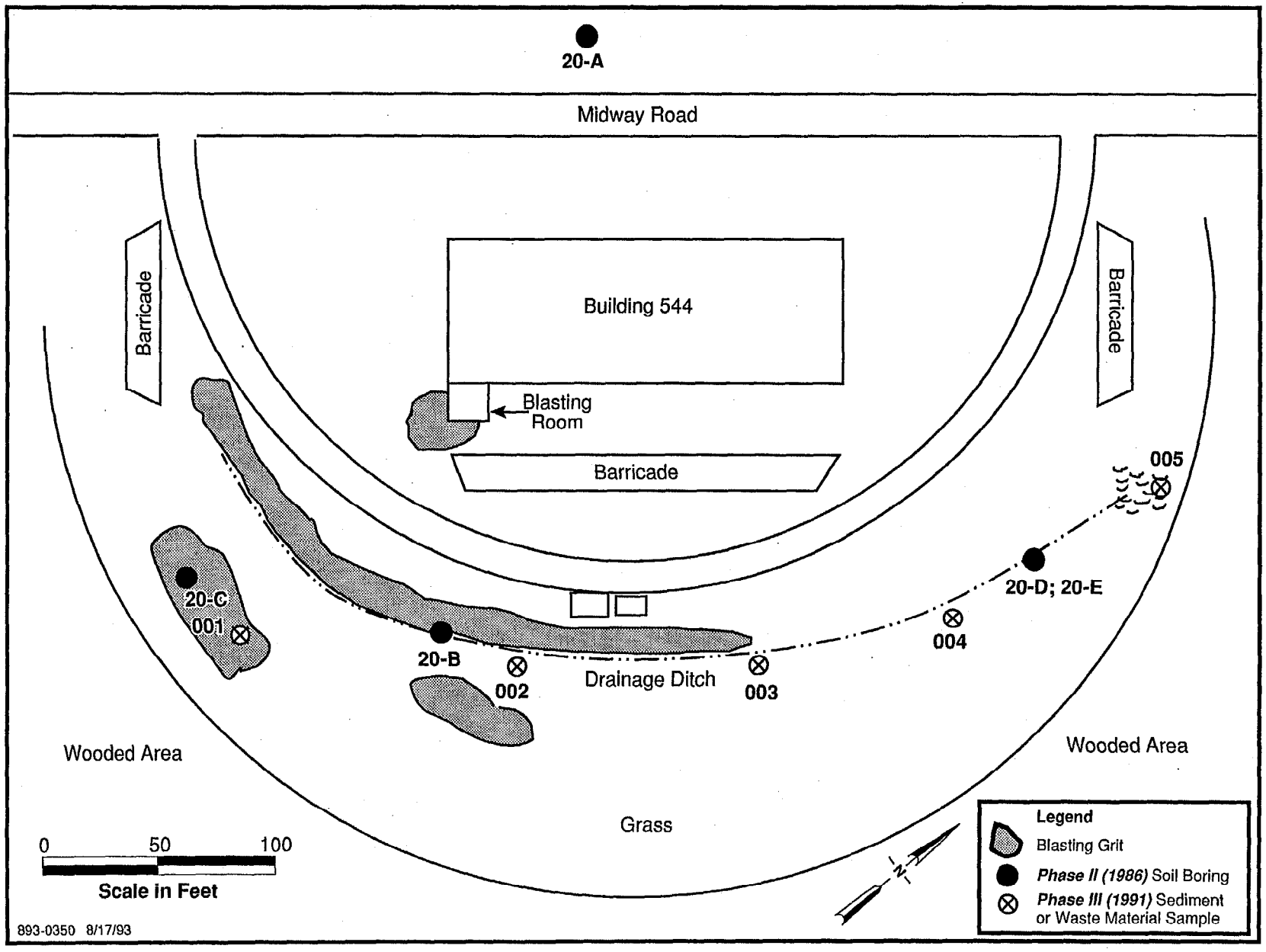

FIGURE 3-10 SITE 20 - GRIT BLASTING AREA AT BUILDING 544 SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.9.2 Sediment and Soil Sampling — Site 20

Five sediment samples were taken, one in the waste material and four in the drainage ditch. One subsurface sample was taken in the drainage ditch at the farthest downgradient point at a depth of approximately 2 feet. All five sediment samples were analyzed for TAL inorganics. Two of these, 20-003 and 20-005, were also analyzed for pesticides/PCBs and BNAs. The single subsurface soil sample was analyzed for VOCs.

3.2.10 Site 22 Scope of Work

3.2.10.1 Introduction

Site 22 is an ordnance maintenance area where waste sand blasting material was disposed of. The field investigation conducted during the SI 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 NJDEPE ECRA soil guidelines was detected.

3.2.10.2 Soil Sampling — Site 22

Six soil samples were collected at three locations identified as "stained or discolored areas" shown in Figure 3-11. Of the six samples, three "shallow" soil (0 to 1 foot deep) samples were analyzed for TAL inorganics (with cyanide), BNAs, and pesticides/PCBs. The three "deep" samples (approximately 2 feet) were analyzed for VOCs.

3.2.10.3 Sediment Sampling — Site 22

Sediment samples were collected at six locations in the drainage swale shown in Figure 3-10. Samples were analyzed for TAL inorganics, TPH, BNAs, and pesticides/PCBs.

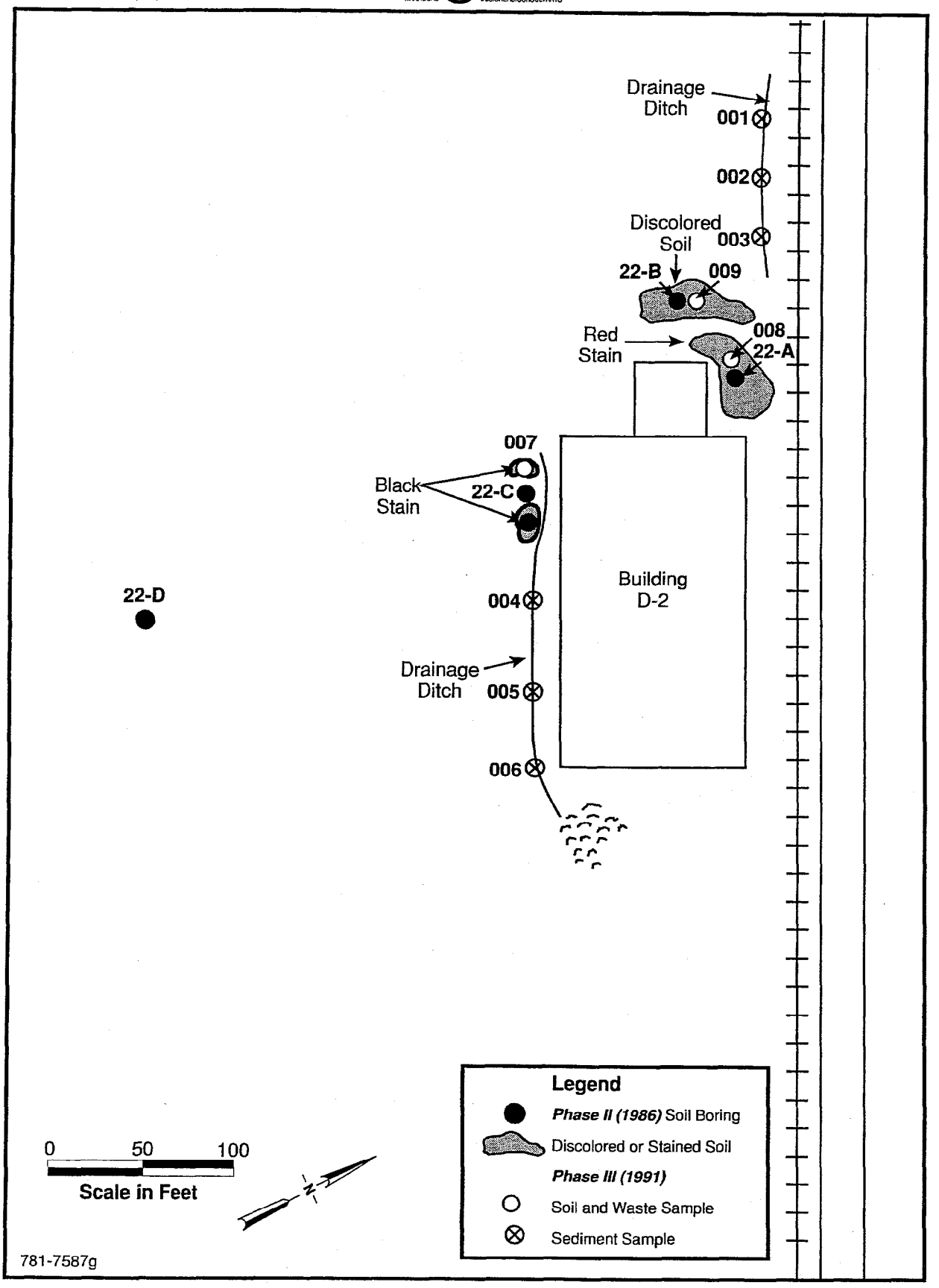

FIGURE 3-11 SITE 22 - PAINT CHIP DISPOSAL AREA SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.11 Site 26 Scope of Work

3.2.11.1 Introduction

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. During the Phase II study, Site 26 was investigated through the installation of three monitor wells. Groundwater samples from these wells were analyzed for picric acid and pH. These were considered the most likely byproducts 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 NWS Earle area.

One new monitor well was constructed in an area hydraulically downgradient from the settling pit at the end of the open tile ditch. The new well (MW26-04) has a total depth of 15 feet with 10 feet of screen. New and existing monitor well locations as well as the sampling locations are presented in Figure 3-12.

3.2.11.2 Monitor Well Installation and Sampling — Site 26

The groundwater flow gradient is flat, as currently determined. One monitor well was installed which, based on current flow direction, was located downgradient of the settling basin at the end of the tile drainage ditch shown in Figure 3-12.

Groundwater samples were collected from existing and new wells in three separate sampling rounds according to protocols described in the RI/FS Work Plan, January 1991, and the QAPP, June 1990. In March 1991, analyses were performed for TCL organics and TAL inorganics, explosive compounds, and pesticides/PCBs. In subsequent sampling in October and November 1991, the analytes were VOCs, drinking water metals, and explosives.

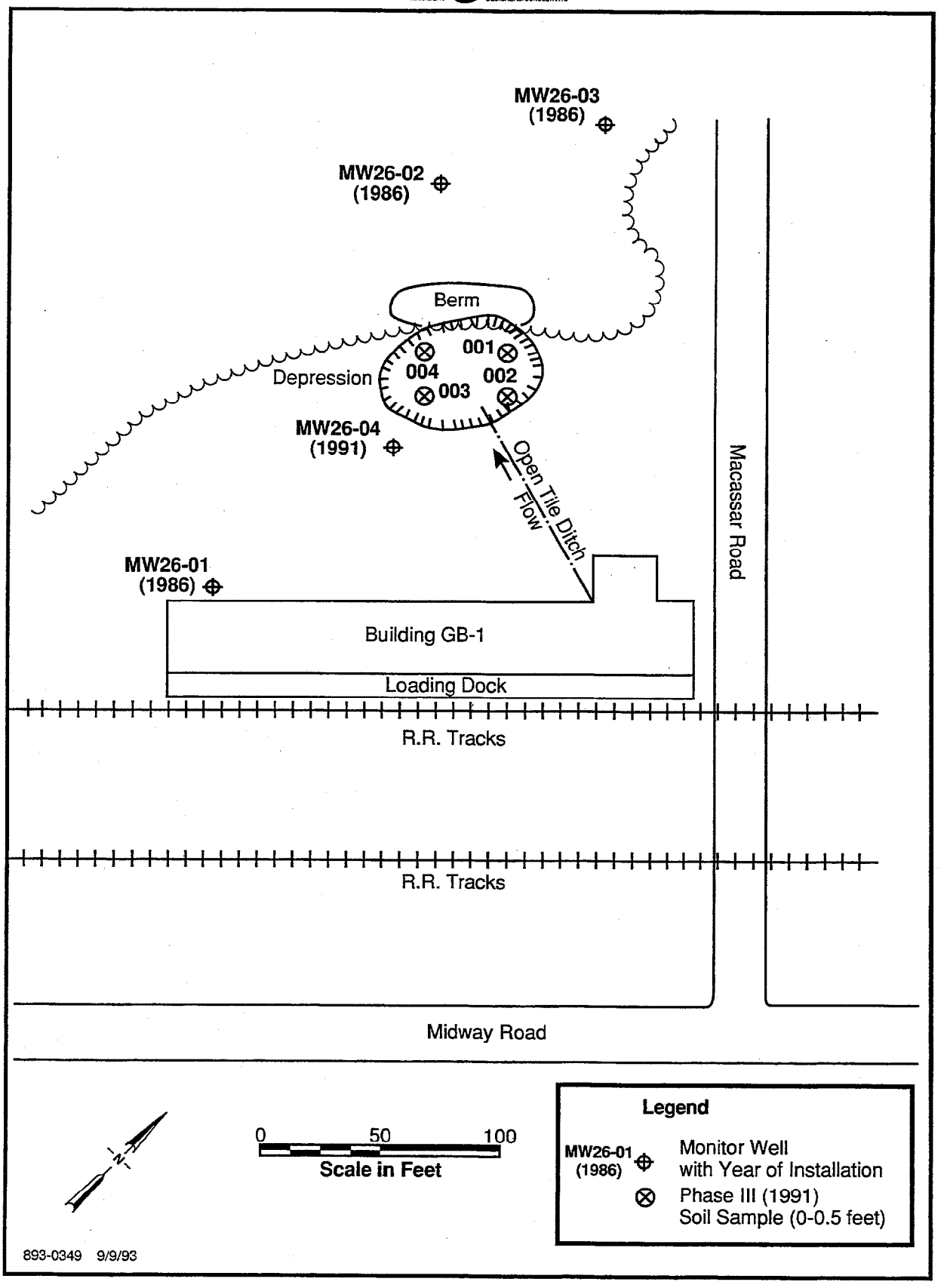

FIGURE 3-12 SITE 26 - EXPLOSIVE "D" WASHOUT AREA MONITOR WELL AND SAMPLING LOCATIONS, NWS EARLE, NJ

3.2.11.3 Soil Sampling — Site 26

Four subsurface soil sampling locations were located within the settling basin. From these, four soil samples were collected, using a hand auger, at depths of 0 to 0.5 feet. The soil samples were analyzed for explosive compounds and nitrate/nitrite. Four sediment samples were analyzed for TAL inorganics.

3.2.11.4 Sediment Sampling — Site 26

Sediment samples were collected from four points in the depression. The sediment samples were analyzed for TAL inorganics.

SECTION 4
RESULTS OF THE FIELD INVESTIGATION

This section describes the results of the field investigation, including the presence of contaminants, the medium affected, and potential and observed pathways of contaminant migration. Each site is presented separately with the physical data first, followed by the chemical data. Data tables summarize "hits" for each medium and site. For comparison of the data, the groundwater results are compared to the tables on EPA Maximum Concentration Limits for Drinking Water (MCLs), and the NJDEPE cleanup standards for Class II-A groundwater (N.J.R. 3 February, 1992, 389). Surface soil results are compared to NJDEPE direct contact action levels for industrial and residential soils. Subsurface soils are compared to NJDEPE impact to groundwater criteria (revised 8 March 1993). No reference standards are available for sediments, because ecological risk factors may be involved. The NJDEPE soil contact criteria are based on human health risk only. It is recognized that these are not the only applicable standards. ARARs are discussed in Section 7. Groundwater sample results include three rounds of sampling and analysis: the first round was comprehensive (complete TCL/TAL scans for each well); the second and third rounds were for selected parameters. Comprehensive laboratory data packages and validation reports have been submitted to EPA separately. These reports are voluminous and cannot be included in this report.

Each site subsection in Section 4 is concluded with a characterization of the site as understood through current and past information. General site descriptions and histories have been presented in Section 1. A discussion of the investigation conducted at each site has been presented in Section 3. Well construction information, groundwater elevations, and the results of the slug test analysis have also been tabulated in Section 3. The significance of the results is discussed in Section 5.

The presence of acetone in water and soil samples and respective QC blanks in the RI was a concern. It appeared to be an artifact and at least in part caused by the use of acetone in the decontamination of field equipment. In order to avoid future problems, a different decontamination procedure, not using acetone, was used for the SI that followed this RI. The

presence of even high concentrations of acetone did not affect detection and quantification of other compounds because all samples were initially run undiluted and the acetone peak is distinct (see Appendix C).

The Round 1 results of groundwater analysis for inorganic constituents are presented on the tables in milligrams per liter (mg/L) to accurately present the data as reported by the laboratory. For consistency and to facilitate comparison with the other analysis results, these results are discussed in the text using micrograms per liter (µg/L).

4.1 SITE 2: ORDNANCE DEMILITARIZATION SITE (ODS)

4.1.1 Physical Characteristics

Site 2 is approximately 11 acres in size and appears as a shallow, wide open, nonvegetated, oval-shaped sand pit with a high berm and is bordered by woodlands. Two undeveloped dirt roads access the site, one from the south past Site 5, and one from the west from the direction of Piney Brook. The topography at the site slopes gently toward the north from approximately 125 feet above MSL at the bunker to approximately 90 feet MSL in the open detonation area. An elongated sand berm approximately 200 feet long and 15 feet high, oriented northeast to southwest, is situated in the center of the site.

Standing water and a few remnants of demilitarized or spent ordnance casings were observed during the field investigation (in January 1991) in several depressions located at the base of the berm in the northeastern portion of the site. A few large empty ordnance casings were also noted outside of the southeastern berm. With the exception of these few ordnance casings, the site appears to be generally free of debris and well maintained.

4.1.1.1 Soils and Sediments

The original soils within site proper (part of the Lakehurst Sands Series [LeB] Section 2) have been altered or excavated in the past, consequently exposing the upper sand unit of the

Vincentown Formation. Based on the samples obtained during the drilling and sampling, the shallow "soils" at Site 2 are generally characterized as sand, fine- to coarse-grained, quartz, some silt, olive green to olive brown (5y4/3 to 2.5y4/4 munsel color classification).

4.1.1.2 Drainage

Precipitation at the site collects, by way of overland flow, in the depressions in the northeastern portion of the site. Drainage at the site occurs through infiltration and evaporation. Infiltration is the main source of recharge to the shallow aquifer at the site and is a controlling factor of groundwater flow. This interrelationship is discussed in the following subsection.

The surface water body nearest to Site 2 is a small tributary of Piney Brook which is located approximately one-half mile northeast (downgradient) of Site 2.

4.1.1.3 Hydrogeology

The following lithologic description of the geologic materials at Site 2 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These descriptions are contained in the boring logs presented in Appendix A. The sediments underlying Site 2 consist of a relatively homogeneous matrix of very fine to coarse quartz sand with some glauconite and silt, and vary in color from olive to very dark gray. These characteristics are consistent with the sediments which compose the lower member of the Vincentown Formation. Site 2 is situated within the outcrop and recharge area of the Vincentown Formation.

Generally groundwater levels range between 5 and 15 feet bgs across Site 2. Figure 4-1 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the north mimicking topography with an average gradient of .005 feet/foot. This pattern is similar to that observed during other measurement rounds. MW02-02 is hydraulically crossgradient of the site while MW02-03 is the farthest downgradient. The groundwater flow velocity, V, in the shallow aquifer is related to the hydraulic gradient, i, and

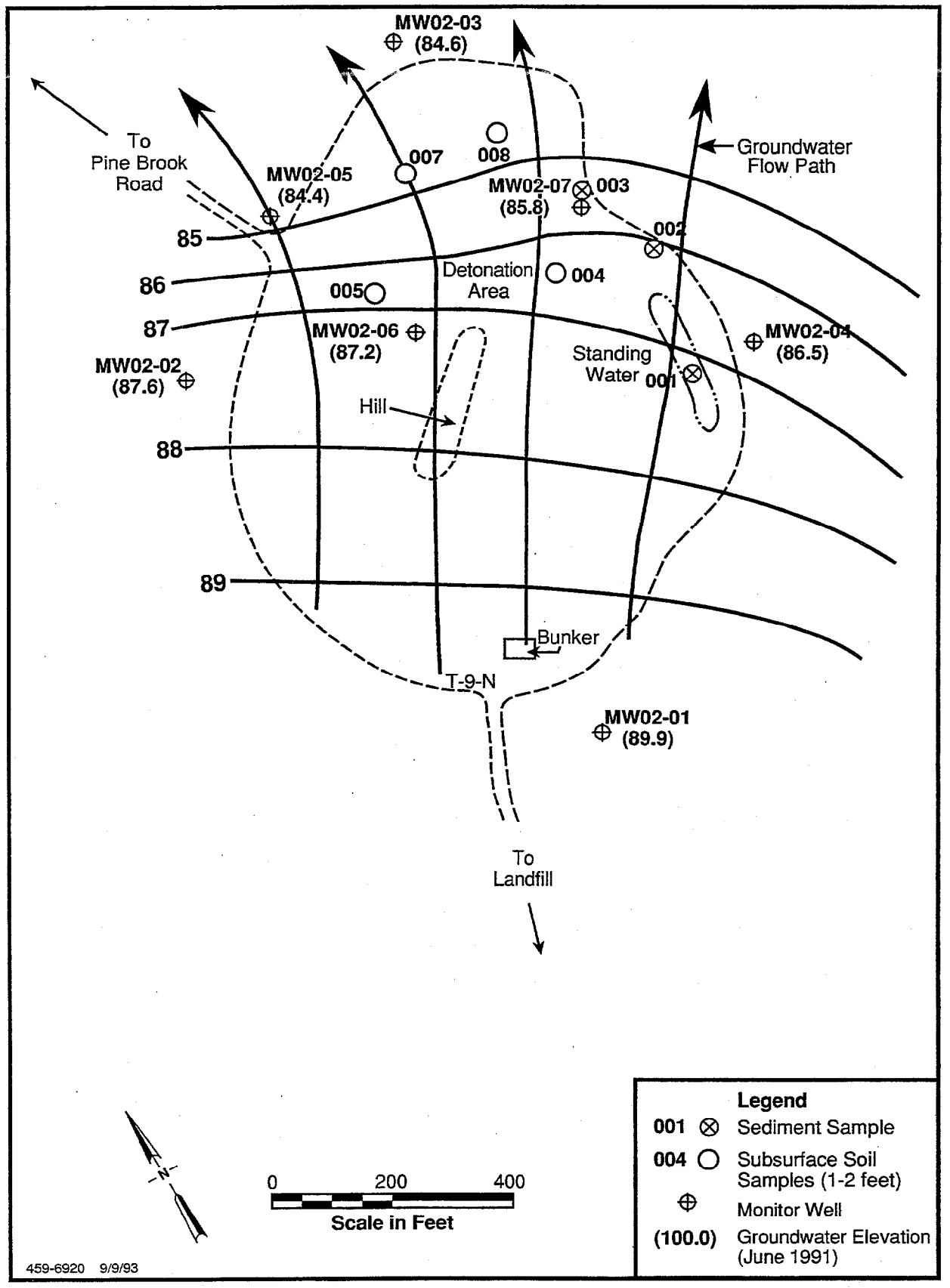

FIGURE 4-1 SITE 2 - ORDNANCE DEMILITARIZATION SITE GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

the hydraulic conductivity, K, of the sediments and can be calculated using the following expression of Darcy's Law:

$$V = Ki/n$$

Where n is the effective porosity of the sediments.

Porosity varies over a narrow range in sandy sediments and can be estimated at 0.3 without introducing a significant error. The hydraulic conductivities at Site 2 were determined from the aquifer slug tests conducted at several monitoring wells (see Appendix A). Based on the hydraulic conductivity calculated from the slug test data, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) ranges from approximately .002 feet/day (MW02-06) to 0.3 ft/day (MW02-01) or 1 to 110 feet/year.

4.1.2 Chemical Results

4.1.2.1 Analysis of Soils and Sediments

The results of the soil sample analysis are presented on Table 4-1. Explosive compounds were not detected in any of the soil samples. Nineteen metals were detected in some or all of the samples. Each of these elements occurs to some extent in natural soils; therefore, they are only considered present as introduced "contaminants" if they occur above normal soil "background" levels. Arsenic, occurring in concentrations of 3-7.8 mg/kg, exceeds current NJDEPE cleanup guidelines of 2 mg/kg but is below former guidelines of 20 mg/kg based on natural background (NJDEPE Soil Cleanup Criteria, revised 8 March 1993). One cadmium sample at 1.2 mg/kg was just above the NJDEPE residential cleanup level of 1 mg/kg. No other metals exceeded current criteria. There is no cleanup criteria for chromium which occurred at concentrations ranging from 71 to 286 mg/kg.

Precise background soil composition and chemistry can vary considerably from location to location, and specific background samples were not taken for Site 2. However, from the pattern and distribution of metals in the samples most appear to be in a normal "background" range when compared to available data. Table 4-2 presents concentrations of the metals for crustal rocks and sediments (Mason, 1966), soils of the east coast of the United States (Shacklette and Boerngen

Table 4-1

Summary of Soil and Sediment Sample Analytical Results

NWS Earle, Site 2 (ODS)

Site I.D.[a] / Compounds	02-001-D001 Sediment Sample 2-001	02-002-D001 Sediment Sample 2-002	02-003-D001 Sediment Sample 2-003	02-004-S001 Soil Sample 2-004	02-004-S201 Soil Sample 02-004 (Eq. Blank)	02-004-S201 Replicate	02-005-S001 Soil Sample 2-005	02-006-S001 Soil Sample 2-006	02-006-S001 Replicate	02-006-S101 Soil Sample 2-006 (Dup.)	02-007-S001 Soil Sample 2-007	02-008-S001 Soil Sample 2-008	02-008-S001 Replicate	NJDEPE Guidelines [b] (mg/kg)
Inorganics (mg/kg)														
Aluminum	10300	7640	9650	3860	0.021	NR	3030	3650	NR	3710	8490	4970	4807	–
Arsenic	6.3	7.5	4.7	1.7	U .0018	NR	3.0	3.8	NR	4.6	7.5	6.1	6.8	2/2 [c]
Barium	7.5	10.1	5.3	1.3	U .0040	NR	2.0	1.3	NR	1.4	2.0	1.5	1.3	700/47000
Beryllium	1.2	1.0	1.1	0.43	U .0005	NR	0.28	0.41	NR	0.44	1.1	0.66	0.60	1/1
Calcium	44.5	14.5	7.6	15.0	0.17	NR	4.2	12.0	NR	9.9	15.4	4.9	4.6	–
Cadmium	1.2	U .89	U .79	U .76	U .0034	NR	U .79	U .73	NR	U .79	U .79	U .80	U .79	1/100
Cobalt	1.4	1.1	1.1	U .76	U .0034	NR	U .79	U .73	NR	U .79	1.4	U .80	U .79	–
Chromium	286	227	208	92.0	U .0063	NR	71.1	93.5	NR	81.9	265	183	184	
Copper	12.6	17.6	4.1	3.4	0.021	NR	2.8	1.6	NR	1.6	4.2	1.1	1.6	600/600
Cyanide	U .56	U .52	U .62	U .40	NR	NR	.57	U .58	NR	U .55	U .54	U .57	NR	1100/21000
Iron	41300	30000	32700	13800	0.068	NR	12800	12400	NR	12900	33900	19000	18030	–
Potassium	6560	4650	6130	2040	U .142	NR	1400	2110	NR	2240	6480	2630	2398	–
Nitrate	1.3	1.2	1.7	3.1	0.34	0.34	2.9	1.4	NR	2.9	1.7	1.0	1.0	–
Magnesium	2150	1490	2160	686	U .0516	NR	502	727	NR	788	2060	847	771	–
Manganese	10.6	6.8	8.3	6.5	0.0011	NR	3.9	3.8	NR	3.5	6.1	4.6	4.5	–
Sodium	36.3	10.3	11.2	32.2	0.19	NR	5.0	50.4	NR	21.6	17.7	8.4	7.2	–
Lead	27.0	19.3	7.2	7.5	U .0016	NR	10.8	4.0	NR	3.8	5.5	4.7	5.4	100/600
Selenium	U .33	U .33	U .33	U .31	U .0013	NR	U .031	U 0.50	NR	0.34	0.65	U 0.3	U .31	63/3100
Vanadium	210	187	149	81.6	U .0026	NR	66.6	61.4	NR	61.5	168	117	118	370/7100
Zinc	26.6	21.1	21.3	10.2	0.0053	NR	6.2	12.4	NR	7.4	21.1	9.5	8.8	1500/1500
% Solids (%)	66.2	68.6	71.8	84.4	NR	NR	81.5	85.6	85.1	86.2	86.0	88.0	NR	–
Explosives µg/g	U 5	U 5	U 5	U 5	U 5	U 5	U 5	U 5	U 5	U 5	U 5	U 5	U 5	–

Legend: U = Not detected
NR = Not required
(a) = Refer to June 90 QAAP

(b) = Soil cleanup criteria (revised 3/8/93)
(c) = Residential/nonresidential soils
Replicate = Lab QA sample

Table 4-2

Naturally Occurring Concentrations of Elements in Rock and Soil

Metal	Average Concentration in the Earth's Crust (ppm)[a]	Ranges of Metals Concentrations in Natural Soils in North America[b]	Range of Select Metals in Natural Soils in NJ (NJDEPE, March 1992)[c]
	Concentration Range (ppm) Except Where Noted		
Aluminum (%)	8.13	1-30	-
Arsenic	1.8	1-50	1.35-17.1
Barium	10	100-5,000	-
Beryllium	2.8	0.1-40	0.07-0.76
Cadmium	0.2	0.01-7.0	0.03-0.08
Calcium (%)	3.6	0.01-28	-
Chromium	100	1-1,000	3.2-20.7
Cobalt	25	1-40	-
Copper	55	2-200	1.95-7.27
Iron	50,000	14,000-42,000	-
Lead	13	2-200	ND-44.3
Manganese	950	2-4,000	11-120
Mercury	0.08	0.02-0.30	ND-0.17
Nickel	75	5-500	0.8-8.3
Potassium (%)	2	0.005-3.7	-
Selenium	.05	0.1-2.0	ND
Silver	.07	0.1-5.0	0.1-0.26
Vanadium	135	20-500	1.3-23.6
Zinc	70	10-300	9.6-44.6

[a]Mason (1966)
[b]Shacklette and Boerngen (1984)
[c]NJDEPE (1992) Ranges presented are based on four samples in Monmouth County and one sample in Ocean County nearby. (Appendix II, sample numbers 19, 20, 35, 36, and 63)
ND - Not detected

1984) and soils of New Jersey (NJDEPE, 1992). These concentrations are presented as a range of values on Table 4-2. Therefore, it is concluded that most of the metals concentrations observed in the soil samples at Site 2 represent ambient soil concentrations. Chromium and possibly cadmium may be above the normally expected range. However, since chrome is an oxidizing agent in detonators and may be present in some ordnance materials burned at Site 2, the impact from site activities can not be ruled out without first establishing background concentrations.

4.1.2.2 Analysis of Groundwater

The groundwater quality results for the three sampling rounds are presented on Tables 4-3a, 4-3b, and 4-3c. Table 4-3a presents the first sampling round which was the most comprehensive including the full EPA TCL/TAL scans plus explosive compounds. Only one semivolatile compound was found (bis{2-ethylhexyl}phthalate at a concentration of 1J µg/L, below quantifiable detection limits in six samples). No pesticides or PCBs were detected in the groundwater samples. Subsequently, the round two and three sampling included VOCs, drinking water metals, and explosive compounds. Three volatile compounds, methylene chloride, acetone, and chloroform, were detected in almost all samples, including the upgradient well MW02-01, in all three rounds of sampling. The first two compounds were also detected in the blanks and are common solvents in the laboratory and field decontamination, respectively. Chloroform was found at concentrations near the detection limit of 5 µg/L, and was also detected in some of the blanks.

The first round of TAL inorganic analysis was followed by analysis limited to the drinking water metals[1] in the second and third sampling round. Iron was typically high in all of the wells, 2,200 µg/L in upgradient well MW02-01) and is typical for area groundwater. Zinc was also detected in the range of 20-85 µg/L, 17-50 µg/L in MW02-01. Chromium was elevated (above the MCL of 100 µg/L) in wells MW02-04, MW02-05, MW02-06, and MW02-07 for most sampling rounds. The highest detection was 2,700 µg/L in MW02-07 in the third round. Lead

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[1] Drinking Water Metals include the Primary Metals Ag, As, Ba, Cd, Cr, Hg, Pb, and Se, and Secondary Metals Cu, Fe, Mn, Na, Zn.

Table 4-3a
Summary of Groundwater Sample Analytical Results
Round One: March, 1991
NWS Earle, Site 2 (ODS)

Site I.D. (a) / Compounds	02-001-M001 MW02-01	02-001-M001 Replicate	02-002-M001 MW02-02	02-003-M001 MW02-03	02-003-M101 MW02-03 (Dup.)	02-003-M201 MW02-03 (Eq. Blank)	02-003-M301 MW02-03 (trip Blank)	02-004-M001 MW02-04	02-005-M001 MW02-05	02-006-M001 MW02-06	02-007-M001 MW02-07	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Semivolatiles (µg/l)													
bis(2-Ethylhexyl)phthalate	1 J	NR	1 J	1 J	1 J	U 12	NR	U 24	1 J	10 U	1 J	–	–
Volatile Organics (µg/l)													
Methylene Chloride	28 B	NR	58 B	54 B	54 B	55 B	4 JB	4 JB	3 JB	2 JB	3 JB	–	–
Acetone	18 B	NR	11 B	20 B	14 B	23 B	92 B	7 JB	210 B	11 B	9 JB	–	–
Chloroform	8.0	NR	4 J	U 5	U 5	6.0	5.0	4 J	2 J	U 5	U 5	–	–
Inorganics (mg/L)													
Nitrate	0.14	0.15	0.14	0.17	0.22	0.40	NR	0.24	0.44	0.16	1.9	10	–
Nitrite	U .10	U .10	U .10	U .10	U .10	U .10	NR	U .10	U .10	U .10	U .10	1	–
Aluminum	0.41	NR	3.0	U .178	5.9	0.051	NR	0.31	45.4	11.4	13.4	0.2	–
Barium	0.019	NR	0.055	U .004	0.018	U .004	NR	0.012	0.11	0.072	0.035	2	2
Beryllium	U .0006	NR	U .0006	U .0005	0.00060	U .0005	NR	U .0005	0.0083	0.0014	0.0025	0.004	0.02
Calcium	0.60	NR	1.5	0.038	0.87	0.11	NR	0.33	10.6	33.2	5.2	–	–
Cadmium	U .0034	NR	U .0034	U .0034	U .0034	U .0034	NR	U .0034	U .0034	U .0034	0.0045	0.005	0.004
Cobalt	U .0034	NR	U .0034	U .0034	U .0034	U .0034	NR	U .0034	0.0098	0.0050	U .0034	–	–
Chromium	0.0081	NR	0.036	U .0063	0.068	U .0063	NR	0.012	1.5	0.33	0.33	0.1	0.1
Copper	U .003	NR	U .003	U .0029	U .0029	U .0029	NR	.0029	0.022	0.026	0.026	1.3	–
Cyanide	U .010	NR	U .010	U .010	U .010	U .010	NR	U .010	U .010	U .010	U .010	0.2	0.2
Iron	0.59	NR	5.3	0.0088	9.6	0.026	NR	1.3	202	42.0	51.3	–	–
Mercury	U .0002	NR	U .0002	U .0002	U .0002	U .0002	NR	U .0002	U .0002	0.00028	U .0002	0.002	0.002
Potassium	1.5	NR	1.8	9.9	9.4	U .142	NR	1.6	34.4	8.9	10.3	–	–
Magnesium	1.5	NR	1.2	U .0516	0.98	0.066	NR	1.0	11.9	5.7	4.1	–	–
Manganese	0.0066	NR	0.058	U .0009	0.020	U .0009	NR	0.0047	0.17	0.18	0.079	–	–
Sodium	4.5	NR	4.2	0.056	4.7	0.30	NR	3.3	2.5	3.3	13.5	–	–
Nickel	U .0036	NR	U .0036	U .0036	U .0036	U .0036	NR	U .0036	U .0036	0.0044	0.051	0.1	0.1
Lead	0.0033	NR	0.0014	0.0068	0.0066	U .0016	NR	0.0020	0.028	0.015	0.021	0.015	0.01
Antimony	U .0075	NR	U .0075	U .0075	U .0075	U .0075	NR	U .0075	0.013	U .0075	U .0075	0.006	0.02
Vanadium	U .0026	NR	0.025	U .0026	0.045	U .0026	NR	0.0040	1.1	0.19	0.28	–	–
Zinc	0.017	NR	0.078	U .0027	0.057	0.0054	NR	0.015	0.19	0.067	0.091	5	5
Explosives													
Picric Acid (µg/L)	U 8.22	NR	U 8.22	U 8.22	U 8.22	U 8.22	NR	U 8.22	U 8.22	2.1	U 8.22	–	–
RDX (µg/L)	U .32	NR	U .32	U .32	U .32	U .32	NR	U .32	U .32	4.12	U .32	–	–
2,4-DNT (µg/L)	U .30	NR	U .30	U .30	U .30	U .30	NR	U .30	U .30	3.2	U .30	–	–
Ncellulose/Nglycerine (mg/L)	U 2.5	NR	U 2.5	U 2.5	2.9	U 2.5	NR	U 2.5	U 2.5	U 2.5	U 2.5	–	–
Pesticide/PCB (µg/L)	U 1.0	U 1.0	U 1.2	U 1.2	U 1.1	U 1.1	U 1.2	U 1.2	U 1.0	U 1.1	U 1.1	0.5	0.0005

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4-3b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 2 (ODS)

Site I.D. (a) / Compounds	02-001-M002 MW02-01	02-001-M002 Replicate	02-001-M202 MW02-01(Eq Blank)	02-001-M302 MW02-01(Trip Blank)	02-002-M002 MW02-02	02-003-M002 MW02-03
Volatile Organics (µg/L)						
Methylene Chloride	17 JB	NR	4 JB	5 B	2 JB	1 JB
Acetone	620 B	NR	100 B	6 JB	18 B	16 B
Chloroform	7 J	NR	U 5	U 5	5	U 5
Benzene	U 25	NR	U 5	U 5	U 5	U 5
Inorganics (µg/L)						
Barium	U 200	U 200	U 200	NR	U 200	U 200
Cadmium	U 5	U 5	U 5	NR	U 5	U 5
Chromium	23.4	26.2	U 10	NR	432	32.7
Copper	U 25	U 25	U 25	NR	U 25	U 25
Iron	2230	2090	U 100	NR	52600	4860
Mercury	U 0.2	U 0.2	U 0.2	NR	U 0.2	U 0.2
Manganese	U 15	U 15	U 15	NR	61.9	30.7
Sodium	U 5000	U 5000	U 5000	NR	U 5000	U 5000
Lead	U 3	U 3	U 3	NR	7	U 3
Zinc	50	U 20	U 20	NR	91.3	52.5
Explosives (µg/L)						
1,3,5-TNB	0.5 P	NR	NR	NR	NR	3.02 G
RDX	U 0.63	NR	NR	NR	NR	U 0.63
2,4-DNT	U 0.78	NR	NR	NR	NR	U 0.78
Nitrate, as N	0.11	NR	U 0.1	NR	NR	0.16

Legend U = Not detected
NR = Not detected
B = Detection limit found in blank
J = Present below detection limit
G = Elevated detection limit due to interference
P = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–3b Cont.....
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 2 (ODS)

Site I.D. (a) / Compounds	02–004–M002 MW02–04	02–005–M002 MW02–05	02–006–M002 MW02–06	02–006–M002 Replicate	02–007–M002 MW02–07
Volatile Organics (µg/L)					
Methylene Chloride	5 B	1 JB	U 5	NR	2 JB
Acetone	11 B	15 B	35 B	NR	40 B
Chloroform	3 J	4 J	U 5	NR	U 5
Benzene	U 5	U 5	4 J	NR	U 5
Inorganics (µg/L)					
Barium	U 200	U 200	U 200	NR	292
Cadmium	U 5	U 5	U 5	NR	5
Chromium	400	108	310	NR	2360
Copper	U 25	U 25	U 25	NR	54.4
Iron	62200	14800	42000	NR	3E+05
Mercury	U 0.2	U 0.2	1.1	NR	0.39
Manganese	45.5	27.8	328	NR	819
Sodium	U 5000	U 5000	U 5000	NR	12500
Lead	6.2	3	6.7	NR	190
Zinc	82.8	29.6	74.2	NR	817
Explosives (µg/L)					
1,3,5–TNB	NR	NR	0.84 G	NR	NR
RDX	NR	NR	5.91	NR	NR
2,4–DNT	NR	NR	1.61	NR	NR
Nitrate, as N	NR	NR	0.43	0.43	NR

Legend U = Not detected
NR = Not detected
B = Detection limit found in blank
J = Present below detection limit
G = Elevated detection limit due to interference
P = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-3c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 2 (ODS)

Site I.D. (a) / Compounds	02-001-M003 MW02-01	02-001-M203 MW02-01(Eq Blank)	02-002-M003 MW02-02	02-002-M003 REPLICATE	02-003-M003 MW02-03	02-003-M003 REPLICATE	02-004-M003 MW02-04	02-004-M203 MW02-04(Eq Blank)	02-005-M003 MW02-05	02-006-M003 MW02-06	02-007-M003 MW02-07	02-007-M303 MW02-07(Trip Blank)
Volatile Organics (µg/L)												
Methylene Chloride	3 JB	4 JB	2 JB	NR	3 JB	NR	U 5	4 JB	1 JB	4 JB	2 JB	4 JB
Acetone	100 B	180 B	820 E	NR	590 E	NR	170 B	330 E	160 B	470 E	290 E	120 B
Chloroform	6	7	6	NR	U 5	NR	3 J	U 5	6	U 5	U 5	U 5
Benzene	U 5	U 5	U 5	NR	U 5	NR	U 5	U 5	U 5	2 J	U 5	U 5
Inorganics (µg/L)												
Barium	U 200	U 200	U 200	U 200	U 200	NR	U 200	U 200	U 200	NR	228	NR
Chromium	15.4	U 10	78.9	89.9	26.6	NR	U 10	U 10	82.6	NR	2370	NR
Copper	U 25	U 25	U 25	U 25	U 25	NR	U 25	U 25	U 25	NR	62.6	NR
Iron	3260	U 100	9770	11600	3670	NR	350	U 100	11100	NR	273000	NR
Mercury	U 0.2	U 0.2	U 0.2	NR	U 0.2	NR	U 0.2	U 0.2	U 0.2	NR	0.3	NR
Manganese	U 15	U 15	41.2	40.8	17.4	NR	U 15	U 15	22.8	NR	496	NR
Sodium	U 5000	U 5000	U 5000	U 5000	U 5000	NR	U 5000	U 5000	U 5000	NR	14900	NR
Lead	3.3	U 3	U 3	U 3	U 3	NR	5.9	U 3	U 3	NR	130	NR
Zinc	21.4	U 20	85	74.9	44.5	NR	41.6	24.9	49.5	NR	657	NR
Explosives (µg/L)												
HMX	U 1.3	U 1.3	NR	NR	U 1.3	NR	NR	NR	NR	0.81 J	NR	NR
RDX	U 0.63	U 0.63	NR	NR	U 0.63	NR	NR	NR	NR	4.21	NR	NR
1,3,5-TNB	U 0.56	U 0.56	NR	NR	U 0.56	NR	NR	NR	NR	0.54 J	NR	NR
TETRYL	U 0.66	U 0.66	NR	NR	U 0.66	NR	NR	NR	NR	1.15	NR	NR
2,4-DNT	U 0.6	U 0.6	NR	NR	U 0.6	NR	NR	NR	NR	1.59	NR	NR
Nitrate, as N	U 0.1	U 0.1	NR	NR	0.35	0.36	NR	NR	NR	13.3	NR	NR

Legend U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Detection beyond calibration range but no dilution analysis due to suspected field contamination

REPLICATE = Lab QA sample
(a) = Refer to June 90 QAPP

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

was also detected slightly above the MCL of 15 µg/L in MW02-05, MW02-06, and MW02-07. The subsequent sampling rounds did not confirm the earlier lead results in MW02-05 or MW02-06. In one case, MW02-07 showed relatively high lead levels in the second and third rounds of sampling (130-190 µg/L), compared to the first round. Beryllium was also above MCLs of 1 µg/L in the first round in several wells. Antimony was found in MW02-05 at 13 µg/L, over the MCL of 6 µg/L. It should be noted that the detection limit for antimony was 7.5 µg/L. The NJDEPE action level for antimony is 20 µg/L.

Explosive-related compounds were detected at very low levels in wells MW02-03 (nitrocellulose at 2.9 mg/L) and MW02-06 (<10 µg/L total picric acid, RDX and 2,4, DNT) and in no other well in the first round. The two wells were resampled for explosives analysis during the second and third rounds with similar results for MW02-06. Only nitrates were found in MW02-03. MW02-06 is within the detonation area, while MW02-03 is downgradient of the site.

4.1.3 Summary of the Site 2 Characterization

Site 2 has been and is currently used as an explosives detonation area on an occasional basis. No open burning or dumping of raw material occurs. This is consistent with the soils analysis, which showed no explosive compounds present. Very low concentrations of explosive compounds were found in one well in the detonation area and one directly downgradient. However, the occurrence and migration of explosive compounds in groundwater and soils overall at Site 2 appears minimal. Explosives compounds were not found in second and third round samples from MW02-03.

Based on available data, the levels of metals in soil and sediment samples appear to be within normal background levels except for chromium and, in one sample, cadmium. The occurrence of certain metals in groundwater samples showed some anomalies. Part of this may be explained by the fact that samples were not filtered prior to preservation and the samples were not totally free of turbidity. Iron concentrations were high and varied considerably between wells and sampling events. There is no health risk-based standard for iron, but levels above 1 mg/L would require pretreatment before use for taste and aesthetic reasons. High iron content is a common

naturally occurring condition in area groundwater, and the variation observed in Site 2 wells is probably within normal background levels. No other contaminants were observed which could have resulted in additional mobilization of iron from soils.

Chromium, which was also found in the soils, was found in several downgradient wells above 100 µg/L, which is the current MCL. Lead, which was not found in the soil and sediment samples, was also detected in MW02-07 at levels above the 15 µg/L MCL for lead, and at lesser concentrations above MCLs in MW02-05 and 06 wells. Chrome is an oxidizing agent in detonators. The association of lead with site activities is unknown, and chrome appears to be widely distributed in the soils at the site. These metals typically are attenuated in soils and are not highly mobile in groundwater. Their presence in unfiltered samples from the shallow groundwater does not imply significant mobility. Beryllium was found in MW02-05, MW02-06, and MW02-07 at concentrations of 1.4-8.3 µg/L which is above the 1 µg/L MCL.

4.2 SITE 3: LANDFILL SOUTHWEST OF "F" GROUP

4.2.1. Physical Characteristics

Site 3 is approximately 5 acres in size and appears as a wide open area surrounded by woodlands. The site is moderately vegetated with grasses and some scrub pines, with the exception of a few scarred areas (on the order of 20 feet in diameter) where no vegetation exists. An undeveloped dirt road accesses the site, one from the southeast past the F group bunkers. The topography across the site is relatively flat, between 120 and 125 feet above MSL. However, some relief along the south and southeastern boundaries of the site, in the vicinity of monitoring well MW03-01, suggests that the edge of the fill tapers out to the original ground surface. A broad drainage swale exists outside of the southeastern boundary.

4.2.1.1 Soils and Waste Characterization

The site is obviously disturbed ground and the surface is uneven but only mildly sloping in character with the surrounding topography. Topsoils in this "barrens" terrain are poorly

developed, and vegetation cover is generally light with disturbed areas slow to recover. Waste is sparsely exposed at the surface in one small area in the center of the landfill. The test pits completed at the site provided some view of the underlying waste material. The physical characteristics of the test pits are summarized on Table A-1, Appendix A. A layer of "trash" was encountered in three of the seven test pits that were excavated at Site 3. As presented in Table A-1, the general composition of the trash consisted of glass bottles, metal cans, plastics, wood, and metallic debris. The layer of trash ranged in thickness from 2 to 4 feet under 0 to 2 feet of cover material. No anomalous organic vapor readings were detected in any of the test pits. The original soils within site proper (part of the Lakehurst Sands Series [LaA] Section 2), have been altered by past waste disposal practices. Based on the samples obtained during the drilling, test pit excavations, and sampling, the shallow "soils" at Site 3 are variable in both composition and color. The shallow soils ranged from sand, fine- to coarse-grained, quartz, some silt, yellow (10YR7/8); to sand and loam, dark gray (5YR4/1).

4.2.1.2 Drainage

Drainage at the site occurs through rapid infiltration and evapotranspiration. Infiltration is the main source of recharge to the shallow aquifer at the site and is a controlling factor of groundwater flow.

A broad drainage swale outside of the southeastern boundary in the area of MW03-01 accepts some contribution of overland flow from the site.

The surface water body nearest to Site 3 is a branch of Mingamahone Brook which is located approximately 800 feet west, (crossgradient) of Site 3. It is not known whether recharge from Site 3 contributes as a source of inflow to this tributary.

4.2.1.3 Hydrogeology

The following lithologic description of Site 3 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These

descriptions are contained in the boring logs presented in Appendix A. In general, the sediments underlying Site 3 consist of very fine to coarse quartz sand with some glauconite and silt, and some clay stringers, overlain by a layer of light gray to yellow-brown sand with little quartz gravel (Figure 4-2). These characteristics are consistent with the sediments of the Kirkwood Formation. Site 3 is situated within the outcrop and recharge area of the Kirkwood Formation.

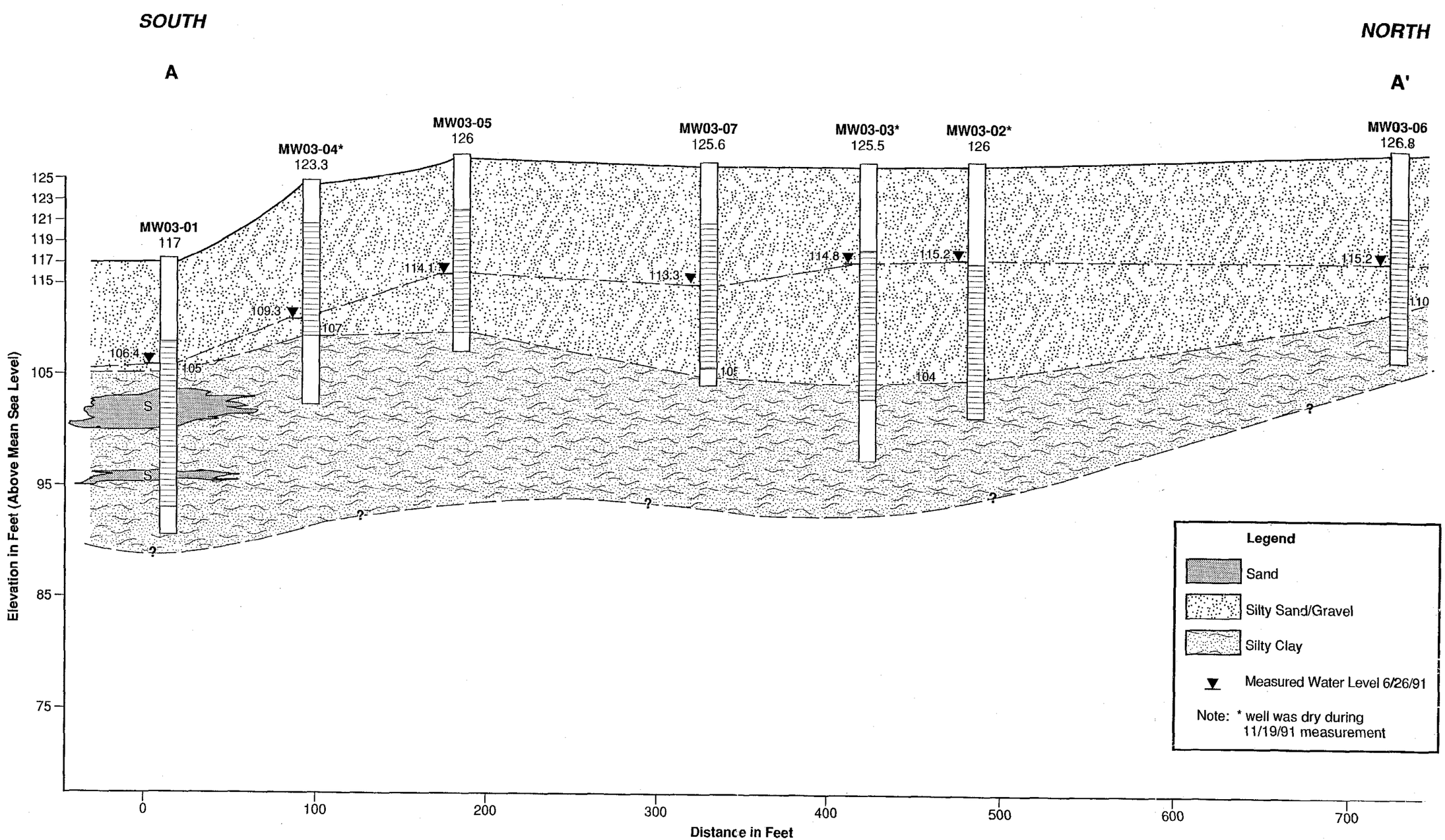
During the first sampling round in June 1991, groundwater levels ranged between 8 and 12 feet bgs across Site 3. During the second and third rounds in October and November of 1991, groundwater levels dropped 12 feet or more in some wells. This was generally due to very low rainfall levels through the summer and fall of 1991. However, water levels at Site 3 dropped more markedly than levels at the other sites, possibly because of a perching effect caused by the clay horizon that underlies the site.

Figure 4-3 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the south mimicking topography with an average gradient of .015 feet/foot. This pattern is similar to that observed during the fall measurement rounds, although at that time MW03-02, MW03-03, and MW03-04 were dry. MW03-02 and MW03-06 are hydraulically upgradient of the site, while MW03-01 is the farthest downgradient. Based on the average hydraulic conductivity calculated from the slug test data for MW03-03 and MW03-06, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) is approximately 0.11 feet/day or 39 feet/year.

4.2.2 Chemical Results

4.2.2.1 Analysis of Test Pit Samples

The analytical results for the test pit investigation conducted at Site 3 are presented on Table 4-4. Chemical analyses were conducted on samples from two of the seven test pits (03-004-T001 and 03-007-T001) that were excavated at Site 3. The samples were analyzed for the full EPA TCL/TAL scans and TPH. Three semivolatile compounds, fluoranthene, pyrene and bis(2-ethylhexyl)phthalate, were detected at concentrations below detection limits as indicated by the



459-6926

FIGURE 4-2 GENERALIZED CROSS SECTION A-A'
SITE 3- LANDFILL SW OF "F" GROUP
NWS EARLE, NJ

00286A032

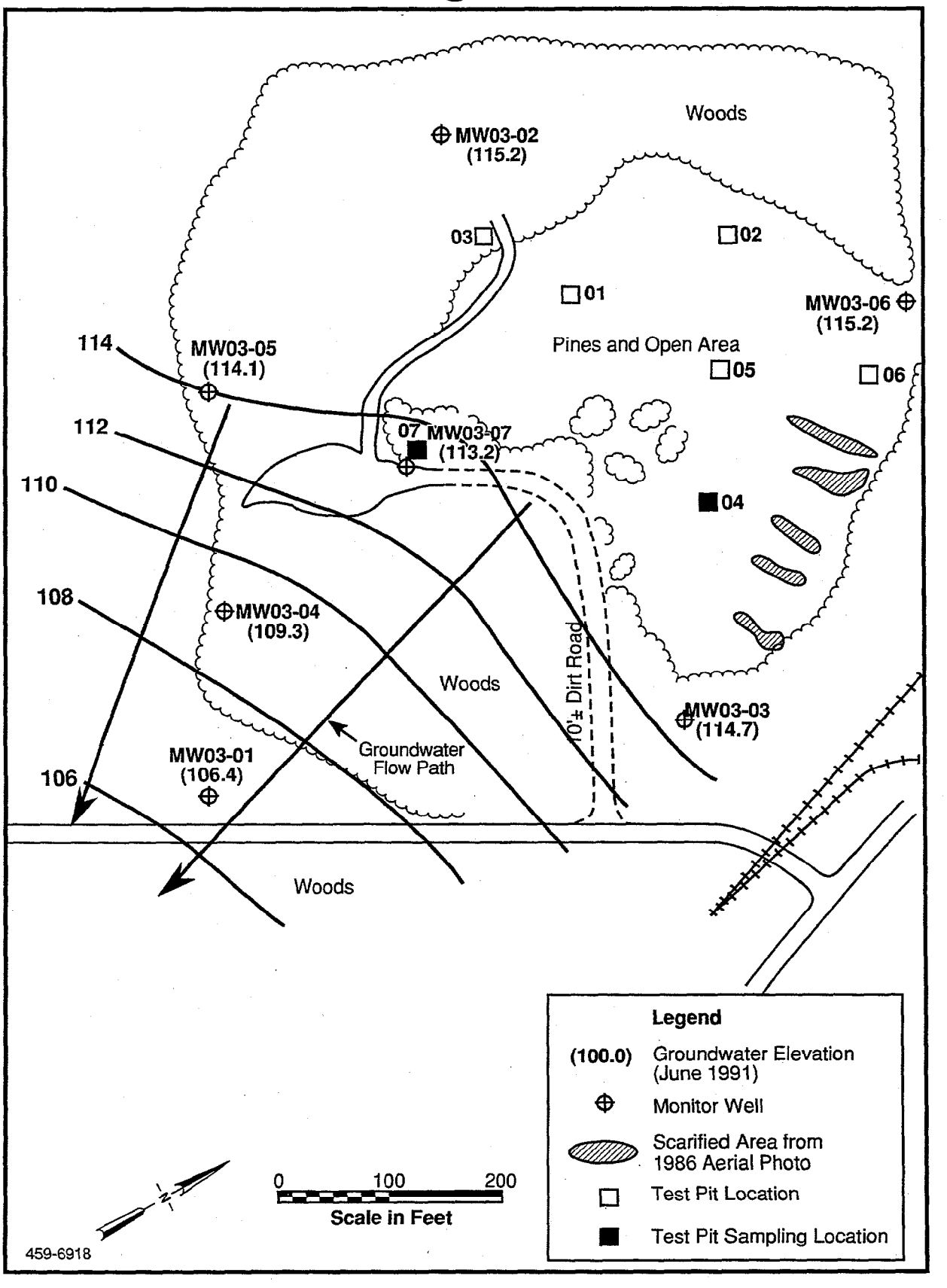


FIGURE 4-3 SITE 3 - LANDFILL SOUTHWEST OF "F" GROUP GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

Table 4-4

Summary of Soil Sample Analytical Results

NWS Earle, Test Pits, Sites 3, 4, and 5

Site I.D. (a) / Compounds	03-004-T001	03-004-T001 Replicate	03-004-T301	03-007-T001	03-TP03-001	03-TP03-001 Replicate	04-002-T001	04-003-T001	05-001-T001	05-001-T001 Replicate	05-001-T101	05-003-T001	NJDEPE[b] Guidelines
TCL Semi-Volatiles (µg/kg)													
Benzoic Acid	U 1800	NR	NR	U 2000	910 J	NR	U 45000	U 1900	U 2000	NR	U 2000	U 2100	–
Acenaphthene	U 370	NR	NR	U 400	U 490	NR	U 8900	U 380	79 J	NR	110 J	U 430	100000
Dibenzofuran	U 370	NR	NR	U 400	U 490	NR	U 8900	U 380	55 J	NR	82 J	U 430	–
Phenanthrene	U 370	NR	NR	U 400	250 J	NR	U 8900	U 380	220 J	NR	310 J	100 J	–
Anthracene	U 370	NR	NR	U 400	62 J	NR	U 8900	U 380	48 J	NR	49 J	U 430	500000
Di-n-Butylphthalate	U 370	NR	NR	U 400	U 490	NR	U 8900	U 380	U 400	NR	U 410	U 430	100000
Fluoranthene	37 J	NR	NR	U 400	350 J	NR	U 8900	U 380	230 J	NR	310 J	200 J	500000
Pyrene	51 J	NR	NR	U 400	410 J	NR	U 8900	U 380	140 J	NR	180 J	160 J	500000
Benzo(a)anthracene	U 370	NR	NR	U 400	200 J	NR	U 8900	U 380	U 400	NR	U 410	83 J	500000
Chrysene	U 370	NR	NR	U 400	230 J	NR	U 8900	U 380	U 400	NR	U 410	95 J	500000
bis(2-Ethylhexyl)phthalate	350 JB	NR	NR	160 JB	76 JB	NR	U 8900	44 JB	85 JB	NR	68 JB	180 JB	100000
Benzo(b)fluoranthene	U 370	NR	NR	U 400	190 J	NR	U 8900	U 380	U 400	NR	U 410	89 J	–
Benzo(k)fluoranthene	U 370	NR	NR	U 400	210 J	NR	U 8900	U 380	U 400	NR	U 410	71 J	500000
Benzo(a)pyrene	U 370	NR	NR	U 400	190 J	NR	U 8900	U 380	U 400	NR	U 410	79 J	100000
Inorganics (mg/kg)													
Blanks are mg/L													
Silver	U .78	U .78	NR	U .81	U 1.1	NR	U .73	U .86	U .90	NR	U .76	2.3	–
Aluminum	1250	1225	NR	1080	1220	NR	2060	1720	3930	NR	4220	1630	–
Arsenic	0.46	0.44	NR	0.33	0.94	NR	0.48	0.41	4.7	NR	5.6	2.7	–
Barium	1320	307	NR	4.8	73.5	NR	20.8	10.1	2.9	NR	2.8	5.6	–
Beryllium	0.16	0.12	NR	U .13	U .17	NR	0.17	0.16	0.66	NR	0.72	0.28	–
Calcium	85.2	78.7	NR	27.8	7410	NR	201	168	224	NR	236	110	–
Cadmium	U .56	U .56	NR	U .58	U .76	NR	U .52	U .61	U .64	NR	U .54	U .58	–
Cobalt	1.6	0.67	NR	U .64	1.8	NR	1.5	0.79	0.78	NR	U .26	U .65	–
Chromium	7.3	7.9	NR	7.7	2.0	NR	5.6	2.2	117	NR	126	30.3	–
Copper	12.1	10.1	NR	1.0	16.3	NR	5.9	U	0.83	NR	1.5	2.2	–
Cyanide	0.92	1.0	NR	U .58	U .70	NR	U .48	U .58	U .60	U .60	U .56	U .54	–
Iron	3210	2259	NR	1040	3590	NR	3200	2210	26200	NR	28200	5410	–
Potassium	96.2	89.2	NR	141	110	NR	177	161	3880	NR	4200	870	–
Magnesium	66.2	58.1	NR	29.9	1150	NR	80.8	20.4	1170	NR	1230	273	–
Manganese	11.6	10.0	NR	5.5	43.7	NR	8.0	20.4	8.6	NR	9.0	5.9	–
Sodium	315	U	NR	29.1	43.4	NR	35.4	20.3	63.5	NR	48.7	18.6	–
Nickel	2.9	2.5	NR	1.3	U 1.1	NR	3.3	U .88	U .92	NR	U .92	.93	–
Lead	32.4	31.1	NR	3.3	13.4	NR	13.8	2.4	4.8	NR	4.4	16.0	–
Selenium	U .23	U .23	NR	U	0.34	NR	U .22	U 2.4	1.0B	NR	0.97	0.30	–
Vanadium	6.9	6.6	NR	5.0	6.7	NR	7.9	3.8	103	NR	106	26.1	–
Zinc	34.7	31.2	NR	21.5	17.8	NR	71.1	38.2	70.5	NR	98.9	30.2	–
% Solids	90.9	92.2	NR	84.0	67.6	NR	93.2	86.8	82.2	NR	81.3	77.9	–
Nitrite	U	NR	NR	U	NR	NR	0.64	U	3.7	NR	2.5	U	–
Nitrate	1.3	NR	NR	1.2	NR	NR	1.1	0.84	U	NR	U	1.2	–

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refe[illegible] 90 QAAP

(b) = NJDEPE Soil Cleanup Criteria (revised 3/8/93) for impact to groundwater

Table 4-4 cont...

Summary of Soil Sample Analytical Results

NWS Earle, Test Pits, Sites 3, 4 and 5

Site ID: (a) / Compounds	03-004-T001	03-004-T001 Replicate	03-004-T301	03-007-T001	03-TP03-001	03-TP03-001 Replicate	04-002-T001	04-003-T001	05-001-T001	05-001-T001 Replicate	05-001-T101	05-003-T001	NJDEPE[b] Guidelines
Pesticide/PCB (µg/kg)													
Blanks are ug/l													
Dieldrin	31 J	NR	NR	U 19	U 240	NR	U 84	U 18	U 96	NR	U 98	U 100	50000
4,4-DDE	52 J	NR	NR	U 19	U 240	NR	U 84	U 18	U 96	NR	U 98	U 100	100000
4,4-DDD	120 J	NR	NR	U 19	U 240	NR	U 84	U 18	U 96	NR	U 98	11 J	100000
4,4-DDT	50 J	NR	NR	U 19	U 240	NR	13J	U 18	U 96	NR	U 98	U 100	100000
alpha-Chlordane	51 J	NR	NR	U 95	U 1200	NR	U 420	U 91	U 480	NR	U 490	U 510	–
gamma-Chlordane	35 J	NR	NR	U 95	U 1200	NR	U 420	U 91	U 480	NR	U 490	U 510	–
Explosives (µg/g)	U .005			U .005			U .005	U .005	U .005	NR	U .005	U .005	–
Petroleum Hydrocarbons (mg/kg)	110	NR	NR	5.1 B	NR	NR	2100	5.6 B	57	NR	55	25	–
Volatile Organics (µg/kg)													
Blanks are µg/L													
Methylene Chloride	61 B	NR	19 B	32 B	NR	NR	58 B	43 B	40 B	NR	49 B	48 B	10000
Acetone	43 B	NR	6JB	45 B	NR	NR	64 B	49 B	47 B	NR	57 B	62 B	50000
Toluene	U 6	NR	U 5	U 6	NR	NR	4J	2J	22	NR	11	U 5	500000
Ethylbenzene	U 6	NR	U 5	U 6	NR	NR	U 6	U 6	3J	NR	U 6	U 5	100000
Xylene	U 6	NR	U 5	U 6	NR	NR	U 6	4J	12	NR	4J	3J	–

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
(b) = NJDEPE Soil Cleanup Criteria (revised 3/8/93) for impact to groundwater

"J" qualifier on the data. Barium was detected at 1,320 mg/kg in sample 03-004-T001. Trace levels of pesticides at J value level (present below detection limits) and TPH at 110 mg/kg were detected in sample 03-004-T001. In addition, methylene chloride and acetone were detected at trace concentrations of 61 and 43 µg/kg. However, these compounds were also found in the blank samples and were most likely introduced during the sampling or analysis procedures. No PCBs were detected in either sample.

4.2.2.2 Analysis of Groundwater at Site 3

Groundwater quality results for the three sampling rounds are presented in Tables 4-5a, 4-5b, and 4-5c. Table 4-5a presents the first sampling round which was the most comprehensive, including the full EPA TCL/TAL scans. All seven Site 3 monitor wells were sampled during the first round; because of very low rainfall levels through the summer and fall of 1991, groundwater levels dropped and MW03-02, MW03-03, and MW03-04 were dry during subsequent sampling rounds.

The first round of groundwater analysis showed one well, MW03-04, with semivolatile compounds above detection limits (naphthalene, 74 µg/L and 4-ethylphenol, 52 µg/L); bis (2-ethylhexyl)phthalate was present below the method detection limit (J values) in samples from three wells and is probably an artifact. Volatile organic compounds methylene chloride and acetone were present but attributable to field or laboratory cross contamination. Fuel-related compounds, ethylbenzene and xylene, were detected in well MW03-04 at 180 and 470 µg/L, respectively; toluene was also present at J values. MW03-04 and MW03-05 also had J value (below detection limit) levels of several pesticide compounds. No PCBs were detected. Lead and chromium were under 0.5 and 0.1 µg/L, respectively. Arsenic was elevated (0.37 µg/L) in one well, MW03-01.

The second and third round of groundwater sampling included analysis of VOCs, drinking water metals, and inorganic landfill indicator parameters. Because of significant drops in water levels at the site discussed previously, wells MW03-02, MW03-03, and MW03-04 did not provide sufficient water to sample. Results for VOCs were similar to the first round; the only compound

Table 4-5a

Summary of Groundwater Sample Analytical Results

Round One: March 1991

NWS Earle, Site 3 (Landfill SW of "P" Group)

Site I.D. (a) / Compounds	03-001-M001 MW03-01	03-002-M001 MW03-02	03-002-M001 Replicate	03-003-M001 MW03-03	03-004-M001 MW03-04	03-005-M001 MW03-05	03-006-M001 MW03-06	03-007-M001 MW03-07	03-007-M201 MW03-07 (Eq. Blank)	03-007-M201 MW03-07 (Eq. Blank)	Primary Drinking Water Standards(b)	NJDEPE Groundwater Cleanup Standards(c)
Semivolatiles (µg/L)												
1,4-Dichlorobenzene	U 10	U 13	NR	U 11	10J	U 75	U 10	U 11	U 11	NR	-	-
4-Methylphenol	U 10	U 13	NR	U 11	52	U 75	U 10	U 11	U 11	NR	-	-
Naphthalene	U 10	U 13	NR	U 11	74	U 75	U 10	U 11	U 11	NR	-	-
2-Methylnaphthalene	U 10	U 13	NR	U 11	5J	U 75	U 10	U 11	U 11	NR	-	-
Diethylphthalate	U 10	U 13	NR	U 11	4J	U 75	U 10	U 11	U 11	NR	-	-
N-Nitrosodiphenylamine (1)	U 10	U 13	NR	U 11	1J	U 75	U 10	U 11	U 11	NR	-	-
bis (2-Ethylhexyl)phthalate	1J	U 13	NR	U 11	1J	3J	1J	U 11	U 11	NR	-	-
Volatile Organics (µg/L)												
Methylene Chloride	42 J	U 2500	NR	4 J	U 83	16 BJ	U 5	U 5	U 50	NR	-	-
Acetone	1600	4400	NR	25	970	590 B	240	U 10	8	NR	-	700
Toluene	U 50	U 2500	NR	U 5.0	77 J	U 25	U 5.0	U 5.0	U 50	NR	1000	1,000
Chlorobenzene	U 50	U 2500	NR	U 5.0	U 83	10 J	U 5.0	U 5.0	U 50	NR	100	-
Ethylbenzene	U 50	U 2500	NR	U 5.0	180	U 25	U 5.0	U 5.0	U 50	NR	700	700
Xylene	U 50	U 2500	NR	U 5.0	470	U 25	U 5.0	U 5.0	U 50	NR	10000	40
Inorganics (mg/L)												
Aluminum	11.2	1.4	NR	1.4	1.5	8.0	7.5	4.4	U 1.400	U	-	-
Arsenic	0.37	U .0009	NR	U .0009	0.0014	0.0048	U .0009	U .0009	U .0009	U .0009	0.05	0.008
Barium	0.046	0.037	NR	0.024	0.20	0.12	0.041	0.035	U .024	0.21	2	2
Beryllium	0.0012	0.0006	NR	U .0006	U .0006	0.0011	U .0006	U .0006	U .0006	U .0006	0.004	0.02
Calcium	1.3	1.3	NR	0.90	18.6	17.8	24.3	2.0	0.903	0.080	-	-
Cadmium	0.044	U .0027	NR	U .0027	U .0027	0.021	U .0027	U .0027	U .0027	U .0027	0.005	0.004
Cobalt	0.0081	U .004	NR	U .003	0.0071	0.016	U .004	0.0032	U .003	U .003	-	-
Chromium	0.082	U .007	NR	U .0069	U .007	0.060	0.041	0.018	U .0069	U .0069	0.1	0.1
Copper	0.011	0.0033	NR	U	0.0042	0.027	0.013	0.0047	U .0025	0.006	1.3	-
Cyanide	U .010	U .020	U .020	U .010	U .010	U .010	U .010	U .010	U .010	U .010	0.2	0.2
Iron	244	10.9	NR	0.81	170	41.3	20.7	9.2	0.027	0.017	-	-
Mercury	U .0002	U .0002	NR	U .0002	U .0002	U .0002	U .0002	0.0004	U .0002	U .0002	0.002	0.002
Potassium	1.7	0.49	NR	0.25	1.9	2.8	1.9	1.4	0.14	U	-	-
Magnesium	0.74	0.58	NR	0.32	1.4	2.6	6.2	0.81	U .316	U .316	-	-
Manganese	0.053	0.037	NR	0.039	0.45	0.93	0.10	0.060	U .0387	U .0387	-	-
Sodium	3.2	2.1	NR	2.2	1.7	2.3	1.9	2.1	0.41	0.43	-	-
Nickel	U .0039	0.0045	NR	U .0039	U .0039	0.022	U .0039	U .0039	U .0039	U .0039	0.1	0.1
Lead	0.035	0.0020	NR	U	0.011	0.030	0.022	0.0068	U .0014	0.008	0.015	0.01
Antimony	U .0182	U .0182	NR	U .0182	0.025	U .0182	U .0182	U .0182	0.021	U .0182	0.006	0.02
Selenium	0.0038	U .0012	NR	U .0012	U .0012	0.0021	0.0011	0.0018	U .0011	U .0011	0.05	0.05
Vanadium	0.49	U .002	NR	U .002	0.0023	0.042	0.033	0.016	U .002	U .002	-	-
Zinc	0.087	0.042	NR	0.067	0.26	0.32	0.016	0.015	U .0674	U .0674	5	5
Pesticide/PCB (µg/L)												
Aldrin	U 0.59	U .065	NR	U .056	0.031 J	U .052	U .060	U .050	U .054	NR	-	-
4,4-DDE	U .12	U .13	NR	U .11	U .52	0.021 J	U .12	U .10	U .11	NR	-	-
4,4-DDT	U .12	U .13	NR	U .11	U .52	0.093 J	U .12	U .10	U .11	NR	-	-
Alpha-Chlordane	U 0.59	U 0.65	NR	U 0.56	.50 J	U .052	U 0.60	U 0.50	0.54	NR	-	-
Gamma-Chlordane	U 0.59	U 0.65	NR	U 0.56	0.26 J	U 0.52	U 0.60	U 0.50	U 0.54	NR		

Legend: U = Not detected; J = Present below detection limit; (b) = Maximum Contaminant Levels (MCLs) (mg/L)

NR = Not requested; (a) = Refer to June 90 QAPP; (c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4-5b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 3 (Landfill SW of "F" Group)

Site I.D. (a) / Compounds	03-001-M002 MW03-01	03-001-M002 Replicate	03-005-M002 MW03-05	03-006-M002 MW03-06	03-006-M002 Replicate
Volatile Organics (µg/L)					
Methylene Chloride	3 JB	NR	1 JB	2 JB	NR
Acetone	95 B	NR	54 B	140 B	NR
Chloroform	U 5	NR	U 5	U 5	NR
Chlorobenzene	U 5	NR	13	U 5	NR
Semivolatile Organics (µg/L)					
1,4-Dichlorobenzene	NR	NR	3 J	U 12	NR
Di-n-Butylphthalate	NR	NR	1 JB	3 JB	NR
bis(2-Ethylhexyl)phthalate	NR	NR	2 JB	3 JB	NR
Inorganics (µg/L)					
Arsenic	3500	NR	20.5	U 10	U 10
Barium	U 200	NR	290	U 200	U 200
Cadmium	49.2	NR	30	U 5	U 5
Chromium	641	NR	338	209	208
Copper	U 500	NR	122	55.6	55.4
Iron	1240000	NR	369000	113000	114000
Mercury	1.6	0.97	0.82	0.98	1
Manganese	894	NR	2640	219	221
Sodium	U 5000	NR	U 5000	U 5000	U 5000
Lead	147	NR	114	51.3	42.8
Selenium	U 50	NR	6.8	5 5	U 5
Zinc	U 400	NR	835	213	217
Inorganics (mg/L)					
NO3/NO2 (mg-n/L)					
Turbidity (NTU)					
BOD 5 Day	3.5	NR	7.1	U 1	NR
Chloride	8.8	9	6.2	5.3	U 5
Chemical Oxygen Demand	1810	1960	235	96.8	96.8
Nitrate/ Nitrite, Nitrate, as N	0.32	NR	1.9	0.6	0.59
Ammonia, as N	0.31	0.31	1.6	U 0.1	U 0.1
Phosphate, as P	0.2	0.19	0.78	0.6	0.6
Sulfate	74.6	72.7	64.9	13.8	14.3
Turbidity	785	785	341	325	325
Pesticides/PCB (µg/L)	NR	NR	U 1.0	U 1.0	U 1.0

Legend: U = Not detected
NR = Not detected
B= Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–5b cont.....
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 3 (Landfill SW of "F" Group)

Site I.D. (a) / Compounds	03-006-M202 03-06(Dup.)	03-006-M102 MW03-06(Trip Blank)	03-007-M002 MW03-07	03-007-M102 MW03-07(Dup.)	03-007-M102 Replicate
Volatile Organics (µg/L)					
Methylene Chloride	2 JB	2 JB	1 JB	5 B	NR
Acetone	80 B	12 B	100 B	100 B	NR
Chloroform	6	U 5	U 5	U 5	NR
Chlorobenzene	U 5	U 5	U 5	U 5	NR
Semivolatile Organics (µg/L)					
1,4-Dichlorobenzene	U 11	NR	NR	NR	NR
Di-n-Butylphthalate	3 JB	NR	NR	NR	NR
bis(2-Ethylhexyl)phthalate	3 JB	NR	NR	NR	NR
Inorganics (µg/L)					
Arsenic	U 10	NR	16	13.9	NR
Barium	U 200	NR	U 200	U 200	NR
Cadmium	U 5	NR	19	25.3	NR
Chromium	U 10	NR	227	159	NR
Copper	U 25	NR	51.4	46.2	NR
Iron	U 100	NR	111000	77400	NR
Mercury	U 0.2	NR	2	0.97	NR
Manganese	U 15	NR	606	565	NR
Sodium	U 5000	NR	U 5000	U 5000	NR
Lead	U 3	NR	59.7	50	NR
Selenium	U 5	NR	U 50	6	NR
Zinc	U 20	NR	288	305	NR
Inorganics (mg/L)					
NO3/NO2 (mg-n/L)					
Turbidity (NTU)					
BOD 5 Day	U 1	NR	U 1	1.1	NR
Chloride	U 5	NR	6	5.9	NR
Chemical Oxygen Demand	13.8	NR	106	32.5	NR
Nitrate/ Nitrite, Nitrate, as N	0.27	NR	0.77	0.71	0.72
Ammonia, as N	U 0.1	NR	1.9	1.8	NR
Phosphate, as P	U 0.25	NR	0.14	0.11	NR
Sulfate	U 5	NR	99.1	87.5	85.7
Turbidity	0.7	NR	1240	463	NR
Pesticides/PCB (µg/L)	U 1.0	NR	NR	NR	NR

Legend: U = Not detected
NR = Not detected
B= Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-5c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 3 (Landfill SW of "F" Group)

Site I.D. (a) / Compounds	03-001-M003 MW03-01	03-001-M303 MW03-01(Trip Blank)	03-005-M003 MW03-05	03-005-M003 REPLICATE	03-006-M003 MW03-06	03-006-M003 REPLICATE	03-006-M203 MW03-06(Eq. Blank)	03-006-M203 REPLICATE	03-007-M003 MW03-07
Volatile Organics (µg/L)									
Methylene Chloride	U 5	5 B	3 JB	NR	4 JB	NR	4 JB	NR	U 5
Acetone	7700 E	22 B	1200 E	NR	49 B	NR	28 B	NR	190 B
Chloroform	U 5	U 5	U 5	NR	U 5	NR	6	NR	U 5
Chlorobenzene	U 5	U 5	U 5	NR	U 5	NR	U 5	NR	U 5
Semivolatile Organics (µg/L)									
Diethylphthalate	NR	NR	1 JB	NR	U 10	NR	26	NR	NR
Di-n-Butylphthalate	NR	NR	4 J	NR	2 JB	NR	2 JB	NR	NR
bis(2-Ethylhexyl)phthalate	NR	NR	3 J	NR	U 10	NR	U 11	NR	NR
Inorganics (µg/L)									
Silver	60.1	NR	15.2	NR	12.5	U 10	U 10	NR	U 10
Arsenic	115	NR	U 10	NR	U 10	U 10	U 10	NR	U 10
Cadmium	23.5	NR	34.7	NR	U 5	U 5	U 5	NR	33.6
Chromium	245	NR	157	NR	114	103	U 10	NR	86.1
Copper	37	NR	71.3	NR	43.9	33.6	U 25	NR	42.9
Iron	355000	NR	524000	NR	56400	53600	U 100	NR	19000
Mercury	0.8	NR	0.5	NR	0.89	0.88	U 0.2	NR	0.23
Manganese	342	NR	1730	NR	89.2	81.4	U 15	NR	590
Lead	4.5	NR	157	NR	24.9	23	U 3	NR	42.5
Selenium	7.7	NR	U 5	NR	U 5	U 5	U 5	NR	U 5
Zinc	314	NR	699	NR	99.2	86.1	U 20	NR	592
Inorganics (mg/L)									
NO3/N02 (mg-n/L)									
Turbidity (NTU)									
BOD 5 Day	NR	NR	3.8	NR	NR	NR	U 1	NR	NR
Chloride	NR	NR	9.1	NR	5.7	5.6	U 5	NR	NR
Chemical Oxygen Demand	NR	NR	187	NR	87.9	NR	11.3	U 10	NR
Nitrate, as N	NR	NR	0.62	0.64	0.52	0.5	U 10	NR	NR
Ammonia, as N	NR	NR	2.6	2.6	U 0.1	NR	U 0.1	NR	NR
Phosphate, as P	NR	NR	0.17	0.21	0.19	0.18	U 0.02	NR	NR
Sulfate	NR	NR	69.6	NR	14.6	14.9	U 5	NR	NR
Turbidity	NR	NR	360	NR	7.4	7.4	0.07	NR	NR
Pesticides/PCB (µg/L)	NR	NR	U 1.1	U 1.0	U 1.0	U 1.0	U 1.11	U 1.0	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

above detection limit was dichlorobenzene in MW03-05. Elevated arsenic was also detected during the second and third rounds in MW03-01. Chromium and cadmium were also elevated in the three wells sampled during the second and third rounds. Antimony was detected in two wells (MW03-04 and MW03-07) at 21 and 25 µg/L, respectively. The detection limit for antimony was .018 µg/L, above the MCL of 6 µg/L, but below the NJDEPE Class II-A standard of 20 µg/L.

Results for the landfill indicator parameters showed elevated levels in the downgradient wells MW03-01, MW03-05, and MW03-07 relative to upgradient well MW03-06 for BOD, COD, ammonia, sulfate, and turbidity, indicating that the landfill has some impact on shallow groundwater quality.

4.2.3 Summary of the Site 3 Characterization

Site 3 is an inactive solid waste landfill containing, based on the test pit inspection, the normal range of municipal waste. Four of the six monitor wells are hydrologically downgradient of the landfill. One well, MW03-01, showed elevated arsenic, which is used in pesticides and herbicides, and one well, MW03-04, contained hydrocarbons, possibly fuel-related. MW03-04 was dry during the second and third sampling rounds. The downgradient wells also contained levels of indicator parameters (COD and SO_4) above background referenced to MW03-06. However, these levels are not high enough to indicate that the old landfill is generating highly concentrated leachate.

The site's shallow water-bearing sediments are thin and underlain by a clay layer. This may have exacerbated the effect of the water table drop produced by the dry summer and fall of 1991.

4.3 SITE 4: SOLID WASTE LANDFILL WEST OF "D" GROUP

4.3.1 Physical Characteristics

Site 4 is approximately 5 acres in size and appears as a wide open area surrounded by woodlands. The site is bordered on the northwest by Macasser Road. An undeveloped dirt road encompasses the site. Similar to Site 3, the site is moderately vegetated with grasses and some scrub pines, with the exception of a few scarred areas where no vegetation exists. The topography across the site slopes to the east from approximately 170 feet above MSL near MW04-01 to approximately 150 feet MSL near MW04-06. A drainage ditch running northeast to southwest borders the southeastern boundary of the site. The cover material used at the site is predominantly loose sand apparently quarried from the surrounding area. A reconnaissance of the site conducted during the RI identified at least two areas where the cover was eroded and waste was exposed at the surface. These findings are consistent with the IAS. Historical aerial photographs and the physical topographic relief suggest that the edge of the fill tapers out to the original ground surface. The fill face is steepest, approximately 25 feet high, on the east side of the site in the vicinity of old spring sample 4-A. A broad low-lying area (with a tall stand of Fragmities) exists along the drainage near the base of the fill face and extends beyond the northeastern boundary road.

4.3.1.1 Soils and Waste Characterization

The original soils within the site proper were mostly part of the Atsion Series [At] (Section 2). The soils have been altered by past waste practices and have subsequently been classified as Udorthents (smoothed) [UA] or Pit (sands) [PT] (Soils Conservation Service, April 1989). Based on the samples obtained during the drilling, test pit excavations, and sampling, the shallow "soils" at Site 4 vary in both composition and color. The shallow soils and cover materials range from sand, fine to medium with some coarse grains and silt, dark brown (10YR4/3) to light gray (10YR7/4).

The site is obviously disturbed ground and the surface is uneven but only mildly sloping in character with the surrounding topography. Topsoils in this "barrens" terrain are poorly developed, and vegetation cover consists of scrub pines and grass with disturbed areas slow to recover. Large amounts of waste (mostly steel banding and metallic scrap) were exposed at the surface of at least two areas along the edges of the landfill. The test pits completed at Site 3 provided some view of the underlying waste material. The physical characteristics of the test pits are summarized in Table A-2, Appendix A. A layer of "trash" was encountered in four of the six test pits that were excavated at Site 4. As presented in Table A-2, the general composition of the trash consisted mainly of metal scrap materials, including steel banding, pipes, and empty metal trash barrels. Lumber, concrete, bricks, and other construction-type debris were also encountered. The layer of trash ranged in thickness from 0.5 to 9 feet. Cover material was thin and scrap material is exposed at the surface. No anomalous organic vapor readings were detected in any of the test pits.

4.3.1.2 Surface Water and Drainage

Drainage at the site occurs through rapid infiltration and evapotranspiration. Infiltration is the main source of recharge to the shallow aquifer at the site and is a controlling factor of groundwater flow.

A broad drainage swale along the southeastern boundary of the site receives spring discharge as well as the overland flow from this area of the site. The surface water bodies nearest to Site 4 include Lake Earle, (probably an old gravel pit) which is located approximately 300 feet north, and a branch of Hockhockson Brook, which is located approximately 400 feet east (crossgradient) of Site 4 and receives flow from the site surface drainage.

4.3.1.3 Hydrogeology

The following lithologic description of Site 4 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These descriptions are contained in the boring logs presented in Appendix A. As shown in boring logs

MW04-04 and MW04-05, in general, the sediments underlying Site 4 consist of fine to coarse quartz sand and gravel, poorly sorted with some iron staining/banding (limonitic), yellow-brown to light gray. A layer of very fine sand and silt was encountered in MW04-06. These characteristics are consistent with the sediments of the Cohansey Formation. Site 4 is situated within the outcrop and recharge area of the Cohansey Formation.

Generally groundwater levels ranged between near ground surface and 25 feet bgs across Site 4 during the first sampling round. The difference across the site reflects topographic relief of 25 feet.

Figure 4-4 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the northeast mimicking topography with an average gradient of .012 feet/foot. This pattern is similar to that observed during other measurement rounds, although in the fall 1991 measurements, all well levels had dropped several feet and the gradient flattened slightly. MW04-04 is hydraulically upgradient of the site while MW04-02 and MW04-06 are the most directly downgradient. Based on the hydraulic conductivity calculated from the slug test data for MW04-04, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) is approximately 0.06 feet/day or 22.3 feet/year.

4.3.2 Chemical Results

4.3.2.1 Analysis of Test Pit Samples

The analytical results for the test pit investigation conducted at Site 4 are presented on Table 4-4. Chemical analysis was conducted on samples from two of the six test pits (04-002-T001 and 04-003-T001) that were excavated at Site 4. The samples were analyzed for the full EPA TCL/TAL scans and TPH. One semivolatile compound, bis(2-ethylhexyl)phthalate was detected at 44J µg/kg (below detection limits) in sample 04-003-T001. The pesticide 4,4-DDT was reported at 13J µg/kg (below detection limits), and TPH was detected at 2,100 mg/kg in sample 04-002-T001. No other pesticides or PCBs were detected in either sample.

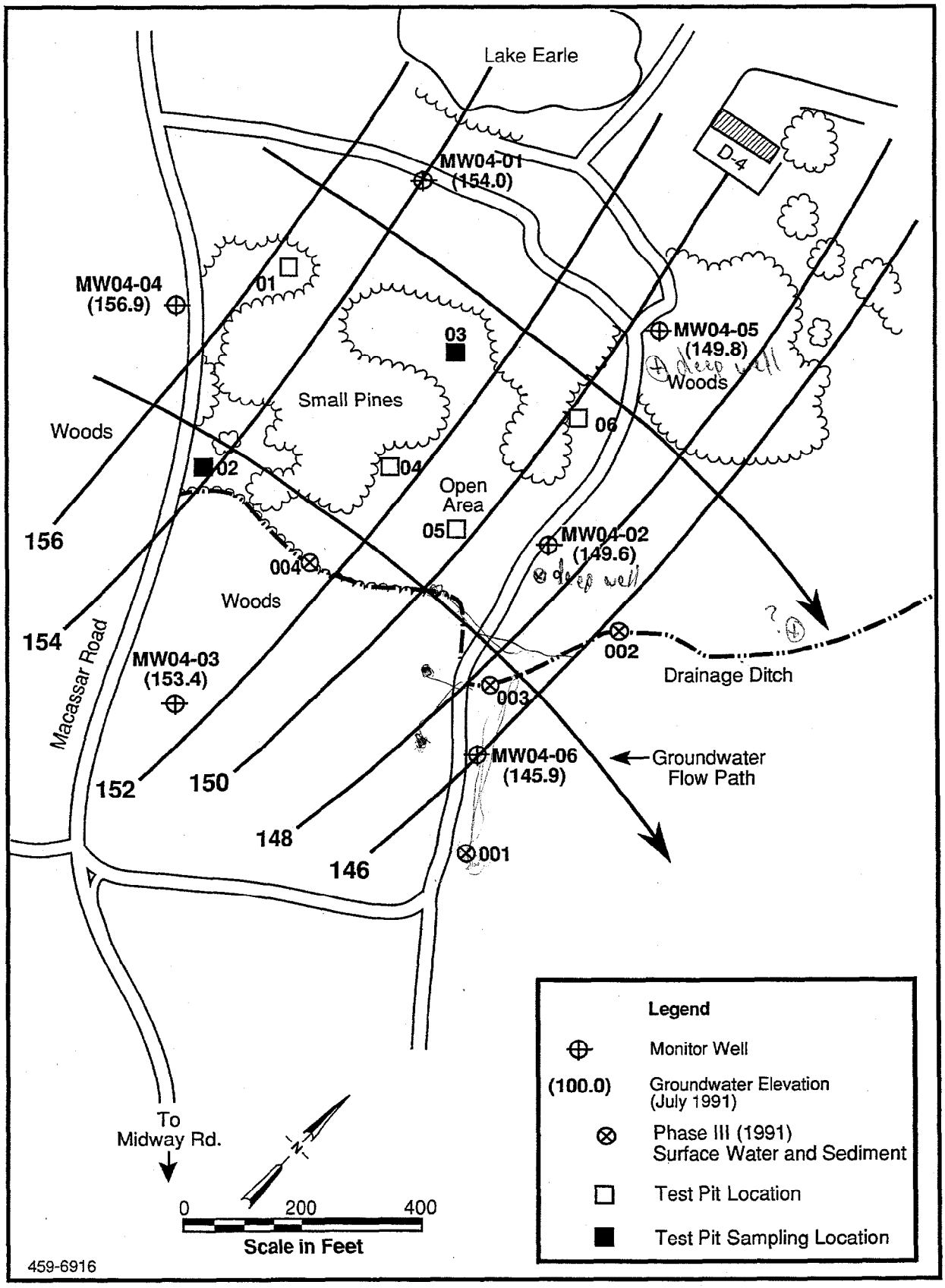


FIGURE 4-4 SITE 4 - LANDFILL WEST OF "D" GROUP GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

4.3.2.2 Analysis of Surface Water and Sediments at Site 4

Four surface sampling locations were selected in the spring-fed stream and associated drainage running in a gully along the southeastern edge of the fill area. The results of the sediment and surface water sampling are presented on Tables 4-6 and 4-7a, respectively. The sampling locations are presented in Figure 3-4. As shown on Figure 3-4, the samples 002 through 004 are located along the gully which cuts deeply into the elevated ground surface. Sample-001 was located in a small tributary to the main gully which flows toward the landfill area. Sample 004 is furthest upstream in the gully and closest to the landfill.

The only VOCs detected were also identified in the sample blanks. Two semivolatile compounds, pyrene and phenanthrene, were found at J values in one sample (004). These compounds are found in residues from burning such as fly ash. Sample 004 generally had higher levels of metals compared to the other samples reported, including iron (22 mg/kg), chromium (36.8 mg/kg), cadmium (5.7 mg/kg), and lead (192 mg/kg). Sample 004 also contained 1.4 mg/kg of Aroclor-1260. No other PCB or pesticide compound was found in any of the sediment samples.

The surface water samples were analyzed for VOCs and total petroleum hydrocarbons TPH only. No VOCs were detected which were not also identified in the blank samples. TPH was also not detected.

4.3.2.3 Analysis of Groundwater at Site 4

The groundwater quality results for the three sampling rounds conducted at Site 4 are presented in Tables 4-7a, 4-7b, and 4-7c.

The first round of groundwater analysis detected only one semivolatile compound, bis(2-ethylhexyl)phthalate (associated with plastics), which was present below the method detection limit (J values) in samples from two wells. Volatile organic compounds methylene chloride and acetone were present but attributable to field or laboratory cross contamination. Chloroform was

Table 4-6
Summary of Sediment Sample Analytical Results
NWS Earle, Site 4 (Landfill W of "D" Group)

Site I.D. / Compounds	04-001-D001 Sediment Sample 04-001	04-001-D101 Sediment Sample 04-001 (Dup.)	04-001-D201 Sediment Sample 04-001 (Eq. Blank)	04-001-D201 Replicate	04-002-D001 Sediment Sample 04-002	04-003-D001 Sediment Sample 04-003	04-003-D001 Replicate	04-004-D001 Sediment Sample 04-004
Volatile Organics (µg/kg)								
Methylene Chloride	84 B	68 B	25 B	NR	100 B	85 B	NR	63 B
Acetone	15 B	18 B	40 B	NR	69 B	85 B	NR	46 B
Carbon Disulfide	U 6	U 6	1 JB	NR	2 J	U 8.0	NR	U 8.0
Semivolatiles (µg/kg)								
Blanks are in µg/L								
Phenanthrene	U 470	U 440	U 12	NR	U 730	U 530	NR	68 J
Di-n-Butylphthalate	U 470	U 440	U 12	NR	U 730	U 530	NR	U 610
Pyrene	U 470	U 440	U 12	NR	U 730	U 530	NR	130 J
bis(2-Ethylhexyl)phthalate	71 J	64 J	1 JB	NR	370 J	140 J	NR	89 J
Inorganics (mg/kg)								
Blanks are in mg/L								
Silver	0.78	U 0.70	U .0029	U .0029	U 0.78	U 0.78	U 0.78	1.3
Aluminum	935	731	0.033	U 0.033	1010	515	536	14100
Arsenic	U 0.48	U 0.44	U .0018	U .0018	U 0.50	U 0.46	U 0.48	3.0
Barium	3.8	2.8	U .004	U .004	7.3	4.8	4.0	113
Beryllium	U 0.13	U 0.12	U .0005	U .0005	U 0.14	U 0.14	U 0.14	0.24
Calcium	208	115	0.041	0.030	438	237	230	1530
Cadmium	U 0.92	U 0.82	U .0034	U .0034	U 0.90	U 0.90	U 0.90	5.7
Cobalt	U 0.92	U 0.82	U .0034	U .0034	U 0.92	U 0.92	U 0.92	3.7
Chromium	3.0	1.7	U .0063	U .0063	5.1	3.6	4.7	36.8
Copper	U 0.78	U 0.70	0.032	0.030	U 0.78	U 0.78	U 0.78	71.5
Iron	652	456	0.11	0.09	4070	1940	2040	22100
Mercury	U 0.11	U 0.09	U .0004	U .0004	U 0.10	U 0.094	U 0.098	1.9
Potassium	U 38.3	U 34.3	U .142	U .142	80.4	U 38	U 38	999
Magnesium	34.5	18.3	U .0516	U .0516	69.7	34.5	33.6	545
Manganese	1.7	1.6	U .0009	U .0009	31.6	10.0	9.0	77.6
Sodium	55.8	20.1	0.063	.0036	20.3	41.6	19.5	60.2
Nickel	1.0	U 0.87	U .0036	U .0036	U 0.98	U 0.98	1.0	10.1
Lead	4.8	4.6	U .0016	0.002	9.5	4.7	4.5	192
Antimony	U 2.0	U 1.8	U .0075	U .0075	U 2.0	2.8	U 1.9	6.1
Vanadium	1.8	1.3	U .0026	U .0026	4.3	1.8	2.0	48.1
Zinc	10.7	6.0	0.010	0.013	57.6	43.8	20.9	688
% Solids (%)	71.6	80.1	NR	NR	74.2	72.3	75.7	53.7
Pesticide/PCB (µg/kg)								
Blanks are in µg/L								
Aroclor-1260	U 200	U 190	U 1.0	NR	U 320	U 230	NR	1600

Legend: U = Not detected
NR = Not requested
J = Present below detection limit
Replicate = LabQA sample
(a) = Refer to June 90 QAAP
B = Detection limit found in blank

Table 4–7a

Summary of Groundwater & Surface Water Sample Analytical Results

Round One: March 1991

NWS Earle, Site 4 (Landfill W D Group)

Site I.D. (a) / Compounds	04–001–M001 Groundwater MW04–01	04–001–M001 Groundwater Replicate	04–001–M301 Groundwater MW04–01 (Trip Blank)	04–002–M001 Groundwater MW04–02	04–002–M101 Groundwater MW04–02 (Dup.)	04–002–M201 Groundwater MW04–02 (Eq. Blank)	04–003–M001 Groundwater MW04–03	04–004–M001 Groundwater MW04–04	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Semivolatiles (µg/L)										
bis(2–Ethylhexyl)phthalate	1 J	NR	NR	U 10	U 10	NR	U 12	2 J	–	–
Volatile Organics (µg/L)										
Methylene Chloride	U 5	NR	7.0	3 BJ	U 5	U 5	U 5	U 5	–	–
Acetone	U 10	NR	U 10	16 B	U 10	130.0	U 180	U 81	–	–
Carbon Disulfide	U 5	NR	U 5	U 5	U 5	U 5	U 5	U 5	–	–
Chloroform	U 5	NR	U 5	U 5	U 5	7.0	2 J	U 5	–	–
1,2–Dichloroethene	U 5	NR	U 5	20.0	18.0	U 5	U 5	U 5	–	–
Trichloroethene	U 5	NR	U 5	U 5	U 5	U 5	U 5	U 5	5.0	–
Inorganics (mg/L)										
Aluminum	3.5	NR	NR	1.5	1.4	NR	3.2	4.1	–	–
Barium	0.033	NR	NR	0.015	0.027	NR	0.015	0.048	2.0	2.0
Calcium	3.4	NR	NR	29.9	34.8	NR	1.4	9.6	–	–
Chromium	U .0069	NR	NR	U .0069	U .0069	NR	0.010	U .0069	0.1	0.1
Copper	0.0079	NR	NR	0.0037	U .0025	NR	0.019	0.024	1.3	–
Cyanide	.020	U .010	NR	U .010	U .010	U .010	U .010	U .010	0.2	0.2
Iron	3.3	NR	NR	44.0	53.2	NR	10.7	12.6	–	–
Potassium	0.80	NR	NR	4.8	5.2	NR	0.84	1.2	–	–
Magnesium	1.2	NR	NR	14.4	16.4	NR	1.7	1.2	–	–
Manganese	0.023	NR	NR	0.19	0.22	NR	0.010	0.089	–	–
Sodium	2.6	NR	NR	3.5	3.5	NR	2.2	2.7	–	–
Nickel	U .0039	NR	NR	U .0039	U .0039	NR	0.020	U .0039	0.1	0.1
Lead	0.0019	NR	NR	0.0023	0.0041	NR	0.0018	0.0060	0.015	0.01
Selenium	0.0011	NR	NR	0.0015	U .0011	NR	U .0011	U .0011	0.05	0.05
Vanadium	0.0046	NR	NR	0.0052	0.0054	NR	0.011	0.010	–	–
Zinc	0.016	NR	NR	U .0049	U .0047	NR	0.059	0.049	5.0	5.0
Pesticide/PCB (µg/L)	U 1.1	U 1.0	NR	U 1.0	U 1.0	U 1.11	U 1.1	U 1.1		
Petroleum Hydrocarbons (mg/L)	NR	NR	NR	NR	NR	NR	NR	NR	–	–

Legend: U = Not detected

NR = Not requested

J = Present below detection limit

Replicate = Lab QA sample

(a) = Refer to June 90 QAAP

(b) = Maximum Contaminant Levels (MCLs) (mg/L)

(c) = NJDEPE Standards for Class II–A Groundwater (mg/L)

Table 4-7a cont....

Summary of Groundwater & Surface Water Sample Analytical Results

Round One: March 1991

NWS Earle, Site 4 (Landfill W D Group)

Site I.D. (a) / Compounds	04-004-M001 Groundwater Replicate	04-005-M001 Groundwater MW04-05	04-006-M001 Groundwater MW04-06	04-004-W001 Surface Water 04-004	04-003-W001 Surface Water 04-003	04-002-W001 Surface Water 04-002	04-001-W001 Surface Water 04-001	04-001-W101 Surface Water 04-001 (Dup.)	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Semivolatiles (µg/L)										
bis (2-Ethylhexyl) phthalate	NR	U 3.5	U 11	NR	NR	NR	NR	NR	–	–
Volatile Organics (µg/L)										
Methylene Chloride	NR	U 5	U 5	8 B	27 B	25 B	30 B	29 B	–	–
Acetone	NR	U 10	52.0	51 B	74 B	37 B	32 B	39 B	–	–
Carbon Disulfide	NR	U 5	U 5	2 JB	1 JB	1 JB	1 JB	1 JB	–	–
Chloroform	NR	U 5	U 5	U 5	U 5	U 5	U 5	U 5	–	–
1,2-Dichloroethene	NR	7.0	U 5	U 5	U 5	U 5	U 5	U 5	–	–
Trichloroethene	NR	14.0	U 5	U 5	U 5	U 5	U 5	U 5	5.0	–
Inorganics (mg/L)										
Aluminum	4.8	9.5	0.98	NR	NR	NR	NR	NR	–	–
Barium	0.049	0.061	0.051	NR	NR	NR	NR	NR	2.0	2.0
Calcium	9.7	8.9	2.8	NR	NR	NR	NR	NR	–	–
Chromium	U .0069	0.026	U .0069	NR	NR	NR	NR	NR	0.1	0.1
Copper	0.023	0.015	0.0051	NR	NR	NR	NR	NR	1.3	–
Cyanide	NR	U .010	U .010	NR	NR	NR	NR	NR	0.2	0.2
Iron	14.4	29.3	2.7	NR	NR	NR	NR	NR	–	–
Potassium	1.2	2.0	0.75	NR	NR	NR	NR	NR	–	–
Magnesium	1.2	1.4	1.1	NR	NR	NR	NR	NR	–	–
Manganese	0.089	0.15	0.047	NR	NR	NR	NR	NR	–	–
Sodium	2.7	2.1	2.1	NR	NR	NR	NR	NR	–	–
Nickel	U .0039	U .0039	U .0039	NR	NR	NR	NR	NR	0.1	0.1
Lead	0.0061	0.013	0.0027	NR	NR	NR	NR	NR	0.015	0.01
Selenium	U .0011	U .0011	U .0011	NR	NR	NR	NR	NR	0.05	0.05
Vanadium	0.011	0.028	0.0033	NR	NR	NR	NR	NR	–	–
Zinc	0.041	0.015	0.010	NR	NR	NR	NR	NR	5.0	5.0
Pesticide/PCB (µg/L)	NR	U 1.1	U 1.1							
Petroleum Hydrocarbons (mg/L)	NR	NR	NR	0.54 J	U 1.3	U 1.1	U 1.0	U 1.1	–	–

Legend: U = Not detected

NR = Not requested

J = Present below detection limit

Replicate = Lab QA sample

(a) = Refer to June 90 QAAP

(b) = Maximum Contaminant Levels (MCLs) (mg/L)

(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4–7b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 4 (Landfill W of "D" Group)

Site I.D. (a) / Compounds	04–001–M002 MW04–01	04–001–M002 REPLICATE	04–001–M302 MW04–01(Trip Blank)	04–002–M002 MW04–02	04–002–M102 MW04–02(Dup.)	04–003–M002 MW04–03
Volatile Organics (µg/L)						
Methylene Chloride	6 B	NR	9 B	9 B	6 B	7 B
Acetone	7 JB	NR	11 B	17 B	82 B	10 B
1,2–Dichloroethene	U 5	NR	U 5	13	13	U 5
Chloroform	U 5	NR	U 5	U 5	U 5	3 J
Trichloroethene	U 5	NR	U 5	U 5	U 5	U 5
Inorganics (µg/L)						
Chromium	U 10	NR	NR	U 10	U 10	U 10
Iron	4660	NR	NR	25000	25300	2900
Manganese	33.6	NR	NR	254	274	22.7
Sodium	U 5000	NR	NR	U 5000	5190	U 5000
Lead	U 3	NR	NR	U 3	U 3	U
Zinc	32.2	NR	NR	U 20	U 20	26.7 20
Inorganics (mg/L)						
NO3/N02 (mg–n/L)						
Turbidity (NTU)						
BOD 5 Day	U 1	NR	NR	U 1	1.4	U 1
Chloride	6.3	NR	NR	6.5	6.2	U 5
Chemical Oxygen Demand	9.1	NR	NR	39.4	36.5	23.5
Nitrate, as N	0.16	NR	NR	U 0.1	U 0.1	0.12
Ammonia, as N	U 0.1	NR	NR	0.29	0.29	U 0.1
Phosphate, as P	U 0.05	U 0.05	NR	U 0.05	U 0.05	U 0.05
Sulfate	23.8	NR	NR	31.2	30.7	10.5
Turbidity	0.08	NR	NR	336	314	0.07

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–7b cont.....

Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 4 (Landfill W of "D" Group)

Site I.D. (a) / Compounds	04–004–M002 MW04–04	04–004–M002 REPLICATE	04–004–M202 MW04–04(Eq. Blank)	04–005–M002 MW04–05	04–005–M002 REPLICATE	04–006–M002 MW04–06
Volatile Organics (µg/L)						
Methylene Chloride	13 B	NR	6 B	4 JB	NR	10 B
Acetone	8 JB	NR	24 B	85 B	NR	20 B
1,2–Dichloroethene	U 5	NR	U 5	33	NR	U 5
Chloroform	U 5	NR	U 5	U 5	NR	1 J
Trichloroethene	U 5	NR	U 5	78	NR	U 5
Inorganics (µg/L)						
Chromium	15.9	U 10	NR	U 10	NR	U 10
Iron	23400	5960	NR	3850	NR	1090
Manganese	139	60.1	NR	58.3	NR	45.6
Sodium	U 5000	U 5000	NR	U 5000	NR	U 5000
Lead	6.9	3.4	NR	U 3	NR	U 3
Zinc	68.4	54.6	NR	20	NR	32.1
Inorganics (mg/L)						
NO3/N02 (mg–n/L)						
Turbidity (NTU)						
BOD 5 Day	U 1	U 1	1.1	U 1	NR	U 1
Chloride	U 5	5.4	U 5	5.6	NR	5.9
Chemical Oxygen Demand	24	26.9	20.7	14.9	NR	16.3
Nitrate, as N	0.13	0.12	U 0.1	0.25	NR	0.11
Ammonia, as N	U 0.1	NR	U 0.1	U 0.1	U 0.1	U 0.1
Phosphate, as P	0.35	NR	U 0.025	U 0.05	NR	U 0.025
Sulfate	11.4	11.4	U 5	13.6	NR	10.5
Turbidity	1120	1120	0.19	186	NR	15.1

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-7c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 4 (Landfill W of "D" Group)

Site I.D.(a) / Compounds	04-001-M003 MW04-01	04-001-M003 REPLICATE	04-001-M303 MW04-01(Trip Blank)	04-002-M003 MW04-02	04-002-M103 MW04-02(Dup.)	04-003-M003 MW04-03	04-004-M003 MW04-04	04-004-M003 REPLICATE	04-004-M203 MW04-04(Eq. Blank)	04-005-M003 MW04-05	04-006-M003 MW04-06	04-006-M003 REPLICATE
Volatile Organics (µg/L)												
Methylene Chloride	U 5	NR	3 JB	U 5	U 5	U 5	U 5	NR	U 5	3 JB	6 B	NR
Acetone	U 10	NR	U 10	710 E	820 E	13000 E	54	NR	940 E	1200 E	5000 B	NR
1,2-Dichloroethene	U 5	NR	U 5	8	9	U 5	U 5	NR	U 5	21	U 5	NR
Chloroform	U 5	NR	U 5	U 5	U 5	3 J	U 5	NR	U 5	U 5	1 J	NR
Trichloroethene	U 5	NR	U 5	U 5	U 5	U 5	U 5	NR	U 5	46	U 5	NR
Inorganics (µg/L)												
Chromium	U 10	NR	NR	U 10	U 10	U 10	24.3	34.5	U 10	25	U 10	NR
Copper	U 25	NR	NR	U 25	U 25	U 25	U 25	29.1	U 25	U 25	U 25	NR
Iron	1960	NR	NR	31000	35300	5720	17400	30000	U 100	21000	1890	NR
Mercury	U 0.2	NR	NR	U 0.2	U 0.2	U 0.2	0.34	0.39	U 0.2	0.32	U 0.2	NR
Manganese	23.6	NR	NR	278	294	23.4	306	356	U 15	183	33.2	NR
Lead	3.4	NR	NR	U 3	U 3	U 3	17.3	29.5	U 3	14.3	U 3	NR
Zinc	57.9	NR	NR	38.7	39.6	42.3	156	159	U 20	62.8	47.9	NR
Inorganics (mg/L)												
NO3/N02 (mg-n/L)												
Turbidity (NTU)												
BOD 5 Day	U 1	NR	NR	U 1	1.1	9.5	U 1	U 1	2.6	U 1	U 1	NR
Chloride	6	NR	NR	6.9	7.2	U 5	U 5	U 5	U 5	5.5	5.6	NR
Chemical Oxygen Demand	2270	NR	NR	50.8	30.7	20.7	23.6	NR	16.4	42.5	13.5	13.5
Nitrate/Nitrite	U 1	U 1	NR	0.33	0.2	0.26	0.19	0.19	0.4	0.32	0.29	NR
Ammonia, as N	U 0.1	NR	NR	0.39	0.41	U 0.1	U 0.1	U 0.1	U 0.1	U 0.1	U 0.1	NR
Phosphate, as P	0.58	0.56	NR	U 0.04	U 0.04	0.048	0.12	NR	0.04	0.63	0.045	NR
Sulfate	23.2	NR	NR	31.8	30.9	9.9	11.1	11.9	U 5	13.3	9.9	NR
Turbidity	242	242	NR	509	463	250	2550	2550	5.3	840	0.46	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, not analyzed as dilution due to suspected field contamination
REPLICATE = Lab QA sample
(a) = Refer to June 90 QAAP

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

present in one sample (well MW04-01) at 7 µg/L. Dichloroethene (DCE) was detected in MW04-02 and MW04-05 at 20 and 7 µg/L, respectively, and trichloroethene (TCE) was detected at 14 µg/L in MW04-05. No pesticides or PCBs were detected. Nitrates were below 0.3 mg/L, and nitrites were undetected. Lead and chromium were highest in MW04-05 at 13 and 26 µg/L, respectively, and undetected in some wells.

The second and third rounds of groundwater sampling included analysis of VOCs, drinking water metals, and landfill indicator parameters. Results for VOCs were similar to the first round, with DCE and TCE confirmed in MW04-05. TCE was found in MW04-05 at 78 and 46 µg/L in the two rounds. Chloroform was also found at 7 and 8 µg/L in MW04-02. Manganese and lead were detected generally at higher concentrations during the second and third rounds in all wells, including MW04-04, the upgradient well. Iron was the most abundant element with the other metals in concentrations roughly proportional to iron. Lead and chromium were not detected in the second round in MW04-05, but were present in the third round at 62 and 25 µg/L, respectively.

Results of the landfill parameters showed slightly elevated levels of COD and sulfates in the downgradient wells relative to upgradient well MW04-04.

4.3.3 Summary of the Site 4 Characterization

Based on the observations made in the test pits, Site 4 landfill received a variety of scrap metal and inert construction-related debris. Groundwater was not encountered. Analysis of soil samples from the test pits showed the presence of petroleum hydrocarbons (as TPH at 2,100 mg/L). However, no specific petroleum-related VOCs or BNAs were detected. Pesticides and PCBs were also undetected.

Two pathways for contaminant migration from the site were identified: surface water via the drainageway originating adjacent to the site, and groundwater. The sediment sample taken in the drainageway at a location closest to the site contained the PCB compound Aroclor-1260 (1.4 mg/kg) and higher concentrations of metals than the two downstream samples. While this may be related to the landfill, PCBs were not found in the test pit samples.

Chlorinated solvent TCE and its breakdown product DCE were found in groundwater samples from one downgradient well. TCE was commonly used as a degreaser and metal cleaner. Its likely source is small quantities of waste associated with the scrap metal. The TCE was limited to one well (MW04-05) at a range of concentrations (14-78 µg/L).

In summary, while the Site 4 landfill has impacted sediments and groundwater at its boundaries, the sampling showed isolated and relatively limited contamination. However, additional investigation will be required to fully delineate the extent of the TCE and other solvent compounds. The steep slope on the southeastern boundary of the fill area and the thin soil cover make the site subject to erosion that would physically expose the waste material.

4.4 SITE 5: LANDFILL WEST OF ARMY BARRICADES

4.4.1 Physical Characteristics

Site 5 is approximately 13 acres in size and appears as a wide open area surrounded by woodlands. The site is located approximately 1,000 feet southwest of Site 2 (EOD). An undeveloped dirt road accesses the site from the northwest. Similar to landfills 3 and 4, the site is moderately vegetated with grasses and some scrub pines. The topography across the site gently slopes to the southwest from approximately 115 feet above MSL near MW05-06 to approximately 105 feet MSL near MW05-03. A railroad siding borders the southwestern boundary of the site. The cover material used at the site is predominantly loose sand from the surrounding area.

4.4.1.1 Soils and Waste Characterization

The original soils within site proper were part of the Lakewood sands [LeB] and Keyport sandy loam [KeB] Series (Section 2). The soils have been altered by past waste practices. Based on the samples obtained during the drilling, test pit excavations, and sampling, the shallow "soils" at Site 5 vary in both composition and color. The shallow soils ranged from sand, fine to medium with some quartz gravel and silt, very pale brown (10YR7/3 to 10YR6/8).

Topsoils in this "barrens" terrain are poorly developed and vegetation cover consists of scrub pines and grass with disturbed areas slow to recover. The test pits completed at the site provided some view of the underlying waste material.

The physical characteristics of the test pits are summarized on Table A-3, Appendix A. A layer of "trash" was encountered in all four test pits that were excavated at Site 5. As presented on Table A-3, the general composition of the trash consisted of foam rubber, glass, paper, plastic, metal scrap materials, lumber, concrete, bricks, and other construction-type debris. The layer of trash ranged in thickness from 6.5 to 13.5 feet. Similar to Site 4, the cover material was thin to nonexistent, and ranged in thickness from 0 to 0.5 feet. No anomalous organic vapor readings were detected in any of the test pits. No groundwater was encountered.

4.4.1.2 Surface Conditions and Drainage

The drainage at Site 5 is a closed system. Drainage at the site occurs primarily through rapid infiltration and evapotranspiration. Infiltration is the main source of recharge to the shallow aquifer at the site and is a controlling factor of groundwater flow at Site 5. The surface water body nearest to Site 5 is a branch of Hockhockson Brook, which is located approximately 1,000 feet east (crossgradient) of Site 5.

4.4.1.3 Hydrogeology

The following lithologic description of Site 5 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These descriptions are contained in the boring logs presented in Appendix A. The sediments underlying Site 5 consist of a relatively homogeneous matrix of very fine to coarse quartz sand with some glauconite and silt, with some iron staining/banding, and varying color from pale brown to very dark gray. These characteristics are consistent with the sediments which compose the lower member of the Vincentown Formation. Site 5 is situated north of the contact which delineates the Vincentown and Kirkwood Formation outcrop. Site 5 is situated within the recharge area of the Vincentown Formation.

Generally, groundwater levels ranged between 15 and 23 feet across Site 5 during the first sampling round. Figure 4-5 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow radiates toward the northeast and southeast with a relatively flat average gradient of .003 feet/foot. This pattern is similar to that observed during other measurement rounds, although in the fall, measurements at all well levels had dropped several feet and the gradient was almost flat. MW05-08 is hydraulically upgradient of the site while MW05-05, MW05-06, and MW05-07 are the most directly downgradient. Based on the average hydraulic conductivity calculated from the slug test data for MW05-02 and MW05-06, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) is approximately .016 feet/day or 6 feet/year.

4.4.2 Chemical Results

4.4.2.1 Analysis of Test Pit Samples

The analytical results for the test pit investigation conducted at Site 5 are presented on Table 4-4. Chemical analysis was conducted on two of the four test pits (05-001-T001 and 05-003-T001) that were excavated at Site 5. The samples were analyzed for the full EPA TCL/TAL scans and TPH. As shown on Table 4-4, several volatile and semivolatile compounds were detected at J values (present below detection limits) in both samples. Toluene and xylene were detected at 22 and 12 µg/kg in sample 05-001-T001. Chromium was detected at 117 mg/kg in sample 05-001-T001. No pesticides or PCBs were detected.

4.4.2.2 Analysis of Groundwater at Site 5

The groundwater quality results for the three sampling rounds conducted at Site 5 are presented in Tables 4-8a, 4-8b and 4-8c. The first round of groundwater analysis showed no semivolatile compounds above detection limits. Three semivolatile compounds were present at J values only (phthalates and 1-4 dichlorobenzene) in samples from four wells. Volatile organic compounds methylene chloride and acetone were present but attributable to field or laboratory cross contamination. Ethylbenzene was present at J values in one sample, and chloroform was detected

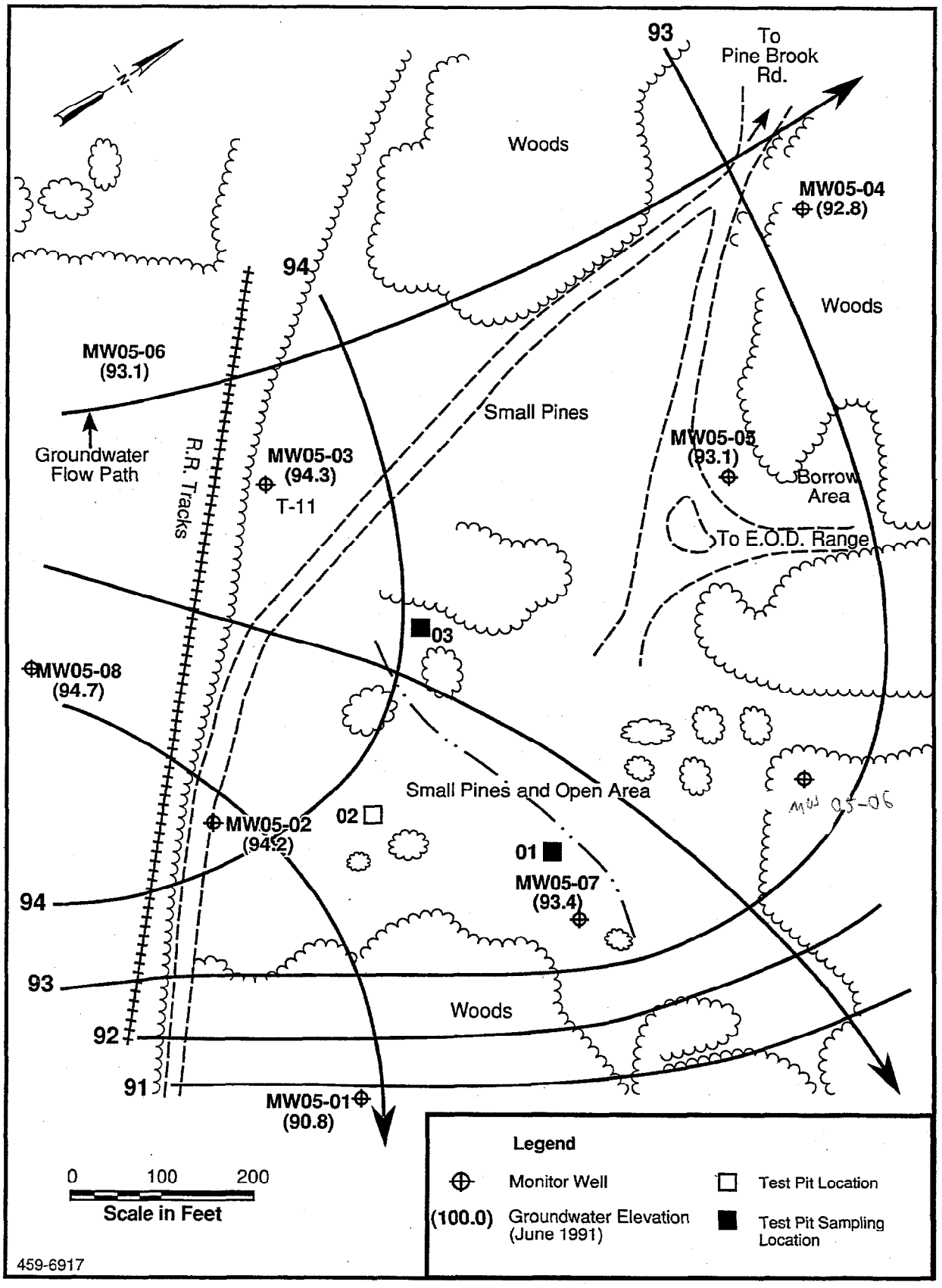


FIGURE 4-5 SITE 5 - LANDFILL WEST OF ARMY BARRICADES GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

Table 4-8a
Summary of Groundwater Sample Analytical Results
Round One: March 1991
NWS Earle, Site 5 (Landfill W of Army Barricades)

Site I.D. (a) / Compounds	05-001-M001 MW05-01	05-001-M301 MW05-01 (Trip Blank)	05-002-M001 MW05-02	05-003-M001 MW05-03	05-004-M001 MW05-04	05-004-M101 MW05-04 (Dup.)	Primary Drinking Water Standards(b)	NJDEPE Groundwater Cleanup Standards(c)
TCL Semi-Volatiles (µg/L)								
1,4-Dichlorobenzene	U 10	NR	U 13	U 10	U 10	U 10	–	–
Naphthalene	U 10	NR	U 13	U 10	U 10	U 10	–	–
Di-n-Butylphthalate	U 10	NR	U 13	U 10	U 10	U 10	–	–
bis(2-Ethylhexyl)phthalate	U 10	NR	U 13	U 10	U 10	U 10	–	–
Volatile Organics (µg/L)								
Methylene Chloride	18	U 5	U 33	U 33	U 5	U 5	–	–
Acetone	U 18	10	920	2100	21	69 B	–	–
Chloroform	2J	U 5	U 33	U 50	U 5	U 5	–	–
Ethylbenzene	U 5	U 5	U 33	U 50	U 5	U 5	700	700
Inorganics (mg/L)								
Aluminum	11.7	NR	10.0	10.6	0.62	0.59	–	–
Barium	0.045	NR	0.040	0.036	0.021	0.021	2.0	2.0
Beryllium	0.0018	NR	0.0013	U .0006	U .0006	U .0006	0.004	0.02
Calcium	0.69	NR	4.2	2.6	2.1	2.1	–	–
Cadmium	U .0027	NR	U .0027	U .0027	U .0027	U .0027	0.005	0.004
Cobalt	0.0030	NR	0.0066	0.0082	U .0003	U .0003	–	–
Chromium	0.31	NR	0.17	0.021	0.016	0.013	0.1	0.1
Copper	0.0060	NR	0.0045	0.0035	0.0045	0.0035	1.3	–
Cyanide	U .010	NR	U .010	U .010	U .010	U .010	0.2	0.2
Iron	45.8	NR	26.2	2.6	5.9	5.8	–	–
Potassium	8.4	NR	7.8	2.9	1.2	1.1	–	–
Magnesium	2.9	NR	4.6	1.3	1.7	1.6	–	–
Manganese	0.032	NR	0.067	0.090	0.072	0.071	–	–
Sodium	2.6	NR	3.3	4.0	1.9	1.9	–	–
Nickel	U .0039	NR	0.015	0.029	0.0046	U .0039	0.1	0.1
Lead	0.0054	NR	0.0042	0.0034	0.013	0.011	0.015	0.01
Antimony	U 0.0182	NR	U 0.0182	U 0.0182	U 0.0182	U 0.0182	0.006	0.02
Vanadium	0.25	NR	0.12	0.010	0.013	0.012	–	–
Zinc	0.036	NR	0.022	0.061	U 0.0047	U 0.0047	5.0	5.0
Pesticide/PCB (µg/L)	U 1.0	NR	U 1.2	U 1.1	U 1.0	U 1.0		

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit

Replicate = Lab QA sample
(a) = Refer to June 90 QAAP

(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4-8acont....
Summary of Groundwater Sample Analytical Results
Round One: March 1991
NWS Earle, Site 5 (Landfill W of Army Barricades)

Site I.D. (a) / Compounds	05-004-M201 MW05-04 (Eq. blank)	05-005-M01 MW05-05	05-006-M001 MW05-06	05-007-M001 MW05-07	05-008-M001 MW05-08	05-008-M001 Replicate	Primary Drinking Water Standards[b]	NJDEPE Groundwater Cleanup Standards[c]
TCL Semi-Volatiles (µg/L)								
1,4-Dichlorobenzene	U 11	2J	U 12	U 11	U 10	NR	-	-
Naphthalene	U 11	U 10	2J	U 11	U 10	NR	-	-
Di-n-Butylphthalate	U 11	U 10	1J	U 11	U 10	NR	-	-
bis(2-Ethylhexyl)phthalate	U 11	U 10	4J	3J	2J	NR	-	-
Volatile Organics (µg/L)								
Methylene Chloride	U 5	U 6	340J	U 26	5J	NR	-	-
Acetone	66	U 12	7600	330	620	NR	-	-
Chloroform	8	U 6	U 500	U 26	6	NR	-	-
Ethylbenzene	U 5	U 6	U 500	14J	U 6	NR	700	700
Inorganics (mg/L)								
Aluminum	0.025	8.0	114	69.6	43.2	55.9	-	-
Barium	U .0044	0.084	0.18	0.071	0.093	0.094	2.0	2.0
Beryllium	U .0006	0.0013	0.017	0.0038	0.0045	0.0088	0.004	0.02
Calcium	0.12	13.1	55.9	53.7	19.3	18.9	-	-
Cadmium	U .0027	U .0027	U .0027	0.034	U .0027	U .0027	0.005	0.004
Cobalt	U .0030	0.0047	0.036	0.066	0.012	0.013	-	-
Chromium	U .0069	0.17	4.1	0.69	1.2	1.6	0.1	0.1
Copper	U .0025	0.0060	0.051	0.019	0.022	0.025	1.3	-
Cyanide	U .010	U .010	U .010	U .010	U .010	U .010	0.2	0.2
Iron	0.029 B	27.7	571	120	150	234	-	-
Potassium	0.16	6.2	74.4	21.6	28.4	45.9	-	-
Magnesium	U .0359	8.6	27.7	16.7	10.6	16.0	-	-
Manganese	U .001	0.17	1.2	0.72	0.22	0.23	-	-
Sodium	0.36	6.8	21.4	15.2	4.1	4.1	-	-
Nickel	U .0039	0.013	0.058	0.14	0.018	0.018	0.1	0.1
Lead	0.0014	0.028	0.061	0.026	0.038	0.033	0.015	0.01
Antimony	U 0.0182	U 0.018	0.062	U 0.018	U 0.018	0.031	0.006	0.02
Vanadium	U 002	0.13	2.2	0.38	0.72	1.1	-	-
Zinc	U .0047	0.060	0.99	1.8	0.12	0.15	5.0	5.0
Pesticide/PCB (µg/L)	U 1.2	U 1.0	U 5.9	U 5.1	U 1.0			

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit

Replicate = Lab QA sample
(a) = Refer to June 90 QAAP

(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4–8b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 5 (Landfill W of Army Barricades)

Site I.D. (a) / Compounds	05–001–M002 MW05–01	05–001–M002 REPLICATE	05–001–M302 MW05–01(Trip Blank)	05–002–M002 MW05–02	05–002–M002 REPLICATE	05–003–M002 MW05–03	05–004–M002 MW05–04
Volatile Organics (µg/L)							
Vinyl Chloride	U 10	NR	U 10	U 10	NR	U 10	2 J
Chloroethane	U 10	NR	U 10	U 10	NR	U 10	U 10
Methylene Chloride	2 JB	NR	4 JB	1 JB	NR	3 JB	3 JB
Acetone	24 B	NR	91 B	110 B	NR	18 B	150 B
Carbon Disulfide	U 5	NR	1 J		NR	U 5	U 5
Chloroform	4 J	NR	U 5	U 5	NR	U 5	U 5
1,2–Dichloroethene	U 5	NR	U 5	U 5	NR	U 5	3 J
1,2–Dichloroethane	U 5	NR	U 5	U 5	NR	U 5	U 5
Trichloroethene	U 5	NR	U 5	U 5	NR	U 5	U 5
Benzene	U 5	NR	U 5	U 5	NR	U 5	1 J
1,12,2–Tetrachloroethane	U 5	NR	U 5	U 5	NR	U 5	U 5
Chlorobenzene	U 5	NR	U 5	U 5	NR	U 5	1 J
Ethylbenzene	U 5	NR	U 5	U 5	NR	U 5	U 5
Xylene	U 5	NR	U 5	U 5	NR	U 5	U 5
Inorganics (µg/L)							
Cadmium	U 5	NR	NR	U 5	NR	U 5	U 5
Chromium	362	NR	NR	789	NR	27.7	403
Copper	U 25	NR	NR	U 25	NR	U 25	U 25
Iron	56700	NR	NR	110000	NR	2800	58900
Manganese	53.4	NR	NR	134	NR	67.6	102
Sodium	U 5000	NR	NR	U 5000	NR	U 5000	5960
Lead	5.6	NR	NR	12.1	NR	U 3	15
Zinc	70.8	NR	NR	95.1	NR	88.1	78.4
Inorganics (mg/L)							
NO3/N02 (mg–n/L)							
Turbidity (NTU)							
BOD 5 Day	U 1	NR	NR	U 1	NR	U 1	1.4
Chloride	7.6	7.6	NR	8.9	NR	7.2	8.3
Chemical Oxygen Demand	21	NR	NR	18.1	NR	9.4	31.2
Nitrate/Nitrite, Nitrate, as N	0.16	NR	NR	0.14	NR	0.28	0.13
Ammonia, as N	U 0.1	NR	NR	U 0.1	NR	U 0.1	U 0.1
Phosphate, as P	0.25	0.23	NR	0.17	NR	U 0.05	0.088
Sulfate	11.7	NR	NR	28.5	28.4	89.9	18.7
Turbidity	1170	1710	NR	1530	NR	53	331

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–8b cont....
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 5 (Landfill W of Army Barricades)

Site I.D.(s) / Compounds	05–005–M002 MW05–05	05–006–M002 MW05–06	05–006–M102 MW05–06(Dup.)	05–006–M202 MW05–06(Eq. Blank)	05–007–M002 MW05–07	05–008–M002 MW05–08	05–008–M202 MW05–08(Eq. Blank)
Volatile Organics (µg/L)							
Vinyl Chloride		U 10	U 10		U 10	U 10	U 10
Chloroethane	U 10	2 J	2 J	U 10	1 J	U 10	U 10
Methylene Chloride	2 JB	25 B	25 B	3 JB	6 B	10 B	3 JB
Acetone	19 B	83 B	140 B	46 B	25 B	15 B	16 B
Carbon Disulfide	U 5	U 5	U 5	U 5	U 5		U 5
Chloroform	U 5	U 5	U 5	U 5	U 5	U 5	6
1,2–Dichloroethene	U 5	16	15	U 5	1 J	U 5	U 5
1,2–Dichloroethane	U 5	U 5	U 5	U 5	U 5	U 5	U 5
Trichloroethene	U 5	12	12	U 5	2 J	U 5	U 5
Benzene	2 J	4 J	3 J	U 5	1 J	U 5	U 5
1,1,2,2–Tetrachloroethane	U 5	3 J	3 J	U 5	U 5	U 5	U 5
Chlorobenzene	2 J	1 J	1 J	U 5	U 5	U 5	U 5
Ethylbenzene	U 5	3 J	3 J	U 5	U 5	U 5	U 5
Xylene	U 5	10	9	U 5	U 5	U 5	U 5
Inorganics (µg/L)							
Cadmium	5.3	16.6	5.6	U 5	25.1	U 5	U 5
Chromium	650	6060	460	U 10	2800	155	U 10
Copper	U 25	U 250	U 25	U 25	35.3	U 25	U 25
Iron	102000	880000	98500	222	497000	21600	U 100
Manganese	322	1460	701	U 15	591	51.2	U 15
Sodium	U 5000	29500	34800	U 5000	7880	U 5000	U 5000
Lead	26.3	98.5	26.9	U 3	64.8	U 3	U 3
Zinc	193	1120	29	U 20	916	47.9	U 20
Inorganics (mg/L)							
NO3/N02 (mg–n/L)							
Turbidity (NTU)							
BOD 5 Day	U 1	6.3	2.3	U 1	3.6	NR	U 1
Chloride	24.1	47.2	45	U 5	11.2	7.7	U 5
Chemical Oxygen Demand	22.5	48.4	29.5	U 5	60.3	21	7.9
Nitrate/Nitrite, Nitrate, as N	0.13	0.23	0.18	0.17	0.63	NR	U 0.1
Ammonia, as N	U 0.1	0.34	0.11	U 0.1	U 0.1	NR	U 0.1
Phosphate, as P	0.16	0.31	0.25	U 0.025	1.2	NR	U 0.025
Sulfate	43.2	93.3	91.7	U 5	184	15	U 5
Turbidity	211	835	7380	0.61	644	182	U 0.05

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–8c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 5 (Landfill W of Army Barricades)

Site I.D.(a) / Compounds	05-001-M003 REPLICATE	05-001-M303 MW05-01(Trip Blank)	05-002-M003 MW05-02	05-003-M003 MW05-03	05-003-M003 REPLICATE	05-004-M003 MW05-04	05-005-M003 MW05-05
Volatile Organics (µg/L)							
Chloroethane	NR	U 10	U 10	U 10	NR	U 10	U 10
Methylene Chloride	NR	12 B	3 JB	3 JB	NR	2 JB	2 JB
Acetone	NR	660 E	120 B	120 B	NR	4900 E	120 B
1,1-Dichloroethane	NR	U 5	U 5	U 5	NR	U 5	U 5
1,2-Dichloroethene	NR	U 5	U 5	U 5	NR	4 J	U 5
Chloroform	NR	U 5	U 5	U 5	NR	U 5	U 5
1,2-Dichloroethane	NR	U 5	U 5	U 5	NR	U 5	U 5
Trichloroethene	NR	U 5	U 5	U 5	NR	U 5	U 5
Benzene	NR	U 5	U 5	U 5	NR	1 JB	1 J
1,1,2,2-Tetrachloroethane	NR	U 5	U 5	U 5	NR	U 5	U 5
Chlorobenzene	NR	U 5	U 5	U 5	NR	U 5	1 J
Ethylbenzene	NR	U 5	U 5	U 5	NR	U 5	U 5
Xylene	NR	U 5	U 5	U 5	NR	U 5	U 5
Inorganics (µg/L)							
Cadmium	NR	NR	U 5	U 5	NR	U 5	5.7
Chromium	NR	NR	41.6	51.3	NR	273	614
Iron	NR	NR	4870	6200	NR	38000	65900
Mercury	NR	NR	U 0.2	U 0.2	NR	U 0.2	0.28
Manganese	NR	NR	69.6	42.4	NR	80.8	280
Sodium	NR	NR	U 5000	U 5000	NR	5600	5820
Lead	NR	NR	3.1	15.3	NR	15.7	30.9
Zinc	NR	NR	76.3	97.9	NR	101	222
Inorganics (mg/L)							
NO3/NO2(mg-n/L)							
Turbidity(NTU)							
BOD 5 Day	NR	NR	U 1	1.2	NR	3.3	1.7
Chloride	7.8	NR	8	8.2	NR	7.8	23.4
Chemical Oxygen Demand	NR	NR	15.3	19.7	NR	22.7	30
Nitrate, as N	U 0.1	NR	U 0.1	0.14	NR	U 0.1	0.1
Ammonia, as N	NR	NR	U 0.1	U 0.1	NR	U 0.1	U 0.1
Phosphate, as P	NR	NR	U 0.04	U 0.04	NR	0.15	0.24
Sulfate	NR	NR	33.3	24.5	24.4	14.9	33.8
Turbidity	NR	NR	418	177	NR	433	470

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-8c cont.....
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 5 (Landfill W of Army Barricades)

Site I.D.(a) / Compounds	05-005-M000 REPLICATE	05-006-M000 MW05-06	05-006-M103 MW05-06(Dup.)	05-006-M103 REPLICATE	05-007-M000 MW05-07	05-007-M000 REPLICATE	05-008-M000 MW05-08
Volatile Organics (µg/L)							
Chloroethane	NR	2 J	U 10	NR	U 10	NR	U 10
Methylene Chloride	NR	15 B	16 B	NR	2 JB	NR	U 5
Acetone	NR	1100 E	1600 E	NR	360 E	NR	400 E
1,1-Dichloroethane	NR	1 J	U 5	NR	U 5	NR	U 5
1,2-Dichloroethene	NR	12	17	NR	U 5	NR	U 5
Chloroform	NR	U 5	U 5	NR	U 5	NR	U 5
1,2-Dichloroethane	NR	8	8	NR	U 5	NR	U 5
Trichloroethene	NR	12	14	NR	U 5	NR	U 5
Benzene	NR	4 J	4 J	NR	U 5	NR	U 5
1,1,2,2-Tetrachloroethane	NR	3 J	3 J	NR	U 5	NR	U 5
Chlorobenzene	NR	1 J	U 5	NR	U 5	NR	U 5
Ethylbenzene	NR	4 J	4 J	NR	U 5	NR	U 5
Xylene	NR	9	11	NR	U 5	NR	U 5
Inorganics (µg/L)							
Cadmium	NR	U 5	U 5	NR	U 5	NR	U 5
Chromium	NR	416	247	NR	120	NR	104
Iron	NR	81500	52900	NR	15500	NR	13300
Mercury	NR	U 0.2	U 0.2	NR	U 0.2	NR	U 0.2
Manganese	NR	640	615	NR	84.1	NR	37.5
Sodium	NR	35100	34900	NR	7240	NR	U 5000
Lead	NR	23.4	15.2	NR	5.4	NR	4.2
Zinc	NR	305	308	NR	127	NR	45.4
Inorganics (mg/L)							
NO3/NO2(mg-n/L)							
Turbidity(NTU)							
BOD 5 Day	NR	7.7	6.9	6.9	1.2	NR	U 1
Chloride	NR	43.5	45.7	NR	7	NR	7.7
Chemical Oxygen Demand	30	40.3	10.9	NR	22.2	NR	14.9
Nitrate, as N	NR	U 0.1	U 0.1	NR	0.27	0.26	U 0.1
Ammonia, as N	NR	0.11	0.11	0.11	U 0.1	NR	U 0.1
Phosphate, as P	0.26	0.16	0.059	NR	0.051	0.051	U 0.04
Sulfate	NR	110	107	NR	59.9	NR	13.5
Turbidity	NR	629	781	NR	398	NR	195

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

in two samples, wells MW05-04 and MW05-08 at 8 and 6 µg/L, respectively. MW05-08 is an upgradient well. No pesticides or PCBs were detected. Lead and chromium were highest in MW05-06 at 61 and 4,100 µg/L, respectively. Beryllium was detected in six samples from 1.3 to 8.8 µg/L, above the MCL of 1 µg/L. Elevated cadmium was also found in one well (MW05-07, 34 µg/L).

The second and third rounds of groundwater sampling included analysis of VOCs, drinking water metals, and landfill indicator parameters. Results for VOCs were similar to the first round with DCE, TCE, and xylene also detected in MW05-06. DCE was highest at 16 and 17 µg/L in the two rounds. Chloroform was not found in the second and third rounds. Elevated chromium, cadmium and, to a lesser extent, lead were detected during the second and third rounds in several wells.

Results of the landfill parameters showed slightly elevated sulfate levels during the second round but no clear distinction for other parameters between downgradient wells and upgradient well MW05-08.

4.4.3 Summary of the Site 5 Characterization

Based on the observations made in the test pits, Site 5 landfill received a variety of municipal trash and inert construction-related debris. Analysis of soil samples from the test pits showed the presence of low concentrations of petroleum-related VOCs or BNAs. Pesticides and PCBs were undetected.

No surface water drainage was observed at the site, and the sandy soils allow most precipitation to percolate downward. Groundwater is the main pathway for contaminant migration from the site.

Chlorinated solvent compound TCE and its breakdown product DCE and fuel-related xylene were found in low concentrations in groundwater samples from one downgradient well. The likely source of these compounds is small quantities of waste associated with the landfill.

In summary, while the Site 5 landfill has impacted groundwater at its boundaries, the sampling showed isolated and relatively limited contamination and the landfill does not appear to have caused or have the potential to cause major releases of contaminants to the environment.

4.5 SITE 7: LANDFILL SOUTH OF "P" BARRICADES

4.5.1 Physical Characteristics

Site 7 is approximately 5 acres in size and appears as a wide open area surrounded by woodlands. The site is bordered on three sides by an undeveloped dirt road. Similar to the other landfill sites, Site 7 is moderately vegetated with grasses and some scrub pines, with the exception of a few scarred areas where no vegetation exists. The topography across the site gently slopes to the west-southwest from approximately 165 feet above MSL near MW07-03 to approximately 125 feet above MSL near MW07-02. The cover material used at the site is predominantly loose sand apparently quarried from the surrounding area. A reconnaissance of the site conducted during the RI identified remnants (brick piles) of the former houses and a large steel plate (in the area of the reported tank) in the southeast corner of the site. The steel plate may possibly serve as a cover for an underground structure other than an underground tank.

A pile of construction rubble and scrap metal is present at the surface adjacent to MW07-05. The physical topographic relief suggests that the edge of the fill tapers out to the original ground surface. The fill face is steepest (approximately 10 feet high) on the northwestern side of the site in the area northeast of MW07-04.

4.5.1.1 Soils and Waste Characterization

The original soils within the site proper were part of the Tinton loamy sand [ToA] Series. The soils have been altered by past waste practices and have subsequently been classified as Psamments waste substratum [PW] Series (Section 2). Based on the samples obtained during the drilling, test pit excavations and sampling, the shallow "soils" at Site 7 vary in both composition and color. The shallow soils ranged from sand, very fine to medium, and loam, very pale brown

(10YR7/4) to dark brown (7.5YR5/8). In contrast with the surrounding soils, the soils covering the landfill are poorly developed and vegetation cover consists primarily of scrub pines. The test pits completed at Site 7 provided some view of the underlying waste material.

The physical characteristics of the test pits are summarized on Table A-4, Appendix A. A layer of "trash" was encountered in five of the seven test pits that were excavated at Site 7. As presented on Table A-4, the general composition of the trash consisted of glass, paper, plastic, cans, and other types of household or shipboard-generated waste. Some metal scrap materials, lumber, concrete, bricks, and other construction-type debris were also encountered. The layer of trash ranged in thickness from 2.5 to 6 feet. Similar to Sites 4 and 5, the cover material was thin to nonexistent and ranged in thickness from 0 to 0.5 feet. No anomalous organic vapor readings were detected in any of the test pits.

4.5.1.2 Surface Conditions and Drainage

Drainage at Site 7 occurs primarily through rapid infiltration and evapotranspiration. Infiltration is the main source of recharge to the shallow aquifer at the site and is a controlling factor of groundwater flow at Site 7. The surface water body nearest to Site 7 is a branch of the head waters of Compton Creek, which is located approximately one-half mile east of Site 7. Compton Creek discharges into a tidal marsh area contiguous with Sandy Hook Bay.

4.5.1.3 Hydrogeology

The following lithologic description of Site 7 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These descriptions are contained in the boring logs presented in Appendix A. The sediments underlying Site 7 consist of a matrix of silt to medium sand, micaceous, and varying in color from brown to very dark gray. The sediments grade upward to fine to coarse semi-indurated sands. This is evidenced by the local presences of weathered, loose ferruginous sandstone exposed at the surface of the site. This same layer of ferruginous sandstone was also encountered (dense and cemented) in some of the shallow test pits at Site 8, located in the same area. These characteristics are

consistent with the sediments of the Wenonah Formation. Site 7 is situated within the outcrop and recharge areas of the Wenonah Formation and Mount Laurel Sand.

Groundwater levels range between 15 and 18 feet bgs across Site 7 during the first sampling round. Topographic relief is more than 34 feet across the site. Figure 4-6 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the southwest, mimicking topography, at an average gradient of .025 feet/foot. This pattern is similar to that observed during other measurement rounds, although in the fall measurements, all well levels had dropped several feet. MW07-03 is hydraulically upgradient of the site while MW07-02, MW07-04, and MW07-05 are the most directly downgradient. Based on the average hydraulic conductivity calculated from the slug test data for MW07-02 and MW07-03, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) is approximately 0.2 feet/day or 64 feet/year.

4.5.2 Chemical Results

4.5.2.1 Analysis of Test Pit Samples

The analytical results for the test pit investigation conducted at Site 7 are presented in Table 4-9. Chemical analysis was conducted on samples from two of the seven test pits (07-001-T001 and 07-007-T001) that were excavated at Site 7. The samples were analyzed for the full EPA TCL/TAL scans and TPH. Bis(2-ethylhexyl)phthalate was detected at 90J and 110 µg/kg (below detection limits) in samples 07-001-T001 and 07-007-T001, respectively. No pesticides or PCBs were detected in either sample.

4.5.2.2 Analysis of Groundwater at Site 7

The groundwater quality results for the three sampling rounds conducted at Site 7 are presented in Tables 4-10a, 4-10b and 4-10c. The first round of groundwater analysis showed no semivolatile compounds above detection limits. Two semivolatile compounds were present at J values only, occurring once each in different samples. Volatile organic compounds, methylene

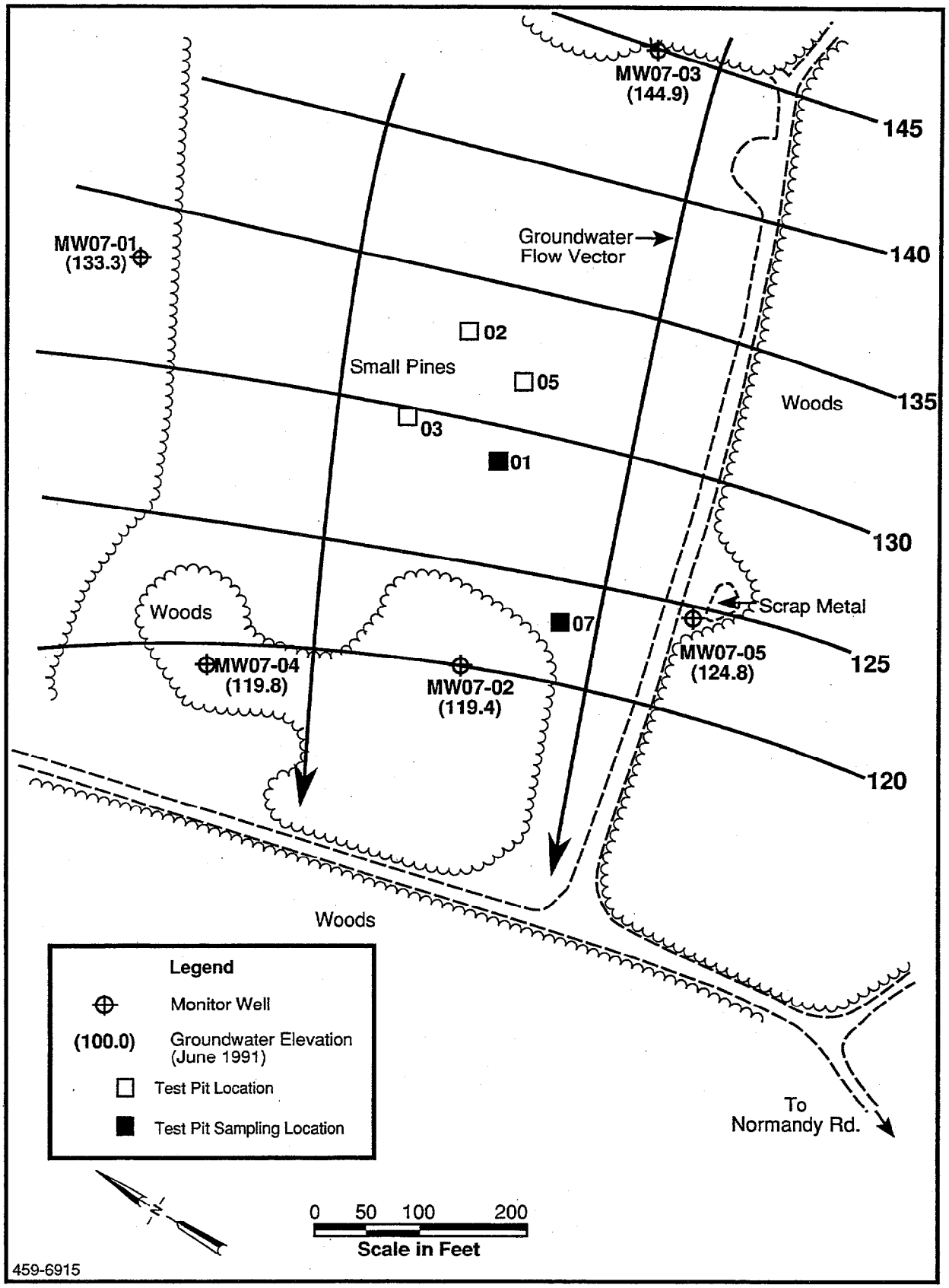


FIGURE 4-6 SITE 7 - LANDFILL SOUTH OF "P" BARRICADES GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

Table 4-9
Summary of Soil Sample Analytical Results
NWS Earle, Test Pits, Sites 7 and 10

Site ID: (a) / Compounds	07-001-T001	07-001-T001 Replicate	07-007-T001	10-004-T001	10-004-T001 Replicate	10-004-T201	10-004-T201 Replicate	10-004-T301
TCL Semi-Volatiles (µg/kg)								
Benzoic Acid	U 1800	NR	U 2100	U 1900	NR	U 52	NR	NR
Acenaphthene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Dibenzofuran	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Phenanthrene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Anthracene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Di-n-Butylphthalate	U 360	NR	49 J	U 380	NR	U 10	NR	NR
Fluoranthene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Pyrene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Benzo(a)anthracene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Chrysene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
bis(2-Ethylhexyl)phthalate	90 J	NR	110 J	86 J	NR	U 10	NR	NR
Benzo(b)fluoranthene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Benzo(k)fluoranthene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Benzo(a)pyrene	U 360	NR	U 420	U 380	NR	U 10	NR	NR
Inorganics (mg/kg)								
Silver	U 0.71	U 0.71	U 0.91	U 0.67	NR	U .0038	U .0038	NR
Aluminum	7260	7634	5740	7550	NR	0.12	0.077	NR
Arsenic	11.9	11.4	18.3	5.3	NR	U .0009	U .0009	NR
Barium	14.2	14.9	8.4	6.0	NR	U .0044	U .0044	NR
Beryllium	0.32	0.39	0.31	0.69	NR	U .0006	U .0006	NR
Calcium	165	170	146	117	NR	0.19	0.099	NR
Cadmium	U 0.51	U 0.51	U 0.65	U 0.48	NR	0.0045	U .0027	NR
Cobalt	1.3	1.3	U	0.55	NR	U .003	U .003	NR
Chromium	24.3	23.8	22.3	94.4	NR	U .0069	U .0069	NR
Copper	3.1	3.04	3.3	U 0.44	NR	0.0040	U .040	NR
Cyanide	U 0.26	U 0.26	U 0.32	U 0.28	NR	U .083	U .033	NR
Iron	15200	15331	11600	20000	NR	0.11	0.039	NR
Potassium	733	769	500	4240	NR	U .095	U .095	NR
Magnesium	555	559	358	1480	NR	0.082	0.054	NR
Manganese	15.1	16.9	6.2	11.8	NR	U .0001	U .0001	NR
Sodium	162	152	54.0	19.6	NR	0.40	0.25	NR
Nickel	1.4	1.2	U 0.94	U 0.64	NR	0.0054	U .0039	NR
Lead	13.8	11.5	6.0	2.6	NR	U .0015	U .0015	NR
Selenium	0.56	0.61	0.50	0.52	NR	U .0011	U .0011	NR
Vanadium	36.1	34.4	26.1	76.4	NR	U .002	U .002	NR
Zinc	13.3	16.9	10.2	8.9	NR	0.027	U .0047	NR
% Solids	90.2	90.1	79.1	87.7	NR	NR	NR	NR
Nitrite	0.64	NR	U	U	U	U	NR	NR
Nitrate	0.81	NR	0.65	5.1	5.1	0.27	NR	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

Table 4-9cont....
Summary of Soil Sample Analytical Results
NWS Earle, Test Pits, Sites 7 and 10

Site ID (a) / Compounds	07-001-T001	07-001-T001 Replicate	07-007-T001	10-004-T001	10-004-T001 Replicate	10-004-T201	10-004-T201 Replicate	10-004-T301
Pesticide/PCB (µg/kg)								
Blanks are µg/L								
Dieldrin	U 88	NR	U 20	U 18	NR	U .11	NR	NR
4,4-DDE	U 88	NR	U 20	U 18	NR	U .11	NR	NR
4,4-DDD	U 88	NR	U 20	U 18	NR	U .11	NR	NR
4,4-DDT	U 88	NR	U 20	U 18	NR	U .11	NR	NR
alpha-Chlordane	U 440	NR	U 99	U 91	NR	U .57	NR	NR
gamma-Chlordane	U 440	NR	U 99	U 91	NR	U .57	NR	NR
Explosives (µg/g)	U .005	NR	U .005	U .005	NR	U .013	NR	NR
Petroleum Hydrocarbons (mg/kg)	19.0	NR	58.0	4.9 B	NR	0.38 J	NR	NR
Volatile Organics (µg/kg)								
Blanks are µg/L								
Methylene Chloride	NR	NR	NR	NR	NR	15 B	NR	NR
Acetone	NR	NR	NR	NR	NR	6 JB	NR	NR
Toluene	NR	NR	NR	NR	NR	U 5	NR	NR
Ethylbenzene	NR	NR	NR	NR	NR	U 5	NR	NR
Xylene	NR	NR	NR	NR	NR	U 5	NR	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

Table 4-10a
Summary of Groundwater Sample Analytical Results
Round One: March 1991
NWS Earle, Site 7 (Landfill South Of "P" Barricades)

Site I.D. (a) / Compounds	07-001-M001 MW7-001	07-002-M001 MW07-02	07-002-M101 MW07-02(Dup.)	07-002-M201 MW07-02(Eq. Blank)	07-003-M001 MW07-03	07-003-M001 Replicate	07-004-M001 MW07-04	07-005-M001 MW07-05	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
TCL Semi-Volatiles (µg/L)										
Benzoic Acid	U 51	3 J	U 51	U 54	U 54	NR	U 52	U 50	–	–
bis-2-chloroisopropylether	U 10	U 11	U 10	U 11	U 11	NR	U 10	1 J	–	–
Volatile Organics (µg/L)										
Methylene Chloride	U 12	2 BJ	U 5	U 5	U 5	NR	U 100	2 J	–	–
Acetone	500	U 11	U 10	220	U 10	NR	1100	U 10	–	–
Chlorobenzene	U 12	5	5 J	U 5	U 5	NR	U 100	U 5		
1,2-Dichloroethene	U 12	U 5	U 5	U 5	U 5	NR	U 100	4 J	–	–
2-Butadone	U 26	U 10	U 10	U 5	U 10	NR	U 200	88	–	–
1,1,2-Trichloroethane	U 12	U 5	U 5	U 5	U 5	NR	U 100	26	–	–
1,1,2,2-Tetrachloroethane	U 12	U 5	U 5	U 5	U 5	NR	U 100	8	–	–
Inorganics (mg/L)										
Aluminum	27.8	2.0	2.0	0.024	10.4	10.7	13.3	7.8	–	–
Arsenic	0.040	U .0009	U .0009	U .0009	0.0026	0.0034	0.011	0.0071	0.05	0.008
Barium	0.053	0.036	0.037	U .0044	0.044	0.043	0.11	0.10	2.0	2.0
Beryllium	0.0013	U .0006	U .0006	U .0006	U .0006	U .0006	0.0009	0.0006	0.004	0.02
Calcium	1.6	4.9	4.9	0.071	1.7	1.7	5.8	5.9	–	–
Cobalt	0.013	0.0057	0.0051	U .0003	0.014	0.012	0.0094	0.012	–	–
Chromium	0.041	U .0069	U .0069	U .0069	0.030	0.033	0.047	0.014	0.1	0.1
Copper	0.025	0.0055	0.0065	0.0030	0.012	0.013	0.024	0.0091	1.3	–
Cyanide	U .010	U .010	U .010	U .010	U .010	U .010	U .010	U .010	0.2	0.2
Iron	43.0	3.1	3.0	0.054	30.3	30.3	45.1	11.2	–	–
Potassium	3.2	1.1	1.1	0.19	3.1	3.2	3.2	2.6	–	–
Magnesium	2.7	1.4	1.4	.0359	2.1	2.1	4.3	5.6	–	–
Manganese	0.084	0.16	0.16	U .001	0.097	0.097	0.17	0.12	–	–
Sodium	4.4	11.8	12.7	0.28	5.0	7.9	5.6	15.3	–	–
Nickel	0.042	0.0049	0.0053	U .0039	0.0055	U .0039	0.024	0.023	0.1	0.1
Lead	0.019	0.0040	0.0056	U .0014	0.010	0.011	0.017	0.0081	0.015	0.01
Antimony	U .0182	U .0182	U .0182	U .0182	U .0182	U .0182	U .0182	U .0182	0.006	0.02
Selenium	0.0039	U .0011	U .0011	U .0011	U .0011	U .0011	0.0017	U .0011	0.05	0.05
Vanadium	0.059	U .0002	0.0032	U .002	0.056	0.055	0.062	0.018	–	–
Zinc	0.061	0.087	0.086	U .0047	0.011	0.010	0.063	0.046	5	5
Pesticide/PCB (µg/L)										
Heptachlor	U .056	0.010 J	0.010 J	U .055	U .069	NR	U .051	U .063	0.4	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate – LabQA sample

(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4–10b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 7 (Landfill S of "P" Barricades)

Site I.D. (a) / Compounds	07–001–M02 MW07–01	07–001–M02 REPLICATE	07–001–M02 MW07–01(Trip Blank)	07–002–M02 MW07–02	07–003–M02 MW07–03	07–003–M02 REPLICATE
Volatile Organics (µg/L)						
Methylene Chloride	4 JB	NR	7 B	3 JB	2 JB	NR
Acetone	140 B	NR	25 B	410 B	23 B	NR
1,2–Dichloroethene	U 5	NR	U 5	U 5	U 5	NR
1,2–Dichloroethane	U	NR	U 5	U 5	U 5	NR
1,1,2–Trichloroethane	U 5	NR	U 5	U 5	U 5	NR
Chlorobenzene	U 5	NR	U 5	4 J	U 5	NR
Inorganics (µg/L)						
Arsenic	NR	NR	NR	U 10	U 10	NR
Barium	NR	NR	NR	U 200	U 200	NR
Cadmium	NR	NR	NR	U 5	U 5	NR
Chromium	NR	NR	NR	U 10	U 10	NR
Copper	NR	NR	NR	U 25	U 25	NR
Iron	NR	NR	NR	9570	9070	NR
Mercury	NR	NR	NR	U 0.2	U 0.2	NR
Manganese	NR	NR	NR	69.5	74.4	NR
Sodium	NR	NR	NR	25600	U 5000	NR
Lead	NR	NR	NR	3.5	6.1	NR
Zinc	NR	NR	NR	34.5	U 20	NR
Inorganics (mg/L)						
NO3/N02 (mg–n/L)						
Turbidity (NTU)						
BOD 5 Day	3.3	NR	NR	U 1	0.3	NR
Chloride	U 50	NR	NR	27.6	8.1	NR
Chemical Oxygen Demand	126	NR	NR	35.6	12.3	13.8
Nitrate/Nitrite	0.3	NR	NR	2	0.29	NR
Ammonia, as N	U 0.1	U 0.1	NR	2.1	U 0.1	NR
Phosphate, as P	0.15	0.14	NR	0.52	U 0.05	NR
Sulfate	6.7	NR	NR	36.4	8.6	NR
Turbidity	553	553	NR	46.6	88.1	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
REPLICATE = Lab QA sample
(a) Refer to June 90 QAAP

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–10b cont.....
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 7 (Landfill S of "P" Barricades)

Site I.D. (a) / Compounds	07–003 – M202 MW07–03 (Eq. Blank)	07–004 – M002 MW07–04	07–004 – M102 MW07–04 (Dup.)	07–005 – M002 MW07–05	07–005 – M002 REPLICATE
Volatile Organics (µg/L)					
Methylene Chloride	4 JB	3 JB	1 JB	2 JB	NR
Acetone	130 B	62 B	39 B	15 B	NR
1,2 – Dichloroethene	U 5	U 5	U 5	4 J	NR
1,2 – Dichloroethane	U 5	U 5	U 5	1 J	NR
1,1,2 – Trichloroethane	U 5	U 5	U 5	5	NR
Chlorobenzene	U 5	U 5	U 5	U 5	NR
Inorganics (µg/L)					
Arsenic	U 10	91.6	106	196	NR
Barium	U 200	218	250	416	NR
Cadmium	U 5	U 5	5.6	8	NR
Chromium	U 10	217	235	289	NR
Copper	U 25	94.4	110	160	NR
Iron	U 100	183000	213000	282000	NR
Mercury	U 0.2	U 0.2	U 0.2	1	NR
Manganese	U 15	480	560	682	NR
Sodium	U 5000	6820	6770	18800	NR
Lead	U 3	92	152	150	NR
Zinc	U 20	280	345	464	NR
Inorganics (mg/L)					
NO3/NO2 (mg – n/L)					
Turbidity (NTU)					
BOD 5 Day	U 1	4.8	3.9	8.6	7.4
Chloride	U 5	15.9	15.2	28.2	28.2
Chemical Oxygen Demand	13.8	221	156	323	NR
Nitrate/Nitrite	0.24	0.25	0.23	0.18	0.18
Ammonia, as N	U 0.1	U 0.1	U 0.1	U 0.1	NR
Phosphate, as P	U 0.025	1.4	0.99	1.4	NR
Sulfate	U 5	17.4	18.6	39.3	NR
Turbidity	0.11	1850	2160	3580	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
REPLICATE = Lab QA sample
(a) Refer to June 90 QAAP

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-10c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 7 (Landfill S of "P" Barricades)

Site I.D. (a) / Compounds	07-001-M003 MW07-01	07-001-M003 REPLICATE	07-002-M003 MW07-02	07-002-M003 REPLICATE	07-003-M003 MW07-03	07-003-M003 REPLICATE	07-003-M203 MW07-03(Eq. Blank)
Volatile Organics (µg/L)							
Methylene Chloride	4 JB	NR	2 JB	NR	2 JB	NR	4 JB
Acetone	10000 E	NR	640 E	NR	87 B	NR	900 E
Chloroform	1 JB	NR	U 5	NR	U 5	NR	U 5
1,2-Dichloroethene	U 5	NR	U 5	NR	U 5	NR	U 5
1,1,2-Trichloroethane	U 5	NR	U 5	NR	U 5	NR	U 5
Chlorobenzene	U 5	NR	5	NR	U 5	NR	U 5
Inorganics (µg/L)							
Arsenic	111	NR	U 10	NR	U 10	NR	U 5
Barium	289	NR	U 200	NR	U 200	NR	U 200
Cadmium	6.9	NR	U 5	NR	U 5	NR	U 5
Chromium	248	NR	10.7	NR	30.1	NR	U 10
Copper	140	NR	U 25	NR	28.5	NR	U 25
Iron	353000	NR	14500	NR	48200	NR	U 100
Mercury	0.34	NR	U 0.2	NR	U 0.2	NR	U 0.2
Manganese	619	NR	65.5	NR	146	NR	U 15
Sodium	U 5000	NR	27700	NR	U 5000	NR	U 5000
Lead	156	NR	5.2	NR	10.7	NR	U 3
Zinc	481	NR	38.9	NR	58.2	NR	U 20
Inorganics (mg/L)							
NO3/NO2 (mg-n/L)							
Turbidity (NTU)							
BOD5 Day	8.1	NR	1.2	NR	8.1	NR	U 1
Chloride	11.8	NR	27.8	NR	9.7	9.6	U 5
Chemical Oxygen Demand	170	NR	58.1	NR	103	NR	12.8
Nitrare/Nitrite	0.52	0.52	2.2	NR	0.19	NR	1.9
Ammonia, as N	U 0.1	U 0.1	2.1	NR	0.13	NR	U 0.1
Phosphate, as P	0.61	NR	0.21	0.19	1	NR	0.058
Sulfate	10	NR	38.7	NR	33.9	NR	U 5
Turbidity	505	505	1160	NR	1160	NR	1.6

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

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Table 4-10c cont.....
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 7 (Landfill S of "P" Barricades)

Site I.D. (a) / Compounds	07-003-M203 REPLICATE	07-004-M003 MW07-04	07-004-M103 MW07-04(Dup.)	07-004-M303 MW07-04(Trip Blank)	07-005-M003 MW07-05	07-005-M003 REPLICATE
Volatile Organics (µg/L)						
Methylene Chloride	NR	2 JB	2 JB	7 B	4 JB	3.3
Acetone	NR	810 E	350 E	13 B	2700 E	NR
Chloroform	NR	U 5	U 5	U 5	U 5	NR
1,2-Dichloroethene	NR	U 5	U 5	U 5	4 J	NR
1,1,2-Trichloroethane	NR	U 5	U 5	U 5	5	NR
Chlorobenzene	NR	U 5	U 5	U 5	U 5	NR
Inorganics (µg/L)						
Arsenic	NR	61.1	25.9	NR	152	NR
Barium	NR	U 200	U 200	NR	310	NR
Cadmium	NR	U 5	U 5	NR	U 5	NR
Chromium	NR	106	69.4	NR	176	NR
Copper	NR	68.3	47.3	NR	118	NR
Iron	NR	110000	66500	NR	178000	NR
Mercury	NR	U 0.2	0.22	NR	1.9	NR
Manganese	NR	306	223	NR	430	NR
Sodium	NR	6860	6930	NR	18800	NR
Lead	NR	63	53.8	NR	83	NR
Zinc	NR	178	137	NR	364	NR
Inorganics (mg/L)						
NO3/NO2 (mg-n/L)						
Turbidity (NTU)						
BOD5 Day	NR	2.9	2.9	NR	2.9	3.3
Chloride	NR	14	13.8	NR	26.7	NR
Chemical Oxygen Demand	12.8	59.5	70.9	NR	170	NR
Nitrare/Nitrite	NR	0.32	0.27	NR	0.27	NR
Ammonia, as N	NR	U 0.1	U 0.1	NR	U 0.1	NR
Phosphate, as P	NR	0.12	0.12	NR	0.44	NR
Sulfate	U 5	21.4	22.1	NR	44	NR
Turbidity	NR	1130	1110	NR	455	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

chloride and acetone, were present but attributable to field or laboratory cross contamination. 1,1,2-trichloroethane (TCA), 1,1,2,2-tetrachloroethane, and 2-butanone were found in one well, MW07-05. The pesticide heptachlor was detected in well MW07-02 at J values; no PCBs were detected. The maximum concentrations of lead and chromium were 19 and 47 µg/L, respectively.

The second and third rounds of groundwater sampling included analysis of VOCs, drinking water metals, and landfill indicator parameters. Results for VOCs were similar to the first round, although only TCA was detected at 5 µg/L in MW07-05. Elevated lead and chromium relative to round 1 were detected during rounds 2 and 3 in wells MW07-01, MW07-04, and MW07-05. The maximum concentration of lead and chromium detected in the groundwater was 156 and 248 µg/L, respectively, in well MW07-01 during round 3. Arsenic was also elevated in MW07-04, and MW07-05 in rounds 2 and 3. Concentrations of arsenic ranged from 92-196 µg/L.

Results of the landfill parameters showed slightly elevated levels of COD, chlorides, and sulfates in the downgradient wells relative to upgradient well MW07-03.

4.5.3 Summary of the Site 7 Characterization

Similar to the other landfill sites, Site 7 is an inactive solid waste landfill containing, based on the test pit inspection, the normal range of municipal wastes. Cover material was found to be thin to nonexistent in some areas (ranging in thickness from 0 to 0.5 feet).

Three of the five monitor wells (MW07-02, MW07-04, and MW07-05) are hydrologically downgradient of the landfill. 1,1,2-trichloroethane (TCA), 1,1,2,2-tetrachloroethane, and 2-butanone were found in one well, MW07-05. The pesticide heptachlor was detected in well MW07-02 at J values; PCBs were not detected. Lead and chromium were less than 19 and 47 µg/L, respectively. Arsenic concentrations in three wells ranged from 96-196 µg/L. MW07-05 showed slightly elevated concentrations of TCA in all three sampling rounds. The local occurrence of these "hits" does not suggest a major source of contamination in the landfill. The

existing data are not high enough to indicate that the old landfill is generating large quantities of leachate.

The finding that the cover material was thin to nonexistent in some areas (ranging in thickness from 0 to 0.5 feet) will be given further consideration during the screening of alternatives.

4.6 SITE 10 SCRAP METAL LANDFILL

4.6.1 Physical Characteristics

Site 10 (shown on Figure 4-7) is approximately 2 acres in size and appears as a very small open area surrounded by woodlands. The boundaries of the site are ill-defined. The site is bordered on the east by railroad tracks and on the northeast by a small stream which joins a branch of the head waters of Hockhockson approximately 500 feet toward the northwest. An undeveloped dirt road enters Site 10 from Munda Road. Site 10 is vegetated with grasses and some scrub pines, with the exception of a scarred area in the center of the site where no vegetation exists. The topography across the site is relatively flat at an average elevation of 110 feet above MSL. In the open area near MW10-02, the physical topographic relief suggests that the edge of the fill tapers out to the original ground surface to a low-lying area east to northeast. The cover material used at the site is predominantly loose sand apparently quarried from the surrounding area. A few ordnance casings (corroded almost beyond recognition) were exposed at the surface in the open area where some of the surface cover had eroded away.

4.6.1.1 Soils and Waste Characterization

The original soils at Site 10 are mainly part of the Atsion [At] soil Series. However, a thin band, or inclusion, of the Lakehurst sand [LaA] Series (Section 2) is present along the northwest portion of the site adjacent to Midway Road. The contrast between these two soil series is evident in the samples obtained during the drilling and soil sampling. The shallow "soils" at Site 10 vary in both composition and color between sampling locations. The shallow soils ranged from silt loam and sand, grayish brown (10YR5/2) in the MW10-07 indicative of the Atsion

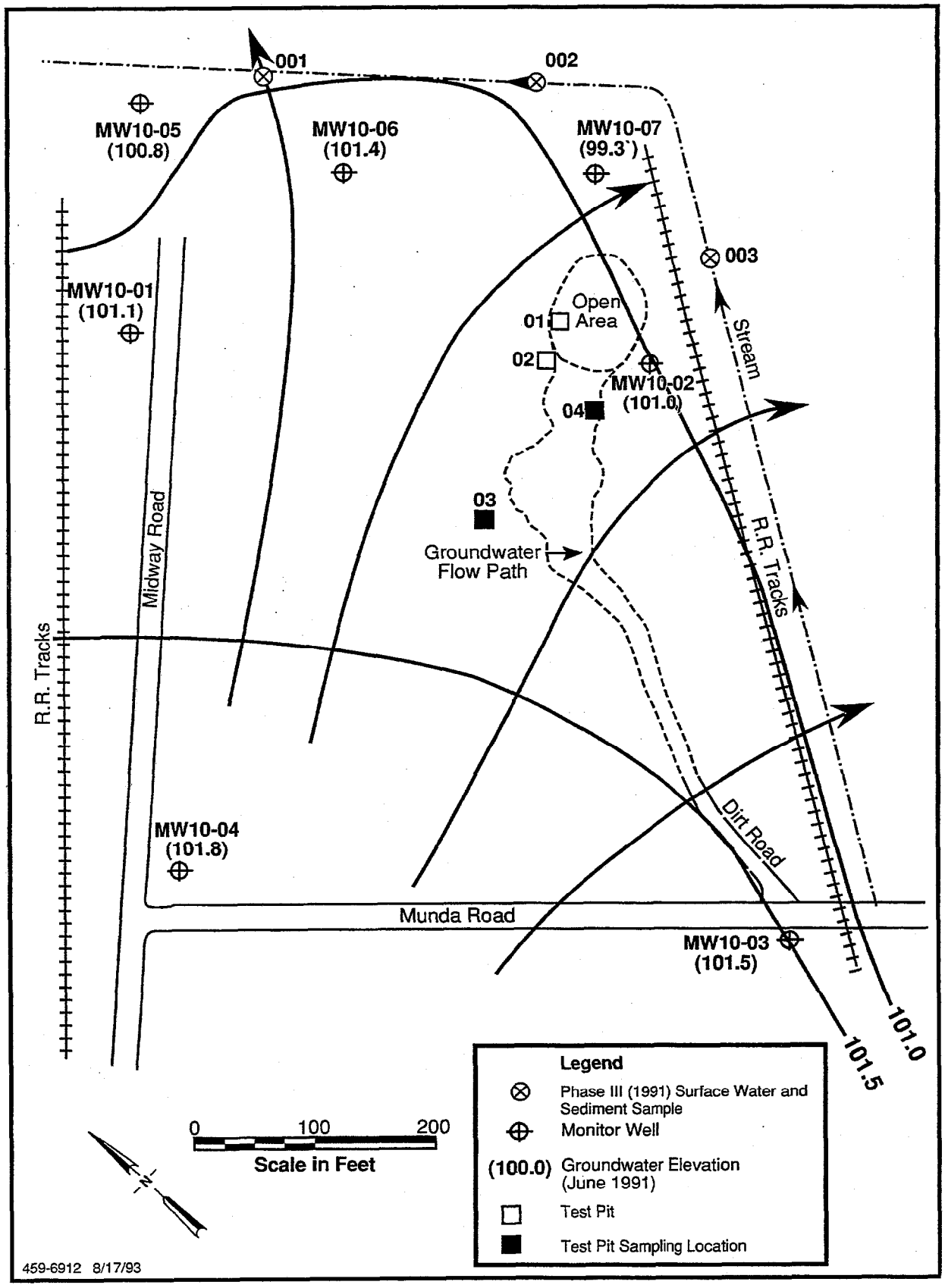

FIGURE 4-7 SITE 10 - SCRAP METAL LANDFILL GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

Series, to sand, fine to medium, pale brown (10YR7/3) at MW10-05 in the Lakehurst Series.

The test pits completed at Site 10 provided some view of the underlying waste characteristics. The physical characteristics of the test pits are summarized on Table A-5, Appendix A. Waste was encountered in two of the four test pits that were excavated at Site 10. As presented on Table A-5, the general composition of the waste consisted of metallic debris such as rusted shell casings. The layer of trash ranged in thickness from approximately 0.5 to 2 feet. A layer or mat of decomposed natural organic material (i.e., leaf litter, root matter, black organic silt) was encountered at between 3.5 to 5.5 feet in all of the test pits. Similar to the other landfills, the cover material was thin to nonexistent, and ranged in thickness from 0 to 0.5 feet. No anomalous organic vapor readings were detected in any of the test pits.

4.6.1.2 Surface Conditions and Drainage

Drainage at Site 10 occurs primarily through overland flow, infiltration, and evapotranspiration. Infiltration is the main source of recharge to the shallow aquifer at the site and is a controlling factor of groundwater flow at Site 10. A stream located along the east and northeast boundaries of Site 10 runs to the east of the railroad on the east, but directly borders the site on the northeast.

4.6.1.3 Hydrogeology

The following lithologic description of Site 10 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These descriptions are contained in the boring logs presented in Appendix A. In general, the sediments underlying Site 10 consist of very fine to coarse quartz sand and glauconite (green silt), and some clay stringers. Although Site 10 is reported to be situated within the outcrop and recharge area of the Kirkwood Formation, these sediment descriptions are more characteristic of the Shark River Formation which underlies the Kirkwood Formation.

Groundwater levels range between 6 and 12 feet bgs across Site 10 during the first sampling round. Shallow groundwater is influenced by a stream that runs along the southeast boundary of the site. Figure 4-7 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the east with the contours bending parallel to the stream consistent with the stream acting as a line of shallow groundwater discharge, average gradient of .0035 feet/feet. This pattern is similar to that observed during other measurement rounds, although in the fall measurements, most well levels had dropped slightly. MW10-04 is hydraulically upgradient of the site, while MW10-02, MW10-06, and MW10-07 are the most directly downgradient. Based on the average hydraulic conductivity calculated from the slug test data for MW10-04, MW10-05, and MW10-07, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) is approximately 0.04 feet/day or 13 feet/year.

4.6.2 Chemical Results

4.6.2.1 Analysis of Test Pit Samples

The analytical results for the test pit investigation conducted at Site 10 are presented in Table 4-9. Chemical analysis was conducted on one of the four test pits (10-004-T001) that were excavated at Site 10. The samples were analyzed for the full U.S. EPA TCL/TAL scans and TPH. As shown in Table 4-9, one semivolatile compound, bis(2-ethylhexyl)phthalate, was detected at 86J µg/kg (below detection limits) in sample 10-004-T001. No anomalous levels of inorganic compounds were detected. No VOCs, pesticides, or PCBs were detected.

4.6.2.2 Analysis of Surface Water and Sediments at Site 10

Three surface sampling locations were selected in the small stream running adjacent to the railroad tracks northeast of the site, then turning under the tracks and across the northwest edge of Site 10. The results of the sediment and surface water sampling are presented in Tables 4-11a and 4-11b, respectively. The sampling locations are presented in Figure 3-7. As shown on Figure 3-7, the samples 001 through 002 are located along the stream as it runs through a low

Table 4-11a
Summary of Sediment Sample Analytical Results
NWS Site 10 (Scrap Metal Landfill near De-Mil)

Site I.D. (a) / Compounds	10-001-D001 Sediment Sample 10-01	10-002-D001 Sediment Sample 10-02	10-003-D001 Sediment Sample 10-02
Volatile Organics (µg/L)			
Methylene Chloride	74 B	56 B	69 B
Acetone	29 B	15 B	79 B
Semivolatiles (µg/L)			
Phenanthrene	66 J	U 450	170 J
Fluoranthene	65 J	U 450	88 J
Pyrene	U 100	U 450	92 J
Benzo(a)anthracene	54 J	U 450	52 J
Chrysene	76 U	U 450	90
bis (2-Ethylhexyl)phthalate	61 J	U 450	U 460
Inorganics (mg/kg)			
Aluminum	475	508	676
Arsenic	U 0.41	U 0.46	1.7
Barium	4.1	3.3	5.5
Calcium	99.3	94.9	139
Cobalt	U 0.82	U 0.82	2.8
Chromium	2.2	3.3	6.3
Iron	3490	3230	9790
Mercury	U 0.010	U 0.098	0.13
Potassium	67.6	80.1	97.6
Magnesium	24.3	41.8	24.5
Manganese	14.8	8.9	58.9
Sodium	33.9	29.2	44.7
Lead	4.5	3.5	5.8
Antimony	3.2	U 1.8	U 1.8
Vanadium	3.2	3.4	7.2
Zinc	13.1	13.0	14.9
% Solids (%)	84.3	78.5	79.6
Pesticide/PCB (µg/L)	U 200	U 190	U 200

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP

Table 4–11b

Summary of Surface Water Sample Analytical Results
NWS Site 10 (Scrap Metal Landfill near De–Mil)

Site I.D. (a) / Compounds	10–001–W001	10–002–W001	10–003–W001	10–003–W301
Volatile Organics (μg/L)				
Methylene Chloride	28 B	27 B	3 JB	5 B
Acetone	11 B	33 B	140 B	120 B
Carbon Disulfide	1 JB	1 JB	5 U	5 U
Chloroform	5 U	5 U	5 U	5
Petroleum Hydrocarbons (mg/L)	1.0 U	1.1 U	1.1 U	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

area northwest of the site; sample 003 was taken in a ditch where the stream flows adjacent to the railroad tracks which occupy an elevated strip of ground separating Site 10 from the stream. Sample 003 was considered the background sample because this portion of the stream receives no surface runoff from the site. The groundwater from the site area may recharge the stream at this point. However, the results of the groundwater and surface water sampling do not indicate impact to the stream from groundwater.

For sediments, the results of the analysis show no VOCs detected in the sample which were not also identified in the blanks. Four semivolatile compounds associated with coal ash, including pyrene, were detected at J values in sediment samples 001 and 003. These compounds are probably associated with material in the railroad bed that may have washed into the stream. Levels of metals were low in all three samples compared to results reported for other site soils and sediments in this RI. No PCB or pesticide compound was found in any of the sediment samples.

The surface water samples were analyzed for VOCs and TPH only. No VOCs not identified in blank samples were detected. TPH was also undetected.

4.6.2.3 Analysis of Groundwater at Site 10

The groundwater quality data for the three sampling rounds conducted at Site 10 are presented in Tables 4-12a, 4-12b, and 4-12c. The first round of groundwater analysis showed no semivolatile compounds above detection limits. One compound, bis(2-ethylhexyl) phthalate, was present below the method detection limit (J values) in two samples. Volatile organic compounds, methylene chloride and acetone and carbon disulfide, were present but attributable to field or laboratory cross contamination. No pesticides or PCBs were detected. Lead and chromium were highest in MW10-07 at 20 and 3,600 µg/L, respectively. Arsenic was found in several wells and was highest in MW10-05 ranging from 71-196 µg/L. Cadmium was found slightly above MCL in several wells, up to 8 µg/L. Antimony was detected in five wells from 9.7 to 51 µg/L. The highest value (MW10-07) was not confirmed in the replicate sample which had much lower concentrations of antimony (7.7 µg/L).

Table 4-12a

Summary of Groundwater Sample Analytical Results
NWS Site 10 (Scrap Metal Landfill near De-Mil)

Site ID. (a) / Compounds	10-001-M001 MW10-01	10-001-M001 Replicate	10-002-M001 MW10-02	10-003-M001 MW10-03	10-004-M001 MW10-04	10-005-M001 MW10-05	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Volatile Organics (µg/L)								
Methylene Chloride	16 B	NR	4 JB	10 B	4 JB	3 JB	–	–
Acetone	12 B	NR	4000	38	U 10	U 10	–	–
Carbon Disulfide	2 JB	NR	U 5	2 JB	2 JB	2 JB	–	–
Chloroform	U 5	NR	U 5	U 5	U 5	U 5	–	–
Semivolatiles (µg/L)								
bis (2-Ethylhexyl)phthalate	U 11	NR	U 11	U 10	U 10	U 10	–	–
Inorganics (mg/L)								
Aluminum	3.9	NR	2.9	0.73	14.3	31.9	–	–
Antimony	U .0075	NR	0.0097	0.012	0.013	0.017	0.006	0.020
Arsenic	0.0019	NR	U .0018	U .0018	0.019	0.0089	0.05	0.008
Barium	0.065	NR	0.061	U .004	0.034	0.027	2.0	2.0
Beryllium	U .0005	NR	U .0005	U .0005	0.0020	0.0048	0.004	0.02
Calcium	5.4	NR	0.54	2.9	2.9	3.2	–	–
Cadmium	0.0042	NR	U .0034	U .0034	U .0034	U .0034	0.005	0.004
Cobalt	0.0036	NR	U .0034	U .0034	0.010	0.012	–	–
Chromium	0.080	NR	0.028	0.023	0.45	0.76	0.1	0.1
Copper	U .0029	NR	0.019	U	U .0029	0.013	1.3	–
Cyanide	U .020	U .010	U .010	U .010	U .010	U .010	0.2	0.2
Iron	12.3	NR	3.1	4.9	73.9	98.9	–	–
Potassium	3.1	NR	0.92	0.85	10.3	23.7	–	–
Magnesium	2.8	NR	0.41	1.5	4.1	8.2	–	–
Manganese	0.16	NR	0.023	0.0033	0.055	0.047	–	–
Sodium	20.6	NR	1.6	10.2	3.6	4.5	–	–
Nickel	0.013	NR	0.0075	U	0.027	0.019	0.1	0.1
Lead	0.038	NR	U .0016	0.0021	0.030	0.062	0.015	0.01
Selenium	U .0011	NR	U .0011	U .0011	U .0011	0.0016	0.05	0.05
Vanadium	0.045	NR	0.020	0.028	0.36	0.59	–	–
Zinc	0.044	NR	0.31	0.018	0.12	0.16	5.0	5.0
Pesticide/PCB (µg/L)	U 1.1	U 1.1	U 1.1	U 1.1	U 1.1	U 1.2	NR	
Petroleum Hydrocarbons (mg/L)	NR	NR	NR	NR	NR	NR	–	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
Replicate = Lab QA sample
(a) = Refer to June 90 QAAP
(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4-12a cont....

Summary of Groundwater Sample Analytical Results
NWS Site 10 (Scrap Metal Landfill near De-Mil)

Site ID (a) / Compounds	MW10-006-M001 MW10-06	MW10-006-M001 Replicate	MW10-006-M301 MW10-06(Trip Blank)	10-007-M001 MW10-07	10-007-M201 MW10-07(Eq. Blank)	10-007-M201 Replicate	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Volatile Organics (µg/L)								
Methylene Chloride	30 B	NR	34 B	3JB	19 B	NR	–	–
Acetone	3100 B	NR	26 B	22	160	NR	–	–
Carbon Disulfide	U 5	NR	U 5	2JB	2JB	NR	–	–
Chloroform	U 5	NR	U 5	U 5	U 5	NR	–	–
Semivolatiles (µg/L)								
bis (2-Ethylhexyl)phthalate	2J	NR	NR	2JB	U	NR	–	–
Inorganics (mg/L)								
Aluminum	3.8	NR	NR	122	0.088	0.022	–	–
Antimony	U .0075	NR	NR	0.051	U .0075	0.0078	0.006	0.020
Arsenic	0.0022	NR	NR	0.096	U .0018	U .0018	0.05	0.008
Barium	0.060	NR	NR	0.13	U .0040	U .0040	2.0	2.0
Beryllium	U	NR	NR	0.017	U .0005	U .0005	0.004	0.02
Calcium	1.9	NR	NR	4.5	0.10	0.10	–	–
Cadmium	U .0034	U .0034	NR	0.015	U .0034	U .0034	0.005	0.004
Cobalt	U .0034	U .0034	NR	0.15	U .0034	U .0034	–	–
Chromium	0.043	0.054	NR	3.6	U .0063	U .0063	0.1	0.1
Copper	U .0029	U .0029	NR	0.044	U .0029	U .0029	1.3	–
Cyanide	U .010	U .010	NR	U .010	U .010	NR	0.2	0.2
Iron	8.0	9.2	NR	452	0.19	0.032	–	–
Potassium	2.0	2.3	NR	63.8	U .142	U .142	–	–
Magnesium	1.3	1.5	NR	19.7	U .0516	U .0516	–	–
Manganese	0.028	0.028	NR	0.43	U .0009	U .0009	–	–
Sodium	5.0	5.0	NR	9.6	0.24	0.22	–	–
Nickel	0.0055	0.006	NR	0.38	U .0036	U .0036	0.1	0.1
Lead	0.018	0.017	NR	0.20	U .0016	U .0016	0.015	0.01
Selenium	U .0011	U .0011	NR	U .0011	U .0011	U .0011	0.05	0.05
Vanadium	0.033	0.037	NR	3.0	U .0026	U .0036	–	–
Zinc	0.090	0.090	NR	1.2	0.0078	0.0045	5.0	5.0
Pesticide/PCB (µg/L)	U 1.1	NR	NR	U 1.1	U 1.1	U 1.1	NR	
Petroleum Hydrocarbons (mg/L)	NR	NR	NR	NR	NR	NR	–	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
Replicate = Lab QA sample
(a) = Refer to June 90 QAAP
(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4-12b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 10 (Scrap Metal Landfill)

Site I.D. (a) / Compounds	10-001-M002 MW10-01	10-002-M002 MW10-02	10-003-M002 MW10-03	10-003-M002 REPLICATE	10-003-M302 MW10-03(Trip Blank)	10-004-M002 MW10-04	10-004-M002 REPLICATE
Volatile Organics (µg/L)							
Methylene Chloride	14 B	2 JB	2 JB	NR	3 JB	14 B	NR
Acetone	25 B	U 10	4 JB	NR	5 JB	22 B	NR
Inorganics (µg/L)							
Arsenic	U 10	U 10	U 10	NR	NR	U 10	NR
Cadmium	U 5	U 5	U 5	NR	NR	U 5	NR
Chromium	133	86.3	68.1	NR	NR	1060	NR
Copper	U 25	U 25	U 25	NR	NR	35.1	NR
Iron	22600	9440	7420	NR	NR	161000	NR
Manganese	217	40.9	U 15	NR	NR	225	NR
Sodium	23200	U 5000	9120	NR	NR	U 5000	NR
Lead	6.7	U 3	5.9	NR	NR	35.1	NR
Zinc	124	233	32.4	NR	NR	231	NR
Inorganics (mg/L)							
NO3/N02 (mg-n/L)							
Turbidity (NTU)							
BOD5 Day	U 1	U 1	U 1	NR	NR	2.7	NR
Chloride	47.3	U 5	8.1	8.1	NR	8	NR
Chemical Oxygen Demand	32.7	U 5	U 5	NR	NR	52.9	NR
Nitrate/Nitrite	0.26	U 0.1	0.24	0.24	NR	0.22	NR
Ammonia, as N	U 0.1	U 0.1	U 0.1	NR	NR	U 0.1	NR
Phosphate, as P	0.03	U 0.02	0.03	NR	NR	0.16	0.17
Sulfate	52.5	17.2	16	NR	NR	18.8	NR
Turbidity	171	45	139	139	NR	967	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–12b cont.....

Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 10 (Scrap Metal Landfill)

Site I.D. (a) / Compounds	10-005-M002 MW10-05	10-005-M002 REPLICATE	10-005-M202 MW10-05(Eq. Blank)	10-006-M002 MW10-06	10-007-M002 MW10-07	10-007-M002 REPLICATE	10-007-M102 MW10-07(Dup.)
Volatile Organics (µg/L)							
Methylene Chloride	15 B	NR	6 B	3 JB	7 B	NR	2 JB
Acetone	30 B	NR	7 JB	9 JB	11 B	NR	6 JB
Inorganics (µg/L)							
Arsenic	10.4	NR	U 10	U 10	18.3	NR	29.9
Cadmium	5.4	NR	U 5	U 5	U 5	NR	U 5
Chromium	530	NR	U 10	54.5	76.6	NR	68.1
Copper	46.8	NR	U 25	U 25	U 25	NR	U 25
Iron	62700	NR	108	50400	36000	NR	39700
Manganese	83.1	NR	U 15	140	150	NR	167
Sodium	U 5000	NR	U 5000	5130	U 5000	NR	U 5000
Lead	109	NR	U 3	7.9	10.4	NR	12.3
Zinc	170	NR	U 20	266	87	NR	94
Inorganics (mg/L) NO3/N02 (mg-n/L) Turbidity (NTU)							
BOD5 Day	3.2	3.9	U 1	U 5	U 1	NR	1.7
Chloride	6.9	NR	U 5	10.8	5.9	NR	5.8
Chemical Oxygen Demand	81.6	NR	9.2	70.1	52.9	NR	32.7
Nitrate/Nitrite	0.38	NR	0.1	U 0.1	U 0.1	U 0.1	U 0.1
Ammonia, as N	0.2	0.38	U 0.1	U 0.1	0.26	NR	0.25
Phosphate, as P	0.3	0.25	U 0.02	0.062	0.13	0.15	0.089
Sulfate	U 5	NR	U 5	39.1	46.6	NR	24.6
Turbidity	751	NR	0.23	114	319	319	177

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–12c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 10 (Scrap Metal Landfill)

Site I.D. (a) / Compounds	10–001–M003 MW10–01	10–001–M003 REPLICATE	10–002–M003 MW10–02	10–003–M003 MW10–03	10–003–M003 REPLICATE	10–004–M003 MW10–04
Volatile Organics (µg/L)						
Methylene Chloride	4 JB	NR	4 JB	7 B	NR	9 B
Acetone	88 B	NR	3300 E	200 B	NR	94 B
Chloroform	U 5	NR	U 5	U 5	NR	U 5
Inorganics (µg/L)						
Arsenic	U 10	U 10	U 10	U 10	NR	37.7
Chromium	151 10	153	34.7	21.3	NR	1130
Copper	U 25	U 25	U 25	U 25	NR	25.2
Iron	21800	22400	2650	4490	NR	1E+05
Manganese	220	2.6	26.1	U 15	NR	170
Sodium	21500	20800	U 500	6740	NR	U 5000
Lead	10.5	11.7	U 3	14	NR	56
Zinc	238	209	285	U 20	NR	228
Inorganics (mg/L)						
NO3/N02 (mg–n/L)						
Turbidity (NTU)						
BOD 5 Day	U 1	NR	1.1	1.2	NR	3.3
Chloride	40.9	NR	5.8	8	NR	8.8
Chemical Oxygen Demand	31	NR	10.5	14.9	NR	9.5
Ammonia, as N	U 0.1	NR	U 0.1	U 0.1	NR	U 0.1
Nitrate, as N	U 0.1	NR	U 0.1	0.26	0.25	U 0.1
Phosphate, as P	0.056	0.049	U 0.02	U 0.04	NR	0.38
Sulfate	59.7	58.9	18	18.3	NR	20.3
Turbidity	228	228	36.6	81.9	NR	560

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–12c cont.....
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 10 (Scrap Metal Landfill)

Site I.D. (a) / Compounds	10–004–M203 MW10–04(Eq. Blank)	10–004–M203 REPLICATE	10–005–M003 MW10–05	10–005–M003 REPLICATE	10–005–M303 MW10–05(Trip Blank)	10–006–M003 MW10–06
Volatile Organics (µg/L)						
Methylene Chloride	9 B	NR	4 JB	NR	6 B	2 JB
Acetone	100 B	NR	450 E	NR	25 B	26 B
Chloroform	U 5	NR	U 5	NR	U 5	U 5
Inorganics (µg/L)						
Arsenic	U 10	NR	U 10	NR	NR	U 10
Chromium	U 10	NR	209	NR	NR	32.5
Copper	U 25	NR	U 25	NR	NR	U 25
Iron	U 100	NR	35700	NR	NR	7650
Manganese	U 15	NR	41.8	NR	NR	31.3
Sodium	U 5000	NR	U 5000	NR	NR	7120
Lead	10.8	NR	50	NR	NR	U 3
Zinc	326	NR	86.5	NR	NR	248
Inorganics (mg/L)						
NO3/N02 (mg–n/L)						
Turbidity (NTU)						
BOD 5 Day	U 1	NR	3.6	NR	NR	U 1
Chloride	U 5	NR	9.1	9.3	NR	12.4
Chemical Oxygen Demand	14.9	14.9	56	NR	NR	51.6
Ammonia, as N	U 0.1	NR	U 0.1	NR	NR	U 0.1
Nitrate, as N	U 0.1	NR	0.38	0.38	NR	1.6
Phosphate, as P	U .020	NR	0.3 5	0.37	NR	0.44
Sulfate	U 5	NR	U 5	NR	NR	36.8
Turbidity	0.07	NR	427	427	NR	32.2

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–12c cont.....
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 10 (Scrap Metal Landfill)

Site I.D. (a) / Compounds	10–006–M203 M.W10–06(Eq. Blank)	10–006–M203 REPLICATE	10–007–M003 M.W10–07	10–007–M003 REPLICATE	10–007–M103 M.W10–07(Eq. Blank)
Volatile Organics (µg/L)					
Methylene Chloride	6 B	NR	7 B	NR	2 JB
Acetone	340 E	NR	220 E	NR	170 B
Chloroform	6	NR	U 5	NR	U 5
Inorganics (µg/L)					
Arsenic	U 10	NR	U 10	NR	U 10
Chromium	U 10	NR	41.3	NR	48.2
Copper	U 25	NR	U 25	NR	U 25
Iron	U 100	NR	25800	NR	28200
Manganese	U 15	NR	135	NR	143
Sodium	U 5000	NR	5040	NR	5240
Lead	U 3	NR	11.3	NR	11.2
Zinc	U 20	NR	144	NR	108
Inorganics (mg/L)					
NO3/N02 (mg–n/L)					
Turbidity (NTU)					
BOD 5 Day	U 1	U 1	U 1	NR	U 1
Chloride	U 5	NR	6.5	NR	6.1
Chemical Oxygen Demand	7.5	10.5	44.3	NR	79.7
Ammonia, as N	U 0.1	NR	0.33	0.33	0.32
Nitrate, as N	U 0.1	NR	U 0.1	NR	U 0.1
Phosphate, as P	U 0.02	NR	0.066	NR	U 0.04
Sulfate	U 5	NR	108	NR	105
Turbidity	0.11	NR	132	NR	131

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

The second and third rounds of groundwater sampling included analysis of VOCs, drinking water metals, and landfill indicator parameters. Results for VOCs were similar to the first round. High chromium and lead relative to round 1 were detected in several wells in round 2, and levels were slightly lower in round 3.

Results of the landfill parameters showed no clear distinction between downgradient wells and upgradient wells MW10-03 and MW10-04.

4.6.3 Summary of the Site 10 Characterization

Site 10 is an inactive scrap waste landfill containing, based on the test pit inspection, small quantities of scrap metal wastes. Cover material was found to be thin to nonexistent in some areas (ranging in thickness from 0 to 0.5 feet).

Five of the seven monitor wells (MW10-01, MW10-02, MW10-05, MW10-06, and MW10-07) are hydrologically downgradient of the fill area. High lead and chromium relative to round 1 were detected in several wells in round 2, and levels were slightly lower in round 3. Lead and chromium were highest in MW10-07 at 20 and 3,600 µg/L, respectively. Elevated arsenic (up to 192 µg/L) and cadmium (up to 8 µg/L) were also found.

Results of the landfill parameters showed no clear distinction between downgradient wells and upgradient wells MW10-03 and MW10-04. No pesticides or PCBs were detected.

The local occurrence of these "hits" does not suggest a major source of contamination in the landfill. The existing data are not high enough to indicate that the old landfill is generating large quantities of leachate.

The presence of relatively elevated metals in groundwater samples at Site 10 may be more a function of ambient soil conditions (natural or broadly impacted by human activities) plus the unfiltered sample protocol, than any past site activities.

The finding that the cover material was thin to nonexistent in some areas (ranging in thickness from 0 to 0.5 feet) will be given further consideration during the screening of alternatives.

4.7 SITE 11 CONTRACT ORDNANCE DISPOSAL AREA

4.7.1 Physical Characteristics

Site 11 is approximately 2 acres in size and appears as a wide open fan-shaped area surrounded by woodlands. An undeveloped dirt road accesses Site 11 off the transmission line right of way. Site 11 is sparsely vegetated with grasses and some small scrub pines near its perimeter. There are a few scarred areas where no vegetation exists. The topography across Site 11 slopes gently to the northwest from approximately 100 feet above MSL near MW11-02 to approximately 90 feet MSL near MW11-05. The cover material used at the site is predominantly loose sand apparently quarried from the surrounding area. A reconnaissance of the site conducted during the RI confirmed the presence of two concrete pads.

4.7.1.1 Soils and Sediments

The soils within Site 11 are part of the Atsion [At] Series. Based on the samples obtained during the drilling and soil sampling, the shallow "soils" at Site 11 are widely similar in composition and color. The shallow soils consist of silt and clay, dark gray (5Y3/1) to black (7.5YR2/0). Topsoils on the site proper are poorly developed and vegetation is slow to recover.

4.7.1.2 Drainage

Site 11 has a closed drainage system because no direct discharge to surface water is evident. Drainage at the site occurs primarily through rapid infiltration and evapotranspiration. Infiltration is the main source of recharge to the shallow aquifer at the site and is a controlling factor of groundwater flow at Site 11. The surface water body nearest to Site 11 is a head water branch of Hockhockson Brook which is located approximately 1,000 feet north (upgradient) of Site 11.

4.7.1.3 Hydrogeology

The following lithologic description of Site 11 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These descriptions are contained in the boring logs presented in Appendix A. The sediments underlying Site 11 consist of silt to medium quartz sand, glauconite and thin clay layers, and vary in color from olive brown to very dark gray. These characteristics are consistent with the sediments which compose the lower member of the Vincentown Formation. Site 11 is situated within the outcrop and recharge area of the Vincentown Formation.

Generally, groundwater levels range between 1 and 7 feet bgs across Site 11. Figure 4-8 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the southwest with an average gradient of .025. This pattern is similar to that observed during other measurement rounds. MW02-02 is hydraulically upgradient of the site, while MW11-04 and MW11-05 are directly downgradient. Based on the average hydraulic conductivity calculated from the slug test data for MW11-02 and MW11-04, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) is approximately 0.17 feet/day or 63 feet/year.

4.7.2 Chemical Results

4.7.2.1 Analysis of Soils at Site 11

The analytical results for the soil sampling conducted at Site 11 are presented on Table 4-13. No explosive compounds were detected in 11 soil samples and duplicates from Site 11. Low concentrations of nitrates were detected (0.7- 3.0 mg/L) and petroleum hydrocarbons were detected at levels above 100 mg/L in two samples (640 and 290) and from 8.2- 53 mg/L in four other samples.

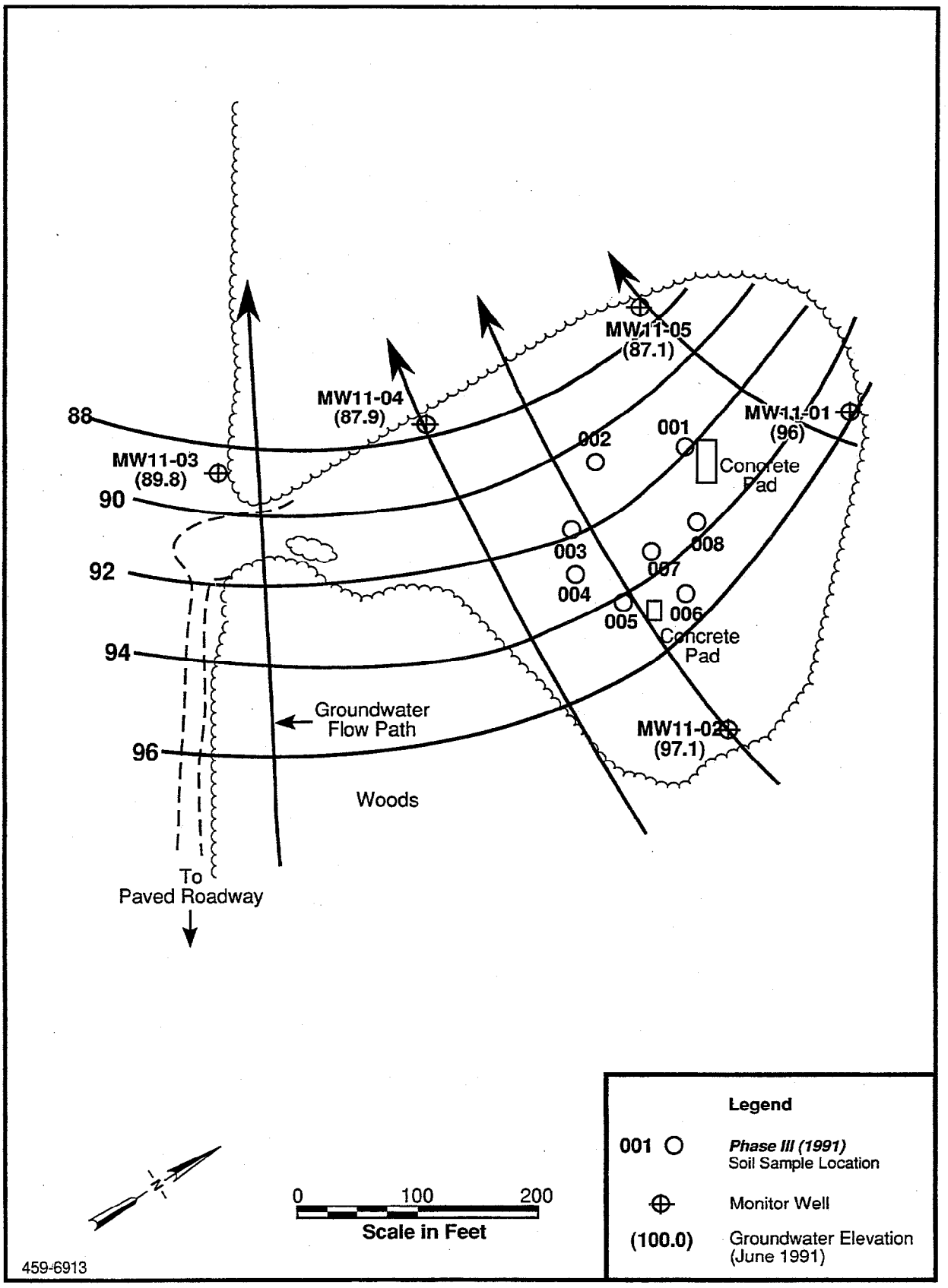

FIGURE 4-8 SITE 11 - CONTRACT ORDNANCE DISPOSAL AREA GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

Table 4-13

Summary of Surface Soil Sample Analytical Results

NWS Earle, Site 11 (Contract Ordnance Disposal Area)

Site I.D.(a) / Compounds	11-001-S001 Soil Sample 11-01	11-002-S001 Soil Sample 11-02	11-003-S001 Soil Sample 11-03	11-003-S101 Soil Sample 11-04	11-004-S001 Soil Sample 11-05	11-004-S001 Replicate	11-005-S001 Soil Sample 11-05	11-006-S001 Soil Sample 11-06	11-007-S001 Soil Sample 11-07	11-008-S001 Soil Sample 11-08	11-008-S001 Replicate	NJDEP Guidelines
Inorganics (mg/kg)												
Nitrate	1.8	3.0	U	0.84	0.88	0.94	0.58	0.80	0.66	1.0	NR	-
Nitrite	U 0.10	U 0.10	0.66	U 0.10	U 0.10	U 0.10	U 0.10	U 0.10	U 0.10	U 0.10	NR	-
% Solids	79.5	83.5	87.2	87.4	89.2	NR	88.1	84.4	85.8	86.2	86.5	-
Petroleum Hydrocarbons (mg/kg)	640	290	15	11	U 4.6	NR	U 4.6	8.2	U 4.7	53	NR	100
Explosives (µg/g) Picric Acid	U 1.23	U 1.23	U 1.11	U 1.19	U 1.11	NR	U 1.11	U 1.15	U 1.15	U 1.15	U 1.15	

Legend: U = Not detected

NR = Not requested

(a) = Refer to June 90 QAPP

Replicate = Lab QA sample

4.7.2.2 Analysis of Groundwater Samples at Site 11

The groundwater quality data for the three sampling rounds conducted at Site 11 are presented in Tables 4-14a, 4-14b, and 4-14c. The first round of groundwater analysis showed only one semivolatile compound, bis(2-ethylhexyl)phthalate, which was present below the method detection limit (J values) in samples from three wells. Volatile organic compounds, methylene chloride and acetone, were present but attributable to field or laboratory cross contamination. Chloroform was present in one sample (upgradient well MW11-01) at 6 µg/L. No pesticides, PCBs, or explosives compounds were detected. Nitrates were below 0.3 mg/L, and nitrites were undetected. Lead and chromium were below 5 and 23 µg/L, respectively.

The second and third rounds of groundwater sampling included analysis of VOCs, drinking water metals, and explosive compounds. Results for VOCs were similar to the first round with chloroform just above the detection limit in MW11-01. No explosive compounds were detected. Chromium, iron, manganese, and lead were detected generally at higher concentrations during the second and third rounds in all wells, including MW11-01, the upgradient well. Lead and chromium were detected as high as 77 and 1,580 µg/L respectively.

4.7.3 Summary of the Site 11 Characterization

The residues of petroleum hydrocarbons in the soils at Site 11 are consistent with Site 11's past use as a burn area. However, these levels are relatively low and there is no visual or analytical evidence of extensive hydrocarbon contamination of soils or of impact from hydrocarbons on groundwater. No explosive compounds were found in either the soils or groundwater samples. Therefore, the impact on this site from past activities is negligible and the residual hydrocarbons can be expected to naturally degrade over time. Because an endangered plant species *(Rhynchospora Knieskernii)* resides at this site, disturbance of the area is not desirable.

Table 4-14a

Summary of Groundwater Sample Analytical Results

Round One: March 1991

NWS Earle, Site 11 (Contract Ordnance Disposal Area)

Site I.D.(a) / Compounds	11-001-M001 MW11-01	11-002-M001 MW11-02	11-002-M001 Replicate	11-003-M001 MW11-03	11-004-M001 MW11-04	11-004-M101 MW11-04(DUP)	11-004-M201 MW11-04(Eq Blank)	11-005-M001 MW11-05	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Semivolatiles (µg/L)										
bis(2-Ethylhexyl) phthalate	3 J	1 J	NR	1 J	U 10	U 10	U 10	3 J	–	–
Volatile Organics (µg/L)										
Methylene Chloride	7 B	38 B	NR	40 B	53 B	58 B	51 B	51 B	–	–
Acetone	4200 B	3100 B	NR	7700 B	11 B	40 B	990 B	87000 B	–	–
Chloroform	6.0	U 5	NR	U 5	U 5	U 5	U 5	U 5	–	–
Inorganics (mg/L)										
Nitrate	0.17	0.26	0.26	0.27	0.13	0.14	0.13	0.12	10.0	–
Nitrite	U .10	U .10	U .10	U .10	U .10	U .10	U .10	U .10	1.0	–
Aluminum	0.72	0.40	0.36	2.5	0.56	0.83	0.029	1.1	–	–
Barium	0.057	0.032	0.030	0.025	0.029	0.030	U .0040	0.035	2.0	2.0
Calcium	1.0	1.8	1.7	0.85	4.8	5.0	0.12	2.6	–	–
Cadmium	U .0034	U .0034	0.0036	0.0042	U .0034	U .0034	U .0034	U .0034	0.005	0.004
Chromium	0.023	U .0063	U .0063	0.013	0.012	0.014	U .0063	0.025	–	–
Copper	0.013	0.016	0.022	U .0029	U .0029	U .0029	U .0029	U .0029	1.3	–
Cyanide	U .010	U .010	U .010	U .010	U .010	U .010	U .010	U .010	0.2	0.2
Iron	1.8	1.2	1.2	1.5	1.5	2.3	0.024	3.0	–	–
Potassium	1.7	2.1	1.9	1.3	1.4	1.5	U .142	1.5	–	–
Magnesium	1.3	0.74	0.72	0.74	1.7	1.7	U .0156	1.6	–	–
Manganese	0.012	0.020	0.019	0.0091	0.028	0.029	U .0009	0.032	–	–
Sodium	2.5	2.9	2.7	5.4	8.2	8.3	0.31	3.0	–	–
Nickel	0.0049	0.0083	0.0061	U .0036	U .0036	0.0043	U .0036	U .0036	0.1	0.1
Lead	0.0013	0.0016	0.0021	0.0052	0.0034	U .0016	U .0016	0.0038	0.015	0.01
Vanadium	0.0049	U .0026	U .0026	0.0049	0.0034	0.0040	U .0026	0.015	–	–
Zinc	0.014	0.037	0.036	0.054	0.016	0.022	0.0061	0.021	5.0	5.0
Pesticide/PCB (µg/L)	U 1.1	U 1.1	U 1.1	U 1.1	U 1.1	U 1.1	U 1.1	U 1.1		
Explosives (µg/L)	U 0.78	U 0.78	U 0.78	U 0.78	U 0.78	U 0.78	U 0.78	U 0.78		

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4-14b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 11 (Contract Ordnance Disposal Area)

Site I.D. (a) / Compounds	11-001-M002 MW11-01	11-001-M302 MW11-01(Trip Blank)	11-002-M002 MW11-02	11-003-M002 MW11-03	11-003-M202 MW11-03(Eq. Blank)	11-004-M002 MW11-04	11-005-M002 MW11-05
Volatile Organics (µg/L)							
Methylene Chloride	3 JB	13 B	11 B	8 B	10 B	5 B	2 JB
Acetone	27 B	10 B	20 B	27 B	12 B	31 B	52 B
Chloroform	3 J	U 5	U 5	U 5	U 5	U 5	U 5
Inorganics (µg/L)							
Chromium	U 10	NR	213	80	U 10	14.4	16.8
Iron	289	NR	32000	9560	U 100	2180	3420
Manganese	16.6	NR	35.1	20.6	U 15	15.4	18.5
Sodium	U 5000	NR	U 5000	U 5000	U 5000	5100	U 5000
Lead	U 3	NR	20.3	6.8	U 3	U 3	U 3
Zinc	23.4	NR	58.8	59.7	U 20	120	24.6

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-14c
Summary of Water Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 11 (Contract Ordnance Disposal Area)

Site I.D. (a) / Compounds	11-001-M003 MW11-01	11-001-M003 REPLICATE	11-002-M003 MW11-02	11-001-M303 MW11-01(Trip Blank)	11-003-M003 MW11-03	11-003-M003 REPLICATE	11-004-M003 MW11-04	11-005-M003 MW11-05	11-005-M003 REPLICATE	11-005-M203 MW11-05(Eq.Blank)	11-005-M303 MW11-05(Trip Blank)
Volatile Organics (µg/L)											
Methylene Chloride	U 5	NR	U 5	3 J	1 JB	NR	U 5	U 5	NR	1 JB	6 B
Acetone	380 E	NR	24 B	24 B	2700 E	NR	110 B	120 B	NR	5500 B	3 JB
Chloroform	5	NR	U 5	U 5	2 J	NR	U 5	U 5	NR	2 J	U 5
Inorganics (µg/L)											
Chromium	881	1580	108	NR	427	436	36.8	64.7	NR	U 10	NR
Iron	96000	194000	16100	NR	63400	65300	5130	10000	NR	U 100	NR
Mercury	U 0.2	U 0.2	U 0.2	NR	0.27	NR	U 0.2	U 0.2	NR	U 0.2	NR
Manganese	83.7	159	23.2	NR	53.6	54.9	15.7	24.5	NR	U 15	NR
Sodium	U 5000	U 5000	U 5000	NR	U 5000	U 5000	7200	U 5000	NR	U 5000	NR
Lead	51.5	76.5	U 3	NR	36.4	29.5	U 3	3.8	NR	U 3	NR
Zinc	181	181	77.7	NR	89.3	88.8	23.8	24	NR	U 20	NR
Explosives											
Nitrate, as N	NR		NR	NR	NR	NR	NR	U 0.1	0.26	NR	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

4.8 SITE 19 PAINT CHIP AND SLUDGE DISPOSAL AREA

4.8.1 Physical Characteristics

Site 19 appears as a raised circular area approximately 300 feet in diameter and is surrounded by woodlands. The topography across the site is relatively flat, approximately 113 feet above MSL. The site is bordered on the west by a branch of Mingamahone Brook, and to the north by marsh and wetlands. An asphalt road accesses Site 19 from Tulagi Road. Half of the site is paved, from the building S-34 south to its perimeter. The remainder of the site north of S-34 is a gravel surface. A depression measuring approximately 50 feet in diameter and 15 feet deep is situated in the center of the site behind a barricade. The depression drains through a culvert near MW19-05 to a drainage ditch which empties into a branch of Mingamahone Brook.

4.8.1.1 Soils and Sediments

The original soils at Site 19 are classified as Atsion sand [At], and Lakehurst sands [LaA] Series in the main area, and Humaquepts (stratified layers of sandy loam, loam, silt loam, and muck) [HV] Series in the area adjacent to Mingamahone Brook. The soils have been altered by past excavation and construction activities. Based on the samples obtained during the drilling and soil sampling, the shallow "soils" at Site 19 are composed of a thin layer of naturally occurring organic material (root matter) and silty sand. The soils range in color from dark to light yellowish brown (10YR3/6 to 10YR6/4). Sediments along the drainage are composed of a loamy sand, silty clay, and muck.

4.8.1.2 Drainage

The drainage at Site 19 occurs primarily by way of overland flow or runoff from the asphalt surface, radially to the surrounding soils, and to the depression located in the center of the site behind the barricade. Runoff collects in the depression and discharges by way of a drainage

ditch, to a branch of Mingamahone Brook which is located approximately 300 feet west of Site 19.

4.8.1.3 Hydrogeology

The following lithologic description of Site 19 was determined from the physical characterization of continuous split-spoon samples obtained from the SI and RI drilling activities. These descriptions are contained in the boring logs presented in Appendix A. In general, the sediments underlying Site 19 consist of silt to coarse quartz sand with glauconite, and some clay stringers, overlain by a layer of light gray to yellow-brown sand with little quartz gravel. These characteristics are consistent with the sediments of the Kirkwood Formation. Like Site 3, Site 19 is situated within the outcrop and recharge area of the Kirkwood Formation.

Groundwater levels ranged between 10 and 14 feet bgs across Site 19 during the first sampling round. Shallow groundwater is influenced by a stream that runs along the northwest boundary of the site. Figure 4-9 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the west and northwest with an average gradient of .01 feet/foot. This pattern is similar to that observed during other measurement rounds, although in the fall measurement most well levels had dropped slightly. MW19-04, which was originally set at the top of a confining layer and had only 2 feet of water, was dry during the October and November 1991 sampling. MW19-01 is hydraulically upgradient of the site, while MW19-02, MW19-03, and MW19-06 are directly downgradient. Based on an average hydraulic conductivity calculated from the slug test data for MW19-04 and MW19-05, the lateral groundwater flow velocity calculated from Darcy's Law ($V = Ki/n$) is approximately 0.1 feet/day or 37 feet/year.

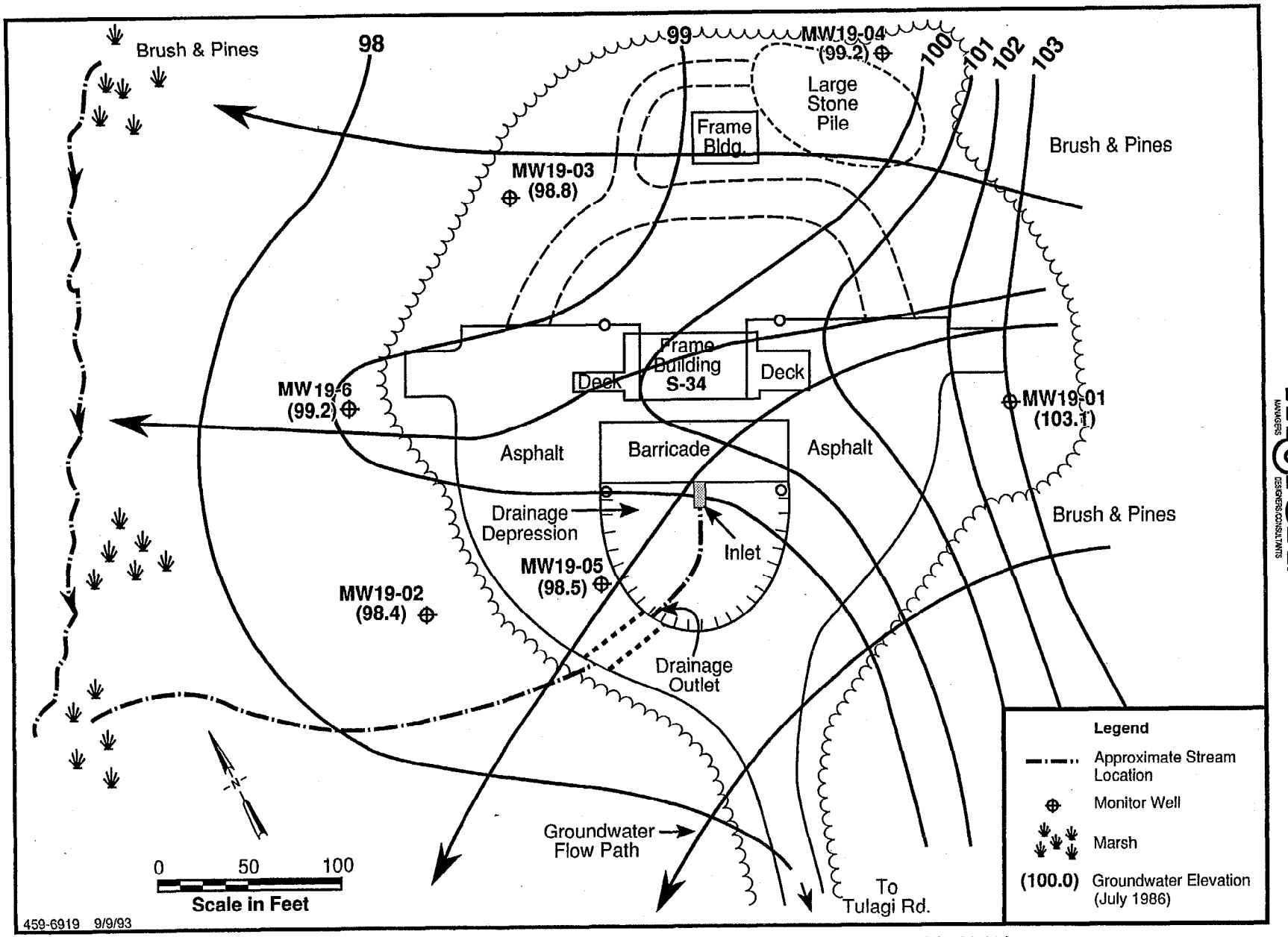

FIGURE 4-9 SITE 19 - PAINT CHIP AND SLUDGE DISPOSAL AREA
GROUNDWATER SURFACE CONTOURS
NWS EARLE, N

4.8.2 Chemical Results

4.8.2.1 Analysis of Soils and Sediments

The results of the soil and sediment sampling are presented on Table 4-15. As shown on Table 4-15, lead was detected at very high concentrations in 7 of the 32 samples (19-023, 19-024, 19-026, 19-027, 19-028, 19-030, and 19-032) that were collected in the surface depression and along the drainage at Site 19. The highest concentrations of lead were found in samples 19-032 (12,600 mg/kg) and 19-030 (5,380 mg/kg), which were collected from the surface depression behind the barricade shown in Figure 4-10. The remaining samples mentioned above had lead concentrations of between 200 to 400 mg/kg. With the exception of samples 19-029 (69.6 mg/kg) and 19-031 (74.5 mg/kg), also located in the depression, the remaining 23 lead samples had concentrations ranging from nondetected to 33.6 mg/kg. Chromium was detected in sediment samples 19-023 (464 mg/kg) and 19-027 (103 mg/kg). Zinc was also detected in sample 19-027 (1,050 mg/kg).

The volatile compounds methylene chloride and acetone were detected in several samples. These two compounds were also detected in the blanks and are common solvents in the laboratory and field decontamination, respectively. No other VOCs were detected in any well in the other soil samples above J values.

4.8.2.2 Analysis of Groundwater at Site 19

The results of the three rounds of groundwater sampling are presented in Tables 4-16a, 4-16b, and 4-16c, respectively. The sampling locations are presented in Figure 3-9. Two volatile compounds, methylene chloride and acetone, were detected in almost all samples in all three rounds of sampling. These two compounds were also detected in the blanks and are common solvents in the laboratory and field decontamination, respectively. No other VOCs were detected in any well in the three sampling rounds.

Table 4-15

Summary of Soil and Sediment Sample Analytical Results

NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19-001-S001 Soil Sample 19-01	19-002-S001 Soil Sample 19-02	19-003-S001 Soil Sample 19-03	19-003-S001 Replicate	19-003-S002 Soil Sample 19-03	19-004-S001 Soil Sample 19-04	19-005-S001 Soil Sample 19-05	19-006-S001 Soil Sample 19-06	19-007-S001 Soil Sample 19-07	19-008-S001 Soil Sample 19-08	NJDEPE Guidelines (c)
TCL Volatiles											
Methylene Chloride (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Acetone (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Carbon Disulfide (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Inorganics (mg/kg)											
Aluminum	NR	NR	1990	NR	NR	NR	NR	NR	NR	NR	–
Antimony	NR	NR	3.8	NR	NR	NR	NR	NR	NR	NR	14/340
Arsenic	NR	NR	1.2	NR	NR	NR	NR	NR	NR	NR	2/2 (d)
Barium	NR	NR	8.2	NR	NR	NR	NR	NR	NR	NR	700/47000
Beryllium	NR	NR	U 0.11	NR	NR	NR	NR	NR	NR	NR	1/1
Calcium	NR	NR	619	NR	NR	NR	NR	NR	NR	NR	–
Cadmium	U 0.72	U 0.76	U 0.74	U 0.74	U 0.74	U 0.44	U 0.78	U 0.76	1.1	U 79	1/100
Chromium	NR	NR	7.8	NR	NR	NR	NR	NR	NR	NR	
Cobalt	NR	NR	U 0.74	NR	NR	NR	NR	NR	NR	NR	–
Copper	NR	NR	6.5	U 0.3	NR	NR	NR	NR	NR	NR	600/600
Cyanide	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1100/21000
Iron	NR	NR	6090	NR	NR	NR	NR	NR	NR	NR	–
Lead	6.6	4.9	163	NR	13.4	28.9	5.6	8.1	33.6	27.0	100/600
Magnesium	NR	NR	363	NR	NR	NR	NR	NR	NR	NR	–
Manganese	NR	NR	24.9	NR	NR	NR	NR	NR	NR	NR	–
Mercury	NR	NR	U 0.91	U	NR	NR	NR	NR	NR	NR	14/270
Nickel	NR	NR	1.3	NR	NR	NR	NR	NR	NR	NR	250/2400
Potassium	NR	NR	236	NR	NR	NR	NR	NR	NR	NR	–
Selenium	NR	NR	U 0.28	NR	NR	NR	NR	NR	NR	NR	63/3100
Silver	NR	NR	0.71	NR	NR	NR	NR	NR	NR	NR	110/4100
Sodium	NR	NR	58.9	NR	NR	NR	NR	NR	NR	NR	–
Thallium	NR	NR	U 0.52	NR	NR	NR	NR	NR	NR	NR	2/2
Vanadium	NR	NR	10.5	NR	NR	NR	NR	NR	NR	NR	370/7100
Zinc	NR	NR	25.5	NR	NR	NR	NR	NR	NR	NR	1500/1500
% Solids	93.2	90.8	90.4	NR	90.8	76.5	86.3	89.0	90.2	87.3	–
Petroleum Hydrocarbons (mg/kg) (Blank units are mg/L)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = VOC Blank samples reported in µg/L
(c) = Soil cleanup criteria (revised 3/8/93)
(d) = Residential/nonresidential soils

Table 4-15 con't
Summary of Soil and Sediment Sample Analytical Results
NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19-009-S001 Soil Sample 19-09	19-009-S101 Soil Sample 19-09 (Dup.)	19-009-S002 Soil Sample 19-09	19-010-S001 Soil Sample 19-10	19-011-S001 Soil Sample 19-11	19-011-S001 Replicate	19-012-S001 Soil Sample 19-12	19-012-S001 Replicate	19-013-S001 Soil Sample 19-13	19-013-S002 Soil Sample 19-13	NJDEPE Guidelines (c)
TCL Volatiles											
Methylene Chloride (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Acetone (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Carbon Disulfide (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Inorganics (mg/kg)											
Aluminum	928	1030	NR	NR	NR	NR	NR	NR	692	NR	–
Antimony	1.5	U 1.5	NR	NR	NR	NR	NR	NR	2.3	NR	14/340
Arsenic	0.65	0.56	NR	NR	NR	NR	NR	NR	0.46	NR	2/2 (d)
Barium	3.2	3.5	NR	NR	NR	NR	NR	NR	17.3	NR	700/47000
Beryllium	U .10	U .10	NR	NR	NR	NR	NR	NR	U .12	NR	1/1
Calcium	49.0	53.2	NR	NR	NR	NR	NR	NR	NR	NR	–
Cadmium	U .69	U .70	U .74	U 0.78	U 0.75	NR	U 0.73	NR	U 0.75	U 0.75	1/100
Chromium	2.1	3.7	NR	NR	NR	NR	NR	NR	U 1.6	NR	
Cobalt	U .70	U .70	NR	NR	NR	NR	NR	NR	U .85	NR	–
Copper	5.7	5.8	NR	NR	NR	NR	NR	NR	5.1	NR	600/600
Cyanide	U 0.48	U 0.53	NR	NR	NR	NR	NR	NR	U 0.64	NR	1100/21000
Iron	1900	2220	NR	NR	NR	NR	NR	NR	377	NR	–
Lead	7.6	8.8	5.5	20.4	9.9	NR	2.6	NR	9.4	5.3	100/600
Magnesium	90.1	73.9	NR	NR	NR	NR	NR	NR	27.2	NR	–
Manganese	16.8	17.0	NR	NR	NR	NR	NR	NR	2.9	NR	–
Mercury	U .072	U .091	NR	NR	NR	NR	NR	NR	U .10	NR	14/270
Nickel	U .076	U 0.76	NR	NR	NR	NR	NR	NR	U 0.92	NR	250/2400
Potassium	86.0	91.0	NR	NR	NR	NR	NR	NR	63.4	NR	–
Selenium	U .27	U .26	NR	NR	NR	NR	NR	NR	U .33	NR	63/3100
Silver	U .58	U .60	NR	NR	NR	NR	NR	NR	U 0.72	NR	110/4100
Sodium	25.8	6.2	NR	NR	NR	NR	NR	NR	11.6	NR	–
Thallium	U .50	U .48	NR	NR	NR	NR	NR	NR	U .60	NR	2/2
Vanadium	4.4	5.9	NR	NR	NR	NR	NR	NR	3.9	NR	370/7100
Zinc	8.0	8.7	NR	NR	NR	NR	NR	NR	7.0	NR	1500/1500
% Solids	95.2	94.9	89.7	87.0	90.0	89.4	92.4	92.5	78.8	84.7	–
Petroleum Hydrocarbons (mg/kg) (Blank units are mg/L)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = VOC Blank samples reported in µg/L
(c) = Soil cleanup criteria (revised 3/8/93)
(d) = Residential/nonresidential soils

Table 4-15 con't

Summary of Soil and Sediment Sample Analytical Results

NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19-014-S001 Soil Sample 19-14	19-014-S001 Replicate	19-015-S001 Soil Sample 19-15	19-016-S001 Soil Sample 19-16	19-017-S001 Soil Sample 19-17	19-018-S001 Soil Sample 19-18	19-018-S002 Soil Sample 19-18	19-018-S201 Soil Sample 19-18 (Eq. Bl.)	19-019-S001 Soil Sample 19-19	19-020-S001 Soil Sample 19-20	NJDEPE Guidelines (c)
TCL Volatiles											
Methylene Chloride (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Acetone (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Carbon Disulfide (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Inorganics (mg/kg)											
Aluminum	NR	NR	NR	NR	NR	1930	NR	0.063	NR	NR	–
Antimony	NR	NR	NR	NR	NR	U 1.5	NR	U .0075	NR	NR	14/340
Arsenic	NR	NR	NR	NR	NR	1.2	NR	U .0018	NR	NR	2/2 (d)
Barium	NR	NR	NR	NR	NR	8.2	NR	U .0040	NR	NR	700/47000
Beryllium	NR	NR	NR	NR	NR	U 1.6	NR	U .0005	NR	NR	1/1
Calcium	NR	NR	NR	NR	NR	510	NR	0.16	NR	NR	–
Cadmium	U 0.78	U 0.78	U 0.78	U 0.78	U 0.76	U 0.70	U	U .0034	U 0.68	0.76	1/100
Chromium	NR	NR	NR	NR	NR	6.3	NR	U .0063	NR	NR	-
Cobalt	NR	NR	NR	NR	NR	U 0.70	NR	U .0034	NR	NR	–
Copper	NR	NR	NR	NR	NR	4.2	NR	U .0029	NR	NR	600/600
Cyanide	NR	NR	NR	NR	NR	U 0.51	NR	U 0.010	NR	NR	1100/21000
Iron	NR	NR	NR	NR	NR	3020	NR	0.028	NR	NR	–
Lead	6.8	7.6	10.9	19.7	9.7	12.0	15.9	U .0016	9.6	7.3	100/600
Magnesium	NR	NR	NR	NR	NR	229	NR	U .052	NR	NR	–
Manganese	NR	NR	NR	NR	NR	15.9	NR	U .0009	NR	NR	–
Mercury	NR	NR	NR	NR	NR	U .075	NR	U .0002	NR	NR	14/270
Nickel	NR	NR	NR	NR	NR	U 0.75	NR	U .0036	NR	NR	250/2400
Potassium	NR	NR	NR	NR	NR	197	NR	U 0.14	NR	NR	–
Selenium	NR	NR	NR	NR	NR	U .29	NR	U .0013	NR	NR	63/3100
Silver	NR	NR	NR	NR	NR	U 0.60	NR	U .0029	NR	NR	110/4100
Sodium	NR	NR	NR	NR	NR	42.6	NR	0.27	NR	NR	–
Thallium	NR	NR	NR	NR	NR	U .53	NR	U .0024	NR	NR	2/2
Vanadium	NR	NR	NR	NR	NR	8.0	NR	U .0026	NR	NR	370/7100
Zinc	NR	NR	NR	NR	NR	10.0	NR	0.0044	NR	NR	1500/1500
% Solids	86.6	NA	87.1	88.2	89.5	88.8	90.3	NR	90.6	84.2	–
Petroleum Hydrocarbons (mg/kg) (Blank units are mg/L)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = VOC Blank samples reported in µg/L
(c) = Soil cleanup criteria (revised 3/8/93)
(d) = Residential/nonresidential soils

Table 4-15 con't

Summary of Soil and Sediment Sample Analytical Results

NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19-021-D001 Sediment Sample 19-21	19-022-D001 Sediment Sample 19-22	19-023-D001 Sediment Sample 19-23	19-024-D001 Sediment Sample 19-24	19-025-D001 Sediment Sample 19-25	19-026-D001 Sediment Sample 19-26	19-027-D001 Sediment Sample 19-27	19-027-D001 Replicate	19-027-D002 Sediment Sample 19-27	19-028-D001 Sediment Sample 19-28	NJDEPE Guidelines (c)
TCL Volatiles											
Methylene Chloride (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Acetone (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Carbon Disulfide (µg/kg)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Inorganics (mg/kg)											
Aluminum	NR	NR	2240	NR	NR	NR	3110	2527	NR	NR	–
Antimony	NR	NR	U 2.0	NR	NR	NR	U 1.9	U 1.9	NR	NR	14/340
Arsenic	NR	NR	2.0	NR	NR	NR	1.7	1.7	NR	NR	2/2 (d)
Barium	NR	NR	28.4	NR	NR	NR	84.2	63.5	NR	NR	700/47000
Beryllium	NR	NR	U .14	NR	NR	NR	0.25	0.15	NR	NR	1/1
Calcium	NR	NR	181	NR	NR	NR	508	396	NR	NR	–
Cadmium	U 0.92	U 1.1	U 0.90	U 0.74	U 1.0	U 1.0	1.9	1.5	1.8	1.6	1/100
Chromium	NR	NR	464	NR	NR	NR	103	76.8	NR	NR	
Cobalt	NR	NR	2.7	NR	NR	NR	3.1	1.7	NR	NR	–
Copper	NR	NR	21.9	NR	NR	NR	27.8	16.7	NR	NR	600/600
Cyanide	NR	NR	U 0.69	NR	NR	NR	U 0.64	U 0.64	NR	NR	1100/21000
Iron	NR	NR	3200	NR	NR	NR	5280	4237	NR	NR	–
Lead	5.8	19.5	364	300	18.8	379	233	157	172	267	100/600
Magnesium	NR	NR	260	NR	NR	NR	473	408	NR	NR	–
Manganese	NR	NR	39.8	NR	NR	NR	43.7	35.7	NR	NR	–
Mercury	NR	NR	U .12	NR	NR	NR	0.13	0.1	NR	NR	14/270
Nickel	NR	NR	U 0.98	NR	NR	NR	U 0.91	U 0.89	NR	NR	250/2400
Potassium	NR	NR	308	NR	NR	NR	332	330	NR	NR	–
Selenium	NR	NR	U 0.32	NR	NR	NR	U 0.31	U 0.32	NR	NR	63/3100
Silver	NR	NR	U 0.78	NR	NR	NR	U 0.72	U 0.73	NR	NR	110/4100
Sodium	NR	NR	36	NR	NR	NR	33.7	32.3	NR	NR	–
Thallium	NR	NR	U 0.61	NR	NR	NR	U 0.59	U 0.60	NR	NR	2/2
Vanadium	NR	NR	11.3	NR	NR	NR	14.6	11.6	NR	NR	370/7100
Zinc	NR	NR	234	NR	NR	NR	1050	789	NR	NR	1500/1500
% Solids	65.4	58.7	71.2	85.2	52.0	61.7	77.2	78.3	78	73.1	–
Petroleum Hydrocarbons (mg/kg) (Blank units are mg/L)	28 B	NR	74 B	NR	39 B	NR	110 B	NR	NR	NR	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = VOC Blank samples reported in µg/L
(c) = Soil cleanup criteria (revised 3/8/93)
(d) = Residential/nonresidential soils

Table 4-15 con't

Summary of Soil and Sediment Sample Analytical Results

NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19-028-S002 Soil Sample 19-28	19-028-S202 Soil Sample 19-28(Eq. Blank)(b)	19-029-D001 Sediment Sample 19-29	19-029-S002 Soil Sample 19-29	19-030-D001 Sediment Sample 19-30	19-030-S002 Soil Sample 19-30	19-030-S302 Soil Sample 19-30(Trip Blank)(b)	19-031-D001 Sediment Sample 19-31	19-031-S002 Soil Sample 19-31	19-032-D001 Sediment Sample 19-32	19-032-D001 Replicate	NJDEPE Guidelines (c)
TCL Volatiles												
Methylene Chloride (µg/kg)	60 B	4 JB	NR	54 B	NR	41 B	13 B	NR	46 B	NR	NR	
Acetone (µg/kg)	9 JB	32	NR	20 B	NR	42 B	U 10	NR	12 B	NR	NR	
Carbon Disulfide (µg/kg)	U 6	1 JB	NR	U 6	NR	U 6	2 JB	NR	U 6	NR	NR	
Inorganics (mg/kg)												
Aluminum	NR	NR	NR	NR	NR	NR	NR	1330	NR	NR	NR	–
Antimony	NR	NR	NR	NR	NR	NR	NR	U 1.9	NR	NR	NR	14/340
Arsenic	NR	NR	NR	NR	NR	NR	NR	1.2	NR	NR	NR	2/2 (d)
Barium	NR	NR	NR	NR	NR	NR	NR	36.3	NR	NR	NR	700/47000
Beryllium	NR	NR	NR	NR	NR	NR	NR	U 0.13	NR	NR	NR	1/1
Calcium	NR	NR	NR	NR	NR	NR	NR	1100	NR	NR	NR	–
Cadmium	NR	NR	U	NR	25.9	NR	NR	U 0.87	NR	33.7	23.4	1/100
Chromium	NR	NR	NR	NR	NR	NR	NR	15.5	NR	NR	NR	–
Cobalt	NR	NR	NR	NR	NR	NR	NR	0.88	NR	NR	NR	–
Copper	NR	NR	NR	NR	NR	NR	NR	7.9	NR	NR	NR	600/600
Cyanide	NR	NR	NR	NR	NR	NR	NR	U 0.63	NR	NR	NR	1100/21000
Iron	NR	NR	NR	NR	NR	NR	NR	2950	NR	NR	NR	–
Lead	NR	NR	69.6	NR	5380	NR	NR	74.5	NR	12600	8938	100/600
Magnesium	NR	NR	NR	NR	NR	NR	NR	307	NR	NR	NR	–
Manganese	NR	NR	NR	NR	NR	NR	NR	39.9	NR	NR	NR	–
Mercury	NR	NR	NR	NR	NR	NR	NR	U 0.13	NR	NR	NR	14/270
Nickel	NR	NR	NR	NR	NR	NR	NR	U 0.44	NR	NR	NR	250/2400
Potassium	NR	NR	NR	NR	NR	NR	NR	193	NR	NR	NR	–
Selenium	NR	NR	NR	NR	NR	NR	NR	U 0.32	NR	NR	NR	63/3100
Silver	NR	NR	NR	NR	NR	NR	NR	U 0.74	NR	NR	NR	110/4100
Sodium	NR	NR	NR	NR	NR	NR	NR	41.5	NR	NR	NR	–
Thallium	NR	NR	NR	NR	NR	NR	NR	U 0.60	NR	NR	NR	2/2
Vanadium	NR	NR	NR	NR	NR	NR	NR	5.5	NR	NR	NR	370/7100
Zinc	NR	NR	NR	NR	NR	NR	NR	162	NR	NR	NR	1500/1500
% Solids	NR	NR	86	NR	73	NR	NR	76.9	NR	82.1	84.1	–
Petroleum Hydrocarbons (mg/kg) (Blank units are mg/L)	3500 B	NR	83 B	12 B	NR	23 B	NR	NR	17 B	NR	NR	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = VOC Blank samples reported in µg/L
(c) = Soil cleanup criteria (revised 3/8/93)
(d) = Residential/nonresidential soils

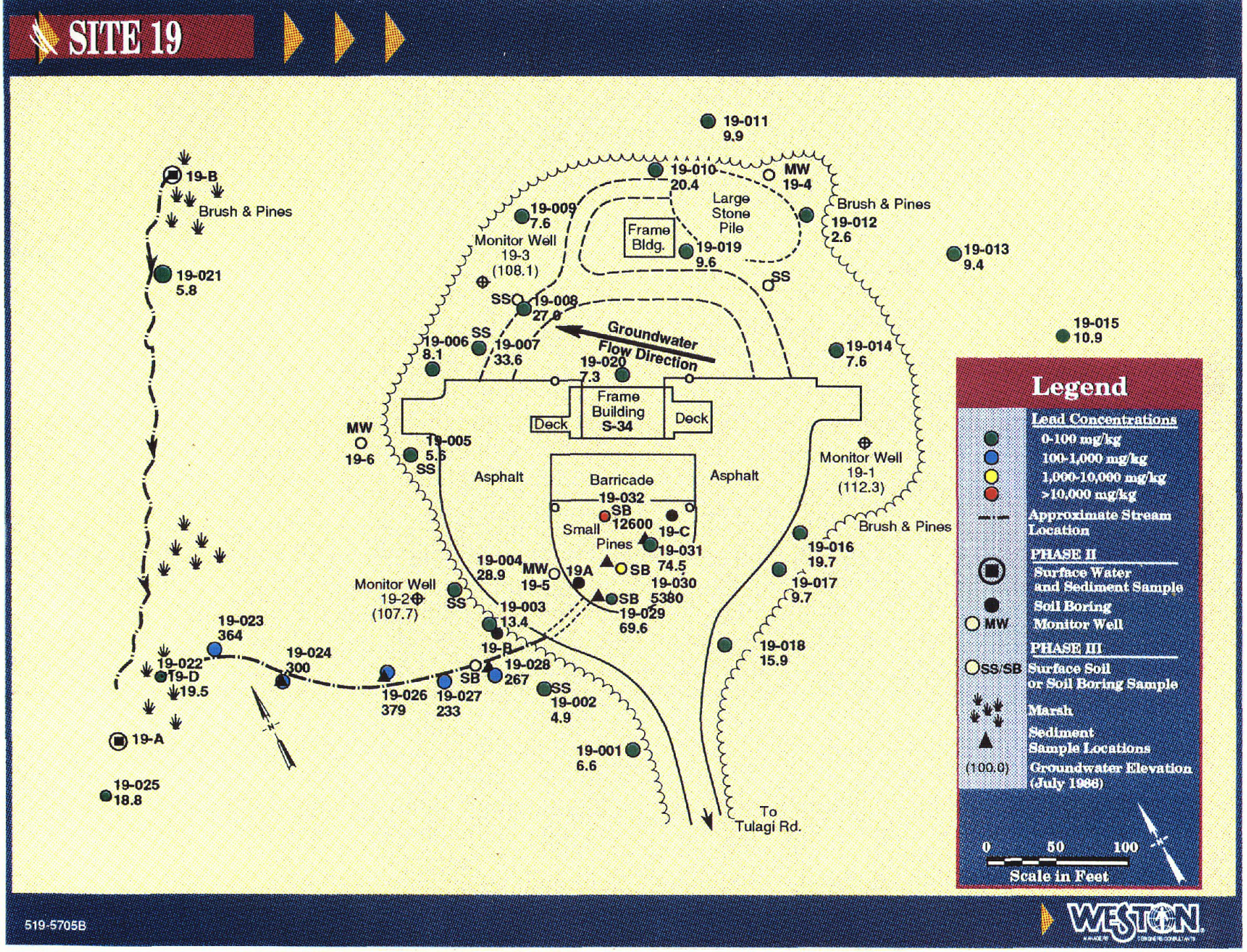

FIGURE 4-10 PAINT CHIP AND SLUDGE DISPOSAL AREA DISTRIBUTION OF LEAD IN THE SOILS, NWS EARLE, NJ

Table 4-16a

Summary of Groundwater Sample Analytical Results

Round One: March 1991

NWS Earle, Site 19 (Paint Chip and Sludge Disposal Area)

Site I.D.(a) / Compounds	19-001-M001 MW19-01	19-001-M001 Replicate	19-002-M001 MW19-02	19-003-M001 MW19-03	19-003-M101 MW19-03 (Dup.)	19-003-M201 MW19-03(Eq. Blank)	19-004-M001 MW19-04	19-005-M001 MW19-05	19-006-M001 MW19-06	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Semivolatiles (µg/L)											
Naphthalene	U 10	NR	1 J	U 10	U 12	U 11	U 11	U 11	U 10	–	–
bis(2-Ethylhexyl)phthalate	U 10	NR	2 J	1 J	U 12	U 11	U 11	U 11	1 J	–	–
Volatile Organics (µg/L)											
Methylene Chloride	11 J	NR	U 5	U 25	U 5	U 25	U 5	U 5	730 B		
Acetone	430	NR	58	430	340	300	53	67	31 B		
Inorganics (mg/L)											
Aluminum	4.0	3.9	30.0	3.6	3.8	0.048	18.3	2.6	35.5	–	–
Arsenic	U .0009	U .0009	0.0027	U .0009	U .0009	U .0009	0.0037	U .0009	0.0084	0.05	0.008
Barium	0.069	0.581	0.059	0.040	0.040	U .0014	0.091	0.030	0.088	2.0	2.0
Beryllium	U .0006	U .0006	0.0037	U .0004	0.0006	U .0006	0.0080	U .0010	0.0041	0.004	0.02
Calcium	7.4	7.3	12.2	9.9	9.7	0.12	9.3	1.5	11.8	–	–
Cadmium	U .0027	U .0027	0.013	U .0027	U .0027	U .0027	U .0027	U .0028	0.0073	0.005	0.004
Cobalt	U .003	U .003	0.023	U .003	U .003	U .003	0.0075	.0028	0.026	–	–
Chromium	U .003	0.053	0.77	0.024	0.030	U .0069	0.17	0.059	0.85	0.1	0.1
Copper	0.0075	0.0061	0.018	0.0051	0.0047	0.0028	0.018	0.0047	0.034	1.3	–
Cyanide	U .010	U .010	U .010	U .010	U .010	U .010	U .010	U .010	U .010	0.2	0.2
Iron	5.4	5.1	99.0	4.8	4.9	0.045	30.3	12.5	106	–	–
Potassium	1.7	1.6	19.6	1.2	1.3	U .0948	6.2	1.6	20.2	–	–
Magnesium	13.0	12.7	10.0	2.4	2.7	0.045	5.1	1.4	8.1	–	–
Manganese	0.024	0.023	0.16	0.0089	0.0099	U .001	0.12	0.014	0.25	–	–
Sodium	4.4	4.5	4.0	2.8	3.2	0.38	3.0	4.8	1.9	–	–
Nickel	0.0064	U .002	0.056	0.0074	0.0087	U .0039	0.027	0.0055	0.082	0.1	0.1
Lead	0.0048	0.0066	0.038	0.0030	0.0040	0.0017	0.019	0.0048	0.054	0.015	0.1
Antimony	0.023	U .0182	U .0182	U .0182	U .0182	U .0182	U .0182	U .0182	U .0182	0.006	0.02
Selenium	0.0039	0.0042	U .0011	U .0011	U .0011	U .0011	0.0025	.0011 U	0.0022	0.05	0.05
Vanadium	0.021	0.021	0.44	0.016	0.019	U .0020	0.10	0.040	0.63	–	–
Zinc	U .0047	U .0047	0.097	0.026	0.029	U .0047	0.23	0.036	0.20	5.0	5.0
Pesticide/PCB (µg/L)											
4,4-DDE	U .010	NR	0.022 J	U 0.11	U 0.11	U 0.11	U 0.11	U .010	0.010 J	–	–
4,4-DDT	U .010	NR	0.14	U 0.11	U 0.11	U 0.11	U 0.11	U .010	0.082 J	–	–

Legend: U = Not detected
NR = Not requested
J = Below detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4-16b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19-001-M002 MW19-01	19-001-M002 REPLICATE	19-001-M202 MW19-01(Eq. Blank)	19-001-M302 MW19-01(Trip Blank)	19-002-M002 MW19-02
Volatile Organics (µg/L)					
Methylene Chloride	1 JB	NR	3 JB	4 JB	4 JB
Acetone	79 B	NR	130 B	13 B	46 B
Inorganics (µg/L)					
Arsenic	U 10	U 10	U 10	NR	U 10
Barium	U 200	U 200	U 200	NR	U 200
Cadmium	U 5	U 5	U 5	NR	U 5
Chromium	61	61.4	U 10	NR	139
Copper	U 25	U 25	U 25	NR	U 25
Iron	7520	7410	284	NR	26700
Mercury	U 0.2	U 0.2	U 0.2	NR	U 0.2
Manganese	52.6	51.1	15.6	NR	29.5
Lead	9.1	10.7	U 3	NR	11.2
Zinc	23.5	23.2	22.3	NR	94

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below deetction limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-16b cont.....
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19-003-M002 MW19-03	19-005-M002 MW19-05	19-006-M002 MW19-06	19-006-M302 MW19-06(Trip Blank)
Volatile Organics (µg/L)				
Methylene Chloride	2 JB	5 B	1 JB	6 B
Acetone	22 B	28 B	180 B	17 B
Inorganics (µg/L)				
Arsenic	12.8	13.7	80.8	NR
Barium	U 200	U 200	237	NR
Cadmium	12.2	20.1	48.2	NR
Chromium	536	1180	4540	NR
Copper	U 25	80.1	140	NR
Iron	70900	129000	534000	NR
Mercury	U 0.2	0.58	0.45	NR
Manganese	96.9	318	1170	NR
Lead	39.7	88	282	NR
Zinc	194	140	1190	NR

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below deetction limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one ore more samples are listed above.

Table 4–16c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a) / Compounds	19–001–M003 MW19–01		19–001–M203 MW19–01(Eq. Blank)		19–002–M003 MW19–02		19–002–M203 MW19–02(Eq. Blank)		19–002–M203 REPLICATE	
Volatile Organics (µg/L)										
Methylene Chloride	U	5	6 B		U	5	8 B		NR	
Acetone	20000 E		22000 E		89		310 E		NR	
Inorganics (µg/L)										
Arsenic	U	10	U	10	U	10	U	10	U	10
Cadmium	U	5	U	5	5.2		U	5	U	5
Chromium	44.6		45.1		640		U	10	U	10
Copper	U	25	U	25	28		U	25	U	25
Iron	6980		7360		57600		U	100	U	100
Mercury	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2
Manganese	57.1		50.4		68.7		U	15	U	15
Sodium	U	5000	5050		5020		U	5000	U	5000
Lead	12.3		17.2		47.8		U	30	U	30
Zinc	39.8		33.8		145		U	20	U	20
Pesticide/PCB (U)	NR		NR		U		U		U	

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below deetction limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4–16c cont.....
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 19 (Paint Chip & Sludge Disposal Area)

Site I.D. (a)	19–002–M303	19–003–M003	19–005–M003	19–006–M003
	MW19–02(Trip Blank)	MW19–03	MW19–05	MW19–06
Compounds				
Volatile Organics (μg/L)				
Methylene Chloride	9 B	U 5	U 5	6 B
Acetone	680 E	13000 E	500 E	33000 E
Inorganics (μg/L)				
Arsenic	NR	U 10	U 10	19.2
Cadmium	NR	U 5	5.4	14
Chromium	NR	30.1	452	438
Copper	NR	U 25	U 25	U 25
Iron	NR	7270	33500	86100
Mercury	NR	U 0.2	0.25	U 0.2
Manganese	NR	17.3	196	550
Sodium	NR	U 5000	6780	U 5000
Lead	NR	6.3	32.1	49.8
Zinc	NR	79.1	74.9	386
Pesticide/PCB (U)	NR	NR	NR	U

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below deetction limit
E = Compound detected beyond calibration range, but not analyzed as dilution due to suspected field contamination
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one ore more samples are listed above.

The first round of groundwater analysis showed only three wells, MW19-02, MW19-03, and MW19-06 with semivolatile compounds, naphthalene, bis(2-ethylhexyl)phthalate, which were present below the method detection limit (J values). MW19-02 had small concentrations (<1 µg/L) of pesticide compounds DDE and DDT. No PCBs were detected. MW19-02 was resampled for pesticides in the third round and none were detected.

The first round of TAL inorganic analysis was followed by analysis limited to the drinking water metals in the second and third sampling rounds. Inorganics were comparable to other sites; In round 1, iron was typically high in all of the wells (5,000-106,000 µg/L, 30,000 µg/L in upgradient well MW19-04). Chromium was very variable for individual wells between the initial and final two sampling rounds. The highest detection of chromium was 4,500 µg/L in MW19-06 in the second round, an order of magnitude higher than for the same well in the first and third rounds. Lead was also detected in the first round in all wells at low levels (< 38 µg/L) but was similarly elevated in MW19-06 and other wells in round 2.

4.8.3 Summary of the Site 19 Characterization

The localized distribution of lead found in the soils at Site 19 is best illustrated in Figure 4-10. This figure shows the sampling locations, along with the concentrations of lead found in the soils at the site. As shown, the distribution of lead appears to be localized to the area within the surface depression, located behind the barricade, and along the drainageway between the depression and the tributary to Mingamahone Brook, which is located approximately 300 feet west of Site 19.

Lead was detected in the first round in all wells at low levels (< 38 µg/L) but similarly elevated in MW19-06 (located immediately adjacent to the surface depression) and other wells in round 2. The highest detection of chromium was 4,500 µg/L in MW19-06 in the second round, an order of magnitude higher than for the same well in the first and third rounds. This concentration is well above the current MCL for chromium, which is 100 µg/L. The association of lead or chrome with site activities is well known. These metals typically are attenuated in soils and are not highly mobile in groundwater. Considering the relatively high concentration found in the

soils, the presence of paint chips in the soils, the period of time since deposition, and the relative location and construction of the monitoring well, the concentrations of these metals in unfiltered samples from the shallow groundwater do not imply significant mobility. This is further supported by the relatively low concentrations of chromium in the wells located downgradient of the apparent source area.

4.9 SITE 20 GRIT BLASTING AREA AT BUILDING 544

4.9.1 Physical Characteristics

Site 20 includes the spent grit pile, shallow drainage and surrounding area located behind Building 544 along Midway Road. To the southeast of Midway Road the site is surrounded by woodlands. A small pile of blasting grit, commonly known as "black beauty," measuring approximately 10 feet in diameter and 1 foot high is located southwest of Building 544. The site is bordered on the northeast by marsh and wetlands. A gravel road accesses Site 20 from Midway Road. The surface of the site behind Building 544 is sand and gravel with traces of blasting grit material. A shallow drainage depression measuring approximately 300 feet in length and 0.5 to 1.5 feet deep runs the length of the site behind Building 544 and discharges toward the northeast to the marsh.

4.9.1.1 Soils and Waste Description

The original soils at Site 20 and surrounding area are classified as Lakehurst sands [LaA] Series (Section 2). The soils have been altered by past construction activities and have therefore been reclassified as Udorthants [UA]. Sediment samples collected along the drainage are characterized as silty sand and gravel within the drainage and sandy loam and muck closer to the marshy area. The grit blasting material was confined to the pile area and did not appear to be distributed around the site.

4.9.1.2 Drainage

Drainage at Site 20 occurs primarily through overland flow, infiltration, and evapotranspiration. A shallow drainage ditch is located behind Building 544 along the east and southeast boundaries of the site. Runoff collects in the depression and discharges by way of the drainage ditch to a marshy area which is located approximately 250 feet northeast of the center of the site. The surface water body nearest to Site 20 is a headwater of Hockhockson Brook which is located approximately 500 feet east of Site 20.

4.9.2 Chemical Results

4.9.2.1 Analysis of the Waste Material

The results of the waste material sampling collected in the grit pile at Site 20 are presented on Table 4-17. The grit pile sample is identified as sample number 20-001-D001. As shown on Table 4-17, several metals were detected at elevated concentrations. These metals included chromium (83.5 mg/kg), copper (1,320 mg/kg), nickel (711 mg/kg), lead (710 mg/kg), and zinc (2,720 mg/kg).

4.9.2.2 Analysis of Sediments

The results of the sediment sampling conducted along the drainageway at Site 20 are presented on Table 4-17. As shown on Table 4-17, chromium, copper, nickel, lead, and zinc were detected at elevated concentrations in all of the samples. Samples 20-002 through 20-005, which were collected in the surface drainage behind Building D-2, had chromium concentrations of between 94 and 204 mg/kg. Copper was detected at concentrations between 261 and 895 mg/kg. Nickel was detected at concentrations between 80 and 425 mg/kg. Lead was detected at concentrations between 305 and 780 mg/kg. Zinc was also detected at concentrations between 700 and 2,890 mg/kg.

Table 4-17
Summary of Sediment and Soil Sample Analytical Results
NWS Earle, Site 20 (Grit Blast Disposal)

Site ID(a) / Compounds	20-001-D001 Sediment Sample 20-01	20-002-D001 Sediment Sample 20-02	20-003-D001 Sediment Sample 20-03	20-004-D001 Sediment Sample 20-04	20-005-D001 Sediment Sample 20-05	20-005-D001 Replicate	20-005-D101 Sediment Sample 20-05 (Dup.)	20-005-D201 Sediment Sample 20-02 (Eq. Blank)	20-005-D201 Replicate	20-005-S002 Soil Sample 20-05	20-005-S102 Soil Sample 20-05 (Dup)	20-005-S202 Soil Sample 20-05 (Eq. Blank)
Volatile Organics (µg/kg)												
Blanks are in µg/L												
Methylene Chloride	NR	NR	NR	NR	NR	NR	NR	NR	NR	130 B	74 B	3 JB
Acetone	NR	NR	NR	NR	NR	NR	NR	NR	NR	78 B	60 B	86 B
Chloroform	NR	NR	NR	NR	NR	NR	NR	NR	NR	U 10	U 12	5
Semivolatiles (ug/kg) Blanks (µg/L)												
Phenol	NR	NR	U 560	NR	U 780	NR	U 850	8 JB	NR	NR	NR	NR
1,4-Dichlorobenzene	NR	NR	U 560	NR	U 780	NR	U 850	4 JB	NR	NR	NR	NR
N-Nitroso-Di-n-propylamine	NR	NR	U 560	NR	U 780	NR	U 850	6 JB	NR	NR	NR	NR
1,2,4-Trichlorobenzene	NR	NR	U 560	NR	U 780	NR	U 850	5 JB	NR	NR	NR	NR
Acenaphthene	NR	NR	U 560	NR	U 780	NR	U 850	7 JB	NR	NR	NR	NR
2,4-Dinitrotoluene	NR	NR	U 560	NR	U 780	NR	U 850	6 JB	NR	NR	NR	NR
4-Chloro-3-methylphenol	NR	NR	U 560	NR	U 780	NR	U 850	13 B	NR	NR	NR	NR
Pentachlorophenol	NR	NR	U 2800	NR	U 780	NR	U 850	6 JB	NR	NR	NR	NR
Phenanthrene	NR	NR	110 J	NR	910	NR	U 850	U 11	NR	NR	NR	NR
Anthracene	NR	NR	U 560	NR	200 J	NR	210 J	U 11	NR	NR	NR	NR
Di-n-Butylphthalate	NR	NR	78 J	NR	180 J	NR	200 J	U 11	NR	NR	NR	NR
Fluoranthene	NR	NR	260 J	NR	3300	NR	3400	U 11	NR	NR	NR	NR
Pyrene	NR	NR	260 J	NR	2600	NR	3900	10 JB	NR	NR	NR	NR
Butyl benzylphthalate	NR	NR	U 560	NR	U 940	NR	550 J	U 11	NR	NR	NR	NR
Benzo (a) anthracene	NR	NR	120 J	NR	1700	NR	1900	U 11	NR	NR	NR	NR
Chrysene	NR	NR	200 J	NR	2200	NR	2600	U 11	NR	NR	NR	NR
bis (2-Ethylhexyl) phthalate	NR	NR	450 J	NR	1900	NR	1200	U 11	NR	NR	NR	NR
Benzo (b) fluoranthene	NR	NR	230 J	NR	2400	NR	2800	U 11	NR	NR	NR	NR
Benzo (k) fluoranthene	NR	NR	170 J	NR	2000	NR	2600	U 11	NR	NR	NR	NR
Benzo (a) pyrene	NR	NR	150 J	NR	2300	NR	2700	U 11	NR	NR	NR	NR
Ideno (1,2,3-cd) pyrene	NR	NR	120 J	NR	1900	NR	2000	U 11	NR	NR	NR	NR
Dibenzo (a,h) anthracene	NR	NR	U 560	NR	710 J	NR	830 J	U 11	NR	NR	NR	NR
Benzo (g,h,i) perylene	NR	NR	160 J	NR	2200	NR	2400	U 11	NR	NR	NR	NR

Legend: U = Not detected
NR = Not Requested
J = Below Detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Soil cleanup criteria (revised 3/8/93)
(c) = Residential/nonresidential soils

Table 4-17 cont...

Summary of Sediment and Soil Sample Analytical Results

NWS Earle, Site 20 (Grit Blast Disposal)

Site I.D.(a) / Compound	20-001-D001 Sediment Sample 20-01	20-002-D001 Sediment Sample 20-02	20-003-D001 Sediment Sample 20-03	20-004-D001 Sediment Sample 20-04	20-005-D001 Sediment Sample 20-05	20-005-D001 Replicate	20-005-D101 Sediment Sample 20-05 (Dup.)	20-005-D201 Sediment Sample 20-05 (Eq. Blank)	20-005-D201 Replicate	20-005-S002 Soil Sample 20-05	20-005-S102 Soil Sample 20-05 (Dup.)	20-005-S202 Soil Sample 20-05 (Eq. Blank)	NJDEPE Guidelines [b] (mg/kg)
Inorganics (mg/kg) Blanks (mg/l)													
Aluminum	7720	4700	17300	6650	9710	10475	NR	U .018	NR	NR	NR	NR	–
Arsenic	3.5	2.8	2.7	0.79	4.6	3.6	NR	U .0018	NR	NR	NR	NR	2/2 [c]
Barium	146	48.6	325	142	99.8	113	NR	U .0040	NR	NR	NR	NR	700/47000
Beryllium	5.1	2.5	9.9	6.5	2.5	2.8	NR	U .0005	NR	NR	NR	NR	1/1
Calcium	5220	1220	6750	3240	2750	2902	NR	0.11	NR	NR	NR	NR	–
Cadmium	1.3	U 0.83	1.8	U 0.80	U 1.5	U 1.5	NR	U .0034	NR	NR	NR	NR	1/100
Cobalt	64.9	13.4	62.6	33.0	13.6	16.7	NR	U .0063	NR	NR	NR	NR	–
Chromium	83.5	94.7	204	120	171	176	NR	U .012	NR	NR	NR	NR	
Copper	1320	261	859	461	333	372	NR	0.012	NR	NR	NR	NR	600/600
Iron	35500	16800	54100	26000	23500	25606	NR	0.045	NR	NR	NR	NR	–
Potassium	553	973	1930	604	834	937	NR	U 0.14	NR	NR	NR	NR	–
Magnesium	1250	871	2280	1100	1580	1655	NR	U .052	NR	NR	NR	NR	–
Manganese	299	107	329	214	160	175	NR	U .0009	NR	NR	NR	NR	–
Nickel	711	117	425	220	80.1	90.6	NR	U .0036	NR	NR	NR	NR	250/2400
Lead	710	305	780	429	383	348	NR	0.0017	NR	NR	NR	NR	100/600
Antimony	U 1.8	U 1.8	U 2.2	3.4	4.6	7.1	NR	U .0075	NR	NR	NR	NR	14/340
Selenium	1.9	0.61	1.8	1.8	2.9	3.2	NR	U .0013	NR	NR	NR	NR	63/3100
Vanadium	12.7	30.5	42.3	15.7	47.4	50.7	NR	U .0026	NR	NR	NR	NR	370/7100
Zinc	2720	980	2890	1760	700	765	NR	0.012	NR	NR	NR	NR	1500/1500
% Solids (%)	80.0	80.8	68.4	83.7	43.7	43.5	NR	NR	NR	47.1	42.5	NR	–
Pesticide/PCB (µg/kg)	U 240	NR	U 430	NR	U 670	NR	U 740	U 1.0	NR	NR	NR	NR	

Legend: U = Not detected
NR = Not Requested
J = Below Detection limit
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Soil cleanup criteria (revised 3/8/93)
(c) = Residential/nonresidential soils

As shown on Table 4-17, several semivolatile compounds were detected at elevated levels in sample 20-005-D001.

The volatile compounds methylene chloride and acetone were detected in samples 20-005-S001 and S002. These two compounds were also detected in the blanks and are common solvents in the laboratory and field decontamination, respectively. No other VOCs were detected in any well in the other soil samples above J values.

4.9.3 Summary of the Site 20 Characterization

The concentrations of chromium, copper, nickel, lead, and zinc in the soils at Site 20 are consistent with its past use as a grit (sand) blasting area. However, these levels are relatively low and there is no evidence, visual or analytical, of extensive contamination of soils. Considering the relative concentrations found in the soils and the period of time since deposition, concentrations of these metals in the shallow soils do not imply significant mobility. These metals typically are attenuated in soils and are not highly mobile in groundwater. Therefore, the impact on this site from past activities is negligible and the residual hydrocarbons can be expected to naturally degrade over time.

4.10 SITE 22: PAINT CHIP DISPOSAL AREA

4.10.1 Physical Characteristics

Site 22 includes the discolored soils located behind Building D-2 along a shallow drainageway. As reported in the IAS, the area measures approximately 50 ft^2. The site is bordered on the north by a railroad siding and on the east by a marshy area. A macadam road accesses Site 22 from Midway Road. The surface of the site behind Building D-2 is predominantly sand and gravel. Traces of paint stains are barely evident in the surface materials. A shallow drainage depression, measuring approximately 275 feet in length and 0.5 to 1 foot in depth, runs the length of the site behind Building D-2, and discharges toward the southeast to a marsh.

4.10.1.1 Waste Description

Based on the field observations, the waste material at Site 22 appears to be limited to those areas of black and red staining on the surface of the soils.

4.10.1.2 Sediments and Drainage

Based on the samples obtained during the sediment sampling, the shallow sediments along the drainage are composed of a loamy sand, silty clay, and muck. The drainage pattern observed at Site 22 is very similar to Site 20. Drainage at Site 22 occurs primarily through overland flow, infiltration, and evapotranspiration. A shallow drainage ditch is located behind Building D-2, running east to west along the boundary of the site. Runoff which collects at the site discharges by way of the drainage ditch to a marshy area which is located approximately 25 feet southeast of Building D-2. The surface water body nearest to Site 22 is a headwater of Hockhockson Brook, which is located approximately 250 feet to the southeast.

4.10.2 Chemical Results

4.10.2.1 Analysis of the Waste Material

The results of the waste material samples collected in the stained areas at Site 22 are presented on Table 4-18. The samples are identified as sample numbers 22-007, 22-008, and 22-009. Several metals were detected at elevated concentrations. The concentrations of these metals were within the normal range for naturally occurring soils. The highest levels of chromium and lead were detected in sample 22-003-D001 at concentrations of 31.8 mg/kg and 106 mg/kg. The highest concentration of zinc was detected in sample 22-001-D001 at a concentration of 119 mg/kg.

As shown on Table 4-18, fluoranthene and pyrene were detected at concentrations of 580 µg/kg and 570 µg/kg, respectively, in sample 22-008-S001. In addition, several other semivolatile compounds were also detected at J levels in sample 22-008-S001.

Table 4-18

Summary of Sediment Sample Analytical Results

NWS Earle, Site 22 (Paint Chip Disposal Area)

Site I.D. / Compunds	22-001-D001 Sediment Sample 22-01	22-001-D001 Replicate	22-002-D001 Sediment Sample 22-02	22-003-D001 Sediment Sample 22-03	22-004-D001 Sediment Sample 22-04	22-005-D001 Sediment Sample 22-05	22-006-D001 Sediment Sample 22-06	22-006-D201 Sediment Sample 22-06 (Eq. Blank)	22-006-D201 Replicate	22-007-S001 Soil Sample 22-07	NJDEPE Guidelines [b] (mg/kg)
Volatile Organics (ug/kg) Blanks (µg/L)											
Methylene Chloride	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	–
Acetone	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	–
Carbon Disulfide	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	–
1,1,1-Trichloroethane	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	–
											–
Semivolatiles (µg/kg) Blanks (µg/L)											–
Benzoic Acid	NR	NR	NR	U 250	NR	NR	U 2600	U 60	NR	U 2200	–
Acenaphthene	NR	NR	NR	U 500	NR	NR	300 J	U 12	NR	U 440	–
Fluorene	NR	NR	NR	U 500	NR	NR	150 J	U 12	NR	U 440	–
N-Nitrosodiphenylamine(1)	NR	NR	NR	U 500	NR	NR	U 520	U 12	NR	U 440	–
Phenanthrene	NR	NR	NR	610	NR	NR	6300	U 12	NR	U 440	–
Anthracene	NR	NR	NR	71 J	NR	NR	880	U 12	NR	U 440	–
Di-n-Butylphthalate	NR	NR	NR	69 J	NR	NR	68 J	U 12	NR	58 J	–
Fluoranthene	NR	NR	NR	1500	NR	NR	5000	U 12	NR	110 J	–
Pyrene	NR	NR	NR	1100	NR	NR	3300	U 12	NR	74 J	–
Benzo(a)anthracene	NR	NR	NR	490 J	NR	NR	1800	U 12	NR	U 440	–
Chrysene	NR	NR	NR	730	NR	NR	1700	U 12	NR	U 440	–
bis(2-ethylhexyl)phthalate	NR	NR	NR	U	NR	NR	77 J	U 12	NR	U 440	–
Benzo (b) fluoranthene	NR	NR	NR	630	NR	NR	1200	U 12	NR	71 J	–
Benzo (k) fluoranthene	NR	NR	NR	550	NR	NR	1200	U 12	NR	52 J	–
Benzo (a)pyrene	NR	NR	NR	460 J	NR	NR	970	U 12	NR	U 440	–
Ideno (1,2,3-cd) pyrene	NR	NR	NR	390 J	NR	NR	780	U 12	NR	U 440	–
Dibenzo (a,h) anthracene	NR	NR	NR	64 J	NR	NR	220 J	U 12	NR	U 440	–
Benzo g,h,i) perylene	NR	NR	NR	440 J	NR	NR	830	U 12	NR	U 440	–
Inorganics (mg/kg) Blanks (µg/L)											
Aluminum	3930	NR	NR	2220	3010	1300	2360	U 17.8	0.031	1370	–
Arsenic	2.9	NR	NR	2.5	2.8	1.2	0.94	U 1.8	U 18.0	3.3	2/2 [c]
Barium	16.5	NR	NR	8.0	9.2	1.1	6.6	U 4.0	U 4.0	7.2	700/47000
Beryllium	0.76	NR	NR	0.27	0.16	0.13	0.22	U 0.50	0.50	0.22	1/1
Calcium	1260	NR	NR	422	671	56.6	944	0.097	0.097	55.2	–
Cadmium	2.7	NR	NR	U 0.90	1.8	U 0.75	0.93	U 0.34	U 0.34	U 0.75	1/100
Cobalt	5.2	NR	NR	1.1	U 0.93	U 0.75	U 0.93	U 3.4	U 3.4	U 0.75	–
Chromium	14.3	NR	NR	31.8	24.0	11.6	13.6	U 6.3	U 6.3	17.1	
Copper	18.3	NR	NR	4.6	5.3	0.77	4.0	0.021	U	4.7	600/600
Iron	13400	NR	NR	7090	3970	2550	3010	0.045	0.051	8340	–
Potassium	342	NR	NR	1440	678	450	465	U 142	U 142	530	–
Magnesium	641	NR	NR	558	318	171	405	51.6	0.058	131	–
Manganese	155	NR	NR	23.7	9.5	2.4	8.3	U 0.90	U 0.90	11.2	–
Sodium	67.1	NR	NR	36.6	57.6	10.3	42.9	0.26	0.26	97.4	–
Nickel	8.6	NR	NR	U 0.94	U .98	U 0.79	U 0.99	U 3.6	U 3.6	U 0.80	250/2400
Lead	42.9	NR	NR	106	26.9	6.4	11.9	0.0020	0.014	29.8	100/600
Selenium	0.38	NR	NR	U 0.34	0.37	U 0.31	U 0.35	U 1.3	U 1.3	U 0.31	63/3100
Vanadium	21.4	NR	NR	29.0	12.5	9.5	10.1	U 2.6	U 2.6	12.6	370/7100
Zinc	119	NR	NR	20.9	35.6	4.0	36.8	0.0045	0.0048	5.6	1500/1500
%Solids	73.4	73.1	NR	75.6	64.4	78.8	72.4	NR	NR	81.5	–
Pesticide/PCB (µg/kg)											Total = 1 – 5
Blanks are in µg/L											
4,4-DDT	NR	NR	NR	13 J	NR	NR	U 110	U .010	NR	4 J	
Petroleum Hydrocarbons (mg/kg)	27	NR	5.9	12	15	13	48	U 1.2	NR	NR	100
Blanks are in mg/L											

Legend: U = Not detected
NR = Not requested
J = Present below detection limit

B = Detection limit found in blank
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Soil cleanup criteria (revised 3/8/93)
(c) = Residential/nonresidential soils

Table 4-18 cont...

Summary of Sediment Sample Analytical Results

NWS Earle, Site 22 (Paint Chip Disposal Area)

Site I.D. / Compounds	22-007-S002 Soil Sample 22-07	22-008-S001 Soil Sample 22-08	22-008-S101 Soil Sample 22-08 (Dup.)	22-008-S002 Soil Sample 22-08	22-009-S001 Soil Sample 22-09	22-009-S002 Soil Sample 22-09	22-009-S102 Soil Sample 22-09 (Dup.)	22-009-S102 Replicate	22-009-S202 Soil Sample 22-09 (Eq. Blank)	22-009-S302 Soil Sample 22-09 (Trip Blank)	NJDEPE Guidelines (b) (mg/kg)
Volatile Organics (ug/kg) Blanks (µg/L)											
Methylene Chloride	44 B	NR	NR	50 B	NR	49 B	53 B	NR	4 JB	5 B	–
Acetone	130 B	NR	NR	140 B	NR	130 B	220 B	NR	98 B	14 B	–
Carbon Disulfide	U 6	NR	NR	U 6	NR	U 6	U 6	NR	1 J	1 J	–
1,1,1-Trichloroethane	U 6	NR	NR	U 6	NR	2 J	U 6	NR	U 5	U 5	–
											–
Semivolatiles (µg/kg) Blanks (µg/L)											–
Benzoic Acid	NR	54 J	U 2200	NR	U 2400	NR	NR	NR	NR	NR	–
Acenaphthene	NR	U 450	U 440	NR	U 480	NR	NR	NR	NR	NR	–
Fluorene	NR	U 450	U 440	NR	U 480	NR	NR	NR	NR	NR	–
N-Nitrosodiphenylamine (1)	NR	U 450	U 440	NR	U 480	NR	NR	NR	NR	NR	–
Phenanthrene	NR	230 J	81 J	NR	U 480	NR	NR	NR	NR	NR	–
Anthracene	NR	82 J	U 440	NR	U 480	NR	NR	NR	NR	NR	–
Di-n-Butylphthalate	NR	U 450	71 J	NR	60 J	NR	NR	NR	NR	NR	–
Fluoranthene	NR	580	190 J	NR	U 480	NR	NR	NR	NR	NR	–
Pyrene	NR	570	120 J	NR	U 480	NR	NR	NR	NR	NR	–
Benzo(a)anthracene	NR	280 J	64 J	NR	U 480	NR	NR	NR	NR	NR	–
Chrysene	NR	270 J	73 J	NR	U 480	NR	NR	NR	NR	NR	–
bis(2-ethylhexyl)phthalate	NR	U 450	97 J	NR	U 480	NR	NR	NR	NR	NR	–
Benzo (b) fluoranthene	NR	260 J	62 J	NR	U 480	NR	NR	NR	NR	NR	–
Benzo (k) fluoranthene	NR	200 J	60 J	NR	U 480	NR	NR	NR	NR	NR	–
Benzo (a) pyrene	NR	210 J	U 440	NR	U 480	NR	NR	NR	NR	NR	–
Ideno (1,2,3-cd) pyrene	NR	97 J	U 440	NR	U 480	NR	NR	NR	NR	NR	–
Dibenzo (a,h) anthracene	NR	U 450	U 440	NR	U 480	NR	NR	NR	NR	NR	–
Benzo g,h,i) perylene	NR	100 J	U 440	NR	U 480	NR	NR	NR	NR	NR	–
Inorganics (mg/kg) Blanks (µg/L)											
Aluminum	NR	3070	NR	NR	4350	NR	NR	NR	NR	NR	–
Arsenic	NR	2.7	NR	NR	1.9	NR	NR	NR	NR	NR	2/2 (c)
Barium	NR	5.3	NR	NR	9.6	NR	NR	NR	NR	NR	700/47000
Beryllium	NR	0.45	NR	NR	0.30	NR	NR	NR	NR	NR	1/1
Calcium	NR	39.4	NR	NR	9.7	NR	NR	NR	NR	NR	–
Cadmium	NR	U 0.81	NR	NR	U 0.84	NR	NR	NR	NR	NR	1/100
Cobalt	NR	U 0.81	NR	NR	U 0.84	NR	NR	NR	NR	NR	–
Chromium	NR	48.2	NR	NR	46.8	NR	NR	NR	NR	NR	
Copper	NR	17.2	NR	NR	2.5	NR	NR	NR	NR	NR	600/600
Iron	NR	9480	NR	NR	5520	NR	NR	NR	NR	NR	–
Potassium	NR	2270	NR	NR	1710	NR	NR	NR	NR	NR	–
Magnesium	NR	661	NR	NR	452	NR	NR	NR	NR	NR	–
Manganese	NR	6.0	NR	NR	5.0	NR	NR	NR	NR	NR	–
Sodium	NR	31.8	NR	NR	21.7	NR	NR	NR	NR	NR	–
Nickel	NR	2.8	NR	NR	U 0.89	NR	NR	NR	NR	NR	250/2400
Lead	NR	6.3	NR	NR	8.0	NR	NR	NR	NR	NR	100/600
Selenium	NR	U 0.30	NR	NR	0.35	NR	NR	NR	NR	NR	63/3100
Vanadium	NR	36.1	NR	NR	25.8	NR	NR	NR	NR	NR	370/7100
Zinc	NR	33.3	NR	NR	5.3	NR	NR	NR	NR	NR	1500/1500
% Solids	87.6	81.1	79.5	91.1	77.9	79.1	78.8	82.6	NR	NR	–
Pesticide/PCB (µg/kg)											Total = 1 – 5
Blanks are in µg/L											
4,4-DDT	NR	U 20	U 19	NR	5.2 J	NR	NR	NR	NR	NR	
Petroleum Hydrocarbons (mg/kg)	NR	NR	NR	NR	NR	NR	NR	NR			100
Blanks are in mg/L									NR	NR	

Legend: U = Not detected
NR = Not requested
J = Present below detection limit

B = Detection limit found in blank
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Soil cleanup criteria (revised 3/8/93)
(c) = Residential/nonresidential soils

The volatile compounds methylene chloride and acetone were detected in all three samples. These two compounds were also detected in the blanks and are common solvents in the laboratory and field decontamination, respectively.

The pesticide compound 4,4-DDT was found in sample 22-007 at a concentration of 4J.

4.10.2.2 Analysis of Soils and Sediments

The results of the sediment sampling conducted along the drainageway at Site 22 are presented on Table 4-18. Samples 22-001 through 22-006 were collected in the surface drainage behind Building D-2. Some metals were detected at slightly elevated levels.

As shown on Table 4-18, several semivolatile "derivative" compounds of anthracene, pyrene, and chrysene were also detected at elevated levels in samples 22-003 and 22-006.

In addition, some semivolatile compounds were detected at J levels. The volatile compounds methylene chloride and acetone were detected in samples 2-005-S001 and S002. These two compounds were also detected in the blanks and are common solvents in the laboratory and field decontamination, respectively. No other VOCs were detected in any well in the other soil samples above J values.

The pesticide compound 4,4-DDT was found in sample 22-003 at a concentration of 13J. No PCBs were detected in any of the samples.

4.10.3 Summary of the Site 22 Characterization

Several metals were detected at elevated concentrations in the waste sample. The concentrations of metals were within the normal range for naturally occurring soils.

Fluoranthene and pyrene were detected at concentrations of 580 µg/kg and 570 µg/kg, respectively, in sample 22-008-S001. These compounds, along with anthracene and chrysene, which were also detected at lower concentrations in other samples, are all constituents of gasoline, lubricating motor oils, and coal tars.

The pesticide compound 4,4-DDT was found in three samples at J concentrations. No PCBs were detected in any of the samples.

4.11 SITE 26 EXPLOSIVE "D" WASHOUT AREA

4.11.1 Physical Characteristics

Site 26 comprises a very small area approximately 200 by 200 feet in size. The site is bordered on the west by a branch of Mingamahone Brook, and to the north by marsh and wetlands. The site is situated on the northwest side of the intersection of Midway and Macassar Roads. Topography across the site is relatively flat, approximately 150 feet above MSL. A depression measuring approximately 30 feet in diameter and 10 feet deep is situated in the center of the site approximately 75 feet behind Building GB-1. A terra-cotta sluice pipe approximately 100 feet long traverses the site at ground surface from Building GB-1 to the depression.

4.11.1.1 Soils and Sediments

The soils within Site 26 are part of the Lakehurst sands [LaA] Series. Based on the samples obtained during the drilling and soil sampling at Site 26, the shallow soils consist of fine to coarse sand and gravel and vary in color from yellowish to reddish brown (5 YR 6/4 to 10 YR 4/3).

4.11.1.2 Drainage

A depression measuring approximately 30 feet in diameter and 10 feet deep is situated in the center of the site behind Building GB-1. Runoff water which collects in the depression drains via infiltration through the soils.

4.11.1.3 Hydrogeology

Generally groundwater levels range between 10 and 15 feet bgs across Site 26. Figure 4-11 presents groundwater elevation contours developed from water level elevations obtained in June 1991. Groundwater flow is toward the southwest with an average gradient of .005. The site is small and the maximum head difference between wells is only 0.5 feet. MW26-08 is hydraulically upgradient of the site while MW26-04 and MW26-01 are downgradient of the potential source area. Based on the average hydraulic conductivity calculated from the slug test data for MW26-01, MW26-03, and MW26-04, the lateral groundwater flow velocity calculated from Darcy's Law (V = Ki/n) is approximately 0.17 feet/day or 63 feet/year.

4.11.2 Chemical Results

4.11.2.1 Analysis of Soils at Site 26

The analytical results of the soils collected at Site 26 are presented on Table 4-19. The soil samples were all obtained in the depression where the drain pipe emptied. Lead ranged from 100 to 300 µg/L in three samples. All other metals appeared within normal background ranges. Picric acid was found in only one sample and duplicate sample at 26-004 at 14 and 27 µg/L. No other explosive compounds were detected.

4.11.2.2 Analysis of Groundwater Samples at Site 26

The groundwater quality results for the three rounds of sampling conducted at Site 26 are presented in Tables 4-20a, 4-20b, and 4-20c. The first round of groundwater analysis detected

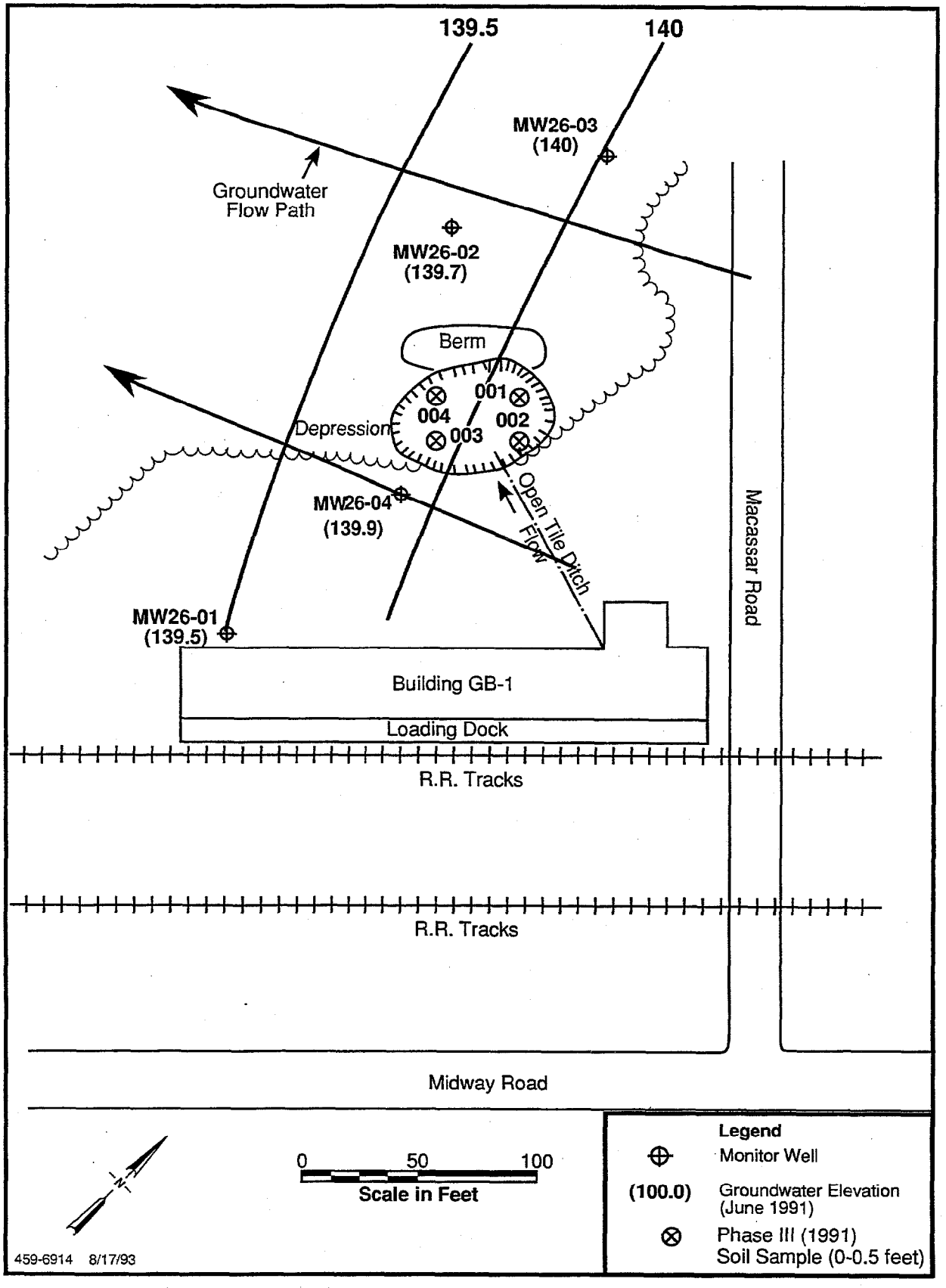

FIGURE 4-11 SITE 26 - EXPLOSIVE "D" WASHOUT AREA GROUNDWATER SURFACE CONTOURS NWS EARLE, NJ

Table 4-19

Summary of Soil and Sediment Sample Analytical Results

NWS Earle, Site 26 (Explosive "D" Washout Area)

Site I.D.(a) / Compounds	26-001-S001 Soil Sample 26-01	26-001-S002 Soil Sample 26-01	26-002-D001 Sediment Sample 26-02	26-002-D001 Replicate	26-002-D101 Sediment Sample 26-02 (Dup.)	26-002-D201 Sediment Sample 26-02 (Eq.Blank)	26-002-D201 Replicate	26-002-S001 Soil Sample 26-02	26-002-S002 Soil Sample 26-02	Regulatory NJDEPE Guidelines (b) (mg/kg)
Inorganics (mg/kg)										
(blank units are mg/L)										
Aluminum	NR	NR	3720	3452	4270	0.11	0.05	NR	NR	–
Antimony	NR	NR	2.6	3.3	4.1	U .0075	0.009	NR	NR	14/340
Arsenic	NR	NR	3.7	4.6	4.0	U .0018	U .0018	NR	NR	2/2 (c)
Barium	NR	NR	6.3	15.9	7.4	0.0043	U .0040	NR	NR	700/47000
Beryllium	NR	NR	0.31	0.24	0.27	U .00050	U .00050	NR	NR	1/1
Calcium	NR	NR	123	164	142	0.38	0.14	NR	NR	–
Cadmium	NR	NR	2.9	3.0	2.7	U .0034	U .0034	NR	NR	1/100
Chromium	NR	NR	64.1	62.1	76	U .0063	U .0063	NR	NR	
Cobalt	NR	NR	0.75	U 0.77	U 0.78	U .0034	U .0034	NR	NR	–
Copper	NR	NR	13.1	20.3	24.2	U 0.0034	0.0031	NR	NR	600/600
Cyanide	NR	NR	U .40	NR	U .41	U .010	NR	NR	NR	1100/21000
Iron	NR	NR	10400	9645	12000	0.039	0.034	NR	NR	–
Lead	NR	NR	115	107	98.7	U .0016	U .0016	NR	NR	100/600
Magnesium	NR	NR	576	483	657	0.12	U .051	NR	NR	–
Manganese	NR	NR	4.5	3.9	3.8	U .0021	0.001	NR	NR	–
Mercury	NR	NR	U .093	U .96	U 0.11	U .00020	U .00020	NR	NR	14/270
Nickel	NR	NR	U 0.76	U .77	U 0.83	U .0036	U .0036	NR	NR	250/2400
Nitrate	2.0	6.1	NR	NR	NR	NR	NR	1.3	1.6	–
Nitrite	U	3.4	NR	NR	NR	NR	NR	0.74	2.6	–
Sodium	NR	NR	17.3	19.8	22.1	0.62	0.3	NR	NR	–
Thallium	NR	NR	U 0.53	U 0.53	U 0.54	U .0024	U .0024	NR	NR	2/2
Vanadium	NR	NR	71.5	73.1	85.2	U .0026	U .0026	NR	NR	370/7100
Zinc	NR	NR	30.4	64.9	33.9	0.012	0.007	NR	NR	1500/1500
% Solids (%)	89.2	86.6	87.4	87.5	87.1	NR	NR	87.7	88.4	–
Explosives										
Picric Acid (μg/g)	U 1.11	U 1.19	NR	NR	NR	NR	NR	U 1.11	U 1.11	

Legend: U = Not detected
NR = Not requested
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Soil cleanup criteria (revised 3/8/93)
(c) = Residential/nonresidential soils

Table 4-19 cont....

Summary of Soil and Sediment Sample Analytical Results

NWS Earle, Site 26 (Explosive "D" Washout Area)

Site I.D.(a) / Compounds	26-003-S001 Soil Sample 26-03	26-003-S002 Soil Sample 26-03	26-004-D001 Sediment Sample 26-04	26-004-S001 Soil Sample 26-04	26-004-S002 Soil Sample 26-04	26-004-S101 Soil Sample 26-04 (Dup.)	26-004-S101 Replicate	Regulatory NJDEPE Guidelines (b) (mg/kg)
Inorganics (mg/kg)								
(blank units are mg/L)								
Aluminum	NR	NR	9000	NR	NR	NR	NR	-
Antimony	NR	NR	4.4	NR	NR	NR	NR	14/340
Arsenic	NR	NR	6.0	NR	NR	NR	NR	2/2 (c)
Barium	NR	NR	16.8	NR	NR	NR	NR	700/47000
Beryllium	NR	NR	0.35	NR	NR	NR	NR	1/1
Calcium	NR	NR	289	NR	NR	NR	NR	-
Cadmium	NR	NR	16.5	NR	NR	NR	NR	1/100
Chromium	NR	NR	123	NR	NR	NR	NR	
Cobalt	NR	NR	0.9	NR	NR	NR	NR	-
Copper	NR	NR	52.6	NR	NR	NR	NR	600/600
Cyanide	NR	NR	U .55	NR	NR	NR	NR	1100/21000
Iron	NR	NR	16200	NR	NR	NR	NR	-
Lead	NR	NR	300	NR	NR	NR	NR	100/600
Magnesium	NR	NR	719	NR	NR	NR	NR	-
Manganese	NR	NR	7.6	NR	NR	NR	NR	-
Mercury	NR	NR	0.13	NR	NR	NR	NR	14/270
Nickel	NR	NR	2.4	NR	NR	NR	NR	250/2400
Nitrate	1.9	0.86	NR	1.5	1.2	1.5	NR	-
Nitrite	U	0.80	NR	1.2	U	U	NR	-
Sodium	NR	NR	23.1	NR	NR	NR	NR	-
Thallium	NR	NR	U 0.63	NR	NR	NR	NR	2/2
Vanadium	NR	NR	80.2	NR	NR	NR	NR	370/7100
Zinc	NR	NR	99.4	NR	NR	NR	NR	1500/1500
% Solids (%)	83.2	87.3	74.4	87.6	73.6	76.5	75.8	-
Explosives								
Picric Acid (µg/g)	U 1.23	U 1.15	NA	14	U 1.15	27	NA	

Legend: U = Not detected
NR = Not requested
(a) = Refer to June 90 QAAP
Replicate = Lab QA sample

(b) = Soil cleanup criteria (revised 3/8/93)
(c) = Residential/nonresidential soils

Table 4-20a
Summary of Water Sample Analytical Results
Round One: March 1991
NWS Earle, Site 26 (Explosive "D" Washout Area)

Site I.D.(a) / Compounds	26-001-M001 MW26-01	26-002-M001 MW26-02	26-002-M301 MW26-02(Trip Blank)	26-003-M001 MW26-03	26-003-M001 Replicate	26-004-M001 MW26-04	26-004-M201 MW26-04(Eq Blank)	Primary Drinking Water Standards (b)	NJDEPE Groundwater Cleanup Standards (c)
Volatile Organics (µg/L)									
Vinyl Chloride	1 J	U 10	U 10	U 10	NA	U 10	U 10	2.0	-
Methlyene Chloride	44 B	41 B	8 B	40 B	NR	4 JB	6 B	-	-
Acetone	U 10	U 10	190 B	12 B	NR	U 10	3 JB	-	-
Carbon Disulfide	1 J	1 J	U 5	1 J	NR	1 JB	1 JB	-	-
1,1 Dichloroethene	3 J	U 5	U 5	U 5	NR	U 5	U 5	7.0	-
1,2 Dichloroethene	8 10	U 5	U 5	U 5	NR	U 5	U 5	-	-
Trichloroethene	660	U 5	U 5	U 5	NR	U 5	U 5	5.0	-
Toluene	1 J	U 5	U 5	U 5	NR	U 5	U 5	1000	-
Xylene	3 J	U 5	U 5	U 5	NR	U 5	U 5	10000	-
Inorganics (mg/L)									
Silver	U .0029	U .0029	NR	U .0029	U .0029	0.017	U .0029	-	110/4 100
Aluminum	4.2	6.1	NR	1.2	1.3	22.8	0.026	-	-
Arsenic	U .0018	U .0018	NR	U .0018	U .0018	U .0018	U .0018	0.05	0.008
Barium	0.022	0.011	NR	0.0058	0.006	0.089	0.029	2.0	2.0
Beryllium	U .00050	U	NR	U .0005	U .0005	0.0011	U .0005	0.004	0.02
Calcium	9.5	1.2	NR	2.5	2.5	13.1	0.11	-	-
Cobalt	U .0034	U .0034	NR	U .0034	U .0034	0.0045	U .0034	-	-
Chromium	U .0063	0.0099	NR	U .0063	U .0063	0.053	U .0063	0.1	0.1
Copper	0.0051	0.0063	NR	U .0029	U .0029	0.023	U .0029	1.3	-
Cyanide	U .010	U .010	NR	U .020	U .010	U .010	U .010	0.2	0.2
Iron	20.3	10.1	NR	2.6	2.8	60.7	0.053	-	-
Potassium	1.8	5.3	NR	0.79	0.87	3.6	U .142	-	-
Magnesium	1.7	0.71	NR	0.86	0.92	1.9	U .056	-	-
Manganese	0.081	0.011	NR	0.0040	0.0097	0.076	U .0009	-	-
Sodium	2.7	4.2	NR	2.6	2.7	2.2	0.27	-	-
Lead	0.0045	0.0029	NR	0.0035	0.0023	0.024	U .0016	0.015	0.1
Antimony	0.015	U .0075	NR	U .0075	U	0.038	U .0075	0.006	0.02
Vanadium	0.012	0.013	NR	0.0036	0.0037	0.061	U .0026	-	-
Zinc	0.011	0.035	NR	0.0067	0.0072	0.056	0.0097	5.0	5.0
Nitrate (mg/L)	0.43	0.50	NR	0.14	NR	3.4	0.19	10.0	-
Nitrite (mg/L)	U .10	U .10	NR	U .10	NR	U .10	U .10	1.0	-
Pesticide/PCB (U)	U .0011	U .0011	U .0011	U .0011	U .0011	U .0011	U .0011		
Explosives (µg/L)									
2,4,6-TNT	1.27	U 0.76	NR	U 0.76	NR	U 0.76	U 0.76	-	-
Picric Acid	U 8.22	U 8.22	NR	U 8.22	NR	U 8.22	U 8.22	-	-
Nocllulose/Nglycerine (mg/L)	U 2.5	U 2.5	NR	U 2.5	U 2.5	3.9	U 2.5	-	-

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
Replicate = Lab QA sample

(a) = Refer to June 90 QAAP
(b) = Maximum Contaminant Levels (MCLs) (mg/L)
(c) = NJDEPE Standards for Class II-A Groundwater (mg/L)

Table 4–20b
Summary of Groundwater Sample Analytical Results
Round Two: October 1991
NWS Earle, Site 26 (Explosive "D" Washout Area)

Site ID: (a) / Compounds	26–001–M002 MW26–01	26–001–M102 MW26–01(Dup.)	26–001–M302 MW26–01(Trip Blank)	26–002–M002 MW26–02	26–002–M002 REPLICATE	26–002–M202 MW26–02(Eq. Blank)	26–003–M002 MW26–03	26–004–M002 MW26–04
Volatile Organics (µg/L)								
Methylene Chloride	4 JB	4 JB	4 JB	2 JB	NR	8 B	3 JB	3 JB
Acetone	43 B	50 B	11 B	12 B	NR	16 B	79 B	21 B
1,2 Dichloroethene	420	510	U 5	U 5	NR	U 5	U 5	U 5
Trichloroethene	120	160	U 5	U 5	NR	U 5	U 5	U 5
Xylene	1 J	1 J	U 5	U 5	NR	U 5	U 5	U 5
Inorganics (µg/L)								
Silver	U 10	U 10	NR	U 10	U 10	U 10	U 10	36.4
Barium	U 200	U 200	NR	U 200	U 200	U 200	U 200	214
Cadmium	U 5	U 5	NR	U 5	U 5	U 5	U 5	8.1
Chromium	U 10	U 10	NR	51.7	45.7	U 10	U 10	168
Copper	U 25	U 25	NR	34.1	35.2	U 25	U 25	79.3
Iron	13500	17000	NR	91300	70500	U 100	3200	167000
Mercury	U 0.2	U 0.2	NR	0.41	0.4	U 0.2	U 0.2	1.9
Manganese	122	126	NR	110	92.3	U 15	U 15	331
Sodium	U 5000	U 5000	NR	5660	5580	U 5000	U 5000	U 5000
Lead	U 3	U 3	NR	6.9	6.6	U 3	U 3	28.1
Zinc	20	U 20	NR	66.8	72.9	U 20	U 20	163
Explosives (µg/L)								
RDX	U 0.63	U 0.63	NR	U 0.63	NR	U 0.63	NR	0.94
Nitrate (mg/L)	1.1	1.1	NR	0.5	NR	NR	NR	0.55
Picric Acid	U 8.22	U 8.22	NR	U 8.22	NR	U 8.22	NR	U 8.22

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one or more samples are listed above.

Table 4-20c
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 26 (Explosive "D" Washout Area)

Site I.D. (a) / Compounds	26-001-M003 MW26-01	26-001-M103 MW26-01(Dup.)	26-002-M003 MW26-02	26-002-M003 REPLICATE
Volatile Organics (µg/L)				
Methylene Chloride	4 JB	3 JB	2 JB	NR
Acetone	25 B	24 B	27 B	NR
1,2 Dichloroethene	600	550	U 5	NR
Trichloroethene	240	210	U 5	NR
Inorganics (µg/L)				
Cadmium	U 5	U 5	U 5	U 5
Chromium	U 10	U 10	16	15.9
Copper	36.8	U 25	U 25	U 25
Iron	6020	7940	21500	22900
Mercury	U 0.2	U 0.2	U 0.2	0.21
Manganese	88.8	88.5	38.5	42.1
Sodium	U 5000	U 5000	5230	5240
Lead	3.8	U 3	U 3	U 3
Zinc	118	28.5	81.7	81
Explosives				
Nitrate, as N (mg/L)	1.5	1.5	0.55	0.54

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one ore more samples are listed above.

Table 4–20c cont.....
Summary of Groundwater Sample Analytical Results
Round Three: November 1991
NWS Earle, Site 26 (Explosive "D" Washout Area)

Site I.D. (a) / Compounds	26-003-M003 MW26-03	26-003-M303 MW26-03(Trip Blank)	26-004-M003 MW26-04	26-004-M203 MW26-04(Eq. Blank)
Volatile Organics (µg/L)				
Methylene Chloride	3 JB	11 B	2 JB	9 B
Acetone	18 B	13 B	15 B	13 B
1,2 Dichloroethene	U 5	U 5	U 5	U 5
Trichloroethene	U 5	U 5	U 5	U 5
Inorganics (µg/L)				
Cadmium	U 5	NR	5.6	U 5
Chromium	U 10	NR	41.2	U 10
Copper	U 25	NR	29.1	U 25
Iron	3270	NR	50500	U 100
Mercury	U 0.2	NR	0.28	U 0.2
Manganese	U 15	NR	99.3	U 15
Sodium	U 5000	NR	U 5000	U 5000
Lead	U 3	NR	12.3	U 3
Zinc	43.4	NR	97.4	U 20
Explosives				
Nitrate, as N (mg/L)	NR	NR	0.97	0.14

Legend: U = Not detected
NR = Not requested
B = Detection limit found in blank
J = Present below detection limit
(a) = Refer to June 90 QAAP
REPLICATE = Lab QA sample

Inorganic analysis included: the Primary Drinking Water Metals Ag, As, Ba, Cd, Cr, Hg, Pb and Se, and the Secondary Drinking Water Metals Cu, Fe, Mn, Na and Zn. Only analytes detected in one ore more samples are listed above.

no semivolatile compounds. Volatile organic compounds methylene chloride, carbon disulfide, and acetone were present but attributable to field or laboratory cross contamination. TCE was present in one sample (crossgradient well MW26-01) at 660 µg/L. Other compounds, such as dichloroethanes related to TCE as impurities or breakdown products, were also present. Low concentrations of several explosives compounds were detected in wells MW26-01 and 004. Both wells are crossgradient of the pit, but because no TCE was detected in MW26-04, the source may be between the two wells. There is a subgrade concrete vault in that area (Figure 4-11) that could be a holding or septic tank. Lead and chromium were under 24 and 53 µg/L, respectively.

The second and third rounds of groundwater sampling included analysis of VOCs, drinking water metals, and explosives compounds. Results for VOCs were similar to the first round, with TCE confirmed at slightly lower levels in MW26-01. Results for the metals and explosives generally confirmed the first round.

4.11.3 Summary of the Site 26 Characterization

Generally, impacts to soils and groundwater from the disposal of explosives compounds in wash out to the pit are measurable but not extensive. A more significant level of TCE and related compounds was found in samples from MW26-01. TCE, a commonly used solvent, is slow to degrade and is relatively mobile in groundwater. It is used to clean metal parts and also as a degreaser for septic systems. A likely source at Site 26 is a possible tank associated with Building GB-1.

SECTION 5
SUMMARY OF RESULTS OF THE REMEDIAL INVESTIGATION

The purpose of the RI was to complete the characterization of contamination at each of the 11 sites and to identify if contamination is migrating from any of the sites. Site-specific results were presented in Section 4. Section 5 examines these findings as they relate to the nature of the site contaminant sources and the contaminants and pathways of concern. This information will be further developed in the Baseline Risk Assessment, Section 6; the development of ARARs (applicable or relevant and appropriate requirements), Section 7; and the Initial Screening of Remedial Technologies, Section 8. For the discussion of contaminants of concern found at the sites, references have been made to common standards such as MCLs (EPA maximum concentration limits for drinking water) and NJDEPE action levels for soils. These references are for discussion purposes only; Section 7 will discuss chemical- and site-specific ARARS.

For the purpose of this summary, the sites are arranged into three operable units based on past activities and type of waste. In addition to this grouping, the presence of elevated concentrations of metals in the shallow groundwater monitor wells is addressed separately in Subsection 5.4.

5.1 SOLID WASTE LANDFILLS

This proposed operable unit includes Sites 3, 4, 5, 7, and 10, where some or all of the following were disposed of: municipal waste, construction debris, and metal scrap. The landfills are mostly covered with native sandy soil and are partially vegetated. However, the cover material is in some cases thin and waste such as metal scrap and other hard fill is occasionally exposed. Steep slopes adjacent to the toe of Site 4 may require future management.

Shallow groundwater quality was evaluated at the boundaries of all of the landfills. Where there was developed surface drainage (Sites 4 and 10), sediments and surface water were sampled. Test pits were completed in all of the landfills to visually inspect the waste and to obtain samples of soils in direct contact with waste.

Table 5-1 compares concentrations of indicator parameters with levels reported for water quality criteria. Impact from leachate generation is relatively low, based on the levels of indicator parameters in the groundwater at the sites. Where water quality criteria apply, no results exceed drinking water standards for the indicator parameters listed in Table 5-1. Appendix D presents water quality data compiled for indicator parameters at other landfills nationally and in the State of New Jersey.

No levels of hazardous constituents were found in soils in contact with waste that indicate a significant contaminant source in the landfill. None of the organic compounds were detected above or even near NJDEPE action levels relative to impact to groundwater. The investigation demonstrated that while there were TCL chemicals identified at the sites, the bulk of the waste can be characterized as municipal or inert industrial (rubble and metal). Metals and TCL organic compounds were also found in sediments and surface water samples at Sites 4 and 10.

Table 5-2 lists possible contaminants of concern identified on a preliminary basis by landfill site and by media based, where applicable, on reference to NJDEPE groundwater standards and EPA groundwater MCLs and is intended at this stage for discussion purposes. Final ARARs will be developed in the FS. Six wells at four sites (Sites 3, 4, 5, and 7) contained TCL organic compounds, the most common being the solvents TCE, TCA, and related products. Chromium was found in one or more unfiltered groundwater samples above MCLs in one or more wells at all four landfills. Lead, cadmium, antimony, arsenic, and beryllium were also found above MCLs in some unfiltered groundwater samples.

5.2 ORDNANCE DISPOSAL SITES

This proposed operable unit includes Sites 2, 11, and 26. Explosives material was disposed of at all three sites in different ways. Site 2 was a detonation area; Site 11 was a burning area; and Site 26 was a casing-rinse disposal pit.

There are no EPA MCLs or NJDEPE action levels for explosive compounds. In all three cases, residues of explosive compounds in soils and groundwater were not detected in most samples and

Table 5-1
(Concentrations of Landfill Parameters)
NWS Earle, Site 3 Landfill

Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells			National Drinking Water Standards	
(mg/L)	MW3-2	MW3-6	MW3-3	MW3-5		MW3-1	MW3-4	MW3-7	PRIMARY	SECONDARY
									mg/l	mg/l
Round 2										
BOD		U		7.1		3.5		U		
CL		5.3		6.2		8.8		6		250
COD		96.8		235		1810		106		
N		0.6		1.9		0.32		0.77	10	
NH3		U		1.6		0.31		1.9		
P		0.6		0.78		0.2		0.14		
SO4		14.3		64.9		74.6		99.1		250
Turbidity		325		341		785		1240	1-5 tu	
Round 3										
BOD		-		3.8						
CL		5.7		9.1						
COD		87.9		187						
N		0.52		0.62						
NH3		U		2.6						
P		0.19		0.17						
SO4		14.6		69.6						
Turbidity		7.4		360						

Legend: U = Not detected

NR = Not requested

Table 5-1 cont....
NWS Earle, Site 4 Landfill

Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells			National Drinking Water Standards	
(mg/L)	MW4-4		MW4-1	MW4-3		MW4-2	MW4-5	MW4-6	PRIMARY	SECONDARY
									mg/l	mg/l
Round 2										
BOD	U		U	U		U	U	U		
CL	U		6.3	U		6.5	5.6	5.9		250
COD	24		9.1	23.5		39.4	14.9	16.3		
N	0.13		0.16	0.12		U	0.25	0.11	10	
NH3	0.35		U	U		0.29	U	U		
P	11.4		U	U		U	U	U		
SO4	1120		23.8	10.5		31.2	13.6	10.5		250
Turbidity			0.08	0.07		336	186	15.1	1-5 tu	
Round 3										
BOD	U		U	0.5		U	U	U		
CL	U		6	U		6.9	5.5	5.6		
COD	23.6		2270	20.7		50.8	42.5	13.5		
N	0.19		U	0.26		0.33	0.32	0.29		
NH3	U		U	U		0.39	U	U		
P	0.12		0.58	0.048		U	0.63	0.045		
SO4	11.1		23.2	9.9		31.8	13.3	9.9		
Turbidity	2550		242	250		509	840	0.46		

Legend: U = Not detected

NR = Not requested

Table 5 – 1 cont...
NWS Earle, Site 5 Landfill

Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells				National Drinking Water Standards	
(mg/L)	MW5-8		MW5-1	MW5-2	MW5-3	MW5-4	MW5-5	MW5-6	MW5-7	PRIMARY	SECONDARY
										mg/l	mg/l
Round 2											
BOD	NR		U	U	U	1.4	U	6.3	3.6		
CL	7.7		7.6	8.9	7.2	8.3	24.1	47.2	11.2		250
COD	21		21	18.1	9.4	31.4	22.5	48.4	60.3		
N	NR		0.16	0.14	0.28	0.13	0.13	0.23	0.63	10	
NH3	NR		U	U	U	U	U	0.34	U		
P	NR		0.25	0.17	U	0.088	0.16	0.31	1.2		
SO4	15		11.7	28.5	89.9	18.7	43.2	93.3	184		250
Turbidity	182		1170	1530	53	331	211	835	644	1-5 tu	
Round 3											
BOD	U			U	1.2	3.3	1.7	7.7	1.2		
CL	7.7			8	8.2	7.8	23.4	43.5	7		
COD	14.9			15.3	19.7	22.7	30	40.3	22.2		
N	U			U	0.14	U	0.1	U	0.27		
NH3	U			U	U	U	U	0.11	U		
P	U			U	U	0.15	0.24	0.16	0.051		
SO4	13.5			33.3	24.5	14.9	33.8	110	59.9		
Turbidity	195			418	177	433	470	629	398		

Legend: U = Not detected

NR = Not requested

Table 5 –1 cont....
NWS Earle, Site 7 Landfill

Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells			National Drinking Water Standards	
(mg/L)	MW7-3		MW7-1			MW7-2	MW7-4	MW7-5	PRIMARY	SECONDARY
									mg/l	mg/l
Round 2										
BOD	0.3		3.3			U	4.8	8.6		
CL	8.1		U			27.6	15.9	28.2		250
COD	12.3		126			35.6	221	323		
N	0.29		0.3			2	0.25	0.18	10	
NH3	U		U			21	U	U		
P	U		0.15			0.52	1.4	1.4		
SO4	8.6		6.7			36.4	17.4	39.3		250
Turbidity	88.1		553			46.6	1850	3580	1-5 tu	
Round 3										
BOD	8.1		8.1			1.2	2.9	2.9		
CL	9.7		11.8			27.8	14	26.7		
COD	103		170			58.1	59.5	170		
N	0.19		0.52			2.2	0.32	0.27		
NH3	0.13		U			2.1	U	U		
P	1		0.61			0.21	0.12	0.44		
SO4	33.9		10			38.7	21.4	44		
Turbidity	1160		505			1160	1130	455		

Legend: U = Not detected

NR = Not requested

Table 5-1 cont...
NWS Earle, Site 10 Landfill

Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells			National Drinking Water Standards	
(mg/L)	MW10-3	MW10-4	MW10-1	MW10-2		MW10-5	MW10-6	MW10-7	PRIMARY	SECONDARY
									mg/l	mg/l
Round 2										
BOD	U	2.7	U	U 1		3.2	U	U		
CL	8.1	8	47.3	U 5		6.9	10.8	5.9		250
COD	U	52.9	32.7	U 5		81.6	70.1	52.9		
N	0.24	0.22	0.26	U 0.1		0.38	U	U	10	
NH3	U	U	U	U 0.1		0.2	U	0.26		
P	0.03	0.16	0.03	U 0.02		0.3	0.062	0.13		
SO4	16	18.8	52.5	17.2		U	39.1	46.6		250
Turbidity	139	967	171	45		751	114	319	1-5 tu	
Round 3										
BOD	1.2	3.3	U	1.1		3.6	U	U		
CL	8	8.8	40.9	5.8		9.1	12.4	6.5		
COD	14.9	9.5	31	10.5		56	51.6	44.3		
N	U	U	U 0.1	U 0.1		U	U	0.33		
NH3	0.26	U	U 0.1	U 0.1		0.38	1.6	U		
P	U	0.38	0.056	U 0.02		0.3	0.44	0.066		
SO4	18.3	20.3	59.7	18		U	36.8	108		
Turbidity	81.9	560	228	36.6		427	32.2	132		

Legend: U = Not detected

NR = Not requested

Table 5-2

Contaminants of Concern
(Solid Waste Landfills)

Site Identification	Medium	Location	Contaminants of Concern/Concentration	Primary Drinking Water Standards (a)	NJDEPE Groundwater Cleanup Standards (b)
Site 3	Groundwater	MW3-01	Arsenic-.37,3.5,.115 mg/L	0.05 mg/L	0.008 mg/L
			Cadmium-.044,.049,.024 mg/L	0.005 mg/L	0.004 mg/L
			Chromium-.082,82,.641,.245 mg/L	0.1 mg/L	0.1 mg/L
			Lead-.035,.147,.004, mg/L	0.015 mg/L	0.01 mg/L
		MW3-04	Antimony-0.025 mg/L	0.006 mg/L	0.02 mg/L
			Naphthalene-74 µg/L	-	-
			4-ethylphenol-52 µg/L	-	-
			ethylbenzene-180 µg/L	700 µg/L	700 µg/L
			xylene-470 µg/L	1,000 µgL	40 µg/L
		MW3-05	Cadmium-0.021 mg/L	0.005 mg/L	0.004 mg/L
			Chromium-.06,.338,.157 mg/L	0.1 mg/L	0.1 mg/L
			Lead-0.03,.114,.157 mg/L	0.015 mg/L	0.01 mg/L
		MW3-06	Lead-0.022,.051,.042,.025 mg/L	0.015 mg/L	0.01 mg/L
		MW3-07	Lead-0.021,.059,.043 mg/L	0.015 mg/L	0.01 mg/L
			Alpha-Chlordane-0.54, µg/L	2 µg/L	0.5 µg/L

Note: (a) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(b) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(c) - No established guidance for Sediment Cleanup Standards. MCLs for sediments are established by Risk Screening/Assessment criteria.

NWS-EARL\RNTBL5-3.TBL

Table 5-2 (Continued)

Contaminants of Concern
(Solid Waste Landfills)

Site Identification	Medium	Location	Contaminants of Concern/Concentration	Primary Drinking Water Standards (a)	NJDEPE Groundwater Cleanup Standards (b)
Site 4	Sediments	4-004	Aroclor-1260-1600 µg/kg Pyrene-130(J) µg/kg Phenanthrene-68(J)µg/kg Cadmium-5.7mg/kg Chromium-36.8mg/kg Lead-192mg/kg Mercury-1.9 mg/kg	(c)	
	Groundwater	MW4-02	DCE-20,13,& 8 µg/L	70 µg/L	10 µg/L
		MW4-05	DCE-7,33,& 21 µg/L TCE-14,78,& 46 µg/L	70 µg/L 5 µg/L	10 µg/L 1 µg/L
Site 5	Groundwater	MW5-01	Chromium-0.31, 0.36	0.1 mg/L	0.1 mg/L
		MW5-02	Chromium-.17,.789 mg/L	0.1 mg/L	0.1 mg/L
		MW5-05	Chromium-.17,.650,.614 mg/L Lead-0.028,0.026,0.03 mg/L	0.1 mg/L 0.015 mg/L	0.1 mg/L 0.01 mg/L

Note: (a) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(b) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(c) - No established guidance for Sediment Cleanup Standards. MCLs for sediments are established by Risk Screening/Assessment criteria.

NWS-EARL\RI\TBL5-3.TBL

Table 5-2 (Continued)

Contaminants of Concern
(Solid Waste Landfills)

Site Identification	Medium	Location	Contaminants of Concern/Concentration	Primary Drinking Water Standards (a)	NJDEPE Groundwater Cleanup Standards (b)
Site 5 (Continued)		MW5-06	Antimony-0.062,ND,ND mg/L	0.006 mg/L	0.02 mg/L
			Chromium-4.1,6.06,.416 mg/L	0.1 mg/L	0.1 mg/L
			Lead-0.061,0.98,.023 mg/L	0.015 mg/L	0.01 mg/L
			DCE-16,& 17 µg/L	70 µg/L	10 µg/L
			TCE-12,& 14 µg/L	5 µg/L	1 µg/L
			Xylene-10,& 11 µg/L	1,000 µg/L	40 µg/L
			DCA-ND,& 8 µg/L	-	70 µg/L
		MW5-07	Cadmium-0.034,0.025, mg/L	0.005 mg/L	0.004 mg/L
			Chromium-.69,2.8, mg/L	0.1 mg/L	0.1 mg/L
			Lead-0.026,0.065, mg/L	0.015 mg/L	0.01 mg/L
		MW5-08	Antimony-0.031,ND, ND mg/L	0.006 mg/L	0.02 mg/L
			Chromium-1.2,.155,.104 mg/L	0.1 mg/L	0.1 mg/L
			Lead-0.038,ND, .004 mg/L	0.015 mg/L	0.01 mg/L
Site 7	Groundwater	MW7-01	Arsenic-0.04 mg/L	0.05 mg/L	0.008 mg/L
			Chromium-.041,.248 mg/L	0.1 mg/L	0.1 mg/L
			Lead-0.019,.156 mg/L	0.015 mg/L	0.01 mg/L

Note: (a) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(b) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(c) - No established guidance for Sediment Cleanup Standards. MCLs for sediments are established by Risk Screening/Assessment criteria.

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Table 5-2 (Continued)

Contaminants of Concern
(Solid Waste Landfills)

Site Identification	Medium	Location	Contaminants of Concern/Concentration	Primary Drinking Water Standards (a)	NJDEPE Groundwater Cleanup Standards (b)
Site 7 (Continued)		MW7-04	Chromium-.047,.235,.106 mg/L	0.1 mg/L	0.1 mg/L
			Lead-0.017,.152,.063 mg/L	0.015 mg/L	0.01 mg/L
			Arsenic-.011,.106	0.05 mg/L	0.008 mg/L
		MW7-05	Arsenic-0.007,.196,.152 mg/L	0.05 mg/L	0.008 mg/L
			Chromium-.014,.289,.176 mg/L	0.1 mg/L	0.1 mg/L
			Lead-0.008,.15,.08 mg/L	0.015 mg/L	0.01 mg/L
			2-Butanone-88 µg/L	-	300 µg/L
			TCA-26,5J,& 5 µg/L	5 µg/L	1 µg/L
			DCE-4J,4J,& 4J µg/L	70 µg/L	10 µg/L
			1,1,2Tetrachloroethane-8, ND, & ND µg/L	-	2 µg/L
			DCA-ND,1J,& ND µg/L	-	70 µg/L
		MW7-07	Heptachlor-0.10J µg/L	0.4 µg/L	0.4 µg/L
			1,dichlorobenzene-ND,4J,& 5 µg/L	600 µg/L	600 µg/L

Note: (a) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(b) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(c) - No established guidance for Sediment Cleanup Standards. MCLs for sediments are established by Risk Screening/Assessment criteria.

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Table 5-2 (Continued)

Contaminants of Concern
(Solid Waste Landfills)

Site Identification	Medium	Location	Contaminants of Concern/Concentration	Primary Drinking Water Standards (a)	NJDEPE Groundwater Cleanup Standards (b)
Site 10	Sediments	10-001&003	Phenanthrene-66J, 170Jµg/kg Fluoranthrene-65J,88Jµg/kg Pyrene-ND,92(J) µg/kg Benzo(a)anthracene-54J, 52Jµg/kg Chrysene-ND,90 µg/kg	(c)	
	Groundwater	MW10-0	Lead-.038,.007,.011 mg/L Chromium-.08,.0.13,0.15 mg/L	0.015 mg/L 0.1 mg/L	.01 mg/L 0.1 mg/L
		MW10-04	Chromium-.45,1.06,1.13 mg/L Lead-0.030,.035,.056 mg/L	0.1 mg/L 0.015 mg/L	0.1 mg/L 0.01 mg/L
		MW10-05	Chromium-.76,.53,.209 mg/L Lead-0.062,.109,.05 mg/L Antimony-.017,ND,ND	0.1 mg/L 0.015 mg/L .006 mg/L	0.1 mg/L 0.01 mg/L .02 mg/L
		MW10-07	Antimony-0.051,ND,ND mg/L Arsenic-0.096,.018,ND mg/L Cadmium-0.015,ND,ND mg/L Chromium-3.6,.076,.041 mg/L Lead-0.20,.01,.011 mg/L	0.006 mg/L 0.05 mg/L 0.005 mg/L 0.1 mg/L 0.015 mg/L	0.02 mg/L 0.008 mg/L 0.004 mg/L 0.1 mg/L 0.01 mg/L

Note: (a) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(b) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(c) - No established guidance for Sediment Cleanup Standards. MCLs for sediments are established by Risk Screening/Assessment criteria.

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were near detection limits in a few samples. The lack of residual explosives compounds probably is a function of the small quantities initially involved along with their induced or natural chemical breakdown. Table 5-3 lists possible contaminants of concern identified on a preliminary basis by site and by media, referenced to NJDEPE soil and groundwater standards and MCLs, where appropriate. The solvent compound TCE is prominent at Site 26 in well MW26-01 because it was detected as high as 660 µg/L. Based on the other data, this result is not associated with the disposal pit and probably has another source, possibly a nearby septic tank.

5.3 GRIT BLASTING/PAINT CHIP DISPOSAL SITES

This group includes Sites 19, 20, and 22, where paint chip residues from sandblasting operations were disposed of directly on the ground. The raw material is visible on the ground at these sites, and the volumes are relatively small.

Surface sampling of waste piles, drainageways, and soils has delineated the nature and extent of waste material. Transport has occurred in surface drainage related to each of the sites. The extent of contamination is well defined by the sampling results.

Table 5-4 lists possible contaminants of concern identified on a preliminary basis by site and by media. Metal concentrations in groundwater are addressed separately in the following subsection.

5.4 SHALLOW GROUNDWATER METALS CONCENTRATIONS

The presence of metals in groundwater is being addressed as a separate issue in this section, because an initial review of the site data showed that metals were detected in almost all wells at all sites at concentrations that varied significantly from round to round of sampling. The heavy metals that may be of concern at the sites include lead, chromium, cadmium, and arsenic, which occur naturally in area soils. Groundwater samples, as per EPA protocol, were not filtered prior to preservation, and thus it was suspected that sample turbidity could affect results. In order to examine distribution patterns of metals of interest a series of tables and associated graphs

Table 5-3
Contaminants of Concern
(Ordnance Disposal Sites)

Site Location	Medium	Location	Contaminants of Concern/Concentration	NJDEPE Guidelines(a) (Soils)	Primary Drinking Water Standards(c)	NJDEPE Groundwater Cleanup Standards (d)
Site 2	Soils	02-005	Arsenic-3.0 mg/Kg	2/2 mg/Kg(b)		
		02-006	Arsenic-4.6 mg/Kg	2/2 mg/Kg		
		02-007	Arsenic-75 mg/Kg Chromium-265 mg/Kg	2/2 mg/Kg		
		02-008	Arsenic-6.1 mg/Kg Chromium-183 mg/Kg	2/2 mg/Kg		
	Groundwater	MW2-03	NC/NG-2.9 mg/L			
		MW2-05	Chromium-1.5,.108,.083 mg/L Lead-0.028,.003,ND mg/L Antimony-0.013,ND,ND mg/L		0.1 mg/L 0.015 mg/L 0.006 mg/L	0.1 mg/L 0.01 mg/L 0.02 mg/L
		MW2-06	Nitrate-U,0.43,13.3 mg/L Picric acid-2.1,ND,ND µg/L RDX-4.12,5.91,4.21 µg/L Tetryl-ND,ND,1.15 µg/L HMX-ND,ND,0.18J µg/L 1,3,5 TNB-U,U,0.54Jµg/L 2,4 DNT-3.2 µg/L Chromium-0.33 mg/L		10 mg/L - - - - - - 0.1 mg/L	- - - - - - 0.1 mg/L

Note: (a) - Proposed new Cleanup Standards for contaminated sites issued by NJDEPE 8 March 1993.
Not enforceable until adopted as Final Regulations. Used as guidance to determine if a site is to be considered contaminated.
(b) - Residential/Nonresidential.
(c) - Drinking Water Regulations and Health Advisories. (U.S. EPA, May 1993).
(d) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(e) - No established guidance for Sediment Cleanup Standards. MCLs for sediment are established by Risk Screening/Assessment criteria.

Table 5-3 (Continued)
Contaminants of Concern
(Ordnance Disposal Sites)

Site Location	Medium	Location	Contaminants of Concern/Concentration	NJDEPE Guidelines(a) (Soils)	Primary Drinking Water Standards(c)	NJDEPE Groundwater Cleanup Standards (d)
Site 2 (Continued)		MW2-07	Chromium-0.33,2.36,2.37 mg/L Lead-0.021,0.19,0.13 mg/L		0.1 mg/L 0.015 mg/L	0.1 mg/L 0.01 mg/L
		MW11-01	Chromium-.02,ND,.88 mg/L Lead-.001,ND,.051 mg/L		0.1 mg/L 0.015 mg/L	0.1 mg/L 0.01 mg/L
		MW11-02	Chromium-ND,0.21,0.11 mg/L Lead-.002,.02,.08 mg/L		0.1 mg/L 0.015 mg/L	0.1 mg/L 0.01 mg/L
		MW11-03	Chromium-.013,ND,0.43 mg/L Lead-.005,ND,.089 mg/L		0.1 mg/L 0.015 mg/L	0.1 mg/L 0.01 mg/L
Site 26	Sediments(e)	26-002	Arsenic-3.7 mg/Kg Cadmium-2.9 mg/Kg Lead-115 mg/Kg Chromium-64.1 mg/Kg	(e)		
		26-004	Picric acid-14 µg/g	-		
		26-004 (DUP)	Arsenic-6 mg/Kg Cadmium-16.5 mg/Kg Chromium-123 mg/Kg Lead-300 mg/Kg Picric acid-27 µg/g			

Note: (a) - Proposed new Cleanup Standards for contaminated sites issued by NJDEPE 8 March 1993. Not enforceable until adopted as Final Regulations. Used as guidance to determine if a site is to be considered contaminated.
(b) - Residential/Nonresidential.
(c) - Drinking Water Regulations and Health Advisories. (U.S. EPA, May 1993).
(d) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(e) - No established guidance for Sediment Cleanup Standards. MCLs for sediment are established by Risk Screening/Assessment criteria.

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Table 5-3 (Continued)
Contaminants of Concern
(Ordnance Disposal Sites)

Site Location	Medium	Location	Contaminants of Concern/Concentration	NJDEPE Guidelines(a) (Soils)	Primary Drinking Water Standards(c)	NJDEPE Groundwater Cleanup Standards (d)
Site 26 (Continued)	Groundwater	MW26-01	Antimony-.015,ND,ND mg/L		0.006 mg/L	0.02 mg/L
			TCE-660,120,& 240 µg/L		5 µg/L	1 µg/L
			1,2-DCE-810,420 &600µg/L		70 µg/L	10 µg/L
			1,1-DCA-3J,ND,& ND µg/L		-	70 µg/L
			2,4,6TNT-1.27,ND,ND µg/L		-	-
		MW26-04	Antimony-.038,ND,ND mg/L		0.006 mg/L	0.02 mg/L
			Lead-.024,.028,.012 mg/L		.015 mg/L	.01 mg/L
			NC/NG-3.9,ND,ND mg/L		-	-
			RDX-ND,0.94,ND µg/L		-	-

Note: (a) - Proposed new Cleanup Standards for contaminated sites issued by NJDEPE 8 March 1993. Not enforceable until adopted as Final Regulations. Used as guidance to determine if a site is to be considered contaminated.
(b) - Residential/Nonresidential.
(c) - Drinking Water Regulations and Health Advisories. (U.S. EPA, May 1993).
(d) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(e) - No established guidance for Sediment Cleanup Standards. MCLs for sediment are established by Risk Screening/Assessment criteria.

Table 5-4

Contaminants of Concern
(Grit Blasting/Paint Chip Disposal Sites)

Site Identification	Medium	Location	Contaminants of Concern/Concentrations	NJDEPE Guidelines(a) (Soils)	Primary Drinking Water Standards(c)	NJDEPE Groundwater Cleanup Standards (d)
Site 19	[e]Sediments/Soils	19-23	Chromium - 464 mg/Kg Lead - 364 mg/Kg	 100/600 mg/Kg		
		19-24	Lead - 300 mg/Kg	100/600 mg/Kg		
		19-26	Lead - 379 mg/Kg	100/600 mg/Kg		
		19-27	Cadmium - 1.9 mg/Kg Chromium - 103 mg/Kg Lead - 233 mg/Kg	1/100 mg/Kg 100/600 mg/Kg		
		19-28	Cadmium - 1.6 mg/Kg Lead - 267 mg/Kg	1/100 mg/Kg 100/600 mg/Kg		
		19-30	Cadmium - 25.9 mg/Kg Lead - 5380 mg/Kg	1/100 mg/Kg 100/600 mg/Kg		
		19-32	Cadmium - 33.7mg/Kg Lead 12,600 mg/Kg	1/100 mg/Kg 100/600 mg/Kg		

Note:
(a) - Proposed new Cleanup Standards for contaminated sites issued by NJDEPE 8 March 1993. Not enforceable until adopted as Final Regulations. Used as guidance to determine if a site is to be considered contaminated.
(b) - Residential/Nonresidential.
(c) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(d) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(e) - No current guidance established for sediment cleanup standards. MCLs for sediments established from Risk Screening/Assessment criteria.
(f) - Semivolatile compounds too numerous to list. See Section 4, Tables 4-17 and 4-18.

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Table 5-4 (Continued)

Contaminants of Concern
(Grit Blasting/Paint Chip Disposal Sites)

Site Identification	Medium	Location	Contaminants of Concern/Concentrations	NJDEPE Guidelines(a) (Soils)	Primary Drinking Water Standards(c)	NJDEPE Groundwater Cleanup Standards (d)
Site 19 (Continued)	Groundwater	MW19-02	Cadmium - .013,ND,.005 mg/L Chromium - .77,.139,.64 mg/L Lead - .038,.011,.048 mg/L 4,4 DDT - .14,ND,ND µg/L		0.005 mg/L 0.1 mg/L 0.015 mg/L	0.008 mg/L 0.1 mg/L 0.01 mg/L
		MW19-03	Arsenic - ND,.013,ND mg/L Cadmium - ND,.012,ND mg/L Chromium - 0.024,.536,.03 mg/L Lead - 0.003,.039,.006 mg/L		0.05 mg/L 0.005 mg/L 0.1 mg/L 0.015 mg/L	0.008 mg/L 0.004 mg/L 0.1 mg/L 0.01 mg/L
		MW19-05	Arsenic - ND,.014,ND mg/L Cadmium - ND,.02,.005 mg/L Chromium - 0.059,1.18,.452 mg/L Lead - 0.005,.088,.032 mg/L		0.05 mg/L 0.005 mg/L 0.1 mg/L 0.015 mg/L	0.008 mg/L 0.004 mg/L 0.1 mg/L 0.01 mg/L
		MW19-06	Arsenic - .008,.081,.019 mg/L Chromium-0.85,4.54,.44 mg/L Lead-0.054,0.282,.05 mg/L		0.05 mg/L 0.1 mg/L 0.015 mg/L	0.008 mg/L 0.1 mg/L 0.01 mg/L

Note: (a) - Proposed new Cleanup Standards for contaminated sites issued by NJDEPE 8 March 1993. Not enforceable until adopted as Final Regulations. Used as guidance to determine if a site is to be considered contaminated.
(b) - Residential/Nonresidential.
(c) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(d) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(e) - No current guidance established for sediment cleanup standards. MCLs for sediments established from Risk Screening/Assessment criteria.
(f) - Semivolatile compounds too numerous to list. See Section 4, Tables 4-17 and 4-18.

Table 5-4 (Continued)

Contaminants of Concern
(Grit Blasting/Paint Chip Disposal Sites)

Site Identification	Medium	Location	Contaminants of Concern/Concentrations	NJDEPE Guidelines(a) (Soils)	Primary Drinking Water Standards(c)	NJDEPE Groundwater Cleanup Standards (d)
Site 20	Sediments	20-1	Chromium-83.5,1320,711 mg/Kg Copper-83.5,1320,711 mg/Kg Nickel-83.5,1320,711 mg/Kg Lead-710,2720 mg/Kg Zinc-710,2720 mg/Kg	(e)		
		20-2	Chromium-94.7,305 mg/Kg Lead-94.7,305 mg/Kg			
		20-3	Chromium-204,780,2890 mg/Kg Lead-204,780,2890 mg/Kg Zinc-204,780,2890 mg/Kg			
		20-4	Chromium-120,429,1760 mg/Kg Lead-120,429,1760 mg/Kg Zinc-120,429,1760 mg/Kg			

Note: (a) - Proposed new Cleanup Standards for contaminated sites issued by NJDEPE 8 March 1993. Not enforceable until adopted as Final Regulations. Used as guidance to determine if a site is to be considered contaminated.
(b) - Residential/Nonresidential.
(c) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(d) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(e) - No current guidance established for sediment cleanup standards. MCLs for sediments established from Risk Screening/Assessment criteria.
(f) - Semivolatile compounds too numerous to list. See Section 4, Tables 4-17 and 4-18.

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Table 5-4 (Continued)

Contaminants of Concern
(Grit Blasting/Paint Chip Disposal Sites)

Site Identification	Medium	Location	Contaminants of Concern/Concentrations	NJDEPE Guidelines(a) (Soils)	Primary Drinking Water Standards(c)	NJDEPE Groundwater Cleanup Standards (d)
Site 20 (Continued)		20-5	Chromium-171,383,700 mg/Kg Lead-171,383,700 mg/Kg Zinc-171,383,700 mg/Kg Misc. Semivolatile Compounds(f) 18,100 µg/Kg	(e)		
Site 22	Grit Blasting Materials in Stained Soils	22-8	Misc. Semivolatile Compounds(f) 7,100 µg/Kg	(e)		
	Soils and Sediments	22-3	Misc. Semivolatile Compounds(f) 24,100 µg/Kg			
		22-6	Misc. Semivolatile Compounds(f) 2,800 µg/Kg			

Note: (a) - Proposed new Cleanup Standards for contaminated sites issued by NJDEPE 8 March 1993. Not enforceable until adopted as Final Regulations. Used as guidance to determine if a site is to be considered contaminated.
(b) - Residential/Nonresidential.
(c) - Drinking Water Regulations And Health Advisories. (U.S. EPA, May 1993).
(d) - Proposed Groundwater Cleanup Standards for Class II-A Groundwaters issued by NJDEPE 3 February 1992.
(e) - No current guidance established for sediment cleanup standards. MCLs for sediments established from Risk Screening/Assessment criteria.
(f) - Semivolatile compounds too numerous to list. See Section 4, Tables 4-17 and 4-18.

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(presented in Appendix D) were prepared to compare the following:

- Distribution of chromium, lead, and iron (which is an abundant naturally occurring element). These metals were selected as typical and do not represent all metals of concern.

- Distribution of the above-listed metals in background wells for all sites for each sampling round.

- Distribution of the above-listed metals at all wells at each site for each sampling round.

The tabulated results used to generate the graphs are presented in Tables 5-5.1 through 5-5.9.

Based on the analytical results, the following observations can be made:

- Generally, for Sites 10 and 11, the concentrations of metals in downgradient wells are similar to upgradient wells. At the other seven sites, one or more of the downgradient wells show concentrations of metals higher than the calculated mean values for upgradient wells.

- For most wells, metals concentrations were highly variable between sampling rounds. Where turbidity was measured (landfill wells, rounds 2 and 3), there is frequent but not complete correlation between level of metals concentrations and turbidity between the two rounds (Figure 5-1.4).

- Mean concentrations for chromium, iron, and lead in background wells were 91, 22,447, and 48 µg/L, respectively.

- The highest concentrations of chromium and iron in background wells were found in MW05-08 at 1,200 and 150,000 µg/L, respectively. Lead concentrations in background wells were highest in MW03-06 at 51.3.

- Sites 4 and 26 have no downgradient wells exceeding MCLs for chromium or lead. Sites 3, 5, and 11 exceeded MCLs for chromium in upgradient and downgradient wells, although downgradient concentrations were higher. Elevated chromium was more common at all sites, but in all the sites with wells exceeding MCLs for chromium, one or more wells also exceeded MCLs for lead. Except in one sample, upgradient wells were below MCLs for lead.

In summary, the overall impact of metals concentration on the sites was not precisely determined because of sample turbidity and natural abundance of metals in soils. However, some trends are evident in a qualitative review of the tabulated and graphical data presentations. Several sites show noticeable differences between upgradient and downgradient water quality.

5.5 RECOMMENDATIONS

The results of the RI indicate several areas of investigation that require further definition. Additional sampling to address these areas has been discussed among the Navy, EPA, and NJDEPE as part of the review of the initial Draft RI Report, March 1992. These recommendations are outlined below.

5.5.1 Establishing Background Levels for Soils and Sediments

Surface soil and sediment results should be compared to natural background levels in the area. Because of the lack of base-specific data, it is recommended that a minimum of three surface soil samples for metals analysis be taken in each of the four geologic outcrop areas on the main base and Chapel Hill area (see Figure 2-2) where RI and SI sites are located. Prior to sampling, an agreement should be reached with the Agencies as to the number of samples, specific parameters, and the method of data analysis to be used in the evaluation. The number of samples should be appropriate to the planned data analysis approach.

5.5.2 Metals in Groundwater

The use of unfiltered samples for metals analysis present difficulties in interpretation of groundwater quality data. Because of sample turbidity, the results may not reflect true mobility in groundwater. On the other hand, it is recognized that pre-filtering with the standard 0.45 micron filter can remove constituents that are mobile in colloidal form. EPA recognized this issue, and professional papers have examined sampling factors affecting groundwater results (e.g., Puls et al., 1989 and Puls et al., 1992). The most promising practical suggestion involves using very low purge rates for wells prior to sampling to reduce turbidity. Specific recommendations

for sampling are presented in Puls et al., 1992. Because this method is time-consuming and labor-intensive, it is recommended that a limited, representative number of wells be selected by a protocol agreed to by the Navy and EPA based on the Puls or other similar approaches.

5.5.3 Additional Groundwater Monitor Wells

Additional monitor wells will be required to define the vertical and lateral extent of volatile organic compounds found in shallow monitor wells at some sites.

Fuel-related compounds, benzene, toluene, xylene, and ethylbenzene (BTXE), were detected at Site 3 (landfill southwest of "F" Group). Chlorinated solvent compounds, predominantly trichloroethylene (TCE), were detected in one monitor well at each of Site 4 (solid waste landfill west of "D" Group), Site 5 (landfill west of Army Barricades), Site 7 (landfill south of "P" Barricades), and 26 (Explosive "D" Washout Area).

One shallow monitor well is recommended downgradient of each affected well to determine lateral extent. Prior to installing shallow wells, three to five Hydropunch samples analyzed for volatile organic compounds (VOCs) are recommended for each area of concern. These results can be used to determine downgradient spacing of the monitor wells. Additionally, a deep well is recommended at the location of the affected wells.

A single deep well is also recommended at landfill Site 10, where shallow groundwater is minimally impacted, to confirm the absence of vertical impact to groundwater quality.

Deep wells should be installed and constructed according to NJDEPE protocol and the current QAPP. A 10-foot screen length is recommended. Assuming no major lithologic changes, the total depth should be approximately 60 feet, with at least 20 feet between the top of the sand pack of the deep well and the base of the adjacent shallow well. The presence of major changes in lithology such as confining units or anomalously high-producing zones may require changes to the well completion plans and should be addressed on a site-by-site basis.

Specific proposed deep well locations are listed below:

Site Name	Existing Shallow Well	Proposed Well ID
Site 3	MW03-01	MW03-01A
Site 4	MW04-05	MW04-05A
Site 5	MW05-06	MW05-06A
Site 7	MW07-05	MW07-05A
Site 10	MW10-06	MW10-06A
Site 26	MW26-01	MW26-01A

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INSTALLATION RESTORATION PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FOR 11 SITES AT NWS EARLE, COLTS NECK, NJ

VOLUME 2

APPENDICES TO THE RI REPORT

Prepared for

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PA

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APPENDIX A

BORING LOGS AND WELL CONSTRUCTION SUMMARIES

TABLE A-1
Summary of Test Pit Investigations,
Site 3, Landfill Southwest of "F" Group
NWS Earle, Colts Neck, New Jersey

Test Pit Number	Test Pit Total Depth (ft)	Thickness (ft)		Composition Description		Comments
		Cover	Waste	Cover	Waste	
TP 3-1	7	--	--	—	--	All homogeneous sand
TP 3-2	5.2	0-2	2-4.3	Sand and gravel	Black sand/grit, charred wood and charcoal, large pieces of wood	--
TP 3-3	8	0-2	--	Sand and gravel	--	2.0-3.5' black grit - natural ?
TP 3-4	6	--	0-4	--	"Municipal" trash, bottles, cans, plastic, wood, metal debris	4.0-4.2' moist black layer
TP 3-5	3	0-2	--	Sand and gravel	--	2.0-2.5' dark brown-black layer
TP 3-6	4	0-1.5	--	Sand and gravel	--	1.5-2.0' dark brown-black layer
TP 3-7	7	0-3.5	3.5-5.5	Sand and gravel	"Municipal" and "base" bottles, cans, batteries, etc.	--

TABLE A-1
Summary of Test Pit Investigations,
Site 4, Landfill West of "D" Group
NWS Earle, Colts Neck, New Jersey

Test Pit Number	Test Pit Total Depth (ft)	Thickness (ft)		Composition Description		Comments
		Cover	Waste	Cover	Waste	
TP 4-1	9.3	--	--	—	--	sand and gravel, Fe staining
TP 4-2	7.5	--	0.6	--	Rusted scrap material, steel, drums, concrete	HNu = 0.4
TP 4-3	4	--	0.5-2.5	--	Construction debris - bricks, lumber, metals, rubber	0-0.5' top soil
TP 4-4	8.5	--	--	--	--	HNu 2.0 in stained area, possibly due to pine aromatics
TP 4-5	9.5	--	0-9	--	Rusted metal scraps, concrete	
TP 4-6	4.5	--	0-2.3	--	Fill and metal scraps mixed with roots	

TABLE A-1
Summary of Test Pit Investigations,
Site 5, Landfill West of Army Barricades
NWS Earle, Colts Neck, New Jersey

Test Pit Number	Test Pit Total Depth (ft)	Thickness (ft)		Composition Description		Comments
		Cover	Waste	Cover	Waste	
TP 5-1	13.5	--	0-13.5	—	Steel, wood, vermiculite, foam, rubber, glass, paper, plastics	HNu 20.0 @ 5-8' interval waste decreased with depth at 13-13.5'
TP 5-2	4	--	--	--	Few wood scraps	Saturated at 3'
TP 5-3	8.5	--	0-8	--	Construction debris, mostly wood, glass, cans metals, styrofoam, decomposed trash	HNu 1.1
TP 5-4	6.5	--	0-6.3	--	Construction debris	--

TABLE A-1
Summary of Test Pit Investigations,
Site 7, Landfill South of "P" Barricades
NWS Earle, Colts Neck, New Jersey

Test Pit Number	Test Pit Total Depth (ft)	Thickness (ft)		Composition Description		Comments
		Cover	Waste	Cover	Waste	
TP 7-1	4	--	0.25-3.75	—	Mixed fill, plastic, wood, cans, paper, cardboard	--
TP 7-2	8	--	1.5-4	--	Household type trash, plastic, cans, glass, wood, etc.	Thin black clay layers
TP 7-3	7	--	2.5-4	--	Household trash	--
TP 7-4	3.5	--	0-3.5	--	Household trash	--
TP 7-5	4	--	--	--	Debris on ground surface	--
TP 7-6	6.5	--	--	--	--	--
TP 7-7	7.5	--	0-6	--	Household type trash, plastic, cans, wood	--

TABLE A-1
Summary of Test Pit Investigations,
Site 10, Scrap Metal Landfill Near Bldg S-589
NWS Earle, Colts Neck, New Jersey

Test Pit Number	Test Pit Total Depth (ft)	Thickness (ft)		Composition Description		Comments
		Cover	Waste	Cover	Waste	
TP 10-1	8.3	--	--	--	Some wood scraps	Black organic seam @ 45' .5 - 1" thick
TP 10-2	4	--	--	--	Rusted casing	--
TP 10-3	6.3	--	--	--	--	Black organic layer
TP 10-4	6.8	--	--	--	--	Black organic layer

NO. 1 and 2 Mix
USED FOR MONITOR WELLS FOR THE
RI INVESTIGATION NWS EARLE, JANUARY 1991

RICCI BROS. Sand Co., Inc. • INDUSTRIAL SAND AND GRAVEL
Dragston Road P.O. Box 664 • Port Norris, NJ 08349 • Phone 609-785-0166 • Fax 609-785-2136

NSF Certified

WELL GRAVEL

Typical Analysis

Meets AWWA Standard B-100-89

national water well association

Well Gravel Grades

		00		00N		0		1		2		3		4	
MM	U.S. SIEVE NO.	% RET	% PASS	% RET	% PASS	% RET	% PASS	% RET	% PASS	% RET	% PASS	% RET	% PASS	% RET	% PASS
	1/4													0	100.0
4.76	4											0	100.0	.2	99.8
3.36	6									0	100.0	3.0	97.0	28.3	71.5
2.36	8									2.8	97.2	58.8	32.2	62.9	8.6
2.00	10							0	100.0	16.5	80.7	26.1	12.1	4.6	4.0
1.68	12							1.1	98.9	30.6	50.1	7.5	4.6	2.0	2.0
1.40	14					0	100.0	23.4	75.5	32.6	17.5	2.9	1.7		
1.17	16					1.6	98.4	48.1	27.4	13.6	3.9	.5	1.2		
1.00	18			0	100.0	22.8	75.6	14.3	13.1	2.4	1.5	.4	.8		
.84	20			1.1	98.9	32.3	43.3	6.9	6.2	1.1	.4	.6	.2		
.71	25	0	100.0	15.1	83.6	28.2	15.1								
.59	30	2.3	97.7	49.6	34.0	8.8	6.3								
.50	35	33.8	63.9	27.9	6.1	3.1	3.2								
.42	40	23.3	40.6	3.5	2.6	1.1	2.1								
.35	45	24.9	15.7	1.7	.9	.7	1.5								
.30	50	11.6	4.1	.6	.3	.8	.7								
.25	60														
.20	70														
.15	100														
	PAN	4.1		.3		.7		6.2		.4		.2		2.0	

*Custom Blending Available

Product Description

Composition (Wt%)

SI02	99.40	K20	0.02
Al203	0.13	TI02	0.02
Ca0	0.03	Na20	0.01
Fe203	0.03	Mg0	0.01
		L.O.I.	0.21

Hardness on Moh's scale: 6-8

Specific Gravity: 2.65

Acid solubility - .11

1991 Ricci Bros. Sand Co. Inc.

WESTON

1/71-62-10

FILE

DRILLING LOG

WELL NUMBER: 2-1

LOCATION: Ordnance Demilitarization Site

SURFACE ELEVATION: 102.56'

OWNER: WPNSTA Earle

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 30'

WATER LEVEL: 17'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 2/27/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES: "Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Olive (5Y5/4) and yellowish brown (10YR6/8) silty medium sand
5		111	S_S	5 6 7 9	4'-5.5' Olive (5Y5/4) and yellowish brown (10YR6/8) medium to coarse sand with 20% silt, damp, Rec = 18".
10		112	S_S	6 8 9 10	9'-10.5' Olive (5Y5/4) and yellowish brown (10YR6/8) medium to coarse sand with 15% silt, slightly wet, Rec = 18".
15		113	S_S	4 5 5 6	14'-14.5' Olive (5Y5/4) and yellowish brown (10YR6/8) medium sand, trace silt, wet, Rec = 6".
20		114	S_S	WOR	19'-21' Olive (5Y5/4) and yellowish brown

* A.S.T.M. D1586

WESTON

1771-62-10
FILE

DRILLING LOG

WELL NUMBER: Z-1
OWNER: WPNSTA Earle
LOCATION: Ordnance Demilitarization Site
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 30'
SURFACE ELEVATION: 102.56'
WATER LEVEL: 17'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: HSA
DATE DRILLED: 2/27/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20					medium to coarse Sand, saturated, Rec. = 24"
25		115	SS	2 5 8 12	24'-25.25' Olive (5Y5/4) fine to coarse Sand trace (5%) silt, yellowish red staining (5YR4/6), Saturated, Rec=15"
		116	SS	8 9 20 21	28'-30' Olive (5Y5/4) medium to coarse Sand, saturated, Rec. = 24"
30					

* A.S.T.M. D1586

Well 2-1

Well Construction Summary

Location or Coords: EOD Range

Elevation: Ground Level

Top of Casing 102.56'

Drilling Summary:

Total Depth 30'

Borehole Diameter

Driller J.E. Fritts

Rig Track Rig

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' - GS+2'	C1		30' - 15'	S1
15' - GS+2'	C2			

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 30'-13'

Cement 6:1 Portland Cement: Bentonite 12'-GS

Other Bentonite Pellets 13'-12'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	2/27 1986	0815	2/27 1986	0945
Roller Bit	"	0945	"	1015
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1040	"	1055
Filter Placement:	"	1055	"	1205
Cementing:	"	1315	"	1400
Development:	3/20/86	1423	3/20/86	1427
Other:				
	7/7/86	1000	7/7/86	14.25

Well Development:

Screen filled up with fine sand during initial development. Flushed well of sand during final development - pumping sustained at 7gpm. Pumped 1 hour 10 minutes at 7gpm after flushing.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

US NAVY

1771-02- 10

DRILLING LOG

WELL NUMBER: 2-2

OWNER: ~~WPNSTA~~ - Earle

LOCATION: Ordnance Demilitarization Site

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 20'

SURFACE ELEVATION: 95.98'

WATER LEVEL: 9'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 2/28/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Yellowish brown (10YR 6/8) becoming olive (5Y 5/4) fine to medium sand with little silt.
5		121	S_S	7 9 8 7	4'-5.5' Olive (5Y 5/4) and yellowish brown (10YR 6/8) fine to medium sand, some (25%) silt, damp, Rec = 18".
10		122	S_S	4 5 7 8	9'-10.5' Olive (5Y 5/4) medium sand, 5% silt, saturated, Rec = 18".
15		123	S_S	4 10 15 22	14'-16' Olive (5Y 5/4) medium sand, 5% silt, saturated, Rec. = 24"
20		124	S_S	6 5 8 13	18'-20' Olive (5Y 5/4) medium sand, saturated, Rec = 24".

* A.S.T.M. D1586

Well 2-2

Well Construction Summary

Location or Coords: EOD Range

Elevation: Ground Level

Top of Casing 95.98'

Drilling Summary:

Total Depth 20'

Borehole Diameter

Driller J.E. Fritts

Rig Track Rig

Bit(s) Hollow Stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log ____ Geophysical Log ____

Casing String(s): C=Casing S=Screen

3'	- GS+2'	C1	20'	- 5'	S1
5'	- GS+2'	C2		-	
	-			-	
	-			-	
	-			-	
	-			-	
	-			-	
	-			-	

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 19-3'

Cement 6:1 Portland Cement: Bentonite 2.5'-GS

Other Bentonite Pellets 3'-2.5'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	2/28 1986	1240	2/28 1986	1345
Roller Bit	"	1345	"	1415
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1415	"	1425
Filter Placement:	"	1425	"	1515
Cementing:	"	1530	"	1600
Development:	3/20/86	1615	3/20/86	1730
Other:				

Well Development:

Pumped at average rate of 3 gpm until discharge was free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

US NAVY

1771-02-10

DRILLING LOG

WELL NUMBER: 2-3

OWNER: FUPNSTA Earle

LOCATION: Ordnance Demilitarization Site

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 24'

SURFACE ELEVATION: 89.87'

WATER LEVEL: 4'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 2/21/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES: "Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Strong brown (7.5YR 5/8) medium sand
					Water at approximately 4'.
5		108	SS	3 6 9 8	4'-4.5' Strong brown (7.5YR 5/8) with dark reddish brown (5YR 3/4) mottles, medium to coarse sand
					4.5'-5' Olive (5Y 5/4) medium to coarse sand, saturated, Rec. = 12".
10		109	SS	WOR 2 5 7	9'-10.5' Olive (5Y 5/4) medium to coarse sand, saturated, Rec. = 18".
15		110	SS	3 4 5 11	14'-14.5' Olive (5Y 5/4) medium to coarse sand, saturated, Rec. = 6".

* A.S.T.M. D1586

SHEET 1 OF 1

Well 2-3

Well Construction Summary

Location or Coords: EOD Range

Elevation: Ground Level

Top of Casing 89.87'

Drilling Summary:

Total Depth 24'

Borehole Diameter

Driller J. E. Fritts

Rig Track Rig

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

2' - GS+3'	C1		24' - 4'	S1	
4' - GS+3'	C2				

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 24'-2.5'

Cement 6:1 Portland Cement: Bentonite 2'-GS

Other Bentonite Pellets 2.5'-2'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	2/21 1986	0830	2/21 1986	0940
Roller Bit	"	0940	"	1240
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1440	"	1450
Filter Placement:	"	1450	"	1525
Cementing:	"	1525	"	1600
Development:	3/20/86	1545	3/20/86	1715
Other:				

Well Development:

Pumped at average rate of 12 gpm until discharge free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

DRILLING LOG

WELL NUMBER: 2-4
OWNER: WPNSTA Earle
LOCATION: Ordnance Demilitarization Site
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 19'
SURFACE ELEVATION: 90.06'
WATER LEVEL: 4'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: Auger
DATE DRILLED: 2/27/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

US NAVY
1771-02-10
FILE

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Olive (5Y5/4) to blue green clayey sand. Water at approximately 4'
5		117	S_S	3 4 3 4	4'-5' Olive with blue green mottles clayey fine to medium sand, wet. Rec = 12".
10		118	S_S	W O R 6	9'-11' Light olive brown (2.5Y5/6) medium sand, saturated, Rec = 24".
15		119	S_S	7 9 14 16	14'-16' Olive brown (2.5Y 4/4) medium sand, saturated, Rec = 24"
20		120	S_S	3 9	19'-21' Olive brown (2.5Y 4/4) medium

* A.S.T.M. D1586

WESTON
US NAVY
1771-02-10

DRILLING LOG

WELL NUMBER: 2-4
OWNER: ~~WHE~~ NSTA Earle
LOCATION: Ordnance Demilitarization Site
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 19'
SURFACE ELEVATION: 90.06'
WATER LEVEL: 4'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: Auger
DATE DRILLED: 2/27/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20				14 16	sand, saturated, Rec = 24"

* A.S.T.M. D1586

SHEET 2 OF 2

Well 2-4

Well Construction Summary

Location or Coords: EOD Range

Elevation: Ground Level

Top of Casing 90.06'

Location

Personnel

Project

Drilling Summary:

Total Depth 19'

Borehole Diameter

Driller J. E. Fritts

Rig Track Rig

Bit(s) Hollow Stem Auger

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	-	GS+2'	C1	19'	- 4'	S1
4'	-	GS+2'	C2		-	

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC

S2

Centralizers

Filter Material No. 2 Ottawa Sand 19'-2.5'

Cement 6:1 Portland Cement: Bentonite 2'-GS

Other Bentonite Pellets 2.5'-2'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	2/27 1986	1455	2/27 1986	1550
Roller Bit	"	1550	"	1640
Geophys. Logging:				
Casing:				
Install 4" PVC	2/28 1986	0920	2/28 1986	0930
Filter Placement:	"	0930	"	1055
Cementing:	"	1105	"	1135
Development:	3/20/86	1515	3/20/86	1605
Other:				

Well Development:

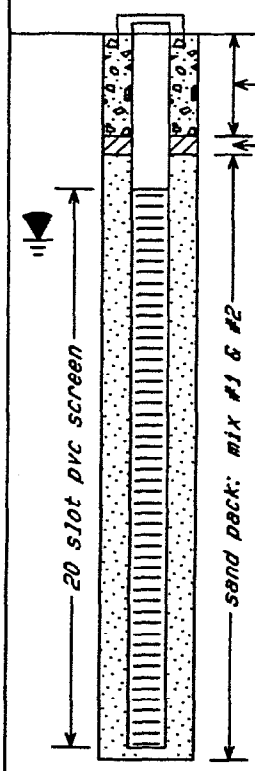
Pumped at average rate of 9 gpm until discharge free of fines.

Comments:

WESTON DESIGNERS CONSULTANTS

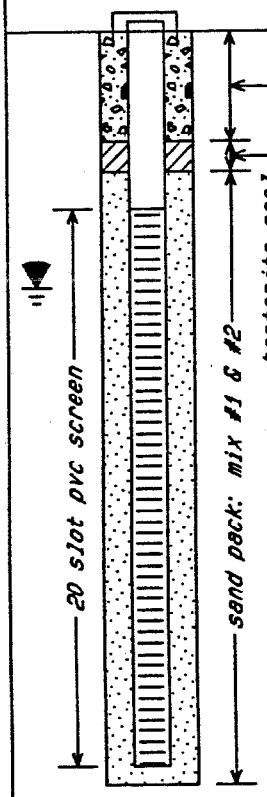
MONITOR WELL 2-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW02-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	103.05 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	19.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	19.28 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/25/91
Diameter of Well Casing	4 inches	Date Well Completed	1/25/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			2,6	67	SM	0.0-2.0 0-.5': Olive (5y4/3), SAND, fine to crse., some Silt, little Qtz gravel, subround, dry. .5-1.3': Olive (5Y4/3), SAND, low plast., slightly cohesive.
2			5,6		SC	
			6,9	69		
4			10,12		SM	
			4,5	71		2.0-4.0 Same as above. Damp.
6			6,7			
			4,5	62		4.0-6.0 Olive (5Y4/4), SAND, fine to med., some Silt, Fe staining, loose, moist.
8			6,8			
			1,4	38		6.0-8.0 Same as above. moist.
10			3,1			
12						8.0-10.0 Olive (5Y4/4), SAND, fine to med., some Silt, loose, Fe staining, Wet.
14			1,2	83		14.0-16.0 Olive (5Y4/4), SAND, v.f. to fine, some Silt, loose, 2-5% Glauconite 14-14.5'. wet.
16			1,1			
18			1,1	29		18.0-20.0 Same as above. Wet.
20			1,1			
22						
24						
26						
28						
30						

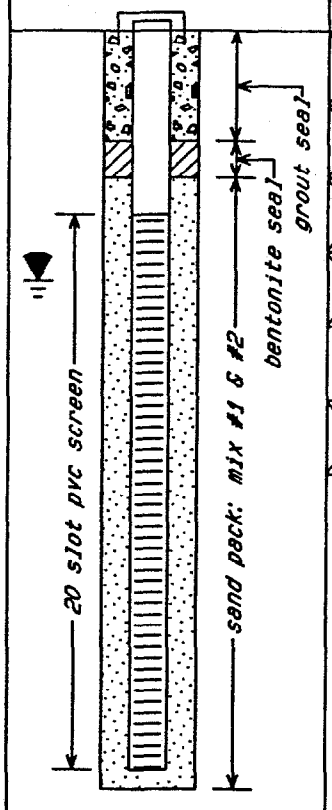
MONITOR WELL 2-6

Project	N.W.S. Earle/ Colts Neck	Well Number	MW02-6
Location	Colts Neck, N.J.	Coordinates	
Geologist	N. Pulczak	Top of Casing Elevation	95.07 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	20.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	19.80 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/23/91
Diameter of Well Casing	4 inches	Date Well Completed	1/24/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			17,10 / 16,18	75	SM	0.0-2.0 Light olive brown (2.5Y5/4), SAND, f. to med., some Silt, trace Qtz., med. grain, damp. 1.5-2.0': SAND, f-c, Olive to black.
2			6,12 / 11,13	79		
4			1,3 / 2,1	33		2.0-4.0 Dark yellowish brown (10YR4/4), SAND, f. to crse, trace silt (10%), damp. 3.5-4.0: grades to Olive (5Y4/3), SAND fine-med., loose.
6			1,1 / 3,2	25	SC	
8			4,6 / 7,12	79	SM	4.0-6.0 Olive (5Y4/3), SILT and SAND, low plast., some organic root matter, moist.
10			3,4 / 5,17	88		6.0-8.0 Dark gray (5Y4/1), SILT and SAND, fine gr., low plast., grading to SAND, v. low plast., moist.
12						
14			2,3 / 4,2	92		8.0-10.0 Olive (5Y4/4), SAND, fine to coarse, some Fe staining, loose, wet.
16						10.0-12.0 Olive (5Y4/4), SAND, fine to med., v. low plast., grading to SAND, fine to coarse, some Fe staining, wet.
18			4,3 / 4,2	88		14.0-16.0 Olive (5Y4/4), SAND, little Silt, strong Fe staining of .5-1" bands, loose, wet.
20						18.0-20.0 Olive (5Y4/4), SAND fine to med., little Silt, loose, grading to SAND, some Silt, v. low plast., slightly cohesive, wet.
22						
24						
26						
28						
30						

MONITOR WELL 2-7

Project	N.W.S. Earle/ Colts Neck	Well Number	MW02-7
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	95.18 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	20.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	20.00 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/25/91
Diameter of Well Casing	4 inches	Date Well Completed	1/25/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0						
2			3,4 / 4,5	79	SM	0.0-2.0 Olive brown (2.5Y4/4), SAND and SILT, v. fine, some Qtz gravel, damp.
4			2,2 / 2,3	8		2.0-4.0 Olive brown (2.5Y4/4), SILT and SAND, v. fine, little gravel, dry.
6			2,2 / 2,4	46		
8			4,6 / 16,18	79	SC	4.0-6.0 Very dark gray (10YR3/1), SILT and SAND, v. fine- fine, damp.
10			2,2 / 1,0	12	SC	6.0-8.0 Very dark gray (10YR3/1), SILT and SAND, v. fine to fine, grading at 7.5' to Glauconitic SAND, v. fine, low plast., Wet. 0-4": Olive gray (5G5/2) 4-17": Olive gray (5G4/2)
12						
14						10.0-12.0 Dark gray (5Y4/1), SILT, low plast., little Sand, v. fine, Glauconitic, wet.
16						
18						
20						
22						
24						
26						
28						
30						

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 3-1 OWNER: WPNSTA-EARLE

LOCATION: Landfill Southwest of F Group ADDRESS: COLTS NECK NEW JERSEY

TOTAL DEPTH: 23'

SURFACE ELEVATION: 117.05' WATER LEVEL: 15'

DRILLING COMPANY: JE Fritts DRILLING METHOD: HSA DATE DRILLED: 1/7/86

DRILLER: WL HELPER: USN NAVY

LOG BY: AEB

1771-62-10 FILE

SKETCH MAP

NOTES: "Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Dark brown (10YR 3/3) fine sand
5		23	SS	2 3 2 4	5'-6' White (10YR 8/1) and brownish yellow (10YR 6/8) very fine sand
					6'-6.25' Very dark grayish brown (10YR 3/2) silty clay, moist, Rec. = 15".
10		24	SS	4 5 8 12	10'-10.75' White (10YR 8/1) and brownish yellow (10YR 6/8) very fine sand.
					10.75'-11' Dark gray (10YR 4/1) silt, moist, Rec. = 12".
15		25	SS	10 18 20 22	15'-15.5' White (10YR 8/1) and brownish yellow (10YR 6/8) very fine sand
					15.5'-16.5' Dark gray (10YR 4/1) silt, moist Tip of spoon - brownish yellow (10YR 6/8) fine sand, wet, Rec = 18".

* A.S.T.M. D1586

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 3-1 OWNER: WPNSTA Earle
LOCATION: Landfill Southwest of F Group ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 25'
SURFACE ELEVATION: 117.05' WATER LEVEL: 15'
DRILLING COMPANY: JE Fritts DRILLING METHOD: HSA DATE DRILLED: 1/7/86
DRILLER: WL HELPER: USRJ, VY
LOG BY: AEB

1771-62-10
FILE

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		26	SS	5 10 16 22	20'-20.5' Brownish yellow (10YR 6/8) fine sand, wet
					20.5'-22' Dark gray (10YR 4/1) silt, Rec = 24".
25		27	SS	5 8 12 16	25'-25.5' Dark gray (10YR 4/1) silt and very dark brown (10YR 2/2) clay
					25.5'-26' Glauconitic sand - medium to coarse, saturated, Rec = 12".

* A.S.T.M. D1586

Well 3-1

Well Construction Summary

Location or Coords: Landfill South-West of F Group

Elevation: Ground Level

Top of Casing 117.05'

Drilling Summary:

Total Depth 23'

Borehole Diameter

Driller J.E. Fritts

Rig Mobile Drill B-61

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid WATER

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	GS+2'	C1	23'	8'	S
8'	GS+2'	C2			

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 23'-6' below GS

Cement 6:1 Portland cement: bentonite 4'-GS

Other Bentonite Pellets 6'-4' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/7/86	0800	1/7/86	1030
Roller Bit	"	1130	"	1200
Geophys. Logging:				
Casing:				
	"	1200	"	1215
Filter Placement:	"	1215	"	1330
Cementing:	"	1430	"	1500
Development:	3/21/86	0945	3/21/86	1040
Other:				

Well Development:

Pumped 2 minutes at 10 gpm; then 1 gallon every 5 minutes until discharge free of fines

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON DESIGNERS CONSULTANTS

FILE

1771-02-10

DRILLING LOG

WELL NUMBER: 3-2
OWNER: ~~AWRNSTA~~ Earle
LOCATION: Landfill Southwest of F Group
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 25'
SURFACE ELEVATION: 126.00'
WATER LEVEL: 12'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/6/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES: "Surface Elevation" = Top of PVC

DEPTH (FEET)	OVA/HNU	INTERVAL (FEET)			DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Brownish yellow (10YR 6/8) fine to coarse sand, some gravel.
5		18	SS	3 8 14 18	5'-7' Brownish yellow (10YR 6/8) fine to coarse sand, some gravel (20%) up to 1/2" in diameter, moist, Rec. = 12"
10		19	SS	4 6 7 8	10'-12' Yellow (10YR 7/8) clean, fine sand, moist, Rec = 15".
15		20	SS	2 2 2 5	15'-17' Brown (10YR 5/3) with strong brown (7.5YR 5/8) and white (10YR 8/1) fine sand, saturated.
20					

* A.S.T.M. D1586

WESTON

FILE

DRILLING LOG

WELL NUMBER: 3-2 OWNER: WPNSTA Earle

LOCATION: Land fill Southwest of F Group ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 25'

SURFACE ELEVATION: 126.00' WATER LEVEL: 12'

DRILLING COMPANY: J.E. Fritts DRILLING METHOD: HSA DATE DRILLED: 1/6/86

DRILLER: WL HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		21	SS	7 10 12 14	20'-22' Dark gray (10YR 4/1) clayey silt to silt, becoming siltier with depth, moist
25		22	SS	7 7 9 13	25'-27' Dark gray (10YR 4/1) silt to silty fine sand, wet.

* A.S.T.M. D1586

Well 3-2

Well Construction Summary

Location or Coords: Landfill South-west of F Group

Elevation: Ground Level

Top of Casing 126.00'

Drilling Summary:

Total Depth 25'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	-	GS+2'	C1	25'	-	10' S
10'	-	GS+2'	C2		-	

Casing: C1 4" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 25'-8' below GS

Cement 6:1 Portland cement: bentonite 6'-GS

Other Bentonite Pellets 8'-6' below GS

GS = Ground Surface

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/6/86	0940	1/6/86	1040
Roller Bit	"	1040	"	1100
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1100	"	1120
Filter Placement:	"	1120	"	1345
Cementing:	"	1445	"	1545
Development:	3/21/86	0900	3/21/86	1500
Other:				

Well Development:

Pumped for 5 seconds; went dry. Well had to be bailed.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

FILE

DRILLING LOG

WELL NUMBER: 3-3
OWNER: WPNSTA Earle
LOCATION: Landfill Southwest of F Group
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 23'
SURFACE ELEVATION: 125.53'
WATER LEVEL: 10'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/25/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					
5		13		9 12 22	5'-6.5' Brownish yellow (10YR 6/6) coarse to fine sand, some gravel (25%), dark gray (10YR 4/1) fine sand mottles.
10		14		10 18 19 20	10'-12' Brownish yellow (10YR 6/6) medium to coarse sand, some gravel (30%), saturated, Rec. = 18".
15		15		3 8 6 3	15'-17' White (10YR 8/1) with pink (5YR 7/3) and brownish yellow (10YR 6/6) very fine sand, saturated, Rec. = 6".
20					

* A.S.T.M. D1586

WESTON

US NAVY
1771-02-10

DRILLING LOG

WELL NUMBER: 3-3 ILE
OWNER: WPNSTA Earle
LOCATION: Landfill Southwest of F Group
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 23'
SURFACE ELEVATION: 125.53'
WATER LEVEL: 10'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/25/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		16		2 4 6 6	20'-22' 1" of white (10YR 8/1) and pink (5YR 7/3) very fine sand over dark gray (10YR 4/1) silt with trace sand (5%) and trace clay (5%), moist, Rec. = 23"
25		17		3 6 13 9	25'-27' Dark gray (10YR 4/1) silt with some fine sand to sandy silt, moist, Rec. = 24".
30					

* A.S.T.M. D1586

Well 3-3

Well Construction Summary

Location or Coords: Landfill South-West of F Group

Elevation: Ground Level

Top of Casing 125.53'

Drilling Summary:

Total Depth 23'

Borehole Diameter

Driller J. E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' -	GS+2'	C1	23' -	8'	S
8' -	GS+2'	C2			

Casing: C1 6" Steel

C2 4" PVC SCH 40

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottowa Sand 23'-6' below GS

Cement 6:1 Portland cement: bentonite 4'-GS

Other Bentonite Pellets 6'-4' below GS

GS = Ground Surface

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/2/86	1400	1/2/86	1500
Roller Bit	"	1500	"	1530
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1530	"	1600
Filter Placement:	"	1600	"	1715
Cementing:	"	1715	"	1730
Development:	3/21/86	0845	3/21/86	1040
Other:				

Well Development:

Well did not sustain pumping

Comments:

Location

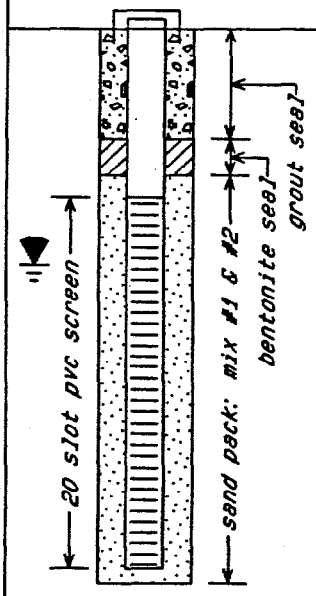
Personnel

Project

WESTON DESIGNERS CONSULTANTS

MONITOR WELL 3-4

Project	N.W.S. Earle/ Colts Neck	Well Number	MW03-4
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	123.27 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	55.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	14.60 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/29/91
Diameter of Well Casing	4 inches	Date Well Completed	1/30/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0						
2			5,5 / 7,6	79	SW	0.0-2.0 Yellow (10YR7/6), SAND, fine to med., some gravel, rnd. to subround, damp.
4			2,12 / 10,10	21		2.0-4.0 Same as above, Very pale brown (10YR7/4), damp.
6			6,6 / 6,4	0		4.0-6.0 No recovery, (gravel?).
8			3,4 / 7,12	67	SM	6.0-8.0 Light gray (2.5Y7/2), SAND, v.f., some silt little Qtz gravel, med., gravel grades out after 8'4.5", damp. HNU=2.5 ABKG (auger)
10			6,6 / 7,8	79	SC	
12			2,1 / 2,6	46		8.0-10.0 SAND, damp: 0-12": White (2.5Y8/0), v.f. SAND 12-15": Light gray (2.5Y7/2), v.f. SAND 13-18": WHite (2.5Y8/0), v.f. SAND 18-19": Gray (2.5Y5/0), SAND, v.f., low plast., little Silt.
14			2,5 / 6,6	50		
16			4,5 / 6,8	92	MH	
18			1,4 / 5,7	79	OH	10.0-12.0 SAND, wet: 0-5": White (2.5Y8/0), SAND, some Silt, low plast., v.f. grain sand. 5-9.5": Gray (med.) (2.5Y6/0), SAND, some silt, med. plast., 9.5-11": Gray (med.) (2.5Y6/0), SAND, v.f.
20			1,1 / 3,9	75		
22			1,3 / 7,10	75		
24			1,3 / 7,13	67	SC	12.0-14.0 Light gray (2.5Y7/0), SAND, v.f., some Silt, low plast., wet.
26						14.0-16.0 0-3": Light gray (2.5Y7/0), SAND, v.f., some silt, wet. 3-22": Very dark gray (2.5Y3/0), SILT, med. to high plast., trace mica flakes, wet.
28						
30						

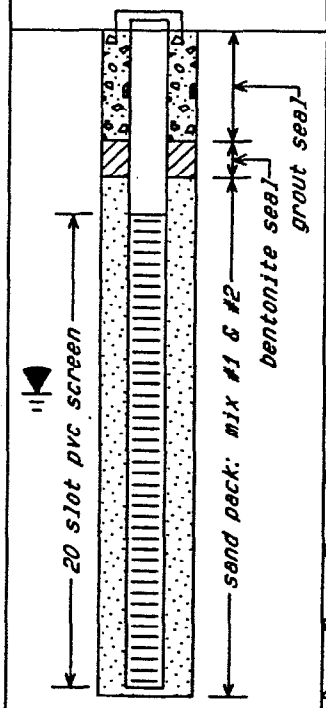
MONITOR WELL 3-4

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW03-4

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						16.0-18.0 Very dark gray (2.5Y3/0), CLAY, med. to high plast., becoming low plast. after 18".
32						18.0-20.0 Same as above. At 2-4" and 16-18" SAND seams, v.f., crumbly, low plast., wet.
34						18.0-20.0 Same as above, med. plast., wet
36						20.0-22.0 Same as above, wet.
38						20.0-22.0 Very dark gray (2.5Y3/0), SILT, v.f., crumbly, low plast., wet.
40						
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

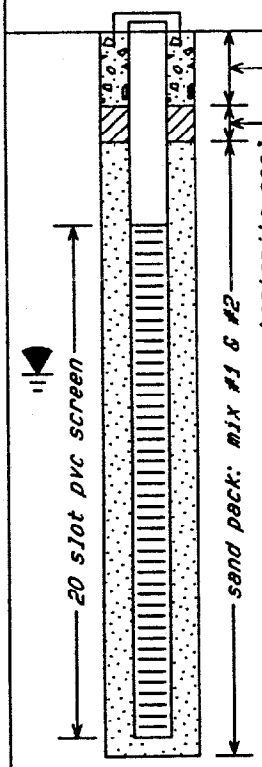
MONITOR WELL 3-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW03-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	126.03 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	18.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	17.75 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/05/91
Diameter of Well Casing	4 inches	Date Well Completed	2/05/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			3,3 / 4,8	71	SM	0.0-2.0 Yellow (10YR7/8), SAND and SILT, v.f., some Qtz gravel, med., rnd. to subround at 8-17", 13.5-14.5" rusted metal, damp.
2			6,6 / 7,6	62		2.0-4.0 Yellow (2.5Y7/8), SAND and SILT, v.f., little Qtz gravel throughout, subrounded, damp. HNU=0 ABKG (spoon & auger)
4			4,2 / 3,4	54		
6			5,10 / 12,5	62		4.0-6.0 Same as above.
8			5,6 / 6,12	71		6.0-8.0 Pale yellow (2.5Y7/4), SAND and SILT, v. fine, trace Qtz gravel, moist.
10			6,10 / 11,15	71		8.0-10.0 Light gray (2.5Y7/2), SAND and SILT, v. fine, no Qtz, wet.
12			5,7 / 10,15	100		10.0-12.0 Pale yellow (2.5Y7/4), SAND and SILT, v. fine, slight Glauconitic coloring, wet.
14			4,2 / 8,15	58		12.0-14.0 0-12": Olive yellow (5Y6/8), SAND 12-21": Gray (5Y5/1), SAND and SILT, v.f., little clay stringers, 21-24": Gray (5Y6/1), SAND and SILT, v.f. no stringers, wet.
16			2,3 / 9,9	42		14.0-16.0 0-8": Brownish yellow (10YR6/8), SAND and SILT, v.f., little clay stringers, wet. 8-14": Very dark gray (10YR3/1), SILT, some Sand, med. plast., wet.
18						16.0-18.0 Very dark gray (10YR3/1), SILT and SAND, some clay stringers, more clay than above, wet.
20						
22						
24						
26						
28						
30						

MONITOR WELL 3-6

Project	N.W.S. Earle/ Colts Neck	Well Number	MW03-6
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	126.78 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	55.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	19.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/07/91
Diameter of Well Casing	4 inches	Date Well Completed	2/11/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			2,2 / 3,4	67	SM	0.0-2.0 Reddish brown (5YR5/4), SAND, v.f., some Silt, some subrounded to rounded gravel.
2			6,12 / 15,14	62	SW	2.0-4.0 0-9.5": Very pale brown (10YR7/4), SAND, some Silt, becoming Dark brown (10YR3/3) between 8-9.5". 9.5-15": Brownish yellow (10YR6/8), SAND and gravel, med. to coarse, rounded to subrounded, damp
4			6,14 / 20,26	65		
6			12,24 / 34,24	54		
8			6,12 / 26,26	58		4.0-6.0 Brownish yellow (19YR6/8), SAND, fine to coarse, some med. subrounded gravel, moist. HNU=0 ABKG (auger)
10			14,24 / 35,44	54		
12			6,10 / 10,7	38	ML	6.0-8.0 Yellow (10YR7/6), SAND, 70% med. grain, 20% fine, 10% v. fine, little Qtz gravel, medium gr., subrounded to subangular, damp.
14			4,10 / 10,14	54		8.0-10.0 0-4": Yellow (10YR7/6), SAND, fine to med., little Qtz gravel, subrounded to sub-angular, wet. 4-5": Light gray (10Yr7/2), SAND, v.f. to fine, wet. 5-14": Reddish yellow (7.5YR6/8), SAND, fine to coarse, some med. Qtz gravel, wet.
16			8,10 / 12,18	96		
18						
20						10.0-12.0 Reddish yellow (7.5YR6/8), SAND, v.f.-med., some Qtz gravel, med., subrounded, wet.
22						
24						12.0-14.0 0-3": Brownish yellow (10Yr6/8), SAND, v.f., little med. Qtz gravel, wet 3-5.5": Light gray (10YR7/1), SAND, v.f., some Silt, no gravel, wet. 5.5-9": Light yellowish brown (10YR6/4), SAND, v.f., some Silt, some clay (low plast.) stringers, wet.
26						
28						
30						

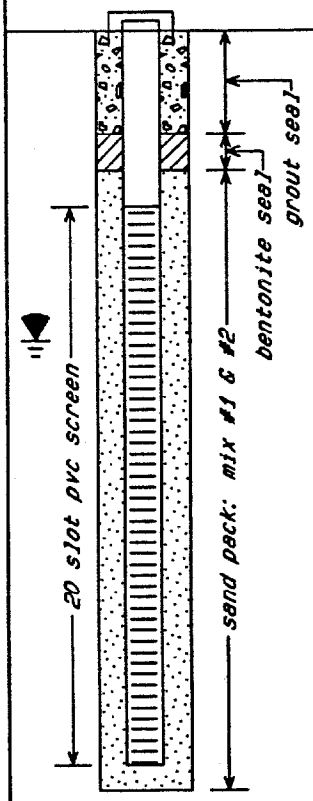
MONITOR WELL 3-6

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW03-6

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						14.0-16.0 0-4": Very pale brown (10YR7/3), SILT, some Sand, v.f., v.low plast., wet. 4-8": Very dark brown (10YR2/2), SILT, low to med. plast., 8-13": Light brownish gray (10YR6/2), SAND and SILT, v.f., little clay stringers, low plast., wet.
32						
34						
36						16.0-18.0 0-2": Yellowish brown (10YR5/6), SILT, some Sand, v.f., low plast., wet 2-10": Dark gray (10YR4/1), med. plast. clay, 10-23": Very dark gray (10YR4/1), CLAY - SILT, v.f., crumbly, low plast., wet.
38						
40						
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

MONITOR WELL 3-7

Project	N.W.S. Earle/ Colts Neck	Well Number	MW03-7
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	125.63 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	55.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	19.8 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/28/91
Diameter of Well Casing	4 inches	Date Well Completed	1/29/91



DEPTH IN FEET	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0–2		3,7 / 20,28	54	GM
2–4		11,27 / 31,38	67	GM
4–6		9,31 / 64,7	50	GM
6–8		15,21 / 61,69	67	GM
8–10		9,21 / 29,31	54	ML
10–12		11,15 / 21,15	58	ML
12–14		2,3 / 7,11	42	ML
18–20		3,2 / 1,0	38	ML

DEPTH IN FEET: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

WELL CONSTRUCTION DETAIL

DESCRIPTION

0.0-2.0
0-3": Dark gray (5YR4/1), SAND, some Silt, loam, dry.
3-13": Brownish yellow (10YR6/8), SAND, fine, some Silt, some Qtz gravel, med. grain, rnd. to subrnd., dry.
HNU = 2 ABKG (jar head space)

2.0-4.0
Brownish yellow (10YR6/8), SAND (95% v.f. - f., 5% med.), some Silt, some med. Qtz Gravel, rnd. to subrnd., poorly sorted, moist.
HNU = 0 ABKG (jar head space)

4.0-6.0
Same as above, moist.
HNU = 0 ABKG (jar & auger)

6.0-8.0
Yellow (2.5Y7/6), SAND, v.f. to fine, and Qtz gravel, fine to med., subrnd. to rnd., wet.
HNU = .1 ABKG (jar head space)

8.0-10.0
Yellow (10YR7/8), Silt, v.f., at 4-13", (0-4": same as above), wet.
HNU = BKG (auger)

10.0-12.0
Yellow (10YR7/6), SILT, v.f., some black organic material 0-5", transition at 5-7" to White (10YR8/2) Silt, no orange grains, wet

12.0-14.0
Yellow (10YR7/6),
0-9": CLAY, some Silt, low - med. plast.,
9-10": SAND, some Silt, v. fine, wet

* Continuous split spoon sampling is stopped due to running sands.

MONITOR WELL 3-7

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW03-7

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						18.0-20.0 0-7": Brownish yellow (10YR6/6), SILT, some Sand, v. fine, mottled dk. red/ black, orange/tan, tan. 7-9": Very dark gray (5Y3/1), CLAY, some Silt, med. plast., wet.
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WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 4-1
OWNER: WPNSTA - EARLE
LOCATION: Landfill west of D group
ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH: 30'
SURFACE ELEVATION: 173.00'
WATER LEVEL: 18'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: Auger
DATE DRILLED: 1/8/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Brownish yellow (10YR 6/6) medium sand, some coarse sand
5		28	SS	6 8 11 13	5'-7' Light gray (10YR 7/1) medium sand, some (10%) fine sand, moist, Rec=12".
10		29	SS	8 15 37 41	10'-12' White (10YR 8/1) and brownish yellow (10YR 6/6) medium sand with 10% fine sand, moist, Rec = 12".
15					15'-17' Brownish yellow (10YR 6/6) medium to coarse sand, trace (5%) gravel becoming strong brown (7.5YR 4/6) medium to coarse sand, moist, Rec = 18"
20					

* A.S.T.M. D1586

WESTON DESIGNERS CONSULTANTS

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DRILLING LOG

WELL NUMBER: 4-1
OWNER: WPNSTA-EARLE
LOCATION: Landfill west of D Group
ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH: 30'
SURFACE ELEVATION: 173.00'
WATER LEVEL: 18'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: Auger
DATE DRILLED: 1/8/86
DRILLER: WL
HELPER: RE
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		31	SS	11 10 19 21	20'-20.5' 2" strong brown (7.5YR 4/6) medium sand over 4" white (10YR 8/1) very coarse sand and gravel.
					20.5'-21.5' Layered, firm fine to medium sand, trace gravel (5%), saturated, Rec=18"
25		32		WOR 10 23	25'-27' 2" brown (10YR 4/3) medium to fine sand over 16" of white (10YR 8/1) and brownish yellow (10YR 6/6) fine and medium sand / coarser with depth, Saturated, Rec=18"
30		33			30'-30.5' Very pale brown (10YR 7/4) fine sand
					30.5'-31' Layered light gray (10YR 7/1) and brownish yellow (10YR 6/6) fine sand.
					31'-31.5' 4" Light gray (10YR 7/1) silt over 2" brownish yellow (10YR 6/8) clay, Saturated, Rec = 18"

* A.S.T.M. D1586

Well 4-1

Well Construction Summary

Location or Coords: Landfill West of D Group

Elevation: Ground Level

Top of Casing 173.00'

Drilling Summary:

Total Depth 30'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' -	GS+2'	C1	30' -	15'	S
15' -	GS+2'	C2	-		

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 30' - 12.5' below GS

Cement 6:1 Portland cement: bentonite 10' - GS

Other Bentonite Pellets 12.5' - 10' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/8/86	1440	1/8/86	1515
Roller Bit	"	1515	"	1530
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1530	"	1600
Filter Placement:	"	1600	"	1730
Cementing:	1/9/86	0830	1/9/86	0915
Development:	3/21/86	1410	3/21/86	1600
Other:				

Well Development:

Comments:

Location

Personnel

Project

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WESTON
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DRILLING LOG

WELL NUMBER: 4-2
OWNER: WPNSTA-EARLE
LOCATION: Landfill west of D group
ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH: 18'
SURFACE ELEVATION: 152.36'
WATER LEVEL: 4'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: Auger
DATE DRILLED: 1/9/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Dark brown (10YR 3/3) becoming brownish yellow (10YR 6/6) medium sand, clean. Glauconitic medium sand layer at ~3'. Soil wet at ~4'.
5		34	SS	10 10 11 22	5'-5.5' Yellow (10YR 7/8) coarse sand with 50% gravel
					5.5'-7' Yellow (10YR 7/8) fine to coarse sand becoming finer with depth, wet. Rec = 20"
10		35	SS	9 11 19 27	10'-12' Yellow (10YR 7/8) fine to medium sand, trace (10%) gravel, saturated, Rec = 20".
15		36	SS	7 6 7 11	15'-16.5' Gray (10YR 7/1) to brownish yellow (10YR 6/6) fine to medium sand, saturated, Rec = 24"
18					16.5'-17' Reddish yellow (7.5YR 6/8) fine to medium sand
		37	SS	2 3 3 5	18'-19' Reddish yellow (7.5YR 6/8) clayey silt
20					19'-19.4' Light gray (10YR 7/1) very fine sand
					19.4-20' Reddish yellow (7.5YR 6/8) clay. Saturated. Rec. = 24"

* A.S.T.M. D1586

SHEET 1 OF 1

Well 4-2

Well Construction Summary

Location or Coords: Landfill West of D Group

Elevation: Ground Level

Top of Casing 152.36'

Drilling Summary:

Total Depth 18'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid

Surface Casing 6" Steel Locking

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/9/86	1350	1/9/86	1500
Roller Bit	"	1500	"	1515
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1515	"	1530
Filter Placement:	"	1530	"	1700
Cementing:	"	1700	"	1715
Development:	3/21/86	1225	3/21/86	1345
Other:				

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

2' - GS+3'	C1		18' - 3'	S	
3' - GS+2'	C2				

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 18' - 2.5' below GS

Cement 6:1 Portland cement: bentonite 2' - GS

Other Bentonite Pellets 2.5' - 2' below GS

Well Development:

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 4-3
OWNER: WPNSTA-EARLE
LOCATION: Landfill west of D group
ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH: 25'
SURFACE ELEVATION: 166.40'
WATER LEVEL: 12'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: Auger
DATE DRILLED: 1/10/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES: "Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Brownish yellow (10YR 6/6) fine to medium sand. Light gray (10YR 7/1) at 4.5'.
5		38	SS	4 7 17 22	5'-5.5' White (10YR 8/1) and brownish yellow (10YR 6/6) fine to medium sand
					5.5'-6' Reddish yellow (7.5YR 6/8) medium to coarse sand.
					6'-6.5' White (10YR 8/1) and yellowish red (5YR 5/8) medium to very coarse sand + gravel (5%), moist, Rec = 18"
10		39	SS	15 24 32 30	8.5'-10.5' Layered white (10YR 8/1) and brownish yellow (10YR 6/6) fine to medium sand and coarse sand to gravel, alternating, moist, tip of spoon damp, Rec = 18"
15		40		12 24 18 18	13.5'-14' Reddish yellow (7.5YR 6/8) fine to coarse sand, trace (5%) gravel (up to ½").
					14'-15.5' Brownish yellow (10YR 6/6) and yellowish red (5YR 5/8) medium to very coarse sand, 20% gravel, saturated, Rec = 22"
20					

* A.S.T.M. D1586

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DRILLING LOG

WELL NUMBER: 4-3 OWNER: WPNSTA - EARLE
LOCATION: Landfill west of D Group ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH: 25'
SURFACE ELEVATION: 166.40' WATER LEVEL: 12'
DRILLING COMPANY: JE Fritts DRILLING METHOD: HSA DATE DRILLED: 11/10/86
DRILLER: WL HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
15					
		41	SS	10 12 32 38	18.5'-19' Brownish yellow (10YR 6/6) very coarse sand and gravel (up to 1/2").
20					19'-20' Brownish yellow (10YR 6/6) fine to medium sand
					20'-20.5' Light gray (10YR 7/1) fine to medium sand, saturated, Rec. = 24"
		42		8 14 19 27	23.5'-24' Brownish yellow (10YR 6/6) medium to very coarse sand.
25					24'-25' Brownish yellow (10YR 6/6) fine to medium sand, some reddish yellow (7.5YR 6/8) mottles.
					25'-25.5' Light gray (10YR 7/1) fine sand, clean, saturated, Rec = 24"

* A.S.T.M. D1586

Well 4-3

Well Construction Summary

Location or Coords: Landfill West of D Group

Elevation: Ground Level

Top of Casing 166.40'

Drilling Summary:

Total Depth 25'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' - GS+2'	C1		25' - 10'	S	
10' - GS+2'	C2				

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 25'-8' below GS

Cement 6:1 Portland cement: bentonite 6'-GS

Other Bentonite Pellets 8'-6' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/10/86	1015	1/10/86	1145
Roller Bit	"	1315	"	1330
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1330	"	1400
Filter Placement:	"	1400	"	1530
Cementing:	"	1530	"	1550
Development:	3/21/86	1050	3/21/86	1215
Other:				

Well Development:

Comments:

Location

Personnel

Project

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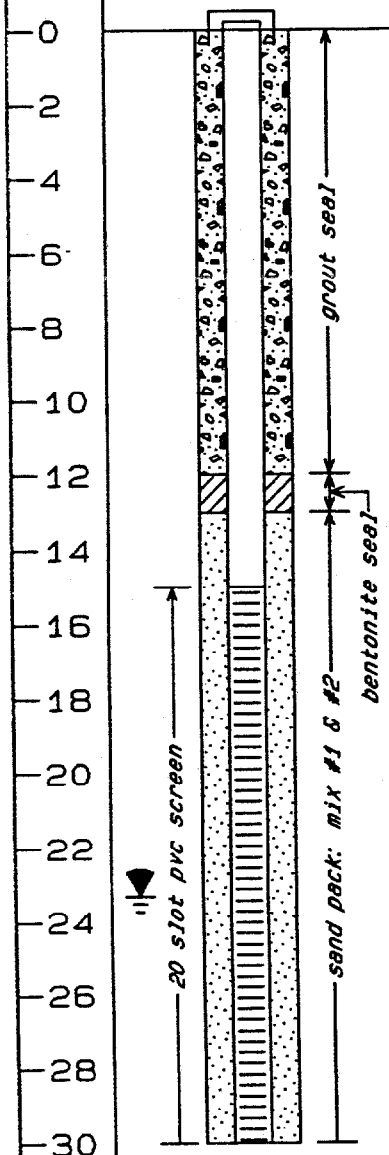
MONITOR WELL 4-4

Project	N.W.S. Earle/ Colts Neck	Well Number	MW04-4
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	181.28 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	35.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	35.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/30/91
Diameter of Well Casing	4 inches	Date Well Completed	2/08/91



DEPTH IN FEET	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0		2,3 / 5,5	79	SM
2		4,5 / 4,7	67	GM
4		3,6 / 7,11	50	
6		2,6 / 10,11	79	SM
8		4,8 / 8,9	71	
10		6,10 / 10,10	75	
12		3,9 / 9,14	75	
14		9,10 / 16,11	81	
16		4,11 / 14,14	75	
18		10,21 / 21,30	73	
20		15,29 / 30,38	46	GM
22		9,34 / 50,99/4		
24		7,9 / 16,23	88	GM
26				
28				
30		5,8		GM

DESCRIPTION

0.0-2.0
0-6": Very dark brown (10YR2/2), SAND, fine, some Silt, loose, moist.
6-19": grading to a Dark grayish brown (10YR4/2), SAND, v.f. to fine, some SILT, loose, moist.
HNU = BKG

2.0-4.0
Yellowish brown (10YR5/8), SAND, some Silt little fine-med. Qtz gravel, subrounded, F staining, at 2.5-3.5 ft. tan SAND, v. fine, some Silt, moist.
HNU = BKG

4.0-6.0
Same as above, little fine to coarse Sand moist.

6.0-8.0
Yellow (10YR8/6), SAND, v. fine, some Silt, banding apparent at 6-6.5ft and 13-13.5ft, both Yellow (10YR7/6), moist.

8.0-10.0
Reddish yellow (7.5YR6/8), SAND, v.f., some Silt, grading to Brownish yellow (10YR6/8) at 9.5-17", moist.

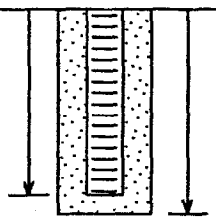
10.0-12.0
10-10.5': Brownish yellow (10YR6/8), SAND, v. fine, some Silt, 2" layer of Dark brown (10YR3/4), SAND, v. fine, some Silt, moist.
10.5-11.5': Very pale brown (10YR7/4), SAND, some Silt, v.f., loose, moist.

12.0-14.0
Very pale brown (10YR7/4), Sand, v. fine, some Silt, grading to Very pale brown (10YR8/4) at 11.5-18". moist.

14.0-16.0
Very pale brown (10YR8/4), SAND and SILT, v. fine, mottled color throughout, strong band of Yellow (10YR7/8) at 6.5-7.5", moist.

MONITOR WELL 4-4

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW04-4

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30			17,28		GM	16.0-18.0 Very pale brown (10YR7/3), SAND, v. fine, some Silt, uniform, no banding, little Qtz gravel @ 13-14.5", rounded, moist. 18.0-20.0 Very pale brown (10YR7/4), Sand, some Silt, little gravel, subrounded, SAND: 80% fine, 15% med., 5% crse, banding: 4-5": (10YR7/6), 12.5-13.5": (10YR8/1), 15.5-16": (10YR7/8), moist. 20.0-22.0 Light gray (10YR7/2), SAND, some Silt, 0-2": Pale brown (10YR6/3) SAND, v.f., 7-7.5": dominant Reddish yellow (5YR6/8), fine, some angular Qtz gravel. 7.5-11": White (10YR8/1), fine-med., SAND, damp. 22.0-24.0 No sample taken. Hammer lost in hole. 24.0-26.0 Olive yellow (2.5Y6/8), SAND and SILT, v. fine, .25mm bands of Very dark grayish brown (2.5Y3/2), some rounded Qtz gravel, wet. HNU = .4 ABKG (spoon) 29.0-31.0 Same as above, wet.
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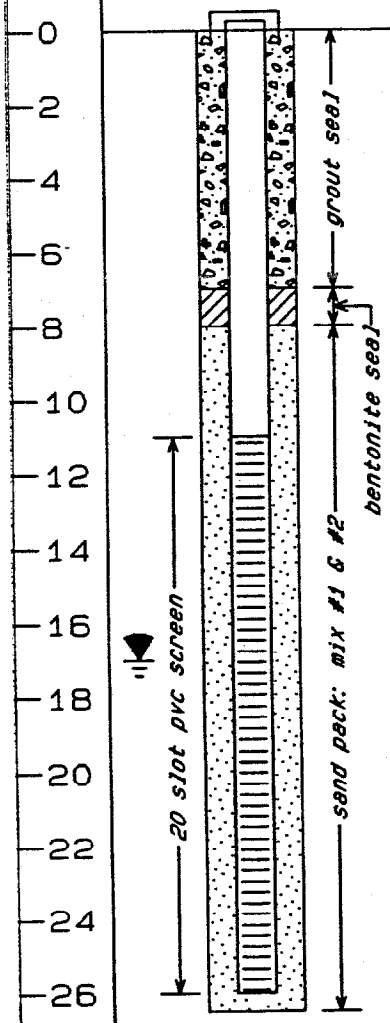
MONITOR WELL 4-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW04-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	J. Williams	Top of Casing Elevation	165.28 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	26.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	26.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/20/91
Diameter of Well Casing	4 inches	Date Well Completed	2/20/91



DEPTH IN FEET	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0–2		1, 9 / 15, 13	92	SM
2–4		11, 13 / 14, 11	71	SM
4–6		5, 8 / 7, 10	46	SM
6–8		6, 16 / 12, 21	62	SM
8–10		8, 10 / 21, 26	54	GM
10–12		9, 14 / 28, 20	71	GM
12–14		14, 16 / 16, 10	58	GM
14–16		9, 12 / 16, 18	62	GM
16–18		9, 11 / 11, 13	62	GM

DESCRIPTION

0.0-2.0
Dark brown (10YR4/3), SAND, med. w/ some coarse grains, Black silt layer (10YR2/1), moist.

2.0-4.0
Grayish brown (10YR5/2), SAND, med. and coarse grain, poor sorting, some fine Qtz gravel, moist.

4.0-6.0
Reddish brown (5YR5/4), SAND, fine - med. grain, Fe staining, trace fine gravel, moist.
HNU = BKG

6.0-8.0
Reddish brown (5YR5/4), SAND, f-m, trace fine to med. Qtz gravel, Fe staining, moist.

8.0-10.0
Reddish brown (5YR5/4), SAND, fine - med. little fine to med. Qtz gravel, subangular, Fe staining, dk. brown silt streaks, moist.

10.0-12.0
Reddish brown (5Yr5/4), SAND, fine to med., some f-m subangular Qtz gravel, seams of Fe stains, moist.

12.0-14.0
Pink (5YR7/3), SAND and Qtz GRAVEL, fine to med., poor sorting, moist.

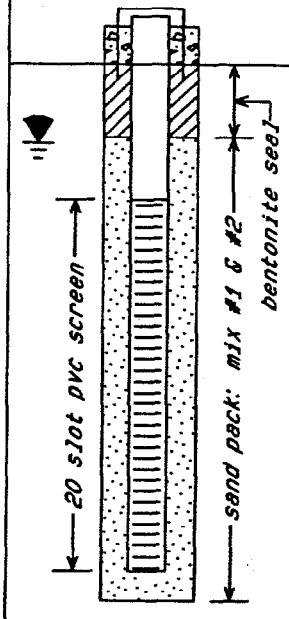
14.0-16.0
Reddish brown (5YR5/4), SAND, fine to coarse, and Qtz GRAVEL, f-m, Fe staining, wet @15'.

16.0-18.0
Brownish yellow (10YR6/8), SAND, fine, at 17ft there is 2" band coarse SAND and fine GRAVEL, loose, wet.

* Discontinue split spooning due to running sands. Drill to 27 ft.

MONITOR WELL 4-6

Project	N.W.S. Earle/ Colts Neck	Well Number	MW04-6
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	149.75 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	14.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	13.7 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/25/91
Diameter of Well Casing	4 inches	Date Well Completed	2/25/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0					
2			5,6 / 5,6	75	SP
4			6,10 / 12,15	75	GM
6			10,16 / 17,17	54	
8			10,12 / 17,17	71	
10			8,10 / 11,12	63	SM
12					
14					
16					
18					
20					
22					
24					
26					
28					
30					

DESCRIPTION

0.0-2.0
Light gray (10YR7/2), SAND, med. to poor sorting, fine to v.fine grain, damp:
0-1": SILT and SAND loam.
1-5": SAND, v.f. to f., some med. Qtz. gravel, (10YR6/4)
5-18": SAND, vf to f, some med. Qtz grvl. (10YR7/2)

2.0-4.0
Light brownish gray, SAND, some Silt, some gravel, wet:
2.0-2.5': SAND, coarse to fine, poor sort, little Qtz gravel, med.,
2.5-2.8': SAND and SILT, some Qtz gravel, med., Dark gray (10YR4/1).
2.8-3.3': SAND, v.f. to f., some Qtz grvl., Very pale brown (10YR7/4).

4.0-6.0
Pale yellow (2.5Y7/4), SILT and SAND, v.f. to fine, little Qtz Gravel, med. grain, subrounded at 4.9' where color grades to Yellow (2.5Y7/6), wet

6.0-8.0
Yellow (2.5Y7/6), SILT and SAND, v.f. to fine, some medium Qtz Gravel, wet

8.0-10.0
Light gray (10YR7/2), SILT and SAND, very fine, wet:
8.0-8.35': Light gray (10YR7/2), SILT and SAND, v. fine, well sorted.
8.35-8.6': Yellow (10YR7/6), SILT and SAND v. fine.
8.6-9.2': Light gray (10YR7/2), SILT and SAND, v. fine, well sorted.

WESTON

DRILLING LOG

US NAVY
1771-02-10

WELL NUMBER: 5-1 OWNER: WPNSTA Earle
LOCATION: Landfill West of Army Barricades ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 29'
SURFACE ELEVATION: 108.77' WATER LEVEL: 18'
DRILLING COMPANY: J.E. Fritts DRILLING METHOD: HSA DATE DRILLED: 2/20/86
DRILLER: WL HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Dark brown (10YR 3/3) becoming pale brown fine to medium sand.
5		103	SS	4 8 8 10	4'-4.3' Olive yellow (2.5Y 6/6) sandy silt. 4.3'-4.9' Olive (5Y 4/4) and olive brown (2.5Y 4/4) medium to coarse sand with some (10%) silt, wet, Rec. = 10".
10		104	SS	18 21 28 36	9'-9.5' Olive (5Y 4/4) and yellowish brown (10YR 6/8) medium to coarse sand with some (10%) silt, damp, Rec. = 6"
15		105	SS	WOR 6 8 13	14'-14.25' Olive (5Y 4/4) and yellowish brown medium to coarse sand with 10% silt, slightly wet, Rec. = 15".

* A.S.T.M. D1586

WESTON

DRILLING LOG

WELL NUMBER: 5-1
OWNER: WPNSTA Earle
LOCATION: Landfill west of Army Barricades
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 29'
SURFACE ELEVATION: 108.77'
WATER LEVEL: 18'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 2/20/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		106	SS	2 6 10 12	19'-21' Olive (5Y 4/4) and olive brown (2.5Y 4/4) fine to coarse sand, saturated, Rec=24".
25		107	SS	4 10 14 21	24'-26' Olive (5Y 4/4) and olive brown (2.5Y 4/4) fine to coarse sand, saturated, Rec=24".

* A.S.T.M. D1586

Well 5-1

Well Construction Summary

Location or Coords: Landfill West of Army Barricades

Elevation: Ground Level

Top of Casing 108.77'

Drilling Summary:

Total Depth 29'

Borehole Diameter

Driller J.E. Fritts

Rig Track Rig

Bit(s) Hollow stem Auger; Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' -	GS+2'	C1	29' -	14'	S
14' -	GS+2'	C2	-		

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 29'-12'

Cement 6:1 Portland Cement: Bentonite 11'-GS

Other Bentonite Pellets 12'-11'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	2/20 1986	0750	2/20 1986	0930
Roller Bit	"	0930	"	1000
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1000	"	1030
Filter Placement:	"	1100	"	1215
Cementing:	"	1315	"	1430
Development:	3/20/86	1100	3/20/86	1155
Other:				

Well Development:

Pumped at average rate of 2.5 gpm until free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON DESIGNERS CONSULTANTS

US NAVY
1771-02-14
FILE

DRILLING LOG

WELL NUMBER: 5-2
LOCATION: Landfill west of Army Barricades
SURFACE ELEVATION: 113.96'
OWNER: WPNSTA Earle
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 28'
WATER LEVEL: 18'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/21/86
DRILLER: WL
HELPER: RT
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-3' Pale brown (10YR 6/3) fine to medium sand.
					3'-4' Strong brown (7.5YR 5/8) fine to medium sand.
5		72	SS	3 1 1 1	4'-5' Light gray (10YR 7/1) with strong brown (7.5YR 5/8) very fine sand.
					5'-5.25' Dark grayish brown (10YR 4/2) clayey silt.
					5.25'-5.5' Dark grayish brown (10YR 4/2) silty very fine sand, wet to saturated, Rec - 18".
10		73	SS	5 6 9 11	9'-10.5' Strong brown (7.5YR 4/6) medium sand, little fine sand (5%), moist, Rec = 18".
					Water perched above 9'
15		74	SS	3 5 9 10	14'-15.5' Strong brown (7.5YR 4/6) medium sand, trace fine sand, moist, Rec = 18".
20		75	SS	4 6	19'-20.5' Olive (5Y 4/4) medium sand,

* A.S.T.M. D1586

WESTON DESIGNERS CONSULTANTS

US NAVY

DRILLING LOG

WELL NUMBER: 5-2

LOCATION: Landfill west of Army Barricades

SURFACE ELEVATION: 113.96'

OWNER: 1771 Finsta Earle

ADDRESS: FLE Colts Neck New Jersey

TOTAL DEPTH: 28'

WATER LEVEL: 18'

DRILLING COMPANY: JE Fritts

DRILLING METHOD: HSA

DATE DRILLED: 1/21/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20				8 12	Saturated, Rec = 18".
25		76	SS	WOR 6 9 12	24'-25.5' Olive (5Y 4/4) clean medium sand, saturated, Rec = 18".
30		77	SS	6 7 13 19	29'-31' Olive brown (2.5Y 4/4) medium sand, trace (10%) fine sand, saturated, Rec = 24".

* A.S.T.M. D1586

SHEET 2 OF 2

Well 5-2

Well Construction Summary

Location or Coords: Landfill West of Army Barricades

Elevation: Ground Level

Top of Casing 113.96'

Drilling Summary:

Total Depth 28'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' - GS+2'	C1		28' - 13'	S	
13' - GS+2'	C2				

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottowa Sand 28' - 11' below GS

Cement 6:1 Portland cement: bentonite 9' - GS

Other Bentonite Pellets 11' - 9' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/21/86	1000	1/21/86	1145
Roller Bit	"	1145	"	1210
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1330	"	1400
Filter Placement:	"	1400	"	1630
Cementing:	"	1630	"	1700
Development:				
Other:				

Well Development:

Well did not sustain pumping
Pumped 2 gallons every 10 minutes.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

DRILLING LOG

US NAVY

WELL NUMBER: 5-3

OWNER: NAVSTA Earle

LOCATION: Landfill West of Army Barricades

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 32'

SURFACE ELEVATION: 109.78'

WATER LEVEL: 20'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 3/3/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES: "Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Yellowish brown (10YR 6/8) silty sand
5		125	SS	4 2 6 12	5'-5.5' Pale yellow (2.5Y 7/4) very fine sand, 5.5'-6' Light olive brown (2.5Y 5/6) sandy silt, wet, Rec = 12".
10		126	SS	4 3 5 8	10'-11.5' Dark yellowish brown (10YR 4/6) with olive (5Y 4/4) fine to medium sand, 10% silt, damp, Rec = 18".
15		127	SS	4 5 9 13	15'-15.5' Pale yellow (2.5Y 7/4) fine sand 15.5'-16' Dark yellowish brown (10YR 4/6) with olive fine to medium sand, 10% silt, slightly wet, Rec = 12".

* A.S.T.M. D1586

WESTON

US NAVY
1771-02-10
FILE

DRILLING LOG

WELL NUMBER: 5-3
OWNER: WPNSTA Earle
LOCATION: Landfill West of Army Barricades
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 32'
SURFACE ELEVATION: 109.78'
WATER LEVEL: 20'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: Auger
DATE DRILLED: 3/3/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		128	SS	5 7 9 12	20'-20.5' Dark yellowish brown (10YR 2/6) with olive (5Y 4/4) fine to medium sand, 15-20% silt becoming less silty (to 5% silt) with depth, Saturated, Rec = 6".
25		129	SS	7 8 13 22	25'-25.5' Yellowish brown (10YR 5/6) sandy silt.
					25.5'-26' Olive (5Y 4/4) fine to medium sand, Saturated, Rec. = 12".
30		130	SS	7 8 13 22	30'-30.9' Olive (5Y 4/4) and dark yellowish brown (10YR 4/6) fine to medium sand with 10-15% silt, Saturated, Rec = 10".

* A.S.T.M. D1586

Well 5-3

Well Construction Summary

Location or Coords: Landfill West of Army Barricades

Elevation: Ground Level _____

Top of Casing 109.78

Drilling Summary:

Total Depth 32'

Borehole Diameter _____

Driller J.E. Fritts

Rig Track Rig

Bit(s) Hollow Stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log _____

Casing String(s): C=Casing S=Screen

3'	-	GS+2'	C_1	32'	-	17'	S_1
17'	-	GS+2'	C_2		-		
37'	-	32'	C_3		-		

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

C3 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2 _____

Centralizers _____

Filter Material No. 2 Ottawa Sand 32'-15'

Cement 6:1 Portland Cement : Bentonite 14'-GS

Other Bentonite Pellets 15'-14'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	3/3/86	0830	3/3/86	1000
Roller Bit	"	1000	"	1225
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1315	"	1330
Filter Placement:	"	1410	"	1525
Cementing:	"	1525	"	1615
Development:	3/20/86	0915	3/20/86	1040
Other:				

Well Development:

Pumped at average rate of 2.5 gpm until discharge free of fines.

Comments:

Location _____

Personnel _____

Project _____

WESTON DESIGNERS CONSULTANTS

WESTON

DRILLING LOG

US N

WELL NUMBER: 5-4

OWNER: NPNSTA Earle

LOCATION: Landfill west of Army Barricade

ADDRESS: Colts Neck FILE New Jersey

TOTAL DEPTH: 27'

SURFACE ELEVATION: 105.65'

WATER LEVEL: 17'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 2/19/86

DRILLER: WL

HELPER: RJ

LOG BY: AB

SKETCH MAP

NOTES: "Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Olive yellow (2.5Y 6/6) to olive brown (2.5Y 4/4) medium to coarse sand.
5		98		2 11 18 22	4'-4.4' Light yellowish brown (2.5Y 6/4) with light gray (10YR 7/1) fine to medium sand. 4.44'-4.9' Olive yellow (2.5Y 6/6) fine to medium sand. 4.9'-5.25' Olive (5Y 4/4) fine to medium sand with some (25%) silt, Rec = 15", damp.
10		99		9 25 23 26	9'-9.25' Gray (5Y 6/1) fine to medium sand 9.25'-9.9' Olive yellow (2.5Y 6/6) fine to medium sand 9.9'-10.25' Olive (5Y 4/4) and olive brown (2.5Y 4/4) fine to medium sand with little (10%) silt, damp, Rec = 15"
15		100		6 10 15 14	14'-15' Olive (5Y 4/4) and olive brown (2.5Y 4/4) medium to coarse sand, wet, Rec. = 12"

* A.S.T.M. D1586

WESTON

US N Y

1771-02-10

FILE

DRILLING LOG

WELL NUMBER: 5-4

OWNER: WPNSFA Earle

LOCATION: Landfill west of Army Barricades

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 27'

SURFACE ELEVATION: 105.65'

WATER LEVEL: 17'

DRILLING COMPANY: JE Fritts

DRILLING METHOD: HSA

DATE DRILLED: 2/19/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		101		6 5 15 19	19'-21' Olive (5Y 4/4) to olive brown (2.5Y 4/4) medium to very coarse sand, saturated. Rec = 24".
25		102		7 9 15	24'-25.5' Olive (5Y 4/4) to olive brown (2.5Y 4/4) medium to very coarse sand, saturated. Rec. = 18".

* A.S.T.M. D1586

Well 5-4

Well Construction Summary

Location or Coords: Landfill West of Army Barricades

Elevation: Ground Level

Top of Casing 105.65'

Drilling Summary:

Total Depth 27'

Borehole Diameter

Driller J.E. Fritts

Rig Track mounted

Bit(s) Hollow Stem Auger; Roller Bit

Drilling Fluid

Surface Casing

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	2/19 1986	0830	2/19 1986	0930
Roller Bit	"	0930	"	1000
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1025	"	1100
Filter Placement:	"	1220	"	1400
Cementing:	"	1400	"	1430
Development:	3/20/86	1200	3/20/86	1345
Other:				

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

2'	-	GS+2'	C1	27'	-	12'	S
12'	-	GS+	C2		-		

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 27'-10'

Cement 6:1 Cement:Bentonite 9'-GS

Other Bentonite Pellets 10'-9'

Well Development:

Pumped at average rate of 2.5 gpm until discharge free of fines

Comments:

Location

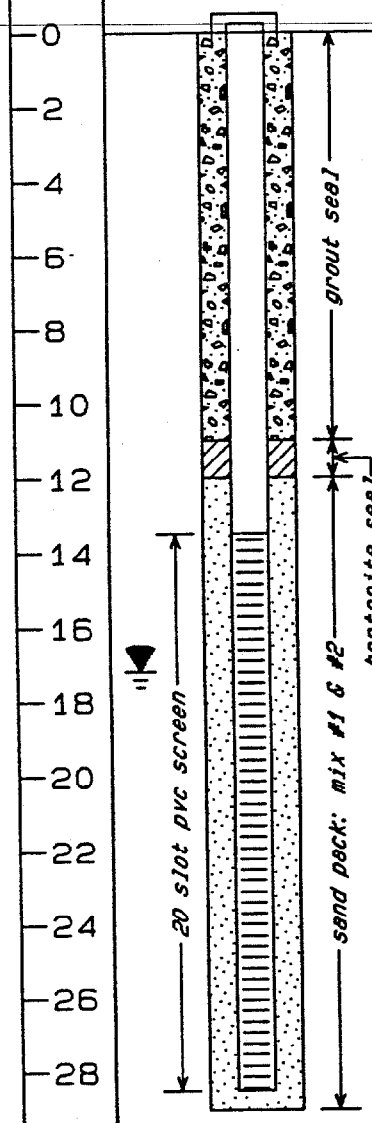
Personnel

Project

WESTON DESIGNERS CONSULTANTS

MONITOR WELL 5-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW05-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	N. Pulczak	Top of Casing Elevation	112.05 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	55.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	28.5 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/18/91
Diameter of Well Casing	4 inches	Date Well Completed	1/18/91



DEPTH IN FEET	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0–2		3, 8 / 10, 13	75	SW
2–4		6, 10 / 18, 16	50	
4–6		6, 13 / 16, 19	45	
6–8		8, 142 / 8, 12	75	
8–10		8, 13 / 15, 11	75	
10–12		6, 14 / 18, 15	40	
12–14		7, 11 / 12, 12	80	
14–16		6, 10 / 7, 9	80	
16–18		6, 7 / 8, 12	75	
18–20		7, 7 / 10, 13	85	
20–22		3, 5 / 12, 17	100	
22–24		7, 8 / 8, 10	100	
24–26			100	
26–28			100	

DESCRIPTION

0.0-2.0
Brownish yellow (10YR6/8), SAND, fine-med grain, trace couarse grain, damp.

2.0-4.0
Olive (5Y5/4), SAND, med. grain, 10% fine 10% coarse, damp:
2.0-2.6: Brownish yellow SAND, as above.
2.6-4.0': Olive SAND.

4.0-6.0
Same as above, trace Qtz fragments in split spoon. Dry.

6.0-8.0
Same as above, trace silt, no Qtz. At 6.8-7.0ft. found paper/cardboard , dry

8.0-10.0
Light gray (10YR7/1), SAND, med. - fine grain, trace coarse sand, trace organics (roots), peat fragemnt- pos. charred wood, v. low plast., dry.

10.0-12.0
10.0-10.6: Same as above. Wood gragments at 10.4-10.6ft.
10.6-11.6: Olive (5Y5/4) and Brownish yellow (10YR6/8) mix, med. grain, low plast., dry.

12.0-14.0
Olive (5Y5/4), White and Olive yellow (2.5Y6/6) mix, SAND, med grain, trace fine (5%), trace coarse (2%), firm, Fe stain @13.2ft, low plast., dry.

14.0-16.0
Same as above w/o Olive Yellow component, dry.

16.0-18.0
Dark green (5GY4/1), SAND, med.-coarse grain, trace fine, moist.

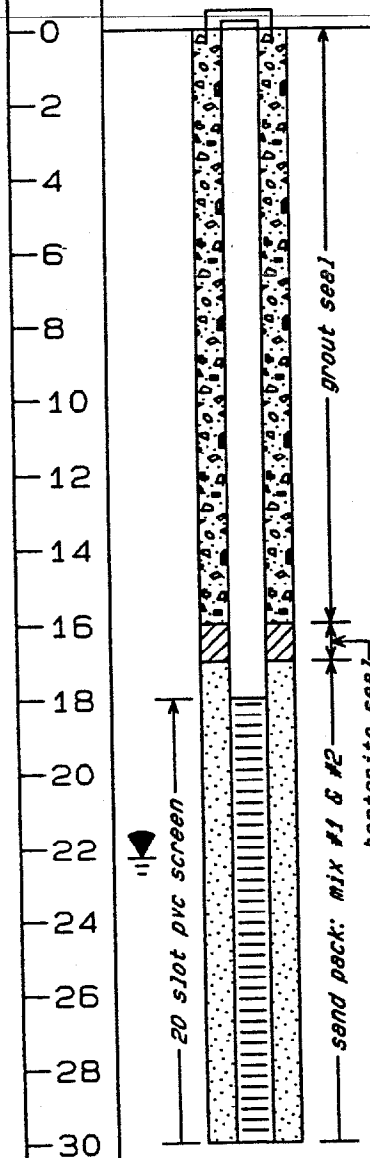
MONITOR WELL 5-5

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW05-5

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						18.0-20.0 Olive (5y5/4), SAND, med- coarse grain, trace fine sand & silt, little orange sand, med grain, wet.
32						
34						20.0-22.0 Same as above. wet
36						22.0-24.0 Same as above. wet.
38						24.0-26.0 Same, with increase in coarse fraction, wet.
40						26.0-28.0 Same, wet.
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

MONITOR WELL 5-6

Project	N.W.S. Earle/ Colts Neck	Well Number	MW05-6
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	117.30 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	33.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	33.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/22/91
Diameter of Well Casing	4 inches	Date Well Completed	1/23/91



DEPTH IN FEET	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0	3,3 / 5,7	54	SW
2	6,6 / 9,12	25	ML
4	3,5 / 6,5	67	SP
6	2,1 / 7,2	50	CL
8	3,5, / 4,7	58	SM
10	3,10 / 10,9	50	
12	9,11, / 13,19	75	
14	7,9 / 27,26	67	
16	4,4 / 11,8	67	
18	4,2 / 9,11	71	
20	2,5 / 5,4	71	
22	2,4 / 7,2	92	
24	2,4 / 6,9	75	
26	2,2 / 1,0	75	
28			
30			

DESCRIPTION

0-2.0
Very pale brown (10YR7/3), SAND, med. grain, some Qtz gravel, med. grain, sub-rounded to rounded.
HNU = BKG

2.0-4.0
Very dark grayish brown (10YR3/2), SILT some sand, low plast., moist.
HNU=BKG

4.0-6.0
Very dark grayish brown (10YR3/2), SILT, v. fine grain, grading to grayish brown (10YR5/2), SAND , coarse grain, moist.
HNU=BKG

6.0-8.0
Yellow (10YR7/6), SAND, fine to v. fine grain, moderate sorting, grading to a yellow (10YR7/8), SILT, low plast, moist
HNU=BKG

8.0-10.0
Yellow (10YR7/8), SILT, low plast., grading to Very pale brown (10YR7/3) SAND, med. grain at 10'5".

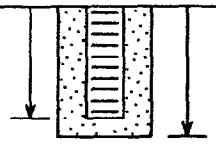
10.0-12.0
Very pale brown (10YR7/3), SAND, med. grain, moist, as above.

12.0-14.0
Gray (10YR5/1), SAND, med. grain, med. sorting, Fe staining at 12'3", damp

14.0-16.0
Light brownish gray (10YR6/2), SAND, tan to lt. brown grain color, med. in gr. size, Fe staining at 8", wet.

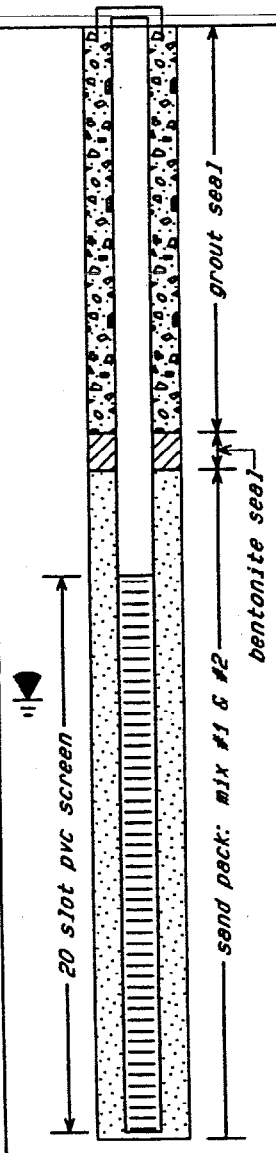
MONITOR WELL 5-6

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW05-6

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30					SM	16.0-18.0 Yellowish brown (10YR5/4), SAND, fine to med. grain, damp
32						18.0-20.0 Brownish yellow (10YR6/6), SAND, fine to med. grain, 5%=green (glauconitic), 15%= dk. brown, 80% = tan, moist.
34						
36						20.0-22.0 Same as above, moist.
38						22.0-24.0 Same as above, wet
40						24.0-26.0 same as above, wet.
42						26.0-28.0 Brownish yellow (10YR6/6), SAND little silt, fine to med. grain, wet.
44						
46						* Auger to 34'. Discontinue split spoon sampling due to sands running up auger.
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

MONITOR WELL 5-7

Project	N.W.S. Earle/ Colts Neck	Well Number	MW05-7
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	113.97 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	30.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	29.8 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/23/91
Diameter of Well Casing	4 inches	Date Well Completed	1/24/91



DEPTH IN FEET	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0		2,3 / 8,8	88	SM	0.0-2.0 Pale brown (10YR6/3), SILT, v. low plast., damp.
2		4,3 / 7,8	79	ML	2.0-4.0 Very dark grayish brown (10YR3/2), SILT, low to med plast., grades to v.low plast. silt after 10", damp.
4		2,3 / 4,8	58		
6		2,4 / 5,8	67	SW	4.0-6.0 Very dark grayish brown (10YR3/2), SILT, as above, more clay stringers apparent, damp.
8		3/4 / 99/5	50		
10		22,28 / 34,38	96	SP	6.0-8.0 Gray (5G5/1), SAND and SILT, v.f. to fine, Glauconitic, 10% green grains v.f., 90% tan grains, v.f. to fine, trace Fe stains, damp.
12		4,6 / 10,18	75		
14		4,9 / 10,11	83		8.0-10.0 Strong brown (7.5YR5/6), SAND, v.f. to fine, med. sorting, some Fe stainiing damp
16		2,5 / 6,1	54		
18		3,5 / 8,10	79		10.0-12.0 Same as above: 10% green (glauconitic) sand, v.f. 90% tan sand v.f. to fine (Fe stains) damp.
20		3,8 / 12,10	62	SW	
22					12.0-14.0 Brown to Dark brown (7.5Yr4/4), same as above, slightly more glauconitic sand (15-20% total green grains), damp.
24					
26					14.0-16.0 Same as above, damp
28					
30					

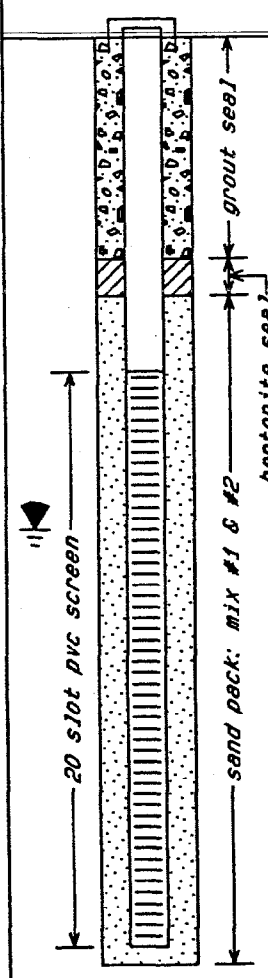
MONITOR WELL 5-7

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW05-7

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						16.0-18.0 Strong brown (7.5YR5/6), SAND, v.f. to fine, less Glauconitic, damp 2-5% green glauconitic sand, v.f. 98-95% tan to orange sand, v.f to f.
32						
34						18.0-20.0 Same as above, damp.
36						20.0-22.0 Same as above, wet.
38						* Discontinue split spoon sampling due to running sands. Following samples taken from cuttings.
40						24.0-26.0 Gray (7.5YR5/0), SAND and SILT, low plast., wet
42						
44						28.0-30.0 Brown (10YR5/4) SAND and SILT, v. fine, wet.
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

MONITOR WELL 5-8

Project	N.W.S. Earle/ Colts Neck	Well Number	MW05-8
Location	Colts Neck, N.J.	Coordinates	
Geologist	J. Williams	Top of Casing Elevation	110.30 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	25.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	24.5 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/12/91
Diameter of Well Casing	4 inches	Date Well Completed	2/13/91



DEPTH IN FEET	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0–2		5, 4 / 3, 4	83	SM
2–4		4, 4 / 4, 5	60	ML
4–6		3, 4 / 6, 6	65	ML
6–8		10, 12 / 11, 14	80	SW
8–10		11, 13 / 14, 16	85	SW
10–12		7, 10 / 15, 19	75	SP
12–14		8, 11 / 12, 12	75	SP
14–16		6, 11 / 13, 16	85	SP
16–18		8, 11 / 12, 17	80	SP
18–20		6, 10 / 14, 14	85	SP
20–22		6, 10 / 11, 14	85	SW
22–24		3, 7 / 14, 21	90	SW

DESCRIPTION

0-2.5
Sand and Silt, trace gravel, v. fine sand, Orange Brown.
HNU=BKG

2.5-6.0'
Silt with trace clay, low plasticity, little (15%) fine to coarse sand and fine gravel, Fe precipitate at 4.6ft.
HNU=BKG

6-10'
Sand, fine to med. grain, little silt (10%), little Fe staining at 8-10 ft.
HNU=BKG

`d=10
10-20'
Sand, fine to med. grain, little (10%) to some (20%) silt, Olive Brown (2.5Y4/4), trace mica at 12', slightly cohesive at 17', low plasticity at 18-20'.
HNU=BKG

20-24'
Sand, fine-med., little (10%) silt, trace coarse sand, becmes Dark Yellow Brown (10YR4/6) at 20-22' then becomes Olive Brown again.
HNU=BKG

US NAVY
1771-02-10
FILE

WESTON

DRILLING LOG

WELL NUMBER: 7-1
OWNER: WPNSTA Earle
LOCATION: Landfill South of "P" Barricades
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 39'
SURFACE ELEVATION: 149.73
WATER LEVEL: 27'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: Auger
DATE DRILLED: 3/4/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Yellowish brown (10YR 5/8) clean fine sand.
5		131	SS	6 5 7 12	5'-5.5' Yellowish brown (10YR 5/8) clean fine sand, damp, Rec = 6".
10		132	SS	4 20 15 13	10'-10.5' Yellowish brown (10YR 5/8) clean fine sand
					10.5'-11' Yellowish brown (10YR 5/8) fine sand, 10% silt with dark reddish brown (2.5YR 3/4) mottles, damp, Rec = 12".
15		133	SS	3 2 4 5	15'-16' Brown (7.5YR 5/2) sandy silt - micaceous moist, Rec = 12"

* A.S.T.M. D1586

WESTON

US NAVY

DRILLING LOG 1771-62-10

WELL NUMBER: 7-1 FILE OWNER: WPNSTA Earle

LOCATION: Landfill South of "P" Barricades ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 39'

SURFACE ELEVATION: 149.73' WATER LEVEL: 27'

DRILLING COMPANY: J.E. Fritts DRILLING METHOD: Auger DATE DRILLED: 3/4/86

DRILLER: WL HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		134	S_S	3 3 5 13	Brown (7.5YR 5/2) sandy silt with yellowish brown (10YR 5/8) mottles
25		135	S_S	2 3 9 17	25'-25.25' Brown sandy silt, saturated. 25.25'-26' Black micaceous silt with some fine quartz sand, dry, Rec = 12"
30		136	S_S		30'-30.25' Brown (7.5YR 5/2) sandy silt, saturated. 30.25'-30.5' Black silt, dry, Rec = 12".
35		137	S_S	14 19 22 28	35'-36.5' Black silt, wet, Rec = 18".

* A.S.T.M. D1586

US N
1771-
FILE

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 7-1
OWNER: WPNSTA Earle
LOCATION: Landfill South of "P" Barricades
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 39'
SURFACE ELEVATION: 149.73'
WATER LEVEL: 27'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: Auger
DATE DRILLED: 3/4/86
DRILLER: WL
HELPER: RT
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
40		138	SS	7 9 12 15	40'-41' Black silt, dry. Rec = 12".

* A.S.T.M. D1586

Well 7-1

Well Construction Summary

Location or Coords: Waterfront

Elevation: Ground Level

Top of Casing 149.73'

Drilling Summary:

Total Depth 39'

Borehole Diameter

Driller J. E. Fritts

Rig Track Rig

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	GS+2'		39'	24'	S1
24'	GS+2'	C1			

Casing: C1 6" Steel Locking

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 39'-22'

Cement 6:1 Portland Cement : Bentonite 21'-GS

Other Bentonite Pellets 22'-21'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	3/4/86	0905	3/4/86	1040
Roller Bit	"	1040	"	1100
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1230	"	1240
Filter Placement:	"	1240	"	1445
Cementing:	"	1615	"	1650
Development:	3/19/86	0915	3/19/86	1050
Other:				

Well Development:

Pumped at average rate of 0.5 gpm. Flow not sustained. Pumped until discharge free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

US NAVY

DRILLING LOG 1771-02-10

WELL NUMBER: FTLE2

OWNER: WPNSTA Earle

LOCATION: Landfill South of "P" Barricades

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 19'

SURFACE ELEVATION: 119.68'

WATER LEVEL: 4'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 3/5/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES: Surface Elevation = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Yellowish brown (10YR 5/8) fine to medium sand. Water at approximately 4 feet.
5		139	SS	4 5 7 7	4'-6' Yellowish brown (10YR 5/8) fine to medium sand, clean, saturated.
10		140	SS	2 3 5 6	9'-11' Brown (7.5YR 5/2) with yellowish brown (10YR 5/8) mottles sandy silt, saturated. Black silt on augers at 10'.
15		141	SS	5 6 9 11	14'-15.5' Brown (7.5YR 5/2) and yellowish brown (10YR 5/4) silty sand becoming sandy silt at 15', saturated, Rec = 18"
20		142	SS	3 8	19-19.5' Brown (7.5YR 5/2) sandy silt, saturated

* A.S.T.M. D1586

US NAVY

1771-62-10

FILE

WESTON

DRILLING LOG

WELL NUMBER: 7-2

OWNER: WPNSTA Earle

LOCATION: Landfill South of "P" Barricades

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 19'

SURFACE ELEVATION: 119.68'

WATER LEVEL: 4'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 3/5/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20				11 13	19.5'-20.5' Black sandy silt, damp. Rec= 18".

* A.S.T.M. D1586

SHEET 2 OF 2

Well 7-2

Well Construction Summary

Location or Coords: Waterfront

Elevation: Ground Level

Top of Casing 119.68'

Drilling Summary:

Total Depth 19'

Borehole Diameter

Driller J.E. Fritts

Rig Track Rig

Bit(s) Hollow Stem Auger; Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

2.5' - GS+2.5'	C1		19' - 4'	S	
4' - GS+2'	C2				

Casing: C1 6" Steel Locking

C2 4" PVC SCH40

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. Ottawa Sand 19' - 2.5'

Cement 6:1 Portland Cement: Bentonite 2' - GS

Other Bentonite Pellets 2.5' - 2'

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	3/5/86	0800	3/5/86	0920
Roller Bit	"	0920	"	0930
Geophys. Logging:				
Casing:				
Install 4" PVC	"	0930	"	0945
Filter Placement:	"	0945	"	1115
Cementing:	"	1135	"	1150
Development:	3/19/86	1110	3/19/86	1300
Other:				

Well Development:

Pumping sustained at 4gpm. Pumped until discharge free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

US NAVY
1771-02- 1
FILE

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 7-3 OWNER: WPNSTA Earle
LOCATION: Landfill South of P Barricades ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 35'
SURFACE ELEVATION: 164.15' WATER LEVEL: 22'
DRILLING COMPANY: JE Fritts DRILLING METHOD: HSA DATE DRILLED: 1/24/86
DRILLER: WL HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' White (10YR 8/1) medium sand.
5		78	SS	8 2 6 9	5'-6' White (10YR 8/1) medium sand, moist, Rec = 12"
10		79	SS	3 2 4 6	10'-11.5' White (10YR 8/1) and reddish yellow (7.5YR 7/8) medium sand, wet, Rec = 18".
15		80	SS	3 4 4 6	15'-16' White (10YR 8/1) medium sand with reddish yellow (7.5YR 7/8) mottling 16'-16.5' Reddish yellow (7.5YR 7/8) medium sand, wet, Rec. = 18"

* A.S.T.M. D1586

FILE

WESTON

DRILLING LOG

WELL NUMBER: 7-3
OWNER: WPNSTA Earle
LOCATION: Landfill South of P Barricades
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 35'
SURFACE ELEVATION: 164.15'
WATER LEVEL: 22'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/24/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		81	SS	3 3 5 7	20'-20.7' White (10YR 8/1) medium sand with reddish yellow (7.5YR 7/8) mottles, saturated at tip of spoon, Rec = 8".
25		82	SS	1 2 4 9	25'-26.5' White (10YR 8/1) medium sand with reddish yellow (7.5YR 7/8) mottles, saturated, Rec = 18".
30		83	SS	6 6 11 15	30'-30.5' Reddish yellow (7.5YR 7/8) medium sand. 30.5'-31' Brown (7.5YR 5/2) medium sand 31'-31.5' Black (7.5YN 2/0) sandy silt, saturated, Rec = 18".
35		84	SS	9 11 13 17	35'-35.5' Reddish yellow (7.5YR 7/8) medium sand. 35.5'-35.6' Brown (7.5YR 5/2) medium sand 35.6'-36.5' Black (7.5YN 2/0) silt, saturated, Rec = 18"

* ASTM D1586

Well 7-3

Well Construction Summary

Location or Coords: Waterfront

Elevation: Ground Level

Top of Casing 164.15'

Drilling Summary:

Total Depth 35'

Borehole Diameter

Driller J. E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log ____ Geophysical Log ____

Casing String(s): C=Casing S=Screen

3'	GS+2'	C1	35	20	S
20	GS+2'	C2			

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 35' - 18' below GS

Cement 6:1 Portland Cement: Bentonite 16' - GS

Other Bentonite Pellets 18' - 16' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/24/86	0800	1/24/86	1000
Roller Bit	"	1015	"	1030
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1030	"	1100
Filter Placement:	"	1220	"	1430
Cementing:	"	1430	"	1530
Development:	3/19/86	0845	3/19/86	1250
Other:				

Well Development:

Pumping not sustained
Pumped approximately 15 gallons per hour.

Comments:

Location

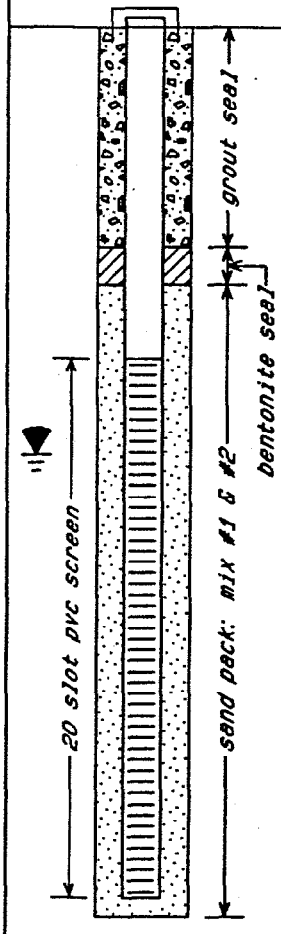
Personnel

Project

WESTON DESIGNERS CONSULTANTS

MONITOR WELL 7-4

Project	N.W.S. Earle/ Colts Neck	Well Number	MW07-4
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	133.90 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	55.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	23.5 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/28/91
Diameter of Well Casing	4 inches	Date Well Completed	2/28/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			2.5, 5.4	91	GM	0.0-2.0 Very pale brown (10Yr7/4), SAND and SILT, very fine grain, damp: 0-1": Dark brown, SILT and SAND loam. 1-22": Dark yellowish brown (10YR7/4) SAND and SILT grading to Very pale brown (10YR7/4), trace Qtz gravel med. grain, subrounded, at 8-10".
2			6.6, 7.6	67	MH	
4			7.9, 9.12	54	SM	
6			14.12, 11.10	50	SS	2.0-4.0 Yellowish brown (10YR5/6), SAND and SILT, damp: 2'0"-2'8": Yellow (10YR7/6), SAND and SILT, v. fine, well sorted. 2'8"-3'4": Yellowish brown (10YR5/6) SAND and SILT, trace mica flakes, decreasing plast. w/ depth, low to v. low.
8			4.3, 3.4	58	MH	
10			2.3, 2.4	54		
12			3.2, 3.4	62		4.0-6.0 Yellowish brown (10YR5/8), SAND and SILT, damp: 4-4'6": Yellowish brown (10YR5/4), SAND & SILT, low plast. grading to 0 at 6". 4'6"-5'1": SAND and SILT, v. fine, 6-10" Brownish yellow (10YR6/8) grades to Yellowish brown (10YR5/8).
14			3.3, 3.6	79		
16			6.8, 10.15	79		
18			6.8, 17.12	46		6.0-8.0 Yellowish brown (10YR5/8) SILT and SAND, v. fine, @1' of Sandstone 6.5'-7.5', med. grain, subrounded, damp.
20			4.8, 9.11	29		
22						8.0-10.0 Light yellowish brown (10YR6/4), SILT and SAND, trace (white Qtz and Orange brown) sand seams throughout, trace mica flakes, damp.
24						10.0-12.0 Pale brown (10YR6/3), SILT and SAND, very fine, low plast., trace mica flakes, damp
26						12.0-14.0 Pinkish gray (7.5YR6/2), SILT and SAND, low plast., trace mica flakes, some Fe stains throughout, wet.
28						
30						

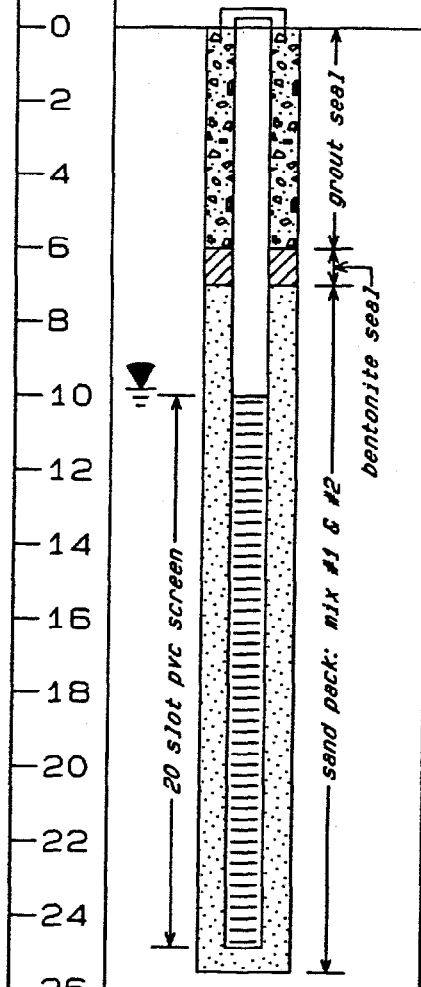
MONITOR WELL 7-4

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW07-4

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						14.0-16.0 Brown (7.5YR5/2), SILT, some Sand, trace mica flakes, wet.
32						16.0-18.0 Dark brown (7.5YR4/2), SILT, low plast., trace mica flakes, grading to Very dark gray (7.5YR3/0) at 16'8", wet.
34						18.0-20.0 BLACK (7.5YR2/0), SILT, low to med. plast., trace mica flakes more prevalent, slight waxy texture, wet
36						20.0-22.0 Same as above.
38						
40						
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

MONITOR WELL 7-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW07-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	137.23 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	55.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	24.8 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/27/91
Diameter of Well Casing	4 inches	Date Well Completed	2/27/91



DEPTH IN FEET	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL
0–2		3,4 / 6,7	69	SM
2–4		6,7 / 6,5	58	
4–6		6,6 / 5,6	46	SW
6–8		6,5 / 6,6	71	
8–10		4,4 / 4,6	83	
10–12		3,4 / 4,5	92	SP
12–14		4,5 / 7,14	67	SW
14–16		4,6 / 14,17	75	SM
16–18		6,7 / 8,11	83	
18–20		6,7 / 8,13	92	

DESCRIPTION

0.0-2.0
Strong brown (7.5YR5/8), SILT and SAND, damp.
0-.5": SILT and SAND loam..
.5-16.5": SILT and SAND v. fine grain.

2.0-4.0
Reddish yellow (7.5YR6/6), SILT and SAND, v. fine grain, well sorted, grades to include tan Qtz grains becoming 7.5YR6/8. damp.

4.0-6.0
Reddish yellow (7.5YR6/8), SAND, v. fine to fine grain, well sorted, 70% tan, 30% orange/brown, tan grain has increased from previous spoon, damp.

6.0-8.0
Reddish yellow (7.5YR6/6), SAND, v. fine to fine, damp:
6'0"-6'5": 70% tan Qtz, 30% orange/brown, small lense 1/8" thick of pure tan (Qtz) sand.
6'5"-7'5": Strong brown (7.5YR5/6), 80% orange brown grain, 20% tan.

8.0-10.0
Light brown (7.5YR6/4), SAND, v. fine to fine, damp:
8.0-9.0': Pale brown (10YR6/3), SAND, v.f. to fine, .5mm seam reddish Yellow (7.5YR6/8) SAND, v. fine.
9.0-9.7': Light brown (7.5YR6/4), SAND 85% sand grains 10YR6/3 15% sand grains 7.5YR6/6

10.0-12.0
Strong brown (7.5YR5/6), SAND, very fine to fine, wet:
10.3-10.7': Pinkish gray (7.5YR6/2), SAND increasing Fe staining w/depth
10.7-11.8': Brown (7.5YR5/2), SAND, strong Fe staining giving 7.5YR5/6 overall, trace Qtz Gravel, fine, subangular.

MONITOR WELL 7-5

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW07-5

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						12.0-14.0 Pinkish gray (7.5YR6/2), SAND, v.f. to fine, wet 12.0-13.1': SAND, v.f., some Fe staining 13.1-13.3': 80% SAND, v.f., 7.5YR2/2 Very dark brown to Black 20% SAND, v.f., 7.5YR6/2 Pinkish gray, little to no Fe staining.
32						
34						
36						14.0-16.0 Very dark gray to Black (7.5YR3/0), SILT v. fine, trace mica flakes
38						
40						16.0-18.0 Same as above.
42						18.0-20.0 Same as above. More prominent mica flakes although still trace (<10%).
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

WESTON
DESIGNERS CONSULTANTS

US NAVY
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DRILLING LOG

WELL NUMBER: 10-4-E
OWNER: WPNSTA-EARLE
LOCATION: Scrap Metal landfill
ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH: 27.5'
SURFACE ELEVATION: 113.99'
WATER LEVEL: 15'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: Auger
DATE DRILLED: 1/13/86
DRILLER: WL
HELPER: RE
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Brownish yellow (10YR 6/6) to pale brown (10YR 6/3) fine to medium sand becoming greenish gray then pale brown
5		43	SS	6 5 3 7	5'-6' Pale brown (10YR 6/3) becoming brownish yellow (10YR 6/6) medium sand with 10% fine sand.
					6'-6.25' Very dark grayish brown medium sand, Some (15%) silt, moist, Rec = 15"
10		44	SS	2 3 3 5	10'-10.25' Brownish yellow (10YR 6/8) fine to medium Sand (15% fine)
					10.25'-10.5' Brownish yellow (10YR 6/8) with olive (5Y 4/3) fine to medium sand
15		45	SS	3 4 7 10	10.5'-11.5' Olive (5Y 4/3) fine to medium sand, some (20%) silt, moist, Rec = 18"
					15'-15.5' Brownish yellow (10YR 6/8) and olive (5Y 4/3) fine to medium sand (20% fine).
					15.5'-17' Glauconitic medium sand, (bluish) Saturated, Rec = 20"

* A.S.T.M. D1586

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 10-1 OWNER: WPNSTA - EARLE

LOCATION: Scrap metal Land fill ADDRESS: COLTS NECK NEW JERSEY

TOTAL DEPTH: 27.5'

SURFACE ELEVATION: 113.99' WATER LEVEL: 15'

DRILLING COMPANY: JE Fritts DRILLING METHOD: Auger DATE DRILLED: 1/13/86

DRILLER: WL HELPER: RJ

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		46	SS	WOR 6 9 16	20'-22' Glauconitic medium sand, 10% coarse, 15% fine, saturated, Rec=20"
25		47		4 7 14 20	25'-27' Glauconitic medium sand, 20% fine sand, 10% coarse sand, saturated, Rec.=24"

* A.S.T.M. D1586

Well 10-1

Well Construction Summary

Location or Coords: Scrap Metal Landfill

Elevation: Ground Level

Top of Casing 113.99'

Drilling Summary:

Total Depth 27.5'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' - GS+2'	C1		27.5' - 12.5'	S	
12.5' - GS+2'	C2				

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 27.5' - 10.5' below GS

Cement 6:1 Portland Cement : bentonite 9' - GS

Other Bentonite Pellets 10.5' - 9' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/13/86	1215	1/13/86	1350
Roller Bit	"	1350	"	1415
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1415	"	1445
Filter Placement:	"	1445	"	1700
Cementing:	1/14/86	0830	1/14/86	0930
Development:	3/14/86	1115	3/14/86	1330
Other:				

Well Development:

Pumping sustained at 0.75 gpm. Pumped until free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

DRILLING LOG

WELL NUMBER: 10-2
OWNER: WPNSTA Earle
LOCATION: Scrap Metal Landfill
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 22'
SURFACE ELEVATION: 111.35'
WATER LEVEL: 12'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/15/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-4' Brown (10YR 5/3) and olive (5Y 4/4) medium sand, some fine sand.
5		53	S_S	3 3 4 5	4-4.25' Brown (10YR 5/3) fine to medium sand, some silt.
					4.25'-5.25' Olive (5Y 4/4) fine to medium sand, moist, Rec. = 15".
10		54	S_S	2 2 2 5	9'-11' Brownish yellow (10YR 6/8) and olive (5Y 4/4) fine to medium sand (10% fine) and 5% coarse sand, some silt, wet.
15		55	S_S	2 3 4 7	14'-16' Brownish yellow (10YR 6/8) with olive (5Y 4/4) fine to medium sand (20% fine), saturated, Rec = 15".
20					

* A.S.T.M. D1586

US NAVY
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WESTON

DRILLING LOG FILE

WELL NUMBER: 10-2
OWNER: WPNSTA Earle
LOCATION: Scrap Metal Landfill
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 22'
SURFACE ELEVATION: 11.35'
WATER LEVEL: 12'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/15/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		56	SS	16 12 17 26	19'-20' Brownish yellow (10YR 6/8) with olive fine to medium sand (20% fine), saturated.
					20'-21' Glauconite (bluish) medium sand, some fine sand, saturated, Rec.=24"
25					

* A.S.T.M. D1586

SHEET 2 OF 2

Well 10-2

Well Construction Summary

Location or Coords: Scrap Metal Landfill

Elevation: Ground Level

Top of Casing 111.35'

Drilling Summary:

Total Depth 22'

Borehole Diameter

Driller J. E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	-	GS+2'	C1	22'	- 7'	S
7'	-	GS+2'	C2		-	

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottowa Sand 22' - 5' below GS

Cement 6:1 Portland cement: bentonite 4' - GS

Other Bentonite pellets 5' - 4" below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/15/86	0915	1/15/86	1100
Roller Bit	"	1100	"	1130
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1130	"	1200
Filter Placement:	"	1300	"	1415
Cementing:	"	1450	"	1500
Development:	3/14/86	1000	3/14/86	1040
Other:				

Well Development:

Pumped at sustained rate of 4 gpm until discharge free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

NAVY
FILE

WESTON

DRILLING LOG

WELL NUMBER: 10-3
OWNER: WPNSTA Earle
LOCATION: Scrap Metal Landfill
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 25'
SURFACE ELEVATION: 110.90'
WATER LEVEL: 15
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/14/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-2' Brown (10YR5/3) fine to medium sand.
					2'-5' Dark olive brown glauconitic sand
5		48	SS	3 3 4 4	5'-7' Glauconitic, olive (5Y5/3) medium sand - 5% coarse, 10% fine sand, wet, not saturated, Rec = 18".
10		49	SS	6 8 8 11	10'-12' Brownish yellow (10YR6/8) and olive (5Y5/3) medium sand 5% coarse, 10% fine, some silt, wet, Rec = 18".
15		50	SS	4 5 9 15	15'-16.25' Brownish yellow (10YR6/8) and olive (5Y5/3) medium sand, 5% coarse, 10% fine, some silt.
					16.25-16.75' Glauconitic (blvish) medium sand, clean, saturated, Rec = 20".
20					

* A.S.T.M. D1586

WESTON

DRILLING LOG

WELL NUMBER: 10-3
OWNER: WPNSTA Earle
LOCATION: Scrap Metal landfill
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 25'
SURFACE ELEVATION: 110.90'
WATER LEVEL: 15'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/14/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		51	Ss	7 12 17 25	20'-22' Glauconitic medium sand, saturated, Rec = 18".
25		52	Ss	5 9 17 23	25'-27' Glauconitic medium sand, saturated, Rec = 18".

* A.S.T.M. D1586

SHEET 2 OF 2

Well 10-3

Well Construction Summary

Location or Coords: Scrap Metal Landfill

Elevation: Ground Level

Top of Casing 110.90'

Drilling Summary:

Total Depth 25'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' - GS+2'	C1		25' - 10'	S	
10' - GS+2'	C2				

Casing: C1 6" steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 25'-7' below GS

Cement 6:1 Portland cement: bentonite 6'-GS

Other Bentonite Pellets 7'-6' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/14/86	1020	1/14/86	1125
Roller Bit	"	1125	"	1200
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1340	"	1400
Filter Placement:	"	1400	"	1520
Cementing:	"	1600	"	1630
Development:	3/14/86	0920	3/14/86	0950
Other:				

Well Development:

Pumped at average rate of 7 gpm until discharge free of fines.

Comments:

Location

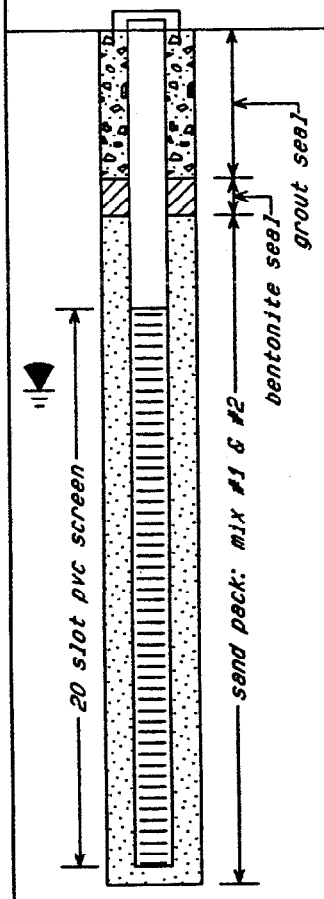
Personnel

Project

WESTON DESIGNERS CONSULTANTS

MONITOR WELL 10-4

Project	N.W.S. Earle/ Colts Neck	Well Number	MW10-4
Location	Colts Neck, N.J.	Coordinates	
Geologist	N. Palczuk	Top of Casing Elevation	114.13 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	G. Myers	Total Borehole Depth	55.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	22.5 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/17/91
Diameter of Well Casing	4 inches	Date Well Completed	1/17/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			2,5 / 4,4	75	SW	0.0-2.0 0-.5': SILT and SAND loam. .5-1.5': Olive yellow (2.5Y6/6), SAND, f-m, trace Silt, non plastic, damp.
2			2,3 / 4,4	85		2.0-4.0 Olive yellow (2.5Y6/6), SAND, med., some coarse, grades to orange, f-m, SAND, @ 3', damp. HNU = BKG
4			5,8 / 8,5	65		4.0-6.0 Olive (5Y5/4), SAND, med. grain, some (15%) fine, trace Silt, compact, reddish (Fe) staining @5', slight plast., damp. HNU = BKG
6			4,4 / 7,7	100		6.0-8.0 Brownish yellow (10YR6/8), SAND, med. to coarse, some fine, wet.
8			3,3 / 6,6	65		8.0-10.0 Olive (5Y4/4), SAND, med., some coarse, stringers of orangish sand (10YR5/8), green Glauconitic coloring throughout, wet.
10			2,3 / 4,4	80		10.0-12.0 Olive (5Y5/3), SAND, coarse, some fine, trace (5%) Silt, poss. 1st real H2O, very wet.
12			5,7 / 7,9	100		12.0-14.0 12-13': Tan-black, SAND, coarse, wet. 13-13.5: Yellowish brown (10YR5/8), SAND, crse to med. 13.5-14': Dark greenish gray (5BG4/1), SAND, coarse, some med. gr. (15%), slightly plast., Glauconitic, wet. HNU = BKD
14			3,8 / 8,15	100		14.0-16.0 Same as above, with trace Orange sand, 15.5-16': Dark blue gray (5B4/1), SAND, med., some (30%) coarse sand, trace Silt, non-plastic, wet. HNU = BKD
16			5,6 / 8,9	100		
18			4,8 / 9,11	100		
20			6,6 / 8,12	100		
22						
24						
26						
28						
30						

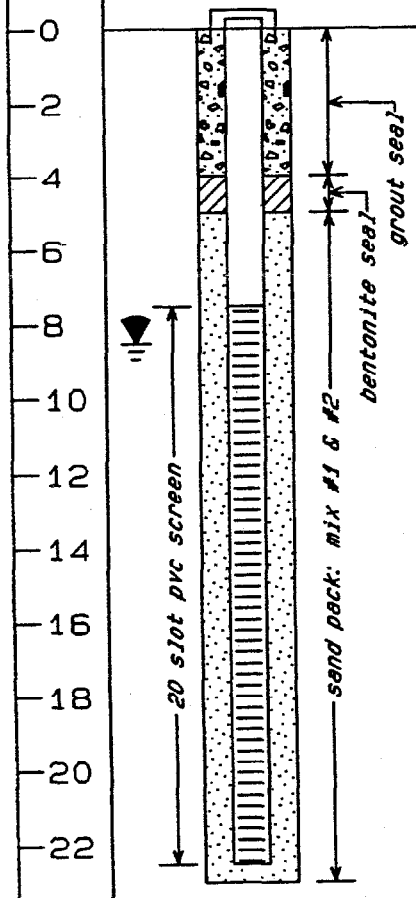
MONITOR WELL 10-4

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW10-4

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						16.0-18.0 Same as above, crse sand 40%, wet.
32						18.0-20.0 Same as above, wet.
34						20.0-22.0 Same as above, wet. HNU = BKD
36						
38						
40						
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

MONITOR WELL 10-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW10-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	N. Palczuk	Top of Casing Elevation	112.44 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	G. Myers	Total Borehole Depth	22.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	21.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/17/91
Diameter of Well Casing	4 inches	Date Well Completed	1/18/91



DESCRIPTION

0.0-2.0
0-.5': fill, soil.
0.5-1.0': Very pale brown (10YR7/3), SAND med. some fine, non-plastic, damp.

2.0-4.0
0-2.9': Light gray (2.5Y7/0), SAND, med. little coarse, little fine, v.low plast., damp

4.0-6.0
Same as above, moist.

6.0-8.0
6.3-7.1': Light gray (2.5Y7/0), SAND, coarse, and GRAVEL, fine, damp.
7.1-7.7: Very dark gray (5YR3/1), SILT, little silt size organics, trace fine Sand.

8.0-10.0
8-9': Same as above w/ higher plast., little (15%) coarse Sand, moist.
9-9.5: Very dark gray (2.5Y3/0), SAND, med. - some fine, trace Silt, trace mica flakes, moist.

10.0-12.0
10-10.5': Same as above, wet.
10.5-11.5': Grayish green (5G4/2), SAND, med.- little fine, trace coarse, Glauconitic, wet.

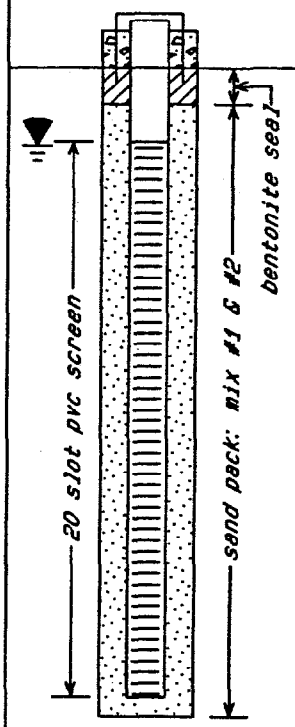
12.0-14.0
Same as above, wet.

14.0-16.0
Same as above, wet, (heave sample?)

16.0-18.0
Same as above, wet, (heave sample?)

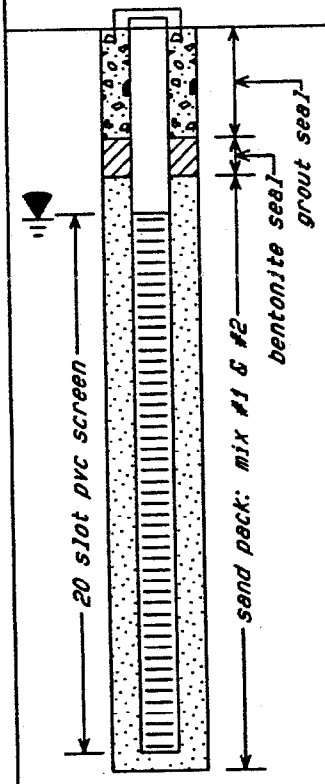
MONITOR WELL 10-6

Project	N.W.S. Earle/ Colts Neck	Well Number	MW10-6
Location	Colts Neck, N.J.	Coordinates	
Geologist	J. Williams/J. Jewell	Top of Casing Elevation	109.11 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	17.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	17.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/15/91
Diameter of Well Casing	4 inches	Date Well Completed	2/19/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0						
			1,0 / 0,1	0		0.0-2.0 No recovery.
2			4,3 / 5,8	54	SM	2.0-4.0 Dark reddish brown (5YR3/2), SAND and SILT, v. fine - fine, wet.
4			5,6 / 8,7	54		4.0-6.0 0-4": Dark reddish brown (5YR3/2), SAND and SILT, v. fine-fine. 4-6": Dark gray (5Y4/1), SAND and SILT, slight Glaucconitic tint increasing w/ depth.
6			4,4 / 4,6	75		
8			4,5 / 4,7	71		6-13": Grayish green (5G5/2), SAND and SILT, v. fine to med., strong Glauconitic tint increasing w/ depth, wet.
10						
12						6.0-8.0 Dark greenish gray (5GY4/1), SAND, f-m, some (20%) Silt, Glauconitic, loose, wet.
14			10,14 / 16,12	69	SM	8.0-10.0 Same as above, 10% silt, trace coarse sand, wet.
16						
18						* Discontinue constant split spoon sampling due to sands running up auger.
20						14.0-16.0 Same as above, coarse sand, some silt, wet.
22						
24						
26						
28						
30						

MONITOR WELL 10-7

Project	N.W.S. Earle/ Colts Neck	Well Number	MW10-7
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	107.44 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	20.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	19.5 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/16/91
Diameter of Well Casing	4 inches	Date Well Completed	1/18/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			1,2 / 3,1	67	SM	0.0-2.0 Grayish brown (10YR5/2), SILT, loam, to SILT, v. low plast. at 8". wet.
2			2,7 / 5,7	75	GM	2.0-4.0 Dark gray (10YR4/1), SAND, fine to crse., some Qtz Gravel, grading to SAND, some Silt at 2'4". 2'4" to 3'6" Brown, SAND, well sorted, wet.
4			7,8 / 12,15	79	SM	4.0-6.0 Dark gray (10YR4/1), SAND and SILT, v.f. grain, low cohesion, wet. HNU = BKGD (auger)
6			8,19 / 20,19	50		
8			9,14 / 16,20	67		6.0-8.0 Dark gray (10YR4/1), SAND and SILT, as above, fine grain, wet. HNU = BKGD (auger, spoon)
10						
12						8.0-10.0 Dark greenish gray (5BG4/1), SAND, fine to med., well sorted, highly Glauconitic, wet.
14						
16					SM	* Discontinue constant split spoon sampling due to sands running up auger. Further spooning at 5' auger intervals.
18						
20						15.0-17.0 Same as above. Sand has come too far up auger to get representative sample.
22						
24						
26						
28						
30						

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 11-1
OWNER: WPNSTA - EARLE
LOCATION: Contract Ordnance Disposal Area
ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH: 19'
SURFACE ELEVATION: 99.07'
WATER LEVEL: 4'
DRILLING COMPANY: Fritts
DRILLING METHOD: Auger
DATE DRILLED: 12/18/85
DRILLER: WL
HELPER: JB
LOG BY: AEB

SKETCH MAP

NOTES: 140 LB. Hammer used for Blow Counts
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					
5		5	SS	3 6 6 8	4'-6' Yellowish brown (10YR5/8) fine to medium sand (20% fine), saturated. Rec. = 12".
					Water coming out of hole while drilling
10		6	SS	2 4 6 8	9'-11' Yellowish brown (10YR5/8) fine to medium sand (10% fine) with olive gray (5Y5/2) staining, trace very coarse sand (5%), saturated.
15		7	SS	4 5 8 8	14'-16' Yellowish brown (10YR5/8) fine to medium sand (10% fine) with olive gray (5Y5/2) very coarse sand mottles, saturated.
20		8	SS	3 4	19'-21' Yellowish brown (10YR5/8) fine to

* A.S.T.M. D1586

WESTON DESIGNERS CONSULTANTS

DRILLING LOG

WELL NUMBER: 11-1 OWNER: WPNSTA-EARLE
LOCATION: Contract Ordnance Disposal Area ADDRESS: COLTS NECK NEW JERSEY
TOTAL DEPTH 19'
SURFACE ELEVATION: 99.07' WATER LEVEL: 4'
DRILLING COMPANY: Fritts DRILLING METHOD: Auger DATE DRILLED: 12/18/85
DRILLER: WL HELPER: JB
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20				7 12	medium sand (20% fine) with strong brown (7.5YR 4/6) mottles, subangular grains, saturated.

* A.S.T.M. D1586

SHEET 2 OF 2

Well 11-1

Well Construction Summary

Location or Coords: Contract Ordnance Disposal Area

Elevation: Ground Level

Top of Casing 99.07'

Drilling Summary:

Total Depth 19'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-80

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	-	GS+2'	C1	19'	-	4'	S
4'	-	GS+2'	C2		-		

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 19' - 3.5' below GS

Cement 6:1 Portland cement: bentonite 3' - GS

Other Bentonite Pellets 3.5' - 3' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	12/18 1985	1300	12/18 1985	1430
Roller Bit	"	1430	"	1530
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1530	"	1600
Filter Placement:	"	1600	"	1800
Cementing:	12/19 1985	1300	12/19 1985	1330
Development:	3/19/86	1505	3/19/86	1615
Other:				

Well Development:

Pumping sustained at 15 gpm. Pumped until discharge free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON DESIGNERS CONSULTANTS

US NAVY

DRILLING LOG 1771-02-10

WELL NUMBER: 11-FALF
OWNER: WPNSTA Earle
LOCATION: WPNSTA-EARLE Contract Ordnance Disposal Area
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 18'
SURFACE ELEVATION: 100.97'
WATER LEVEL: 3'

DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: Auger
DATE DRILLED: 12/19/85
DRILLER: WL
HELPER: JB

LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					
					1'-3' Black (2.5YN2/0) organic and white (10YR8/1) medium sand.
					3'-4' Green glauconitic coarse sand.
5		9	S S	2 2 2 2	4'-6' Very green glauconitic medium sand, trace fine sand (<5%), saturated, Rec. = 12"
10		10	S S	3 3 7 8	9'-10' Green glauconitic medium sand, layer of strong brown (7.5YR5/6) fine and medium sand at 10'.
					10'-11' Yellowish brown (10YR5/8) fine and medium sand, saturated, Rec. = 18"
15		11	S S	0 3 7 7	14'-16' Yellowish brown (10YR5/8) medium sand (<5% fine sand) with strong brown (7.5YR5/6) and glauconite mottles, saturated.
20		12	S S	3 5	19'-21' Yellowish brown (10YR5/8) medium

* A.S.T.M. D1586

US NAVY

WESTON

DRILLING LOG 1771-02-10

FILE

WELL NUMBER: 11 OWNER: WPNSTA Earle

LOCATION: WPNSTA - EARLE Contract Ordnance Disposal Area

ADDRESS: Colts Neck, New Jersey

TOTAL DEPTH: 18'

SURFACE ELEVATION: 100.97'

WATER LEVEL: 3'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: Auger

DATE DRILLED: 12/19/85

DRILLER: WL

HELPER: JB

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20				7 9	and fine sand (10% fine sand). At 20' - band of glauconite sand. Strong brown (7.5YR 5/6) mottles at bottom of spoon, saturated.

* A.S.T.M. D1586

Well 11-2

Well Construction Summary

Location or Coords: Contract Ordnance Disposal Area

Elevation: Ground Level

Top of Casing 100.97'

Drilling Summary:

Total Depth 18'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-80

Bit(s) Hollowstem Auger; Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	12/18 1985	1350	12/18 1985	1500
Roller Bit	"	1500	"	1530
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1530	"	1545
Filter Placement:	"	1545	"	1645
Cementing:	"	1645	"	1700
Development:	3/19/86	1605	3/19/86	1730
Other:				

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

2' -	GSt3'	C1	18' -	3'	S
3' -	GSt3'	C2	-		

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC SLOT 10

S2

Centralizers

Filter Material No. 2 Ottawa Sand 18'-2.5' below GS

Cement 6:1 Portland cement: bentonite 2' - GS

Other Bentonite pellets 2.5'-2' below GS

Well Development:

Pumping sustained at 15 gpm. Pumped until discharge free of fines.

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

US NAVY WESTON
1771-02-10
FILE

DRILLING LOG

WELL NUMBER: 11-3
OWNER: WPNSTA Earle
LOCATION: WPNSTA-EARLE Contract Ordnance Disposal Area
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 20'
SURFACE ELEVATION: 98.37'
WATER LEVEL: 9'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: Auger
DATE DRILLED: 12/17/85
DRILLER: WL
HELPER: JB
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					
5		1	SS	6 9 11 16	4'-6' Light olive brown (2.5Y5/4) medium to coarse. Sand, 10% very coarse sand, 15% clay, very moist.
10		2	SS	2 2 4 6	9'-11' Light olive brown (2.5Y5/4) fine to medium sand with strong brown (7.5YR4/6) mottles, Saturated.
15		3	SS	4 6	14'-16' Light olive brown (2.5Y5/4) fine to medium sand (20% fine sand), Subangular grains, Saturated.
20		4	SS	5 7	19'-21' Light olive brown (2.5Y5/4) fine to

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WESTON

US NAVY

DRILLING LOG 1771-02-1J

WELL NUMBER: 11-3FILE OWNER: WPNSTA Earle

LOCATION: WPNSTA-EARLE ADDRESS: Colts Neck

Contract Ordnance New Jersey

Disposal Area TOTAL DEPTH 20'

SURFACE ELEVATION: 98.37' WATER LEVEL: 9'

DRILLING COMPANY: JE Fritts DRILLING METHOD: Auger DATE DRILLED: 12/17/85

DRILLER: WJ HELPER: JB

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20				11 13	medium sand (10% fine sand) with strong brown (7.5YR 4/6) mottles, subangular grains
25				—	24-25 Light olive brown (2.5Y 5/4) fine to medium sand (10% fine sand) saturated, subangular grains.

* A.S.T.M. D1586

SHEET 1 OF 2

Well 11-3

Well Construction Summary

Location or Coords: Contract Ordnance Disposal Area

Elevation: Ground Level

Top of Casing 98.37'

Drilling Summary:

Total Depth 20'

Borehole Diameter

Driller J. E. Fritts

Rig Mobil Drill B-80

Bit(s) Hollowstem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log ✓ Geophysical Log

Casing String(s): C=Casing S=Screen

2'	-	GSt3'	C1	20'	- 5'	S
5'	-	GSt2'	C2		-	

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottowa Sand 20'-3' below GS

Cement 6:1 Portland cement: bentonite 2.5'-GS

Other Bentonite Pellets 3'-2.5' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	12/17 1985	1230	12/17 1985	1345
Roller Bit	"	1345	"	1600
Geophys. Logging:				
Casing:				
Install 4" PVC	12/18 1985	0900	12/18 1985	0930
Filter Placement:	"	0930	"	1100
Cementing:	"	1100	"	1130
Development:	3/19/86	1445	3/19/86	1550
Other:				

Well Development:

Pumping sustained at 5 gpm.

Comments:

Location

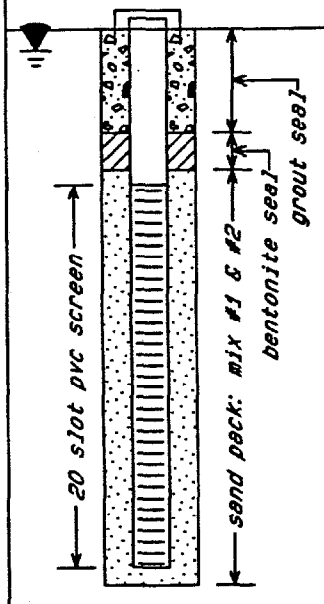
Personnel

Project

WESTON DESIGNERS CONSULTANTS

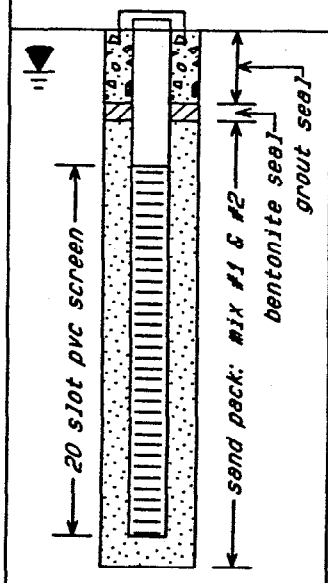
MONITOR WELL 11-4

Project	N.W.S. Earle/ Colts Neck	Well Number	MW11-4
Location	Colts Neck, N.J.	Coordinates	
Geologist	N. Powers	Top of Casing Elevation	92.23 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	15.0 feet
Drilling Method	Hollow stem auger	Total Well Depth	14.5 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/14/91
Diameter of Well Casing	4 inches	Date Well Completed	1/15/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			1,1 / 11,12	70	SM	0.0-2.0 0-.5": Very dark gray (5Y3/1), SILT, little clay, slight plast., moist. .5-6": Gray (5Y6/1), SAND, mottled, some clay, nonb plast., trace fine Gravel, moist. HNU = BKGD (sample jar)
2			12,14 / 28,28	80		
4			3,9 / 12,11	50		2.0-4.0 Reddish brown (7.5YR6/8), SAND, fine, mottled brown & gray, some clay, sl. plast., grading to greenish gray SAND, f-c, little rounded fine Gravel, wet. (off color chart)
6			3,5 / 8,16	75		
8			2,3 / 3,10	90		4.0-6.0 Reddish brown (7.5YR6/8), SAND, fine-med., trace Silt, slightly dense, non-plastic, wet. HNU = BKGD (auger head space)
10			- - / - -	100		
12			6,8 / 10,11	83		6.0-8.0 Brownish yellow (10YR6/8), SAND, f-m, loose, trace Silt, wet.
14						8.0-10.0 Same as above, saturated.
16						10.0-12.0 Same as above w/ little Silt, loose, wet.
18						12.0-14.0 Same as above, wet.
20						
22						
24						
26						
28						
30						

MONITOR WELL 11-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW11-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	90.72 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	G. Myers	Total Borehole Depth	14.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	13.7 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/14/91
Diameter of Well Casing	4 inches	Date Well Completed	1/15/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0						
2			1,3 / 2,7	50	SM	0.0-2.0 Black (7.5YR2.0), SILT, some clay stringers, low plast., moist. HNU = .2 ABKD
4			11,11 / 13,26	71		2.0-4.0 Olive yellow (5Y6/8), SILT & SAND, fine little Qtz gravel, silt and sand alternates, green Glauconitic coloring, wet.
6			9,9 / 10,11	71		
8			5,4 / 6,6	83		4.0-6.0 Olive yellow (5Y6/8), SAND and SILT, fine to v.f., no Qtz gravel, wet.
10			3,4 / 6,10	100		
12						6.0-8.0 Brownish yellow (10YR6/8), SAND, fine, loose, grades to Very pale brown (10YR7/4) at 7'3", wet.
14						8.0-10.0 Same as above. Loose running sands.
16						* Discontinue spooning due to running sands.
18						
20						
22						
24						
26						
28						
30						

WESTON

US NAVY

DRILLING LOG 1771-02-10

WELL NUMBER: F94E
OWNER: WPNSTA Earle
LOCATION: Paint Chip and Sludge Disposal Area adjacent to Bldg. S-34
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 25'
SURFACE ELEVATION: 127.75'
WATER LEVEL: 12'

DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/16/86
DRILLER: WL
HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Brown (10YR 5/3) becoming dark brown (10YR 3/3) silty sand.
5		62	SS	5 3 5 6	4'-5' Dark brown (10YR 3/3) silt. 5'-6' Light yellowish brown (10YR 6/4) sandy silt with some clay, damp.
10		63	SS	2 3 5 7	9'-9.3' Light yellowish brown (10YR 6/4) sandy silt with some clay. 9.3'-10' Brownish yellow (10YR 5/8) with olive (5Y 4/4) fine to medium sand, trace coarse, very clean, moist, Rec. = 12".
15		64	SS	2 4 5 8	14'-15' Dark brown (7.5YR 4/4) fine to medium sand, trace coarse sand, some silt, very wet, Rec = 12"
20					

* A.S.T.M. D1586

US NAVY WESTON

1771-

FILE

DRILLING LOG

WELL NUMBER: 19-1

OWNER: WPNSTA Earle

LOCATION: Paint Chip and Sludge Disposal Area

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 25'

SURFACE ELEVATION: 127.75

WATER LEVEL:

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: HSA

DATE DRILLED: 1/16/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		65	SS	1 8 12 14	19'-21' Glauconitic (bluish) fine to medium sand, saturated, Rec=20".
25		66		5 8 14 18	24'-25' Glauconitic fine to medium sand. 25'-25.5' Brownish yellow (10YR 5/4) clay and silt. 25.5'-26' Glauconitic sand (fine to medium) saturated. Rec=24".

* A.S.T.M. D1586

Well 19-1

Well Construction Summary

Location or Coords: Paint Chip and Sludge Disposal Area

Elevation: Ground Level

Top of Casing 127.75'

Drilling Summary:

Total Depth 25'

Borehole Diameter

Driller J. E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' -	GS+2'	C1	25' -	10'	S
10' -	GS+2'	C2			

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottowa Sand 25' - 8' below GS

Cement 6:1 Portland cement: bentonite 6' - GS

Other Bentonite Pellets 8' - 6' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/16/86	1330	1/16/86	1450
Roller Bit	"	1450	"	1510
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1510	"	1530
Filter Placement:	"	1530	"	1645
Cementing:	1/20/86	1600	1/20/86	1615
Development:	3/18/86	1520	3/18/86	1615
Other:				

Well Development:

Pumped at average rate of 5gpm

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

US NAVY WESTON
1771-02-10
FILE

DRILLING LOG

WELL NUMBER: 19-2
OWNER: WPNSTA Earle
LOCATION: Paint Chip and Sludge Disposal Area adjacent to Building S-34
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 25'
SURFACE ELEVATION: 128.51'
WATER LEVEL: 12'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/17/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-3' Dark brown (10YR 3/3) sandy silt.
					3'-5' Light yellowish brown (10YR 5/4) sandy silt.
5		67	Ss	2 1 2 3	5'-5.75' Light yellowish brown (10YR 6/4) and light gray (10YR 7/1) silty sand becoming medium to coarse sand at 5.75'; damp, Rec = 9".
10		68	Ss	2 2 3 5	10'-10.7' Light yellowish brown (10YR 6/4) silty sand.
					10.7'- Olive (5Y 4/4) fine to medium sand damp, Rec = 8".
15		69	Ss	2 3 6 9	15'-15.75' Olive (5Y 4/4) and strong brown (7.5YR 4/6) fine to medium sand, very wet, Rec. = 9".
20					

* A.S.T.M. D1586

WESTON

US NAVY

DRILLING LOG

WELL NUMBER: 19-2
OWNER: WPNSTA Earle
LOCATION: Paint Chip and Sludge Disposal
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 25'
SURFACE ELEVATION: 120.51'
WATER LEVEL: 12'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/17/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		70	Ss	2 4 3 12	20'-21.25' Glauconitic (blvegreen) fine to medium sand, saturated, Rec=15".
25		71	Ss	6 9 14 24	25'-26.5' Glauconitic fine to medium sand 26.5'-26.75' Yellowish brown silty clay. 26.75-27' Glauconitic fine to medium sand.

* A.S.T.M. D1586

SHEET 2 OF 2

Well 19-2

Well Construction Summary

Location or Coords: Paint Chip and Sludge Disposal Area

Elevation: Ground Level

Top of Casing 120.51'

Drilling Summary:

Total Depth 24'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s)

Drilling Fluid

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	GS+2'	C1	24'	9'	S
9'	GS+2'	C2			

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material #2 Ottawa Sand 24'-7' below GS

Cement 6:1 Portland cement: bentonite 5'-GS

Other Bentonite Pellets 7'-5' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/20/86	0900	1/20/86	1005
Roller Bit	"	1005	"	1045
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1045	"	1115
Filter Placement:	"	1305	"	1410
Cementing:	"	1440	"	1515
Development:	3/18/86	1345	3/18/86	1500
Other:				

Well Development:

Pumped at average rate of 9 gpm

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

US NAVY

DRILLING LOG 1771-02-10

WELL NUMBER: 19-BLE
OWNER: WPNSTA Earle
LOCATION: Paint Chip and Sludge Disposal Area adjacent to Bldg. 5-34
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 24'
SURFACE ELEVATION: 122.47'
WATER LEVEL: 14'
DRILLING COMPANY: J.E. Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/16/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-3' Dark brown (10YR 3/3) fine sand and silt, damp.
					3'-5' Yellowish brown (10YR 5/4) sandy clay, very pliable, damp.
5		57	SS	4 4 5 9	4'-4.25' Dark brown (10YR 3/3) fine sand and silt (50%).
					4.25'-5.25' Yellowish brown (10YR 5/4) sandy clay to silty sand, wet, Rec. = 15".
10		58		2 2 3 6	9'-9.25' Yellowish brown (10YR 5/4) silty sand
					9.25'-10.25' Brownish yellow (10YR 6/8) and olive (5Y 4/4) fine to medium sand, trace coarse sand, some silt (5-10%) very wet, Rec. = 15".
15		59		5 10 17 22	14'-16' Glauconitic (bluish) fine to medium sand, saturated, Rec. = 12".
20					

* A.S.T.M. D1586

WESTON

US NAVY

1771-02-10

FILE

DRILLING LOG

WELL NUMBER: 19-3

OWNER: WPNSTA Earle

LOCATION: Paint Chip and Sludge Disposal Area

ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 24'

SURFACE ELEVATION: 122.47'

WATER LEVEL: 14'

DRILLING COMPANY: J.E. Fritts

DRILLING METHOD: HSA

DATE DRILLED: 1/16/86

DRILLER: WL

HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		60	Ss	3 4 14 21	19'-21' Glauconitic (bluish) fine to medium sand, saturated, Rec=12".
25		61	Ss	8 15 20 26	24'-25' Glauconitic fine to medium sand. 25'-25.3' Yellowish brown (10YR5/4) clay and silt. 25.3'-26' Glauconitic fine to medium sand, saturated, Rec=24".

* A.S.T.M. D1586

Well 19-3

Well Construction Summary

Location or Coords: Paint Chip and Sludge Disposal Area

Elevation: Ground Level _____

Top of Casing 122.47'

Drilling Summary:

Total Depth 24'

Borehole Diameter _____

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log _____

Casing String(s): C=Casing S=Screen

3' - GS+2'	C1		24' - 9'	S	
9' - GS+2'	C2				

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2 _____

Centralizers _____

Filter Material #2 Ottowa Sand 24' - 7' below GS

Cement 6:1 Portland cement: bentonite 5' - GS

Other Bentonite pellets 7' - 5' below GS

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/16/86	0900	1/16/86	1025
Roller Bit	"	1025	"	1045
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1045	"	1100
Filter Placement:	"	1100	"	1200
Cementing:	1/20/86	1530	1/20/86	1600
Development:	3/18/86	1405	3/18/86	1550
Other:				

Well Development:

Sustained pumping rate of 15 gpm

Comments:

Location _____

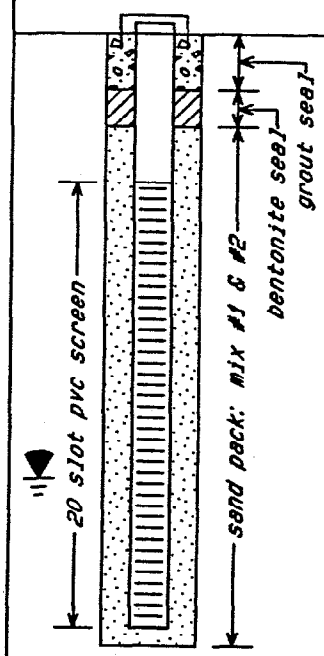
Personnel _____

Project _____

WESTON DESIGNERS CONSULTANTS

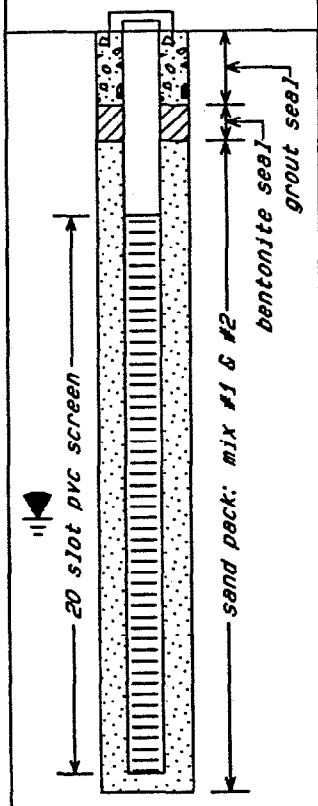
MONITOR WELL 19-4

Project	N.W.S. Earle/ Colts Neck	Well Number	MW19-4
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	114.57 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	16.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	16.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/14/91
Diameter of Well Casing	4 inches	Date Well Completed	1/15/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			1, 2	29	SM	0-2 Olive, SAND and SILT (loam), fine gr. sand, organic odor (septic), damp. HNU = 0 BKG Hand Aerosal Monitor = +.050
2			7, 8	65		
			12, 28			
4			4, 14	79		2.0-4.0 Olive gray, SAND and SILT, more cohesive, animal hair (from deer carcass.) HNU=4.0 ABKG (head space of jar)
6			16, 40		SW	
			5, 6	100	OH	
8			12, 18		ML	4.0-6.0 Black, SILT and SAND, grading to Very pale brown (10YR7/3), CLAY, mottled, med. plast., grading to White (10YR8/1), damp. HNU = 1.5 ABKG (spoon)
			4, 4	75	OL	
10			2, 4			
			4, 5	63		
12			8, 12			6.0-8.0 Light gray (10YR7/2), SILT, high plast., grasding to SAND, v. fine, Fe staining throughout, very cohesive, wet. HNU = 1.5 ABKG (head space of jar)
14						
16					OH	8.0-10.0 Light gray (10YR7/2), SILT, low plast., color varies between 10YR8/3 to 10YR8/1 Fe staining at @ 8'5", wet.
18						
20						10.0-12.0 Dark gray (5Y4/1), SILT, v. low plast., little Fe staining, wet. * Discontinue split spoon sampling due to sand running up auger. Cuttings sampled here on.
22						
24						
26						12.0-14.0 Pale olive (5Y6/3), SILT, low plast., wet. * Drilled @1ft into clay layer of high plast.. Discontinue drilling at 17'.
28						
30						

MONITOR WELL 19-5

Project	N.W.S. Earle/ Colts Neck	Well Number	MW19-5
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	115.16 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	55.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	20.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/16/91
Diameter of Well Casing	4 inches	Date Well Completed	1/16/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0						
2			7,17 / 20,20	54	SM	0-2 Dark yellowish brown (10YR3/6), organic top soil, grading to Very dark gray (10YR3/1), SILT and SAND, at 6", fine gr.,
4			3,8 / 18,28	88	SP	2.0-4.0 Yellowish brown (10YR5/4) grading to Dark grayish brown (10YR4/2) at 7", SILT and SAND, little Qtz gravel, subrounded, med. grain, damp. HNU = BKG
6			11,22 / 28,28	92	SM	
8			6,9 / 4,8	67		4.0-6.0 Light brownish gray (10YR6/2), SILT and SAND, well sorted, damp. HNU = BKG (head space of jar)
10			6,6 / 7,8	63		
12			3,3 / 11,12	88	ML	6.0-8.0 Yellow (10YR7/6), SILT grading to v. fine SAND at 10", some clay lenses, trace gravel, damp.
14			3,4 / 5,7	67		
16			1,1 / 3,4	58	GM / ML	8.0-10.0 Very pale brown (10YR7/3), SILT, some clay lenses, wet.
18						
20			1,2 / 4,5	58	CL	10.0-12.0 Vary pale brown (10YR7/3), SILT, low plast., trace Fe staining but constant, wet.
22						12.0-14.0 Same as above, more Fe staining, wet
24						* Discontinue sampling except at 5' intervals due to sands running up auger.
26						
28						
30						

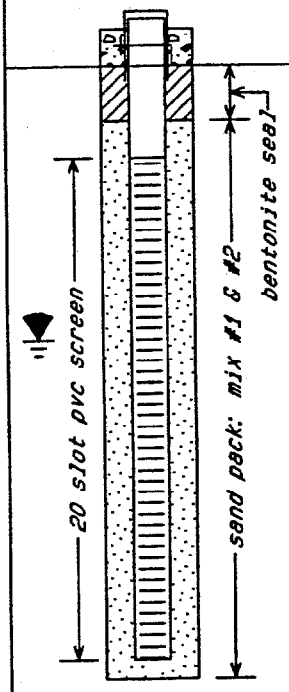
MONITOR WELL 19-5

PROJECT N.W.S. Earle/ Colts Neck WELL NUMBER MW19-5

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
30						16-18 Same as above. some gravel at 0-6"
32						20.0-22.0 Same as above. At 4" grades to SAND, Blue green, med. plasticity, med. grain wet.
34						
36						
38						
40						
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

MONITOR WELL 19-6

Project	N.W.S. Earle/ Colts Neck	Well Number	MW19-6
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	110.26 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	16.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	16.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	2/14/91
Diameter of Well Casing	4 inches	Date Well Completed	2/15/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			3,4 / 5,6	71	ML	0-6.0' Sand and Silt, v. fine grain, (2.5Y7/6 becoming 2.5Y7/4 at 4'), slightly clayey (very low plasticity). HNU=BKG
2			5,6 / 7,7	50		
4			8,7 / 6,5	58		
6			6,3 / 5,6	54	SM	6-8' Silt and Sand, fine grain, (5G5/1), glauconitic coloring increases to a band at @ 7' then decreases, slight iron staining throughout. HNU=BKG
8						
10			3,3 / 3,5	46		10-12' Silt and Sand, v. fine to fine grain, (5G4/2), grayish Green. HNU=BKG
12						
14			7,10 / 15,19	71		14-16' Silt and Sand, very fine to fine, (5G4/1), darker glauconitic coloring, Dark Green Gray
16						
18						
20						
22						
24						
26						
28						
30						

WESTON

DRILLING LOG

WELL NUMBER: 26-1
OWNER: WPNSTA Earle
LOCATION: Explosive D Washout Area, Building GB-1
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 24'
SURFACE ELEVATION: 149.89'
WATER LEVEL: 9'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/28/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-3' Dark brown (10YR 3/3) fine to medium sand
					3'-4' Brownish yellow (10YR 6/6) fine to medium sand.
5		93	SS	6 9 12 12	4'-5.5' Brownish yellow (10YR 6/6) fine sand, damp, Rec=18".
10		94	SS	8 10 14 18	9'-10' Brownish yellow (10YR 6/6) fine to medium sand.
					10'-10.25' White (10YR 8/1) medium to coarse sand, wet, Rec=15".
15		95	SS	6 7 12 18	14'-15.5' Brownish yellow (10YR 6/6) fine sand, saturated, Rec.=18".
20		96	SS	WOR 8	19'-21' Brownish yellow (10YR 6/6) fine

* A.S.T.M. D1586

US NAVY

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WESTON

DRILLING LOG FILE

WELL NUMBER: 26-1 OWNER: WPNSTA Earle

LOCATION: Explosive D Washout Area, Building GB-1 ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 24'

SURFACE ELEVATION: 149.89' WATER LEVEL: 9'

DRILLING COMPANY: JE Fritts DRILLING METHOD: HSA DATE DRILLED: 1/28/86

DRILLER: WL HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20				17 40	Sand with reddish yellow (5YR 5/8) and light gray (10YR 7/1) mottles, saturated, Rec=24"
25		97	SS	7 5 5 7	24'-25' Brownish yellow (10YR 6/6) fine sand 25'-25.75' Light gray (10YR 7/1) and brownish yellow (10YR 6/6) layered fine sand, 25.75'-26' Reddish yellow (7.5YR 6/8) silty clay, saturated, Rec=24"

* A.S.T.M. D1586

SHEET 2 OF 2

Well 26-1

Well Construction Summary

Location or Coords: Explosive 'D' Washout Area, Bldg GB-1

Elevation: Ground Level

Top of Casing 149.89'

Drilling Summary:

Total Depth 24'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow Stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	GS+2'	C1	24'	9'	S
9'	GS+2'	C2			

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 24'-7' below GS

Cement 6:1 Portland cement: bentonite 5'-GS

Other Bentonite Pellets 7'-5' below GS

GS= Ground Surface

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/28 1986	1330	1/28 1986	1540
Roller Bit	"	1540	"	1600
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1600	"	1620
Filter Placement:	"	1620	"	1740
Cementing:	1/29/86	0910	1/29/86	0940
Development:	3/13/86	1030	3/13/86	1100
Other:	3/14/86	0830	3/14/86	0920

Well Development:

Pumping not sustained. Pumped 5 gallons every 2 minutes for one hour

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

US NAVY WESTON
1771-02-10
FILE

DRILLING LOG

WELL NUMBER: 26-2
OWNER: WPNSTA Earle
LOCATION: Explosive D Washout Area, Building GB-1
ADDRESS: Colts Neck New Jersey
TOTAL DEPTH: 22'
SURFACE ELEVATION: 149.64'
WATER LEVEL: 9'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/27/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Light yellowish brown (10YR 6/4) sand and gravel (up to 2" in diameter).
5		85	SS	9 17 24 20	5'-6' Brownish yellow (10YR 6/6) medium sand with some (10%) gravel.
					6'-6.5' Brownish yellow (10YR 6/6) coarse sand, damp, Rec = 18".
10		86	SS	8 7 9 10	10'-11.5' Brownish yellow (10YR 6/6) coarse sand and 10% gravel, some (20%) medium sand, saturated, Rec = 18".
15		87	SS	WOR 15 16	15'-16.5' Brownish yellow (10YR 6/6) clean fine sand, saturated, Rec. = 18".

* A.S.T.M. D1586

WESTON

US NAVY

DRILLING LOG 1771-04

WELL NUMBER: 26-2 OWNER: WPNSTA Earle

LOCATION: Explosive D Washout Area Building GB-1 ADDRESS: Colts Neck, New Jersey

TOTAL DEPTH: 22'

SURFACE ELEVATION: 149.64' WATER LEVEL: 9'

DRILLING COMPANY: JE Fritts DRILLING METHOD: HSA DATE DRILLED: 1/28/86

DRILLER: WL HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		88	SS	WOR 7 7	20'-22' Gray (10YR 7/1) and brownish yellow (10YR 6/6) layered fine sand with strong brown (7.5YR 5/8) mottles, saturated, Rec = 24"
25					

* A.S.T.M. D1586

SHEET 2 OF 2

Well 26-2

Well Construction Summary

Location or Coords: Explosive "D" Washout Area; Bldg GB-1

Elevation: Ground Level

Top of Casing 149.64'

Drilling Summary:

Total Depth 22'

Borehole Diameter

Driller J.E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow Stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3' - GS+2'	C1		22' - 7'	S
7' - GS+2'	C2			

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 22'-5' below GS

Cement 6:1 Portland cement: bentonite 4'-GS

Other Bentonite Pellets 4'-5' below GS

GS = Ground Surface

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/27 1986	1045	1/27 1986	1215
Roller Bit	"	1300	"	1310
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1310	"	1345
Filter Placement:	"	1345	"	1440
Cementing:	"	1520	"	1535
Development:	3/13/86	1100	3/13/86	1650
Other:				

Well Development:

Pumping Not Sustained
Pumped 5 gallons every 2 minutes for one hour

Comments:

Location

Personnel

Project

WESTON DESIGNERS CONSULTANTS

WESTON

US N
1771-
FILE

DRILLING LOG

WELL NUMBER: 26-3
OWNER: WPNSTA Earle
LOCATION: Explosive D Washout Area Building GB-1
ADDRESS: Colts Neck
TOTAL DEPTH: 22'
SURFACE ELEVATION: 150.48'
WATER LEVEL: 10'
DRILLING COMPANY: JE Fritts
DRILLING METHOD: HSA
DATE DRILLED: 1/27/86
DRILLER: WL
HELPER: RI
LOG BY: AEB

SKETCH MAP

NOTES:
"Surface Elevation" = Top of PVC

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
0					0-5' Brownish yellow (10YR 6/6) medium to coarse sand.
5		89	SS	2 5 10 9	5'-5.25' Brownish yellow (10YR 6/6) medium sand
					5.25'-6.25' Brownish yellow (10YR 6/6) medium to coarse sand and gravel with red (10R 4/6) staining interspersed.
10		90	SS	5 7 7 9	10'-11' Brownish yellow (10YR 6/6) with reddish yellow (7.5YR 6/8) medium to coarse sand.
					11'-11.5' Light gray (10YR 7/2) medium sand, saturated, Rec. = 18".
15		91	SS	4 5 7 7	15'-16' Light gray (10YR 7/2) and brownish yellow (10YR 6/6) fine sand, layered, clean, saturated, Rec = 12"
20					

* A.S.T.M. D1586

WESTON

US NA

DRILLING LOG 1771-

WELL NUMBER: 2ELLB OWNER: WPNSTA Earle

LOCATION: Explosive D Washort Area Building GB-1 ADDRESS: Colts Neck New Jersey

TOTAL DEPTH: 22'

SURFACE ELEVATION: 150.48' WATER LEVEL: 10'

DRILLING COMPANY: JE Fritts DRILLING METHOD: HSA DATE DRILLED: 1/27/86

DRILLER: WL HELPER: RI

LOG BY: AEB

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
20		92	SS	WOR 11 16 24	20'-21.5' Brownish yellow (10YR 6/6) and light gray (10YR 7/1) layered, clean fine sand with strong brown (7.5YR 5/6) mottling, saturated, Rec = 18".

* A.S.T.M. D1586

SHEET 2 OF 2

Well 26-3

Well Construction Summary

Location or Coords: Explosive "D" Washout Area, Bldg GB-1

Elevation: Ground Level

Top of Casing 150.48'

Drilling Summary:

Total Depth 22'

Borehole Diameter

Driller J. E. Fritts

Rig Mobil Drill B-61

Bit(s) Hollow Stem Auger, Roller Bit

Drilling Fluid Water

Surface Casing 6" Steel Locking

Well Design:

Basis: Geologic Log X Geophysical Log

Casing String(s): C=Casing S=Screen

3'	-	GS+2'	C1	22'	-	7'	S
7'	-	GS+2'	C2		-		
	-				-		
	-				-		
	-				-		
	-				-		
	-				-		
	-				-		

Casing: C1 6" Steel

C2 4" SCH 40 PVC

Screen: S1 4" SCH 40 PVC 10 SLOT

S2

Centralizers

Filter Material No. 2 Ottawa Sand 22'-5' below GS

Cement 6:1 Portland cement : bentonite 4'-GS

Other Bentonite pellets 5'-4' below GS

GS = Ground Surface

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling:				
HSA	1/27/86	1550	1/27/86	1635
Roller Bit	"	1635	"	1700
Geophys. Logging:				
Casing:				
Install 4" PVC	"	1700	"	1720
Filter Placement:	1/28/86	1000	1/28/86	1130
Cementing:	"	1130	"	1200
Development:	3/4/86	0730	3/4/86	0830
Other:				

Well Development:

Pumping not sustained
Pumped 5 gallons every 2 minutes for one hour.

Comments:

Location

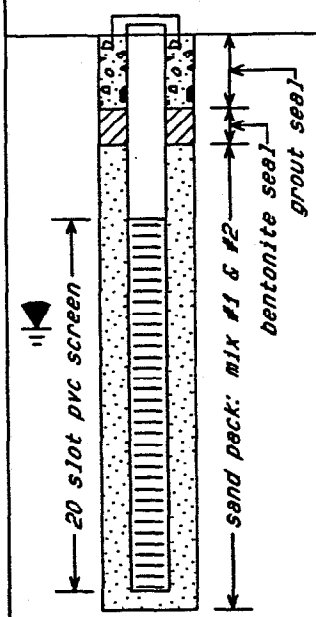
Personnel

Project

WESTON DESIGNERS CONSULTANTS

MONITOR WELL 26-4

Project	N.W.S. Earle/ Colts Neck	Well Number	MW26-4
Location	Colts Neck, N.J.	Coordinates	
Geologist	T. McCann	Top of Casing Elevation	151.09 feet MSL
Drilling Contractor	B. L. Myers	Groundsurface Elevation	feet
Driller	B. Stringer	Total Borehole Depth	15.5 feet
Drilling Method	Hollow stem auger	Total Well Depth	15.0 feet
Diameter of Borehole	11.5 (7.5) inches	Date Started	1/15/91
Diameter of Well Casing	4 inches	Date Well Completed	1/15/91

DEPTH IN FEET	WELL CONSTRUCTION DETAIL	SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	GRAPHIC SYMBOL	DESCRIPTION
0			9, 14	83	SP	0-2.0 Brown to Dark brown (10YR4/3), SAND, fine grain, orange material at 16" (paint?), moisture is damp. HNU=BKG
2			27, 30			
			6, 14	88		
4			13, 14			2.0-4.0 Light yellowish brown (5YR6/4), SAND, fine grain, wet at 3'. HNU=BKG
6					SW	
8						* note: Discontinue split spoon sampling and begin samplipng cuttings due sands running up auger.
10						
12						4.0-6.0 Same as above, rare rounded Qtz gravel included. HNU=BKG
14						
16						6.0-8.0 Same as above, no Qtz gravel. HNU=BKG
18						8.0-10.0 Same as above, Wet.
20						10.0-12.0 Pink (5YR7/4), SAND, fine grain, very wet. HNU=BKG
22						
24						12.0-14.0 Same as above, wet.
26						
28						
30						

APPENDIX B

AQUIFER SLUG TESTS

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW2-1

Test No.: Step No.: RISING HEAD

Total well depth:	30	feet			
Depth to water:	11.41	feet			
Screen length (Le):	17	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	18.59	feet	rw=	0.4791	feet

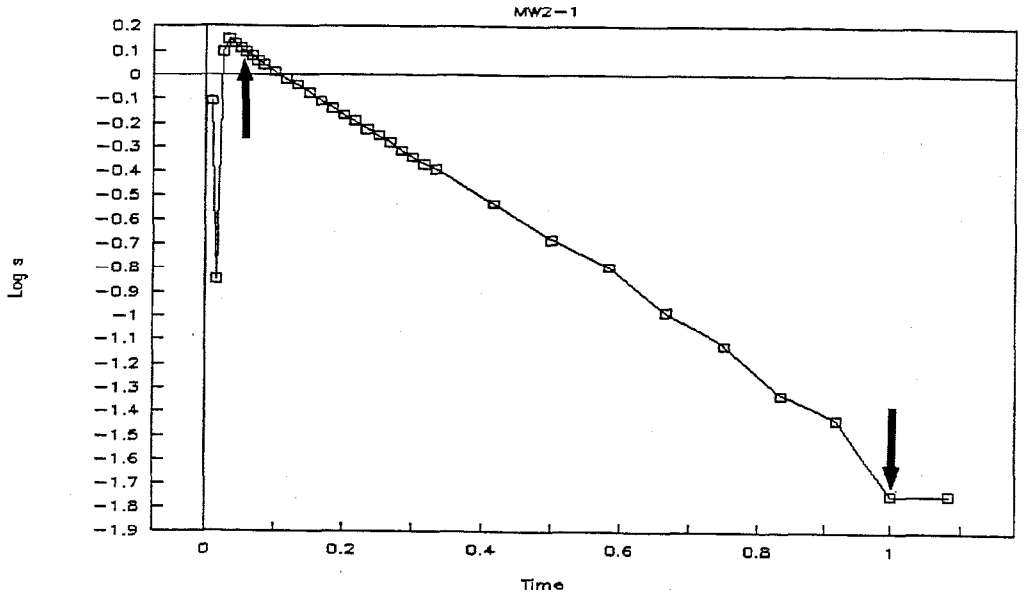
From type curve:
Where Le/rw= 35.478
C= 2.2

ln(Re/rw)= 2.7571

Bouwer and Rice Results:
==========
r squared = 0.9988

Hydraulic conductivity = 13.21 ft/day

Effective radial distance
of slug test = 7.5 feet



MW2-1RH

SE2000
Environmental Logger
03/28 10:37

Unit# 2 Test 8

Setups: INPUT 1

Type Level (F)
I.D. MW2-1

Reference 0.000
SG 1.000
Linearity 0.000
Scale factor 30.068
Offset -0.123
Delay mSEC 50.000

Step 1 03/27 12:12:12

Elapsed Time	INPUT 1
0.0000	-0.018
0.0083	0.777
0.0166	-0.142
0.0250	1.241
0.0333	1.402
0.0416	1.345
0.0500	1.289
0.0583	1.241
0.0666	1.203
0.0750	1.146
0.0833	1.108
0.1000	1.033
0.1166	0.957
0.1333	0.909
0.1500	0.843
0.1666	0.777
0.1833	0.729
0.2000	0.682
0.2166	0.644
0.2333	0.597
0.2500	0.559
0.2666	0.521
0.2833	0.483
0.3000	0.454
0.3166	0.426
0.3333	0.407
0.4166	0.293
0.5000	0.208
0.5833	0.161
0.6666	0.104
0.7500	0.075
0.8333	0.047
0.9166	0.037
1.0000	0.018
1.0833	0.018
1.1666	0.000
1.2500	0.009
1.3333	0.009
1.4166	-0.009
1.5000	-0.018
1.5833	0.000
1.6666	-0.009
1.7500	-0.009
1.8333	-0.009
1.9166	-0.018
2.0000	0.000
2.5000	-0.009

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW2-5

Test No.: Step No.: RISING HEAD

Total well depth:	20.2	feet			
Depth to water:	7.71	feet			
Screen length (Le):	17.2	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	12.49	feet	rw=	0.4791	feet

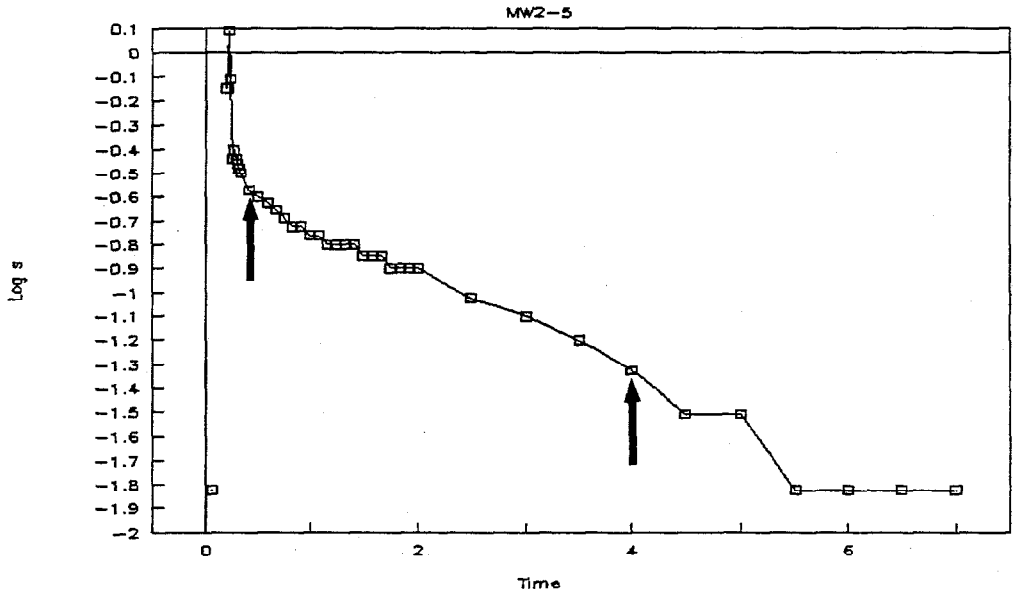
From type curve:
Where Le/rw= 35.895
C= 2.2

ln(Re/rw)= 2.5085

Bouwer and Rice Results:
==========
r squared = 0.9861

Hydraulic conductivity = 1.31 ft/day

Effective radial distance
of slug test = 5.9 feet



MW2-5RH

SE2000
Environmental Logger
02/20 22:09

Unit# 2 Test 2

Setups: INPUT 1

Type Level (F)
I.D. MW2-5

Reference 0.000
SG 1.000
Linearity 0.000
Scale factor 50.130
Offset 0.000
Delay mSEC 1000.00

Step 1 02/20 14:54:33

Elapsed Time	INPUT 1
0.0000	0.015
0.0083	1.264
0.0166	-0.015
0.0250	0.205
0.0333	0.790
0.0416	1.137
0.0500	1.201
0.0583	1.216
0.0666	1.153
0.0750	1.090
0.0833	1.027
0.1000	0.932
0.1166	0.821
0.1333	0.726
0.1500	0.632
0.1666	0.568
0.1833	0.505
0.2000	0.442
0.2166	0.410
0.2333	0.379
0.2500	0.347
0.2666	0.331
0.2833	0.331
0.3000	0.316
0.3166	0.316
0.3333	0.300
0.4166	0.268
0.5000	0.252
0.5833	0.237
0.6666	0.221
0.7500	0.221
0.8333	0.205
0.9166	0.205
1.0000	0.189
1.0833	0.189
1.1666	0.189
1.2500	0.173
1.3333	0.173

Elapsed Time	INPUT 1
1.4166	0.158
1.5000	0.158
1.5833	0.142
1.6666	0.142
1.7500	0.142
1.8333	0.142
1.9166	0.126
2.0000	0.126
2.5000	0.110
3.0000	0.094
3.5000	0.094
4.0000	0.079
4.5000	0.079
5.0000	0.063
5.5000	0.063
6.0000	0.047
6.5000	0.047
7.0000	0.047
7.5000	0.031
8.0000	0.031
8.5000	0.031
9.0000	0.031
9.5000	0.031
10.0000	0.031
11.0000	0.047
12.0000	0.063
13.0000	0.079
14.0000	0.094
15.0000	0.079
16.0000	0.110
17.0000	0.126
18.0000	0.094
19.0000	0.047
20.0000	0.015
21.0000	0.031
22.0000	0.015
23.0000	0.031
24.0000	0.031
25.0000	0.031
26.0000	0.031
27.0000	0.015
28.0000	0.015
29.0000	0.015
30.0000	0.047
31.0000	0.047
32.0000	0.063
33.0000	0.047
34.0000	0.031
35.0000	0.031
36.0000	0.047
37.0000	0.031
38.0000	0.031
39.0000	0.031
40.0000	0.031
41.0000	0.047
42.0000	0.031
43.0000	0.031
44.0000	0.031
45.0000	0.031
46.0000	0.031

Elapsed Time	INPUT 1
47.0000	0.031
48.0000	0.047
49.0000	0.031
50.0000	0.031

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW2-6

Test No.: Step No.: RISING HEAD

Total well depth:	20.2	feet			
Depth to water:	7.71	feet			
Screen length (Le):	17.2	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1668	feet
Sat. thickness (Lw):	12.49	feet	rw=	0.4791	feet

From type curve:
Where Le/rw= 35.9
C= 2.25

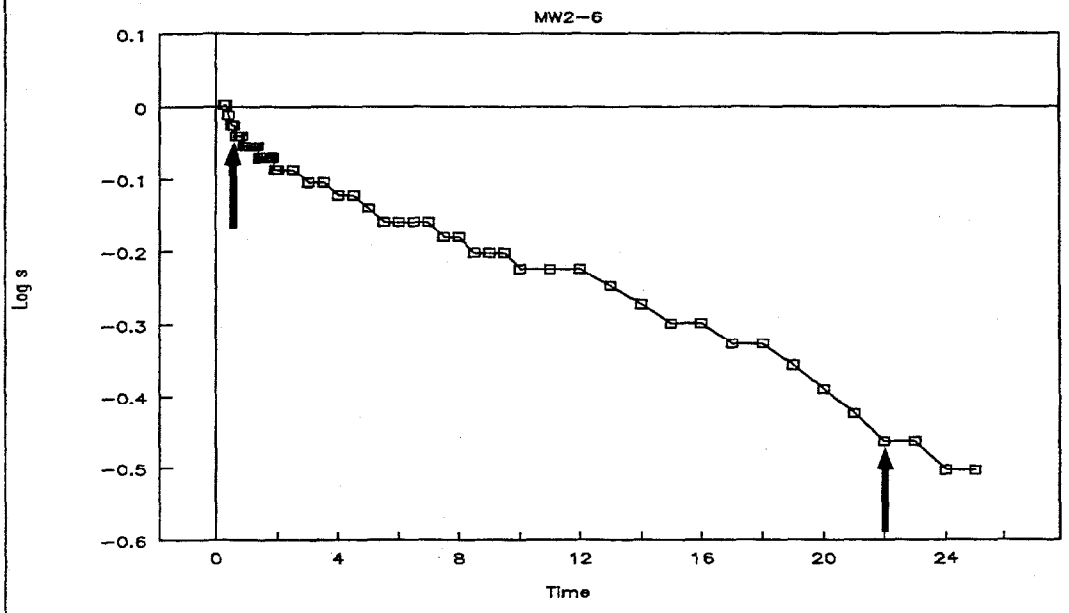
ln(Re/rw)= 2.4999

Bouwer and Rice Results:

r squared = 0.9858

Hydraulic conductivity = 0.12 ft/day

Effective radial distance
of slug test = 5.8 feet



MW2-6RH

SE2000
Environmental Logger
02/20 22:05

Unit# 2 Test 2

Setups: INPUT 2

Type	Level (F)
I.D.	MW2-6
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	99.750
Offset	-0.250
Delay mSEC	50.000

Step 1 02/20 14:54:33

Elapsed Time	INPUT 2
0.0000	0.062
0.0083	0.534
0.0166	0.094
0.0250	0.471
0.0333	-0.408
0.0416	0.566
0.0500	1.069
0.0583	1.069
0.0666	1.477
0.0750	1.572
0.0833	1.477
0.1000	1.383
0.1166	1.320
0.1333	1.226
0.1500	1.194
0.1666	1.132
0.1833	1.100
0.2000	1.100
0.2166	1.069
0.2333	1.037
0.2500	1.037
0.2666	1.006
0.2833	1.006
0.3000	1.006
0.3166	1.006
0.3333	1.006
0.4166	0.974
0.5000	0.943
0.5833	0.943
0.6666	0.911
0.7500	0.911
0.8333	0.911
0.9166	0.880
1.0000	0.880
1.0833	0.880
1.1666	0.880
1.2500	0.880
1.3333	0.880
1.4166	0.849

Elapsed Time	INPUT 2
1.5000	0.849
1.5833	0.849
1.6666	0.849
1.7500	0.849
1.8333	0.849
1.9166	0.817
2.0000	0.817
2.5000	0.817
3.0000	0.786
3.5000	0.786
4.0000	0.754
4.5000	0.754
5.0000	0.723
5.5000	0.691
6.0000	0.691
6.5000	0.691
7.0000	0.691
7.5000	0.660
8.0000	0.660
8.5000	0.628
9.0000	0.628
9.5000	0.628
10.0000	0.597
11.0000	0.597
12.0000	0.597
13.0000	0.566
14.0000	0.534
15.0000	0.503
16.0000	0.503
17.0000	0.471
18.0000	0.471
19.0000	0.440
20.0000	0.408
21.0000	0.377
22.0000	0.345
23.0000	0.345
24.0000	0.314
25.0000	0.314
26.0000	0.314
27.0000	0.283
28.0000	0.251
29.0000	0.251
30.0000	0.251
31.0000	0.251
32.0000	0.251
33.0000	0.220
34.0000	0.220
35.0000	0.220
36.0000	0.188
37.0000	0.188
38.0000	0.188
39.0000	0.188
40.0000	0.188
41.0000	0.188
42.0000	0.157
43.0000	0.157
44.0000	0.157
45.0000	0.157
46.0000	0.125
47.0000	0.157
48.0000	0.157

Elapsed Time	INPUT 2
49.0000	0.125
50.0000	0.125

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW2-7

Test No.: Step No.: RISING HEAD

Total well depth:	21.15	feet			
Depth to water:	8.79	feet			
Screen length (Le):	16.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	12.36	feet	rw=	0.4791	feet

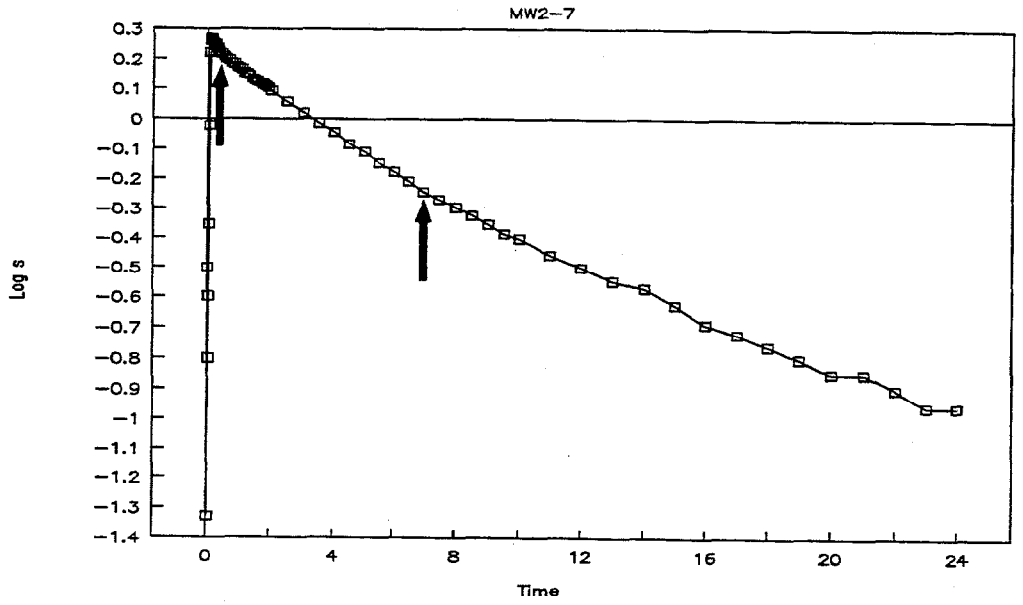
From type curve:
Where Le/rw= 34.434
C= 2.2

ln(Re/rw)= 2.4855

Bouwer and Rice Results:
==========
r squared = 0.9987

Hydraulic conductivity = 0.49 ft/day

Effective radial distance
of slug test = 5.8 feet



MW2-7

SE2000
Environmental Logger
02/20 22:01

Unit# 2 Test 4

Setups: INPUT 1

Type	Level (F)
I.D.	MW2-7
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	50.260
Offset	0.000
Delay mSEC	1000.00

Step 0 02/20 16:18:26

Elapsed Time	INPUT 1
0.0000	0.015
0.0083	0.316
0.0166	0.253
0.0250	-0.047
0.0333	-0.253
0.0416	0.158
0.0500	0.443
0.0583	0.950
0.0666	1.663
0.0750	1.822
0.0833	1.837
0.1000	1.853
0.1166	1.837
0.1333	1.822
0.1500	1.806
0.1666	1.774
0.1833	1.774
0.2000	1.774
0.2166	1.758
0.2333	1.742
0.2500	1.758
0.2666	1.726
0.2833	1.726
0.3000	1.711
0.3166	1.679
0.3333	1.679
0.4166	1.647
0.5000	1.616
0.5833	1.584
0.6666	1.568
0.7500	1.536
0.8333	1.521
0.9166	1.489
1.0000	1.473
1.0833	1.457
1.1666	1.425
1.2500	1.410
1.3333	1.394

Elapsed Time	INPUT 1
1.4166	1.362
1.5000	1.346
1.5833	1.330
1.6666	1.315
1.7500	1.299
1.8333	1.283
1.9166	1.267
2.0000	1.235
2.5000	1.140
3.0000	1.045
3.5000	0.966
4.0000	0.903
4.5000	0.823
5.0000	0.776
5.5000	0.712
6.0000	0.665
6.5000	0.617
7.0000	0.570
7.5000	0.538
8.0000	0.507
8.5000	0.475
9.0000	0.443
9.5000	0.411
10.0000	0.396
11.0000	0.348
12.0000	0.316
13.0000	0.285
14.0000	0.269
15.0000	0.237
16.0000	0.205
17.0000	0.190
18.0000	0.174
19.0000	0.158
20.0000	0.142
21.0000	0.142
22.0000	0.126
23.0000	0.110
24.0000	0.110
25.0000	0.110
26.0000	0.095
27.0000	0.095
28.0000	0.095
29.0000	0.095
30.0000	0.095
31.0000	0.079
32.0000	0.079

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW3-3

Test No.: Step No.: RISING HEAD

Total well depth:	23	feet			
Depth to water:	8.86	feet			
Screen length (Le):	17	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	14.14	feet	rw=	0.4791	feet

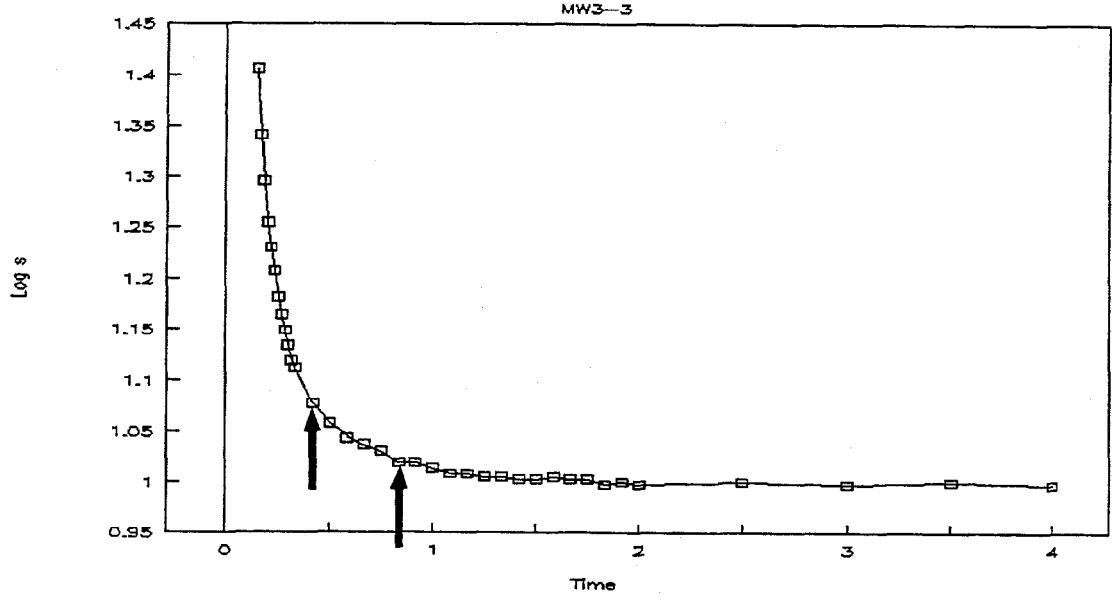
From type curve:
Where Le/rw= 35.478
C= 2.15

ln(Re/rw)= 2.5934

Bouwer and Rice Results:
==========
r squared = 0.9695

Hydraulic conductivity = 2.03 ft/day

Effective radial distance
of slug test = 6.4 feet



MW3-3RH

SE2000
Environmental Logger
03/26 22:53

Unit# 2 Test 0

Setups: INPUT 2

Type Level (F)
I.D. MW3-3

Reference 0.000
SG 1.000
Linearity 0.000
Scale factor 20.098
Offset -0.210
Delay mSEC 50.000

Step 1 03/26 11:00:57

Elapsed Time	INPUT 2
0.0000	-0.025
0.0083	0.190
0.0166	-0.114
0.0250	0.031
0.0333	0.120
0.0416	0.101
0.0500	0.468
0.0583	0.468
0.0666	0.551
0.0750	0.677
0.0833	0.779
0.1000	0.899
0.1166	0.779
0.1333	0.684
0.1500	0.608
0.1666	0.544
0.1833	0.494
0.2000	0.443
0.2166	0.411
0.2333	0.380
0.2500	0.342
0.2666	0.316
0.2833	0.291
0.3000	0.266
0.3166	0.240
0.3333	0.228
0.4166	0.164
0.5000	0.126
0.5833	0.095
0.6666	0.082
0.7500	0.069
0.8333	0.044
0.9166	0.044
1.0000	0.031
1.0833	0.019
1.1666	0.019
1.2500	0.012
1.3333	0.012

Elapsed Time	INPUT 2
1.4166	0.006
1.5000	0.006
1.5833	0.012
1.6666	0.006
1.7500	0.006
1.8333	-0.006
1.9166	0.000
2.0000	-0.006
2.5000	0.000
3.0000	-0.006
3.5000	0.000
4.0000	-0.006
4.5000	-0.006
5.0000	-0.006
5.5000	0.000
6.0000	0.000
6.5000	0.000
7.0000	-0.006
7.5000	-0.006
8.0000	-0.012
8.5000	0.000
9.0000	0.057
9.5000	0.088
10.0000	0.107
11.0000	0.095
12.0000	0.057

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW3-6

Test No.: Step No.: RISING HEAD

Total well depth:	20.14	feet			
Depth to water:	9.85	feet			
Screen length (Le):	16.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	10.29	feet	rw=	0.4791	feet

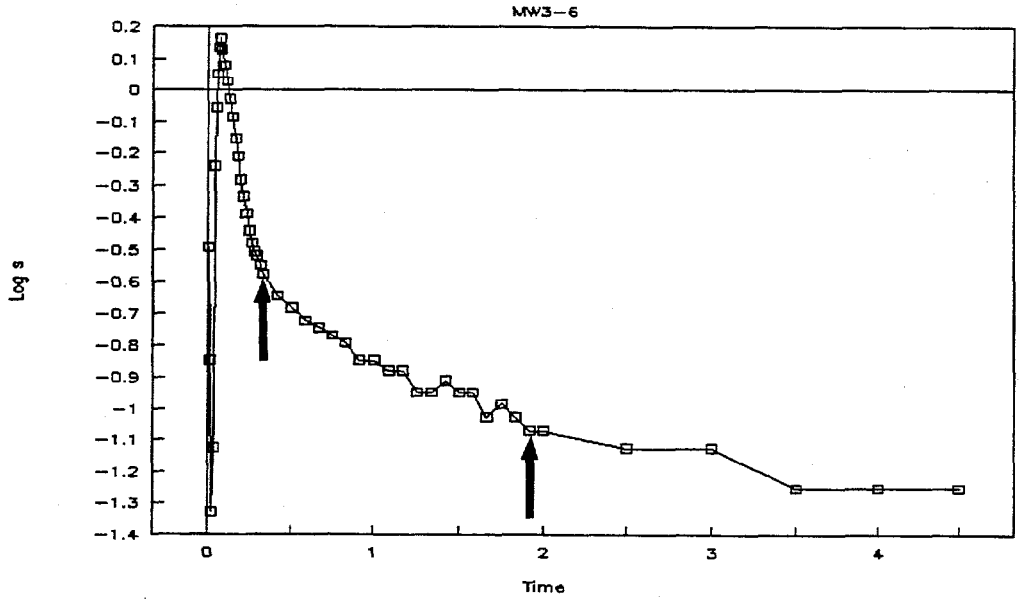
From type curve:
Where Le/rw= 34.434
C= 2.2

ln(Re/rw)= 2.3665

Bouwer and Rice Results:
==========
r squared = 0.9445

Hydraulic conductivity = 1.56 ft/day

Effective radial distance
of slug test = 5.1 feet



MW3–6RH

SE2000
Environmental Logger
03/26 22:56

Unit# 2 Test 0

Setups: INPUT 1

Type	Level (F)
I.D.	MW3–6
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	30.068
Offset	–0.123
Delay mSEC	50.000

Step 1 03/26 11:00:57

Elapsed Time	INPUT 1
0.0000	0.047
0.0083	0.322
0.0166	0.142
0.0250	–0.047
0.0333	0.075
0.0416	0.578
0.0500	0.881
0.0583	1.127
0.0666	1.364
0.0750	1.459
0.0833	1.345
0.1000	1.203
0.1166	1.071
0.1333	0.938
0.1500	0.824
0.1666	0.701
0.1833	0.616
0.2000	0.521
0.2166	0.464
0.2333	0.407
0.2500	0.360
0.2666	0.331
0.2833	0.312
0.3000	0.303
0.3166	0.284
0.3333	0.265
0.4166	0.227
0.5000	0.208
0.5833	0.189
0.6666	0.180
0.7500	0.170
0.8333	0.161
0.9166	0.142
1.0000	0.142
1.0833	0.132
1.1666	0.132
1.2500	0.113
1.3333	0.113

Elapsed Time	INPUT 1
1.4166	0.123
1.5000	0.113
1.5833	0.113
1.6666	0.094
1.7500	0.104
1.8333	0.094
1.9166	0.085
2.0000	0.085
2.5000	0.075
3.0000	0.075
3.5000	0.056
4.0000	0.056
4.5000	0.056
5.0000	0.047
5.5000	0.037
6.0000	0.037
6.5000	0.047
7.0000	0.037
7.5000	0.037
8.0000	0.047
8.5000	0.056
9.0000	0.075
9.5000	0.094
10.0000	0.113
11.0000	0.142
12.0000	0.170

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW4-4

Test No.: Step No.: RISING HEAD

Total well depth:	27.29	feet			
Depth to water:	24.96	feet			
Screen length (Le):	22.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	2.33	feet	rw=	0.4791	feet

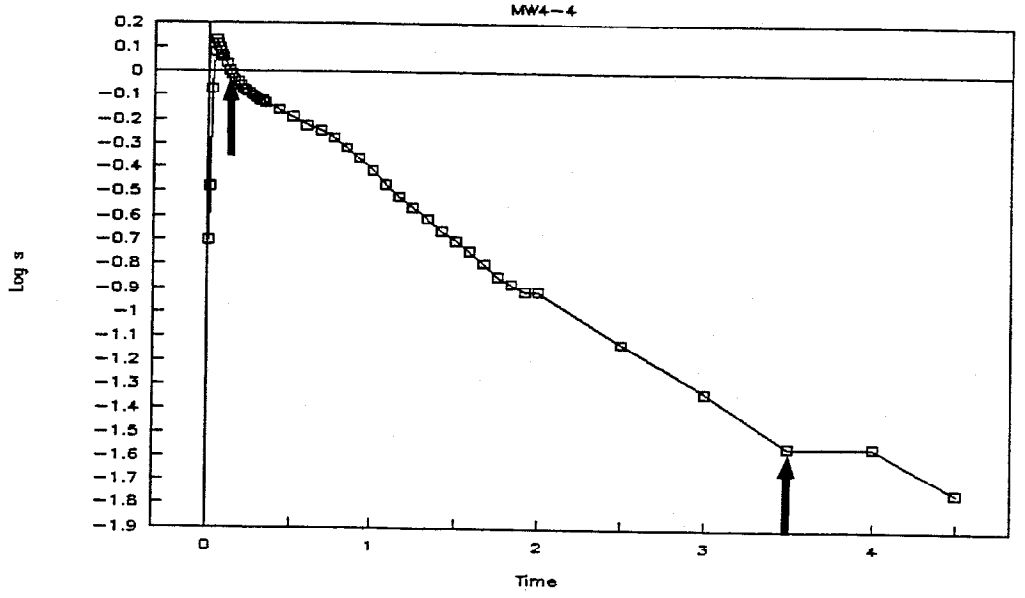
From type curve:
Where Le/rw= 46.956
C= 2.51

ln(Re/rw)= 1.3352

Bouwer and Rice Results:
==========
r squared = 0.9938

Hydraulic conductivity = 1.27 ft/day

Effective radial distance
of slug test = 1.8 feet



MW4-4RH

SE2000
Environmental Logger
03/26 22:42

Unit# 2 Test 2

Setups: INPUT 1

Type	Level (F)
I.D.	MW4-4
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	30.068
Offset	-0.123
Delay mSEC	50.000

Step 1 03/26 14:39:17

Elapsed Time	INPUT 1
0.0000	0.312
0.0083	0.199
0.0166	0.331
0.0250	0.843
0.0333	1.194
0.0416	1.345
0.0500	1.298
0.0583	1.251
0.0666	1.203
0.0750	1.165
0.0833	1.137
0.1000	1.071
0.1166	1.004
0.1333	0.966
0.1500	0.928
0.1666	0.900
0.1833	0.872
0.2000	0.843
0.2166	0.834
0.2333	0.815
0.2500	0.796
0.2666	0.786
0.2833	0.767
0.3000	0.758
0.3166	0.758
0.3333	0.739
0.4166	0.691
0.5000	0.644
0.5833	0.597
0.6666	0.568
0.7500	0.530
0.8333	0.483
0.9166	0.436
1.0000	0.388
1.0833	0.341
1.1666	0.303
1.2500	0.274
1.3333	0.246

Elapsed Time	INPUT 1
1.4166	0.218
1.5000	0.199
1.5833	0.180
1.6666	0.161
1.7500	0.142
1.8333	0.132
1.9166	0.123
2.0000	0.123
2.5000	0.075
3.0000	0.047
3.5000	0.028
4.0000	0.028
4.5000	0.018
5.0000	0.028
5.5000	0.037
6.0000	0.018
6.5000	0.028
7.0000	0.028
7.5000	0.028
8.0000	0.028
8.5000	0.018
9.0000	0.028
9.5000	0.028
10.0000	0.028
11.0000	0.037
12.0000	0.018

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW5-2

Test No.: Step No.: RISING HEAD

Total well depth:	28	feet			
Depth to water:	18.95	feet			
Screen length (Le):	17	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	9.05	feet	rw=	0.4791	feet

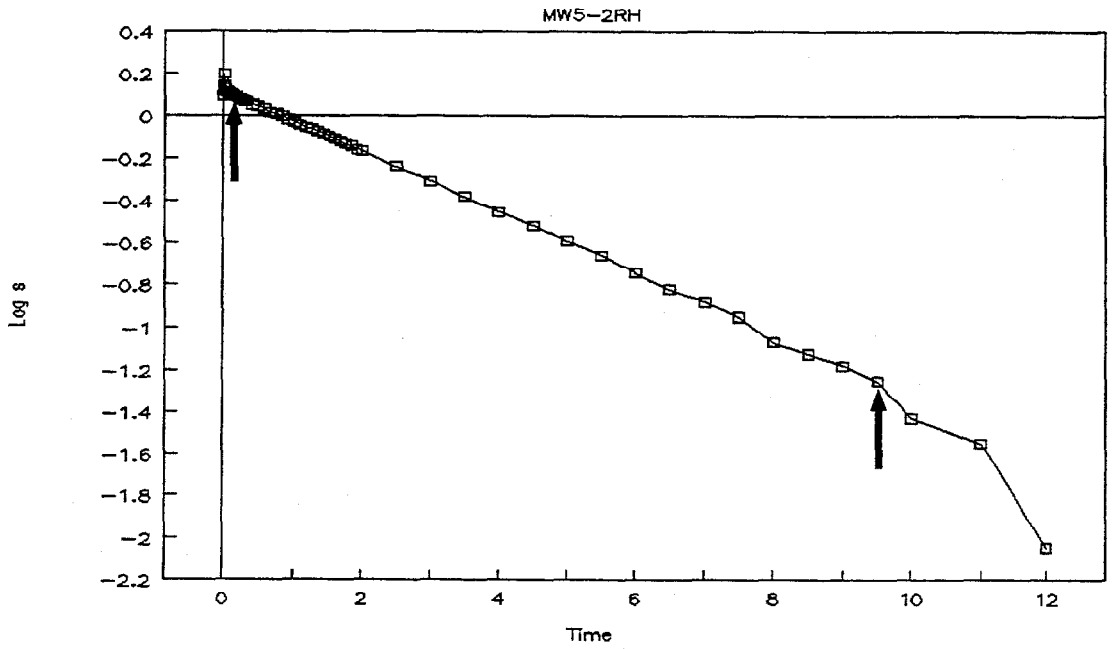
From type curve:
Where Le/rw= 35.478
C= 2.15

ln(Re/rw)= 2.2991

Bouwer and Rice Results:
==========
r squared = 0.9996

Hydraulic conductivity = 0.90 ft/day

Effective radial distance
of slug test = 4.8 feet



MW5–2RH

SE2000
Environmental Logger
03/28 10:40

Unit# 2 Test 7

Setups: INPUT 1

Type Level (F)
I.D. MW5–2

Reference 0.000
SG 1.000
Linearity 0.000
Scale factor 30.068
Offset –0.123
Delay mSEC 50.000

Step 1 03/27 11:37:36

Elapsed Time	INPUT 1
0.0000	0.625
0.0083	1.241
0.0166	1.582
0.0250	1.393
0.0333	1.374
0.0416	1.336
0.0500	1.308
0.0583	1.298
0.0666	1.308
0.0750	1.308
0.0833	1.298
0.1000	1.289
0.1166	1.279
0.1333	1.270
0.1500	1.260
0.1666	1.241
0.1833	1.241
0.2000	1.232
0.2166	1.222
0.2333	1.213
0.2500	1.203
0.2666	1.203
0.2833	1.194
0.3000	1.194
0.3166	1.175
0.3333	1.175
0.4166	1.137
0.5000	1.118
0.5833	1.080
0.6666	1.042
0.7500	1.023
0.8333	0.995
0.9166	0.966
1.0000	0.938
1.0833	0.909
1.1666	0.881
1.2500	0.872
1.3333	0.843
1.4166	0.824
1.5000	0.805
1.5833	0.777
1.6666	0.758
1.7500	0.739
1.8333	0.720
1.9166	0.691
2.0000	0.682
2.5000	0.578
3.0000	0.492
3.5000	0.417
4.0000	0.350
4.5000	0.303
5.0000	0.255
5.5000	0.218
6.0000	0.180
6.5000	0.151
7.0000	0.132
7.5000	0.113
8.0000	0.085
8.5000	0.075
9.0000	0.066
9.5000	0.056
10.0000	0.037
11.0000	0.028
12.0000	0.009

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW5-6

Test No.: Step No.: RISING HEAD

Total well depth:	33.08	feet			
Depth to water:	24.08	feet			
Screen length (Le):	31.8	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	9	feet	rw=	0.4791	feet

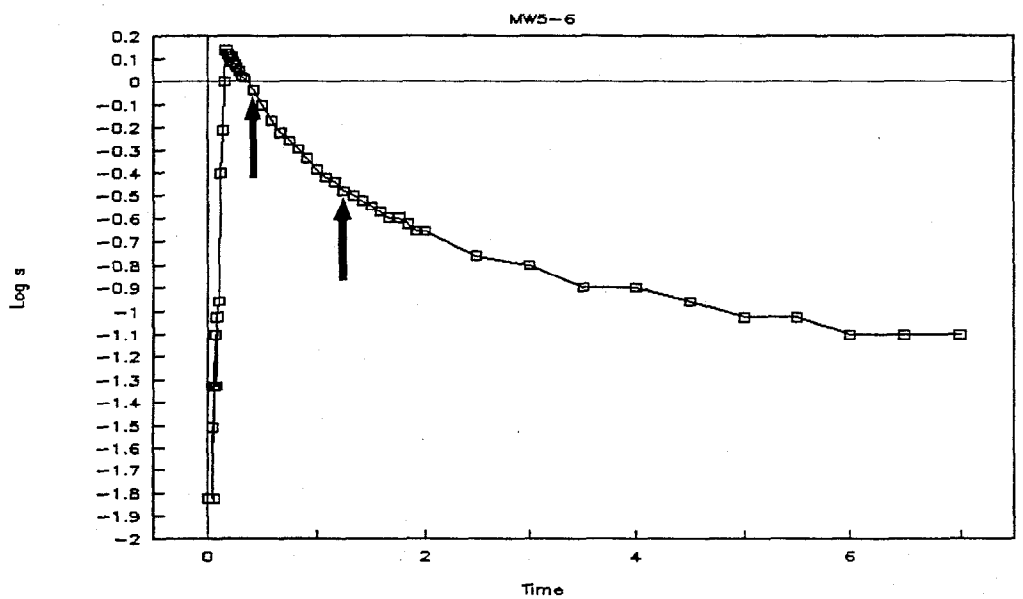
From type curve:
Where Le/rw= 66.365
C= 3.2

ln(Re/rw)= 2.3626

Bouwer and Rice Results:
==========
r squared = 0.9844

Hydraulic conductivity = 1.83 ft/day

Effective radial distance
of slug test = 5.1 feet



MW5-6RH

SE2000
Environmental Logger
02/20 22:16

Unit# 2 Test 1

Setups: INPUT 1

Type	Level (F)
I.D.	MW5-6
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	50.130
Offset	0.000
Delay mSEC	1000.00

Step 1 02/20 12:34:00

Elapsed Time	INPUT 1
0.0000	0.015
0.0083	-0.015
0.0166	0.000
0.0250	0.000
0.0333	0.000
0.0416	-0.031
0.0500	-0.015
0.0583	0.047
0.0666	0.079
0.0750	-0.047
0.0833	-0.094
0.1000	0.110
0.1166	0.395
0.1333	0.616
0.1500	0.995
0.1666	1.359
0.1833	1.311
0.2000	1.280
0.2166	1.280
0.2333	1.216
0.2500	1.185
0.2666	1.153
0.2833	1.122
0.3000	1.058
0.3166	1.042
0.3333	1.027
0.4166	0.916
0.5000	0.790
0.5833	0.679
0.6666	0.600
0.7500	0.553
0.8333	0.505
0.9166	0.458
1.0000	0.410
1.0833	0.379
1.1666	0.363
1.2500	0.331
1.3333	0.316

Elapsed Time	INPUT 1
1.4166	0.300
1.5000	0.284
1.5833	0.268
1.6666	0.252
1.7500	0.252
1.8333	0.237
1.9166	0.221
2.0000	0.221
2.5000	0.173
3.0000	0.158
3.5000	0.126
4.0000	0.126
4.5000	0.110
5.0000	0.094
5.5000	0.094
6.0000	0.079
6.5000	0.079
7.0000	0.079
7.5000	0.079
8.0000	0.063
8.5000	0.063
9.0000	0.063
9.5000	0.047
10.0000	0.063
11.0000	0.047
12.0000	0.047
13.0000	0.047
14.0000	0.047
15.0000	0.063
16.0000	0.063
17.0000	0.047
18.0000	0.047
19.0000	0.047
20.0000	0.047
21.0000	0.047
22.0000	0.047
23.0000	0.031

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW5-7

Test No.: Step No.: RISING HEAD

Total well depth:	29.8	feet			
Depth to water:	20.45	feet			
Screen length (Le):	17.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	9.35	feet	rw=	0.4791	feet

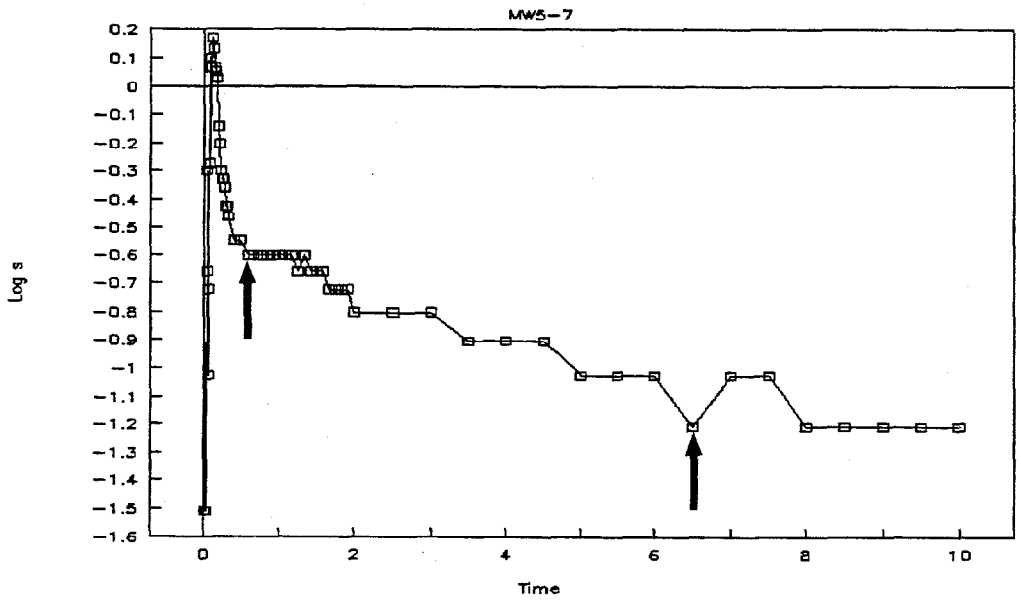
From type curve:
Where Le/rw= 36.521
C= 2.2

ln(Re/rw)= 2.3230

Bouwer and Rice Results:
==========
r squared = 0.9577

Hydraulic conductivity = 0.59 ft/day

Effective radial distance
of slug test = 4.9 feet



MW5-7RH

SE2000
Environmental Logger
02/20 22:13

Unit# 2 Test 1

Setups: INPUT 2

Type	Level (F)
I.D.	MW5-7
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	99.750
Offset	-0.250
Delay mSEC	50.000

Step 1 02/20 12:34:00

Elapsed Time	INPUT 2
0.0000	0.000
0.0083	-0.031
0.0166	0.000
0.0250	-0.031
0.0333	-0.031
0.0416	-0.503
0.0500	-0.220
0.0583	-0.094
0.0666	-0.188
0.0750	1.257
0.0833	0.534
0.1000	1.163
0.1166	1.477
0.1333	1.352
0.1500	1.163
0.1666	1.132
0.1833	1.069
0.2000	0.723
0.2166	0.628
0.2333	0.503
0.2500	0.471
0.2666	0.471
0.2833	0.440
0.3000	0.377
0.3166	0.377
0.3333	0.345
0.4166	0.283
0.5000	0.283
0.5833	0.251
0.6666	0.251
0.7500	0.251
0.8333	0.251
0.9166	0.251
1.0000	0.251
1.0833	0.251
1.1666	0.251
1.2500	0.220
1.3333	0.251
1.4166	0.220
1.5000	0.220
1.5833	0.220
1.6666	0.188
1.7500	0.188
1.8333	0.188
1.9166	0.188
2.0000	0.157
2.5000	0.157
3.0000	0.157
3.5000	0.125
4.0000	0.125
4.5000	0.125
5.0000	0.094
5.5000	0.094
6.0000	0.094
6.5000	0.062
7.0000	0.094
7.5000	0.094
8.0000	0.062
8.5000	0.062
9.0000	0.062
9.5000	0.062
10.0000	0.062
11.0000	0.062
12.0000	0.031
13.0000	0.031
14.0000	0.062
15.0000	0.062
16.0000	0.094
17.0000	0.062
18.0000	0.062
19.0000	0.031
20.0000	0.062
21.0000	0.062
22.0000	0.031
23.0000	0.031

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW7-2

Test No.: Step No.: RISING HEAD

Total well depth:	19	feet			
Depth to water:	4.65	feet			
Screen length (Le):	16.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	14.35	feet	rw=	0.4791	feet

From type curve:
Where Le/rw= 34.434
C= 2.1

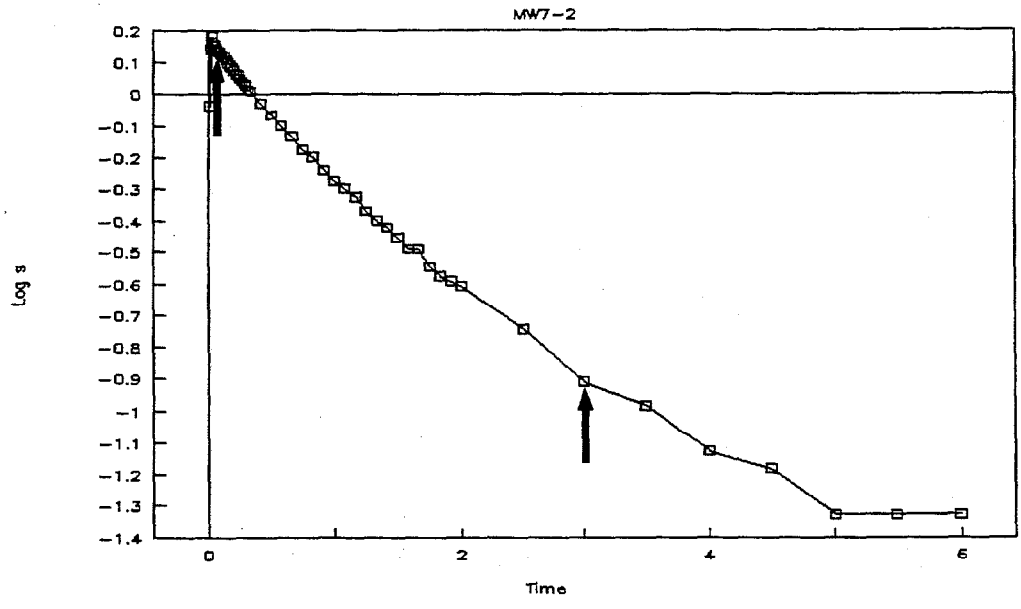
ln(Re/rw)= 2.6003

Bouwer and Rice Results:

r squared = 0.9916

Hydraulic conductivity = 2.76 ft/day

Effective radial distance
of slug test = 6.5 feet



MW7-2RH

SE2000
Environmental Logger
03/28 10:43

Unit# 2 Test 6

Setups: INPUT 1

Type	Level (F)
I.D.	MW7-2
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	30.068
Offset	-0.123
Delay mSEC	50.000

Step 1 03/27 09:47:18

Elapsed Time	INPUT 1
0.0000	0.274
0.0083	0.919
0.0166	1.383
0.0250	1.526
0.0333	1.459
0.0416	1.440
0.0500	1.421
0.0583	1.393
0.0666	1.374
0.0750	1.364
0.0833	1.355
0.1000	1.326
0.1166	1.308
0.1333	1.279
0.1500	1.251
0.1666	1.232
0.1833	1.213
0.2000	1.184
0.2166	1.156
0.2333	1.146
0.2500	1.118
0.2666	1.099
0.2833	1.080
0.3000	1.061
0.3166	1.033
0.3333	1.023
0.4166	0.938
0.5000	0.862
0.5833	0.796
0.6666	0.739
0.7500	0.672
0.8333	0.635
0.9166	0.578
1.0000	0.530
1.0833	0.502
1.1666	0.473
1.2500	0.426
1.3333	0.398

Elapsed Time	INPUT 1
1.4166	0.379
1.5000	0.350
1.5833	0.322
1.6666	0.322
1.7500	0.284
1.8333	0.265
1.9166	0.255
2.0000	0.246
2.5000	0.180
3.0000	0.123
3.5000	0.104
4.0000	0.075
4.5000	0.066
5.0000	0.047
5.5000	0.047
6.0000	0.047
6.5000	0.037
7.0000	0.037
7.5000	0.028
8.0000	0.037
8.5000	0.037
9.0000	0.037
9.5000	0.028
10.0000	0.028

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW7-3

Test No.: Step No.: RISING HEAD

Total well depth:	35	feet			
Depth to water:	20.34	feet			
Screen length (Le):	17	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	14.66	feet	rw=	0.4791	feet

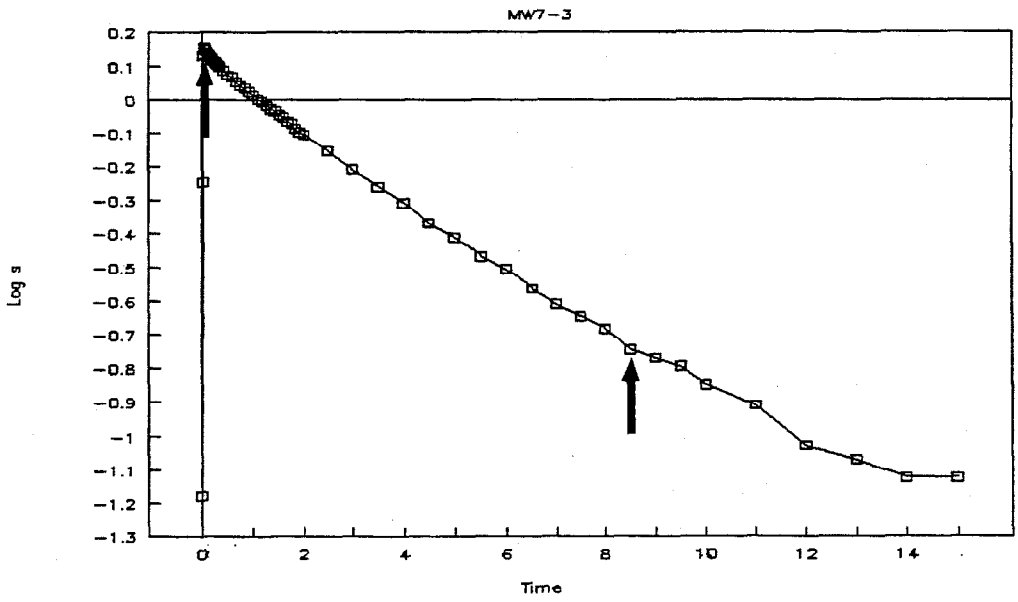
From type curve:
Where Le/rw= 35.478
C= 2.2

ln(Re/rw)= 2.6071

Bouwer and Rice Results:
==========
r squared = 0.9957

Hydraulic conductivity = 0.75 ft/day

Effective radial distance
of slug test = 6.5 feet



MW7-3RH

SE2000
Environmental Logger
03/28 10:46

Unit# 2 Test 5

Setups: INPUT 1

Type	Level (F)
I.D.	MW7-3
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	30.068
Offset	-0.123
Delay mSEC	50.000

Step 1 03/27 09:04:52

Elapsed Time	INPUT 1
0.0000	-0.322
0.0083	0.066
0.0166	0.568
0.0250	1.355
0.0333	1.345
0.0416	1.421
0.0500	1.412
0.0583	1.402
0.0666	1.393
0.0750	1.393
0.0833	1.393
0.1000	1.374
0.1166	1.364
0.1333	1.355
0.1500	1.345
0.1666	1.336
0.1833	1.327
0.2000	1.317
0.2166	1.308
0.2333	1.298
0.2500	1.289
0.2666	1.289
0.2833	1.279
0.3000	1.270
0.3166	1.260
0.3333	1.251
0.4166	1.222
0.5000	1.184
0.5833	1.165
0.6666	1.127
0.7500	1.099
0.8333	1.080
0.9166	1.052
1.0000	1.033
1.0833	1.004
1.1666	0.985
1.2500	0.957
1.3333	0.938

Elapsed Time	INPUT 1
1.4166	0.919
1.5000	0.900
1.5833	0.881
1.6666	0.862
1.7500	0.843
1.8333	0.815
1.9166	0.796
2.0000	0.786
2.5000	0.701
3.0000	0.616
3.5000	0.549
4.0000	0.492
4.5000	0.426
5.0000	0.388
5.5000	0.341
6.0000	0.312
6.5000	0.274
7.0000	0.246
7.5000	0.227
8.0000	0.208
8.5000	0.180
9.0000	0.170
9.5000	0.161
10.0000	0.142
11.0000	0.123
12.0000	0.094
13.0000	0.085
14.0000	0.075
15.0000	0.075
16.0000	0.066
17.0000	0.056
18.0000	0.056
19.0000	0.056
20.0000	0.056
21.0000	0.047
22.0000	0.047

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW10-4

Test No.: Step No.: RISING HEAD

Total well depth:	23.1	feet			
Depth to water:	12.32	feet			
Screen length (Le):	18	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	10.78	feet	rw=	0.4791	feet

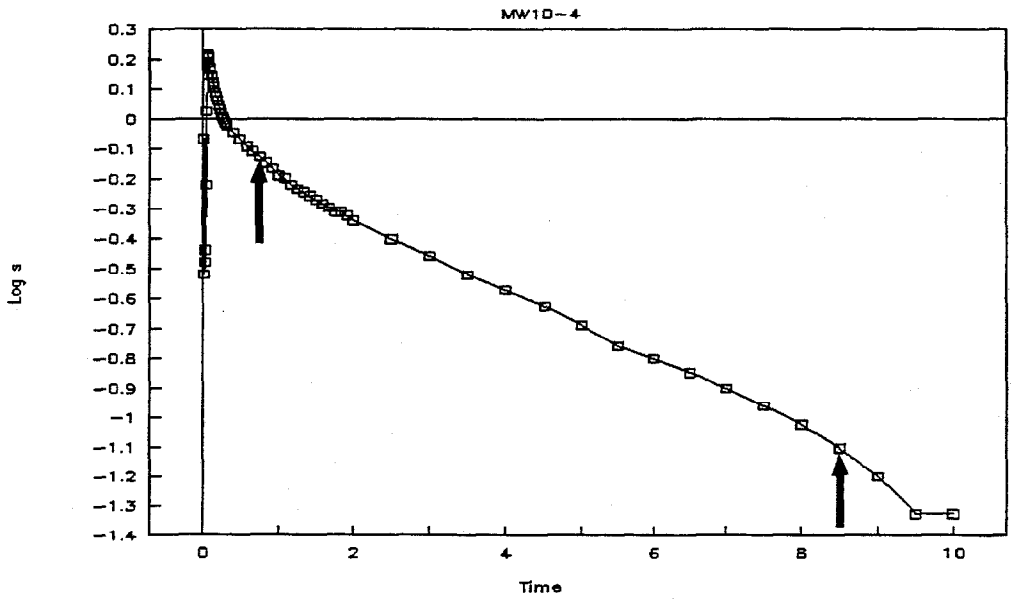
From type curve:
Where Le/rw= 37.565
C= 2.2

ln(Re/rw)= 2.4279

Bouwer and Rice Results:
==========
r squared = 0.9988

Hydraulic conductivity = 0.72 ft/day

Effective radial distance
of slug test = 5.4 feet



MW10–4RH

SE2000
Environmental Logger
02/21 16:02

Unit# 2 Test 1

Setups: INPUT 1

Type	Level (F)
I.D.	MW10–4
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	50.260
Offset	0.000
Delay mSEC	50.000

Step 1 02/21 11:59:28

Elapsed Time	INPUT 1
0.0000	–0.031
0.0083	0.855
0.0166	0.301
0.0250	0.332
0.0333	–0.364
0.0416	0.602
0.0500	1.061
0.0583	1.410
0.0666	1.647
0.0750	1.616
0.0833	1.552
0.1000	1.473
0.1166	1.394
0.1333	1.330
0.1500	1.283
0.1666	1.219
0.1833	1.188
0.2000	1.156
0.2166	1.109
0.2333	1.077
0.2500	1.045
0.2666	1.014
0.2833	0.998
0.3000	0.982
0.3166	0.966
0.3333	0.950
0.4166	0.903
0.5000	0.855
0.5833	0.808
0.6666	0.776
0.7500	0.744
0.8333	0.712
0.9166	0.681
1.0000	0.649
1.0833	0.633
1.1666	0.602
1.2500	0.586
1.3333	0.570
1.4166	0.554
1.5000	0.538
1.5833	0.522
1.6666	0.507
1.7500	0.491
1.8333	0.491
1.9166	0.475
2.0000	0.459
2.5000	0.396
3.0000	0.348
3.5000	0.301
4.0000	0.269
4.5000	0.237
5.0000	0.205
5.5000	0.174
6.0000	0.158
6.5000	0.142
7.0000	0.126
7.5000	0.110
8.0000	0.095
8.5000	0.079
9.0000	0.063
9.5000	0.047
10.0000	0.047
11.0000	0.031
12.0000	0.031
13.0000	0.031
14.0000	0.015
15.0000	0.000
16.0000	0.000

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW10-5

Test No.: Step No.: RISING HEAD

Total well depth:	22.1	feet			
Depth to water:	11.02	feet			
Screen length (Le):	17.5	feet			
Well diameter:	4	inches			
Borehole diameter:	8	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	11.08	feet	rw=	0.3333	feet

From type curve:
Where Le/rw= 52.5
C= 2.6

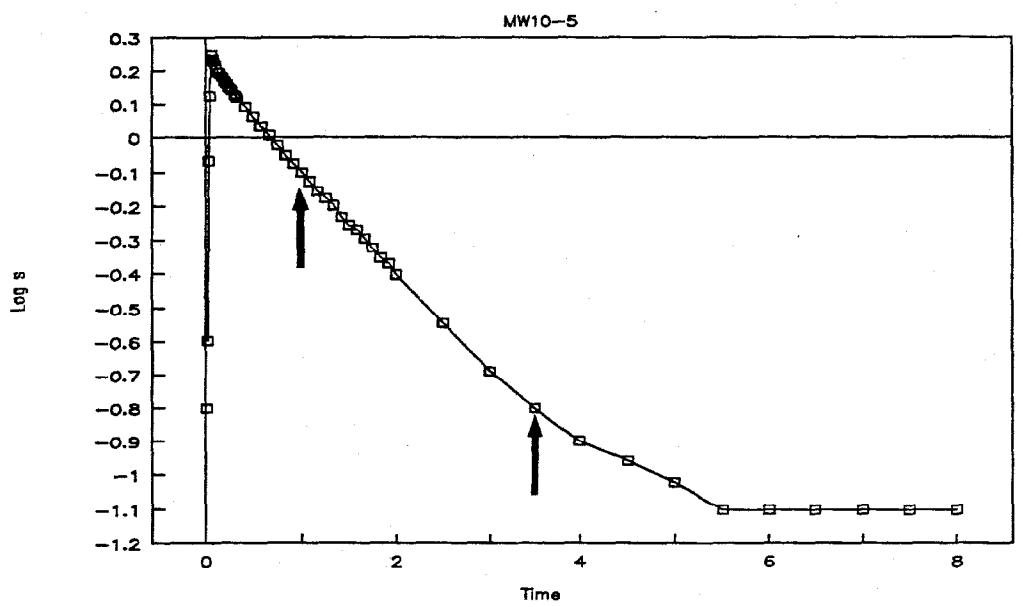
ln(Re/rw)= 2.7512

Bouwer and Rice Results:

r squared = 0.9965

Hydraulic conductivity = 1.98 ft/day

Effective radial distance
of slug test = 5.2 feet



MW10-5RH

SE2000
Environmental Logger
02/21 15:56

Unit# 2 Test 2

Setups: INPUT 1

Type Level (F)
I.D. MW10-5

Reference 0.000
SG 1.000
Linearity 0.000
Scale factor 50.260
Offset 0.000
Delay mSEC 50.000

Step 1 02/21 13:52:00

Elapsed Time	INPUT 1
0.0000	0.316
0.0083	0.158
0.0166	0.000
0.0250	0.253
0.0333	0.855
0.0416	1.330
0.0500	1.695
0.0583	1.774
0.0666	1.726
0.0750	1.711
0.0833	1.679
0.1000	1.647
0.1166	1.600
0.1333	1.568
0.1500	1.552
0.1666	1.521
0.1833	1.505
0.2000	1.473
0.2166	1.457
0.2333	1.441
0.2500	1.410
0.2666	1.394
0.2833	1.378
0.3000	1.346
0.3166	1.330
0.3333	1.315
0.4166	1.235
0.5000	1.156
0.5833	1.077
0.6666	1.014
0.7500	0.950
0.8333	0.887
0.9166	0.839
1.0000	0.792
1.0833	0.744
1.1666	0.697
1.2500	0.665
1.3333	0.633
1.4166	0.586
1.5000	0.554
1.5833	0.538
1.6666	0.507
1.7500	0.475
1.8333	0.443
1.9166	0.427
2.0000	0.396
2.5000	0.285
3.0000	0.205
3.5000	0.158
4.0000	0.126
4.5000	0.110
5.0000	0.095
5.5000	0.079
6.0000	0.079
6.5000	0.079
7.0000	0.079
7.5000	0.079
8.0000	0.079
8.5000	0.079
9.0000	0.079
9.5000	0.063
10.0000	0.079
11.0000	0.079
12.0000	0.079
13.0000	0.079
14.0000	0.079
15.0000	0.079

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW10-7

Test No.: Step No.: RISING HEAD

Total well depth:	23.2	feet			
Depth to water:	7.83	feet			
Screen length (Le):	16	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	15.37	feet	rw=	0.4791	feet

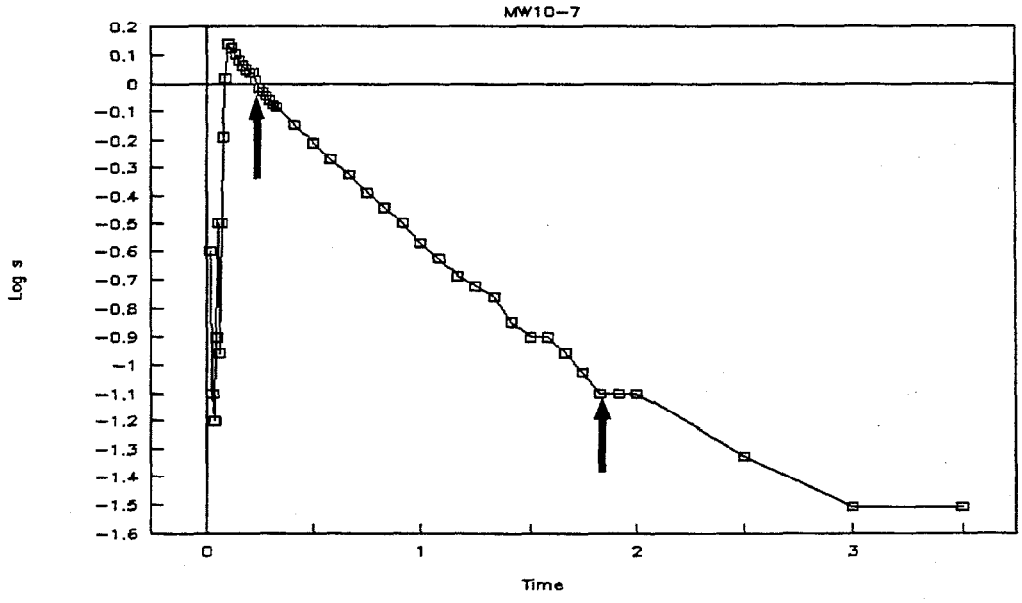
From type curve:
Where Le/rw= 33.391
C= 2.1

ln(Re/rw)= 2.6311

Bouwer and Rice Results:
==========
r squared = 0.9961

Hydraulic conductivity = 4.97 ft/day

Effective radial distance
of slug test = 6.7 feet



MW10–7RH

SE2000
Environmental Logger
02/21 15:53

Unit# 2 Test 3

Setups: INPUT 1

Type Level (F)
I.D. MW10–7

Reference 0.000
SG 1.000
Linearity 0.000
Scale factor 50.130
Offset 0.000
Delay mSEC 50.000

Step 1 02/21 14:43:20

Elapsed Time	INPUT 1
0.0000	0.000
0.0083	0.000
0.0166	0.252
0.0250	0.079
0.0333	0.063
0.0416	0.126
0.0500	0.316
0.0583	0.110
0.0666	0.316
0.0750	0.647
0.0833	1.042
0.1000	1.374
0.1166	1.327
0.1333	1.264
0.1500	1.201
0.1666	1.153
0.1833	1.122
0.2000	1.090
0.2166	1.090
0.2333	1.027
0.2500	0.963
0.2666	0.932
0.2833	0.900
0.3000	0.869
0.3166	0.837
0.3333	0.821
0.4166	0.711
0.5000	0.616
0.5833	0.537
0.6666	0.474
0.7500	0.410
0.8333	0.363
0.9166	0.316
1.0000	0.268
1.0833	0.237
1.1666	0.205
1.2500	0.189
1.3333	0.173
1.4166	0.142
1.5000	0.126
1.5833	0.126
1.6666	0.110
1.7500	0.094
1.8333	0.079
1.9166	0.079
2.0000	0.079
2.5000	0.047
3.0000	0.031
3.5000	0.031
4.0000	0.047
4.5000	0.047
5.0000	0.047
5.5000	0.047
6.0000	0.063
6.5000	0.063
7.0000	0.063
7.5000	0.079
8.0000	0.079
8.5000	0.079
9.0000	0.094
9.5000	0.094
10.0000	0.094
11.0000	0.126

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW11-2

Test No.: Step No.: RISING HEAD

Total well depth:	18	feet			
Depth to water:	3.34	feet			
Screen length (Le):	15.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	14.66	feet	rw=	0.4791	feet

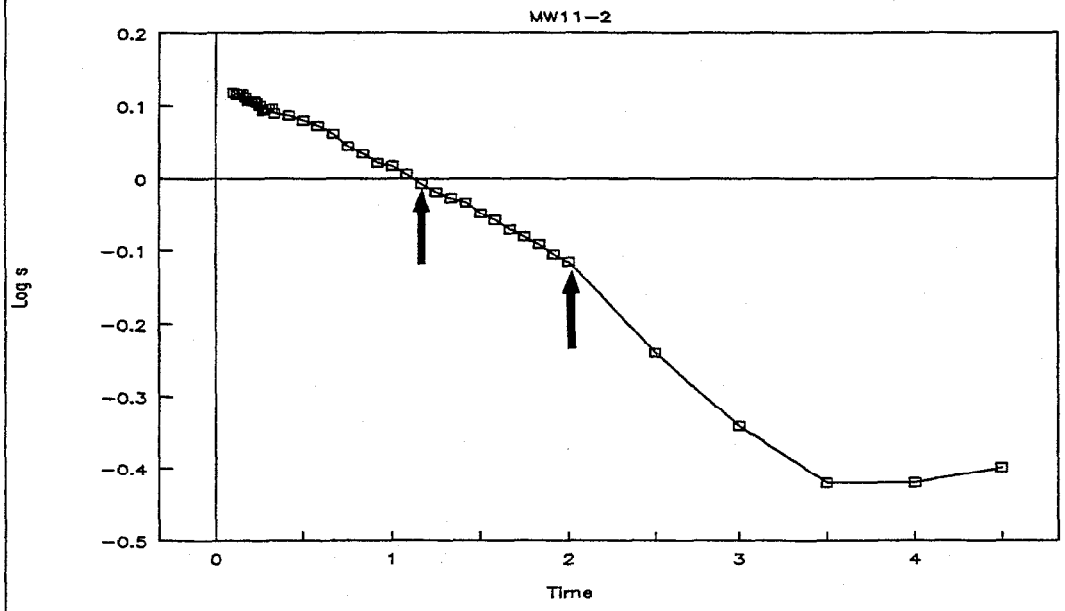
From type curve:
Where Le/rw= 32.347
C= 2.05

ln(Re/rw)= 2.5979

Bouwer and Rice Results:
==========
r squared = 0.9962

Hydraulic conductivity = 1.01 ft/day

Effective radial distance
of slug test = 6.4 feet



MW11-2RH

SE2000
Environmental Logger
03/26 22:47

Unit# 2 Test 1

Setups: INPUT 2

Type	Level (F)
I.D.	MW11-2
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	20.098
Offset	-0.210
Delay mSEC	50.000

Step 1 03/26 12:40:18

Elapsed Time	INPUT 2
0.0000	-0.057
0.0083	-0.069
0.0166	-0.088
0.0250	0.519
0.0333	-0.019
0.0416	0.925
0.0500	1.450
0.0583	1.355
0.0666	1.349
0.0750	1.324
0.0833	1.324
0.1000	1.311
0.1166	1.305
0.1333	1.305
0.1500	1.305
0.1666	1.292
0.1833	1.279
0.2000	1.279
0.2166	1.279
0.2333	1.273
0.2500	1.260
0.2666	1.241
0.2833	1.248
0.3000	1.248
0.3166	1.248
0.3333	1.229
0.4166	1.222
0.5000	1.203
0.5833	1.184
0.6666	1.153
0.7500	1.108
0.8333	1.083
0.9166	1.051
1.0000	1.039
1.0833	1.013
1.1666	0.982
1.2500	0.956
1.3333	0.937

Elapsed Time	INPUT 2
1.4166	0.925
1.5000	0.893
1.5833	0.874
1.6666	0.848
1.7500	0.829
1.8333	0.810
1.9166	0.785
2.0000	0.766
2.5000	0.576
3.0000	0.456
3.5000	0.380
4.0000	0.380
4.5000	0.399
5.0000	0.380
5.5000	0.348
6.0000	0.316
6.5000	0.278
7.0000	0.253
7.5000	0.215
8.0000	0.158
8.5000	0.133
9.0000	0.101
9.5000	0.107
10.0000	0.076
11.0000	0.069
12.0000	0.044
13.0000	-0.025
14.0000	0.000

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW11-4

Test No.: Step No.: RISING HEAD

Total well depth:	16.26	feet			
Depth to water:	3.24	feet			
Screen length (Le):	11.2	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	13.02	feet	rw=	0.4791	feet

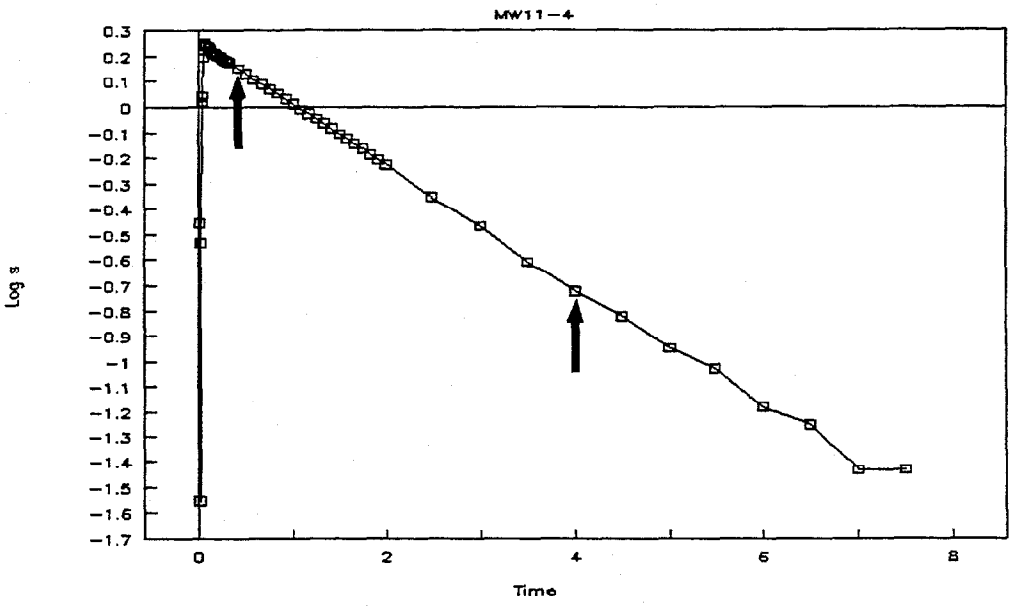
From type curve:
Where Le/rw= 23.373
C= 1.75

ln(Re/rw)= 2.4511

Bouwer and Rice Results:
==========
r squared = 0.9993

Hydraulic conductivity = 2.45 ft/day

Effective radial distance
of slug test = 5.6 feet



MW11–4RH

SE2000
Environmental Logger
03/26 22:50

Unit# 2 Test 1

Setups: INPUT 1

Type	Level (F)
I.D.	MW11–4
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	30.068
Offset	–0.123
Delay mSEC	50.000

Step 1 03/26 12:40:18

Elapsed Time	INPUT 1
0.0000	0.000
0.0083	0.350
0.0166	–0.028
0.0250	0.293
0.0333	1.042
0.0416	1.099
0.0500	1.563
0.0583	1.763
0.0666	1.772
0.0750	1.753
0.0833	1.734
0.1000	1.725
0.1166	1.696
0.1333	1.668
0.1500	1.630
0.1666	1.639
0.1833	1.611
0.2000	1.592
0.2166	1.582
0.2333	1.573
0.2500	1.545
0.2666	1.535
0.2833	1.516
0.3000	1.507
0.3166	1.507
0.3333	1.488
0.4166	1.412
0.5000	1.345
0.5833	1.279
0.6666	1.232
0.7500	1.175
0.8333	1.127
0.9166	1.071
1.0000	1.023
1.0833	0.976
1.1666	0.938
1.2500	0.900
1.3333	0.862

Elapsed Time	INPUT 1
1.4166	0.824
1.5000	0.786
1.5833	0.758
1.6666	0.720
1.7500	0.691
1.8333	0.654
1.9166	0.625
2.0000	0.597
2.5000	0.445
3.0000	0.341
3.5000	0.246
4.0000	0.189
4.5000	0.151
5.0000	0.113
5.5000	0.094
6.0000	0.066
6.5000	0.056
7.0000	0.037
7.5000	0.037
8.0000	0.028
8.5000	0.018
9.0000	0.028
9.5000	0.009
10.0000	0.000
11.0000	0.009
12.0000	–0.018
13.0000	–0.018
14.0000	–0.018

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW19-4

Test No.: Step No.: RISING HEAD

Total well depth:	16.1	feet			
Depth to water:	12.19	feet			
Screen length (Le):	15	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	3.91	feet	rw=	0.4791	feet

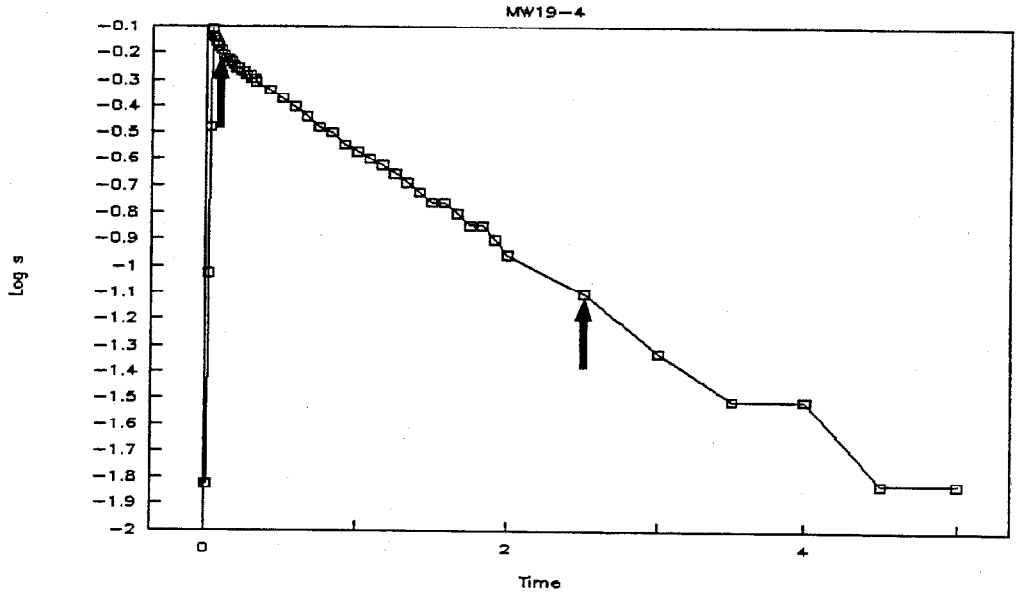
From type curve:
Where Le/rw= 31.304
C= 2.1

ln(Re/rw)= 1.6918

Bouwer and Rice Results:
==========
r squared = 0.9981

Hydraulic conductivity = 1.96 ft/day

Effective radial distance
of slug test = 2.6 feet



MW19–4RH

SE2000
Environmental Logger
02/21 16:05

Unit# 2 Test 0

Setups: INPUT 2

Type Level (F)
I.D. MW19–4

Reference 0.000
SG 1.000
Linearity 0.000
Scale factor 50.130
Offset 0.000
Delay mSEC 50.000

Step 1 02/21 10:01:58

Elapsed Time	INPUT 2
0.0000	0.015
0.0083	0.015
0.0166	0.015
0.0250	0.094
0.0333	0.331
0.0416	0.774
0.0500	0.726
0.0583	0.711
0.0666	0.695
0.0750	0.679
0.0833	0.663
0.1000	0.647
0.1166	0.616
0.1333	0.600
0.1500	0.600
0.1666	0.584
0.1833	0.568
0.2000	0.553
0.2166	0.553
0.2333	0.537
0.2500	0.537
0.2666	0.521
0.2833	0.521
0.3000	0.505
0.3166	0.505
0.3333	0.489
0.4166	0.458
0.5000	0.426
0.5833	0.395
0.6666	0.363
0.7500	0.331
0.8333	0.316
0.9166	0.284
1.0000	0.268
1.0833	0.252
1.1666	0.237
1.2500	0.221
1.3333	0.205

Elapsed Time	INPUT 2
1.4166	0.189
1.5000	0.173
1.5833	0.173
1.6666	0.158
1.7500	0.142
1.8333	0.142
1.9166	0.126
2.0000	0.110
2.5000	0.079
3.0000	0.047
3.5000	0.031
4.0000	0.031
4.5000	0.015
5.0000	0.015
5.5000	0.015
6.0000	0.000
6.5000	0.015
7.0000	0.015
7.5000	0.015
8.0000	0.015
8.5000	0.015
9.0000	0.015
9.5000	0.015
10.0000	0.015
11.0000	0.015

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW19-5

Test No.: Step No.: RISING HEAD

Total well depth:	20	feet			
Depth to water:	15.35	feet			
Screen length (Le):	17.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	4.65	feet	rw=	0.4791	feet

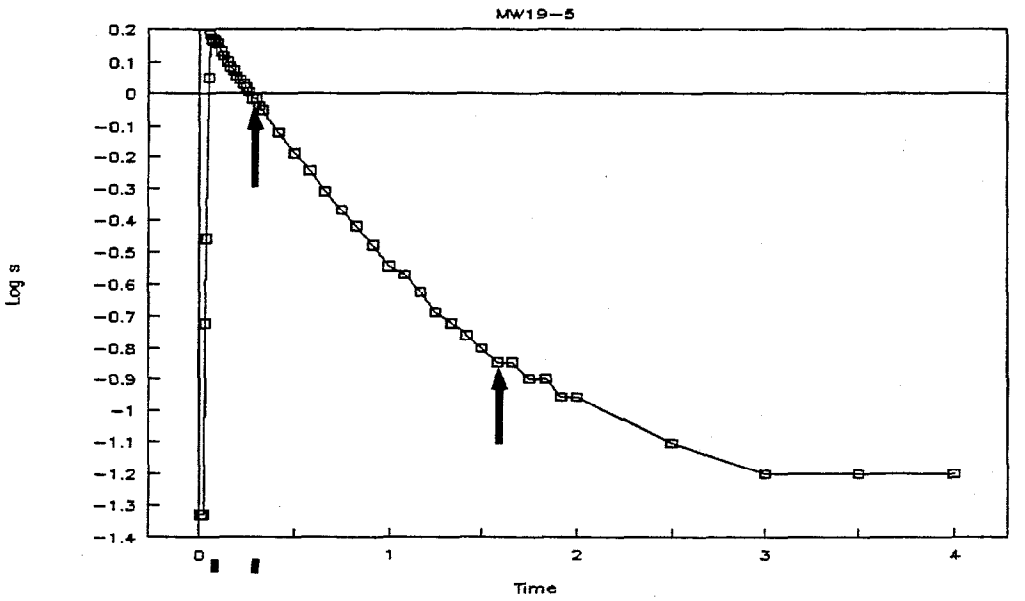
From type curve:
Where Le/rw= 36.521
C= 2.2

ln(Re/rw)= 1.8373

Bouwer and Rice Results:
==========
r squared = 0.9936

Hydraulic conductivity = 3.00 ft/day

Effective radial distance
of slug test = 3.0 feet



MW19–5RH

SE2000
Environmental Logger
02/21 16:09

Unit# 2 Test 0

Setups: INPUT 1

Type	Level (F)
I.D.	MW19–5
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	50.260
Offset	0.000
Delay mSEC	50.000

Step 1 02/21 10:01:58

Elapsed Time	INPUT 1
0.0000	0.031
0.0083	0.047
0.0166	0.047
0.0250	0.047
0.0333	0.190
0.0416	0.348
0.0500	1.124
0.0583	1.536
0.0666	1.489
0.0750	1.473
0.0833	1.457
0.1000	1.441
0.1166	1.362
0.1333	1.315
0.1500	1.267
0.1666	1.219
0.1833	1.188
0.2000	1.140
0.2166	1.109
0.2333	1.077
0.2500	1.045
0.2666	1.014
0.2833	0.966
0.3000	0.966
0.3166	0.918
0.3333	0.887
0.4166	0.760
0.5000	0.649
0.5833	0.570
0.6666	0.491
0.7500	0.427
0.8333	0.380
0.9166	0.332
1.0000	0.285
1.0833	0.269
1.1666	0.237
1.2500	0.205
1.3333	0.190

Elapsed Time	INPUT 1
1.4166	0.174
1.5000	0.158
1.5833	0.142
1.6666	0.142
1.7500	0.126
1.8333	0.126
1.9166	0.110
2.0000	0.110
2.5000	0.079
3.0000	0.063
3.5000	0.063
4.0000	0.063
4.5000	0.063
5.0000	0.063
5.5000	0.063
6.0000	0.063
6.5000	0.063
7.0000	0.063
7.5000	0.063
8.0000	0.063
8.5000	0.063
9.0000	0.063
9.5000	0.063
10.0000	0.063
11.0000	0.110

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW26-1

Test No.: Step No.: RISING HEAD

Total well depth:	24	feet			
Depth to water:	8.13	feet			
Screen length (Le):	17	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	15.87	feet	rw=	0.4791	feet

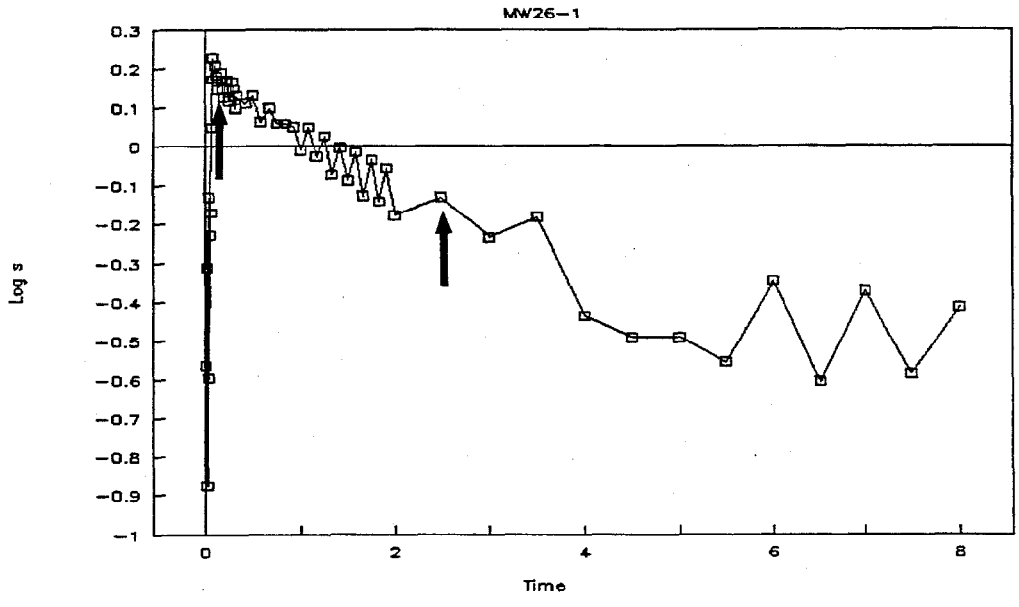
From type curve:
Where Le/rw= 35.478
C= 2.2

ln(Re/rw)= 2.6576

Bouwer and Rice Results:
==========
r squared = 0.9006

Hydraulic conductivity = 1.09 ft/day

Effective radial distance
of slug test = 6.8 feet



MW26-1RH

SE2000
Environmental Logger
03/26 22:29

Unit# 2 Test 4

Setups: INPUT 2

Type	Level (F)
I.D.	MW26-1
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	20.098
Offset	-0.210
Delay mSEC	50.000

Step 1 03/26 16:38:13

Elapsed Time	INPUT 2
0.0000	0.107
0.0083	0.272
0.0166	0.133
0.0250	0.487
0.0333	0.741
0.0416	0.253
0.0500	0.589
0.0583	0.677
0.0666	1.115
0.0750	1.685
0.0833	1.488
0.1000	1.615
0.1166	1.520
0.1333	1.393
0.1500	1.488
0.1666	1.552
0.1833	1.406
0.2000	1.330
0.2166	1.476
0.2333	1.482
0.2500	1.305
0.2666	1.330
0.2833	1.463
0.3000	1.400
0.3166	1.248
0.3333	1.343
0.4166	1.286
0.5000	1.343
0.5833	1.153
0.6666	1.248
0.7500	1.140
0.8333	1.140
0.9166	1.121
1.0000	0.975
1.0833	1.115
1.1666	0.937
1.2500	1.058
1.3333	0.842

Elapsed Time	INPUT 2
1.4166	0.988
1.5000	0.817
1.5833	0.963
1.6666	0.747
1.7500	0.918
1.8333	0.722
1.9166	0.874
2.0000	0.665
2.5000	0.741
3.0000	0.582
3.5000	0.658
4.0000	0.367
4.5000	0.323
5.0000	0.323
5.5000	0.278
6.0000	0.449
6.5000	0.247
7.0000	0.424
7.5000	0.259
8.0000	0.386
8.5000	0.145
9.0000	0.380
9.5000	0.183
10.0000	0.158
11.0000	0.209
12.0000	0.177
13.0000	0.221

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW26-3

Test No.: Step No.: RISING HEAD

Total well depth:	22	feet			
Depth to water:	8.25	feet			
Screen length (Le):	17	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	13.75	feet	rw=	0.4791	feet

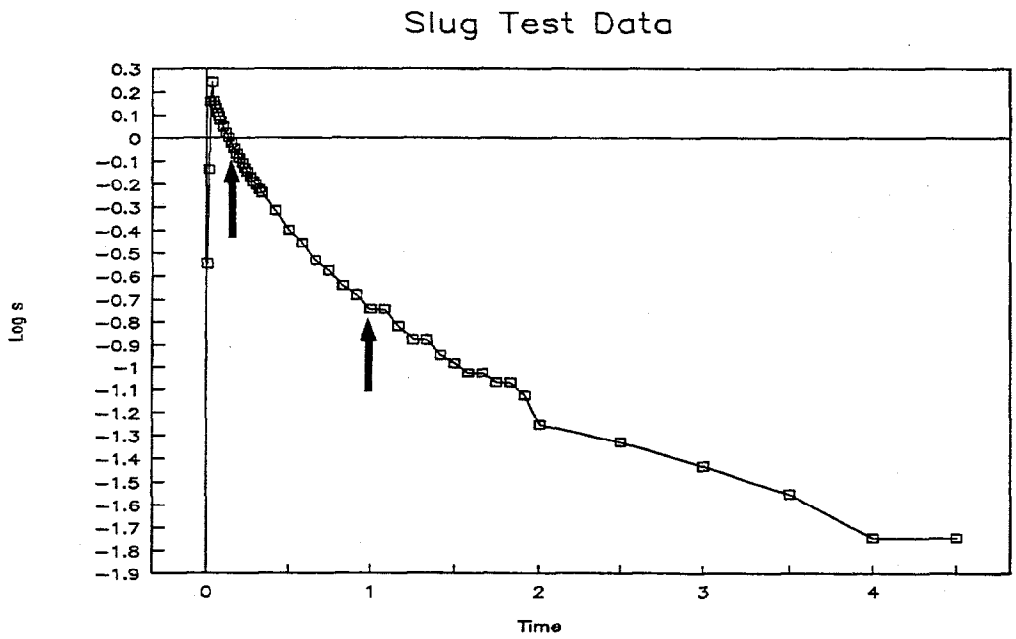
From type curve:
Where Le/rw= 35.478
C= 2.2

ln(Re/rw)= 2.5660

Bouwer and Rice Results:
==========
r squared = 0.9929

Hydraulic conductivity = 5.43 ft/day

Effective radial distance
of slug test = 6.2 feet



MW26-3RH

SE2000
Environmental Logger
04/03 16:21

Unit# 2 Test 4

Setups: INPUT 1

Type	Level (F)
I.D.	MW26-3
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	30.068
Offset	-0.123
Delay mSEC	50.000

Step 1 03/26 16:38:13

Elapsed Time	INPUT 1
0.0000	-0.018
0.0083	0.284
0.0166	0.729
0.0250	1.440
0.0333	1.744
0.0416	1.450
0.0500	1.383
0.0583	1.345
0.0666	1.289
0.0750	1.241
0.0833	1.194
0.1000	1.118
0.1166	1.052
0.1333	1.004
0.1500	0.947
0.1666	0.900
0.1833	0.853
0.2000	0.815
0.2166	0.777
0.2333	0.739
0.2500	0.710
0.2666	0.672
0.2833	0.644
0.3000	0.625
0.3166	0.597
0.3333	0.578
0.4166	0.483
0.5000	0.398
0.5833	0.350
0.6666	0.293
0.7500	0.265
0.8333	0.227
0.9166	0.208
1.0000	0.180
1.0833	0.180
1.1666	0.151
1.2500	0.132
1.3333	0.132

Elapsed Time	INPUT 1
1.4166	0.113
1.5000	0.104
1.5833	0.094
1.6666	0.094
1.7500	0.085
1.8333	0.085
1.9166	0.075
2.0000	0.056
2.5000	0.047
3.0000	0.037
3.5000	0.028
4.0000	0.018
4.5000	0.018
5.0000	0.028
5.5000	0.028
6.0000	0.009
6.5000	0.009
7.0000	0.009
7.5000	0.009
8.0000	0.009
8.5000	0.009
9.0000	0.009
9.5000	0.009
10.0000	0.009
11.0000	0.009
12.0000	0.009
13.0000	0.009

END

SLUG TEST ANALYSIS

Site location: NWS EARLE
Well ID: MW26-4

Test No.: Step No.: RISING HEAD

Total well depth:	16.31	feet			
Depth to water:	10.29	feet			
Screen length (Le):	12.5	feet			
Well diameter:	4	inches			
Borehole diameter:	11.5	inches	Rc=	0.1666	feet
Sat. thickness (Lw):	6.02	feet	rw=	0.4791	feet

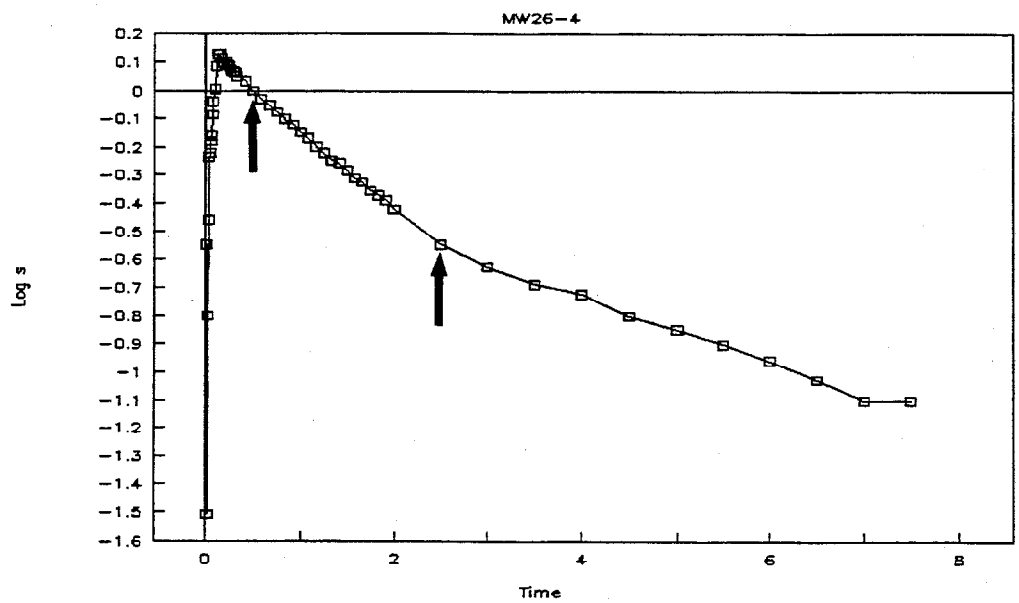
From type curve:
Where Le/rw= 26.086
C= 1.8

ln(Re/rw)= 1.9855

Bouwer and Rice Results:
==========
r squared = 0.9983

Hydraulic conductivity = 2.01 ft/day

Effective radial distance
of slug test = 3.5 feet



MW26–4RH

SE2000
Environmental Logger
02/20 22:20

Unit# 2 Test 0

Setups: INPUT 1

Type	Level (F)
I.D.	MW26–4
Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	50.130
Offset	0.000
Delay mSEC	1000.00

Step 1 02/20 10:08:56

Elapsed Time	INPUT 1
0.0000	–0.015
0.0083	0.284
0.0166	0.031
0.0250	0.158
0.0333	0.347
0.0416	0.584
0.0500	0.600
0.0583	0.663
0.0666	0.695
0.0750	0.821
0.0833	0.916
0.1000	1.011
0.1166	1.216
0.1333	1.327
0.1500	1.327
0.1666	1.295
0.1833	1.248
0.2000	1.232
0.2166	1.248
0.2333	1.232
0.2500	1.216
0.2666	1.185
0.2833	1.169
0.3000	1.153
0.3166	1.153
0.3333	1.122
0.4166	1.074
0.5000	0.995
0.5833	0.932
0.6666	0.884
0.7500	0.837
0.8333	0.790
0.9166	0.758
1.0000	0.711
1.0833	0.679
1.1666	0.632
1.2500	0.600
1.3333	0.568

Elapsed Time	INPUT 1
1.4166	0.553
1.5000	0.521
1.5833	0.489
1.6666	0.474
1.7500	0.442
1.8333	0.426
1.9166	0.410
2.0000	0.379
2.5000	0.284
3.0000	0.237
3.5000	0.205
4.0000	0.189
4.5000	0.158
5.0000	0.142
5.5000	0.126
6.0000	0.110
6.5000	0.094
7.0000	0.079
7.5000	0.079
8.0000	0.063
8.5000	0.047
9.0000	0.047
9.5000	0.047
10.0000	0.047
11.0000	0.047
12.0000	0.047
13.0000	0.047
14.0000	0.047
15.0000	0.031
16.0000	0.047
17.0000	0.047

END

APPENDIX C

ANALYTICAL DATA AND QA/QC EVALUATION RESULTS (SI)

Table 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.

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

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
regulatory concentration

ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits NRC - No specific 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
regulatory concentration

ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits NRC - No specific 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
regulatory concentration

ND - Not detected
A - Duplicate sample
J - Estimated concentration less than quantification limits NRC - No specific but greater than instrument detection limits.

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.

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

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

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

Table 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

Table 5-21

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

Sample Number	Petroleum Hydrocarbons (mg/kg)	EPTOX (mg/L) 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

Table 5-22

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

	Analyte				
	Petroleum Hydrocarbons	EPTOX (mg/L)			
Sample Number	(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

Table 5-23

Analytical Results for Groundwater Samples Collected 1991 -- 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

APPENDIX D

WATER QUALITY CRITERIA FOR LANDFILLS NATIONALLY AND IN STATE OF NEW JERSEY

Table 1

Leachate Composition of Sanitary Landfills

in the United States

Parameter	Range of Analyses
Chemical Oxygen Demand, mg/L	40 - 89,520
Five-day Biochemical Oxygen Demand, mg/L	81 - 33,360
Total Organic Carbon, mg/L	256 - 28,000
pH	3.7 - 8.5
Total Solids, mg/L	0 - 59,200
Total Dissolved Solids, mg/L	584 - 44,900
Total Suspended Solids, mg/L	10 - 700
Specific Conductance, umohs/cm	2,810 - 16,800
Total Alkalinity, mg/L as $CaCO_3$	0 - 20,850
Total Hardness, mg/L as $CaCO_3$	0 - 22,800
Total Phosphorus, mg/L as P	0 - 130
Orthophosphate, mg/L as P	6.5 - 85
Ammonia-Nitrogen, mg/L as N	0 - 1,106
Nitrate-Nitrogen, mg/L as N	0.2 - 10.29
Calcium, mg/L	50 - 7,200
Chloride, mg/L	4.7 - 2,467
Sodium, mg/L	0 - 7,700
Potassium, mg/L	28 - 3,770
Sulfate, mg/L	1 - 1,558
Manganese, mg/L	0.09 - 125
Magnesium, mg/L	17 - 15,600
Iron, mg/L	0 - 2,820
Zinc, mg/L	0 - 370
Copper, mg/L	0 - 9.9
Cadmium, mg/L	0.03 - 17
Lead, mg/L	0.01 - 2

Source: Chian and De Walle, 1976 in Compilation and Evaluation of Leaching Test Methods, EPA-600/2-78-095, May 1978.

Table 1. Group Statistics for selected chemical parameters that frequently exceed WQS/MCL at Industrial/Commercial Landfills in New Jersey.

Parameter	WQS/MCL*	Percent Below Detection Levels	Concentrations of Observations Above Detection levels (ug/L) Arranged by Percentiles									
			N	1	5	10	25	50	75	90	95	100
Ammonia	(500)	22.7	4521	10	60	80	200	1000	10000	80000	187000	478000
BOD	(-)	26.1	4521	1	1	2	3	6	17	42	96	9,999
COD	(-)	20.8	5290	1	5	8	15	37	115	360	844	634000
TDS	(500)	0.6	9444	12	33	51	116	300	885	2502	6739	41560
TOC	(-)	7.0	6614	0.6	1.1	1.5	3	8	27	97	284	11800
TOX	(-)	17.5	2734	0.01	5	10	20	64	418	2655	7542	1.0E6
Nitrate	(10)	30.7	4321	0	0.06	0.1	0.3	1	3	12	34	80000
Cadmium	(10)	66.3	998	0	1	2	5	10	31	230	1200	454000
Chromium	(50)	71.2	918	0	0.3	1	5	10	25	50	100	1000
Iron	(300)	12.6	6473	1.5	20	50	240	2620	18840	52820	90650	9.7E6
Lead	(50)	56.4	2934	0	1	2	5	10	50	159	427	502000
Mercury	(2)	70.8	906	0	0	.001	0.2	0.6	2	8	8	1130

WQS/MCL*=Water quality standard/maximum contaminant level, reported as ug/L, except BOD, COD, Nitrates, TDS, & TOX reported as mg/L

Table 2. Group Statistics for selected chemical parameters that frequently exceed WQS/MCL at Industrial/Commercial Landfills in New Jersey.

Parameter	WQS/MCL*	Percent Below Detection Levels	N	Concentrations of Observations Above Detection levels (ug/L) Arranged by Percentiles								
				1	5	10	25	50	75	90	95	100
Benzene	(1)	84.0	565	0	0	0	3	6	16	74	167	4495
Chlorobenzene	(4)	81.0	716	0	0	0	5	18	186	883	1908	13000
1,1-Dichloroethane	(-)	91.7	277	0	0	0	0	4.7	5	17	51	4300
1,2-Dichloroethane	(2)	92.6	249	0	0	0	0	2	5	18	56	4490
Ethylbenzene	(-)	89.1	380	0	0	0	1	5	21	110	341	5750
Methylene Chloride	(2)	74.4	907	0	0	1	4	5	11	34	91	2800
Tetrachloroethylene	(1)	85.2	544	0	0	0	3	10	63	170	520	7400
Toluene	(-)	87.5	447	0	0	0	1	5	22	320	1056	130000
Trichloroethane	(26)	92.1	268	0	0	0	0	3	5	11	21	610
Trichloroethylene	(1)	85.5	554	0	0	0	2	11	76	300	760	12000

WQS/MCL*=Water quality standard/maximum contaminant level, reported as ug/L

Table 3. Group Statistics for selected chemical parameters that frequently exceed WQS/MCL at Municipal/Sanitary Landfills in New Jersey.

Parameter	WQS/MCL*	Percent Below Detection Levels	Concentrations of Observations Above Detection levels (ug/L) Arranged by Percentiles									
			N	1	5	10	25	50	75	90	95	100
Ammonia	(500)	26.5	5280	10	60	100	300	2000	13000	43000	81000	345000
BOD	(-)	32.5	5000	0.8	1	2	3	7	17	42	93	476
COD	(-)	23.6	5777	2	5	9	16	38	92	239	508	404000
TOC	(-)	13.0	6066	0.6	1.1	1.4	3	8	23	63	128	2000
TOX	(-)	37.2	1046	0.03	5	10	16	41	110	381	987	300030
Nitrate	(10)	28.8	5220	0.01	0.05	0.1	0.3	1	2	6	10	1316
Cadmium	(10)	69.2	782	0	0.1	1	2	6	11	28	62	1.2E6
Chromium	(50)	80.5	543	0	0.1	1	5	20	49	50	128	400000
Iron	(300)	9.1	7088	4	30	67	220	1814	19000	53730	80410	6.0E6
Lead	(50)	60.0	3032	0	1	3	5	15	50	118	249	120000
Mercury	(2)	74.3	613	0	0.1	0.2	0.4	0.8	2	4	8	970

WQS/MCL*=Water quality standard/Maximum contaminant level, ug/L, except BOD, COD, Nitrates, TDS, & TOX reported as mg/L

Table 4. Group Statistics for selected chemical parameters that frequently exceed WQS/MCL at Municipal/Sanitary Landfills in New Jersey.

Parameter	WQS/MCL*	Percent Below Detection Levels	Concentrations of Observations Above Detection levels (ug/L) Arranged by Percentiles									
			N	1	5	10	25	50	75	90	95	100
Benzene	(1)	82.4	490	0	0	0.5	1	5	11	28	70	7892
Chlorobenzene	(4)	79.0	583	0	0	0.5	2	7	18	47	87	680
1,1-Dichloroethane	(-)	88.6	314	0	0	0	1	5	7	77	200	901
1,2-Dichloroethane	(2)	91.3	236	0	0	0	0.5	1	5	10	57	62934
Ethylbenzene	(-)	87.0	362	0	0	0.1	1	5	15	49	87	2913
Methylene Chloride	(2)	75.1	692	0.5	0.5	1	4	7	17	90	236	3400
Tetrachloroethylene	(1)	87.4	346	0	0	0	1	5	8	35	71	410
Toluene	(-)	84.2	435	0	0	0.5	1	5	10	83	294	23581
Trichloroethane	(26)	86.3	379	0	0	0.1	1	5	17	82	210	720
Trichloroethylene	(1)	85.8	390	0	0	0.2	1	5	9	41	71	2700

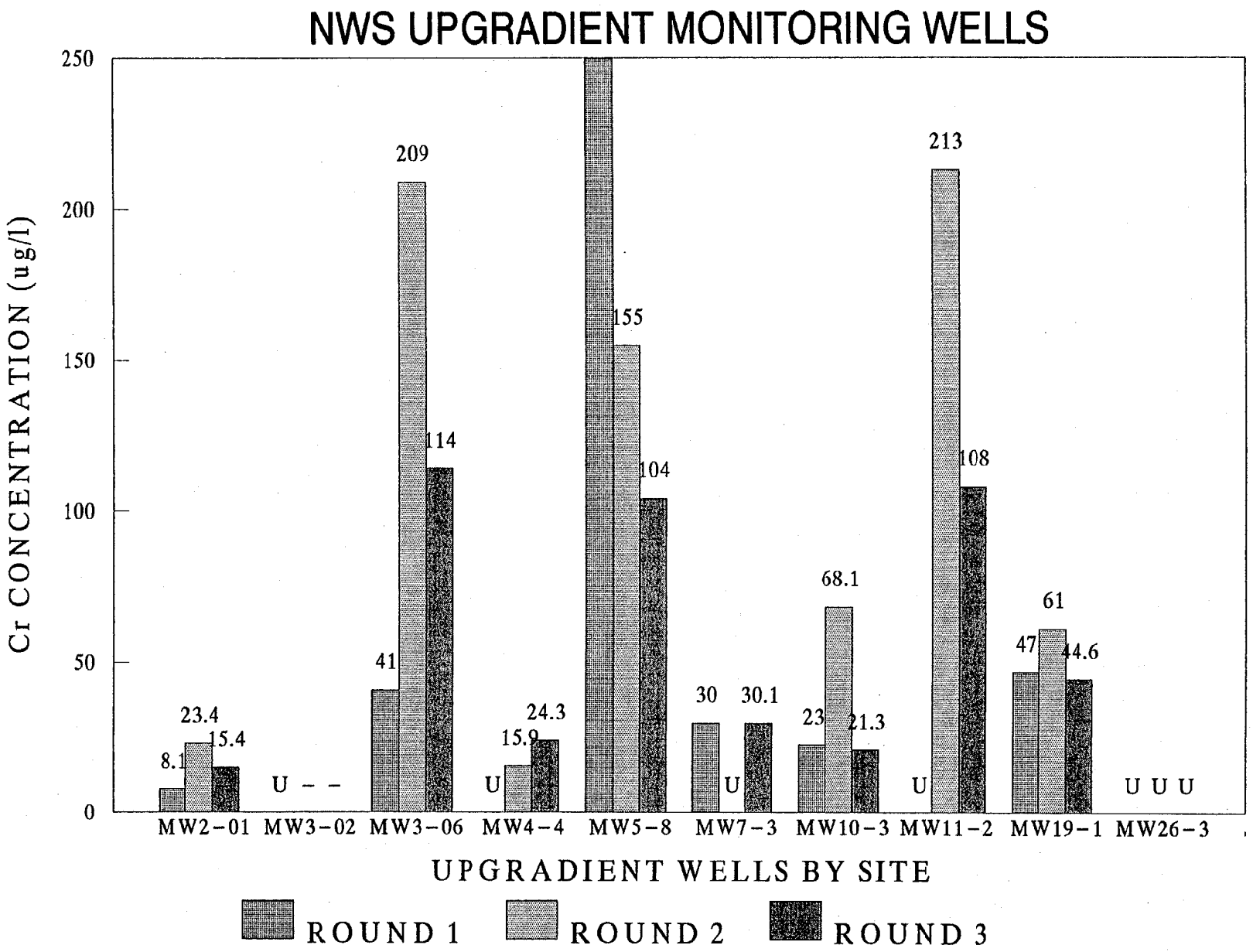
WQS/MCL*=Water quality standard/Maximum contaminant level, reported as ug/L

APPENDIX E

GRAPHS FOR METALS IN GROUNDWATER CONCENTRATIONS

NWS Earle, Background Monitoring Wells
(MEAN CONCENTRATIONS FOR KEY METALS IN UPGRADIENT MONITORING WELLS)

Compounds (ug/L)	MW2-01	MW3-02	MW3-06	MW4-4	MW5-8	MW7-3	MW10-3	MW11-2	MW19-1	MW26-3	
Chromium											
Round 1: March, 1991	8.1	U	41	U	1200	30	23	U	47	U	
Round 2: October, 1991	23.4	-	209	15.9	155	U	68.1	213	61	U	
Round 3: November, 1991	15.4	-	114	24.3	104	30.1	21.3	108	44.6	U	
										MAX	1200
								STD. DEVIATION	215.21	MIN	U
							(Calculated with outlying value-1,200 ug/l)			MEAN	91
Iron											
Round 1: March, 1991	590	10900	20700	12600	150000	30300	4900	1200	5400	2600	
Round 2: October, 1991	2230	-	113000	23400	21600	9070	7420	32000	7520	3200	
Round 3: November, 1991	3260	-	56400	17400	13300	48200	4490	16600	6980	3270	
										MAX	150000
								STD. DEVIATION	32854.91	MIN	590
							(Calculated with outlying value-150,000 ug/l)			MEAN	22447
Lead											
Round 1: March, 1991	3.3	2	22	6	38	10	2.1	1.6	4.8	3.5	
Round 2: October, 1991	3	-	51.3	6.9	U	6.1	5.9	20.3	9.1	U	
Round 3: November, 1991	3.3	-	24.9	17.3	4.2	10.7	14	U	12.3	U	
										MAX	51.3
								STD. DEVIATION	11.72	MIN	U
							9			MEAN	10
Zinc											
Round 1: March, 1991	17	42	16	49	120	11	18	37	U	6.7	
Round 2: October, 1991	50		213	68.4	47.9	U	32.4	58.8	23.5	U	
Round 3: November, 1991	21.4		99.2	156	45.4	58.2	U	77.7	39.8	43.4	
										MAX	213
										MIN	U
								STD. DEVIATION	48.15	MEAN	48


NWS UPGRADIENT MONITORING WELLS
Cr CONCENTRATION (ug/l)
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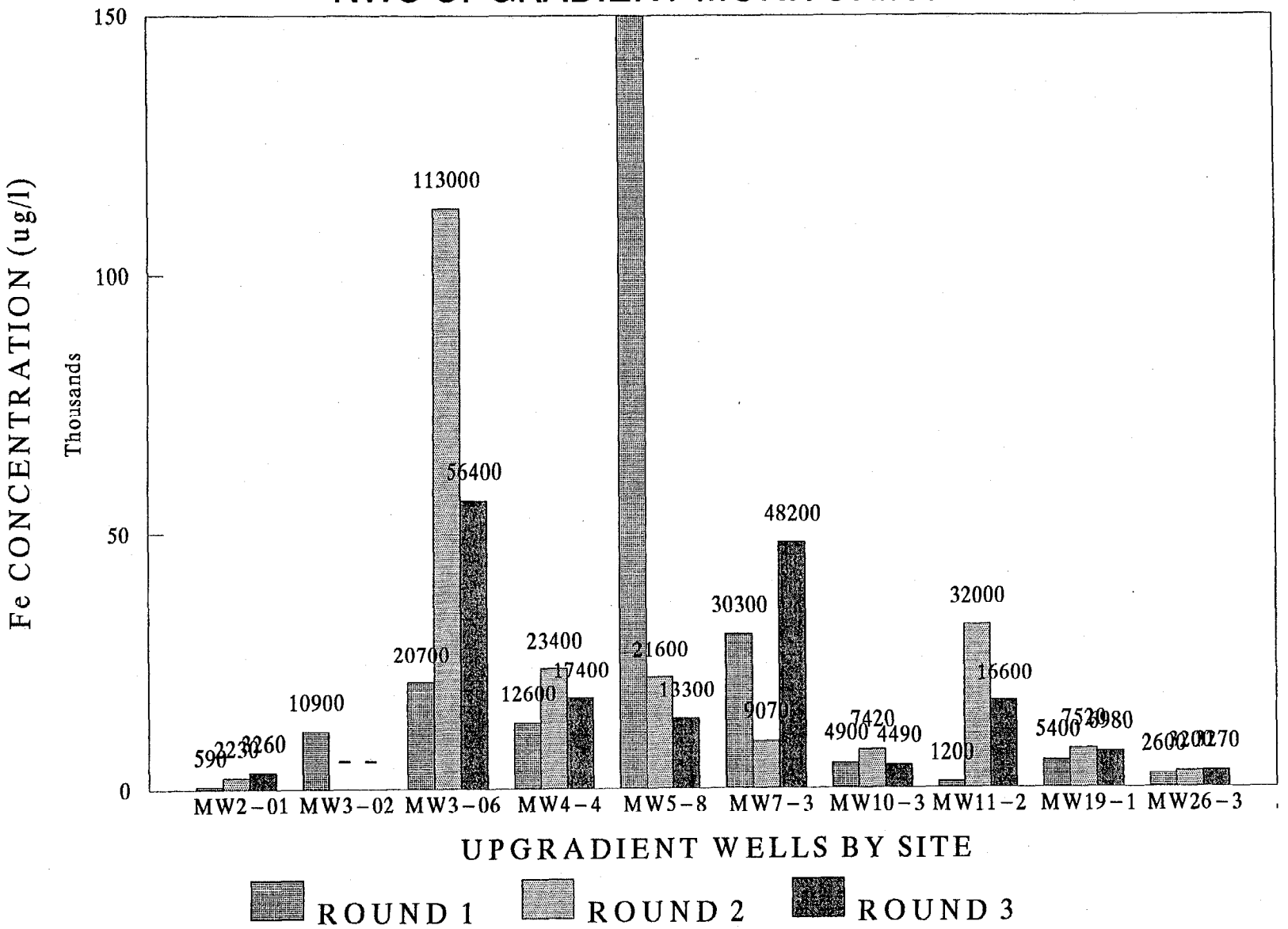
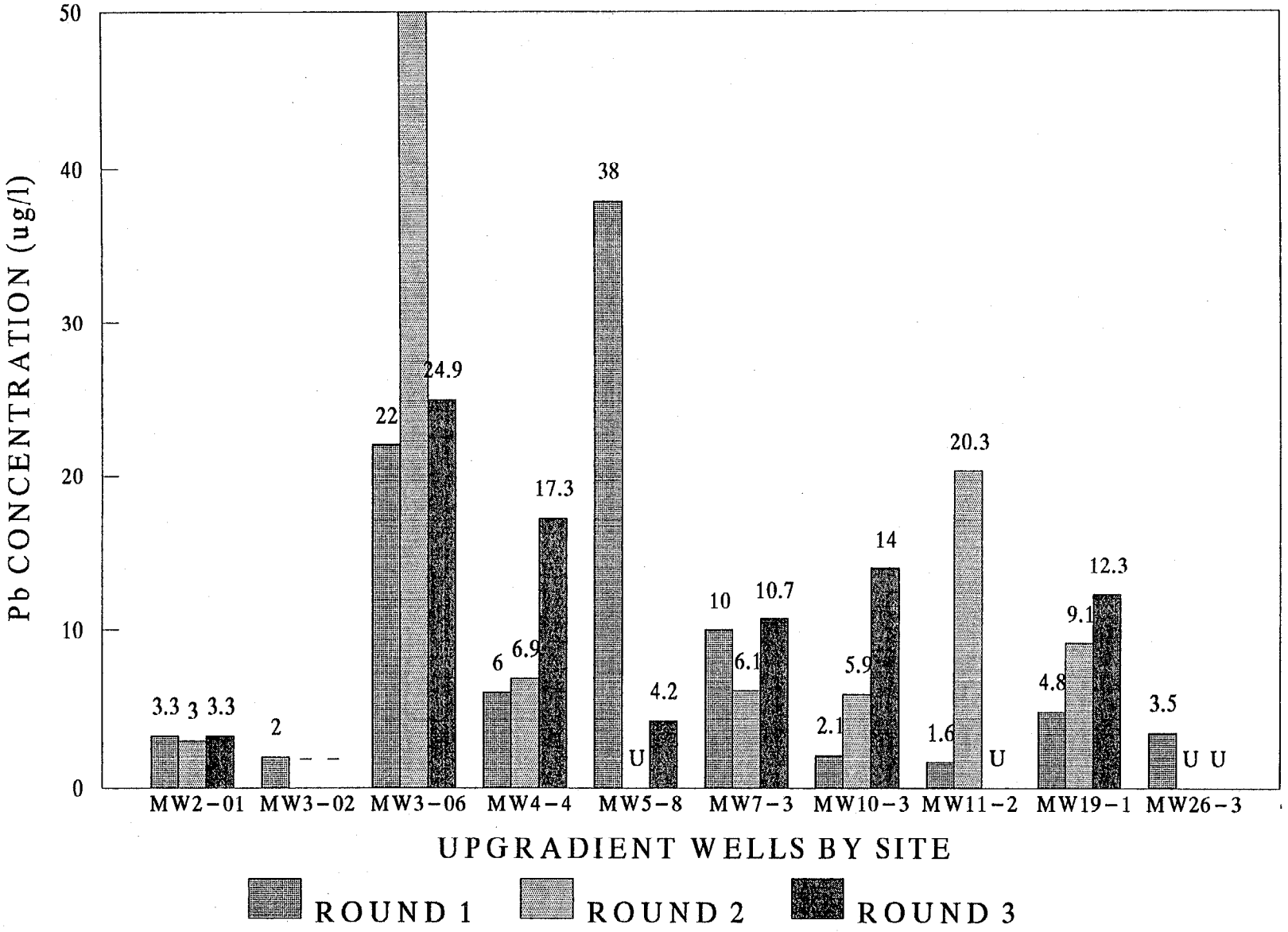
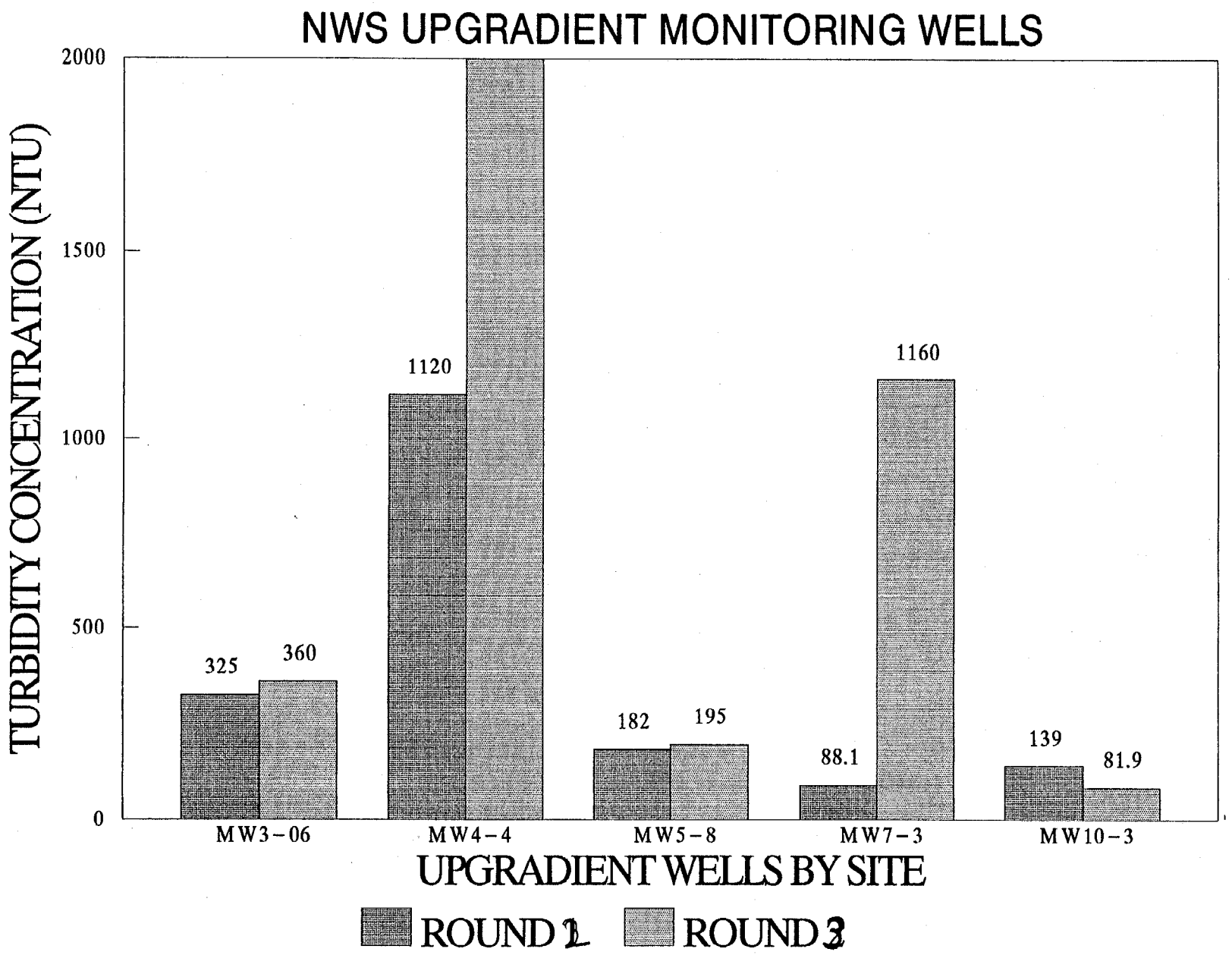
200
150
100
50
0
8.1
23.4
15.4
U - -
41
209
114
U
15.9
24.3
155
104
30
U
30.1
23
68.1
21.3
U
213
108
47
61
44.6
U U U
MW2-01
MW3-02
MW3-06
MW4-4
MW5-8
MW7-3
MW10-3
MW11-2
MW19-1
MW26-3
UPGRADIENT WELLS BY SITE
ROUND 1
ROUND 2
ROUND 3

NWS UPGRADIENT MONITORING WELLS



NWS UPGRADIENT MONITORING WELLS




NWS UPGRADIENT MONITORING WELLS
TURBIDITY CONCENTRATION (NTU)
2000
1500
1000
500
0
325
360
1120
182
195
88.1
1160
139
81.9
MW3-06
MW4-4
MW5-8
MW7-3
MW10-3
UPGRADIENT WELLS BY SITE
ROUND 1
ROUND 3

NWS Earle, Site 2 (ODS)

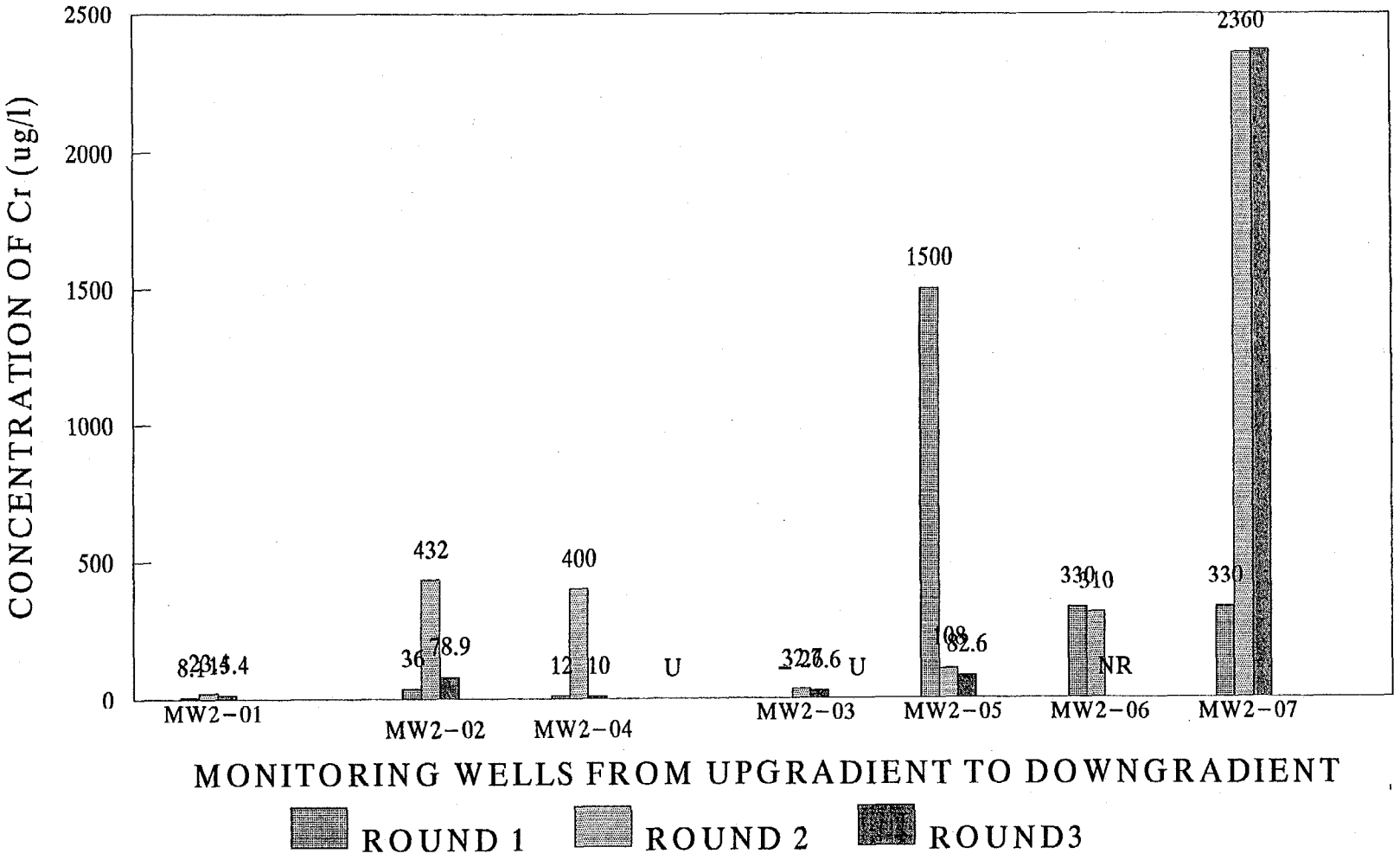
Compounds	Upgradient Well	Crossgradient		Downgradient			
(ug/L)	MW2-01	MW2-02	MW2-04	MW2-03	MW2-05	MW2-06	MW2-07
Round 1: March, 1991							
Cadmium	- U	- U	- U	- U	- U	- U	4.5
Chromium	8.1	36	12	- U	1500	330	330
Iron	590	5300	1300	8.8	202000	42000	51300
Lead	3.3	1.4	2	6.8	28	15	21
Zinc	17	78	15	- U	190	67	91
Round 2: October, 1991							
Cadmium	5 U	5 U	5 U	5 U	5 U	5 U	5
Chromium	23.4	432	400	32.7	108	310	2360
Iron	2230	52600	62200	4860	1480	42000	?
Lead	3 U	7	6.2	3 U	3	6.7	190
Zinc	50	91.3	82.8	52.5	29.6	74.2	817
Round 3: November, 1991							
Cadmium	-	-	-	-	-	-	-
Chromium	15.4	78.9	10 U	26.6	82.6	NR	2370
Iron	3260	9770	350	3670	111000	NR	300000
Lead	3.3	3 U	5.9	3 U	3 U	NR	130
Zinc	21.4	85	41.6	44.5	49.5	NR	657

Legend: U = Not detected

NR = Not requested

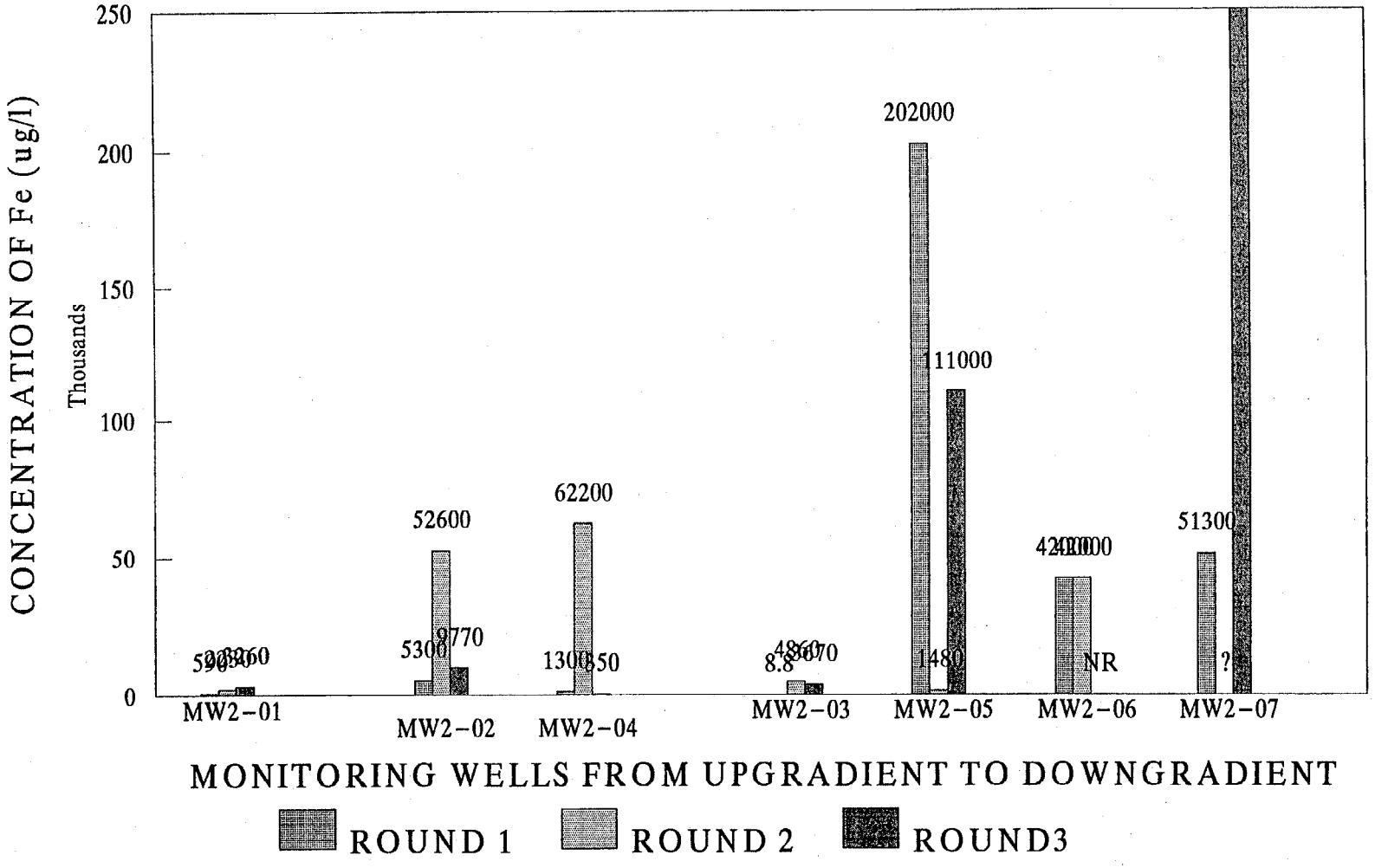
SITE 2

ORDNANCE DEMILITARIZATION SITE



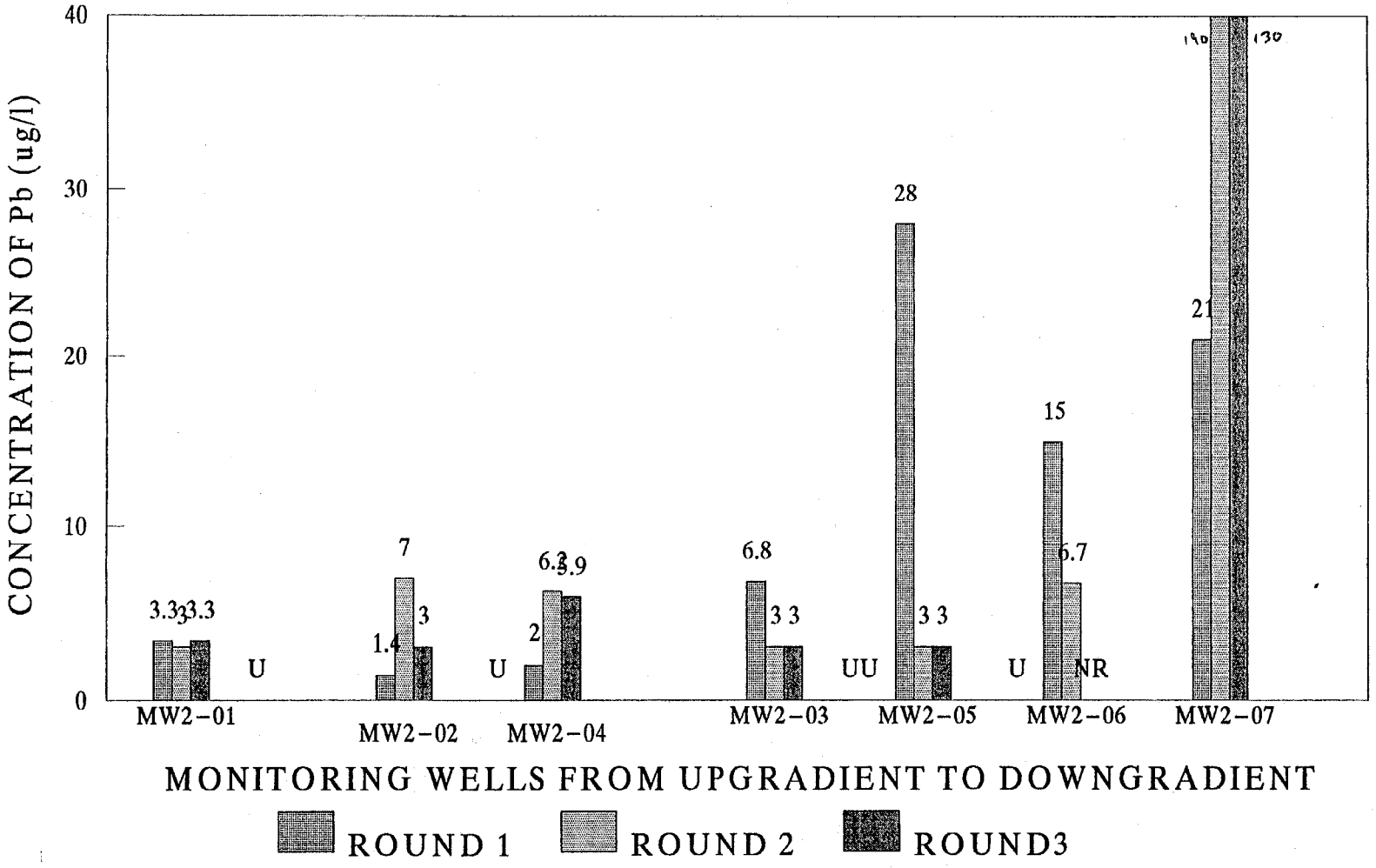
SITE 2

ORDNANCE DEMILITARIZATION SITE



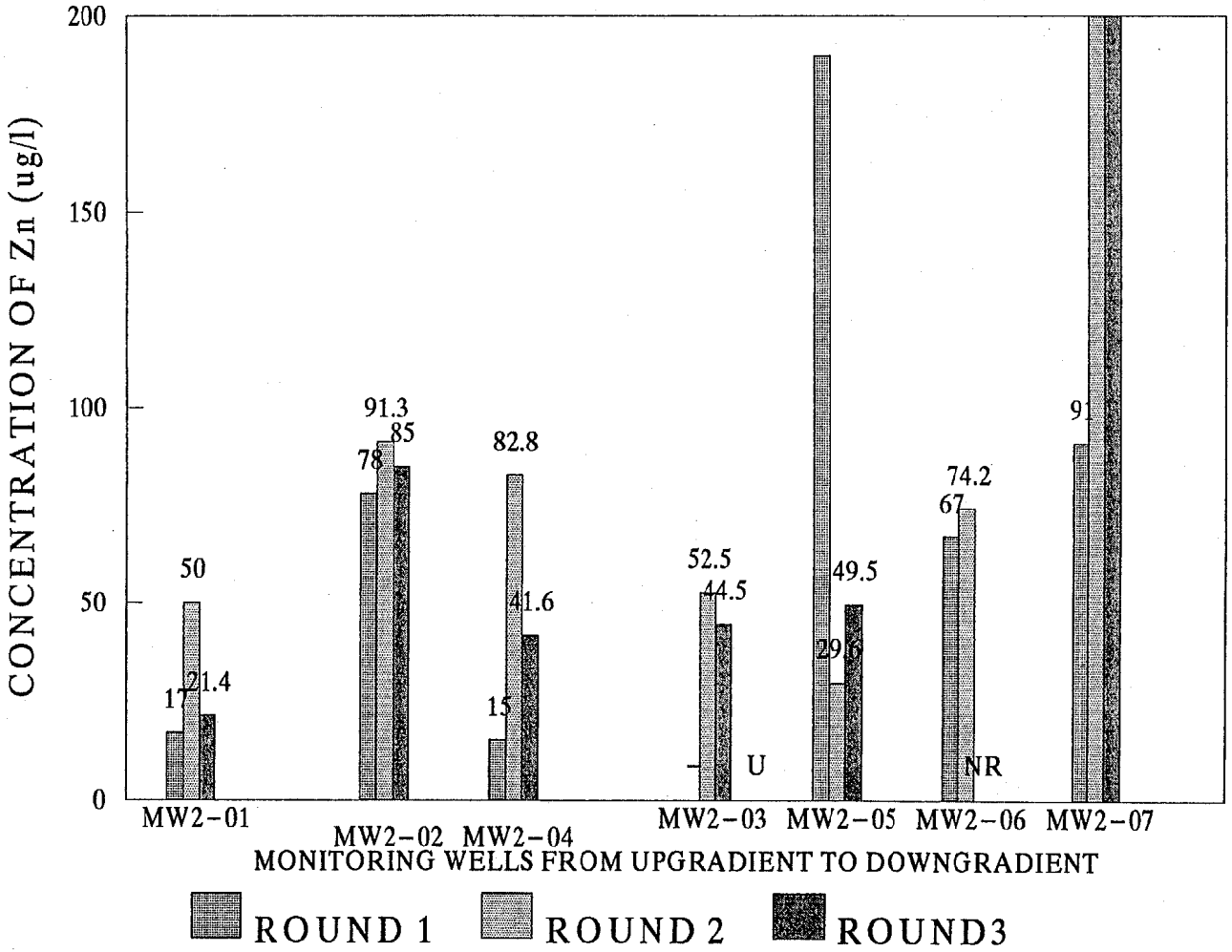
SITE 2

ORDNANCE DEMILITARIZATION SITE



SITE 2

ORDNANCE DEMILITARIZATION SITE



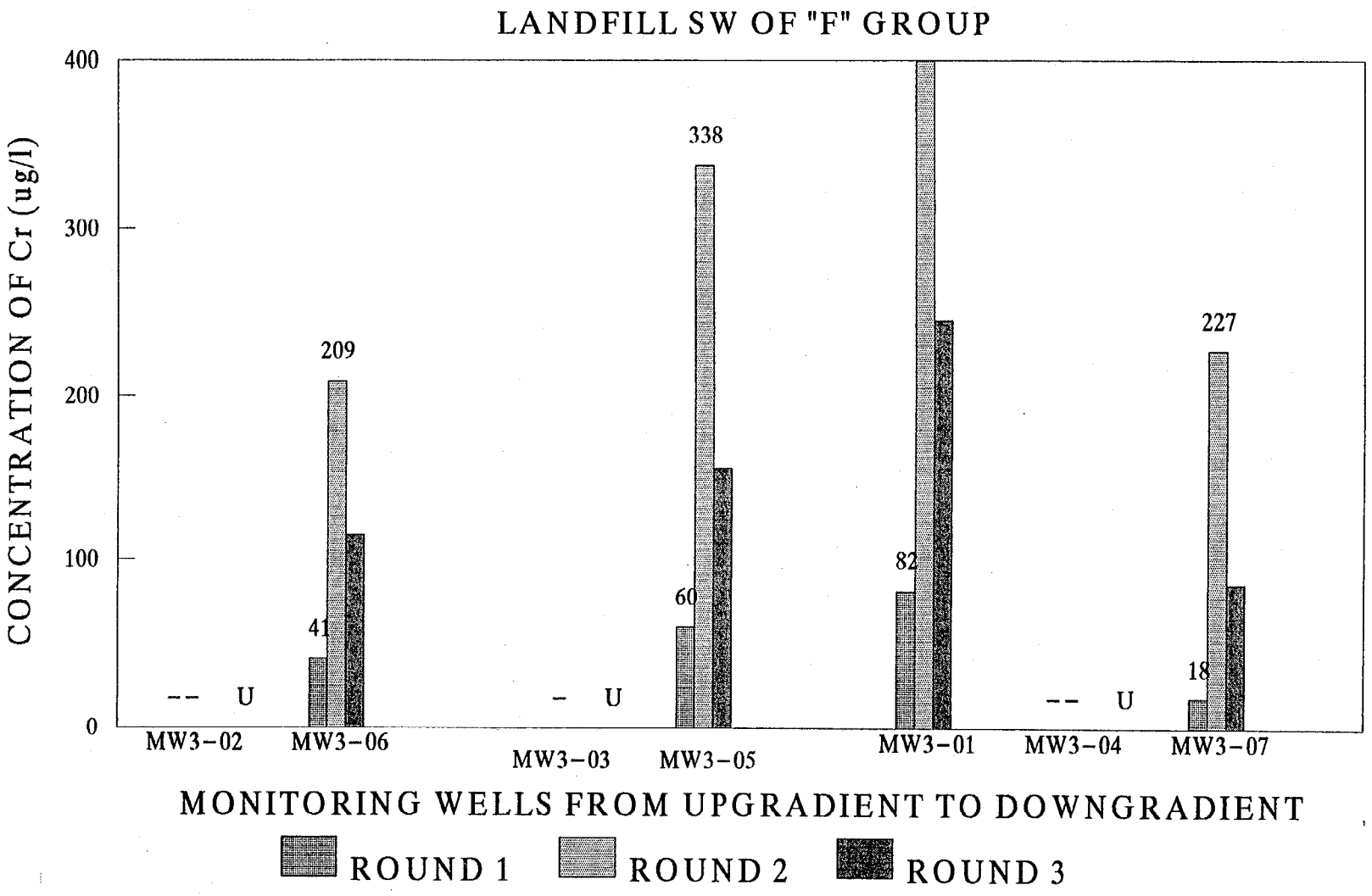
NWS Earle, SITE 3

Compounds	Upgradient		Crossgradient		Downgradient Wells		
(ug/L)	MW3-02	MW3-06	MW3-03	MW3-05	MW3-01	MW3-04	MW3-07
Round 1: March, 1991							
Cadmium	- U	- U	U	21	44	- U	- U
Chromium	- U	41	U	60	82	- U	18
Iron	10900	20700	810	41300	244000	170000	9200
Lead	2	22	U	30	35	11	6.8
Zinc	420	16	42	320	87	260	15
Round 2: October, 1991							
Cadmium	-	5 U	-	30	49.2	-	19
Chromium	-	209	-	338	641	-	227
Iron	-	113000	-	369000	1240000	-	111000
Lead	-	51.3	-	114	147	-	59.7
Zinc	-	213	-	835	400 U	-	288
Round 3: November, 1991							
Cadmium	-	5 U	-	34.7	23.5	-	33.6
Chromium	-	114	-	157	245	-	86.1
Iron	-	56400	-	524000	355000	-	19000
Lead	-	24.9	-	157	4.5	-	42.5
Zinc	-	99.2	-	699	314	-	592

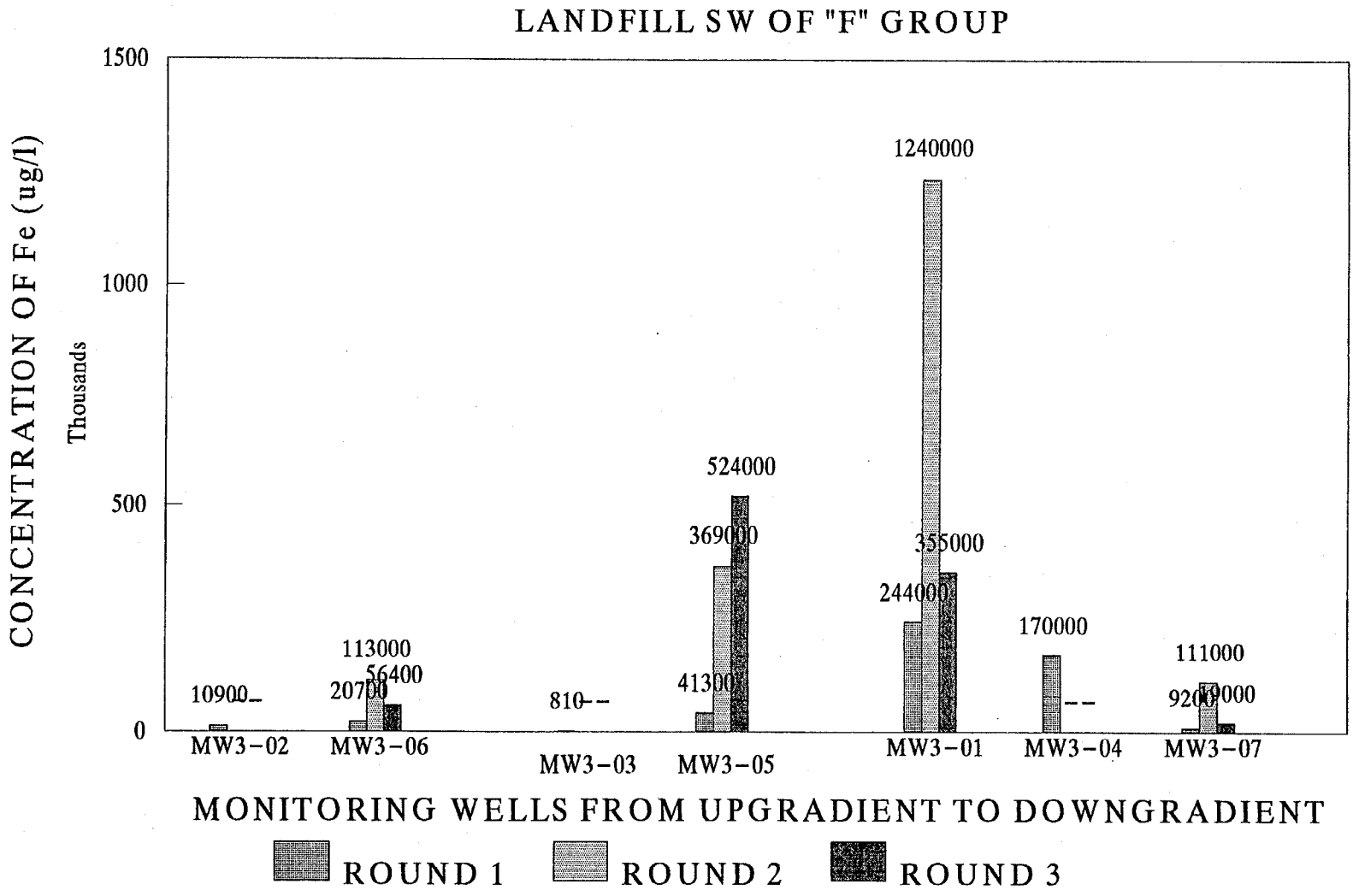
Legend: U = Not detected

NR = Not requested

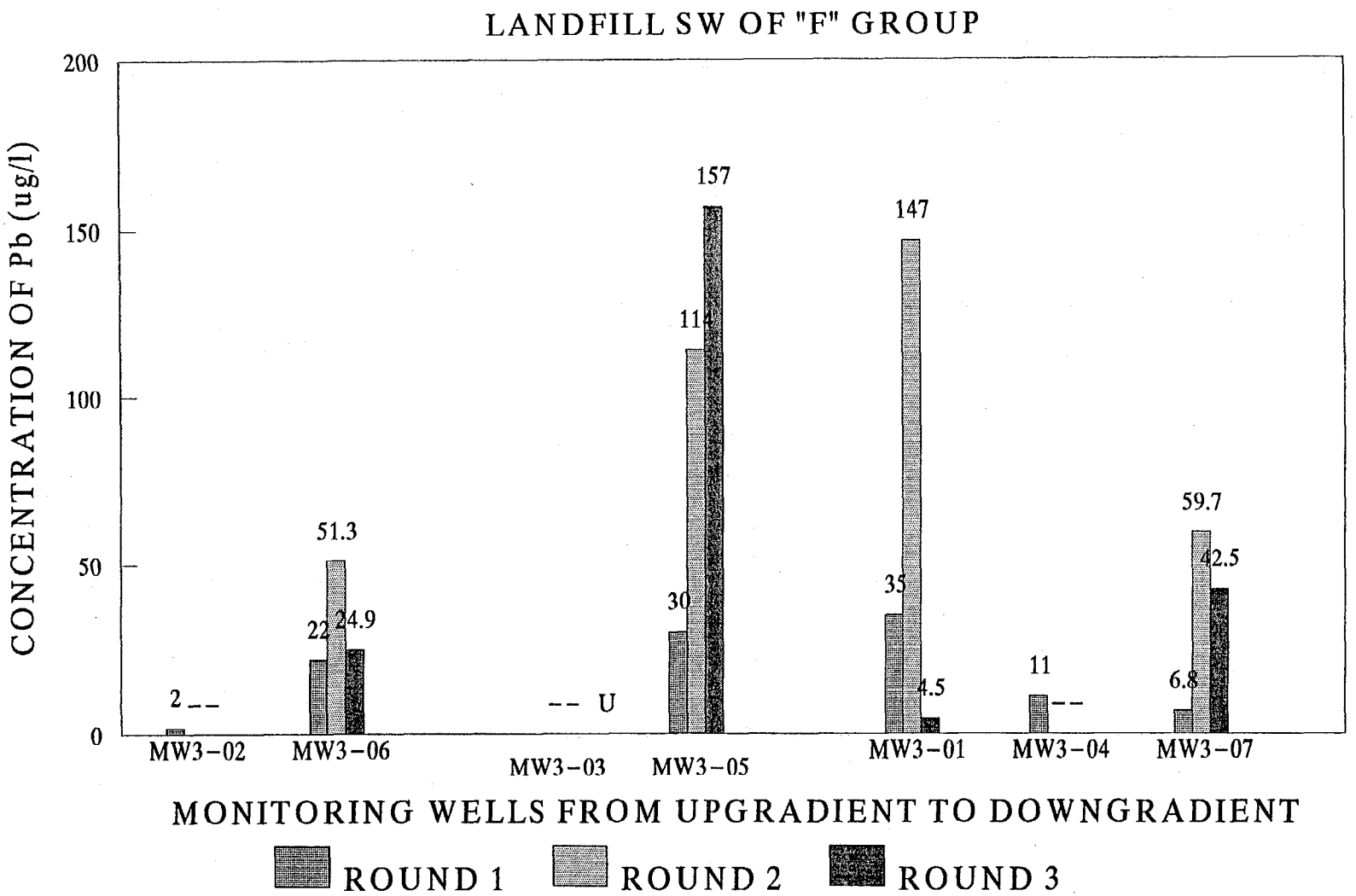
SITE 3


LANDFILL SW OF "F" GROUP
CONCENTRATION OF Cr (ug/l)
400
300
200
100
0
209
41
338
60
82
227
18
-- U
- U
-- U
MW3-02
MW3-06
MW3-03
MW3-05
MW3-01
MW3-04
MW3-07
MONITORING WELLS FROM UPGRADIENT TO DOWNGRADIENT
ROUND 1
ROUND 2
ROUND 3

SITE 3


LANDFILL SW OF "F" GROUP
CONCENTRATION OF Fe (ug/l)
Thousands
1500
1000
500
0
10900
113000
20700
56400
810
413000
369000
524000
1240000
244000
355000
170000
111000
92000
MW3-02
MW3-06
MW3-03
MW3-05
MW3-01
MW3-04
MW3-07
MONITORING WELLS FROM UPGRADIENT TO DOWNGRADIENT
ROUND 1
ROUND 2
ROUND 3

SITE 3


LANDFILL SW OF "F" GROUP
CONCENTRATION OF Pb (ug/l)
200
150
100
50
0
2
--
22
51.3
24.9
--
U
30
114
157
35
147
4.5
11
--
6.8
59.7
42.5
MW3-02
MW3-06
MW3-03
MW3-05
MW3-01
MW3-04
MW3-07
MONITORING WELLS FROM UPGRADIENT TO DOWNGRADIENT
ROUND 1
ROUND 2
ROUND 3

NWS Earle, Site 4 Landfill West of "D" Group

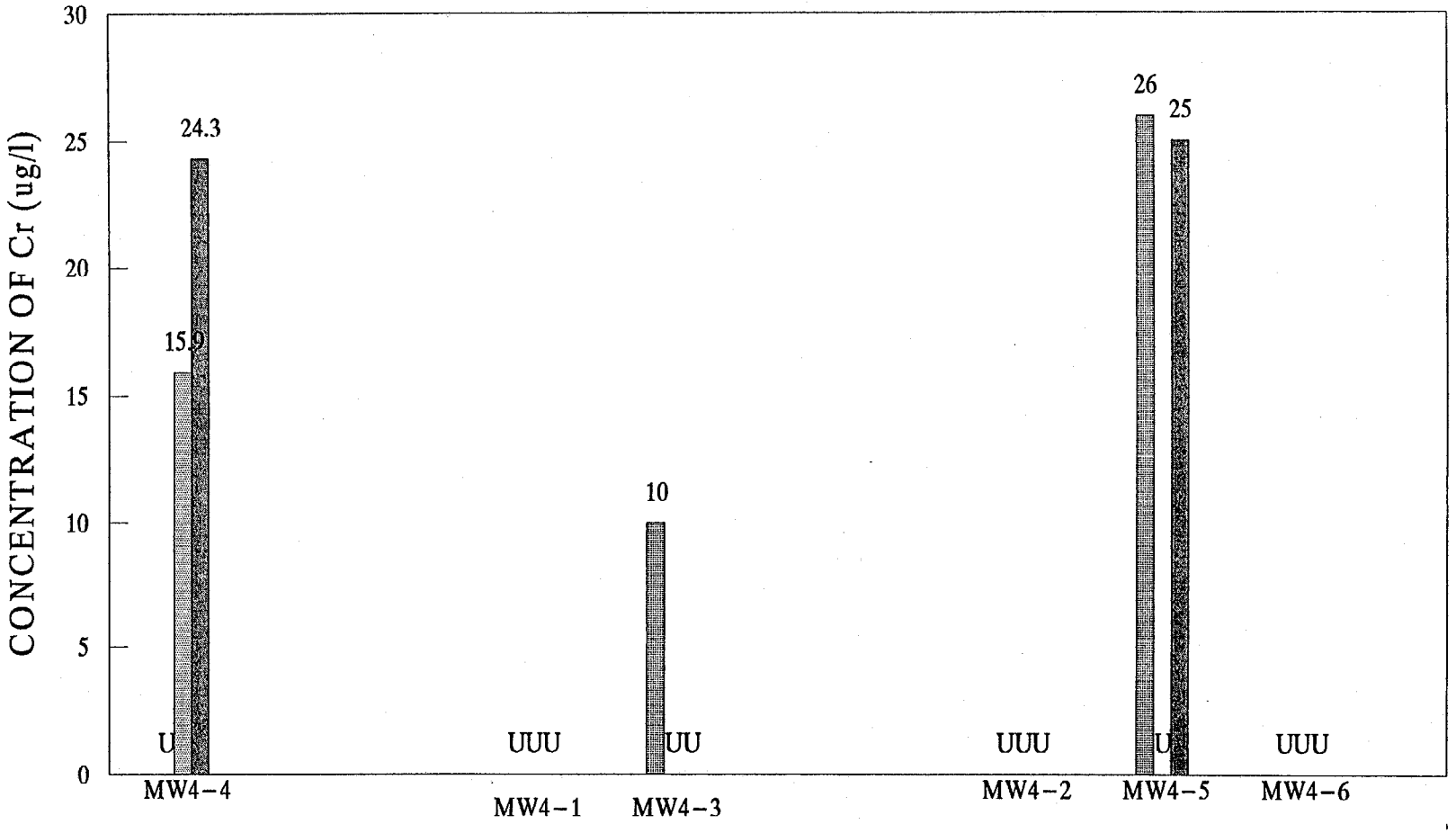
Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells		
(ug/L)	MW4-4		MW4-1	MW4-3		MW4-2	MW4-5	MW4-6
Round 1: March, 1991								
Cadmium	NR		NR	NR		NR	NR	NR
Chromium	U		U	10		U	26	U
Iron	12600		3300	10700		44000	29300	2700
Lead	6		1.9	1.8		2.3	13	2.7
Zinc	\a :gan{?} ~.{r 17}{pg		1.6	59		U	13	10
Round 2: October, 1991								
Cadmium	NR		NR	NR		NR	NR	NR
Chromium	15.9		U	U		U	U	U
Iron	23400		4660	2900		25000	3850	1.09
Lead	6.9		U	U		U	U	U
Zinc	68.4		32.2	26.7		U	20	32.1
Round 3: November, 1991								
Cadmium	NR		NR	NR		NR	NR	NR
Chromium	24.3		U	U		U	25	U
Iron	17400		1960	5720		31000	21000	1890
Lead	17.3		3.4	U		4	14.3	U
Zinc	156		57.9	42.3		38.7	62.8	47.9

Legend: U = Not detected

NR = Not requested

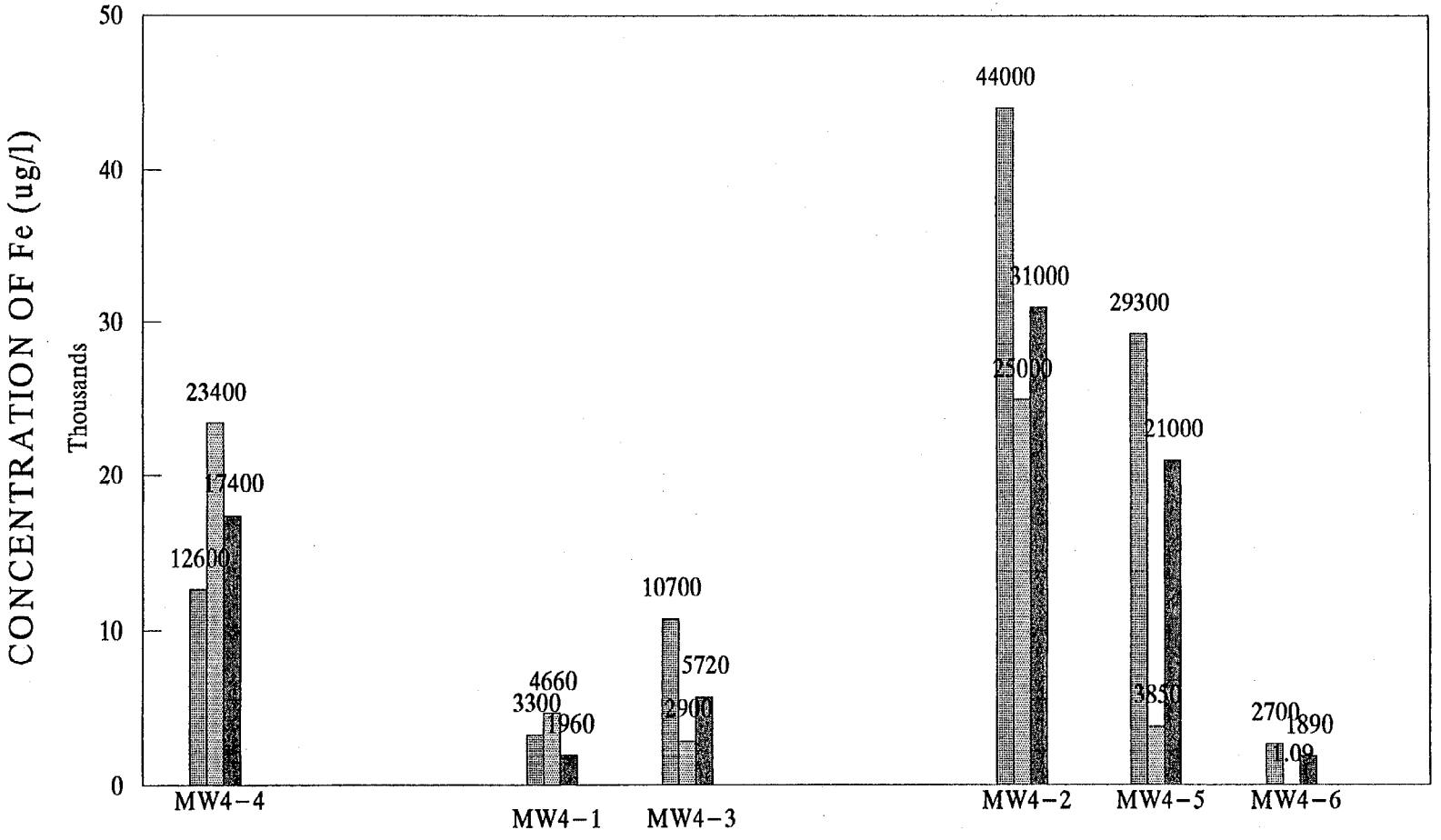
SITE 4

LANDFILL WEST OF "D" GROUP



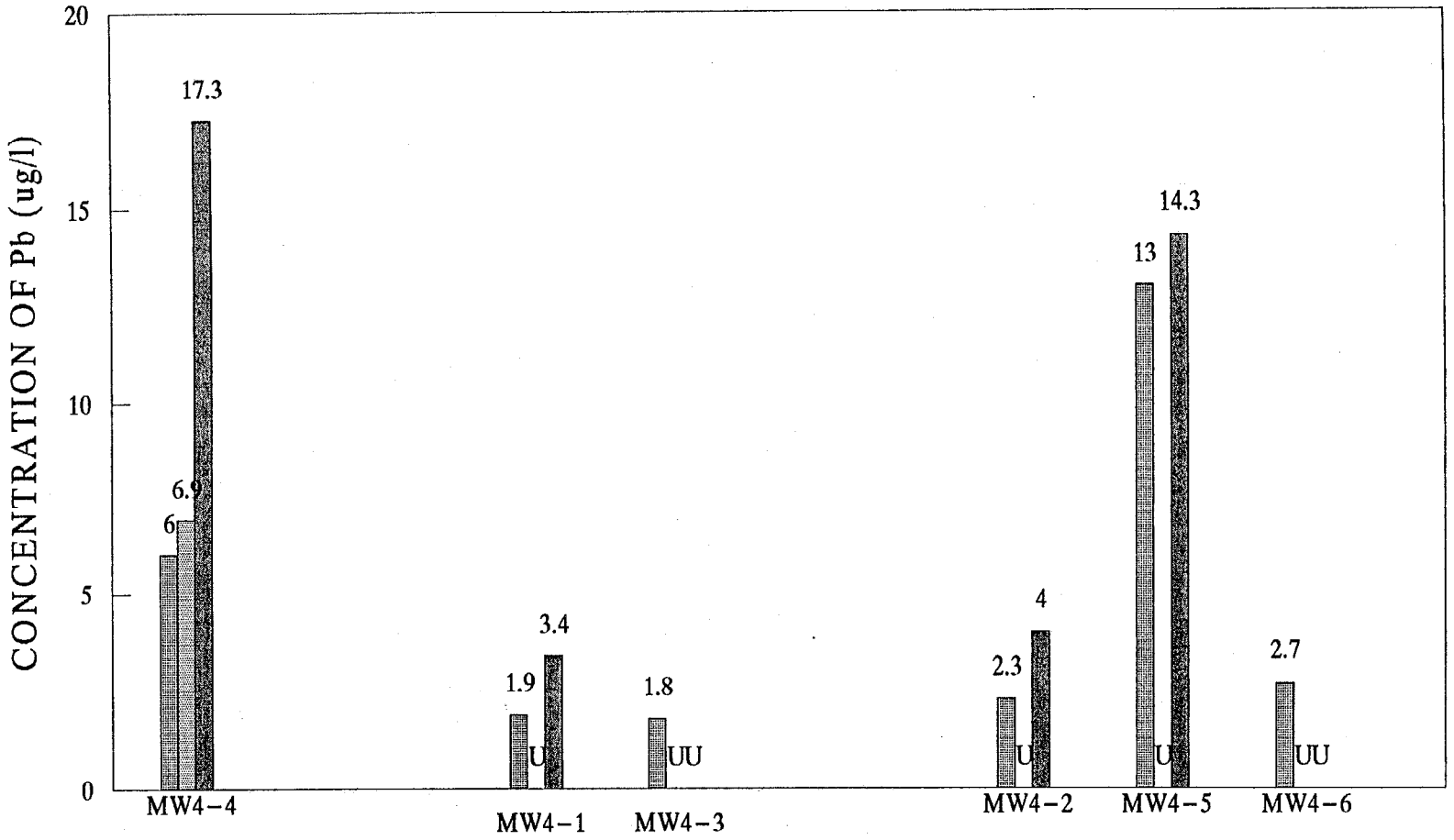
SITE 4

LANDFILL WEST OF "D" GROUP



SITE 4

LANDFILL WEST OF "D" GROUP



NWS Earle, Site 5 Landfill Waste of Army Barricades

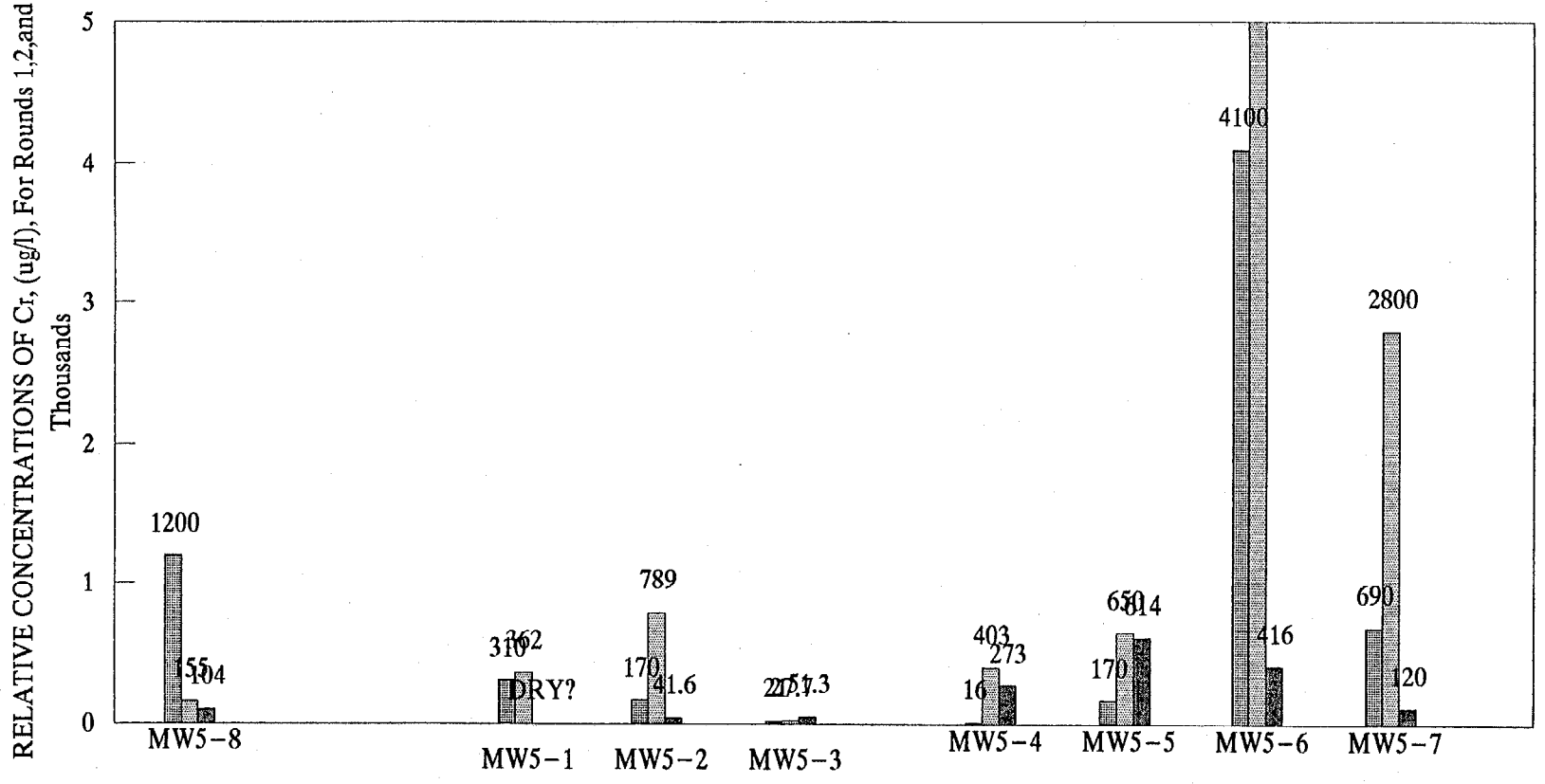
Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells			
(ug/L)	MW5-8		MW5-1	MW5-2	MW5-3	MW5-4	MW5-5	MW5-6	MW5-7
Round 1: March, 1991									
Cadmium	U		U	U	U	U	U	U	34
Chromium	1200		310	170	21	16	170	4100	690
Iron	150000		45800	26200	2600	5900	27700	571000	120000
Lead	38		5.4	4.2	3.4	13	28	61	26
Zinc	120		36	22	61	U	60	990	1800
Round 2: October, 1991									
Cadmium	U		U	U	U	U	5.3	16.6	25.1
Chromium	155		362	789	27.7	403	650	6060	2800
Iron	21600		56700	110000	2800	58900	102000	880000	497000
Lead	U		5.6	21.1	U 3	15	26.3	98.5	64.8
Zinc	47.9		70.8	95.1	88.1	78.4	193	1120	916
Round 3: November, 1991									
Cadmium	U			U	U	U	5.7	U	U
Chromium	104		DRY?	41.6	51.3	273	614	416	120
Iron	13300		DRY?	4870	6200	38000	65900	81500	15500
Lead	4.2		DRY?	3.1	15.3	15.7	23.4	23.4	5.4
Zinc	45.4		DRY?	76.3	97.9	101	222	305	127

Legend: U = Not detected

NR = Not requested

SITE - 5

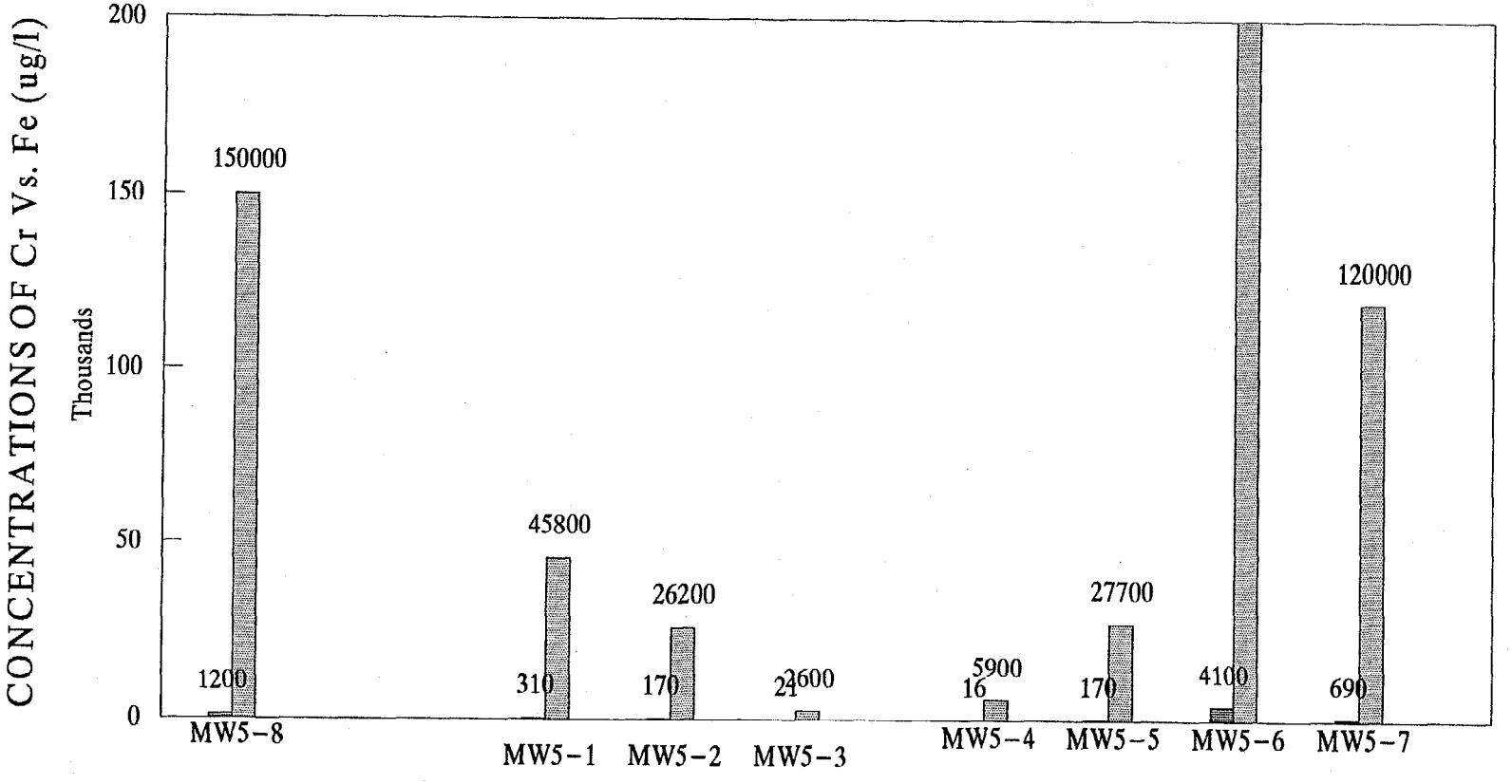
LANDFILL WEST OF ARMY BARRICADES



DATA FOR ALL THREE SAMPLING ROUNRS

SITE - 5

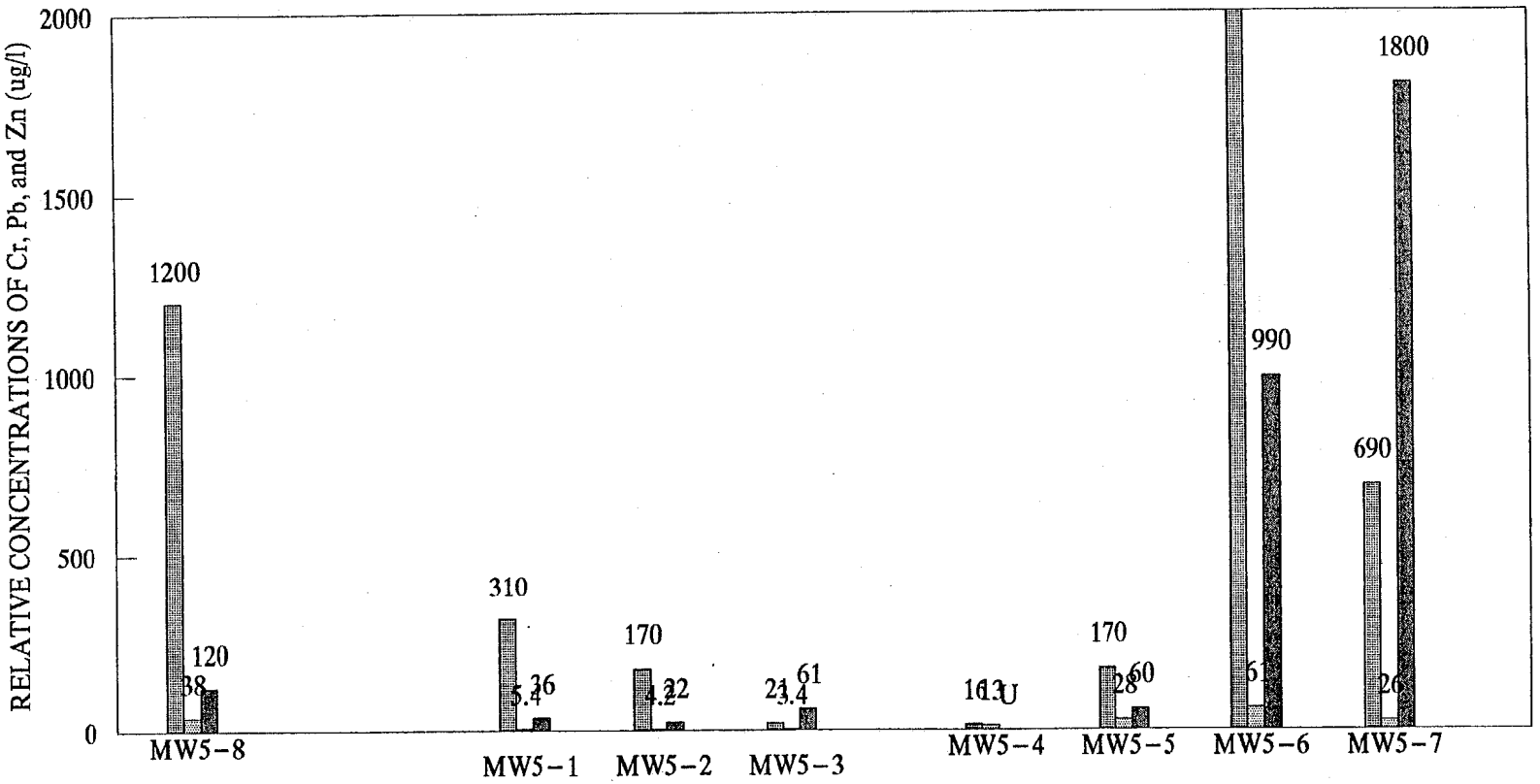
LANDFILL WEST OF ARMY BARRICADES



DATA FOR ALL THREE SAMPLING ROUNRS

SITE - 5

LANDFILL WEST OF ARMY BARRICADES



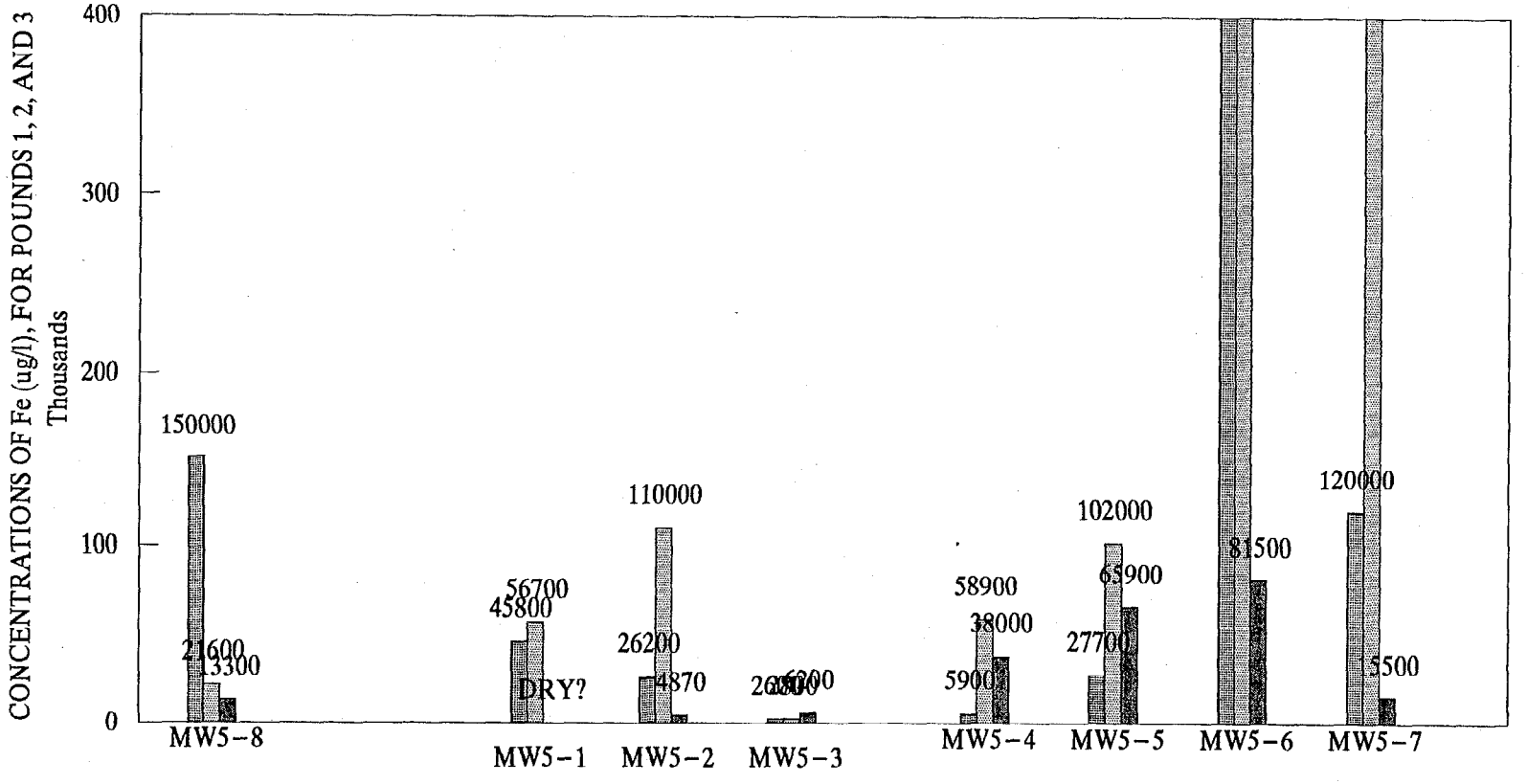
MONITORING WELLS FROM UPGRADIENT TO DOWNGRADIENT

Cr Conc. Pb Conc. Zn Conc.

DATA FOR ALL THREE SAMPLING ROUNRS

SITE - 5

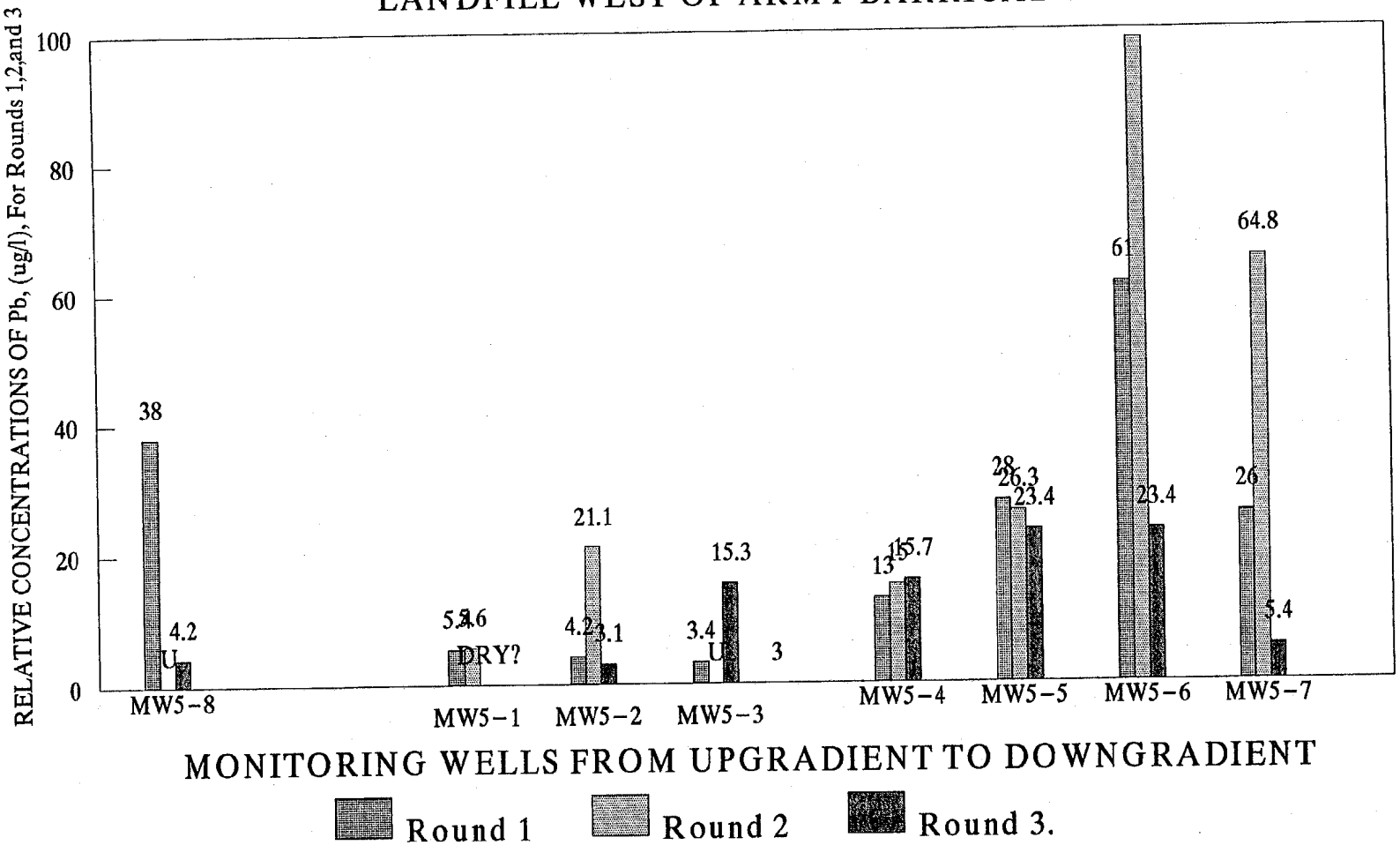
LANDFILL WEST OF ARMY BARRICADES



DATA FOR ALL THREE SAMPLING ROUNRS

SITE - 5

LANDFILL WEST OF ARMY BARRICADES



DATA FOR ALL THREE SAMPLING ROUNRS

NWS Earle, Site 7 Landfill South of "P" Barricades

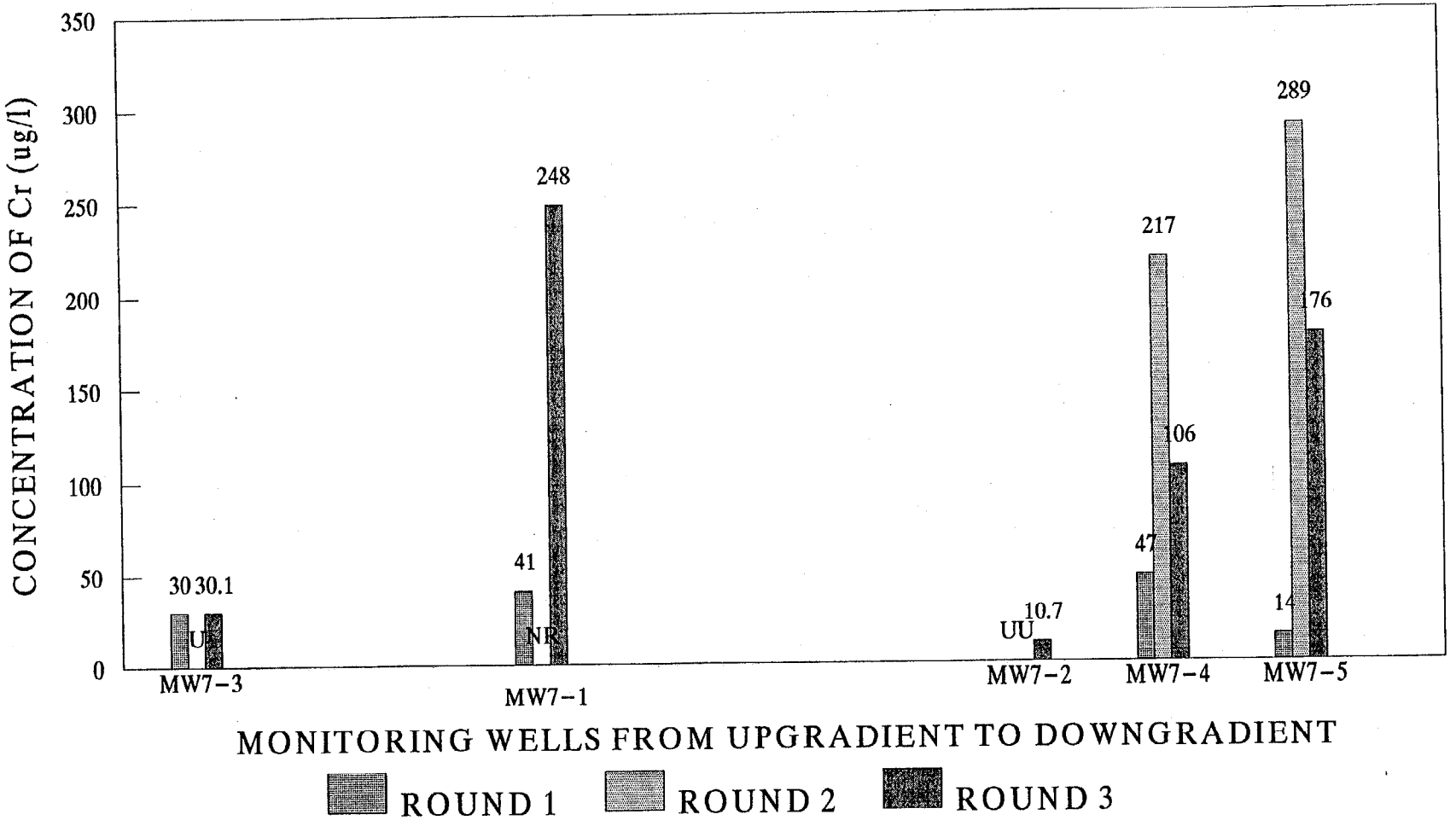
Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells		
(ug/L)	MW7-3		MW7-1			MW7-2	MW7-4	MW7-5
Round 1: March, 1991								
Cadmium	NR		NR			NR	NR	NR
Chromium	30		41			U	47	14
Iron	30300		43000			3100	45100	11200
Lead	10		19			4	17	8.1
Zinc	11		61			87	63	46
Round 2: October, 1991								
Cadmium	U		NR			U	U	8
Chromium	U		NR			U	217	289
Iron	9070		NR			9570	183000	282000
Lead	6.1		NR			3.5	92	150
Zinc	U		NR			34.5	280	464
Round 3: November, 1991								
Cadmium	U		6.9			U	U	U
Chromium	30.1		248			10.7	106	176
Iron	48200		353000			14500	110000	178000
Lead	10.7		156			5.2	63	83
Zinc	58.2		481			38.9	178	364

Legend: U = Not detected

NR = Not requested

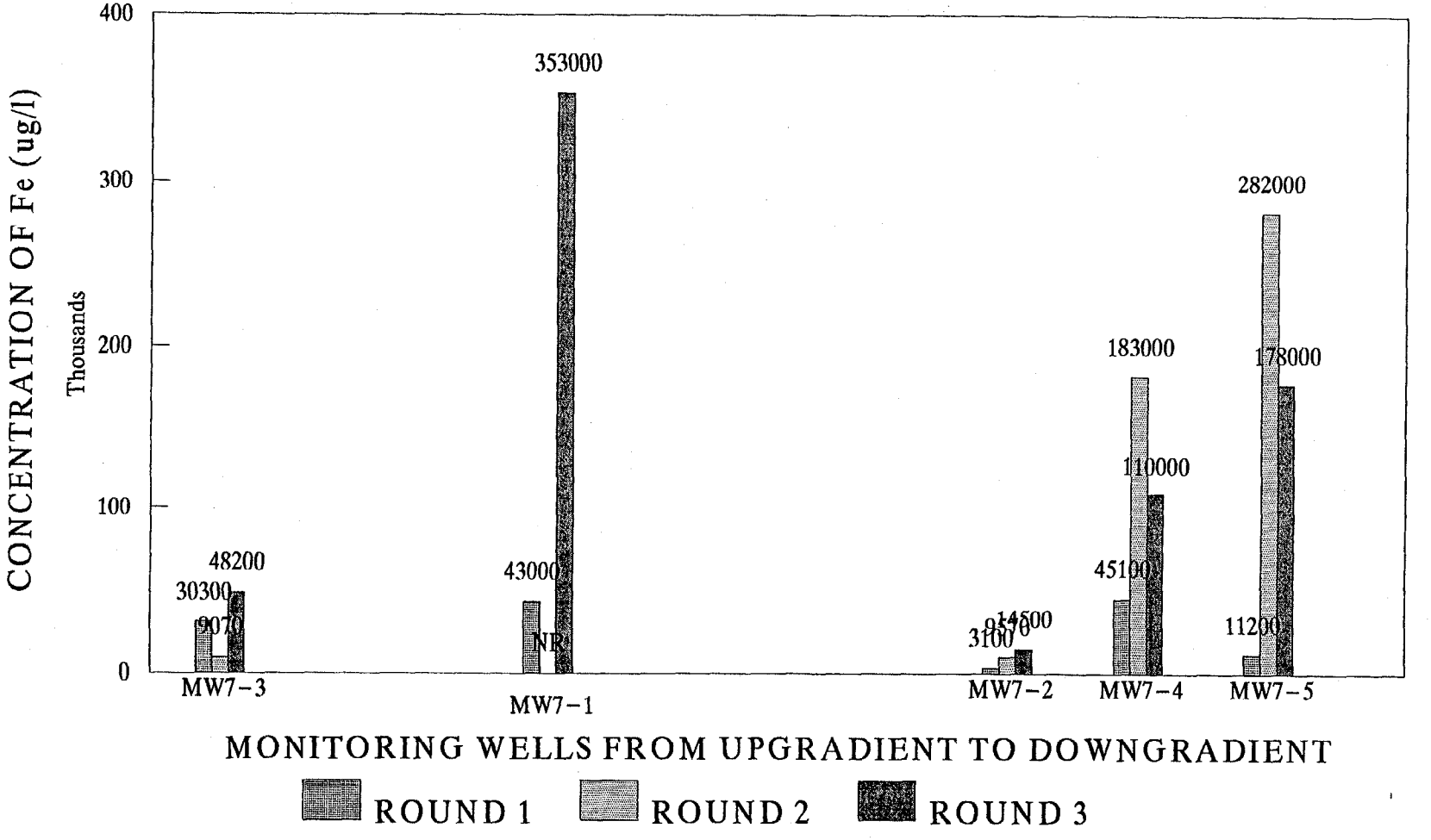
SITE 7

LANDFILL SOUTH OF "P" BARRICADES



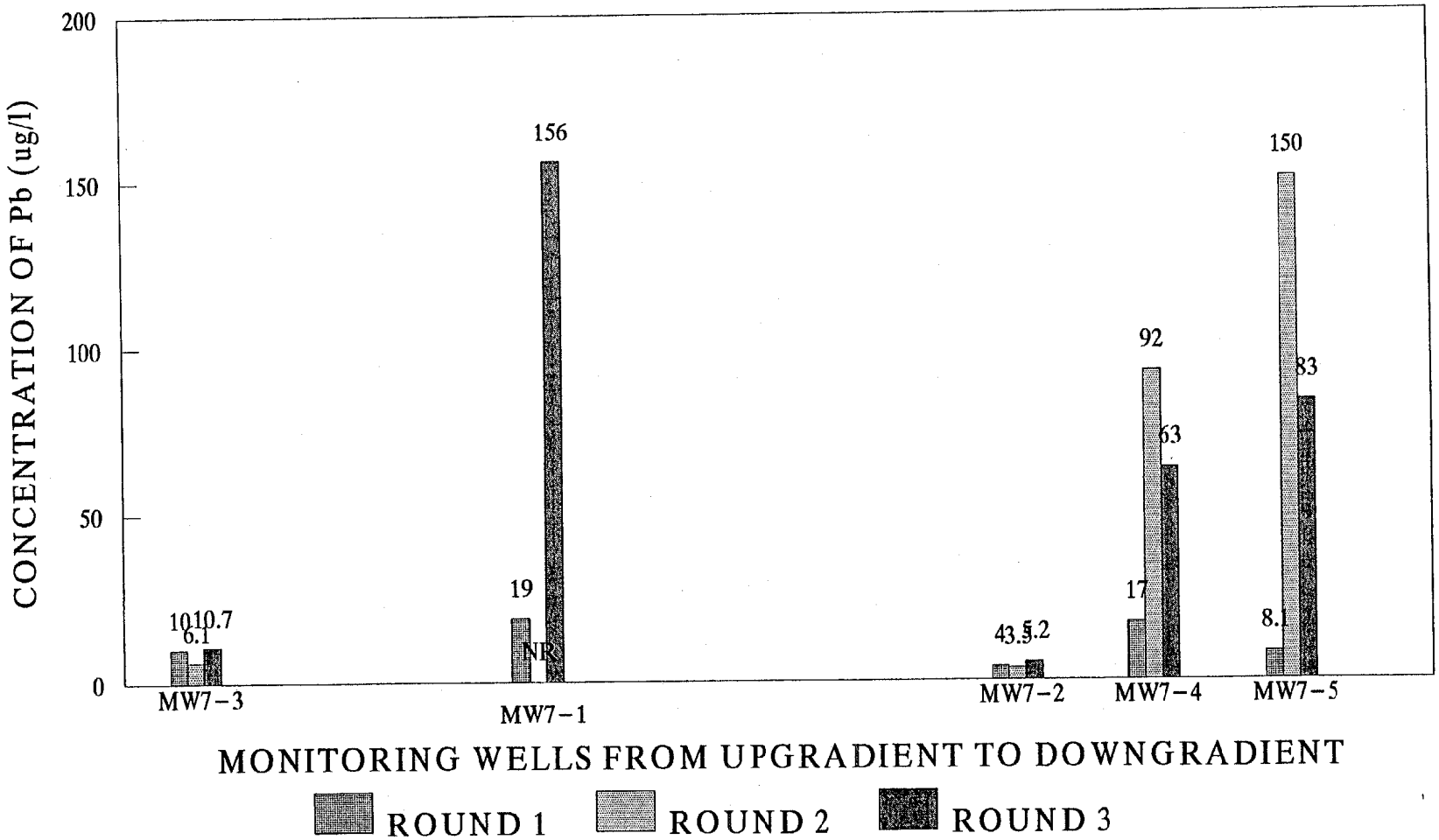
SITE 7

LANDFILL SOUTH OF "P" BARRICADES



SITE 7

LANDFILL SOUTH OF "P" BARRICADES



NWS Earle, Site 10 Scrap Metal Landfill

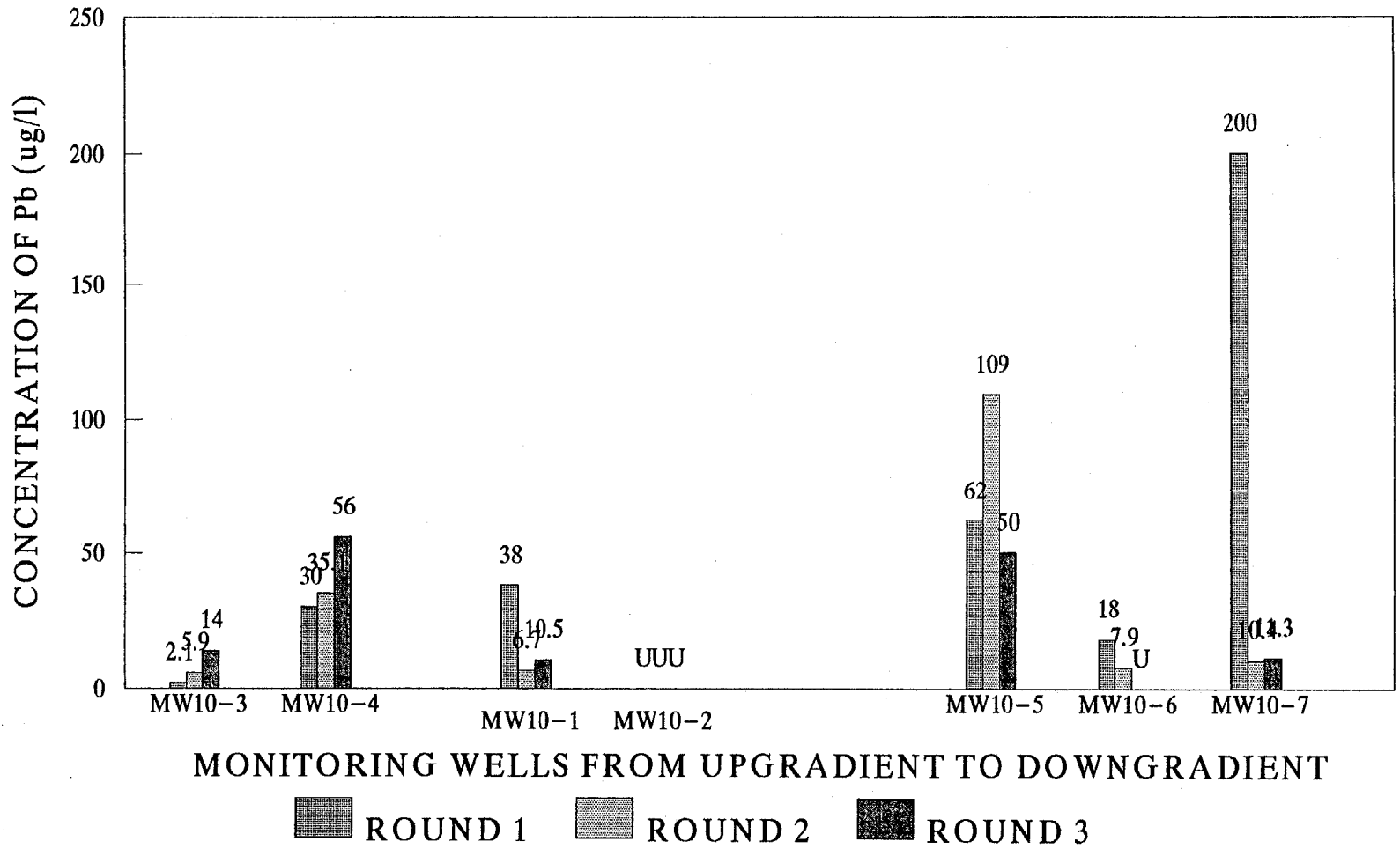
Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells		
(ug/L)	MW10-3	MW10-4	MW10-1	MW10-2		MW10-5	MW10-6	MW10-7
Round 1: March, 1991								
Cadmium	U	U	4.2	U		U	U	15
Chromium	23	450	80	28		760	43	3600
Iron	4900	73900	12300	3100		98900	8000	452000
Lead	2.1	30	38	U		62	18	200
Zinc	18	120	44	310		160	90	1200
Round 2: October, 1991								
Cadmium	U	U	U	U		5.4	U	U
Chromium	68.1	1060	133	86.3		530	54.5	76.6
Iron	7420	161000	22600	9440		62700	50400	36000
Lead	5.9	35.1	6.7	U		109	7.9	10.4
Zinc	32.4	231	124	233		170	266	87
Round 3: November, 1991								
Cadmium	NR	NR	NR	NR		NR	NR	NR
Chromium	21.3	1130	151	34.7		209	32.5	41.3
Iron	4490	?	21800	2650		35700	7650	25800
Lead	14	56	10.5	U		50	U	11.3
Zinc	U	228	238	285		86.5	248	144

Legend: U = Not detected

NR = Not requested

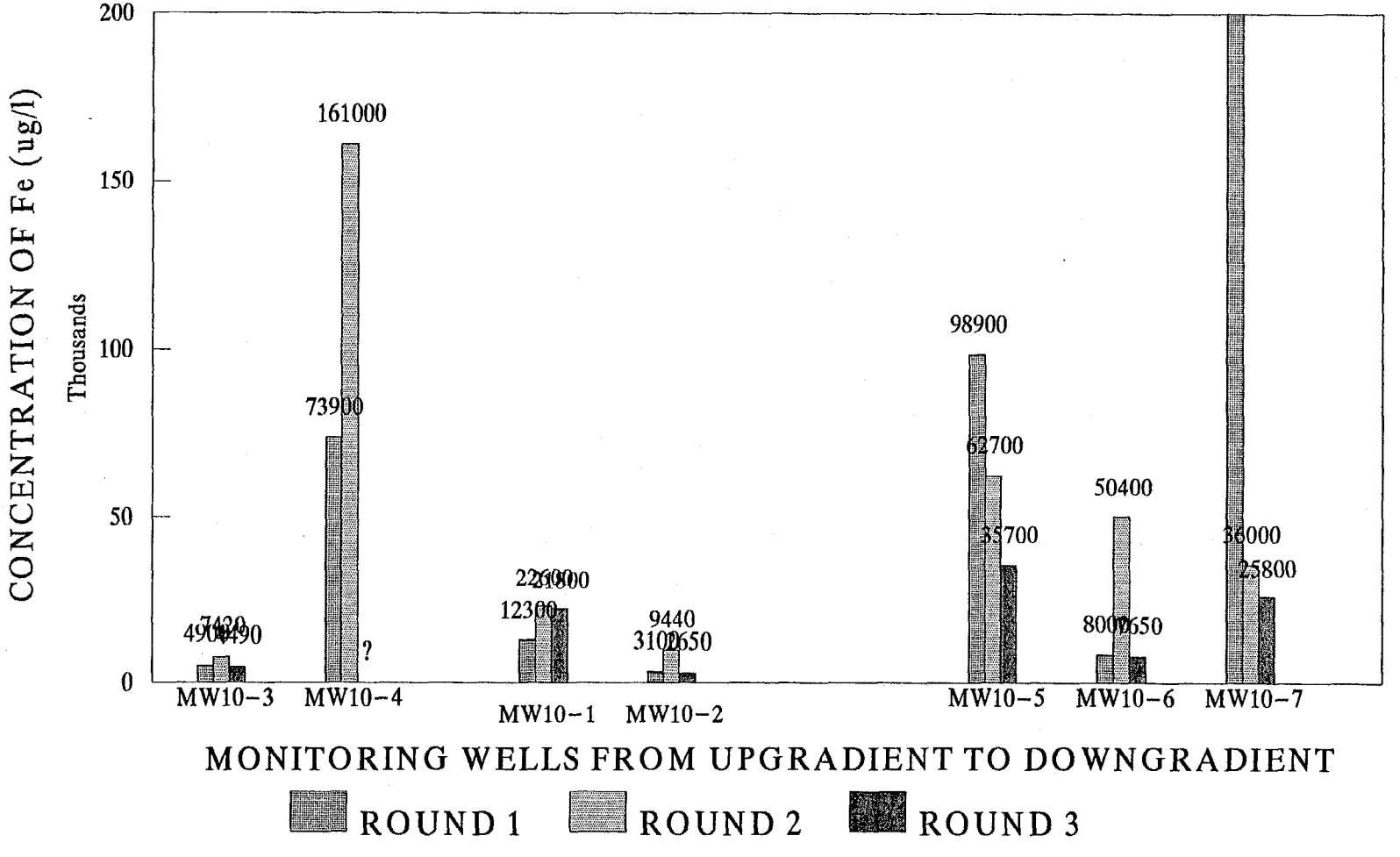
SITE 10

SCRAP METAL LANDFILL



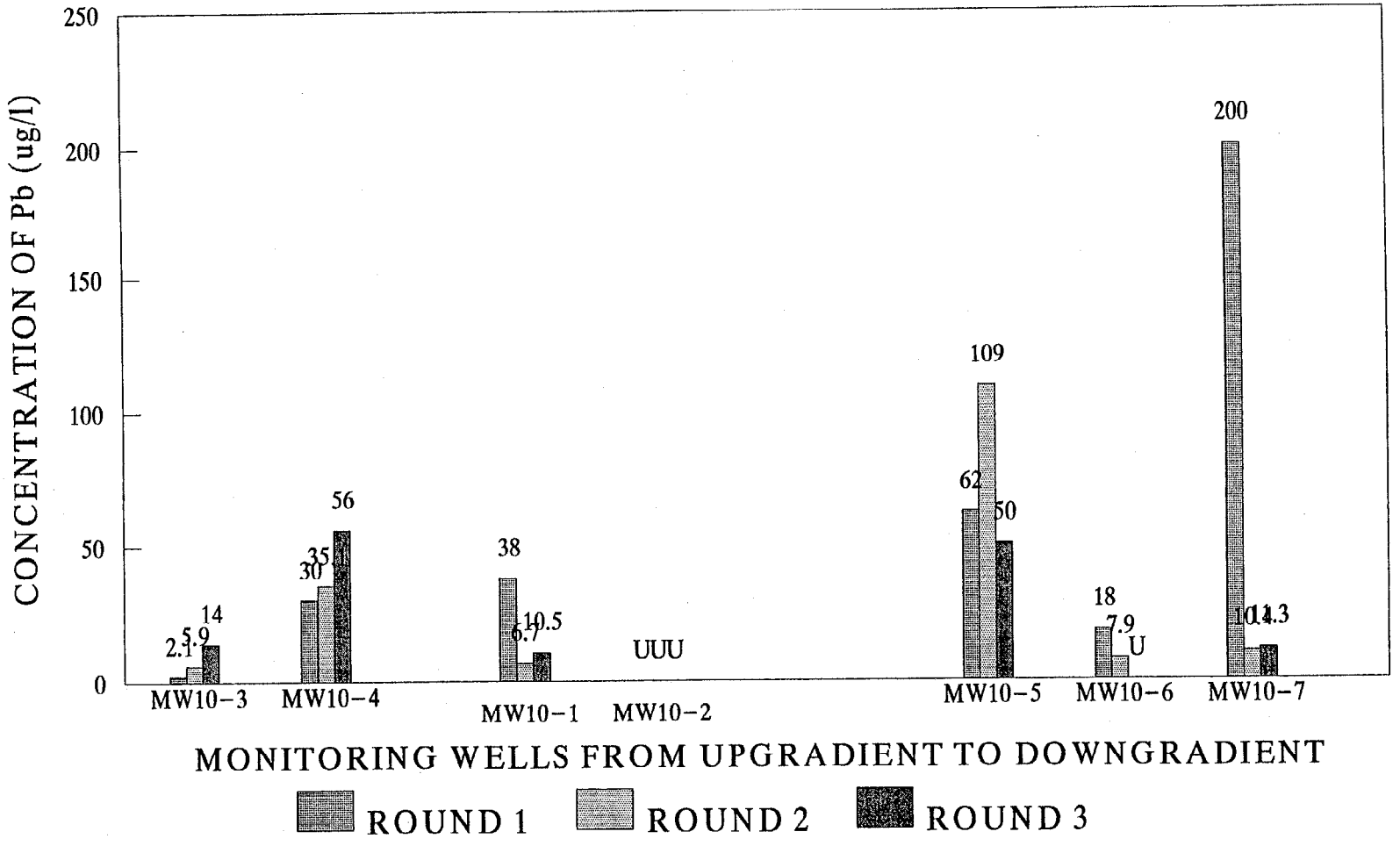
SITE 10

SCRAP METAL LANDFILL



SITE 10

SCRAP METAL LANDFILL



NWS Earle, Site 11 Contract Ordnance Disposal Area

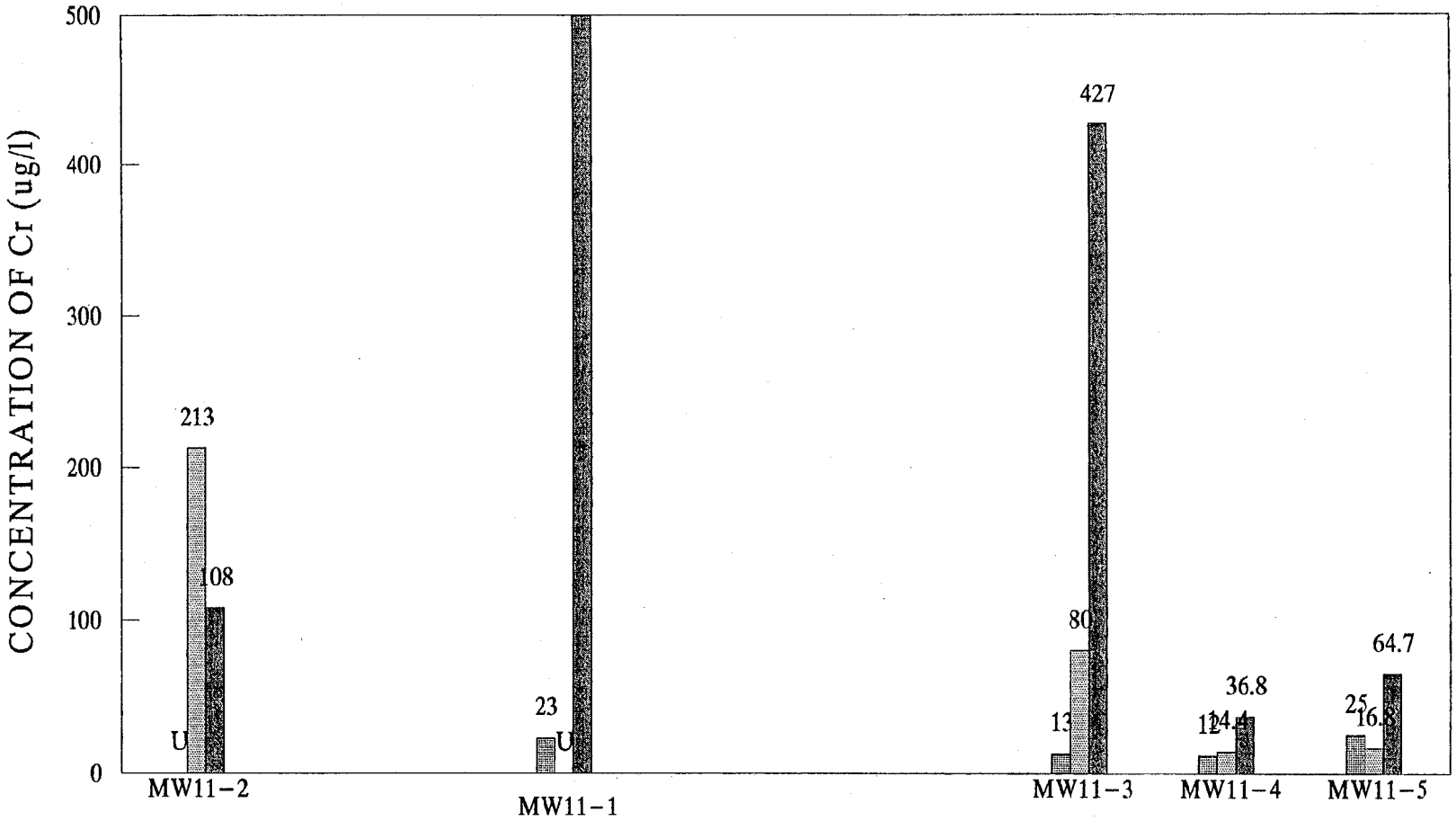
Compounds	Upgradient Well		Crossgradient Wells			Downgradient Wells		
(ug/L)	MW11-2		MW11-1			MW11-3	MW11-4	MW11-5
Round 1: March, 1991								
Cadmium	U		U			4.2	U	U
Chromium	U		23			13	12	25
Iron	1200		1800			1500	1500	3000
Lead	1.6		1.3			5.2	3.4	3.8
Zinc	37		14			54	16	21
Round 2: October, 1991								
Cadmium	NR		NR			NR	NR	NR
Chromium	213		U			80	14.4	16.8
Iron	32000		289			9560	2180	3420
Lead	20.3		U			6.8	U	U
Zinc	58.8		23.4			59.7	120	24.6
Round 3: November, 1991								
Cadmium	NR		NR			NR	NR	NR
Chromium	108		881			427	36.8	64.7
Iron	16600		96000			63400	5130	10000
Lead	U		51.5			36.4	U	3.8
Zinc	77.7		181			89.3	23.8	24

Legend: U = Not detected

NR = Not requested

SITE 11

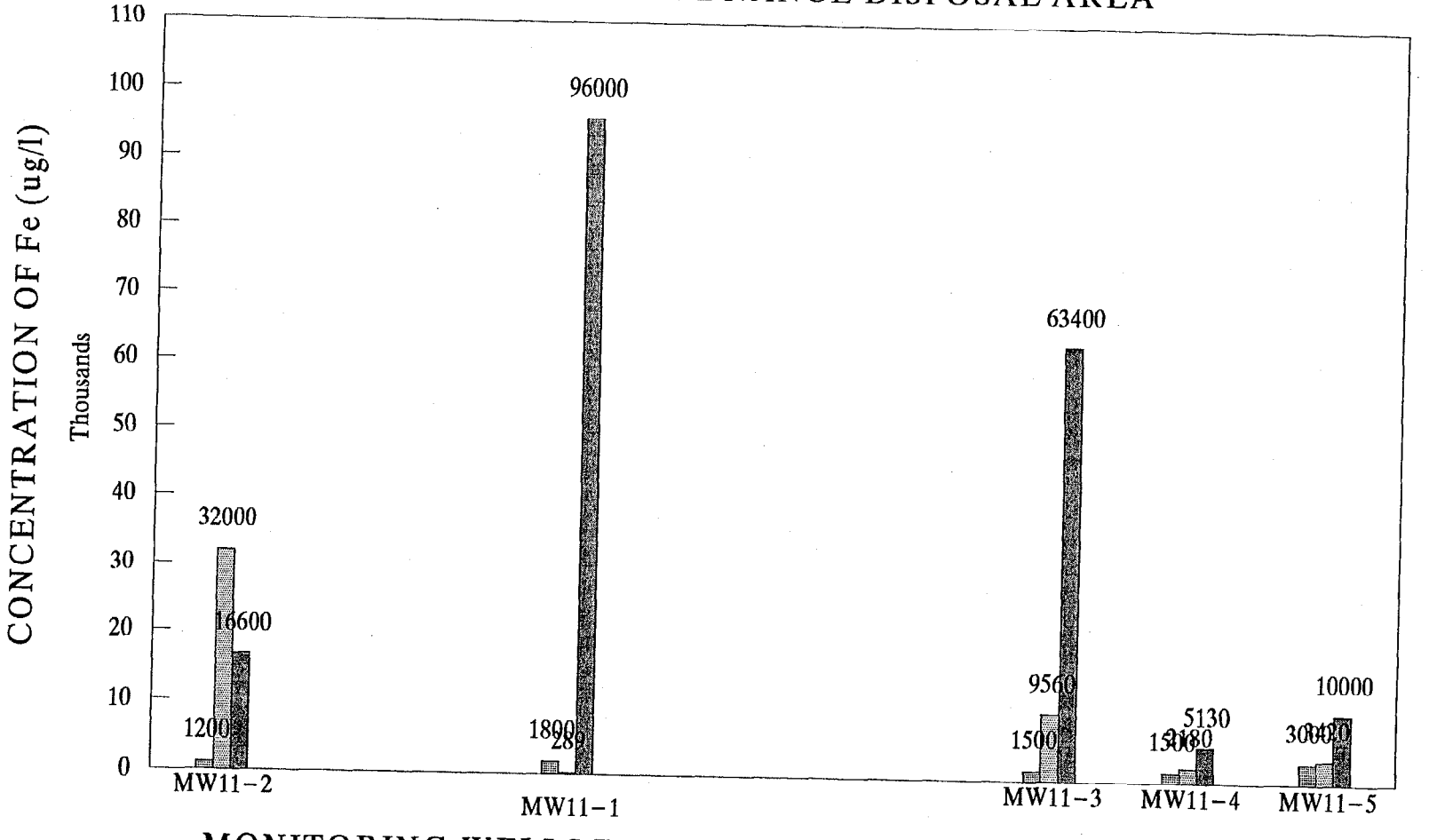
CONTRACT ORDNANCE DISPOSAL AREA



MONITORING WELLS FROM UPGRADIENT TO DOWNGRADIENT

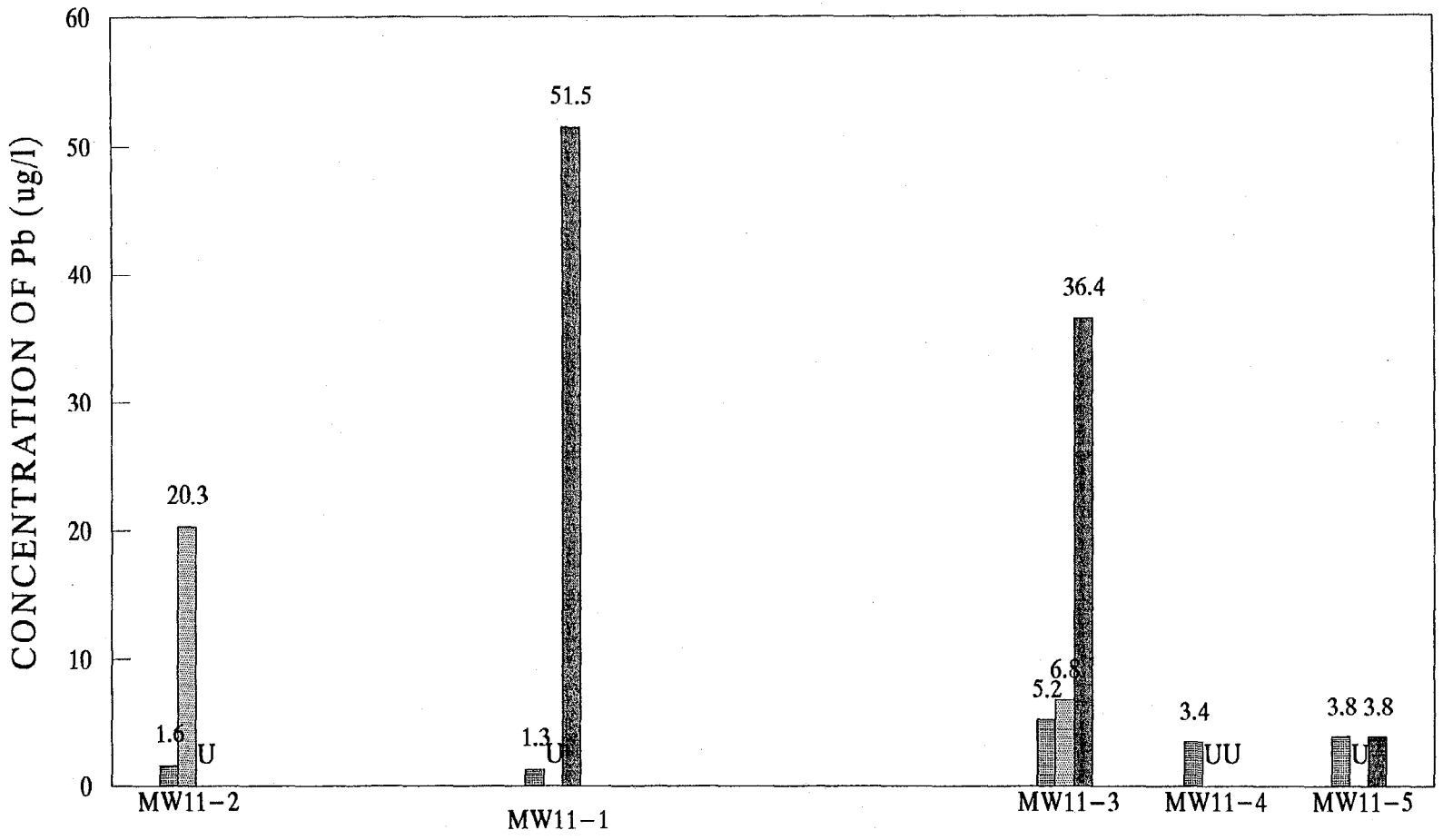
SITE 11

CONTRACT ORDNANCE DISPOSAL AREA



SITE 11

CONTRACT ORDNANCE DISPOSAL AREA



MONITORING WELLS FROM UPGRADIENT TO DOWNGRADIENT

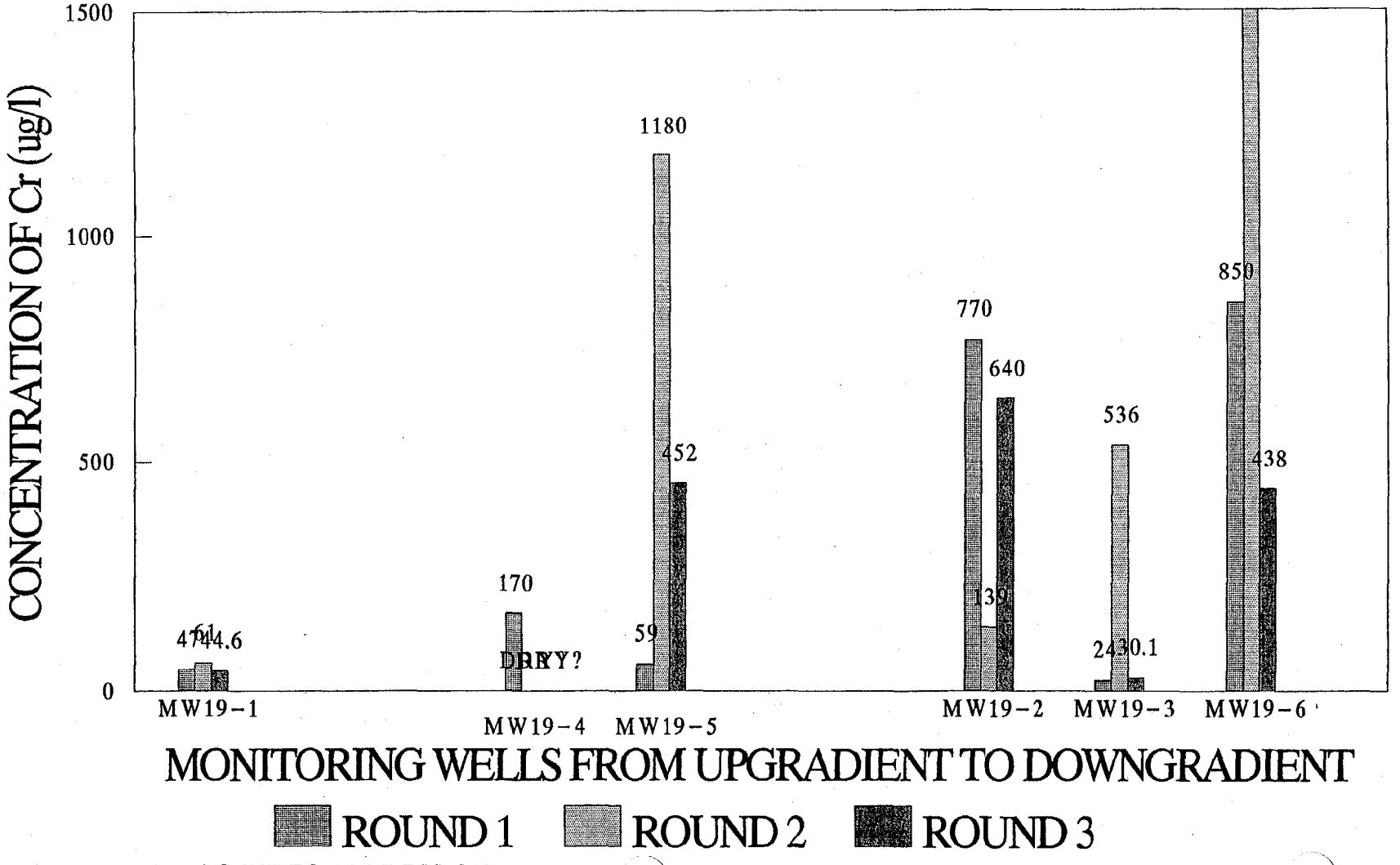
NWS Earle, Site 19 Paint Chip and Sludge Disposal Area

Compounds (ug/L)	Upgradient Well		Crossgradient Wells			Downgradient Wells		
	MW19-1		MW19-4	MW19-5		MW19-2	MW19-3	MW19-6
Round 1: March, 1991								
Cadmium	U		U	U		13	U	7.3
Chromium	47		170	59		770	24	850
Iron	5400		30300	12500		99000	4800	106000
Lead	4.8		19	4.8		38	3	54
Zinc	U		230	36		97	26	200
Round 2: October, 1991								
Cadmium	U			20.1		U	12.2	48.2
Chromium	61		DRY?	1180		139	536	4540
Iron	7520		DRY?	129000		26700	70,900	534000
Lead	9.1		DRY?	88		11.2	39.7	282
Zinc	23.5		DRY?	140		94	194	1190
Round 3: November, 1991								
Cadmium	U			5.4		5.2	U	14
Chromium	44.6		DRY?	452		640	30.1	438
Iron	6980		DRY?	33500		57600	7270	86100
Lead	12.3		DRY?	32.1		47.8	6.3	49.8
Zinc	39.8		DRY?	74.9		145	79.1	386

Legend: U = Not detected
NR = Not requested

SITE 19

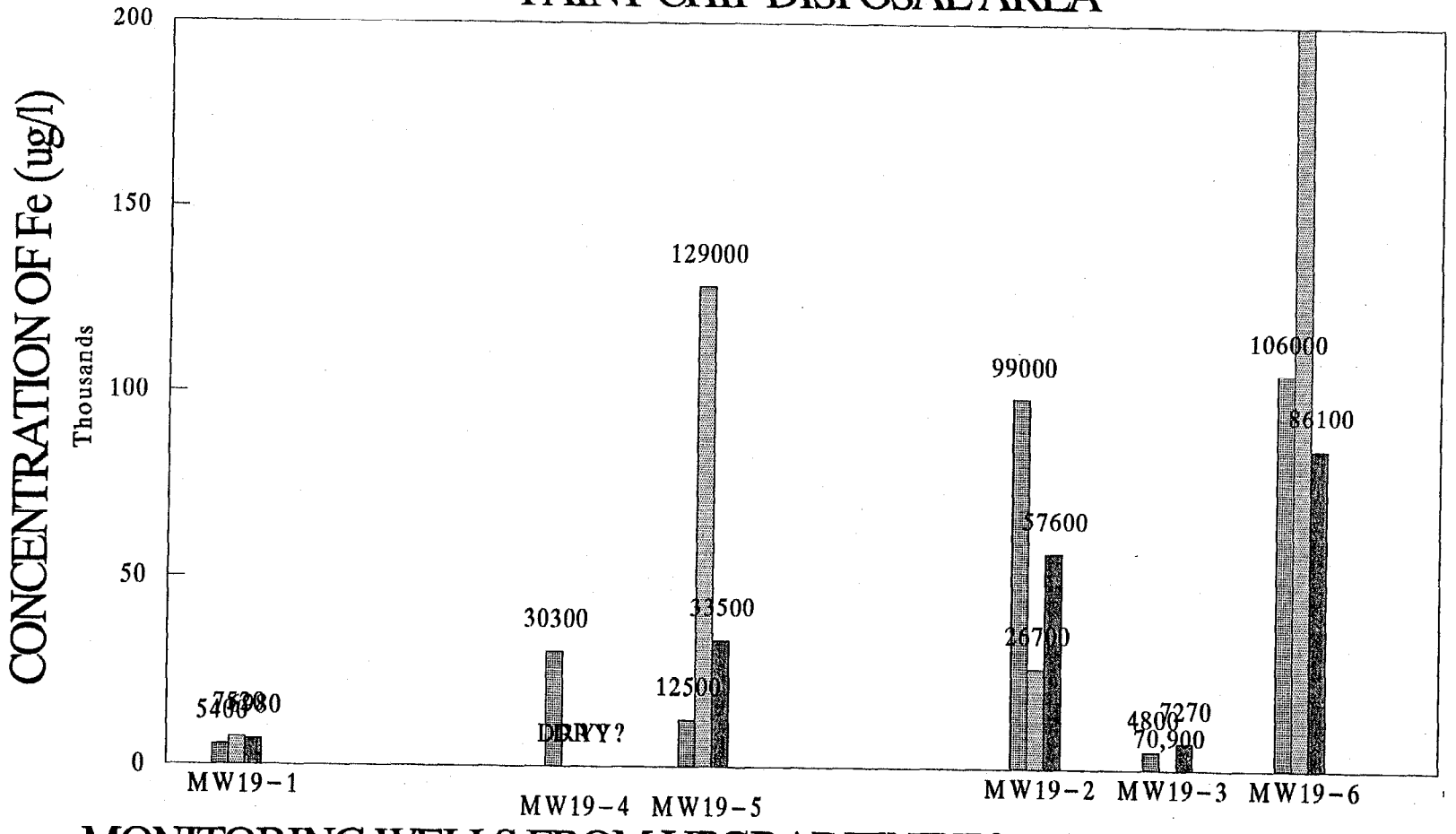
PAINT CHIP DISPOSAL AREA



MW 19-06 ADJACENT TO DEPRESSION

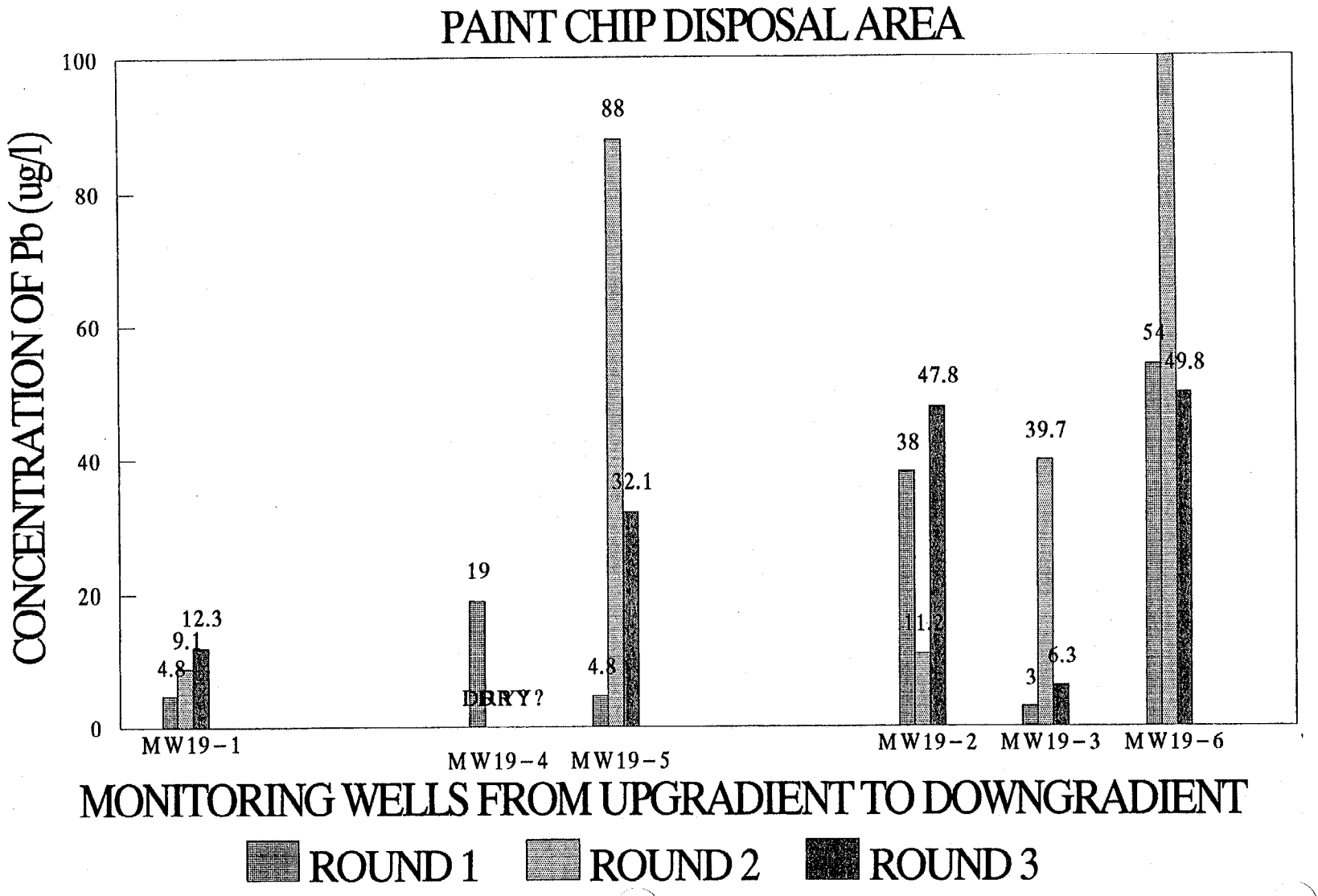
SITE 19

PAINT CHIP DISPOSAL AREA



MW 19-06 ADJACENT TO DEPRESSION

SITE 19



MW 19-06 ADJACENT TO DEPRESSION

NWS Earle, Site 26 Explosives "D" Washout Area

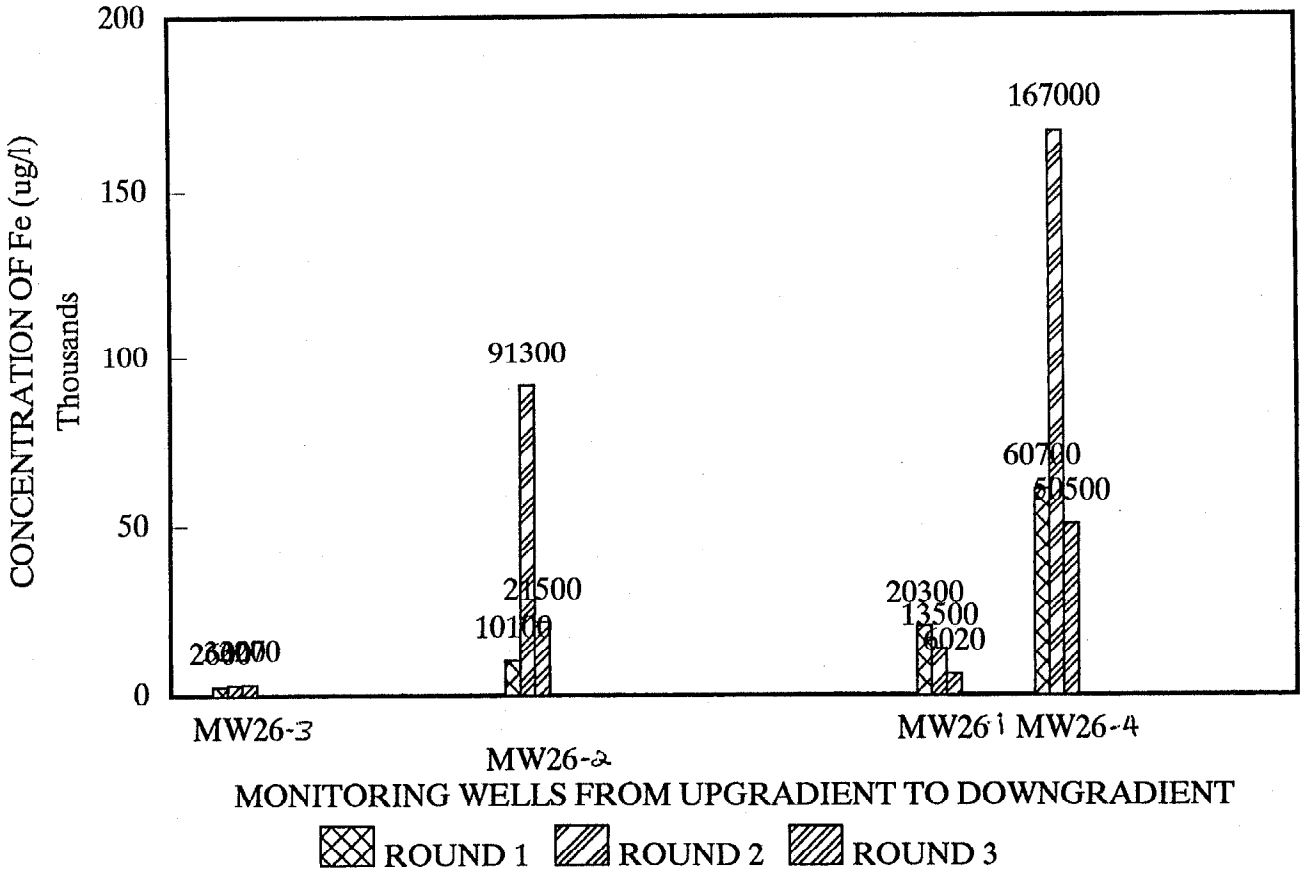
Compounds (ug/L)	Upgradient Well	Crossgradient Wells		Downgradient Wells	
	MW26-3	MW26-2		MW26-1	MW26-4
Round 1: March, 1991					
Cadmium	NR	NR		NR	NR
Chromium	U	9.9		U	53
Iron	2600	10100		20300	60700
Lead	3.5	2.9		4.5	24
Zinc	6.7	35		11	56
Round 2: October, 1991					
Cadmium	U	U		U	8.1
Chromium	U	51.7		U	168
Iron	3200	91300		13500	167000
Lead	U	6.9		U	28.1
Zinc	U	66.8		20	163
Round 3: November, 1991					
Cadmium	U	U		U	5.6
Chromium	U	16		U	41.2
Iron	3270	21500		6020	50500
Lead	U	U		3.8	12.3
Zinc	43.4	81.7		118	97.4

Legend: U = Not detected

NR = Not requested

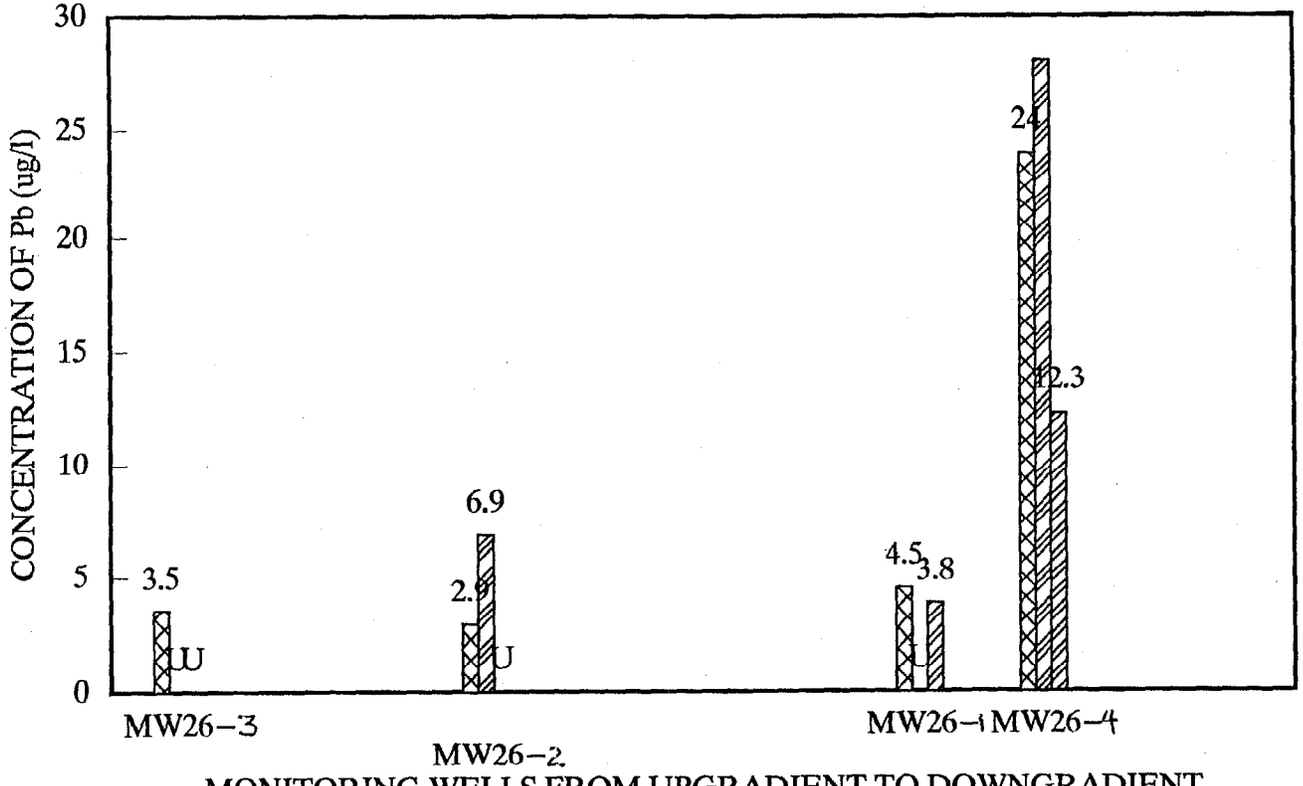
SITE 26

EXPLOSIVES "D" WASHOUT AREA



SITE 26

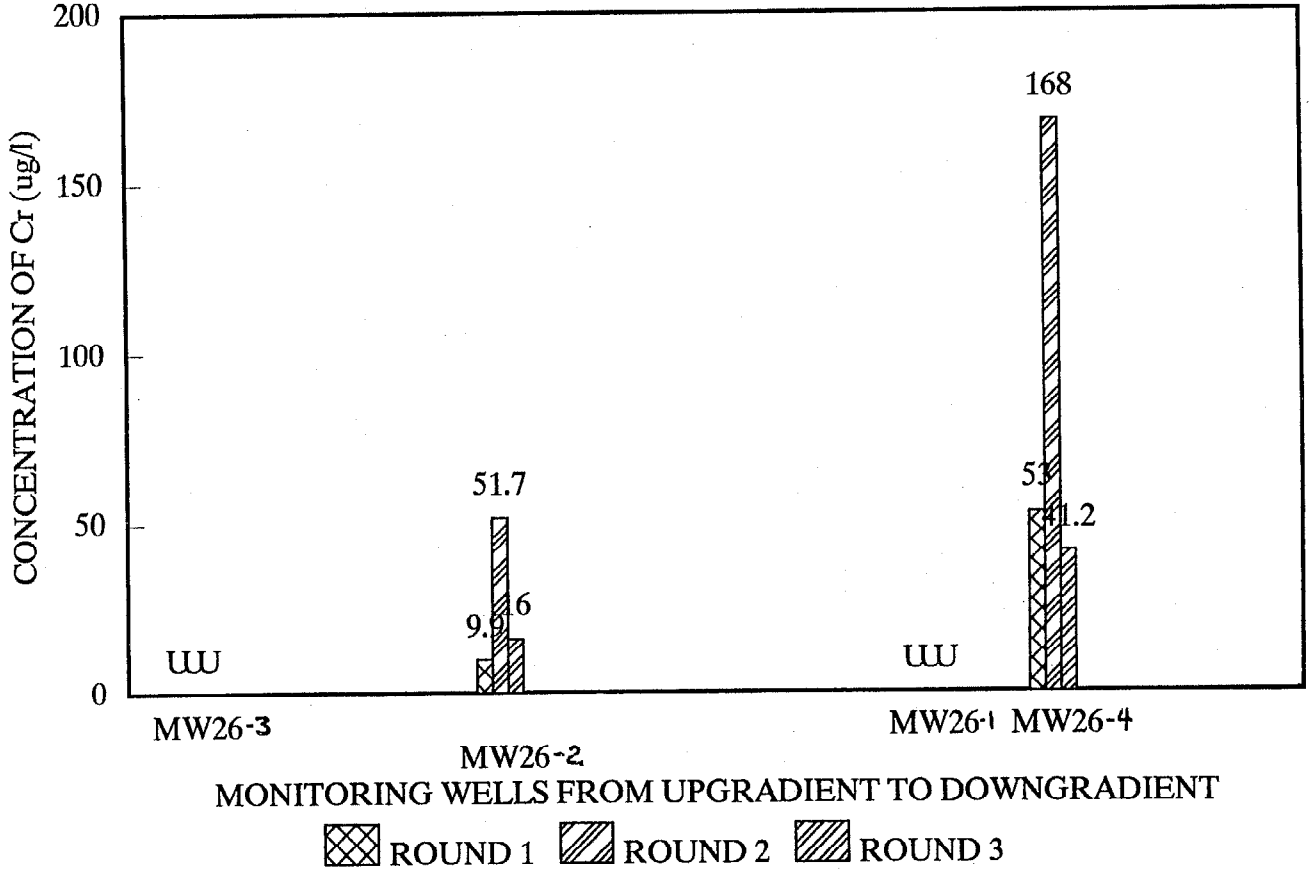
EXPLOSIVES "D" WASHOUT AREA



ROUND 1 ROUND 2 ROUND 3

SITE 26

EXPLOSIVES "D" WASHOUT AREA



INSTALLATION RESTORATION PROGRAM
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FOR 11 SITES AT NWS EARLE, COLTS NECK, NJ

VOLUME 3

SECTION 6 - BASELINE RISK ASSESSMENT
SECTION 7 - APPLICABLE OR RELEVANT AND APPROPRIATE ENVIRONMENTAL AND PUBLIC HEALTH REQUIREMENTS (ARARs)
SECTION 8 - IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Prepared for

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PA

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Prepared by

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West Chester, Pennsylvania 19380-1499

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SECTION 6
BASELINE RISK ASSESSMENT

SECTION 6
BASELINE RISK ASSESSMENT

6.1 APPROACH TO THE BASELINE RISK ASSESSMENT

6.1.1 Background

This section of the Remedial Investigation (RI) Report presents a comprehensive, multiple-pathway assessment of the potential human health and environmental risks associated with ordnance maintenance and disposal activities at 11 sites at the Naval Weapons Station Earle (NWS Earle or the Station) located in Colts Neck, NJ. This baseline risk assessment was prepared on behalf of the Naval Facilities Command (NAVFAC) within the U.S. Navy Installation Restoration Program (IRP). NWS Earle was placed on the National Priority List (NPL) by the U.S. Environmental Protection Agency (EPA) in October 1990.

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), a Federal Facilities Agreement (FFA) was signed by EPA Region II and the Navy in January 1991. As part of this agreement, a risk assessment has been prepared to document the extent to which actual or threatened releases of hazardous substances may pose an imminent and substantial endangerment to public health and the environment. Specifically, and in accordance with the NCP, this risk assessment evaluates the potential risks associated with the Station under the no-action alternative, i.e., in the absence of remedial (corrective) action.

Several objectives are accomplished under the baseline risk assessment for the Station. These objectives include:

- Characterization of the potential human health risks (based on reasonable maximum exposures) associated with past ordnance maintenance and disposal activities.
- Characterization of the ecological risks and impacts associated with the Station.

The no-action alternative is defined for both present and future uses of the affected media (e.g., groundwater) to the extent those uses differ. In addition to defining the baseline risk, this assessment will help focus the selection of site remedies, if necessary, for reducing the concentrations of site-specific chemicals in the environmental media associated with the greatest potential risks to human and ecological health. The 11 RI sites of potential concern at NWS Earle are listed below:

- Site 2: Ordnance Demilitarization Site
- Site 3: Landfill Southwest of "F" Group
- Site 4: Solid Waste Landfill West of "D" Group
- Site 5: Landfill West of Army Barricades
- Site 7: Landfill South of "P" Barricades
- Site 10: Scrap Metal Landfill
- Site 11: Contract Ordnance Disposal Area
- Site 19: Paint Chip and Sludge Disposal Area
- Site 20: Grit Blasting Area at Building 544
- Site 22: Paint Chip Disposal Area
- Site 26: Explosive "D" Washout Area

6.1.2 Organization of the Baseline Risk Assessment

This baseline risk assessment summarizes and interprets data collected to date during remedial investigations at the Station's 11 RI sites in order to:

- Identify and characterize site-specific chemicals in various media.
- Describe potential site-specific chemical exposure pathways and potentially exposed populations.
- Estimate the intake of site-specific chemicals for relevant pathways.
- Define indices of toxicity for appropriate routes of exposure.
- Assess potential adverse impacts to public health and the environment from site-specific chemicals in the study area.

The baseline risk assessment is comprised of three principal components:

- Data Collection and Evaluation — Subsection 6.2
- Human Health Risk Assessment — Subsection 6.3
- Ecological Risk Assessment — Subsection 6.4

Data Collection and Evaluation, Subsection 6.2, presents a summary of the evidence of environmental contamination at the 11 RI sites and selects the contaminants of potential concern to be evaluated in the risk assessment. The available environmental data are reviewed and summarized for each environmental medium (soil, sediment, and groundwater).

The Human Health Risk Assessment, Subsection 6.3, incorporates the RI site characterization (described in Sections 2, 3, and 4 of this RI Report) in the determination of the exposure settings and scenarios of human exposure based on local land and water uses. In addition, four major subsections make up the Human Health Risk Assessment:

- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis

The Ecological Risk Assessment, Subsection 6.4, incorporates a qualitative ecological characterization of the Station along with the RI characterization results in the determination of the exposure settings and scenarios. As in the human health risk assessment, four major categories make up the Ecological Risk Assessment:

- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis

Figure 6-1 provides a schematic of the baseline risk assessment process.

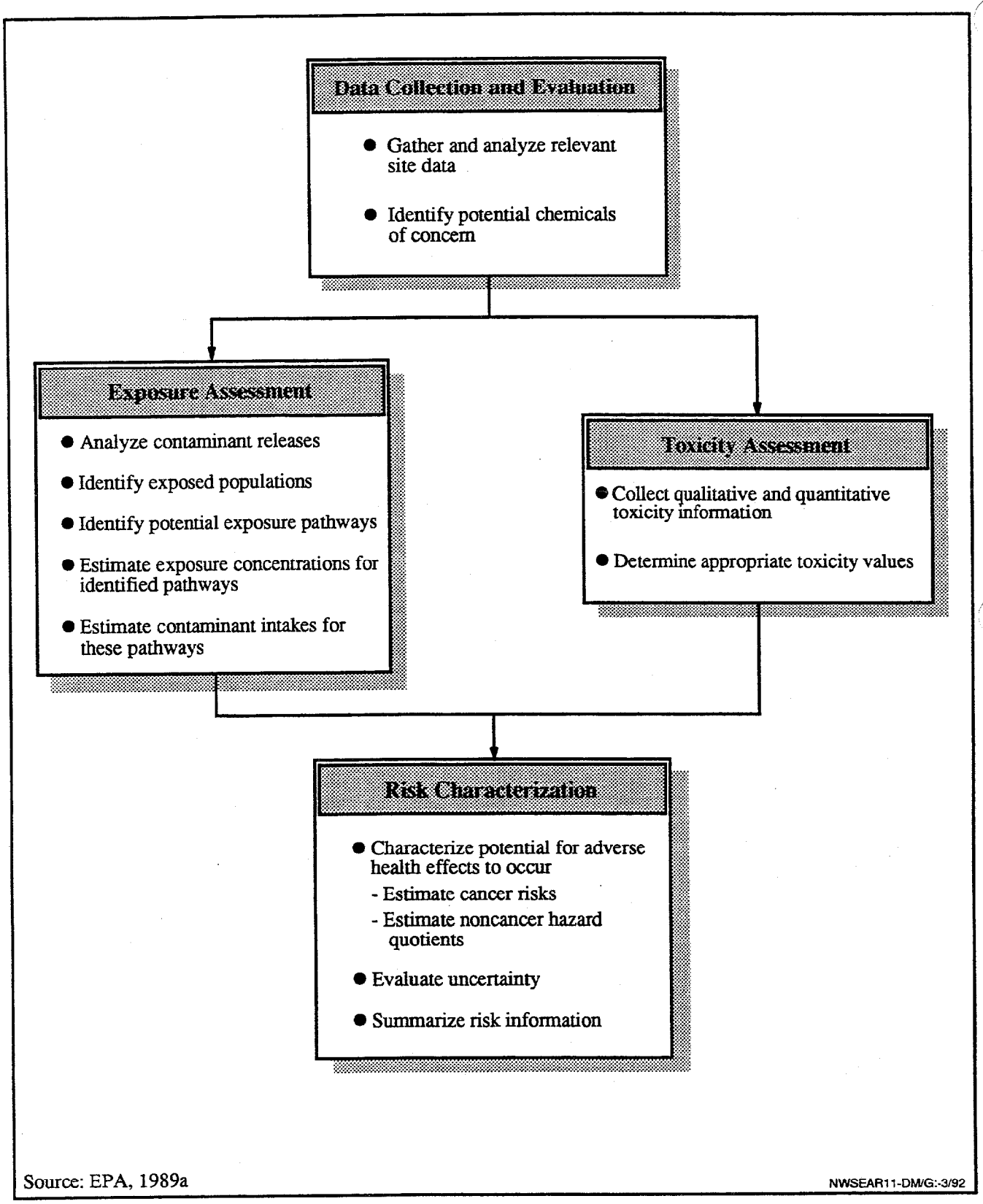

FIGURE 6-1 SCHEMATIC OF THE RISK ASSESSMENT PROCESS

6.2 DATA COLLECTION AND EVALUATION

6.2.1 Introduction

The objective of the data collection and evaluation is to screen and summarize the data that are available on site-related chemicals. The results of the data collection and evaluation are used in both the human health and ecological risk assessments to evaluate risk to the potential receptors in the study area. The relationship of the data collection and evaluation to other components of the risk assessment process is illustrated in Figure 6-1.

The study area at the Station consists of 11 RI sites that are characterized according to past and present use. The studies that have been conducted to characterize the RI sites at the Station are summarized in Section 3, Site Investigations. Sampling data are available for the RI sites for a variety of media including soils, sediments, and groundwater. Specific media were sampled on the basis of previous and existing use patterns on the individual site. These data are summarized in the following subsections of this report:

- Soil - Subsection 6.2.4.1
- Sediment - Subsection 6.2.4.2
- Groundwater - Subsection 6.2.4.3

6.2.2 Chemicals of Concern

A number of chemicals were identified and considered to be site-related and relevant to the risk assessment for the Station. The following subsections present the basis for the selection of the potential chemicals of concern for the 11 RI sites according to medium and site. It is important to note that potential chemicals of concern may differ between the human health risk assessment and the ecological risk assessment because of differences in expected potential exposure and toxicity to designated target receptors.

6.2.3 Data Evaluation

The objective of the data evaluation is to characterize the extent of site contamination in all affected media. Because decisions regarding data useability may influence the risk assessment results, careful consideration must be given to the acceptability of previously acquired data. A comprehensive review of all data collected for the RI sites has been conducted and is discussed in Section 4 of the RI, Results of the Field Investigation. It should be noted that the baseline risk assessment is based on validated soil, sediment, and groundwater data from the first sampling round (June 1991) and unvalidated groundwater data from two subsequent sampling rounds (October 1991 and November 1991).

The following subsections describe the methods by which data were analyzed and summarized for use in the human health and ecological risk assessments. Guidance for the evaluation of the data was derived from the following documents:

- Risk Assessment Guidance for Superfund, Volume 1 (EPA, 1989)
- Guidance for Data Useability in Risk Assessment (EPA, 1990)
- Statistical Methods for Environmental Pollution Monitoring (Gilbert, 1987)

In addition, consideration was also given to guidance from EPA Region II where available.

6.2.3.1 General Approach to Data Summarization

The analytical results of the site-related chemicals were summarized by site and by medium. Each data summary includes the following information for each chemical:

- Number of samples.
- Frequency of detection.
- Minimum and maximum values.
- Arithmetic mean.
- Standard deviation.
- Upper 95% confidence limit of the arithmetic mean.

The frequency of detection represents the ratio of the number of samples detected in a medium and the total number of samples taken. The minimum and maximum values represent all samples excluding nondetected samples.

6.2.3.2 General Assumptions for Data Evaluation

The statistical evaluation of data required that several assumptions be made, including:

- If a chemical was not positively detected in any samples from a given medium because it was reported as a nondetect, it was assumed not to be present in that medium.
- All J-qualified data were assumed to be valid data. "J" values are estimated concentrations that are less than the specific level a laboratory must be able to routinely and reliably detect, but are still present at detectable concentrations.
- All R-qualified data were discarded from the data summary. "R" values are those data that were found to be unusable according to the Contract Laboratory Program (CLP) data validation protocols.
- When a common laboratory contaminant was reported in a field sample and a corresponding laboratory blank, that sample was considered as a positive identification only if the concentration in the field sample exceeded the concentration in the blank by a factor of ten times or greater. Any other chemical that was detected in a field sample and in a laboratory blank was considered to be positively identified only when the field sample concentration exceeded the laboratory blank concentration by a factor of five times or greater. If the concentration of a chemical reported in a field sample did not exceed five or ten times (EPA, 1989a) the laboratory blank concentration, the concentration in the field samples was considered to be "nondetectable."

It should be noted that acetone was not evaluated as a contaminant of concern for any medium at any of the RI sites. Acetone was not considered because detected concentrations of acetone are attributable to the sampling equipment field decontamination procedures that are described in the Quality Assurance Project Plan (QAPP) dated June 1990.

Calculation of the Average Concentration

As recommended by EPA Region II, the arithmetic mean and the upper 95% confidence limit were used in developing the summary statistics for the data. The following describes additional assumptions used in evaluating and summarizing data for the risk assessment.

- When a chemical concentration was reported as nondetectable in a sample, the chemical was assumed to be present at a concentration of one half of the method detection limit.
- For sampling locations for which there were duplicate samples or laboratory replicates, both results were averaged and the average was considered to be the concentration for that location.
  - If duplicate or replicate samples consisted of one detected and one nondetected concentration, one-half of the method detection limit was substituted for the nondetected sample when the average of the duplicates was calculated.
  - For the purpose of reporting the minimum and maximum detected value, the average concentration of the duplicates or replicates was used.

Calculation of the Upper 95% Confidence Limit

As agreed to in the work plan for the human health and ecological risk assessment, the upper 95% confidence limit on the arithmetic mean was used for the reasonable maximum exposure concentration. The upper 95% confidence limit was calculated using the following formula (Wonnacott and Wonnacott, 1977):

$$\overline{X} + t_{\alpha,(n-1)} * \left(S/\sqrt{n}\right)$$

where:

$\overline{X}$ = the sample mean

t_{α} = t value based on (n-1) degree of freedom

s = the sample standard deviation

n = the sample size

6.2.4 Summary of Data

This subsection and the accompanying tables summarize descriptive statistics for the chemicals of concern evaluated in the risk assessment, by site and by medium, as follows:

- Surface Soil Analytical Summary - Tables 6-1 through 6-4.
- Sediment Analytical Summary - Tables 6-5 through 6-10.
- Groundwater Analytical Summary - Tables 6-11 through 6-19.

6.2.4.1 Soil Data

Tables 6-1 through 6-4 summarize the sample number, frequency of detection, range of detected concentrations, arithmetic mean, standard deviation, and upper 95% confidence limit for surface soils according to site.

Samples for surface soils were analyzed and summarized to evaluate risk for potential receptors. The depth interval included in the analysis of the soil pathways was 0 to 2 feet. The soil sampling locations for each site are described in Subsection 3.2.

Surface soil concentrations were compared with background surface soil concentrations established for the eastern United States and areas of New Jersey (Table 6-20). Chemicals were deleted as potential site-related chemicals of concern if the maximum detected concentration was below the mean background soil concentrations presented in Table 6-20. When applicable data were available, the comparisons were made using data for New Jersey. The following naturally occurring essential nutrients were also excluded from evaluation: calcium, magnesium, potassium, and sodium.

Surface soil samples chosen for evaluation for Site 19 differed between the human health assessment and the ecological assessment. Samples from the paved areas were considered

Table 6–1 – Descriptive Statistics for Potential Chemicals of Concern for Soil – Site 2 (mg/kg)

Chemical	Human Health or Ecological[a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Inorganics								
Aluminum		5	5	3030	8490	4790	2173	7074
Arsenic	H,E	5	5	1.7	7.5	4.6	2.4	7.1
Barium		5	5	1.3	2.0	1.6	0.4	2.0
Beryllium		5	5	0.28	1.1	0.6	0.3	0.9
Calcium		5	5	4.2	15.4	10.1	5.4	15.7
Chromium	H,E	5	5	71.1	265	140	83	227
Cobalt		5	1	0.28	1.4	0.6	0.5	1.1
Copper		5	5	1.4	4.2	2.7	1.2	3.9
Iron	H,E	5	5	12650	33900	18333	9025	27818
Lead		5	5	3.9	10.8	6.6	2.7	9.4
Magnesium		5	5	502	2060	963	624	1619
Manganese		5	5	3.7	6.5	4.9	1.3	6.3
Nitrate	H,E	5	5	1.0	3.1	2.2	0.9	3.1
Potassium		5	5	1400	6480	2922	2030	5055
Selenium	H,E	5	1	0.25	0.65	0.27	0.22	0.50
Sodium		5	5	5.0	36.0	19.7	14.0	34.4
Vanadium	H,E	5	5	61.5	168	99	44	146
Zinc		5	5	6.2	21.1	11.3	5.7	17.3

[a] H – represents chemical of concern for human health evaluation, E – represents chemical of concern for ecological evaluation

Table 6–2 – Descriptive Statistics for Potential Chemicals of Concern for Soil – Site 11 (mg/kg)

Chemical	Human Health or Ecological [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Inorganics								
Nitrate	E	8	7	0.58	3.0	1.2	0.8	1.7
Nitrite	E	8	1	0.66	0.66	0.13	0.22	0.27

[a] H – represents chemical of concern for human health evaluation, E – represents chemical of concern for ecological evaluation

Table 6–3 – Descriptive Statistics for Potential Chemicals of Concern for Soil – Human Health Evaluation Site 19 (mg/kg)

Chemical	Used in Ecological Evaluation [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean [**]	Standard Deviation	Upper 95%
Organics								
Acetone		4	4	0.005	0.005	0.005	0.000	0.005
Methylene Chloride	H	4	4	0.003	0.003	0.003	0.000	0.003
Inorganics								
Aluminum		4	4	692	1990	1398	660	2173
Antimony	H	4	2	2.3	3.8	1.9	NA	NA
Arsenic		4	3	0.61	1.2	0.8	0.5	1.4
Barium		4	4	3.35	17.3	9.3	5.8	16
Cadmium	H	20	4	1.10	1.10	0.41	0.16	0.48
Calcium		4	4	25.8	619	301	307	662
Chromium		4	3	2.9	7.8	4.5	3.2	8.2
Copper		4	4	3.4	5.8	4.6	1.0	5.8
Iron		4	4	377	6090	2887	2399	5705
Lead	H	20	20	2.6	33.6	12.8	8.7	16.2
Magnesium		4	4	27.2	363	175	151	353
Manganese		4	3	2.9	24.9	15.2	9.1	25.8
Nickel		4	1	1.30	1.3	0.6	NA	NA
Potassium		4	4	63.4	236	146	83	244
Silver	H	4	1	0.71	0.71	0.42	NA	NA
Sodium		4	4	11.6	58.9	32.3	22.4	58.6
Vanadium		4	4	3.9	10.5	6.9	3.0	10.4
Zinc		4	4	7.0	25.5	12.7	8.6	22.8

[a] H – represents chemical of concern for human health evaluation

[**] Values represent an average when sample number is less than three

NA – Not applicable as a result of sample number less than three

Table 6–4 – Descriptive Statistics for Potential Chemicals of Concern for Soil – Ecological Evaluation Site 19 (mg/kg)

Chemical	Used in Ecological Evaluation [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean **	Standard Deviation	Upper 95%
Organics								
Acetone		4	4	0.005	0.005	0.005	0.000	0.005
Methylene Chloride	E	4	4	0.003	0.003	0.003	0.000	0.003
Inorganics								
Aluminum		2	2	692	1990	1341	NA	NA
Antimony	E	2	2	2.3	3.8	3.1	NA	NA
Arsenic		2	1	1.2	1.2	0.7	NA	NA
Barium		2	2	8.2	17.3	12.8	NA	NA
Calcium		2	2	25.8	619	322	NA	NA
Chromium		2	1	7.8	7.8	4.3	NA	NA
Copper		2	2	3.4	5.1	4.3	NA	NA
Iron		2	2	377	6090	3234	NA	NA
Lead	E	8	8	2.6	28.9	10.8	8.2	15.8
Magnesium		2	2	27.2	363	195	NA	NA
Manganese		2	2	2.9	24.9	13.9	NA	NA
Nickel		2	1	1.30	1.3	0.9	NA	NA
Potassium		2	2	63.4	236	150	NA	NA
Silver	E	2	1	0.71	0.71	0.54	NA	NA
Sodium		2	2	11.6	58.9	35.3	NA	NA
Vanadium		2	2	3.9	10.5	7.2	NA	NA
Zinc		2	2	7.0	25.5	16.3	NA	NA

[a] E – represents chemical of concern for ecological evaluation

** Values represent average when sample number is less than three

NA – Not applicable as a result of sample number less than three

inappropriate for inclusion in the ecological assessment because potential exposure to the target receptors was expected to be minimal in these areas. Chemicals of potential concern also differed for Site 20 between the human health assessment and the ecological assessment as a result of potential exposure to designated target receptors.

6.2.4.2 Sediment Data

Tables 6-5 through 6-10 summarize the number of samples, frequency of detection, range of detected concentrations, arithmetic mean, standard deviation, and upper 95% confidence limit for each of the chemicals of concern in sediments for each applicable site. The sediment sampling locations for each site are described in Subsection 3.2. Sediments are broadly defined in this assessment as matter that is deposited by water. As a result, sediments include matter that is deposited by streams and matter that settles in areas that routinely have standing water. Background sediment concentrations were unavailable; therefore, only calcium, magnesium, potassium, and sodium were deleted as potential chemicals of concern for the reasons described under soil data.

6.2.4.3 Groundwater Data

Tables 6-11 through 6-19 summarize the number of samples, frequency of detection, range of detected concentrations, arithmetic mean, standard deviation, and upper 95% confidence limits for each of the detected chemicals for the RI sites at the Station. These tables represent the results of three separate sampling rounds as described in Subsection 3.2.

For screening the inorganics detected in groundwater, concentrations at each of the downgradient site wells were compared to upgradient well concentrations for the same site. Ideally, comparisons should be done statistically; however, because of limited data for background samples, a statistical comparison was deemed inappropriate. In the absence of specific guidance from EPA or most of the regions (including Region II), the approach used herein was based on EPA Region IV guidance, which addresses the qualitative comparison of background and site well data for inorganic chemicals. If the average concentration in

Table 6–5 – Descriptive Statistics for Potential Chemicals of Concern for Sediment – Site 2 (mg/kg)

Chemical	Human Health or Ecological [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Inorganics								
Aluminum	H	3	3	7640	10300	9197	1387	11535
Arsenic	H	3	3	4.7	7.5	6.2	1.4	8.5
Barium	H	3	3	5.3	10.1	7.6	2.4	11.7
Beryllium	H	3	3	1.0	1.2	1.1	0.1	1.3
Cadmium	H	3	1	1.2	1.2	0.7	0.4	1.4
Calcium		3	3	7.6	44.5	22.2	19.6	55.3
Chromium	H	3	3	208	286	240	41	309
Cobalt	H	3	3	1.1	1.4	1.2	0.2	1.5
Copper	H	3	3	4.1	17.6	11.4	6.8	22.9
Iron	H	3	3	30000	41300	34667	5901	44615
Lead	H	3	3	7.2	27.0	17.8	10.0	34.7
Magnesium		3	3	1490	2160	1933	384	2581
Manganese	H	3	3	6.8	10.6	8.6	1.9	11.8
Nitrate	H	3	3	1.2	1.7	1.4	0.3	1.8
Potassium	H	3	3	4650	6560	5780	1002	7469
Sodium		3	3	10.3	36.3	19.3	14.8	44.1
Vanadium	H	3	3	149	210	182	31	234
Zinc	H	3	3	21.1	26.6	23.0	3.1	28.3

[a] H – represents chemical of concern for human health evaluation, E – represents chemical of concern for ecological evaluation

Table 6–6 – Descriptive Statistics for Potential Chemicals of Concern for Sediment – Site 4 (mg/kg)

Chemical	Human Health or Ecological [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics								
Acetone		4	2	0.003	0.069	0.030	0.032	0.069
Aroclor–1260	H,E	4	1	1.60	1.60	0.573	0.70	1.396
bis (2–Ethylhexyl)phthalate	H,E	4	4	0.067	0.370	0.167	0.139	0.330
Carbon Disulfide	H,E	4	1	0.002	0.002	0.003	0.001	0.004
Methylene Chloride	H,E	4	3	0.063	0.10	0.060	0.042	0.109
Phenanthrene	H,E	4	1	0.068	0.068	0.231	0.123	0.376
Pyrene	H,E	4	1	0.130	0.130	0.247	0.097	0.361
Inorganics								
Aluminum	H,E	4	4	526	14100	4117	6658	11941
Antimony	H,E	4	2	1.9	6.1	2.5	2.4	5.4
Arsenic	H,E	4	1	3.0	3.0	0.9	1.4	2.6
Barium	H,E	4	4	3.3	113	32	54	95
Beryllium	H,E	4	1	0.24	0.24	0.11	0.09	0.21
Cadmium	H,E	4	1	5.7	5.7	1.8	2.6	4.8
Calcium		4	4	162	1530	591	637	1339
Chromium	H,E	4	4	2.4	36.8	12.1	16.5	31.5
Cobalt	H,E	4	1	3.7	3.7	1.3	1.6	3.2
Copper	H,E	4	1	71.5	71.5	18.2	35.6	59.9
Iron	H,E	4	4	554	22100	7179	10052	18989
Lead	H,E	4	4	4.6	192	53	93	162
Magnesium		4	4	26.4	545	169	252	464
Manganese	H,E	4	4	1.7	77.6	30.1	34.1	70.2
Mercury	H,E	4	1	1.9	1.9	0.5	0.9	1.6
Nickel	H,E	4	2	0.7	10.1	3.0	4.7	8.6
Potassium		4	2	80.4	999	279	481	844
Silver	H,E	4	2	0.57	1.3	0.7	0.4	1.2
Sodium		4	4	20.3	60.2	37.3	16.9	57.1
Vanadium	H,E	4	4	1.6	48.1	14.0	22.8	40.7
Zinc	H,E	4	4	8.4	688	197	328	582

[a] H – represents chemical of concern for human health evaluation, E – represents chemical of concern for ecological evaluation

Table 6–7 – Descriptive Statistics for Potential Chemicals of Concern for Sediment – Site 10 (mg/kg)

Chemical	Human Health or Ecological [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics								
Acetone		3	1	0.079	0.079	0.030	0.043	0.102
Benzo(a)anthracene	H,E	3	2	0.052	0.054	0.110	0.099	0.278
bis (2–Ethylhexyl)phthalate	H,E	3	1	0.061	0.061	0.172	0.096	0.334
Chrysene	H,E	3	1	0.090	0.090	0.118	0.097	0.281
Fluoranthene	H,E	3	2	0.065	0.088	0.126	0.087	0.272
Methylene Chloride	H,E	3	1	0.056	0.056	0.020	0.031	0.072
Phenanthrene	H,E	3	2	0.066	0.170	0.154	0.081	0.290
Pyrene	H,E	3	2	0.050	0.092	0.122	0.091	0.276
Inorganics								
Aluminum	H,E	3	3	475	676	553	108	735
Antimony	H,E	3	1	3.2	3.2	1.7	1.3	3.9
Arsenic	H,E	3	1	1.7	1.7	0.7	0.9	2.2
Barium	H,E	3	3	3.3	5.5	4.3	1.1	6.2
Calcium		3	3	94.9	139	111	24	152
Chromium	H,E	3	3	2.2	6.3	3.9	2.1	7.5
Cobalt	H,E	3	1	2.8	2.8	1.2	1.4	3.5
Iron	H,E	3	3	3230	9790	5503	3715	11766
Lead	H,E	3	3	3.5	5.8	4.6	1.2	6.5
Magnesium		3	3	24.3	41.8	30.2	10.0	47.1
Manganese	H,E	3	3	8.9	58.9	27.5	27.3	73.6
Mercury	H,E	3	1	0.13	0.13	0.08	0.05	0.15
Potassium		3	3	67.6	97.6	81.8	15.1	107.2
Sodium		3	3	29.2	44.7	35.9	7.9	49.3
Vanadium	H,E	3	3	3.2	7.2	4.6	2.3	8.4
Zinc	H,E	3	3	13.0	14.9	13.7	1.1	15.5

[a] H – represents chemical of concern for human health evaluation, E – represents chemical of concern for ecological evaluation

Table 6–8 – Descriptive Statistics for Potential Chemicals of Concern for Sediment – Site 19 (mg/kg)

Chemical	Human Health or Ecological [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean **	Standard Deviation	Upper 95%
Inorganics								
Aluminum	H,E	3	3	1330	2819	2130	750	3395
Arsenic	H,E	3	3	1.2	2.0	1.6	0.4	2.3
Barium	H,E	3	3	28.4	73.9	46.2	24.3	87.1
Beryllium	H,E	3	1	0.20	0.20	0.11	NA	NA
Cadmium	H,E	12	4	1.6	28.6	5.1	10.4	10.5
Calcium		3	3	181	1100	578	472	1374
Chromium	H,E	3	3	90	1505	686	733	1922
Cobalt	H,E	3	3	0.88	2.7	2.0	1.0	3.6
Copper	H,E	3	3	7.9	22.3	17.4	8.2	31.2
Iron	H,E	3	3	2950	4759	3636	980	5288
Lead	H,E	12	12	5.8	10769	1486	3288	3195
Magnesium		3	3	260	441	336	94	494
Manganese	H,E	3	3	39.7	39.9	39.8	0.1	40.0
Mercury	H,E	3	1	0.12	0.12	0.08	NA	NA
Potassium		3	3	193	331	277	74	402
Sodium		3	3	33.0	41.5	36.8	4.3	44.1
Vanadium	H,E	3	3	5.5	13.1	10.0	4.0	16.7
Zinc	H,E	3	3	162	920	439	418	1143

[a] H – represents chemical of concern for human health evaluation, E – represents chemical of concern for ecological evaluation

** Values represent average when sample number is less than three

NA – Not applicable as a result of sample number less than three

Table 6–9 – Descriptive Statistics for Potential Chemicals of Concern for Sediment* – Site 20 (mg/kg)

Chemical	Human Health or Ecological [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean **	Standard Deviation	Upper 95%
Organics								
Anthracene	H,E	2	1	0.21	0.21	0.24	NA	NA
Benzo (a) anthracene	H,E	2	2	0.12	1.80	0.96	NA	NA
Benzo (a) pyrene	H,E	2	2	0.15	2.50	1.33	NA	NA
Benzo (b) fluoranthene	H,E	2	2	0.23	2.60	1.42	NA	NA
Benzo (g,h,i) perylene	H,E	2	2	0.16	2.30	1.23	NA	NA
Benzo (k) fluoranthene	H,E	2	2	0.17	2.30	1.24	NA	NA
bis (2–Ethylhexyl) phthalate	H,E	2	2	0.45	1.55	1.00	NA	NA
Chrysene	H,E	2	2	0.20	2.40	1.30	NA	NA
Dibenzo (a,h) anthracene	H,E	2	1	0.77	0.77	0.53	NA	NA
Di–n–Butylphthalate	H,E	2	2	0.08	0.20	0.14	NA	NA
Fluoranthene	H,E	2	2	0.26	3.38	1.82	NA	NA
Indeno (1,2,3–cd) pyrene	H,E	2	2	0.12	1.95	1.04	NA	NA
Phenanthrene	H,E	2	2	0.11	0.73	0.42	NA	NA
Pyrene	H,E	2	2	0.26	3.58	1.92	NA	NA
Inorganics								
Aluminum	H	5	5	4700	17300	9293	4881	13942
Antimony	H,E	5	2	3.40	5.85	2.41	2.20	4.51
Arsenic	H	5	5	0.79	4.10	2.78	1.25	3.97
Barium	H	5	5	49	325	154	103	252
Beryllium	H,E	5	5	2.50	9.90	5.33	3.06	8.25
Cadmium	H,E	5	2	1.30	1.80	0.93	0.61	1.51
Calcium		5	5	1220	6750	3851	2158	5907
Chromium	H,E	5	5	84	204	135	52	185
Cobalt	H,E	5	5	13	65	38	25	62
Copper	H,E	5	5	261	1320	651	438	1068
Iron	H,E	5	5	16800	54100	31391	14329	45040
Lead	H,E	5	5	305	780	518	213	721
Magnesium		5	5	871	2280	1424	550	1948
Manganese	H	5	5	107	329	223	92	311
Nickel	H,E	5	5	85	711	312	260	559
Potassium		5	5	553	1930	989	556	1518
Selenium	H,E	5	5	0.61	3.05	1.83	0.86	2.65
Sodium		5	5	181	766	404	218	612
Vanadium	H	5	5	13	49	30	16	45
Zinc	H,E	5	5	733	2890	1817	981	2751

* Sediments treated as soils for ecological evaluation

** Value represents an average when sample number is less than three

[a] H – represents chemical of concern for human health evaluation, E – represents chemical of concern for ecological evaluation

NA – Not applicable as a result of sample number less than three

Table 6–10 – Descriptive Statistics for Potential Chemicals of Concern for Sediment/Soil* – Ecological Evaluation Site 22 (mg/kg)

Chemical	Used in Ecological Evaluation [a]	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean **	Standard Deviation	Upper 95%
Organics								
Acenaphthene	E	2	1	0.30	0.30	0.28	NA	NA
Acetone		3	3	0.13	0.18	0.15	0.02	0.19
Anthracene	E	5	3	0.07	0.88	0.31	0.32	0.62
Benzo(a)anthracene	E	5	3	0.12	1.80	0.57	0.70	1.24
Benzo (a) pyrene	E	5	3	0.22	0.97	0.42	0.32	0.73
Benzo (b) fluoranthene	E	5	4	0.07	1.20	0.46	0.47	0.90
Benzo (g,h,i) perylene	E	5	3	0.16	0.83	0.38	0.27	0.64
Benzoic Acid	E	3	1	0.58	0.58	0.96	NA	NA
Benzo (k) fluoranthene	E	5	4	0.05	1.20	0.43	0.47	0.88
bis(2–ethylhexyl)phthalate	E	2	1	0.08	0.08	0.16	NA	NA
Chrysene	E	5	3	0.17	1.70	0.61	0.65	1.23
4,4–DDT	E	3	2	0.00	0.01	0.01	NA	NA
Dibenzo (a,h) anthracene	E	2	2	0.06	0.22	0.14	NA	NA
Di–n–Butylphthalate	E	5	4	0.06	0.07	0.08	0.04	0.12
Fluoranthene	E	5	4	0.11	5.00	1.43	2.07	3.40
Fluorene	E	5	2	0.15	0.16	0.20	NA	NA
Indeno (1,2,3–cd) pyrene	E	5	3	0.12	0.78	0.35	0.26	0.60
Phenanthrene	E	5	4	0.07	6.30	1.49	2.70	4.06
Pyrene	E	2	2	1.10	3.30	2.20	NA	NA
1,1,1–Trichloroethane	E	3	1	0.003	0.003	0.003	NA	NA
Inorganics								
Aluminum		8	5	1300	4350	2701	935	3329
Arsenic		8	5	0.94	3.3	2.3	0.9	2.9
Barium		8	5	1.1	16.5	7.9	5.3	11.5
Beryllium		8	5	0.13	0.45	0.25	0.06	0.29
Cadmium	E	5	3	0.93	2.7	1.3	1.0	2.2
Calcium		8	5	9.7	1260	432	444	730
Chromium	E	8	5	11.6	48.2	25.9	8.2	31.4
Cobalt		3	2	1.1	5.2	2.3	NA	NA
Copper		8	5	0.77	18.3	7.17	6.5	11.5
Iron		8	5	2550	13400	6670	4300	9559
Lead	E	8	5	6.3	106	29.8	38	56
Magnesium		8	5	131	661	417	179	538
Manganese		8	5	2.4	155	27.6	62	69
Nickel		7	1	2.8	8.6	1.9	NA	NA
Potassium		8	5	342	2270	986	425	1271
Selenium	E	8	2	0.35	0.38	0.2	NA	NA
Sodium		8	5	10.3	97.4	45.7	20.9	59.7
Vanadium		8	5	9.5	36.1	19.6	8.1	25.1
Zinc		8	5	4	119	32.6	42	61

* Sediment and soil data were combined for the ecological evaluation

[a] E – represents chemical of concern for ecological evaluation

** Value represents an average when sample number is less than three

NA – Not applicable as a result of sample number less than three

Table 6-11 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 2 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
Benzene	12	2	0.002	0.004	0.0026	0.0005	0.0028
bis(2-Ethylhexyl)phthalate	6	4	0.001	0.006	0.0021	0.002	0.0037
Chloroform	18	12	0.003	0.006	0.0033	0.0013	0.0038
Inorganics							
Aluminum	6	5	0.31	45.4	12.7	16.8	27.9
Antimony *	6	1	0.013	0.013	0.005	0.004	0.009
Barium	18	7	0.01	0.292	0.10	0.07	0.13
Beryllium	6	3	0.0014	0.008	0.002	0.003	0.005
Cadmium *	12	2	0.005	0.005	0.003	0.001	0.003
Calcium *	5	5	0.45	33.2	10.2	13.5	23.0
Chromium	19	16	0.012	2.4	0.49	0.76	0.81
Cobalt	6	2	0.005	0.010	0.004	0.003	0.007
Copper	18	5	0.022	0.06	0.02	0.02	0.02
Iron	18	18	0.35	316	64.3	96.3	103.8
Lead	18	14	0.001	0.19	0.03	0.05	0.05
Magnesium *	6	5	1.0	11.9	4.1	4.3	7.6
Manganese	19	16	0.005	0.82	0.16	0.22	0.25
Mercury	18	5	0.0003	0.001	0.0002	0.0003	0.0004
Nickel	6	2	0.004	0.05	0.01	0.02	0.03
Nitrate	6	6	0.14	1.9	0.51	0.69	1.1
Potassium *	6	6	1.6	34.4	11.1	12.1	21.1
Sodium *	18	8	2.4	14.9	4.4	4.2	6.2
Vanadium	6	5	0.004	1.1	0.27	0.42	0.65
Zinc	18	16	0.02	5.0	0.42	1.2	0.90
Explosives							
1,3,5-TNB	4	3	0.0005	0.003	0.0012	0.0013	0.0026
2,4-DNT	10	1	0.0016	0.0032	0.0006	0.0007	0.0012
HMX	2	1	0.0008	0.0008	0.0006	0.0004	0.0022
RDX	6	1	0.004	0.0059	0.0011	0.0018	0.0025
TETRYL	2	1	0.0012	0.0012	0.0007	0.0006	0.0033

* Chemical omitted from human health evaluation

Table 6-12 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 3 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
Aldrin	5	1	3.00E-05	3.00E-05	2.77E-05	2.168E-06	2.98E-05
bis(2-Ethylhexyl)phthalate	7	4	0.001	0.003	0.003	0.002	0.006
Chlorobenzene	11	2	0.01	0.013	0.013	0.02	0.03
4,4-DDE	5	1	2.10E-05	2.10E-05	8.92E-05	9.67E-05	0.0002
4,4-DDT	5	1	9.30E-05	9.30E-05	0.0001	8.90E-05	0.0002
1,4-Dichlorobenzene	6	2	0.003	0.01	0.006	0.002	0.008
Diethylphthalate	6	1	0.004	0.004	0.005	0.0007	0.006
Di-n-Butylphthalate	2	1	0.004	0.004	0.005	0.0007	0.006
Ethylbenzene	5	1	0.18	0.18	0.04	0.08	0.12
2-Methylnaphthalene	5	1	0.005	0.005	0.005	0.0004	0.006
4-Methylphenol	5	1	0.05	0.05	0.01	0.02	0.03
Naphthalene	5	1	0.07	0.07	0.02	0.03	0.05
N-Nitrosodiphenylamine (1)	5	1	0.001	0.001	0.005	0.002	0.007
Toluene	5	1	0.08	0.08	0.02	0.03	0.05
Xylene	5	1	0.47	0.47	0.10	0.21	0.30
Inorganics							
Aluminum	5	5	1.4	11.2	5.3	4.3	9.4
Antimony	5	1	0.03	0.03	0.01	0.007	0.02
Arsenic	11	7	0.001	3.5	0.27	0.59	0.83
Barium	8	6	0.02	0.29	0.11	0.08	0.19
Beryllium	5	2	0.001	0.001	0.0006	0.0005	0.001
Cadmium	11	8	0.02	0.05	0.02	0.02	0.03
Calcium *	5	5	0.9	18.6	8.1	9.2	16.9
Chromium	11	9	0.02	0.64	0.12	0.13	0.25
Cobalt	5	4	0.003	0.02	0.007	0.006	0.01
Copper	11	9	0.004	0.25	0.04	0.04	0.08
Iron	11	11	0.81	1240.0	227.2	247.6	463.3
Lead	11	10	0.005	0.16	0.04	0.04	0.08
Magnesium *	5	5	0.32	2.6	1.2	0.89	2.0
Manganese	11	11	0.04	2.6	0.62	0.66	1.3
Mercury	11	8	0.0002	0.006	0.0007	0.0009	0.002
Nickel *	5	1	0.02	0.02	0.006	0.009	0.01
Potassium *	5	5	0.25	2.8	1.6	0.92	2.5
Selenium	11	6	0.002	0.03	0.006	0.006	0.01
Silver	3	2	0.02	60.1	20.0	34.7	78.5
Sodium *	8	5	1.7	3.2	2.3	0.41	2.7
Sulfate *	4	4	67.3	90.8	77.2	12.2	97.7
Vanadium	5	4	0.002	0.49	0.11	0.21	0.31
Zinc	11	11	0.02	0.84	0.29	0.20	0.48

* Chemical omitted from human health evaluation

Table 6-13 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 4 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
Chloroform	14	4	0.001	0.003	0.002	0.0005	0.003
1,2-Dichloroethene	14	6	0.007	0.033	0.008	0.008	0.02
Trichloroethene	14	3	0.014	0.08	0.01	0.02	0.03
Inorganics							
Aluminum *	5	5	0.98	9.5	3.7	3.4	7.0
Barium *	5	5	0.02	0.06	0.04	0.02	0.05
Calcium *	5	5	1.4	32.4	9.8	12.9	22.1
Chromium *	15	3	0.01	0.03	0.008	0.007	0.01
Iron	15	15	1.1	48.6	13.1	14.8	19.8
Lead *	15	7	0.002	0.01	0.003	0.004	0.005
Magnesium *	5	5	1.1	15.4	4.2	6.3	10.1
Manganese *	15	15	0.01	0.29	0.09	0.10	0.14
Mercury *	5	1	0.0003	0.0003	0.0001	0.0001	0.0002
Nickel	5	1	0.02	0.02	0.006	0.008	0.01
Potassium *	5	5	0.75	5	1.9	1.8	3.6
Selenium	4	2	0.001	0.006	0.004	0.002	0.006
Sodium *	10	6	2.1	3.8	2.6	0.58	3.0
Sulfate *	10	10	9.9	31.4	17.7	8.8	22.8
Vanadium *	5	5	0.003	0.03	0.01	0.01	0.02
Zinc *	15	13	0.01	0.06	0.03	0.02	0.04

* Chemical omitted from human health evaluation

Table 6–14 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 5 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
Acetone *	14	14	0.02	4.9	0.65	1.3	1.3
Benzene	14	7	0.001	0.004	0.002	0.0009	0.003
bis(2–Ethylhexyl)phthalate	7	2	0.003	0.004	0.005	0.001	0.006
Chlorobenzene	14	5	0.001	0.002	0.002	0.0007	0.002
Chloroethane	14	3	0.001	0.002	0.004	0.001	0.005
Chloroform	21	3	0.002	0.008	0.02	0.05	0.04
1,4–Dichlorobenzene	7	1	0.002	0.00	0.005	0.001	0.006
1,1–Dichloroethane	7	1	0.001	0.001	0.002	0.0006	0.003
1,2–Dichloroethane	14	1	0.008	0.008	0.003	0.001	0.004
1,2–Dichloroethene	14	5	0.001	0.02	0.004	0.005	0.006
Di–n–Butylphthalate	7	1	0.001	0.001	0.005	0.002	0.006
Ethylbenzene	21	3	0.003	0.14	0.02	0.05	0.04
Methylene Chloride *	14	6	0.002	0.01	0.004	0.003	0.005
Naphthalene	7	1	0.002	0.002	0.005	0.001	0.006
1,1,2,2–Tetrachloroethane	14	2	0.003	0.003	0.003	0.0002	0.003
Trichloroethene	14	3	0.002	0.01	0.004	0.004	0.006
Vinyl Chloride	7	2	0.002	0.003	0.004	0.001	0.005
Xylene	14	2	0.010	0.01	0.004	0.003	0.005
Inorganics							
Aluminum	7	7	0.61	114.0	32.1	42.9	63.6
Antimony	7	1	0.06	0.06	0.02	0.02	0.03
Barium	7	7	0.02	0.18	0.07	0.05	0.11
Beryllium	7	5	0.001	0.02	0.004	0.006	0.008
Cadmium	21	5	0.005	0.03	0.005	0.008	0.009
Calcium *	7	7	0.69	55.9	18.9	24.9	37.2
Chromium	21	21	0.01	4.1	0.73	1.2	1.2
Cobalt	7	6	0.003	0.07	0.02	0.02	0.04
Copper	14	8	0.004	0.05	0.02	0.03	0.04
Iron	21	21	2.6	571.0	111.2	174.8	177.0
Lead	21	20	0.003	0.06	0.02	0.02	0.03
Magnesium *	7	7	1.3	27.7	9.1	9.8	16.3
Manganese	21	21	0.03	1.2	0.28	0.35	0.41
Mercury	7	1	0.0003	0.0003	0.0001	0.0001	0.0002
Nickel	7	6	0.003	0.14	0.04	0.05	0.07
Potassium *	7	7	1.2	74.4	17.5	25.9	36.5
Sodium *	21	14	1.9	35.0	8.2	9.8	11.9
Sulfate *	14	14	11.7	184.0	54.0	49.2	77.3
Zinc	21	20	0.02	1.8	0.29	0.45	0.46

* Chemical omitted from human health evaluation

Table 6-15 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 7 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
Benzoic Acid	4	1	0.02	0.02	0.02	0.006	0.03
bis-2-Chloroisopropylether	4	1	0.001	0.001	0.004	0.002	0.007
2-Butadone	4	1	0.088	0.088	0.05	0.05	0.11
Chlorobenzene	12	3	0.004	0.005	0.007	0.01	0.01
Chloroform *	4	1	0.001	0.001	0.002	0.0008	0.003
1,2-Dichloroethane	4	1	0.001	0.001	0.002	0.001	0.003
1,2-Dichloroethene	12	3	0.004	0.004	0.007	0.01	0.01
Heptachlor	4	1	1.00E-05	1.00E-05	2.38E-05	9.491E-06	3.49E-05
1,1,2,2-Tetrachloroethane	4	1	0.008	0.008	0.02	0.02	0.04
1,1,2-Trichloroethane	12	3	0.005	0.026	0.009	0.01	0.02
Inorganics							
Aluminum	4	4	2.0	27.8	12.7	11.1	25.7
Arsenic	8	6	0.005	0.20	0.08	0.07	0.13
Barium	12	9	0.04	0.42	0.16	0.12	0.22
Beryllium	4	3	0.0006	0.001	0.0008	0.0004	0.001
Cadmium	8	3	0.003	0.008	0.004	0.002	0.005
Calcium *	4	4	1.6	5.9	4.6	2.0	6.9
Chromium	12	10	0.014	0.29	0.10	0.11	0.15
Copper	12	9	0.006	0.16	0.06	0.06	0.09
Iron	12	12	3.1	353.0	105.9	118.6	167.3
Lead	12	12	0.004	0.16	0.05	0.06	0.09
Magnesium *	4	4	1.4	5.6	3.5	1.8	5.7
Manganese	12	11	0.07	0.68	0.27	0.23	0.39
Mercury	8	4	0.0002	0.002	0.0005	0.0007	0.0009
Nickel	4	4	0.005	0.04	0.02	0.02	0.04
Selenium	4	2	0.0017	0.004	0.002	0.002	0.004
Sodium *	12	10	2.5	27.7	12.3	8.9	16.9
Sulfate	8	8	6.7	44.0	26.9	14.2	36.4
Zinc	12	12	0.03	0.48	0.18	0.17	0.27

* Chemical omitted from human health evaluation

Table 6–16 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 10 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
bis (2–Ethylhexyl) phthalate	6	2	0.002	0.005	0.005	0.001	5.76E–06
Methylene Chloride *	12	8	0.002	0.007	0.003	0.001	4.06E–06
Inorganics							
Aluminum	5	5	0.73	61.0	20.1	26.2	45.1
Antimony	6	4	0.01	0.03	0.01	0.009	0.02
Arsenic	18	6	0.002	0.05	0.008	0.01	0.01
Barium	6	5	0.027	0.07	0.05	0.03	0.07
Beryllium	6	2	0.005	0.009	0.002	0.004	0.005
Cadmium	12	3	0.004	0.008	0.003	0.002	0.004
Calcium *	6	6	0.54	5.4	2.7	1.6	4.0
Chromium	18	18	0.02	1.8	0.23	0.44	0.41
Cobalt	6	3	0.004	0.08	0.02	0.03	0.04
Copper	18	4	0.01	0.05	0.01	0.01	0.02
Iron	18	18	2.7	226.0	35.8	53.8	57.8
Lead	17	13	0.002	0.11	0.03	0.03	0.05
Magnesium *	6	6	0.41	9.9	4.0	4.0	7.3
Manganese	18	16	0.003	0.22	0.09	0.08	0.12
Nickel	6	5	0.006	0.19	0.04	0.07	0.10
Potassium *	4	4	0.85	31.9	10.4	13.7	21.8
Selenium	6	1	0.002	0.002	0.001	0.001	0.002
Sodium *	18	13	1.6	23.2	7.6	6.7	10.4
Sulfate *	12	10	16	106.5	33.7	29.2	48.8
Vanadium	6	6	0.02	1.5	0.37	0.60	0.86
Zinc	18	17	0.02	0.60	0.17	0.14	0.23

* Chemical omitted from human health evaluation

Table 6-17 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 11 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
bis (2-Ethylhexyl) phthalate	3	2	0.001	0.003	0.003	0.002	0.0049
Chloroform	9	4	0.002	0.006	0.003	0.001	0.0036
Inorganics							
Barium	3	3	0.025	0.057	0.04	0.01	0.05
Cadmium	3	1	0.004	0.004	0.002	0.001	0.004
Calcium *	3	3	0.85	4.9	2.3	1.9	4.6
Chromium	9	8	0.013	1.2	0.16	0.36	0.35
Iron	9	9	0.29	145	20.7	42.9	42.9
Lead	9	5	0.0019	0.064	0.01	0.02	0.02
Magnesium *	3	3	0.74	1.7	1.3	0.43	1.8
Manganese	9	9	0.009	0.12	0.03	0.03	0.05
Mercury	3	1	0.0003	0.0003	0.0001	0.0001	0.0002
Nitrate *	3	3	0.12	0.27	0.17	0.07	0.25
Sodium *	9	5	2.5	8.3	3.9	2.1	5.0
Vanadium	3	3	0.004	0.015	0.007	0.005	0.013
Zinc	9	9	0.014	0.18	0.054	0.052	0.081

* Chemical omitted from human health evaluation

Table 6–18 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 19 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
Acetone *	8	8	0.022	33.0	5.9	11.9	0.01
bis (2–Ethylhexyl) phthalate	5	3	0.001	0.004	0.004	0.002	5.436E–06
4,4–DDE	5	1	2.20E–05	5.50E–05	4.64E–05	1.39E–05	5.962E–08
4,4–DDT	5	2	0.0001	0.0001	7.64E–05	3.77E–05	1.124E–07
Methylene Chloride *	8	5	0.001	0.006	0.003	0.002	4.305E–06
Naphthalene	5	1	0.001	0.001	0.005	0.002	6.377E–06
Inorganics							
Aluminum	5	5	2.6	35.5	18.0	14.9	32.3
Arsenic	13	7	0.0027	0.08	0.01	0.01	0.02
Barium	9	6	0.03	0.24	0.09	0.04	0.13
Beryllium	5	3	0.0037	0.008	0.003	0.003	0.006
Cadmium	13	8	0.005	0.05	0.01	0.01	0.02
Calcium *	5	5	1.5	12.2	8.9	4.3	13.0
Chromium	13	13	0.03	4.5	0.68	0.73	1.4
Cobalt	5	3	0.008	0.03	0.012	0.012	0.023
Copper	13	8	0.005	0.14	0.028	0.021	0.048
Iron	13	13	4.9	534.0	83.9	89.7	169.5
Lead	13	13	0.004	0.28	0.05	0.05	0.09
Manganese	13	13	0.009	1.17	0.22	0.25	0.46
Mercury	8	3	0.0003	0.0006	0.0002	0.0002	0.0004
Nickel	5	5	0.006	0.08	0.04	0.03	0.07
Potassium *	5	5	1.3	20.2	9.8	9.5	18.8
Sodium *	4	2	5.0	6.8	4.2	2.1	6.7
Vanadium	5	5	0.02	0.63	0.25	0.27	0.51
Zinc	13	13	0.03	1.2	0.22	0.21	0.43

* Chemical omitted from human health evaluation

Table 6–19 – Descriptive Statistics for Potential Chemicals of Concern for Groundwater – Human Health Evaluation Site 26 (mg/L)

Chemical	Number of Samples	Frequency of Detection	Minimum Value	Maximum Value	Arithmetic Mean	Standard Deviation	Upper 95%
Organics							
Acetone *	6	6	0.012	0.05	0.02	0.01	0.03
1,1 Dichloroethene	3	1	0.003	0.003	0.003	0.0003	0.003
1,2 Dichloroethene	9	3	0.003	0.81	0.21	0.32	0.41
Methylene Chloride *	4	4	0.002	0.004	0.003	0.0009	0.003
Toluene	3	1	0.001	0.003	0.002	0.0009	0.003
Trichloroethene	9	3	0.003	0.66	0.12	0.22	0.25
Vinyl Chloride	3	1	0.001	0.005	0.004	0.002	0.008
Xylene	6	2	0.001	0.003	0.002	0.0007	0.003
Inorganics							
Antimony	3	2	0.004	0.04	0.02	0.02	0.05
Barium	6	4	0.01	0.21	0.09	0.07	0.15
Beryllium	3	1	0.0003	0.001	0.0005	0.0005	0.001
Cadmium	6	2	0.003	0.008	0.004	0.002	0.006
Calcium *	3	3	1.2	13.1	7.9	6.1	18.2
Chromium	9	6	0.003	0.17	0.04	0.05	0.07
Cobalt	3	1	0.002	0.005	0.003	0.002	0.005
Copper	9	7	0.005	0.08	0.03	0.02	0.04
Iron	9	9	7.0	167.0	48.2	51.3	80.0
Lead	8	6	0.002	0.03	0.009	0.01	0.03
Magnesium *	3	3	0.71	1.9	1.4	0.64	2.5
Manganese	9	9	0.01	0.33	0.11	0.09	0.16
Mercury	6	4	0.0001	0.002	0.0005	0.0007	0.001
Nitrate	9	9	0.43	3.4	1.1	0.95	1.6
Potassium *	3	3	1.8	5.3	3.6	1.8	6.5
Silver	6	2	0.001	0.04	0.01	0.01	0.02
Sodium *	9	5	2.2	5.6	3.3	1.3	4.2
Vanadium	3	3	0.01	0.06	0.03	0.03	0.08
Zinc	9	9	0.01	0.16	0.07	0.05	0.10
Explosives							
RDX	2	1	0.0003	0.0009	0.001	0.0004	0.001

* Chemical omitted from human health evaluation

Table 6-20

Background Soil Concentrations Used in Selection of Contaminants of Concern

Chemical	Mean Background Soil Concentration (mg/kg)	Range
Aluminum	33,000[d]	7,000-100,000[d]
Antimony	0.425[a]	0.25-0.6[b]
Arsenic	6.2[f]	<0.1-73[d]
Barium	427[b]	226-497[b]
Beryllium	1.7[a]	<1-7[d]
Cadmium	0.24[b]	0.04-0.58[b]
Calcium	3400[d]	100-280,000[d]
Chromium	19.9[b]	3.6-75[b]
Cobalt	7.1[b]	0.2-30.8[b]
Copper	15.6[b]	0.5-61[b]
Iron	14,000[d]	100->100,000[d]
Lead	28.6[b]	ND-155[b]
Magnesium	2100[d]	50-50,000[d]
Manganese	553[b]	20-5200[b]
Mercury	0.06[f]	0.01-3.4[d]
Nickel	20.9[b]	0.0-78.5[b]
Potassium	12,000[d]	50-37,000[d]
Selenium	0.25[f]	<0.1-3.9[d]
Silver	NA	NA
Sodium	2500[d]	<500-50,000[d]
Vanadium	48.7[b]	9-119[b]
Zinc	71.3[b]	3.2-320[b]

a Kabata-Pendias, A. and H. Pendias. 1984. Trace Elements in Soils and Plants. CRC Press, Boca Raton, Florida.

b Motto, H.L. Environmental Sciences Department. Cook College, Rutgers University, New Brunswick, NJ.

c Page, A.L. 1974. Fate and effects of trace elements in sewage sludge when applied agricultural land. Program element No. 1B2043, U.S. EPA, Cincinnati, Ohio.

d Shacklette, H.T. and J.G. Boerngen. 1984. Element concentrations in soils and other surficial materials of the conterminous United States. U.S. Geological Survey Professional Paper 1270.

e Vinogradov, A.P. 1959. The geochemistry of rare and dispersed elements in soils. Consultants Bureau, Inc., New York, N.Y.

f Average of a, c, d, and e.

the site wells exceeded two times that of the upgradient well, the inorganic chemical was chosen as contaminant of concern. In addition, if more than one sample exceeded two times the concentration in an upgradient well, the contaminant was selected as a contaminant of concern regardless of the average downgradient well concentration. With the exception of acetone, organic compounds were included as contaminants of concern unless all samples were reported as below detection limits or all samples had associated blank contamination as described in Subsection 6.2.3.2.

6.3 HUMAN HEALTH RISK ASSESSMENT

6.3.1 Introduction

The baseline human health risk assessment evaluates the potential for carcinogenic and noncarcinogenic risks associated with exposure to chemicals of concern detected in soil, sediment, and groundwater. This risk assessment evaluates the risk associated not only with current land and water uses at the Station, but also with future uses that may occur. In addition, the baseline risk assessment evaluates the potential human health risks under the no-action alternative, i.e., in the absence of any remedial (corrective) action.

The baseline risk assessment for the Station is being conducted to address several objectives, including:

- Characterization of the potential human health risks associated with exposure to site-specific chemicals in air and soil under current use scenarios, and air, soil, sediment, and groundwater under future use scenarios.
- Evaluation of the need for corrective action at the Station.
- Establishment of the basis for comparing potential health effects of various remedial alternatives.

The technical direction for the performance of the risk assessment comes primarily from several EPA documents, including *Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part 1* (EPA, 1989c), the *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (EPA, 1991b), and the *Exposure*

Factors Handbook (EPA, 1989b). In addition to the published guidance, the risk assessment is being conducted in accordance with a previously submitted and reviewed work plan. This work plan was reviewed by EPA Region II and the New Jersey Department of Environmental Protection and Energy (NJDEPE). Agency comments were evaluated and incorporated in this assessment.

This risk assessment consists of five principal components, briefly described below. The relationship of the components of the human health risk assessment process is illustrated in Figure 6-1.

Contamination Characterization (Subsection 6.2)

The contamination characterization is common to both the human health and ecological evaluations and is discussed in Subsection 6.2. Media-specific summary statistics, selection of chemicals of concern, and other elements of the contamination characterization are presented.

Exposure Assessment (Subsection 6.3.2)

The objective of the exposure assessment is to estimate the chemical doses to potential human receptors. In this subsection, local land and water uses under both current and future use scenarios are characterized, and the pathways through which chemicals may migrate from the site are identified. Based on this information, potentially exposed populations and potential exposure routes are discussed and exposure scenarios are developed. To facilitate an understanding of the information, conceptual site models are developed as part of the exposure assessment for each RI site. The algorithms used to calculate chemical doses for all potential receptors through all potential exposure pathways and routes of exposure are presented, and the doses calculated using these algorithms are summarized.

Toxicity Assessment (Subsection 6.3.3)

This subsection of the risk assessment evaluates the toxicity of each of the chemicals of concern. Applicable human toxicity values are identified for each chemical of concern for all relevant exposure routes. These include reference doses (RfDs) with which to evaluate potential noncarcinogenic health effects and cancer slope factors (CSFs) with which to evaluate potential carcinogenic risk. The primary sources of RfDs and CSFs are EPA's Integrated Risk Information System (IRIS, 1992), which represents EPA's most current database for toxicological information and the Health Effects Assessment Summary Tables (HEAST) (EPA, 1991a). If an EPA-approved toxicity value is not available for a chemical, an appropriate value is derived, when possible, from toxicity data or from a health-based standard.

Risk Characterization (Subsection 6.3.4)

In the risk characterization, the results of the exposure assessment and toxicity assessment are integrated to evaluate the potential carcinogenic and noncarcinogenic risks to humans. Based on the exposure doses calculated in the exposure assessment, and the toxicity values identified in the toxicity assessment, potential risks are evaluated for each chemical through each exposure route and for all chemicals through all exposure routes combined.

Uncertainty Analysis (Subsection 6.3.5)

Numerous assumptions are made in each step of a risk assessment. In the contamination characterization, assumptions are made with regard to the distribution of the data and how the data should be evaluated. When the exposure assessment is conducted, the exposure scenarios that are selected must be health protective yet plausible. Assumptions are made in the absence of site-specific data regarding the most appropriate exposure pathways and contact mechanisms. These assumptions frequently relate to estimates of ingestion and inhalation rates, exposure frequencies, and exposure durations. Furthermore, there is also a great deal of uncertainty associated with the toxicity assessment, as health criteria are

developed from laboratory studies and are extrapolated not only between, but across species and also from the high doses of the laboratory studies to the low doses typically found in the environment. The combined effect of numerous uncertainties at each step of the risk assessment results in compounded uncertainty in the risk characterization when quantitative results are presented. A more appropriate and meaningful discussion of risk involves a presentation of the range of potential risk estimates.

In order to accommodate such a discussion, an uncertainty analysis of the risk assessment is conducted and includes both qualitative and quantitative components. The qualitative analysis includes a discussion of site- and nonsite-related factors that produce uncertainty in a risk assessment. In addition, a quantitative sensitivity analysis is conducted in which certain key assumptions are varied to determine the impact on the risk estimates.

6.3.2 Exposure Assessment

The exposure assessment evaluates the potential magnitude and frequency of contact with the chemicals of concern through all migration pathways (e.g., air, groundwater, soil) for all routes of exposure (inhalation, ingestion, and dermal absorption).

The objectives of the exposure assessment are to:

- Describe current and potential local land and water uses.
- Identify significant pathways and routes of exposure to human receptors.
- Identify potentially exposed human receptors.
- Estimate human exposure doses for chemicals of concern.

The following narrative provides the technical discussion to meet each of these objectives. It should be noted that the exposure scenarios, models, and assumptions are developed in large part from the *Risk Assessment Guidance for Superfund* (EPA, 1989c) and the *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors* (EPA, 1991b). EPA Region II does not have formal guidance for conducting risk assessments at Superfund sites, however; Region II was consulted on several technical issues.

6.3.2.1 Environmental Setting/Local Land and Water Uses

The physical characteristics of individual sites and the results of the media sampling are discussed in Section 4, Results of the Field Investigation. The environmental setting of the Station is described below to put the potential exposure scenarios, particularly those concerning future use, in perspective. The individual sites are described in terms of potential chemical sources, release mechanisms, and known or potential human receptors in Subsection 6.3.2.3, Conceptual Site Models. Supporting information concerning local land and water use is provided in the narrative that follows. A regional site map, which shows the Station in relation to the surrounding communities is provided in Figure 1-1 of this report. Much of the information presented below on the land and water use for the Station and the surrounding communities was obtained from the *Naval Weapons Station Earle Master Plan* (Wallace, Roberts, and Todd, 1991).

Land Use

Any discussion of land use at NWS Earle must consider that there are multiple land uses on the Station proper. The current land uses of the Station and surrounding communities are briefly described below. A detailed map of the Station and the location of each of the RI sites is provided in Figures 1-2a and 1-2b of this report.

- **On-Station** - NWS Earle is comprised of two major parcels of land. The Mainside, which is the larger of the two areas, is 10,160 acres and is located in the interior of Monmouth County, NJ. The second area, the Waterfront, is 705 acres and is located along Sandy Hook Bay. The Mainside and Waterfront areas are connected by a 15-mile government-owned, restricted access road/rail line, the Normandy Road corridor, which is 253 acres. Ten of the 11 RI sites are located on the Mainside; one of the RI sites is located on the Waterfront.

  There are three principal land uses at the Station, including ordnance storage, ordnance production, and developed/populated areas. The ordnance storage areas consist of the Mainside ordnance area, which includes storage magazines and large safety zones surrounding the magazines called Explosive Safety Quantity Distance (ESQD) arcs and the Waterfront rail barricades, which are used to store ordnance that is in transit from the Mainside to the

Waterfront piers. Ordnance production/operation areas are located only on the Mainside, in or near the ordnance storage facilities. Developed/ populated areas are found on both the Mainside and Waterfront and include administrative, personnel support, residential, and industrial areas. Although both the Mainside and Waterfront contain developed areas, the majority of land at the Station is undeveloped and lies within ESQD arcs. Access to the ordnance storage areas, where most of the RI sites are located, is controlled through the use of security patrols and manned guard posts that can only be passed by presenting a permit.

- **Off-Station** - Because of its size, the Station is surrounded by a number of municipalities, each of which has different land uses and growth rates. In general though, land use in Monmouth County is primarily residential with densities ranging from those typical of urban to rural lands.

  Colts Neck, which forms part of the northern border of the Mainside, is primarily a low density community containing both residential and agricultural lands. Some of the land in Colts Neck that is adjacent to the Station is classified as either environmentally sensitive agricultural land or environmentally sensitive land.

  Howell Township has the largest land area and fastest rate of growth of all municipalities in Monmouth County and forms part of the Mainside's southern border. The land in Howell Township that is adjacent to the Station is classified as an environmentally sensitive agricultural area where development must be controlled to maintain the agricultural industry. It should be noted, however, that during the 10-year period of 1980 to 1990, the number of housing units in Howell Township increased by 70% and development is expected to continue.

  Tinton Falls forms much of the eastern border of the Mainside and has experienced rapid growth in the past decade. Most of the land in Tinton Falls consists of new suburban areas or potential future urban land although some environmentally sensitive areas may be found near the Mainside's eastern border.

  The Waterfront and much of the Normandy Road corridor is situated in Middletown Township, Monmouth County's most populated municipality. Land on either side of the Normandy Road corridor to the Waterfront consists of new suburban developments, large estates, horse farms, commercial property and light industry. The development plan for Middletown Township describes multiple land uses for the land surrounding the Waterfront. Mixed use is anticipated for west of the Waterfront Administrative area and medium density residential development is planned for the east. Commercial and high and medium density residential development is also planned.

Drinking Water Supplies

- **On-Station** - The Mainside and the Waterfront are served by two separate water systems that are operated by the New Jersey-American Water Company (NJAWC), which draws water from the Swimming River. The NJAWC supplies water to the Mainside administrative and family housing areas through a 16-inch water main that enters the Station at the east end of Esperance Road. After entering the Station, water is piped into four 250,000 gallon underground storage tanks. Water for the Waterfront area enters at two places, near the main gate and near the Station wave tank. Water consumption at the Station is 225,000 gallons per day (GPD) at the Mainside, and 200,000 GPD at the Waterfront.

- **Off-Station** - The municipalities that surround the Station obtain their water from a variety of sources. Residents of the town of Colts Neck, which is located north of the Station, rely solely on private wells for water. Howell Township, which is located adjacent to the southern border of the Station, obtains water for residents and businesses from two water companies, the Parkway Water Company and the Adelthia Water Company. The Parkway Water Company draws water from an 800- to 850-foot production well finished in the Raritan and Cohancy Formations. The Adelthia Water Company has three production wells, two in the Raritan Formation and one in the Vincetown Formation. The town of Tinton Falls and Middletown Township obtain water from the NJAWC, which utilize the Swimming River as a water source.

Based on available drinking water supplies from neighboring vendors, it is unlikely that exposure to groundwater occurs under current use. However, because of the size of the Station and the potential for sale and development, it may be possible that groundwater use on the Station could occur in the future. It should also be noted that the contaminated wells sampled during the RI are finished in the shallow water table aquifer which would not be used as a future source of water.

6.3.2.2 Exposure Scenarios

The RI sites consist of abandoned landfills that are seldom, if ever, visited and sites that may be visited by Station employees. As described in Subsection 6.3.2.3, no current exposure is expected to occur at the abandoned landfills because they are covered with fill material and in many cases with grasses and trees, access to the area that contains many of

the landfills is controlled, and the landfills are located in remote areas of the Station. Some exposure may occur at the RI sites that are visited by workers on a regular basis. Therefore, a worker may be considered in a current use scenario for those sites where the potential exists for worker exposure.

Based on current and possible future land use, two exposure scenarios, one current and one future, are identified and include:

- Current Worker
- Future Resident

This represents those individuals with the maximum potential for exposure to site-related chemicals of concern.

Two individuals, an adult and a child resident, are evaluated in the future use exposure scenario. These individuals are evaluated because of the potential for residential development of the station and because the future use scenario should be more conservative than the current use scenario. In addition, future residential scenarios should be evaluated "... whenever there are or may be occupied residences on or adjacent to the site." (EPA, 1991b). For those RI sites where it would highly improbable or unrealistic for residential development to take place (e.g., directly on a landfill), it is assumed that individuals living downgradient of the site could be exposed to contaminated groundwater.

The two scenarios and their respective potential exposure pathways are listed in Table 6-21. The relationship between the fate and transport of site-related chemicals of concern and the receptors is described in the conceptual site models (Subsection 6.3.2.3) and is shown in Figure 6-2. The following narrative discusses the rationale for pathways and routes of exposure for each of the exposure scenarios.

- **Current Worker** - Current workers are evaluated because they may be exposed to chemicals of concern while they work at one of the actively used sites. Although the sites vary in nature and the potential for exposure differs, it is conservatively assumed that workers will spend the same amount of time

Table 6-21

Exposure Scenarios and Potential Exposure Routes

Current Worker

- Inhalation of airborne soil.
- Incidental soil ingestion.
- Dermal absorption from soil.

Adult and Child Future Residents

- Inhalation of airborne soil.
- Incidental soil ingestion.
- Dermal absorption from soil.
- Consumption of homegrown produce.
- Ingestion of groundwater.
- Inhalation of volatiles while showering.
- Dermal absorption while showering.
- Incidental ingestion of sediment*.
- Dermal contact with sediment*.

* Child resident only.

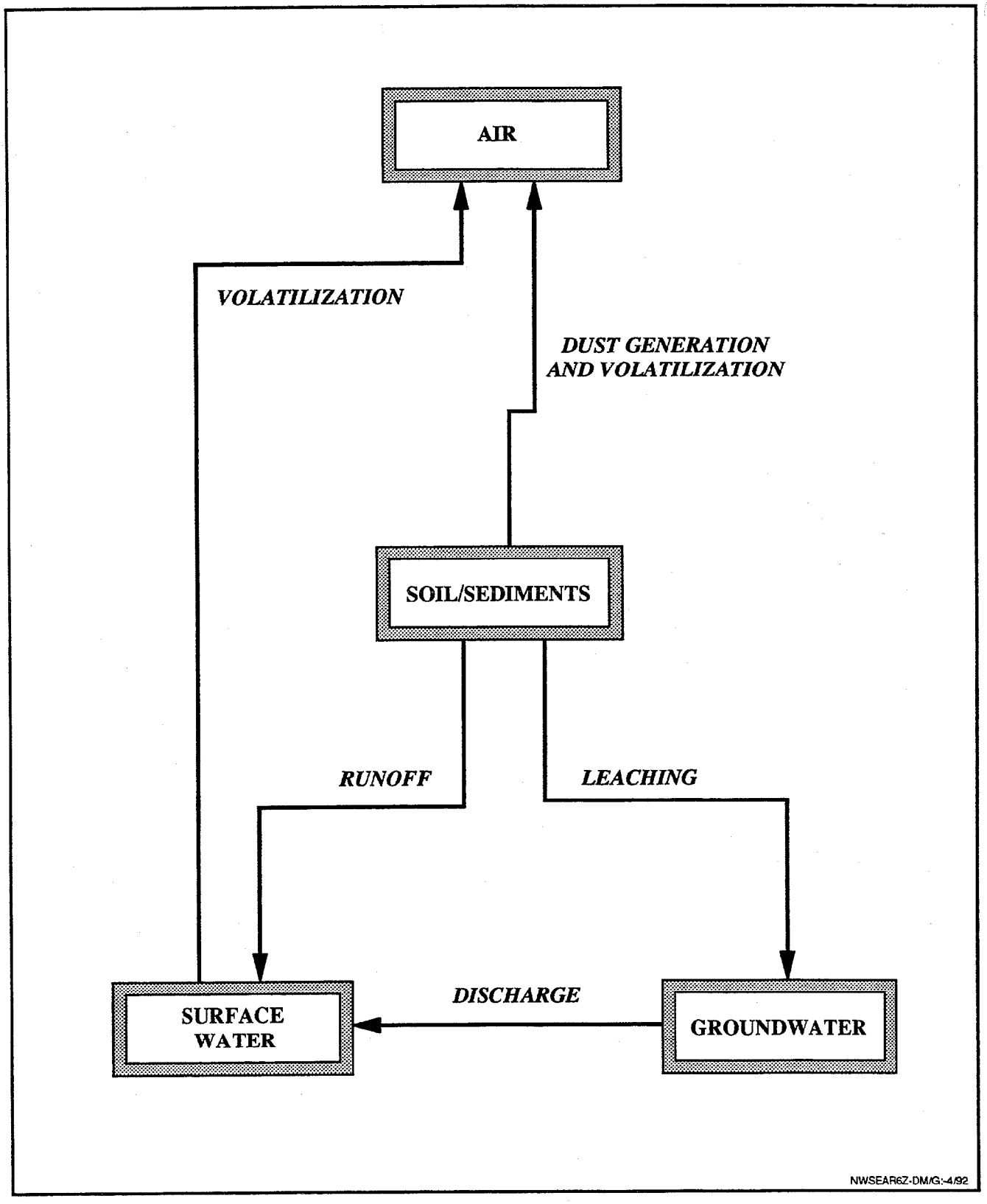

FIGURE 6-2 POTENTIAL MIGRATION PATHWAYS OF THE CHEMICALS OF CONCERN

at each of the actively used sites that are evaluated. This approach is health protective for all workers and takes into account that some workers may be assigned to several areas during their career at the Station. While on-site, it is assumed that the worker spends some time indoors and some time outdoors, resulting in the potential for exposure to air and soil-related pathways. The routes of exposure considered for the current worker are the inhalation of suspended dust, incidental ingestion of soil, and dermal contact with soil.

Exposure to chemicals of concern in groundwater is not evaluated in the current worker scenario because there is no current use of groundwater at the Station. Potable water currently being used at the Station is supplied by the NJAWC, which is the local public water company.

- **Future Resident** - For sites where future residential development or development of a nearby tract is plausible, exposure to air, soil, sediment, and groundwater will be evaluated if the potential exists for exposure to these media. In addition to the air and soil-related routes of exposure previously described for the current worker, the future resident is also assumed to ingest vegetables grown in contaminated soil. The routes of exposure evaluated for sediment will include dermal contact and incidental ingestion. Only the child resident will be assumed to receive exposure from sediment during play activities. The groundwater pathways evaluated for the future resident include ingestion of drinking water, inhalation of volatile contaminants while showering, dermal contact while showering, incidental ingestion while swimming in a back yard pool, and dermal contact while swimming. For sites where future residential development directly on these sites is improbable or highly unlikely, exposure to contaminated groundwater is evaluated assuming that a residential development built nearby may use groundwater contaminated from the site.

6.3.2.3 Conceptual Site Models

The conceptual site models for the Station incorporate information on the potential chemical sources, affected media, release mechanisms, routes of migration, and known or potential human receptors. The purpose of the conceptual site model is to provide a framework in which to identify potential exposure pathways occurring at the sites, as well as to aid in identifying data gaps. Information presented in previous subsections on the site characterization, contamination characterization, local land and water uses, and potential receptors, is used to identify potential exposure pathways at the sites.

An exposure pathway consists of four elements (EPA, 1986c):

1. A source and mechanism of chemical release into the environment.

2. An environmental transport medium for the released contaminant (e.g., surface water) and/or a mechanism of contaminant transfer from one medium to another (e.g., surface water runoff).

3. A point of potential contact of humans or biota (the receptors) with the contaminated medium (i.e., the exposure point).

4. An exposure route (e.g., ingestion) at the exposure point.

When all of these elements are present, the pathway is considered complete.

The assessment of pathways by which human receptors may be exposed to contaminants from the RI sites includes an examination of existing migration pathways (e.g., soil, air, water) and exposure routes (e.g., inhalation, ingestion, dermal absorption), as well as those that may be reasonably expected in the future. The determination of exposure pathways (i.e., the course that a contaminant takes from a source to a receptor) is made by an evaluation of the current extent of contamination on and around the sites in relation to local land and water uses, and the results of a fate-and-transport assessment that evaluates contaminant migration pathways. Figure 6-2 presents potential migration pathways for the RI sites.

Site 2: Ordnance Demilitarization Site

Site 2 is an approximately 11-acre shallow, open, nonvegetated, oval-shaped sand pit surrounded by a high berm and woodlands. A bunker from which ordnance demilitarization may be observed is located at the southern end of the site. The site has been and is currently used on an occasional basis for the purpose of detonating ordnance. No open burning or disposal has occurred on the site. Access is highly restricted because of the nature of the activities conducted on the site. Anyone wishing to enter the site must have

a key to a locked gate or have security personnel unlock the gate. Significant site features are shown on Figure 3-2 of this report.

The primary source of on-site contamination at Site 2 is the ordnance which is detonated on the surface sand and soil of the site. The contaminated soil and sediment now act as secondary sources for contaminant releases to groundwater.

Contaminated soil, sediment, and groundwater are believed to be the major sources of potential exposure for human receptors at Site 2. The following paragraphs describe the pathways by which human receptors can be exposed to contaminated media. The conceptual site model for Site 2 is presented in Figure 6-3.

- **Air** - Contaminated soil may be re-suspended into air by the natural action of wind moving over this sandy, nonvegetated site, or by routine site activities. For the current worker and future residential scenarios, the concentration of re-suspended dust from soils was based on PM_{10} data (the concentration of particles in air that are 10 microns or less in diameter and thus small enough to be inhaled deep into the lungs).

- **Groundwater** - Groundwater can become contaminated through the infiltration and leaching of chemicals of concern from soil. Exposure to contaminated groundwater is not evaluated in the current worker scenario because water is currently supplied to the Station by the NJAWC; however, groundwater use is evaluated for the future resident. Guidance from the EPA suggests that if the groundwater, unaffected by contamination, could potentially serve as a potable water supply, that use must be protected. Consequently, the baseline risk assessment should evaluate the potential threat that site-related contamination poses to potential users of that resource. Groundwater-related pathways evaluated for the future adult and child residents will include ingestion, inhalation while showering, dermal contact while showering, incidental ingestion while swimming in a backyard pool, and dermal contact while swimming. Although several groundwater pathways are evaluated for this and many additional sites, it should be noted that groundwater sampling was conducted for only the shallow "water table" aquifer, which may be unfit for use because of low water yield and/or naturally occurring impurities such as iron.

- **Sediments** - Sediments are found in shallow depressions near the northeastern edge of the site where precipitation collects as a result of drainage patterns. Water that occasionally collects in these depressions either infiltrates into the sandy soils or evaporates. Exposure to the sediments is not evaluated for the

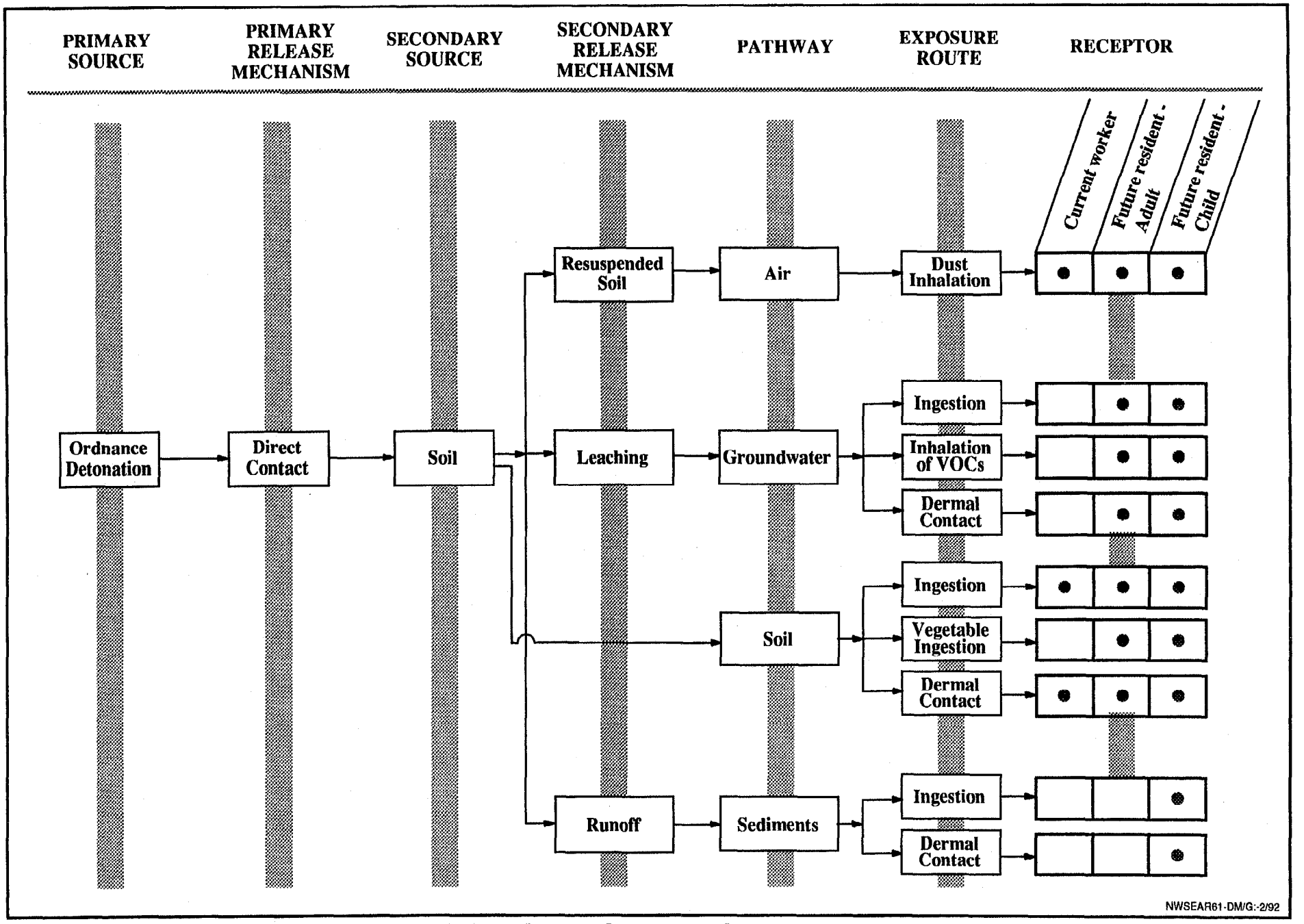

FIGURE 6-3 CONCEPTUAL SITE MODEL FOR SITE 2: ORDNANCE DEMILITARIZATION SITE

current worker because a worker would have no reason to visit these areas. Incidental ingestion and dermal contact with sediments is evaluated for a child future resident because a child might visit these areas.

- **Soil** - Soil represents a major secondary source of contamination at Site 2. Because both the current worker and the future resident may be exposed to contaminated soil, soil-mediated pathways are evaluated in both scenarios. The soil pathways evaluated for the current worker include incidental soil ingestion, and dermal contact. For the future resident, the soil pathways include incidental soil ingestion, dermal contact, and consumption of vegetables from a home garden. The inhalation of airborne soil was considered under the air pathway.

Site 3: Landfill Southwest of "F" Group

Site 3 is an abandoned landfill that is located just southwest of a large bunker complex and within the ordnance area. As a result, entry into this area is controlled. The 5-acre site, which is surrounded by woods, is accessed off an undeveloped dirt road. Most of the site is covered by dense grass although some scarred areas without vegetation exist. Small pine trees have started to grow on the cover material in many locations. The primary source of contamination for this site is the refuse (glass bottles, metal cans, plastic, wood, and metallic debris) that was disposed of in the landfill. The secondary source of contamination is the soil at the base of the landfill, which has become contaminated as a result of disposal practices. The conceptual site model for Site 3 is presented in Figure 6-4. Major site features are shown in Figure 3-3 of the RI report. Relevant pathways are described below.

- **Groundwater** - Groundwater for this site became contaminated as precipitation infiltrated the landfill cover and leached contaminants from the debris. Although the groundwater is contaminated, current exposure is not evaluated because water is supplied to the Station by the NJAWC. Given the proximity of the site to the large bunker installation, and the fact that the site is a landfill, the only plausible exposure pathway is the future use of groundwater at a downgradient location. As a result, only the future use of groundwater at a downgradient location is considered for Site 3. The exposure pathways evaluated for this site include ingestion of groundwater, inhalation while showering, dermal contact while showering, incidental ingestion while swimming in a backyard pool, and dermal contact while swimming.

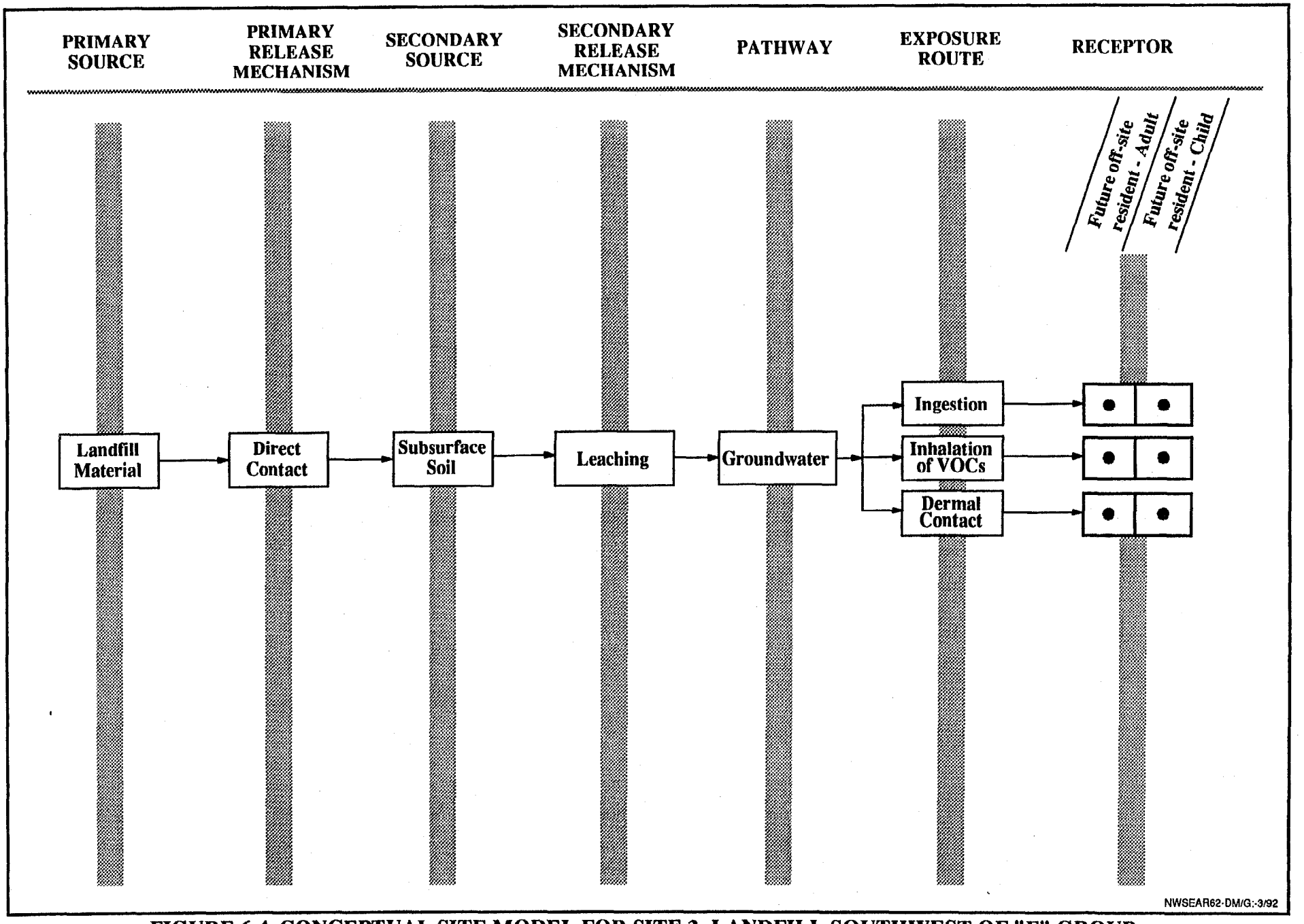

FIGURE 6-4 CONCEPTUAL SITE MODEL FOR SITE 3: LANDFILL SOUTHWEST OF "F" GROUP

Site 4: Solid Waste Landfill West of "D" Group

Site 4 is an approximately 5-acre abandoned landfill that is located within the ordnance area; therefore, the potential for current receptors to visit the site is limited. The site is bordered on the northwest by Macasser Road and by an undeveloped dirt road on the remaining sides. Steep berms that are densely covered with mountain laurel and young hardwood trees form the outside ring of the site. Much of the site is covered with dense scrub pines, and phragmites, a type of wetland vegetation that grows in disturbed areas. The loose sandy material that was used to cover the landfill has been eroded in two small areas leaving disposed waste (rusted metal objects) exposed to the surface. The site is drained by a swale that forms the southeastern border. The site and surrounding are shown in Figure 3-4 of the RI report.

Because the site is an abandoned landfill, residential development of the site proper is implausible. However, because the potential exists for residential development adjacent to the site, potential exposure to groundwater may occur. Consequently, risk from exposure to groundwater for an off-site resident is evaluated in this assessment.

As previously described for Site 3, the primary source of contamination for Site 4 is the material disposed at the landfill. Subsurface soil has become a secondary source of contamination, and infiltration represents the secondary release mechanism. Pathways of concern for Site 4 are exposure to groundwater, and the sediment that has been deposited in the swale that drains the site. The Site 4 conceptual model is presented in Figure 6-5. Relevant pathways are discussed below.

- **Groundwater** - Groundwater is the medium of greatest concern for Site 4 because access to this abandoned landfill is restricted and the site is seldom, if ever, visited. Only a future resident living downgradient of the site will be evaluated because there is no current exposure and building a house on an abandoned landfill is highly unlikely. The previously described groundwater exposure pathways will also be evaluated for this downgradient resident.

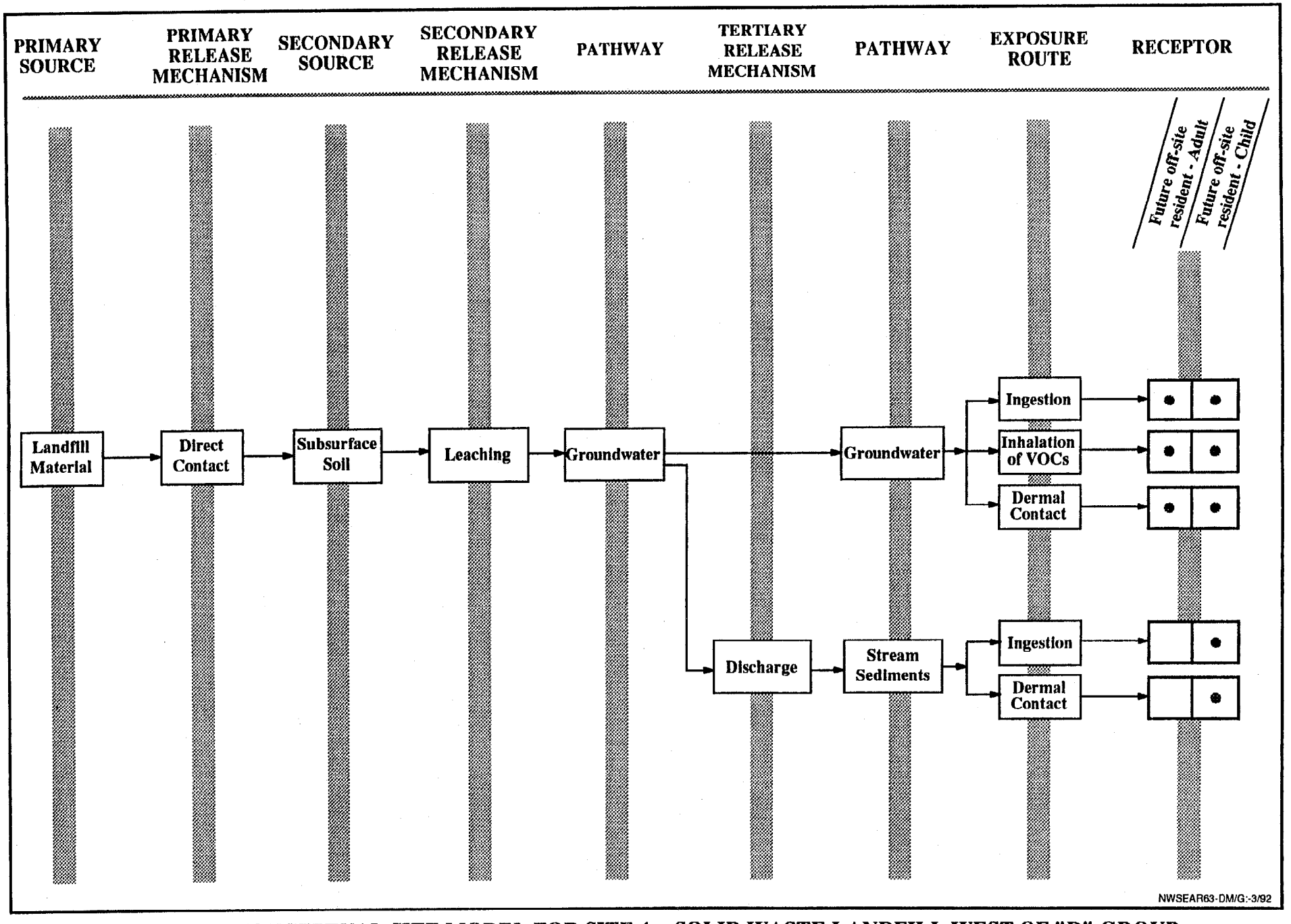

FIGURE 6-5 CONCEPTUAL SITE MODEL FOR SITE 4: SOLID WASTE LANDFILL WEST OF "D" GROUP

- **Sediment** - The sediment that has collected in the drainage swale along the southeastern boundary of Site 4 represents a medium of potential concern for a future resident who may occasionally visit the site. It is assumed that a child future resident would visit the site and be exposed to contaminated sediment through dermal contact and incidental ingestion.

Site 5: Landfill West of Army Barricades

Site 5 is an approximately 13-acre abandoned landfill that is located near an extensive bunker complex. The site is accessed by an undeveloped dirt road and bordered on the southwest by a railroad siding that is used to transport ordnance to the Waterfront piers. The site is an open area that is densely vegetated with grasses and surrounded by woodlands. Thickets of scrub pines can also be found growing on the site. The potential for human exposure at this site is limited because it is a closed landfill that is seldom, if ever, visited. As a result, current use is not evaluated. Site 5 and the surrounding roads and railroad tracks are shown in Figure 3-5 of this report.

As previously described for other abandoned landfills, the waste disposed at the site (foam rubber, glass, plastic, metal scrap materials, lumber, concrete, bricks, and other construction debris) constitutes the primary source of contamination. The soil beneath the landfilled materials now acts as a secondary source, with infiltration acting as a secondary release mechanism to groundwater.

As in the case of other abandoned landfills, it is assumed that residential development of Site 5 is implausible, but that residential development could take place at a downgradient location and that exposure to groundwater at this downgradient location could take place. The site conceptual model is presented in Figure 6-6 and the relevant pathways are described below.

- **Groundwater** - Groundwater is the medium of greatest concern for Site 5 because access to this abandoned landfill is restricted and the site is seldom, if ever, visited. As described for Site 4 above, only a future resident living downgradient of the site will be evaluated because there is no current exposure and building a house on an abandoned landfill is highly unlikely.

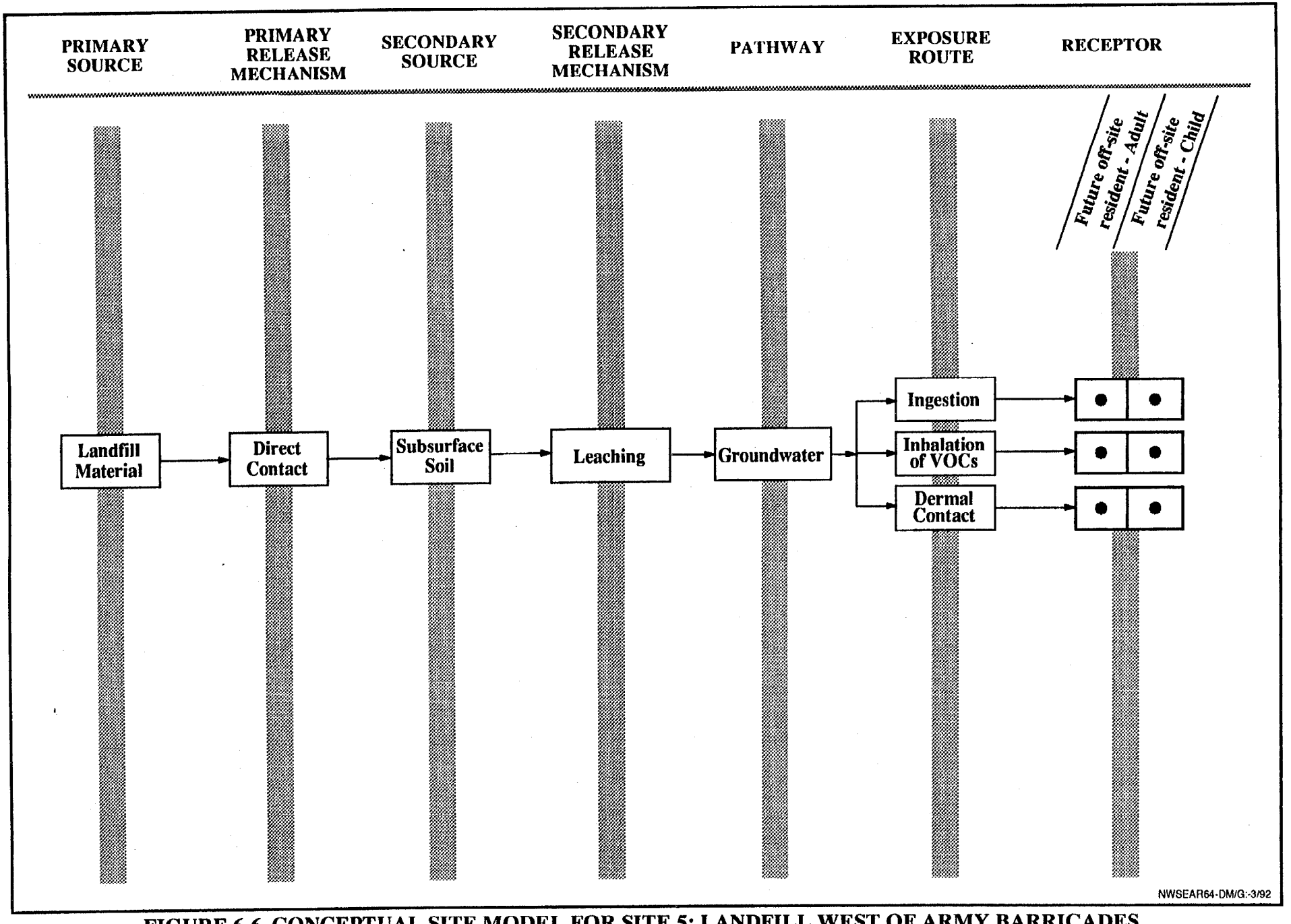

FIGURE 6-6 CONCEPTUAL SITE MODEL FOR SITE 5: LANDFILL WEST OF ARMY BARRICADES

The groundwater exposure pathways described for the preceding sites will also be evaluated for this site.

Site 7: Landfill South of "P" Barricades

Site 7 is located in the Waterfront section of the Station within an ordnance area. The 5-acre site is accessed by an undeveloped dirt road that surrounds the site on three sides. Gaining access to the site requires traveling down the Normandy Road corridor and passing by guardhouses where security personnel check for valid passes. Most of the site is densely vegetated with grasses and scrub pines. A small amount of exposed debris was observed in one area on the site. The remote location of this abandoned landfill and the vegetative cover precludes human contact. Because Site 7 is an abandoned landfill, residential development of the site proper is implausible. However, because the potential exists for residential development near the site, potential exposure to groundwater may occur. Consequently, risk to groundwater for an off-site resident is evaluated in this assessment. Site 7 and the significant site features are shown in Figure 3-6.

The site contains household and ship-generated waste such as scrap metal material, lumber, concrete, bricks, and other construction debris that ranges from 2.5 to 6 feet thick. The debris disposed on-site acts as a primary source, with the soil beneath the landfilled materials now acting as a secondary source. Infiltration is the secondary release mechanism to groundwater, the major pathway. The site conceptual model is presented in Figure 6-7 and the relevant pathways are described below.

- **Groundwater** - Groundwater is the medium of greatest concern for Site 7 because access to this abandoned landfill is somewhat restricted and the site is seldom, if ever, visited. Only a future resident living downgradient of the site will be evaluated because there is no current exposure and building a house on an abandoned landfill is highly unlikely. The groundwater exposure pathways described for the preceding sites will also be evaluated for this site.

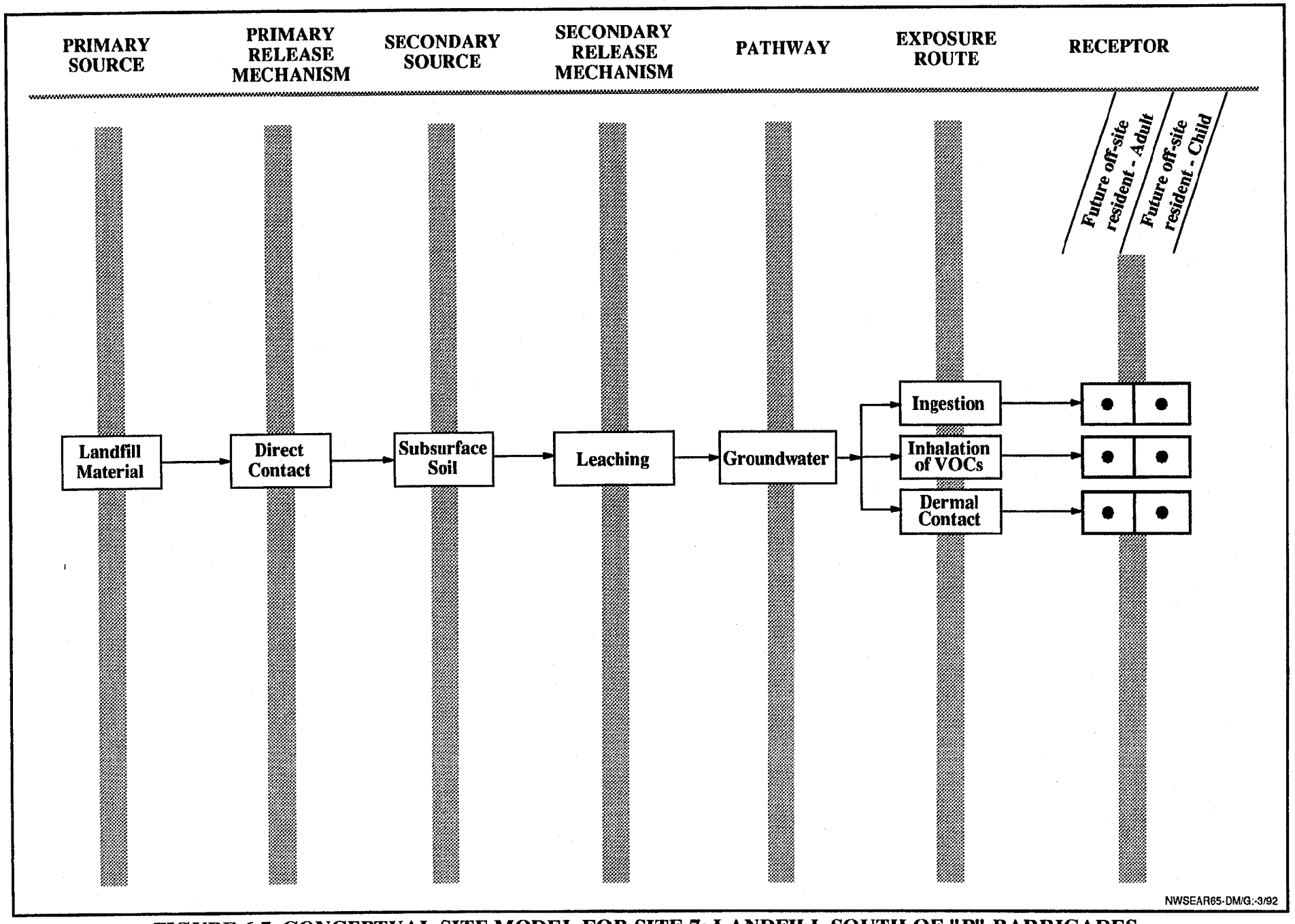

FIGURE 6-7 CONCEPTUAL SITE MODEL FOR SITE 7: LANDFILL SOUTH OF "P" BARRICADES

Site 10: Scrap Metal Landfill

Site 10 is smaller than the other landfills (two acres) and appears as a small open area surrounded by woodlands. The site is bordered on the east and southeast by a railroad track, and a drainage ditch that contained flowing water during a recent site visit. Most of the site was covered with grasses, scrub pines, and small hardwood trees. Based on the size of the trees located on the site, it appears to have been abandoned roughly 20 years ago. The landfill cover is essentially intact except for one area where some material has eroded away, leaving exposed a few rusted ordnance casings.

Casings and other metallic debris disposed at the site are the primary source of contamination, which in turn have affected subsoils and groundwater. Groundwater may then act as an additional contaminant source to the surface water that borders the site on two sides. Given that Site 10 is an abandoned landfill with no current human activity, and that access to the area is restricted, no current exposure is evaluated. Because Site 10 is an abandoned landfill, it would be implausible to evaluate current use of site groundwater. However, it is possible that a future resident living at a downgradient location could be exposed to groundwater from the site. As a result, groundwater exposure is evaluated in a future use scenario. The conceptual site model for this site is presented in Figure 6-8. The position of the site in relation to the surrounding roads, railroad tracks, and stream are shown in Figure 3-7 of this report. The relevant exposure pathways are described below.

- **Groundwater** - Groundwater is the medium of greatest concern for Site 10 because access to this abandoned landfill is restricted and the site is seldom, if ever, visited. As described above, only a future resident living downgradient of the site will be evaluated because there is no current exposure and building a house on an abandoned landfill is highly unlikely. The groundwater exposure pathways described above will also be evaluated for this downgradient resident.

- **Sediment** - The sediment from the drainage ditch that borders the site on the east and southeast represents a medium of potential concern for a future resident. It is assumed that a child future resident would visit the site and may be exposed to contaminated sediment through dermal contact and incidental ingestion while playing in the area.

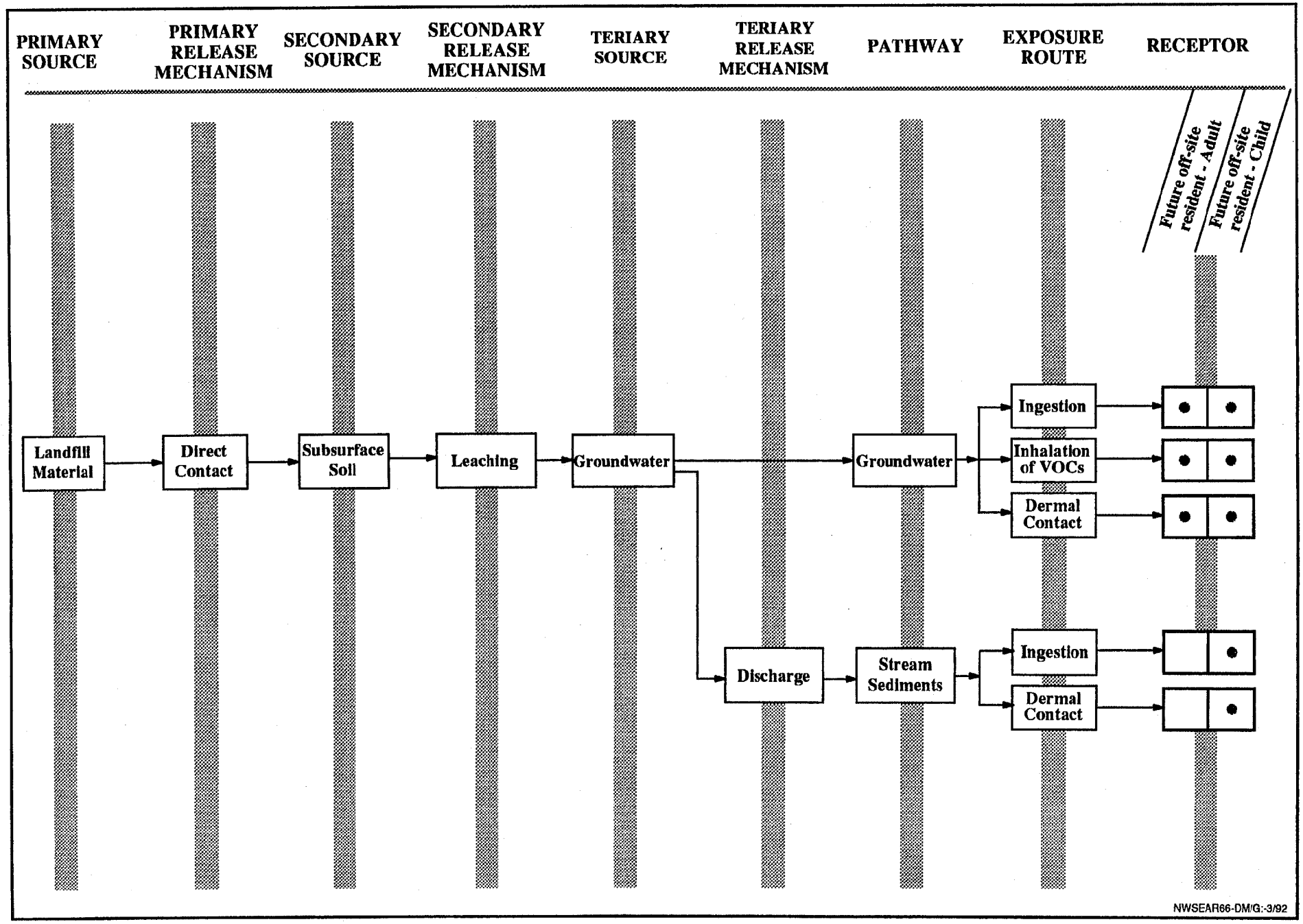

FIGURE 6-8 CONCEPTUAL SITE MODEL FOR SITE 10: SCRAP METAL LANDFILL

Site 11: Contract Ordnance Disposal Area

Site 11 consists of an approximately 2-acre open area that is surrounded by woods. The site is accessed by an undeveloped dirt road that parallels an electric power transmission line right-of-way. Vegetation on the site is made up of low grasses and small isolated scrub pines. There are several scarred areas where no vegetation exists. The site borders are clearly marked by the tall trees located at the perimeter. Significant features of Site 11 are depicted in Figure 3-8 of this report.

Site 11 was used as a fire training area, where equipment was doused with a flammable liquid and ignited. The primary contaminant source for this site is residual flammable liquid that infiltrated the land surface. Contaminated subsurface soil now acts as a secondary release mechanism to groundwater, the major receptor pathway. No current receptors are evaluated for this site because it is not currently used and there is no current use of groundwater. The conceptual site model for this site is presented in Figure 6-9. The relevant exposure pathways are described below.

- **Groundwater** - Groundwater is the medium of greatest concern for Site 11 because the site is no longer used and seldom, if ever, visited. As described above, only a future resident living downgradient of the site will be evaluated because there is no current exposure. The groundwater exposure pathways described for the preceding sites will also be evaluated for this site.

Site 19: Paint Chip and Sludge Disposal Area

Site 19 consists of a raised circular area that is approximately 300 feet in diameter with a frame building (S-34) and a barricade that is located just behind the building. Half of the site is paved and half has a gravel surface. The site is located far away from base housing and administrative areas in the ordnance zone. Site 19 is bordered on the west by a branch of Mingamahone Brook and to the north by a wetland. The site is currently used on an occasional basis to train forklift operators to move ordnance. The site is shown in Figure 3-9 of this report.

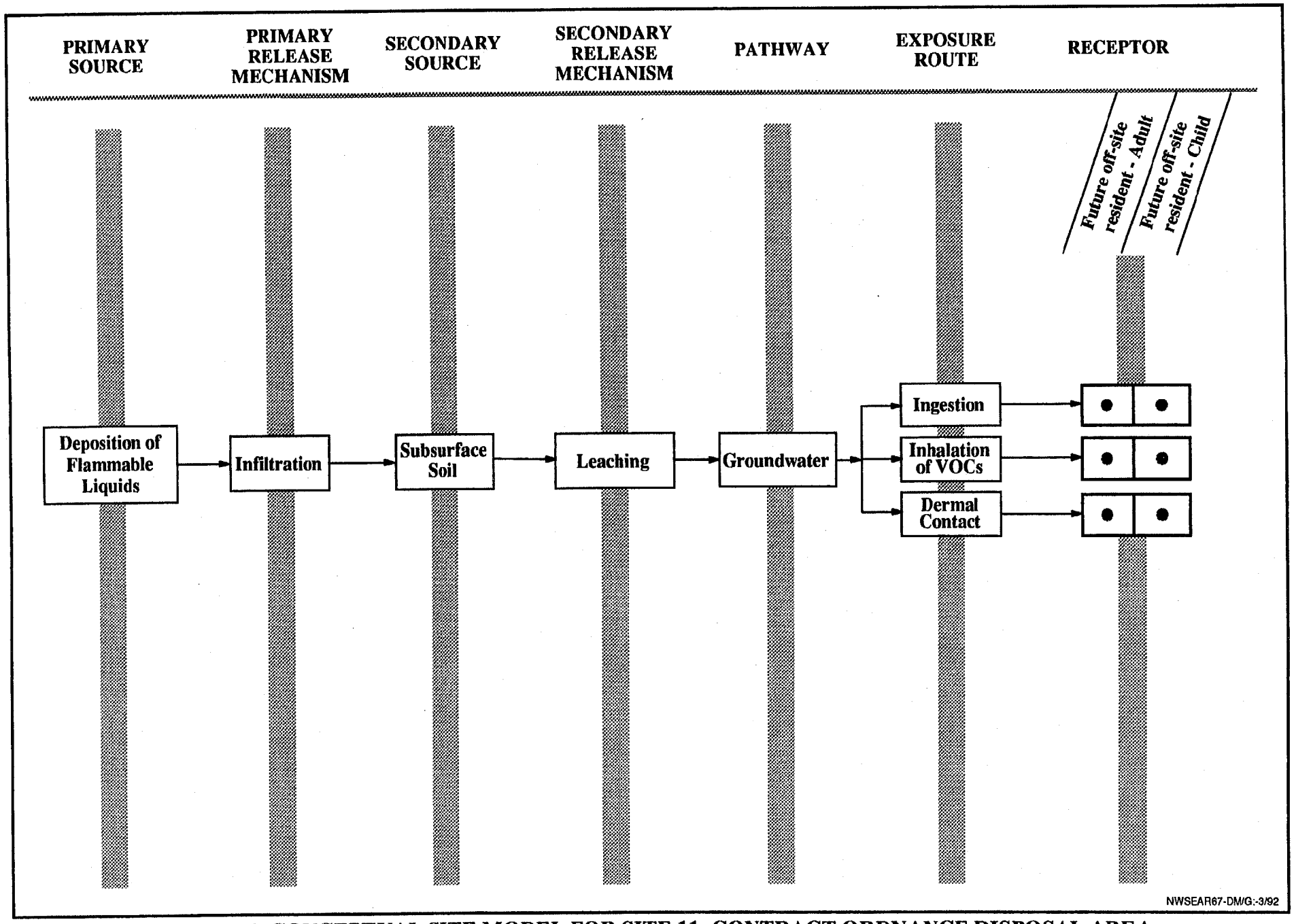

FIGURE 6-9 CONCEPTUAL SITE MODEL FOR SITE 11: CONTRACT ORDNANCE DISPOSAL AREA

The contaminated portions of Site 19 are a small depression behind the barricade and a ditch that drains the depression and empties into a branch of Mingamahone Brook. The depression behind the barricade became contaminated during ordnance maintenance operations when explosives were washed out of casings. Metal grit was allowed to settle in a collection basin as water flowed out of the barricade into the depression. The water from the maintenance operation then flowed through a culvert under the roadway that encircles Site 19 to a wetland north of the site.

The contaminated depression and the area into which the water drained are small in comparison to the rest of the site and located in areas that would not be visited by anyone training in the forklift area. The depression is now densely vegetated with grass and small trees, which would also preclude any current exposure. Although future residential use of Site 19 is unlikely, exposure to groundwater, soil and sediment is evaluated for a future resident.

The primary source of contamination at Site 19 was the precipitation basin that was used to collect metal grit from ordnance casings. Contaminants were released to the environment as the contents of the basin were allowed to spill into the depression located behind the barricade. The soil in the depression became a secondary source of contamination that now releases material through infiltration and runoff to groundwater and surface water. The conceptual site model is presented in Figure 6-10 and the relevant exposure pathways are described below.

- **Air** - Contaminated soil could become re-suspended into the air by the natural action of wind if the vegetation is removed from the contaminated areas of the site. Therefore, inhalation of airborne soil is evaluated for the future resident. The respirable dust fraction for the future residential scenario is evaluated using the PM_{10} as previously described for Site 2 because the PM_{10} represents the ambient dust concentrations that might be expected in a residential area.

- **Groundwater** - Groundwater is evaluated in the future residential scenario for Site 19. The groundwater exposure pathways previously described will also be evaluated for Site 19.

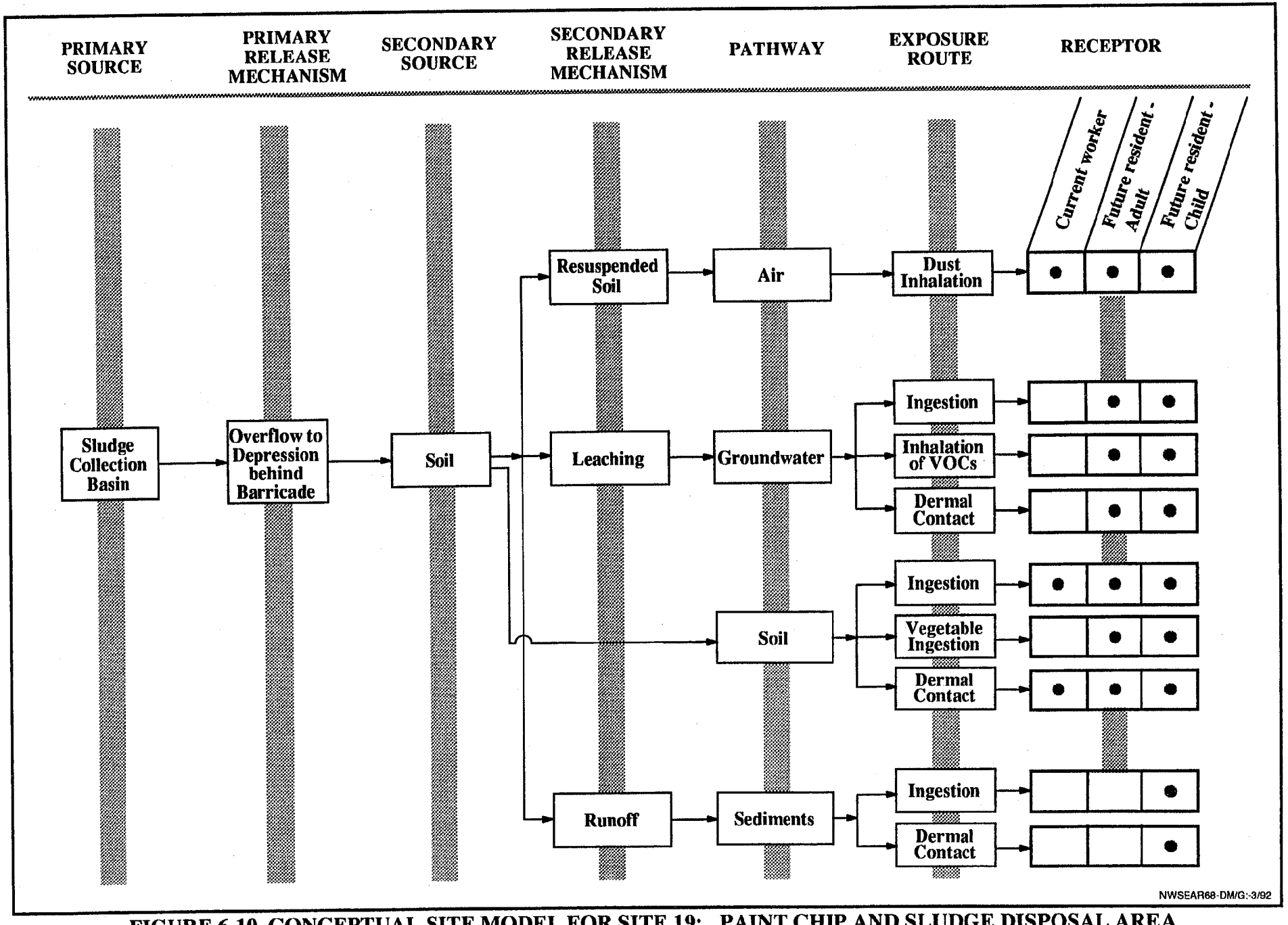

FIGURE 6-10 CONCEPTUAL SITE MODEL FOR SITE 19: PAINT CHIP AND SLUDGE DISPOSAL AREA

- **Sediments** - Sediments are found in the wetlands that form the northern border of the site. As a result, incidental ingestion and dermal contact with sediments is evaluated for a child future resident because a child might visit these areas.

- **Soil** - Exposure to soil, which represents a secondary source of contamination at Site 19, is evaluated for the future resident although the contaminated area is fairly limited. The soil pathways evaluated for the future resident include incidental soil ingestion, dermal contact, and consumption of vegetables from a home garden. The inhalation of airborne soil was considered under the air pathway.

Site 20: Grit Blasting Area at Building 544

Site 20 consists of a large metal frame building that is surrounded on three sides by roof-high mounds of crushed stone, a small pile of blasting grit, and a shallow, grass-covered drainage depression. The site is located in the ordnance area and requires a valid permit for entry. The building is used to maintain ordnance. Site 20 is shown in Figure 3-10 of this report.

Contamination at the site is restricted to the shallow depression located behind the building. The depression measures approximately 300 feet in length and is 0.5 to 1.5 feet deep and only contains water following a rain event. No conceptual site model is presented for this site because only sediment is affected. Risk to a future resident (child) is evaluated for Site 20 although exposure is expected to be very limited because of the confined nature of the contamination. A current worker is not evaluated for Site 20 because of the limited extent of contamination and a worker is not expected to receive exposure from sediments in a shallow drainage swale. The pathways for the future resident are described below.

- **Sediment** - The sediment from the drainage depression located behind Building 544 represents the medium of potential concern for the future resident. It is assumed that the child future resident would have a limited exposure frequency and duration. Pathways evaluated for this site include dermal contact and incidental ingestion of sediment.

Site 22: Paint Chip Disposal Area

Site 22, which is located in the ordnance area, contains a one-story block building that is currently used for ordnance maintenance. Contamination at this site is limited to a 50 ft^2 area where a small amount of paint was disposed. Traces of paint stains are barely evident in the surface soils. There is no evidence of contamination at this site in areas other than the limited amount of barely stained soil. This site is not evaluated in the risk assessment because it is implausible for a potential receptor to obtain significant exposure to soil from such a small area. Building D-2, the adjacent railroad track, and areas of stained soil are shown in Figure 3-11 of this report.

Site 26: Explosive "D" Washout Area

Site 26 is an approximately 40,000 ft^2 ordnance disposal site that is located within the ordnance area. The site contains a one-story block building (Building GB-1) where explosives are washed out of casings. Contaminated runoff water flows from the building through an open terra-cotta pipe-lined ditch to a depression that measures 30 feet in diameter. The depression, where substances from the building infiltrate through the soil to groundwater, is located 75 feet from the building in a wooded area and is densely covered with grass and offers limited exposure potential. Building GB-1, the pipe-lined ditch and depression, and other significant features of Site 26 are provided in Figure 3-12.

The primary source of contamination for Site 26 was Building GB-1, where runoff water was generated. The soils in the depressed area behind the building now act as a secondary source of contamination that release substances of concern to groundwater via infiltration. Because groundwater is the medium of concern for Site 26, only a future residential use scenario is evaluated. The site conceptual model is presented in Figure 6-11 and the relevant exposure pathways are discussed below.

- **Groundwater** - Groundwater is the medium of greatest concern for Site 26 because a current worker would not visit the grass-filled depression where

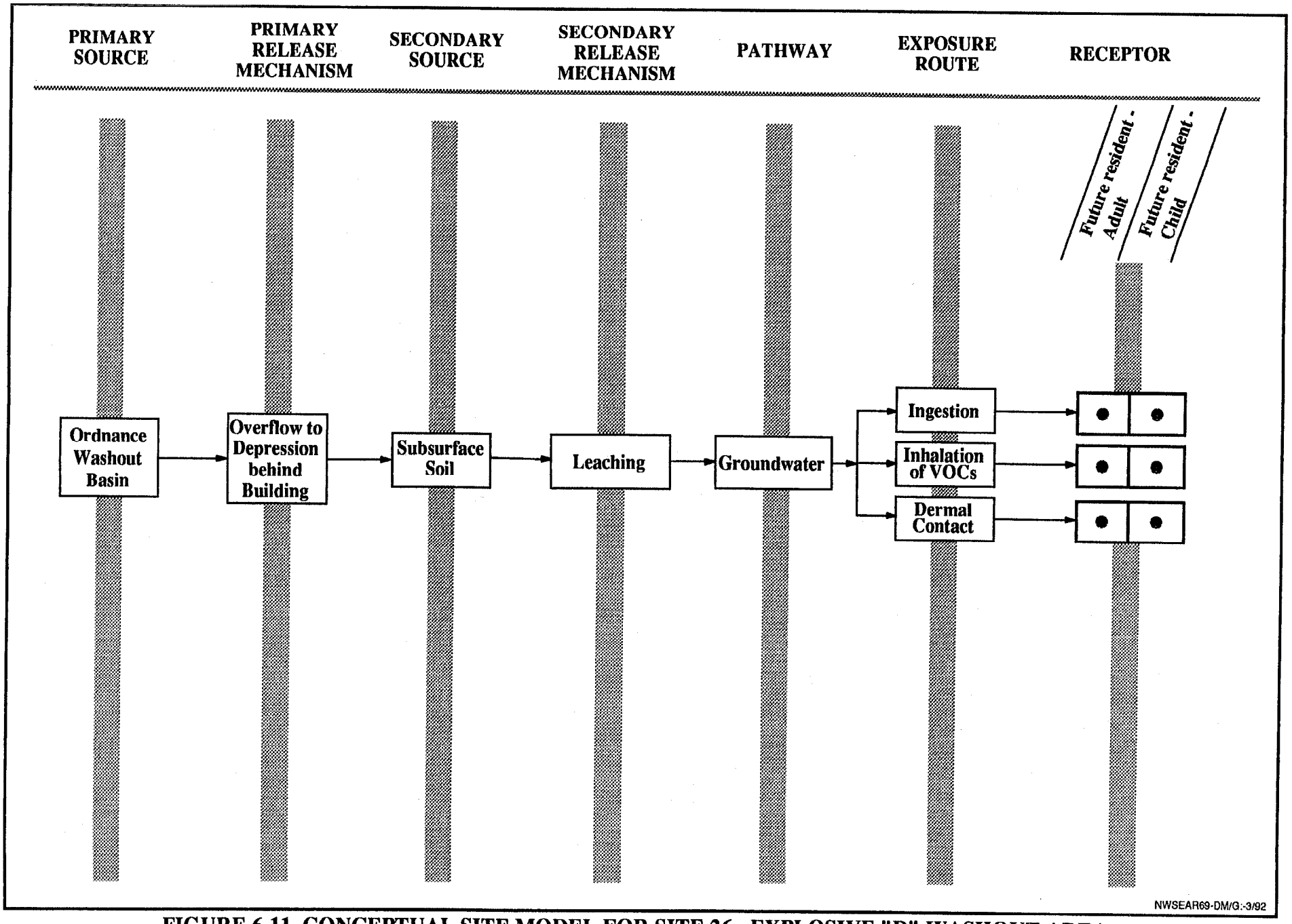

FIGURE 6-11 CONCEPTUAL SITE MODEL FOR SITE 26: EXPLOSIVE "D" WASHOUT AREA

surface soils may be contaminated and a future resident would have insignificant exposure to such a small area. Therefore, only a future resident who uses groundwater from the site is evaluated. The groundwater exposure pathways described for the preceding sites will also be evaluated for this site.

6.3.2.4 Derivation of Exposure Concentrations

Exposure doses for this assessment are calculated using the upper 95% confidence limit on the arithmetic mean concentration for each of the contaminants of concern associated with both the current and future use scenarios. The upper 95% confidence limit on the arithmetic mean is used to provide a conservative estimate of exposure that is still considered possible. This concentration is used as the basis for calculating the reasonable maximum exposure or RME. In the event that the calculated upper 95% confidence limit is greater than the maximum reported concentration, which may result from the wide range of reported concentrations, the maximum reported concentration will be used as the exposure concentration.

Monitoring data were not available for the concentrations of airborne dust from soil. The concentration of airborne soil available for inhalation and future residents was estimated using a PM_{10} of 30.8 $\mu g/m^3$. This value represents the 12-month arithmetic mean PM_{10} dust concentration for Linden, NJ (NJDEP, 1989), which is the location closest to the Station for which annual data are available.

The media concentrations that are used in the risk assessment are provided in Tables 6-1 through 6-19, which provide summary statistics, including the frequency of detection, standard deviation, arithmetic mean and upper 95% confidence limit.

6.3.2.5 Exposure Dose Models and Assumptions

This subsection presents the mathematical models that are used to calculate the intakes (i.e., doses) of substances of concern by each receptor through the applicable exposure routes (see Subsection 6.3.2.3, Conceptual Site Models). The models are presented in tabular

form. Each table defines the variables for the exposure route and includes the assumptions (i.e., exposure parameters) used in the model for each scenario. Additional information regarding the assumptions is presented in the text.

Doses, expressed as chronic daily intakes in milligrams of contaminant per kilogram of body weight on a daily basis (mg/kg-day), are calculated for each exposure route applicable to the current worker and the future residents. Doses are calculated based on two averaging times, using the upper 95% confidence limit chemical concentrations. For both the current worker and the future residential scenarios, doses are averaged over the number of days of exposure (years of exposure x 365 days/year) to evaluate chronic noncarcinogenic health effects, and over a lifetime (70 years x 365 days/year) to evaluate potential carcinogenic effects.

The current worker scenario assumes an adult works at the station five days a week for 50 weeks per year (250 days per year total). The individual is assumed to work at the Station for 25 years (95th percentile, EPA, 1991b). The future resident scenario assumes that an individual lives on or adjacent to a site for 30 years (six years as a child and 24 years as an adult). This value represents the 90th percentile for time spent at one residence. In addition, it is assumed that the residents take about 2 weeks vacation per year and therefore spend 250 days per year at home (EPA, 1991b).

Body weights of 70 kg and 15 kg for the adult and child, respectively, are used in the applicable scenarios (EPA, 1991b). The 70 kg body weight represents the average adult while the 15 kg body weight is the 50th percentile value for children 1 through 6 years old.

Inhalation of Soil/Dust

The inhalation of airborne soil is a potential route of exposure that is evaluated for the worker and the adult and child residents. The equation and assumptions that are used to calculate doses from inhalation of airborne soil are presented in Table 6-22.

Table 6-22
Model for Calculating Doses from Inhalation of Windblown Dust

Dose from Inhalation of Windblown Dust (mg/kg-day)	=	$\frac{CS \times RD \times IR \times CF \times EF \times ED}{BW \times AT}$
Where:		
CS	=	Chemical concentration in soil (mg/kg)
RD	=	Respirable-size dust concentration in the air (µg/m^3)
IR	=	Inhalation rate (m^3/day)
CF	=	Conversion factor (10^{-9} kg/µg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
Assumptions:		
CS	=	Upper 95% confidence limit of the mean concentration in soil (Subsection 6.2.4.1).
RD	=	30.8 µg/m^3, PM_{10} value for Linden, NJ (NJDEPE, 1989).
IR	=	20 m^3/day for the future adult resident (EPA, 1991b)
	=	10 m^3/day for the future child resident (assumed)
	=	20 m^3/day for the current worker (EPA, 1991b)
EF	=	350 days/year for the future child and adult resident (EPA, 1991b).
	=	250 days/year for the current worker (EPA, 1991b)
ED	=	6 years for the future child resident (EPA, 1991b).
	=	24 years for the future adult resident (EPA, 1991b).
	=	25 years for the current worker (EPA, 1991b).
BW	=	70 kg for the future adult resident and the current worker (EPA, 1991b).
	=	15 kg for the future child resident (EPA, 1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

In the absence of site-specific data, it is conservatively assumed that the concentration of substances in airborne soil are the same as those in surface soil. It is further assumed that the worker and the residents will be exposed only to airborne soil that is generated on-site. This assumption is made because exposure to airborne soil is believed to be a localized phenomenon.

An inhalation rate of 20 m^3/day (EPA, 1991b), which represents the reasonable worst-case inhalation rate for adults, is assumed for the worker and adult resident. Inhalation rates for children are reported to be 80% of adults (EPA, 1989). As a result, an inhalation rate of 16 m^3/day has been selected for children in the 1-6 year age group.

Incidental Soil Ingestion

Incidental soil ingestion can result from placing soil-covered hands or objects in the mouth. Soil ingestion is a potential route of exposure for the current worker and the future adult and child residents. The exposure dose models and assumptions for the soil ingestion pathway are presented in Table 6-23.

It has been estimated that children of ages 1 to 6 incidentally ingest 200 mg of soil on a daily basis and that individuals over the age of 6 ingest 100 mg of soil per day (EPA, 1991b). The soil ingestion rates for both age groups take into account the ingestion of outdoor soil and indoor dust and represent reasonable upper-bound residential exposure conditions. An incidental soil ingestion rate of 50 mg/day is used for the current worker (EPA, 1991b).

Dermal Absorption from Soil

The dermal absorption of substances, resulting from dermal contact with surface soil, is a potential route of exposure for all three receptors. The equation and assumptions used to calculate dermal absorption doses are presented in Table 6-24.

Table 6-23
Model for Calculating Doses from Incidental Ingestion of Soil

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS = Chemical concentration in soil (mg/kg)

IR = Soil ingestion rate (mg/day)

CF = Conversion factor (10^{-6} kg/mg)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time (days)

Assumptions:

CS	=	Upper 95% confidence limit of the mean concentration in soil (Subsection 6.2.4.1).
IR	=	100 mg/day for the future adult resident (EPA, 1991b).
	=	200 mg/day for the future child resident (EPA, 1991b).
	=	50 mg/day for the current worker (EPA, 1991b).
EF	=	350 days/year for the future child and adult resident (EPA, 1991b).
	=	250 days/year for the current worker (EPA, 1991b).
ED	=	6 years for the future child resident (EPA, 1991b).
	=	24 years for the future adult resident (EPA, 1991b).
	=	25 years for the current worker (EPA, 1991b).
BW	=	70 kg for the future adult resident and the current worker (EPA, 1991b).
	=	15 kg for the future child resident (EPA, 1991a).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

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Table 6-24
Model for Calculating Doses from
Dermal Contact with Soil

Soil Dermal Absorption Dose (mg/kg-day)	=	$\frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$
Where:		
CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
Assumptions:		
CS	=	Upper 95% confidence limit of the mean concentration in soil (Subsection 6.2.4.1).
SA	=	2300 cm^2/day for the current worker. It represents the 50th percentile surface area of the forearms and hands of an adult male (Anderson, et al., 1985).
	=	1520 cm^2/day for the future child resident. It represents the 50th percentile surface area of the arms, hands, and lower legs (50% of the exposure events) and forearms and hands (50% of the exposure events) of a 1-6 year old (Anderson et al., 1985).
	=	4380 cm^2/day for the future adult resident. It represents the 50th percentile surface area for the arms, hands, and lower legs (50% of the exposure events) and 50th percentile surface area of forearms and hands (50% of the exposure events) of an adult male (Anderson et al, 1985).
AF	=	1.45 mg/cm^2, adherence factor for commercial potting soil was assumed (EPA, 1991b).
ABS	=	0.03 - Polychlorinated biphenyls (EPA, Region II, 1992).
		0.03 - Polyaromatic hydrocarbons (Yang et al., 1989).
	=	0.03 - Semivolatile organics and volatiles (estimated).
	=	0.001 - Cadmium (EPA Region II, 1992).

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Table 6-24
Model for Calculating Doses from
Dermal Contact with Soil
(continued)

EF	=	350 days/year for the future child and adult resident (EPA, 1991b).
	=	250 days/year for the current worker (EPA, 1991b).
ED	=	6 years for the future child resident (EPA, 1991b).
	=	24 years for the future adult resident (EPA, 1991b).
	=	25 years for the current worker (EPA, 1991b).
BW	=	70 kg for the future adult resident and the current worker (EPA, 1991b).
	=	15 kg for the future child resident (EPA, 1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

The exposed skin surface areas for both scenarios are based on the following body part- and age-specific surface areas for males:

- Current Worker:
  - Hands, forearms
- Adult Resident:
  - Arms, hands, lower legs (50% of exposure events)
  - One-half arms, hands (50% of exposure events)
- Child Resident:
  - Arms, hands, one-half legs (50% of exposure events)
  - One-half arms, hands (50% of exposure events)

The skin surface areas for the current worker are based on data for adults and include only hands and forearms because all other areas are expected to be covered while working at the site. The skin surface areas presented in Table 6-24 for the child and adult future residents are time weighted because more exposure to surface soil is expected during the warmer months than during the cooler months.

Absorption of soil-bound substances through the skin involves a number of complex processes. First, the substance must desorb from the soil to an extent that the compound is available for absorption. Second, the substance must penetrate the first skin layer and permeate through the remaining layers. Third, the substance must be taken up by the microcirculation within the skin. Only when all these processes occur can a substance be absorbed.

Information regarding the percentage of chemicals that can be absorbed from soil through the skin was obtained from EPA Region II. According to Regional guidance, dermal absorption of soil-bound chemicals should be evaluated for chemicals for which there are known dermal absorption data. Region II provided dermal absorption data on three chemicals, two of which were detected in soil at the Station sites of concern. The two chemicals and the percentages absorbed from soil through the skin include PCBs (1 to 5%) and cadmium (0.1%). Because limiting the evaluation of dermal contact with soil to only

two chemicals would result in an underestimate of risk, additional organic compounds were evaluated using soil absorption data from Yang (Yang et al., 1989). This study suggests a 3% dermal absorption rate for polycyclic aromatic hydrocarbons (PAHs) which was also used for the volatile and semivolatile organic compounds.

Ingestion of Garden Fruits and Vegetables

Exposure to contaminants of concern through the ingestion of garden fruits and vegetables is a potential route of exposure for the future adult and child residents. The equation and assumptions that are used to calculate intakes through ingestion of homegrown produce are presented in Table 6-25.

Three general categories of garden produce are evaluated: leafy vegetables, root vegetables, and garden fruits. Carrots, lettuce, and tomatoes are used as examples of a root vegetable, leafy vegetable, and garden fruit, respectively. The methodology used to calculate chemical concentrations in garden fruits and vegetables is presented in Appendix E.

For the adult, EPA recommends values of 42 g/day for the consumption of homegrown fruit and 80 g/day for the consumption of homegrown vegetables (EPA, 1991b). The total consumption of fruits and vegetables for a child age 1-6 is reported to be 60% of the adult total. This information is based on data collected by the USDA on the national average consumption rate per day of lettuce, tomatoes, and carrots (Pao et al., 1982).

For an adult, it is assumed that leafy vegetables comprise 45% of total vegetable consumption and root vegetables comprise 55% of total vegetable consumption. For a child, it is assumed that leafy vegetables comprise 35% of total vegetable consumption and root vegetables comprise 65% of total vegetable consumption. These values are based on data for tomato, carrot, and lettuce ingestion rates for male and female children age 3 to 5, and males age 19 to 34 (Pao et al., 1982).

Table 6-25
Model for Calculating Doses from the Consumption of Homegrown Produce

$$\text{Dose from Consumption of Homegrown Produce} = \frac{(C\text{-}L \times IR\text{-}L + C\text{-}F \times IR\text{-}F + C\text{-}R \times IR\text{-}R) \times (CF \times FI \times EF \times ED)}{BW \times AT}$$

Where:

C-L	=	Chemical concentration in leafy vegetables (mg/kg)
IR-L	=	Daily leafy vegetable ingestion rate (g/day)
C-F	=	Chemical concentration in garden fruits (mg/kg)
IR-F	=	Daily garden fruit ingestion rate (g/day)
C-R	=	Chemical concentration in root vegetables (mg/kg)
IR-R	=	Daily root vegetable ingestion rate (g/day)
CF	=	Conversion factor (10^{-3} kg/g)
FI	=	Fraction of homegrown produce ingested from the site (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Assumptions:

C-L	=	Concentration in leafy vegetables based on the upper 95% confidence limit of the mean concentration of soil.
IR-L	=	36 g/day for the future adult resident based on data from EPA (1991b) and Pao et al. (1982) for 19-34 year old male (estimated).
	=	17 g/day for the future child resident, based on data from EPA (1991b) and Pao et al. (1982) for a 3-5 year old male and female (estimated).
C-F	=	Concentration in garden fruits based on the upper 95% confidence limit of the mean concentration of soil.

Table 6-25
Model for Calculating Doses from the Consumption of Homegrown Produce
(continued)

IR-F	=	42 g/day for the future adult resident based on data from EPA (1991b) and Pao et al. (1982) for 19-34 year old male (estimated).
	=	25 g/day for the future child resident, based on data from EPA (1991b) and Pao et al. (1982) for a 3-5 year old male and female (estimated).
C-R	=	Concentration in root vegetables based on the upper 95% confidence limit of the mean concentration of soil.
IR-R	=	44 g/day for the future adult resident based on data from EPA (1991b) and Pao et al. (1982) for a 19-34 year old male (estimated).
	=	31 g/day for the future child resident based on data from EPA (1991b) and Pao et al. (1982) for a 3-5 year old male and female.
FI	=	1, it is assumed that all of the daily consumption of homegrown produce comes from the site.
EF	=	350 days/year for the future child and adult residents (EPA, 1991b).
ED	=	6 years for the future child resident (EPA, 1991b).
	=	24 years for the future adult resident (EPA, 1991b).
BW	=	15 kg for the future child resident (EPA, 1991b).
	=	70 kg for the future adult resident (EPA, 1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

Drinking Water Ingestion

Drinking water ingestion is considered to be a potential exposure route only for the adult and child future residents because groundwater is not currently used on the Station. The drinking water ingestion rates used for child and adult residents assume that all of his/her daily water intake occurs at home. The equations and assumptions that were used to calculate drinking water ingestion doses are presented in Table 6-26.

Inhalation While Showering

Volatile organic compounds (VOCs) may be released to indoor air through a variety of home activities, including showering, cooking, dishwashing, and laundering. Some researchers believe that inhalation doses of VOCs through typical home water uses may be as great or greater than doses from the ingestion of water. Inhalation while showering is evaluated to account for doses of VOCs received from noningestion uses of water for the future adult and child residents. Because of the complexity of the algorithm used to calculate inhalation doses while showering the paper on which the model is based is provided in Appendix F. The inhalation dose equation and key assumptions are provided in Table 6-27.

Dermal Absorption While Showering

Dermal exposure is also expected to occur while showering when lipophilic substances in water are transmitted across the skin. The exposed skin surface areas of 7,195 cm^2 for children and 18,150 cm^2 for adults are based on the 50th percentile of total body surface area (EPA, 1989a). The surface area for children is an average of males and females in the 3 to 6-year age group. The surface area for adults is also an average of males and females. The model and assumptions used to evaluate dermal contact while showering are presented in Table 6-28.

Table 6-26
Model for Calculating Doses from Ingestion of Groundwater

Groundwater Ingestion Dose (mg/kg-day)	=	$\frac{CW \times IR \times EF \times ED}{BW \times AT}$
Where:		
CW	=	Chemical concentration in groundwater (mg/L)
IR	=	Ingestion rate (L/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
Assumptions:		
CW	=	Upper 95% confidence limit of the mean concentration in groundwater (Subsection 6.2.4.3.
IR	=	2 liters/day, for the future adult resident (EPA, 1991b).
	=	1 liters/day, for the future child resident (assuming one half of the adult ingestion rate).
EF	=	350 days/year for the future child and adult residents (EPA, 1991b).
ED	=	6 years for the future child resident (EPA, 1991b).
	=	24 years for the future adult resident (EPA, 1991b).
BW	=	15 kg for the future child resident (EPA, 1991b).
	=	70 kg for the future adult resident (EPA, 1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

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Table 6-27
Model for Calculating Doses through Inhalation While Showering

Shower Inhalation Dose (mg/kg-day) = VR x S/(BW x R x 1E+06) x (D_s+EXP(-RD_t)/R-EXP(R(D_s-D_t))/R)		
Where:		
VR	=	Ventilation rate (l/min).
S	=	Indoor VOC generation rate (µg/m^3-min).
BW	=	Body weight (kg).
R	=	Air exchange rate (min^{-1}).
D_s	=	Duration in shower room (min).
D_t	=	Duration in shower room (min).
Assumptions:		
VR	=	Calculated value (see Appendix G).
S	=	Calculated value (see Appendix G).
BW	=	70 kg for the future adult resident (EPA, 1991b).
	=	15 kg for the future child resident (EPA, 1991b).
R	=	0.025 min^{-1} (Foster-Chrostowski, 1987).
D_s	=	15 min/day for future adult and child resident (EPA, 1989).
D_t	=	20 min/day for the future adult and child resident (assumed value).

Table 6-28

Model for Calculating Doses through Dermal Absorption while Showering

Dermal Absorption Dose while Showering (mg/kg-day) = $\frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$

Where:

CW	=	Chemical concentration in groundwater (mg/l)
SA	=	Skin surface area available for contact (cm^2/event)
PC	=	Chemical-specific dermal permeability constant (cm/hour)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Volumetric conversion factor for water (1 liter/1000 cm^3)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged -- days)

Assumptions:

CW	=	Upper 95% confidence limit of the mean concentration in groundwater (Subsection 6.2.4.3).
SA	=	7,195 cm^2 for future child resident (EPA, 1989c).
	=	18,150 cm^2 for future adult resident (EPA, 1989c).
PC	=	Chemical specific value, see Table 6-29.
ET	=	0.25 hours (15 minutes) for the future adult and child resident (EPA, 1989).
EF	=	350 days/year for the future adult and child resident (EPA, 1989c).
ED	=	6 years for the future child resident (EPA, 1991b).
	=	24 years for the future adult resident (EPA, 1991b).
BW	=	70 kg for the future adult resident (1991b).
	=	15 kg for the future child resident (1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

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The permeability constants used to estimate dermal exposure were calculated using an equation presented in Brown and Rossi (1989) that relies on the K_{ow} (octanol-water partition coefficient) of the compound to be evaluated. The equation, K_{ow}s, and permeability constants for the compounds of interest are presented in Table 6-29.

Incidental Water Ingestion while Swimming

Individuals could be exposed to contaminants when water is incidentally swallowed during swimming. Both the adult and child future resident are evaluated following exposure to chemicals while swimming, where swimming pools are assumed to be filled with groundwater from contaminated water supply wells. Table 6-30 presents the model and assumptions used to calculate doses through incidental water ingestion while swimming. A 50 ml (0.05 l) per hour incidental ingestion rate of pool water was assumed for children and adults based on EPA guidance (EPA, 1989a). Exposure was assumed to occur only during the summer months for 60 days per year, 2.6 hours per day (EPA, 1989a). The 60-day per year exposure frequency was selected because it represents two-thirds (60/90) of the potential number of days a pool is typically used (Memorial Day through Labor Day).

Dermal Absorption while Swimming

Dermal absorption of chemicals while swimming is evaluated only for the adult and child future residents. Dermal absorption of organics in water may occur when hydrophobic substances are transmitted across the skin. Table 6-31 presents the model and assumptions used to calculate doses through dermal absorption while swimming. The exposed skin surface areas of 7,195 cm^2 for children and 18,150 cm^2 for adults are based on total body surface area (EPA, 1989a). Exposure was assumed to occur only during the summer months for 60 days per year, 2.6 hours per day (EPA, 1989a).

Table 6-29

Calculation of Dermal Permeability Constants[a]

Parameter	Log K_{ow}	Permeability Constant (cm/hr)	Reference
Organics			
Aldrin	5.30	0.0987	EPA, 1986
Benzene	2.12	0.0245	EPA, 1986
Benzoic Acid	1.87	0.0174	Howard, 1989
Bis(2-chloroisopropyl)ether	2.10	0.0239	EPA, 1986
Bis(2-ethyhexyl)phthalate	9.61	0.100	Schnoor, 1987
2-Butanone	0.26	0.00128	EPA, 1986
Chlorobenzene	2.84	0.0529	EPA, 1986
Chloroethane	1.5	0.00987	Schnoor, 1987
Chloroform	1.97	0.0200	EPA, 1986
4-4 DDE	7.00	0.0999	EPA, 1986
4,4-DDT	6.19	0.0997	EPA, 1986
1,4-Dichlorobenzene	3.60	0.0807	EPA, 1986
1,1-Dichloroethane	1.79	0.0155	EPA, 1986
1,2-Dichloroethane	1.48	0.00965	EPA, 1986
1,1-Dichloroethene	1.84	0.0167	EPA, 1986
1,2-Dichloroethene (cis)	0.70	0.00271	EPA, 1986
Diethylphthalate	2.50	0.0385	EPA, 1986
Di-n-butylphthalate	5.60	0.0992	EPA, 1986
Ethylbenzene	3.15	0.0658	EPA, 1986
Heptachlor	4.40	0.0943	EPA, 1986
2-Methylnaphthalene	4.10	0.0908	HSDB, 1991
4-Methylphenol	1.97	0.0200	Howard, 1989
Naphthalene	3.29	0.0710	Howard, 1989
N-nitrosodiphenylamine	3.13	0.0650	Schnoor, 1987
1,1,2,2-Tetrachloroethane	2.389	0.0340	EPA, 1986

Table 6-29

Calculation of Dermal Permeability Constants[a]
(continued)

Parameter	Log K_{ow}	Permeability Constant (cm/hr)	Reference
Toluene	2.73	0.0482	EPA, 1986
1,1,2-Trichloroethane	2.47	0.0372	EPA, 1986
Trichloroethene	2.38	0.0337	EPA, 1986
Vinyl Chloride	1.38	0.00829	EPA, 1986
Xylene	3.26	0.0699	EPA, 1986
<u>Explosives</u>			
2,4-DNT	1.98	0.0202	Rosenblatt
HMX	0.26	0.00129	Rosenblatt
RDX	0.87	0.00361	Rosenblatt
Tetryl	1.65	0.0126	Rosenblatt
1,3,5-TNB	1.18	0.00597	Rosenblatt

[a] Calculated from Brown and Rossi (1989) using $PC=0.1x(K_{ow}^{0.75}/(120+K_{ow}^{0.75}))$.

Table 6-30

Model for Calculating Doses through Incidental Water Ingestion while Swimming

Incidental Water Ingestion Dose (mg/kg/day)	=	$\frac{CW \times IR \times ET \times EF \times ED}{BW \times AT}$
Where:		
CW	=	Chemical concentration in groundwater (mg/l)
IR	=	Incidental ingestion rate of pool water (l/hour)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency day/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged -- days)
Assumptions:		
CW	=	Upper 95% confidence limit of the mean concentration in groundwater (Subsection 6.2.4.3).
IR	=	0.05 l/hour for the future child and adult resident (EPA, 1989a).
ET	=	2.6 hours/day for the future child and adult resident (EPA, 1989a).
EF	=	60 days/year for the future child and adult resident (assumed value).
ED	=	6 years for the future child resident (EPA, 1991).
	=	24 years for the future adult resident (EPA, 1991b).
BW	=	70 kg for the future adult resident (1991b).
	=	15 kg for the future child resident (1991b).
AT	=	Exposure duration (years) x 365/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

Table 6-31

Model for Calculating Doses through Dermal Absorption while Swimming

$$\text{Dermal Absorption Dose while Swimming (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

CW	=	Chemical concentration in groundwater (mg/l)
SA	=	Skin surface area available for contact (cm^2/event)
PC	=	Chemical-specific dermal permeability constant (cm/hour)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Volumetric conversion factor for water (1 liter/1000 cm^3)
BW	=	Body weight (kg)
AT	=	Averaging time (period over which exposure is averaged -- days)

Assumptions:

CW	=	Upper 95% confidence limit of the mean concentration in groundwater (Subsection 6.2.4.3).
SA	=	7,195 cm^2 for the future child resident (EPA, 1989c).
	=	18,150 cm^2 for the future adult resident (EPA, 1989c).
PC	=	Chemical specific value, see Table 6-29.
ET	=	2.6 hours/day for the future child and adult resident (EPA, 1989a).
EF	=	60 days/year for the future child and adult resident (assumed value).
ED	=	6 years for the future child resident (EPA, 1991b).
	=	24 years for the future adult resident (EPA, 1991b).
BW	=	70 kg for the future adult resident (1991b).
	=	15 kg for the future child resident (1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

Incidental Ingestion of Sediment

Sediments may by incidentally ingested by placing sediment-covered hands or objects in the mouth. Incidental ingestion of sediments is only evaluated for the child future resident because activities resulting in significant exposure to sediments relates to playing in these areas. The model and assumptions used to calculate intakes through incidental ingestion of sediments are presented in Table 6-32.

In the absence of EPA-derived sediment ingestion rates, the sediment ingestion rates used in this risk assessment are based on soil ingestion rates, because sediment ingestion is likely to occur by the same mechanism as soil ingestion (i.e., hand-to-mouth). It is assumed that the sediment ingestion rate is proportional to the length of time that an individual is considered to be in contact with the contaminated sediments. For the child future resident, the sediment ingestion rate was calculated by multiplying the daily soil ingestion rate of 200 mg/day (EPA, 1991b) by the fraction of hours spent awake in potential contact with the contaminated sediments, (i.e., two hours out of 16 hours) resulting in a sediment ingestion rate of 25 mg/day.

Dermal Absorption from Sediment

Dermal absorption from sediments is only evaluated for the child future resident for the reasons stated above under the incidental ingestion of sediment pathway. The child future resident is expected to have dermal exposure to sediments as they walk through or play in areas that contain sediment. The exposure dose model and assumptions for estimating the dermal dose from sediment are presented in Table 6-33.

The exposed skin areas used to evaluate dermal contact with sediment are the same as those described above for the dermal contact with soil pathway. The dermal absorption factors described above for the soil pathway will also be used to estimate the doses from contact with sediment.

Table 6-32
Model for Calculating Doses from
Incidental Ingestion of Sediment

Sediment Ingestion Dose (mg/kg-day)	=	$\frac{CSD \times IR \times CF \times EF \times ED}{BW \times AT}$

Where:

CSD	=	Chemical concentration in sediment (mg/kg)
IR	=	Ingestion rate (mg/day)
CF	=	Conversion factor (10^{-6} kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Assumptions :

CSD	=	Upper 95% confidence limit of the mean concentration in sediment (Subsection 6.2.4.2).
IR	=	25 mg/day for the future child resident. The sediment ingestion rate is calculated by multiplying the daily soil ingestion rate of 200 mg/day (EPA, 1991b) by the fraction of the hours spent awake (i.e., 2 hours out of 16 hours or 0.125) in contact with the sediments.
EF	=	105 days/year for the future child resident (estimated).
ED	=	6 years for the future child resident (EPA, 1991b).
BW	=	15 kg for the future child resident (EPA, 1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

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Table 6-33
Model for Calculating Doses from Dermal Contact with Sediment

Sediment Dermal Absorption Dose (mg/kg-day)	=	$\frac{CSD \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$
Where:		
CSD	=	Chemical concentration in sediment (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Sediment to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)
Assumptions:		
CSD	=	Upper 95% confidence limit of the mean concentration in sediment (Subsection 6.2.4.2).
SA	=	1240 cm^2/day for the future child resident. It represents the 50th percentile surface area of the feet and hands (50% of the exposure events) and the hands (50% of the exposure events) of a 1-6 year old (Anderson et al., 1985).
AF	=	1.45 mg/cm^2, adherence factor for commercial potting soil was assumed (EPA, 1989a).
ABS	=	0.03 - Polychlorinated biphenyls (EPA Region II, 1992).
		0.03 - Polyaromatic hydrocarbons (Yang et al., 1989).
	=	0.03 - Semivolatile organics and volatiles (estimated).
	=	0.001 - Cadmium (EPA Region II, 1992).
EF	=	105 days/year for the future child resident (estimated).
ED	=	6 years for the future child resident (EPA, 1991b).
BW	=	15 kg for the future child resident (EPA, 1991b).
AT	=	Exposure duration (years) x 365 days/year for evaluating noncancer risk.
	=	70 years x 365 days/year for evaluating cancer risk.

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6.3.2.6 Summary of Calculated Doses

Chronic exposure duration-averaged and lifetime-averaged exposure doses are calculated for the current worker, and future adult and child residents. Because of the number of tables, the doses are presented in Appendix G. Doses for the scenarios are presented in the following tables in Appendix G:

- Site 2 - Tables H-1 through G-5.
- Site 3 - Tables H-6 through G-8.
- Site 4 - Tables H-9 through G-11.
- Site 5 - Tables H-12 through G-14.
- Site 7 - Tables H-15 through G-17.
- Site 10 - Tables H-18 through G-20.
- Site 11 - Tables H-21 through G-23.
- Site 19 - Tables H-24 through G-26.
- Site 20 - Tables H-27 through G-30.
- Site 26 - Tables H-31 through G-33.

6.3.3 Toxicity Assessment

6.3.3.1 Introduction

In evaluating potential health risks, both carcinogenic and noncarcinogenic health effects must be considered. Excessive exposure to any chemical can potentially produce noncarcinogenic health effects, while the potential for carcinogenic effects is limited to exposure to certain substances. Therefore, it is necessary to identify and select noncancer toxicity values (i.e., references doses) for each of the chemicals selected for evaluation and to identify and select cancer toxicity values (i.e., cancer slope factors) only for those chemicals that have evidence of carcinogenicity.

The purpose of the toxicity assessment is to identify the cancer slope factors and reference doses that are used in the risk characterization (Subsection 6.3.4) to evaluate potential human health risks posed by the doses that were estimated in the exposure assessment (Subsection 6.3.2). Human health toxicity values have been developed by EPA for the majority of the chemicals evaluated in this risk assessment. These toxicity values were

obtained from two sources: the Integrated Risk Information System (IRIS) computer database (IRIS, 1992) and the Health Effects Assessment Summary Tables (HEAST) (EPA, 1991a). IRIS was used as the initial source for the most current EPA-approved values. If a value for a chemical was not present in IRIS, HEAST was consulted for an appropriate value. When appropriate established toxicity values were not available in either IRIS or HEAST, interim values were derived from other existing toxicological data according to EPA-approved methods. The established and derived values are conservative and take into account variations in sensitivity between individuals in the receptor population.

6.3.3.2 Cancer Slope Factors

The chemicals evaluated for potential carcinogenic risk in this risk assessment are classified as carcinogens by EPA (Groups A, B, or C) and/or the International Agency for Research on Cancer (IARC) (Groups 1, 2A, or 2B) (CIS, 1988; EPA, 1991a). These chemicals and their EPA and IARC carcinogenicity classifications are presented in Table 6-34. Table 6-35 summarizes the EPA and IARC categorization of carcinogens based on human and animal evidence.

The slope factors that are used in the evaluation of carcinogenic risk have been developed by EPA. In developing cancer slope factors, EPA assumes that there is no threshold for cancer development and that the risk of cancer is linearly related to dose. This means that even if all of the cancer data obtained from laboratory animals or epidemiological studies are for relatively high doses, it is conservatively assumed that these high doses can be extrapolated linearly to extremely small doses, with some risk of cancer remaining until the exposure to the chemical is zero. Figure 6-12 illustrates this approach. This is a no threshold theory that assumes that even a small number of molecules (possibly even a single molecule) of a carcinogen may cause changes in a single cell that could result in the cell dividing in an uncontrolled manner, eventually leading to cancer.

There is some debate as to whether the extrapolation from high to low doses is a realistic approach. It is argued that at low doses, cells may have the ability to detoxify carcinogens

Table 6-34
Carcinogenic Chemicals of Concern and their EPA and IARC Carcinogenicity Classification

Chemical	EPA Carcinogenicity Classification	IARC Carcinogenicity Classification
Organics		
Aldrin	B2	3
Arochlor-1260	B2[a]	2A[a]
Benzene	A	1
Bis(2-ethylhexyl)phthalate	B2	2B
Butylbenzyl phthalate	C	3
Chloroform	B2	2B
4,4'-DDE	B2	NL[b]
4,4'-DDT	B2	2B
1,4-Dichlorobenzene	C	2B
1,1-Dichloroethane	C	NL
1,2-Dichloroethane	B2	2B
1,1-Dichloroethene	C	NL
Heptachlor	B2	NL
Methylene chloride	B2	2B
4-Methylphenol	C	NL
n-Nitrosodiphenylamine	B2	3
PAHs		
Benzo(a)anthracene	B2	2A
Benzo(a)pyrene	B2	2A
Benzo(b)fluoranthene	B2	2B
Benzo(k)fluoranthene	B2	2B
Chrysene	B2	3
Dibenzo(a,h)anthracene	B2	2A
Indeno(1,2,3-cd)pyrene	B2	2B
1,1,2,2-Tetrachloroethane	C	3
1,1,2-Trichloroethane	C	3
Trichloroethene	B2	3

Table 6-34 (Continued)
Carcinogenic Chemicals of Concern and their EPA and IARC Carcinogenicity Classification

Chemical	EPA Carcinogenicity Classification	IARC Carcinogenicity Classification
Vinyl chloride	A	1
Inorganics		
Arsenic	A	1
Beryllium	B2	2A
Cadmium	B1[c]	2A[c]
Chromium VI	A[c]	1[c]
Lead	B2	2B
Nickel	A[c]	1[c]
Explosives		
2,4-Dinitrotoluene	B2	NL
RDX	C	NL

[a]Based on the carcinogenic categories for polychlorinated biphenyls (PCBs).
[b]Not listed.
[c]Classified as a carcinogen through the inhalation route only.

Table 6-35
EPA and IARC Categorizations of Carcinogens Based on Human and Animal Evidence

EPA Categorization of Carcinogens (EPA, 1986b) Human Evidence					
	Sufficient	Limited	Inadequate	No Data	No Evidence
Sufficient	A	A	A	A	A
Limited	B1	B1	B1	B1	B1
Inadequate	B2	C	D	D	D
No Data	B2	C	D	D	E
No Evidence	B2	C	D	D	E

Key

Group A — Human Carcinogen (sufficient evidence from epidemiological studies).

Group B1 — Probable human carcinogen (at least limited evidence of carcinogenicity to humans).

Group B2 — Probable human carcinogen (a combination of sufficient evidence in animals and inadequate data in humans).

Group C — Possible human carcinogen (limited evidence in animals in the absence of human data).

Group D — Not classified (inadequate animals and human data).

Group E — No evidence for carcinogenicity (no evidence for carcinogenicity in at least two adequate animals tests in different species, or in both epidemiological and animals studies).

IARC Categorization of Carcinogenicity (WHO, 1987)

Group 1 — Human carcinogen (sufficient evidence of carcinogenicity in humans).

Group 2A — Probable human carcinogen (at least limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals).

Group 2B — Possible human carcinogen (limited evidence of carcinogenicity in humans and insufficient evidence of carcinogenicity in experimental animals; insufficient evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals; or insufficient evidence of carcinogenicity in humans and limited evidence of carcinogenicity in experimental animals with supporting evidence from other relevant data).

Group 3 — No classifiable (substances in this category do not fall into any other category).

Group 4 — Probably not carcinogenic to humans.

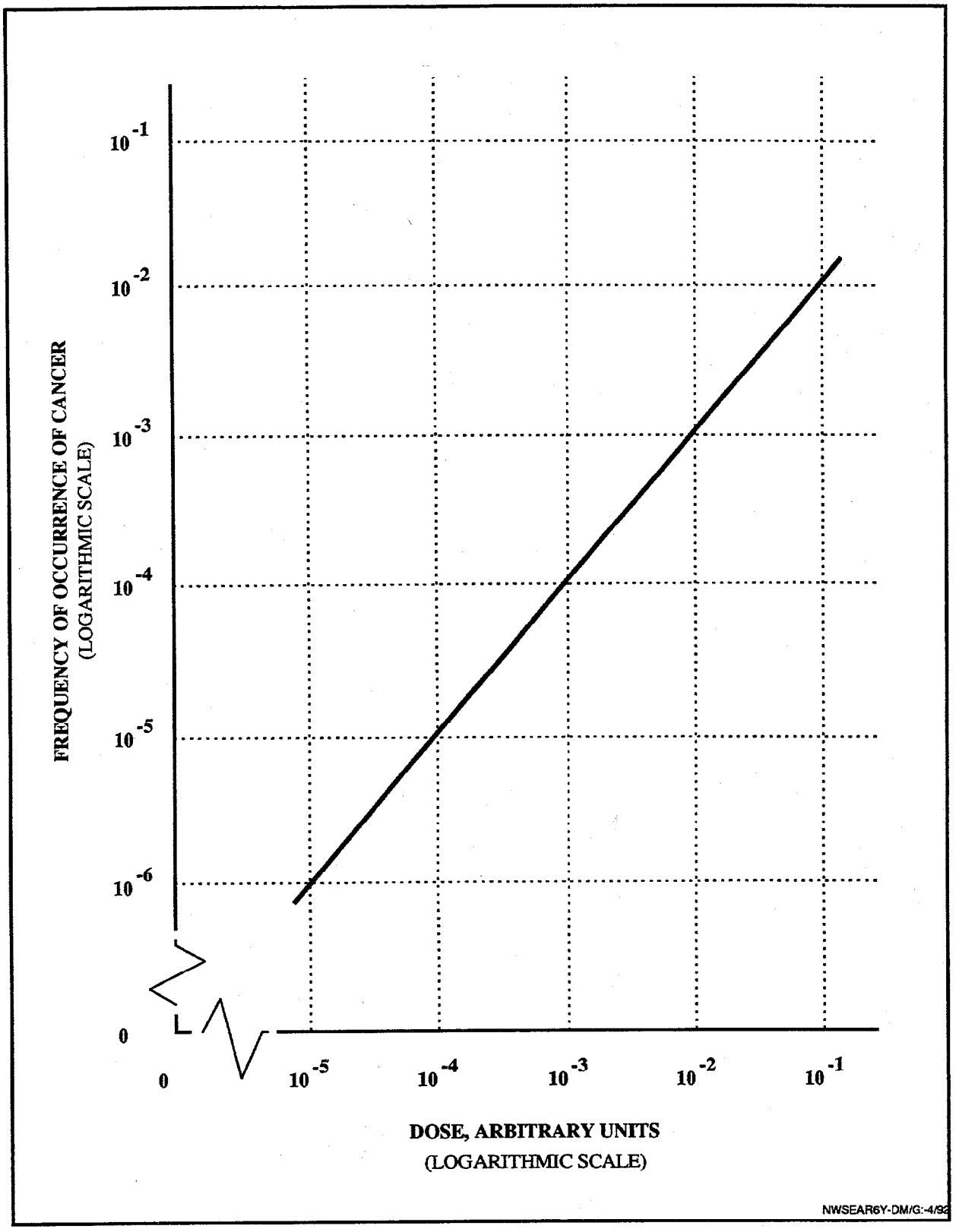


FIGURE 6-12 HYPOTHETICAL DOSE-RESPONSE CURVE FOR A "NO THRESHOLD" OR CARCINOGENIC CHEMICAL

or repair cell-induced damage. Although it is important to recognize the limitations of using data from high dose studies, quantitative adjustments to published slope factors are not available. This baseline risk assessment uses the same slope factors as those used in other studies, so that the estimated risk numbers are comparable.

The slope factors are usually derived by EPA utilizing a linearized multistage model and usually reflect the upper-bound limit of the potency of the chemical. As a result, the calculated carcinogenic risk is likely to represent a plausible upper limit to the risk. The actual risk is unknown, but is likely to be lower than the calculated risk, and may be even as low as zero (EPA, 1986b; EPA, 1989c).

The carcinogenic potency of a substance depends, in part, on its route of entry into the body (e.g., oral, inhalation, or dermal). Therefore, slope factors are developed and classified according to the route of administration. In some cases, a carcinogen may produce tumors only at or near a specific natural route of entry (e.g., nasal passages) and may not be carcinogenic through other exposure routes. This applies to several of the evaluated chemicals including cadmium, chromium VI, and nickel. EPA has developed oral and/or inhalation slope factors for many carcinogens (IRIS, 1992; EPA, 1991a). Dermal slope factors have not been derived by the EPA for any chemicals. However, EPA has provided guidance for developing dermal slope factors from oral slope factors. The slope factors that were used in this evaluation are discussed, by exposure route, in the following subsections.

Oral Route

Cancer slope factors expressed in units of $(mg/kg\text{-}day)^{-1}$ and/or unit risk factors expressed in units of $(\mu g/m^3)^{-1}$ were available for 22 of the carcinogens that are of potential concern through the oral route. A slope factor was converted from a unit risk factor in accordance with EPA guidance (EPA, 1991a) if a slope factor was unavailable. Individual slope factors are discussed below as necessary.

Risk from exposure to Aroclor-1260 was evaluated using the oral slope factor that has been developed for PCBs in general. The carcinogenic risk associated with the ingestion of butyl benzyl phthalate, 1,1-dichloroethane, lead, and 4-methylphenol could not be evaluated because oral slope factors are unavailable. With regard to lead, EPA has stated that lead does not appear to be a potent carcinogen and that at low doses "the noncancer effects of lead are of greatest concern for regulatory purposes" (EPA, 1988a).

The potential cancer risk posed by PAHs will be evaluated using the traditional EPA approach, which assumes that all carcinogenic PAHs have the potency of benzo(a)pyrene (EPA, 1989). Because benzo(a)pyrene is one of the most potent of the carcinogenic PAHs, it is believed that this approach will result in an overestimate of risk posed by exposure to the evaluated PAHs. It should be noted that the oral slope for benzo(a)pyrene was obtained from HEAST (EPA, 1991a) because none was available on IRIS at this writing.

Inhalation Route

EPA-derived inhalation slope factors or unit risk factors were available for all carcinogenic substances of concern. Unit risk factors were converted to slope factors assuming an inhalation rate of 20 m^3/day and a body weight of 70 kg (EPA, 1991a).

Dermal Route

Although few data are available concerning the carcinogenic activity of chemicals that are systemically absorbed through dermal exposure, it is assumed that the chemicals that are carcinogenic through the oral route are potentially carcinogenic through the dermal route, provided that the substance can penetrate the skin. All carcinogenic organic chemicals are considered to be capable of penetrating the skin to at least a limited extent and, therefore are evaluated for potential systemic carcinogenic effects via the dermal route. It should be noted that for PAHs, dermal contact, in addition to posing a potential risk of systemic tumors, may also pose a risk of local skin tumors. Many PAHs have been shown to cause skin tumors in laboratory animals following topical (local) application, and although

quantitative data are not available for humans, prolonged occupational exposure to PAH mixtures has been associated with skin cancer (ATSDR, 1989). However, the evaluation of risk posed by dermal contact with PAHs will be limited in this assessment to that posed by systemic absorption.

In the absence of EPA developed dermal slope factors for the carcinogens, dermal slope factors were derived in accordance with EPA guidance, by dividing the respective oral slope factor by an appropriate gastrointestinal absorption factor (EPA, 1989). As a result, each dermal slope factor represents the potency of the absorbed dermal dose. This is consistent with the approach for calculating intake through dermal exposure, in which the estimated daily intake is expressed as an absorbed dermal dose.

Ideally, each oral slope factor should be adjusted by a gastrointestinal absorption factor that corresponds specifically to the test species/strain and the vehicle that were used in the study(ies) on which the oral slope factor was based. These data are limited for most of the chemicals. Therefore, assumptions were made regarding the gastrointestinal absorption of each of the chemicals depending on their general chemical classifications: volatile organic and semivolatile organic. In addition to professional judgement, the following general guideline was used to classify compounds as either volatile or semivolatile. Volatile organics were considered to be those organics which have a Henry's Law constant equal to or greater than 1E-04 atmospheres-m^3/mole (Smith, 1991) and/or for which the vapor pressure was greater than 100 mm Hg. All other organics were treated as semivolatiles. The vapor pressure criterion was derived from an inspection of the vapor pressures of chemicals that the EPA classifies as volatiles (EPA, 1986). A list of Henry's Law constants and vapor pressures for the organic contaminants is provided in Table 6-36.

Oral toxicity values for volatile organics are commonly based on data from studies in which the agent is administered in drinking water or by gavage, or are extrapolated from inhalation toxicity studies. Absorption through these routes would be expected to be close to or at 100%. Assuming the possibility of less than total absorption, a gastrointestinal absorption factor of 90% (0.90) was used for volatile organics. Oral toxicity values for semivolatile

Table 6-36

Henry's Law Constants and Vapor Pressures Used to Classify Contaminants as Volatile or Semivolatile

Chemical	Henry's Law Constant (atm-m^3/mole)	Reference	Vapor Pressure mm Hg	Reference
Aldrin (sv)	1.60E-05	EPA, 1986	6.00E-06	EPA, 1986
Aroclor-1260 (sv)	1.07E-03[a]	EPA, 1986	7.70E-05	EPA, 1986
Benzene (v)	5.59E-03	EPA, 1986	9.52E+01	EPA, 1986
Benzoic acid (sv)	7.00E-08	Howard, 1989	NA	--
Bis(2-chloroisopropyl)ether (v)	1.13E-04	EPA, 1986	8.50E-01	EPA, 1986
Bis(2-ethylhexyl)phthalate (sv)	3.00E-07	EPA,1987	NA	--
2-Butanone (v)	2.74E-05[a]	EPA, 1986	7.75E+01	EPA, 1986
Butyl benzyl phthalate (sv)	8.30E-06	EPA, 1987	NA	--
Carbon disulfide (v)	3.60E+02	EPA, 1986	2.94E+03	EPA, 1986
Chlorobenzene (v)	3.72E-03	EPA, 1986	1.17E+01	EPA, 1986
Chloroethane (v)	1.48E-01	EPA, 1987	NA	NA
Chloroform (v)	2.87E-03	EPA, 1986	1.51E+02	EPA, 1986
4,4-DDE (sv)	6.80E-05	EPA, 1986	6.50E-06	EPA, 1986
4,4-DDT (sv)	5.13E-04[a]	EPA, 1986	5.50E-06	EPA, 1986
1,4-Dichlorobenzene (v)	1.18E+00	EPA, 1986	7.90E+01	EPA, 1986
1,1-Dichloroethane (v)	1.82E+02	EPA, 1986	5.50E+03	EPA, 1986
1,2-Dichloroethane (v)	9.78E-04	EPA, 1986	6.40E+01	EPA, 1986
1,1-Dichloroethene (v)	3.40E-02	EPA, 1986	6.00E+02	EPA, 1986
1,2-Dichloroethene (cis) (v)	7.58E-03	EPA, 1986	2.08E+02	EPA, 1986
Diethylphthalate (sv)	1.14E-06	EPA, 1986	3.50-03	EPA, 1986
Di-n-butylphthalate (sv)	2.82E-07	EPA, 1986	1.00E-05	EPA, 1986
Ethylbenzene (v)	6.43E-03	EPA, 1986	7.00E+00	EPA, 1986
Heptachlor (sv)	8.19E-04[a]	EPA, 1986	3.00E-04	EPA, 1986
Methylene chloride (v)	2.03E-03	EPA, 1986	3.62E+02	EPA, 1986
2-Methylnaphthalene (sv)	5.18E-04[a]	HSDB, 1991	NA	NA
4-Methylphenol (sv)	7.92E-07	ATSDR, 1991	4.00E-02	ATSDR, 1991
Naphthalene (sv)	4.60E-04[a]	EPA, 1987	NA	NA
N-nitrosodiphenylamine (sv)	6.60E-04[a]	EPA, 1987	NA	--
PAHs				
Anthracene (sv)	1.02E-03	EPA, 1986	1.95E-04	EPA, 1986
Benzo(a)anthracene (sv)	1.16E-06	EPA, 1986	2.20E-08	EPA, 1986

Table 6-36 (cont'd)

Henry's Law Constants and Vapor Pressure Used to Classify Contaminants as Volatile or Semivolatile

Chemical	Henry's Law Constant ($atm\text{-}m^3/mole$)	Reference	Vapor Pressure mm Hg	Reference
Benzo(a)pyrene (sv)	1.55E-06	EPA, 1986	5.60E-09	EPA, 1986
Benzo(b)fluoranthene (sv)	1.19E-05	EPA, 1986	5.00E-07	EPA, 1986
Benzo(g,h,i)perylene (sv)	5.34E-08	EPA, 1986	1.03E-10	EPA, 1986
Benzo(k)fluoranthene (sv)	3.94E-05	EPA, 1986	5.10E-07	EPA, 1986
Chrysene (sv)	1.05E-06	EPA, 1986	6.30E-09	EPA, 1986
Dibenzo(a,h)anthracene (sv)	7.33E-08	EPA, 1986	1.00E-10	EPA, 1986
Fluoranthene (sv)	6.46E-06	EPA, 1986	5.00E-06	EPA, 1986
Indeno(1,2,3-cd)pyrene (sv)	6.86E-08	EPA, 1986	1.00E-10	EPA, 1986
Phenanthrene (sv)	1.59E-04[a]	EPA, 1986	6.80E-04	EPA, 1986
Pyrene (sv)	5.04E-06	EPA, 1986	2.50E-06	EPA, 1986
1,1,2,2-Tetrachloroethane (v)	3.81E-04	EPA, 1986	5.00E+00	EPA, 1986
Toluene (v)	6.37E-03	EPA, 1986	2.81E+01	EPA, 1986
1,1,2-Trichloroethane (v)	1.17E-03	EPA, 1986	3.00E+01	EPA, 1986
Trichloroethene (v)	9.10E-03	EPA, 1986	5.79E+01	EPA, 1986
Vinyl chloride (v)	8.19E-02	EPA, 1986	2.66E+03	EPA, 1986
Xylene (v)	7.04E-03	EPA, 1986	1.00E+01	EPA, 1986
Explosives				
2,4-Dinitrotoluene (sv)	5.09E-06	EPA, 1986	5.10E-03	EPA, 1986
HMX (sv)	NA	NA	NA	NA
Picric acid (sv)	NA	NA	NA	NA
RDX (sv)	NA	NA	NA	NA
Tetryl (sv)	NA	NA	NA	NA
1,3,5-Trinitrobenzene (sv)	NA	NA	NA	NA

NA - Not available.
sv - Treated as a semivolatile.
v - Treated as a volatile.

[a]Treated as listed regardless of Henry's Law constant.

organics are usually derived from studies in which the agent is administered in the diet, by gavage, or by capsule. In a few cases, they may also be developed from inhalation data. Semivolatile organics are also expected to be well absorbed (i.e., 50% or greater); a value of 50% (0.50) was assumed for semivolatile organics. This value probably best approximates absorption through dietary exposure and is likely to be conservative for the other vehicles. It should be noted that this approach is conservative. The lower the gastrointestinal absorption factor, the more conservative the derived toxicity value.

Summary

Table 6-37 summarizes cancer slope factors for carcinogens through the oral, dermal, and inhalation exposure routes. The reference source for each of the slope factors is also indicated.

6.3.3.3 Reference Doses

Unlike the approach used in evaluating cancer risk, for noncarcinogenic health effects it is assumed that a threshold dose exists below which there is no potential for adverse health effects. A "no-observed-adverse-effect level" (NOAEL) is that dose at which no toxic effects are observed in any of the test subjects. Figure 6-13 illustrates this approach.

The toxicity values used to evaluate the potential for noncarcinogenic health effects are generically referred to in this assessment as reference doses (RfDs). The term RfD was developed by the EPA to refer to the daily intake of a chemical to which an individual can be exposed without any expectation of noncarcinogenic adverse health effects occurring (e.g., organ damage, biochemical alterations, birth defects). This term is used in this assessment to apply to any established or derived toxicity value fitting this description. In general terms, the RfD is derived from a NOAEL or a LOAEL (lowest-observed-adverse-effect level) by the application of uncertainty factors of 10 each, and a modifying factor of up to 10 which accounts for a qualitative professional assessment of additional uncertainties in the available data (EPA, 1989c).

Table 6-37
Cancer Slope Factors
$(mg/kg/day)^{-1}$

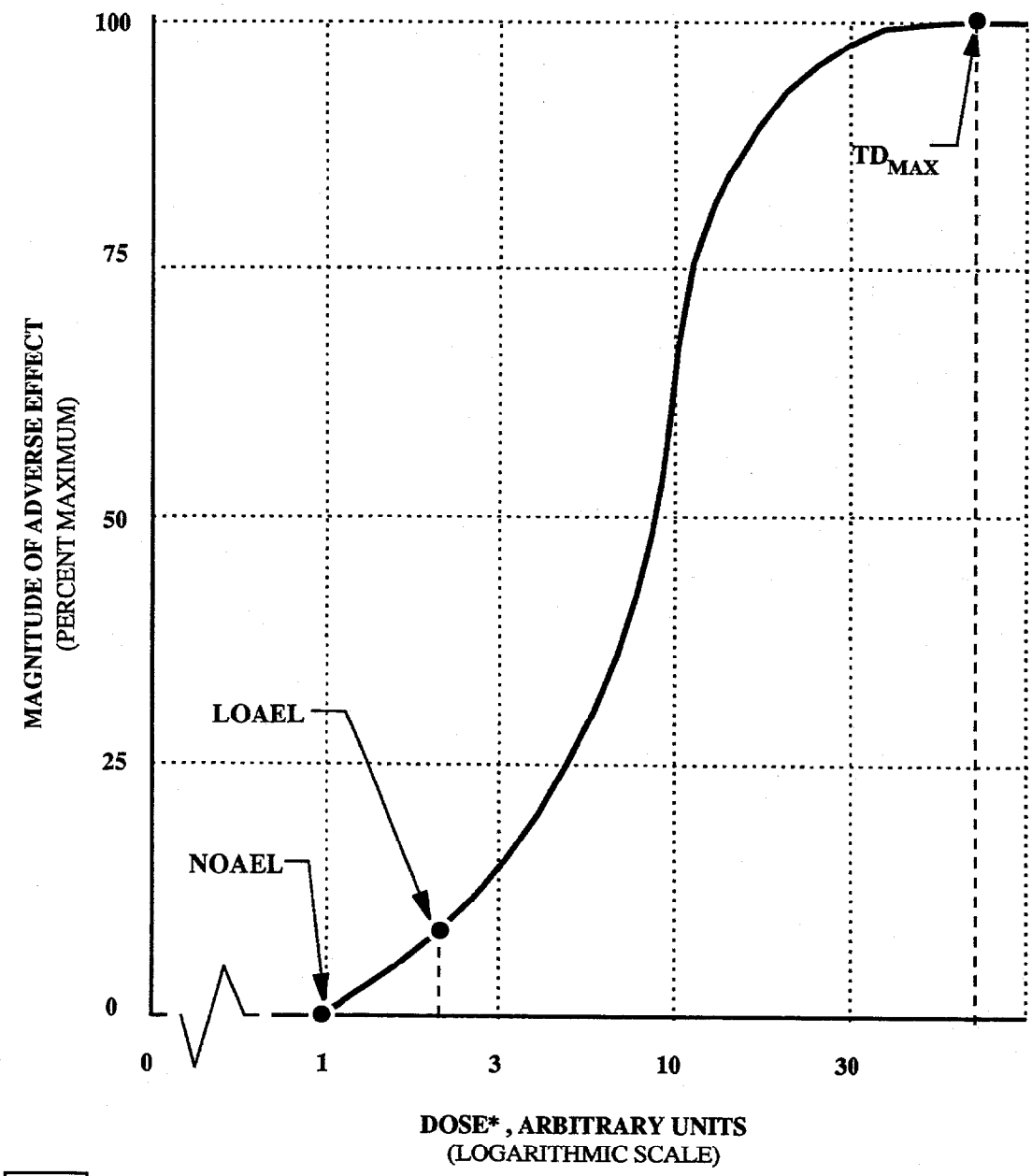
Chemical	Oral Slope Factor	Source or Basis	Inhalation Slope Factor	Source or Basis	Dermal Slope Factor
Organics					
Aldrin	1.70E+01	EPA, 1991a	--	--	3.40E+01(sv)
Arochlor-1260	7.70E+00[a]	IRIS, 1992	--	--	1.54E+01(sv)
Benzene	2.90E-02	IRIS, 1992	2.90E-02	IRIS, 1992	3.22E-02(v)
Bis(2-ethylhexyl) phthalate	1.40E-02	IRIS, 1992	--	--	2.80E-02(sv)
Butylbenzyl phthalate	NSF	--	--	--	--
Chloroform	6.10E-03	IRIS, 1992	8.05E-02	IRIS, 1992	6.77E-03(sv)
4,4-DDE	3.40E-01	IRIS, 1992	--	--	6.80E-01(sv)
4,4-DDT	3.40E-01	IRIS, 1992	--	--	6.80E-01(sv)
1,4-Dichlorobenzene	2.40E-02	EPA, 1991a	2.40E-02	EPA, 1991a	2.67E-02(v)
1,1-Dichloroethane	NSF	--	NSF	--	NSF
1,2-Dichloroethane	9.10E-02	IRIS, 1992	9.10E-02	IRIS, 1992	1.01E-01(v)
1,1-Dichloroethene	6.00E-01	IRIS, 1992	1.75E-01	IRIS, 1992	6.66E-01(v)
Heptachlor	4.50E+00	IRIS, 1992	--	--	9.00E+00(sv)
Methylene chloride	7.50E-03	IRIS, 1992	--	--	8.33E-03(v)
4-Methylphenol	NSF	--	--	NSF	--
n-Nitrosodiphenylamine	4.90E-03	IRIS, 1992	--	--	9.80E-03(sv)
PAHs					
Benzo(a)anthracene	1.15E+01[b]	EPA, 1991a	--	--	2.30E+01(sv)
Benzo(a)pyrene	1.15E+01	EPA, 1991a	--	--	2.30E+01(sv)
Benzo(b)fluoranthene	1.15E+01[b]	EPA, 1991a	--	--	2.30E+01(sv)
Benzo(k)fluoranthene	1.15E+01[b]	EPA, 1991a	--	--	2.30E+01(sv)
Chrysene	1.15E+01[b]	EPA, 1991a	--	--	2.30E+01(sv)
Dibenzo(a,h) anthracene	1.15E+01[b]	EPA, 1991a	--	--	2.30E+01(sv)
Indeno(1,2,3-cd) pyrene	1.15E+01[b]	EPA, 1991a	--	--	2.30E+01(sv)
1,1,2,2-Tetrachloroethane	2.00E-01	IRIS, 1992	2.00E-01	IRIS, 1992	2.22E-01(v)
1,1,2-Trichloroethane	5.70E-02	IRIS, 1992	5.60E-02[c]	IRIS, 1992	6.33E-02(v)

Table 6-37 (Continued)
Cancer Slope Factors
$(mg/kg/day)^{-1}$

Chemical	Oral Slope Factor	Source or Basis	Inhalation Slope Factor	Source or Basis	Dermal Slope Factor
Trichloroethene	1.10E-02	EPA, 1991a	1.70E-02[c]	EPA, 1991a	1.22E-02(v)
Vinyl chloride	1.90E+00	EPA, 1991a	2.94E-01	EPA, 1991a	2.11E+00(v)
Inorganics					
Arsenic	1.75E+00[d]	EPA, 1991a	1.50E+01	IRIS, 1992	--
Beryllium	4.30E+00	IRIS, 1992	--	--	--
Cadmium	NC	--	6.30E+00[c]	IRIS, 1992	NC
Chromium (VI)	NC	--	4.20E+01[c]	IRIS, 1992	NC
Lead	NSF	--	NSF	--	--
Nickel	NC	--	8.40E-01[c]	IRIS, 1992	NC
Explosives					
2,4-Dinitrotoluene	6.80E-01	EPA, 1991a	--	--	1.36E+00(sv)
RDX	1.10E-01	IRIS, 1992	--	--	2.20E-01(sv)

NC = Not carcinogenic by this route.
NE = Not evaluated by this route.
NSF = No slope factor was available.
(v)(sv) = Substances were treated as a volatile (v) or semivolatile (sv) in deriving the dermal slope factors.

[a]The slope factor for polychlorinated biphenyls (PCBs) was used.
[b]The slope factor for benzo(a)pyrene was used.
[c]Converted from a unit risk, assuming the inhalation of 20 m^3/day and body weight of 70 kg (EPA, 1991a).
[d]Converted from a unit risk, assuming the ingestion of 2 L/day of water and body weight of 70 kg (EPA, 1991a).



KEY:

NOAEL = No-observed-adverse-effect level for critical target organ

LOAEL = Lowest-observed-adverse-effect level for critical target organ

TD_{MAX} = Dose at which toxic response is maximum

***DOSE =** Usually expressed in mg chemical per kg body weight of test animal

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FIGURE 6-13 HYPOTHETICAL DOSE-RESPONSE CURVE FOR A "THRESHOLD" OR NONCARCINOGENIC CHEMICAL

RfDs, like cancer slope factors, are developed for specific exposure routes. In addition, separate RfDs are derived to evaluate different exposure periods. Chronic RfDs are developed to evaluate exposures of seven years or longer. Subchronic RfDs are developed to evaluate exposure periods of two weeks to seven years (EPA, 1989c). Because only chronic exposure was assessed at the Station, only chronic RfDs are used in this risk assessment. The RfDs that were used to evaluate noncarcinogenic health effects are described by route of exposure in the following subsections.

Oral Route

Current EPA-derived chronic RfDs were available for the majority of the chemicals of concern that were evaluated through the oral exposure route. For the remaining chemicals, an RfD was derived from available toxicity data, a health standard, or nutritional information. The derivations of those oral RfDs are presented below.

The chronic oral RfD for polybrominated biphenyls (PBBs) was used to evaluate the oral toxicity of Aroclor-1260, a polychlorinated biphenyl (PCB), because an oral RfD was not available for PCBs and PBBs are structurally similar. The oral RfD for benzene was based on a NOAEL of 1 mg/kg-day from a 26-week study in rats. The toxic endpoints manifested in the rats were leucopenia and erythrocytopenia (Wolfe et al., 1956). The chronic RfD was then calculated by dividing the NOAEL by an uncertainty factor of 1,000. The uncertainty factor of 1,000 takes into account an uncertainty factor of 10 for each of the following categories: subchronic to chronic exposure, animal to humans, and human variation.

In the absence of chronic or subchronic toxicity data for n-nitrosodiphenylamine, a chronic oral RfD was derived based on acute oral toxicity data. The lowest reported LD_{50}, 2,500 mg/kg in the rat, was used as the basis of the RfD (RTECS, 1991). An LD_{50} is the dose that is lethal to 50% of the test animals. The chronic RfD was derived by applying an uncertainty factor of 100,000 to the LD_{50} in accordance with the approach developed by Layton et al. (1987).

The RfD for vinyl chloride was derived from a NOAEL that was based on a three-generational study in rats (ATSDR, 1989). The NOAEL of 0.13 mg/kg-day was established from a lifetime dietary study in rats, in which decreased survival and hepatotoxicity were the most sensitive toxic endpoints (Til et al., 1983). An uncertainty factor of 100 was applied, 10 for extrapolating from animals to humans and 10 for human variation.

A chronic oral RfD of 1.93E-02 mg/kg-day was calculated for aluminum from toxicity data. The RfD was based on the results of a multigenerational (180-390 day) study in mice in which aluminum (as aluminum chloride) was administered in the drinking water (Ondreika et al., 1966). At a dose of 19.3 mg/kg-day, marked growth retardation was observed in the second and subsequent litters from the second generation and in all litters from the third generation. Using 19.3 mg/kg-day as a NOAEL, uncertainty factors of 10 each were applied for extrapolating from a LOAEL to a NOAEL, for extrapolating from animals to humans, and for human variation.

For cobalt, a chronic oral RfD of 2.3E-03 mg/kg-day was derived from a reported normal maximum daily intake of 0.160 mg/day, assuming a body weight of 70 kg. This level is known to be without adverse effects (Osol, 1980). The oral RfD for iron of 2.6E-01 mg/kg-day was based on the maximum recommended dietary allowance of 18 mg/day, assuming a body weight of 70 kg (NRC, 1980).

A chronic oral RfD for lead was based on a previously proposed maximum contaminant level (MCL). In 1988 EPA proposed a maximum contaminant level goal (MCLG) of zero for lead and an MCL of 5-10 μg/L (EPA, 1988). An MCL is an enforceable standard for public drinking water supplies. An MCLG is a nonenforceable health goal. The MCLG of zero was recently promulgated, although no MCL has been adopted (EPA, 1991c). However, in 1990 EPA recommended a cleanup level for lead in groundwater of 15 μg/L (EPA, 1990). This cleanup level was believed to correlate with blood lead levels of less than 10 μg/dL, which has been identified as a blood level of concern, particularly in children (EPA, 1990; EPA, 1991). In addition, an action level of 15 μg/L was recently adopted for lead in applicable water supplies (EPA, 1991). Although EPA appears to have targeted 15

μg/L as an acceptable upper limit for lead in water supplies, the exposure threshold for adverse effects is still considered to be uncertain (EPA, 1991). Based on this information, an oral RfD for lead was derived from the most conservative proposed MCL for lead (i.e., 5 μg/L). Assuming the consumption of 2 liters of water per day and a body weight of 70 kg, a chronic oral RfD of 1.0E-04 mg/kg-day was derived for lead.

In the absence of chronic toxicity data for 2,4-dinitrotoluene, an oral RfD was derived based on acute oral toxicity data. The lowest reported dose that is lethal to 50% of the test animals (LD_{50}) was used. The RfD was calculated by applying an uncertainty factor of 100,000 in accordance with the approach developed by Layton et al., (1987). Based on an oral LD_{50} of 268 mg/kg reported for the rat (RTECS, 1992), an RfD of 2.7E-03 mg/kg-day was calculated for 2,4-dinitrotoluene.

The oral ingestion RfD for picric acid was based on a study by Gleason et al. (1969) in which it was reported that the ingestion by humans of 5-50 mg/kg of picric acid causes severe poisoning, coma, and death. A chronic oral RfD of 5E-04 mg/kg-day was derived by applying an uncertainty factor of 10,000. This approach is based on the approach of Layton et al. (1987), for deriving a chronic RfD from an LD_{50}. Layton et al. take into account a factor of 10 for extrapolating from animals to humans. Because the chronic RfD for picric acid is being based on human data, an uncertainty factor of 10,000 instead of 100,000 was applied.

In the absence of oral toxicity data for chloroethane, the inhalation RfD was used as the oral RfD.

Inhalation Route

A chronic inhalation reference dose or reference concentration (RfC) was available for several of the chemicals of concern. RfCs were converted to RfDs by assuming the inhalation of 20 m^3 of air/day and body weight of 70 kg (EPA, 1991b). Generally, inhalation RfDs or RfCs are derived from a NOAEL or LOAEL which is adjusted for

continuous exposure (e.g., from 6 hours/day, 5 days/week to 24 hours/day, 7 days/week) and takes into account differences in various parameters between the animal species used in the experiment and humans (EPA, 1990).

In the absence of a chronic inhalation RfD or RfC for a chemical, an inhalation RfD was calculated, where possible, based on an occupational exposure limit (OEL). The occupational exposure limits (OEL) that were considered included:

- American Conference of Governmental Industrial Hygienists (ACGIH) - threshold limit value-time weighted average (TLV-TWA) (ACGIH, 1991).
- Occupational Safety and Health Administration (OSHA) - permissible exposure limit (PEL) (DOL, 1989).
- National Institute for Occupational Safety and Health (NIOSH) - recommended exposure limit (REL) (CDC, 1988).

It is recognized that there are several factors that limit the usefulness of occupational guidelines in the derivation of chronic RfDs. OELs are intended to protect healthy workers from adverse health effects when exposed to a chemical in the workplace over a 40-hour work week. Inhalation RfDs are intended to protect the general population, including sensitive subpopulations, based on a continuous exposure. Furthermore, OELs are derived by a consensus as opposed to a procedure that incorporates standard uncertainty factors according to the nature of the toxicological database from which the RfD is derived. OELs also may be based on toxic endpoints other than chronic noncarcinogenic health effects.

In consideration of the limitations of the OELs, an equation was developed to derive inhalation RfDs from OELs, incorporating uncertainty factors to account for potential continuity of exposure and variability in human sensitivity. In addition, the support data and/or toxic endpoints for each of the applicable OELs were reviewed to ensure that the OEL was suitable to serve as the basis for a chronic inhalation RfD (ACGIH, 1986; CDC, 1988). For each chemical, the most conservative OEL that has been developed, and which is based on or protective against noncarcinogenic effects, was used to derive the inhalation RfD. The equation and assumptions that were used to calculate chronic inhalation RfDs

from OELs are presented in Table 6-38. The approach is consistent with EPA guidelines for deriving a chronic RfD from a NOAEL (EPA, 1989c). The equation calculates a daily dose to an exposed worker normalized over a 7-day exposure period (i.e., the NOAEL). This dose is adjusted by an uncertainty factor of 10, which takes into account human variability, and, by a modifying factor of 10 which accounts for the possibility of continuous daily exposure over a lifetime.

For benzoic acid, which did not have an OEL, the chronic oral RfD was used as the chronic inhalation RfD. The inhalation RfD for lead was based on the National Ambient Air Quality Standard (NAAQS) which was treated as a RfC and multiplied by an inhalation rate of 20 m^3/day and divided by a body weight of 70 kg.

Dermal Route

As in the case of cancer slope factors, no RfDs have been developed for the dermal route. Therefore, the chronic oral RfDs were used to develop the dermal RfDs in accordance with EPA guidelines (EPA, 1989). Chronic dermal RfDs were derived by multiplying the values used as the chronic oral RfDs by appropriate gastrointestinal absorption factors according the to approach described for the dermal carcinogens (i.e., 0.90 for volatile organics, 0.50 for semivolatile organics). An absorption factor of 5% (0.05) was used for cadmium, an inorganic chemical of concern, following EPA guidance which suggests using 5% for cases in which the gastrointestinal absorption of a substance is not known (EPA, 1989).

Summary

Table 6-39 summarizes chronic reference doses for the inhalation and oral exposure routes. The reference or basis of each of the RfDs is also indicated.

Table 6-38

Approach to Deriving an Inhalation Reference Dose (RfD) from an Occupational Exposure Limit (OEL)

$$\text{Inhalation RfD (mg/kg/day)} = \frac{\text{OEL (mg/m}^3) \times \text{Air breathed/work day (m}^3\text{/day)} \times \text{Work week adjustment factor}}{\text{Body Weight (kg)} \times \text{Uncertainty Factor}}$$

Where:

Inhalation RfD	=	Inhalation reference dose.
OEL	=	Occupational exposure limit.
Air breathed per work day	=	20 m^3 (worker inhalation rate). (EPA, 1991b).
Work week adjustment factor	=	5 days/7 days. Because the OEL is based on a 5-day work week, an adjustment was made to average the dose over a 7-day week.
Body weight	=	70 kg (weight of an average adult) (EPA, 1991b).
Uncertainty factor	=	100. A factor of 10 is recommended by the EPA when deriving RfDs from human data to account for human variation (i.e., to protect sensitive members of the general population (e.g., children and the elderly) (EPA, 1989). An additional modifying factor of 10 was included to take into account a continuous exposure for a resident (versus an intermittent exposure for a worker) and a lifetime exposure for a resident (versus a less than lifetime exposure for a worker). Uncertainty factors of 10 to 100 are commonly used by government agencies when deriving public health criteria from OELs (EPA, 1984; MDNR, 1989; PAMS, 1983).

Table 6-39
Chronic Reference Doses (RfDs)
(mg/kg/day)

Chemical	Chronic Oral RfD	Source or Basis	Chronic Inhalation RfD	Source or Basis	Chronic Dermal RfD
Organics					
Aldrin	3.00E-05	IRIS, 1992	--	--	1.50E-05(sv)
Aroclor-1260	7.00E-06[a]	EPA, 1991a	--	--	3.50E-06(sv)
Benzene	1.00E-03	Derived[b]	6.50E-02	ACGIH-TLV	9.00E-04(v)
Benzoic acid	4.00E+00	IRIS, 1992	--	ORD	2.00E+00(sv)
Bis(2-chloroisopropyl) ether	4.00E-02	IRIS, 1992	--	--	3.60E-02(v)
Bis(2-ethylhexyl) phthalate	2.00E-02	IRIS, 1992	--	--	1.00E-02(sv)
2-Butanone	5.00E-02	EPA, 1991a	9.00E-02	EPA, 1991a	4.50E-02(v)
Butylbenzyl phthalate	2.00E-01	IRIS, 1992	--	--	1.00E-01(sv)
Carbon disulfide	1.00E-01	EPA, 1991a	--	--	--
Chlorobenzene	2.00E-02	EPA, 1991a	5.00E-03	EPA, 1991a	1.80E-02(v)
Chloroethane	2.85E+00	IRD	2.85E+00[c]	EPA, 1991a	2.57E-01(v)
Chloroform	1.00E-02	IRIS, 1992	1.00E-01	ACGIH-TWA	9.00E-03(v)
4,4'-DDE	5.00E-04[d]	IRIS, 1992	--	--	2.50E-04(sv)
4,4'-DDT	5.00E-04	IRIS, 1992	--	--	2.50E-04(sv)
1,4-Dichlorobenzene[e]	9.00E-02	EPA, 1991a	2.00E-01	EPA, 1991a	8.10E-02(v)
1,1-Dichloroethane	1.00E-01	EPA, 1991a	1.00E-01	EPA, 1991a	9.00E-02(v)
1,2-Dichloroethane[f]	1.00E-01	EPA, 1991a	1.00E-01	EPA, 1991	9.00E-02(v)
1,1-Dichloroethene	9.00E-03	IRIS, 1992	2.04E-02	ACGIH-TWA	8.10E-03(v)
1,2-Dichloroethene	1.00E-02[g]	IRIS, 1992	1.62E+00[g]	ACGIH-TWA	9.00E-03(v)
Diethylphthalate	8.00E-01	IRIS, 1992	--	--	4.00E-01(sv)
Di-n-butylphthalate	1.00E-01	IRIS, 1992	--	--	5.00E-02(sv)
Ethylbenzene	1.00E-01	IRIS, 1992	2.90E-01	IRIS, 1992	9.00E-02(v)
Heptachlor	5.00E-04	IRIS, 1992	--	--	2.50E-04(sv)
Methylene chloride	6.00E-02	IRIS, 1992	--	--	5.40E-02(v)
2-Methylnaphthalene	4.00E-03[h]	EPA, 1991a	--	--	2.00E-03(sv)
4-Methylphenol	5.00E-02	EPA, 1991a	--	--	2.50E-02(sv)
Naphthalene	4.00E-03	EPA, 1991a	--	--	2.00E-03(sv)
n-Nitrosodiphenylamine	2.50E-02	Derived[b]	--	--	1.25E-02(sv)

Table 6-39 (Continued)
Chronic Reference Doses (RfDs)
(mg/kg/day)

Chemical	Chronic Oral RfD	Source or Basis	Chronic Inhalation RfD	Source or Basis	Chronic Dermal RfD
PAHS Anthracene	3.00E-01	IRIS, 1992	--	--	1.50E-01(sv)
Benzo(a)anthracene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Benzo(a)pyrene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Benzo(b)fluoranthene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Benzo(g,h,i)perylene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Benzo(k)fluoranthene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Chrysene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Dibenzo(a,h) anthracene	3.00E-02[i]	IRIS, 1992			1.50E-02(sv)
Fluoranthene	4.00E-02	IRIS, 1992	--	--	2.00E-02(sv)
Indeno(1,2,3-cd) pyrene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Phenanthrene	3.00E-02[i]	IRIS, 1992	--	--	1.50E-02(sv)
Pyrene	3.00E-02	IRIS, 1992	--	--	1.50E-02(sv)
1,1,2,2-Tetrachloroethane	7.00E-03[i]	IRIS, 1992	1.41E-02	ACGIH-TLV	6.30E-03(v)
Toluene	2.00E-01	IRIS, 1992	5.71E-01	EPA, 1991a	1.80E-01(v)
1,1,2-Trichloroethene	7.00E-03	IRIS, 1992	1.12E-01	ACGIH-TWA	6.30E-03(v)
Trichloroethene	7.35E-03	EPA, 1987a	5.49E-01	ACGIH-TWA	6.62E-03(v)
Vinyl chloride	1.30E-03	Derived[b]	1.33E-02	ACGIH-TWA	1.17E-02(v)
Xylene	2.00E+00	IRIS, 1992	8.57E-02	EPA, 1991	1.80E+00(v)
Inorganics Aluminum	1.90E-02	Derived[b]	--	--	--
Antimony	4.00E-04	IRIS, 1992	1.02E-03	ACGIH-TWA	--
Arsenic	3.00E-04	IRIS, 1992	4.08E-04	ACGIH-TWA	--
Barium	7.00E-02	IRIS, 1992	--	--	--
Beryllium	5.00E-03	IRIS, 1992	--	--	--
Cadmium H_2O Food	5.00E-04 1.00E-03[k]	IRIS, 1992	1.02E-04	ACGIH-TWA	5.00E-05(i)
Chromium (III)	1.00E+00	EPA, 1991a	5.71E-07[c]	EPA, 1991a	--
Chromium (VI)	5.00E-03	IRIS, 1992	5.71E-07[c]	EPA, 1991a	--

Table 6-39 (Continued)
Chronic Reference Doses (RfDs)
(mg/kg/day)

Chemical	Chronic Oral RfD	Source or Basis	Chronic Inhalation RfD	Source or Basis	Chronic Dermal RfD
Cobalt	2.30E-03	Derived[b]	--	--	--
Copper	3.70E-02[l]	EPA, 1991a	--	--	--
Iron	2.60E-01	Derived[b]	2.04E-03	ACGIH-TWA	--
Lead	1.00E-04	Derived[b]	8.57E-05	NAAQS	--
Manganese	1.00E-01	IRIS, 1992	--	--	--
Mercury	3.00E-04	EPA, 1991a	--	--	--
Nickel	2.00E-02	IRIS, 1992	--	--	--
Nitrate	1.00E-01[m]	EPA, 1991a	NTV	--	--
Selenium	5.00E-03	IRIS, 1992	4.00E-04	ACGIH-TWA	--
Silver	5.00E-03	IRIS, 1992	2.04E-03	ACGIH-TWA	--
Vanadium	7.00E-03	EPA, 1991a	1.02E-04	ACGIH-TWA	--
Zinc	2.00E-01	EPA, 1991a	--	--	--
Explosives					
2,4-Dinitrotoluene	2.73E-03	Derived[b]	--	--	1.37E-03(sv)
HMX	5.00E-02	IRIS, 1992	--	--	2.50E-02(sv)
Picric acid	5.00E-03	Derived[b]	--	--	2.50E-03(sv)
RDX	3.00E-03	IRIS, 1992	--	--	1.50E-03(sv)
Tetryl	NTV	--	--	--	NTV
1,3,5-Trinitrobenzene	5.00E-05	IRIS, 1992	--	--	2.50E-05(sv)

ACGIH-TWA = Inhalation reference dose converted from an American Conference of Governmental Industrial Hygienists threshold limit value-time-weighted average (ACGIH, 1991).
ORD - Oral reference dose was used in the absence of other toxicity values.
IRD - The inhalation dose was used in the absence of other toxicity values.
NTV - No toxicity value available.
--Chemical was treated as a volatile (v), semivolatile (sv), or inorganic (i) in deriving the dermal RfD.

[a]Oral RfD for polybrominated biphenyls was used.
[b]Derived value. See Subsection 6.3.3.3.
[c]Converted from a reference concentration (RfC), assuming an inhalation rate of 20 m^3/day and a body weight of 70 kg (EPA, 1991a).
[d]Oral RfD of structurally similar compound, 4,4'-DDT was used.
[e]Oral and inhalation RfDs are for 1,2-dichlorobenzene.
[f]Oral and inhalation RfDs are for 1,1-dichloroethane.
[g]RfD based on cis-1,2-dichloroethene, which had more conservative health criteria than the trans isomer.
[h]Oral RfD for naphthalene was used.
[i]RfD was based on pyrene, the most conservative RfD that was available for a structually similar PAH.
[j]Oral RfD for 1,1,2-trichloroethane was used.
[k]Oral RfD for food was used to evaluate the ingestion of solid material.
[l]Converted from the current drinking water standard of 1.3 mg/L, assuming the ingestion of 2 L of water/day and a body weight of 70 kg (EPA, 1991a).
[m]Oral RfD for nitrite was used.

6.3.4 Risk Characterization

The objective of the risk characterization is to integrate the information developed in the exposure assessment (Subsection 6.3.2) and the toxicity assessment (Subsection 6.3.3) into an evaluation of the current and potential health risks associated with exposure to chemicals of concern at the Station. This subsection presents an analysis of the nature and degree of health risks posed to the potential receptor populations described in Subsection 6.3.2.2, Exposure Scenarios.

Human health risks are discussed independently for potential carcinogenic and noncarcinogenic effects because of the different toxicological endpoints, relevant exposure durations, and methods employed in characterizing risk. Excessive exposure to all of the chemicals of concern can potentially produce noncarcinogenic effects, while the potential for carcinogenic effects is limited to exposure to only certain substances.

Potential carcinogenic and noncarcinogenic risks are evaluated for each exposure scenario based on the doses summarized in Appendix G. The general approaches to evaluating carcinogenic and noncarcinogenic health effects are summarized in Subsection 6.3.4.1. The results of the risk characterization are summarized in Subsection 6.3.4.2.

6.3.4.1 Approaches to Evaluating Risk

Noncarcinogenic Risk

Noncarcinogenic health effects are evaluated by comparing estimated daily intakes of the chemical of concern, which are averaged over the period of exposure, to reference doses (RfDs). This is accomplished by the calculation of hazard quotients and a hazard index. The hazard quotient for a particular chemical of concern is the ratio between the estimated daily intake through a given exposure route and the applicable RfD. Estimated daily intakes for individual chemicals and routes of exposure are compared to RfDs because the RfD represents the daily intake of a chemical to which a receptor can be exposed over a given

length of time without any reasonable expectation of adverse noncarcinogenic health effects. The hazard quotient-RfD relationship is illustrated by the following equation:

$$HQ = EDI/RfD$$

where:

HQ = Hazard quotient

EDI = Estimated daily intake (averaged over the exposure period) (mg/kg-day)

RfD = Reference dose (mg/kg-day)

The hazard quotients are summed to determine the hazard index (HI) for each chemical of concern, for each exposure route, and for each exposure scenario (i.e., all chemicals and exposure routes combined). The hazard index is calculated to account for the additivity of noncarcinogenic health effects. The principal of additivity assumes that similar organ systems and health endpoints will be affected by the chemicals of concern.

The methodology used to evaluate noncarcinogenic risk, unlike the methodology used to evaluate carcinogenic risk (see Carcinogenic Risk), is not a measure of and cannot be used to determine quantitative risk. The hazard quotient or hazard index is not a mathematical prediction of the incidence of effects or the severity of those effects (EPA, 1985). If a hazard quotient or index exceeds "one" (>1), it simply indicates that there might be a potential for noncarcinogenic health effects occurring under the defined exposure conditions. Because RfDs incorporate a margin of safety, if the criterion of one (1) is exceeded, it does not necessarily indicate that an adverse effect is likely. Conversely, a hazard quotient or index of less than or equal to one (≤ 1) indicates that it is unlikely for even sensitive populations to experience adverse noncarcinogenic health effects.

Carcinogenic Risk

Carcinogenic risk for the potentially carcinogenic chemicals of concern is calculated by multiplying the estimated daily dose that is averaged over a lifetime (lifetime-averaged doses) by a compound and exposure route-specific (oral, inhalation, dermal) carcinogenic slope factor (CSF). The calculation of carcinogenic risk is illustrated by the following equation:

$$\text{Risk} = \text{LAD} * \text{CSF}$$

where:

LAD = Lifetime-averaged dose (dose averaged over a 70-year lifetime) (mg/kg-day)

CSF = Compound and route specific carcinogenic slope factor $(\text{mg/kg-day})^{-1}$

Carcinogenic risks for individual compounds and routes of exposure are then summed to calculate a total carcinogenic risk for each site. Unlike the calculation of noncarcinogenic health effects, the carcinogenic risk calculation yields a probability of developing cancer under the defined exposure conditions; that is, the excess lifetime carcinogenic risk predicted by the above equation represents the number of individuals that may develop cancer following a lifetime of exposure. Because the CSFs are based on the upper 95% confidence limit of the dose-response curve, there is only a 5% chance that the incidence of cancer predicted by the above equation will be exceeded.

The discussion of the carcinogenic risk results (Subsection 6.3.4.2) should be viewed in the context of "acceptable" versus "unacceptable" levels of risk. In general, when exposure to a site results in incremental individual lifetime cancer levels that are less than one in one million (<1E-06) the EPA will not require remediation. The EPA may set remediation goals for sites if exposure to chemicals of concern results in an excess upperbound lifetime cancer risk of between one-in-one-million and one-in-ten-thousand (1E-06 to 1E-04) (40 CFR 300, 1990).

6.3.4.2 Results of Risk Evaluation

Typically, the carcinogenic and noncarcinogenic risk results are discussed separately because of different health effects. However, because of the number of sites evaluated in this report, the risk results will be discussed by site and by health endpoint within each site. The potential exposure pathways for all receptors were described in Subsection 6.3.2.3, Conceptual Site Models. The results of the risk characterization for all receptors are summarized below.

Site 2 - Future Resident

A child and an adult future resident were evaluated for Site 2 by the potential exposure pathways illustrated in Figure 6-3. The total index for the child future resident is 181. The hazard quotients and indices for the child are presented in Table 6-40. The following chemicals of concern had hazard indices that exceeded one for the child receptor:

- Aluminum 9.66E+01 (53%)
- Chromium III 1.08E+01 (6%)
- Chromium VI 3.33E+00 (2%)
- Iron 2.80E+01 (15%)
- Lead 3.02E+01 (17%)
- Vanadium 6.42E+00 (4%)
- 1,3,5-Trinitrobenzene 3.47E+00 (2%)

The ingestion of groundwater accounted for approximately 90% of the total hazard index for the child.

The total hazard index for the adult resident is 74, with ingestion of groundwater accounting for majority of the noncarcinogenic risk (94%). The hazard quotients and indices for the adult are presented in Table 6-41. The chemicals of concern with a hazard index that exceeded one are listed below:

- Aluminum 4.07E+01 (55%)

TABLE 6-40
CHILD HAZARD QUOTIENTS AND INDICES
FOR SITE 2

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	HAZARD INDEX
ORGANICS												
Benzene	1.79E-01	ND	ND	ND	ND	ND	3.99E-03	1.56E-02	ND	5.18E-03	8.76E-03	2.13E-01
bis(2-Ethylhexyl)phthalate	3.20E-03	ND	ND	ND	ND	ND	7.12E-05	2.05E-03	ND	NE	1.15E-03	6.47E-03
Chloroform	2.43E-02	ND	ND	ND	ND	ND	5.41E-04	1.73E-03	ND	3.68E-03	9.72E-04	3.12E-02
INORGANICS												
Aluminum	9.39E+01	2.60E-01	NE	ND	ND	ND	2.09E+00	NE	ND	NE	NE	9.66E+01
Arsenic	ND	1.20E-02	NE	3.03E-01	5.48E-04	NE	ND	ND	9.88E-02	ND	ND	5.34E-01
Barium	1.17E-01	6.92E-05	NE	ND	ND	ND	2.61E-03	NE	ND	NE	NE	1.20E-01
Beryllium	6.39E-02	1.15E-04	NE	ND	ND	ND	1.42E-03	NE	ND	NE	NE	6.55E-02
Cadmium	ND	5.75E-04	8.28E-04	ND	ND	ND	ND	ND	ND	ND	ND	1.40E-03
Chromium III	4.43E-02	1.18E-04	NE	2.50E-03	1.08E+01	NE	9.88E-04	NE	3.73E-04	NE	NE	1.08E+01
Chromium VI	1.44E+00	3.84E-03	NE	8.13E-02	1.75E+00	NE	3.22E-02	NE	1.21E-02	NE	NE	3.33E+00
Cobalt	1.95E-01	2.92E-04	NE	ND	ND	ND	4.34E-03	NE	ND	NE	NE	1.99E-01
Copper	4.32E-02	2.28E-04	NE	ND	ND	ND	9.63E-04	NE	ND	NE	NE	4.44E-02
Iron	2.55E+01	7.62E-02	NE	1.37E+00	3.65E-01	NE	5.69E-01	NE	5.90E-02	NE	NE	2.80E+01
Lead	2.94E+01	1.29E-01	NE	ND	ND	ND	6.55E-01	NE	ND	NE	NE	3.02E+01
Manganese	1.58E-01	5.08E-05	NE	ND	ND	ND	3.52E-03	NE	ND	NE	NE	1.61E-01
Mercury	7.46E-02	ND	ND	ND	ND	ND	1.66E-03	NE	ND	NE	NE	7.62E-02
Nickel	9.05E-02	ND	ND	ND	ND	ND	2.02E-03	NE	ND	NE	NE	9.25E-02
Nitrate	7.24E-01	7.67E-06	NE	3.96E-04	NE	NE	1.61E-02	NE	0.00E+00	NE	NE	7.41E-01
Selenium	ND	ND	ND	1.28E-03	3.94E-05	NE	ND	ND	9.70E-04	ND	ND	2.29E-03
Vanadium	5.94E+00	1.44E-02	NE	2.67E-01	4.51E-02	NE	1.32E-01	NE	2.71E-02	NE	NE	6.42E+00
Zinc	2.87E-01	6.38E-05	NE	ND	ND	ND	6.40E-03	NE	ND	NE	NE	2.93E-01
EXPLOSIVES												
1,3,5-Trinitrobenzene	3.32E+00	ND	ND	ND	ND	ND	7.41E-02	NE	ND	NE	7.19E-02	3.47E+00
2,4-Dinitrotoluene	2.81E-02	ND	ND	ND	ND	ND	6.26E-04	1.77E-03	ND	NE	9.92E-04	3.15E-02
HMX	1.04E-03	ND	ND	ND	ND	ND	2.31E-05	NE	ND	NE	4.80E-06	1.06E-03
Picric Acid	2.68E-02	ND	ND	ND	ND	ND	5.98E-04	NE	ND	NE	2.10E-03	2.95E-02
RDX	5.41E-02	ND	ND	ND	ND	ND	1.21E-03	1.25E-03	ND	NE	7.03E-04	5.73E-02
Tetryl	NE	ND	ND	ND	ND	ND	NE	NE	NE	NE	NE	NE
TOTAL	1.62E+02	4.97E-01	8.28E-04	2.02E+00	1.29E+01	0.00E+00	3.60E+00	2.24E-02	1.98E-01	8.86E-03	8.66E-02	1.81E+02

TABLE 6-41
ADULT HAZARD QUOTIENTS AND INDICES
FOR SITE 2

	GROUNDWATER INGESTION	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	HAZARD INDEX
ORGANICS										
Benzene	7.67E-02	ND	ND	ND	8.55E-04	2.36E-04	ND	1.20E-03	4.73E-03	8.37E-02
bis(2-Ethylhexyl)phthalate	1.37E-03	ND	ND	ND	1.53E-05	3.96E-04	ND	NE	6.22E-04	2.40E-03
Chloroform	1.04E-02	ND	ND	ND	1.16E-04	1.24E-03	ND	8.51E-04	5.25E-04	1.31E-02
INORGANICS										
Aluminum	4.02E+01	ND	ND	ND	4.48E-01	NE	ND	NE	NE	4.07E+01
Arsenic	ND	3.24E-02	1.47E-04	NE	ND	ND	3.85E-02	ND	ND	7.11E-02
Barium	5.01E-02	ND	ND	ND	5.58E-04	NE	ND	NE	NE	5.07E-02
Beryllium	2.74E-02	ND	ND	ND	3.05E-04	NE	ND	NE	NE	2.77E-02
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Chromium III	1.90E-02	2.67E-04	2.89E+00	NE	2.12E-04	NE	1.30E-04	NE	NE	2.90E+00
Chromium VI	6.18E-01	8.71E-03	4.70E-01	NE	6.89E-03	NE	4.23E-03	NE	NE	1.11E+00
Cobalt	8.34E-02	ND	ND	ND	9.29E-04	NE	ND	NE	NE	8.43E-02
Copper	1.85E-02	ND	ND	ND	2.06E-04	NE	ND	NE	NE	1.87E-02
Iron	1.09E+01	1.47E-01	9.78E-02	NE	1.22E-01	NE	2.20E-02	NE	NE	1.13E+01
Lead	1.26E+01	ND	ND	ND	1.40E-01	NE	ND	NE	NE	1.27E+01
Manganese	6.77E-02	ND	ND	ND	7.54E-04	NE	ND	NE	NE	6.84E-02
Mercury	3.20E-02	ND	ND	ND	3.56E-04	NE	ND	NE	NE	3.23E-02
Nickel	3.88E-02	ND	ND	ND	4.32E-04	NE	ND	NE	NE	3.92E-02
Nitrate	3.10E-01	4.25E-05	NE	NE	3.46E-03	NE	NA	NE	NE	3.14E-01
Selenium	ND	1.37E-04	1.05E-05	NE	ND	ND	3.29E-04	ND	ND	4.76E-04
Vanadium	2.54E+00	2.86E-02	1.21E-02	NE	2.83E-02	NE	9.51E-03	NE	NE	2.62E+00
Zinc	1.23E-01	ND	ND	ND	1.37E-03	NE	ND	NE	NE	1.24E-01
EXPLOSIVES										
1,3,5-Trinitrobenzene	1.42E+00	ND	ND	ND	1.59E-02	NE	ND	NE	3.89E-02	1.48E+00
2,4-Dinitrotoluene	1.20E-02	ND	ND	ND	1.34E-04	9.63E-07	ND	NE	5.36E-04	1.27E-02
HMX	4.44E-04	ND	ND	ND	4.95E-06	NE	ND	NE	2.60E-06	4.51E-04
Picric Acid	1.15E-02	ND	ND	ND	1.28E-04	NE	ND	NE	1.13E-03	1.28E-02
RDX	2.32E-02	ND	ND	ND	2.58E-04	4.62E-06	ND	NE	3.80E-04	2.38E-02
Tetryl	NE	ND	ND	ND	NE	NE	NE	NE	NE	NE
TOTAL	6.93E+01	2.17E-01	3.46E+00	0.00E+00	7.72E-01	1.88E-03	7.47E-02	2.05E-03	4.68E-02	7.38E+01

• Chromium III	2.90E+00	(4%)
• Chromium VI	1.11E+00	(2%)
• Iron	1.13E+01	(15%)
• Lead	1.27E+01	(13%)
• Vanadium	2.62E+00	(4%)
• 1,3,5-Trinitrobenzene	1.48E+00	(2%)

The lifetime carcinogenic risk to the Site 2 future resident is 4.3E-04. The ingestion of groundwater pathway accounts for the highest percentage (78%) of the total site risk. Approximately 75% of the total site risk can be attributed to exposure to beryllium and 7% of the total site risk can be attributed to exposure to arsenic. The organic compound that presents the greatest risk is chloroform, which accounts for approximately 8.5% of the total, or 3.7E-05. The lifetime carcinogenic risk and carcinogenic risk distribution for the Site 2 resident are presented in Tables 6-42 and 6-43. Those chemicals of concern that have a risk exceeding 1E-06 are listed below:

• Benzene	1.34E-05	(3.10%)
• Chloroform	3.69E-05	(8.51%)
• Arsenic	3.20E-05	(7.38%)
• Beryllium	3.25E-04	(75.00%)
• Chromium VI	7.47E-06	(1.72%)
• 2,4-Dinitrotoluene	1.37E-05	(3.17%)
• RDX	4.39E-06	(1.01%)

Site 2 - Current Worker

The potential soil-related exposure pathways for the current worker are shown in Figure 6-3. Because only inorganic chemicals were detected in the soil, the dermal absorption pathway was not evaluated for the current worker. The total hazard index for the current Site 2 worker is 2.56 (Table 6-44). Approximately 80% or 2.06 of the total is attributable to the inhalation of chromium III. Chromium III is the only chemical of concern with a hazard index that exceeds one.

TABLE 6-42
RESIDENT LIFETIME CARCINOGENIC RISK
FOR SITE 2

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SOIL INGESTION	SOIL INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	TOTAL RISK
ORGANICS										
Benzene	1.21E-06	ND	ND	ND	1.84E-08	1.23E-07	ND	1.20E-05	6.88E-08	1.34E-05
bis(2-Ethylhexyl)phthalate	2.08E-07	ND	ND	ND	3.17E-09	1.56E-07	ND	0.00E+00	8.73E-08	4.54E-07
Chloroform	3.45E-07	ND	ND	ND	5.26E-09	2.86E-08	ND	3.65E-05	1.60E-08	3.69E-05
INORGANICS										
Arsenic	ND	5.39E-07	1.95E-05	5.96E-07	ND	ND	1.14E-05	ND	ND	3.20E-05
Beryllium	3.20E-04	2.12E-07	ND	ND	4.88E-06	NE	ND	NE	NE	3.25E-04
Cadmium	ND	NE	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Chromium VI	NE	NE	NE	7.47E-06	NE	NE	NE	NE	NE	7.47E-06
Nickel	NE	ND	ND	ND	NE	NE	ND	NE	NE	0.00E+00
								NE	NE	
EXPLOSIVES										
2,4-Dinitrotoluene	1.21E-05	ND	ND	ND	1.85E-07	8.93E-07	ND	NE	5.01E-07	1.37E-05
RDX	4.16E-06	ND	ND	ND	6.34E-08	1.12E-07	ND	NE	6.29E-08	4.39E-06
TOTAL	3.38E-04	7.51E-07	1.95E-05	8.06E-06	5.15E-06	1.31E-06	1.14E-05	4.85E-05	7.36E-07	4.33E-04

ND = COMPOUND NOT DETECTED.
NE = COMPOUND NOT EVALUATED IN THE MEDIUM.

TABLE 6-43
RESIDENT LIFETIME CARCINOGENIC RISK DISTRIBUTION
FOR SITE 2

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SOIL INGESTION	SOIL INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	TOTAL
ORGANICS										
Benzene	0.28	0.00	0.00	0.00	0.00	0.03	0.00	2.78	0.02	3.10
bis(2-Ethylhexyl)phthalate	0.05	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.02	0.10
Chloroform	0.08	0.00	0.00	0.00	0.00	0.01	0.00	8.42	0.00	8.51
INORGANICS										
Arsenic	0.00	0.12	4.49	0.14	0.00	0.00	2.63	0.00	0.00	7.38
Beryllium	73.82	0.05	0.00	0.00	1.13	0.00	0.00	0.00	0.00	75.00
Cadmium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chromium VI	0.00	0.00	0.00	1.72	0.00	0.00	0.00	0.00	0.00	1.72
Nickel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXPLOSIVES										
2,4-Dinitrotoluene	2.80	0.00	0.00	0.00	0.04	0.21	0.00	0.00	0.12	3.17
RDX	0.96	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.01	1.01
TOTAL	77.99	0.17	4.49	1.86	1.19	0.30	2.63	11.20	0.17	100.00

TABLE 6–44
WORKER HAZARD QUOTIENTS AND INDICES
FOR SITE 2

	SOIL INGESTION	SOIL INHALATION	HAZARD INDEX
INORGANICS			
Arsenic	1.16E–02	1.05E–04	1.17E–02
Chromium III	9.55E–05	2.06E+00	2.06E+00
Chromium VI	3.11E–03	3.35E–01	3.39E–01
Iron	5.23E–02	8.22E–02	1.35E–01
Nitrate	1.52E–05	NE	1.52E–05
Selenium	4.89E–05	7.53E–06	5.65E–05
Vanadium	1.02E–02	8.63E–03	1.88E–02
TOTAL	7.74E–02	2.49E+00	2.56E+00

NE – NOT EVALUATED FOR THIS EXPOSURE ROUTE.

The lifetime carcinogenic risk to the current worker is 2.17E-06. Approximately 100% of the total can be attributed to the ingestion of arsenic. The carcinogenic risk to the worker and the carcinogenic risk distribution are presented in Tables 6-45 and 6-46.

Site 3 - Future Resident

Noncarcinogenic and carcinogenic risks to the future residents of Site 3 were evaluated for the exposure pathways presented in Figure 6-4. The hazard quotients and indices for the child and adult future residents are presented in Tables 6-47 and 6-48. The total hazard index for the child resident is 399, with ingestion of groundwater accounting for 97% of the total. The chemicals of concern with a hazard index that exceeds one are listed below:

- Naphthalene 1.20E+00 (0.3%)
- Aluminum 3.22E+01 (8%)
- Antimony 3.10E+00 (1%)
- Arsenic 1.82E+02 (46%)
- Cadmium 4.44E+00 (1%)
- Iron 1.16E+02 (29%)
- Lead 5.23E+01 (13%)
- Vanadium 2.92E+00 (1%)

The total hazard index for the adult resident is 169, with the ingestion of groundwater accounting for approximately 99% of the total. The chemicals of concern with a hazard index exceeding one are listed below:

- Aluminum 1.36E+01 (8%)
- Antimony 1.32E+00 (1%)
- Arsenic 7.70E+01 (46%)
- Cadmium 1.88E+00 (1%)
- Iron 4.93E+01 (29%)
- Lead 2.22E+01 (13%)
- Vanadium 1.24E+00 (1%)

The lifetime carcinogenic risk and the distribution of the lifetime carcinogenic risk are presented in Tables 6-49 and 6-50. The total carcinogenic risk for the hypothetical future

TABLE 6–45
WORKER LIFETIME CARCINOGENIC RISK
FOR SITE 2

	SOIL INGESTION	SOIL INHALATION	TOTAL RISK
INORGANICS			
Arsenic	2.17E–06	6.24E–12	2.17E–06
Chromium VI	NE	3.91E–14	3.91E–14
TOTAL	2.17E–06	6.27E–12	2.17E–06

NE – NOT EVALUATED FOR THIS EXPOSURE ROUTE.

TABLE 6–46
WORKER LIFETIME CARCINOGENIC RISK DISTRIBUTION
FOR SITE 2

	SOIL INGESTION	SOIL INHALATION	TOTAL
INORGANICS			
Arsenic	100.00	0.00	100.00
Chromium VI	NE	0.00	0.00
TOTAL	100.00	0.00	100.00

NE – NOT EVALUATED FOR THIS EXPOSURE ROUTE.

TABLE 6-47
Child Hazard Quotients and Indices
For Site 3

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS (mg/l)						
Aldrin	6.39E-02	NC	2.30E-02	1.42E-03	4.05E-02	1.29E-01
bis(2-ethylhexyl)phthalate	1.83E-02	NC	6.57E-03	4.07E-04	1.17E-02	3.69E-02
Chlorobenzene	4.16E-02	7.62E-03	4.40E-03	9.26E-04	7.84E-03	6.23E-02
1,4-Dichlorobenzene	5.89E-03	1.01E-02	9.50E-04	2.36E-02	5.48E-01	5.89E-01
Diethylphthalate	3.20E-04	NC	4.43E-05	1.14E-02	1.26E-01	1.38E-01
Di-n-Butylphthalate	2.56E-03	NC	9.13E-04	6.33E-05	1.00E-03	4.54E-03
4,4-DDE	2.68E-03	NC	9.65E-04	3.74E-08	1.08E-06	3.65E-03
4,4-DDT	1.19E-02	NC	4.27E-03	1.32E-06	3.80E-05	1.62E-02
Ethylbenzene	7.48E-02	9.24E-05	9.83E-03	1.67E-03	1.75E-02	1.04E-01
2-Methylnaphthalene	7.99E-02	NC	2.61E-02	1.78E-03	4.66E-02	1.54E-01
4-Methylphenol	4.42E-02	NC	3.18E-03	9.86E-04	5.67E-03	5.41E-02
Naphthalene	7.74E-01	NC	5.57E-02	1.72E-02	3.52E-01	1.20E+00
n-Nitrosodiphenylamine	2.56E-03	NC	1.84E-04	5.70E-05	1.07E-03	3.86E-03
Toluene	1.71E-02	2.07E-02	1.65E-03	3.81E-04	2.94E-03	3.82E-02
Xylene	9.56E-03	2.86E-03	1.34E-03	2.13E-04	2.38E-03	1.50E-02
INORGANICS (mg/l)						
Aluminum	3.15E+01	NC	NC	7.02E-01	NC	3.22E+01
Antimony	3.04E+00	NC	NC	6.77E-02	NC	3.10E+00
Arsenic	1.78E+02	NC	NC	3.96E+00	NC	1.82E+02
Barium	1.76E-01	NC	NC	3.93E-03	NC	1.80E-01
Beryllium	1.28E-02	NC	NC	2.85E-04	NC	1.31E-02
Cadmium	4.35E+00	NC	NC	9.69E-02	NC	4.44E+00
Chromium VI	4.49E-01	NC	NC	1.00E-02	NC	4.59E-01
Chromium III	1.38E-02	NC	NC	3.08E-04	NC	1.41E-02
Cobalt	3.61E-01	NC	NC	8.05E-03	NC	3.69E-01
Copper	1.43E-01	NC	NC	3.20E-03	NC	1.47E-01
Iron	1.14E+02	NC	NC	2.54E+00	NC	1.16E+02
Lead	5.11E+01	NC	NC	1.14E+00	NC	5.23E+01
Manganese	7.99E-01	NC	NC	1.78E-02	NC	8.17E-01
Mercury	4.26E-01	NC	NC	9.50E-03	NC	4.36E-01
Selenium	1.53E-01	NC	NC	3.42E-03	NC	1.57E-01
Silver	7.68E-01	NC	NC	1.71E-02	NC	7.86E-01
Vanadium	2.86E+00	NC	NC	6.37E-02	NC	2.92E+00
Zinc	1.55E-01	NC	NC	3.45E-03	NC	1.58E-01
TOTAL	3.89E+02	4.14E-02	1.39E-01	8.70E+00	1.16E+00	3.99E+02

NC= Not of concern through this exposure route.

TABLE 6-48
Adult Hazard Quotients and Indices
For Site 3

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS (mg/l)						
Aldrin	2.74E-02	NC	3.07E-02	3.05E-04	2.19E-02	8.03E-02
bis(2-ethylhexyl)phthalate	7.82E-03	NC	8.77E-03	8.72E-05	6.33E-03	2.30E-02
Chlorobenzene	1.78E-02	1.47E-03	1.11E-02	1.98E-04	4.24E-03	3.48E-02
1,4- Dichlorobenzene	2.52E-03	2.33E-03	2.43E-03	2.81E-05	9.15E-04	8.24E-03
Diethylphthalate	1.37E-04	NC	1.08E-02	1.53E-06	4.27E-05	1.09E-02
Di-n- Butylphthalate	1.10E-03	NC	2.40E-03	1.22E-05	8.80E-04	4.38E-03
4,4- DDE	1.15E-03	NC	1.12E-04	1.28E-05	9.30E-04	2.21E-03
4,4- DDT	5.10E-03	NC	2.30E-03	5.68E-05	4.11E-03	1.16E-02
Ethylbenzene	3.21E-02	2.28E-05	2.48E-02	3.57E-04	9.47E-03	6.67E-02
2-Methylnaphthalene	3.42E-02	NC	6.59E-02	3.82E-04	2.52E-02	1.26E-01
4-Methylphenol	1.90E-02	NC	8.03E-03	2.11E-04	3.07E-03	3.03E-02
Naphthalene	3.32E-01	NC	1.40E-01	3.69E-03	1.90E-01	6.66E-01
n-Nitrosodiphenylamine	1.10E-03	NC	4.64E-04	1.22E-05	5.76E-04	2.15E-03
Toluene	7.33E-03	4.80E-03	4.15E-03	8.17E-05	1.59E-03	1.79E-02
Xylene	4.10E-03	6.60E-04	3.37E-03	4.56E-05	1.29E-03	9.46E-03
INORGANICS (mg/l)						
Aluminum	1.35E+01	NC	NC	1.50E-01	NC	1.36E+01
Antimony	1.30E+00	NC	NC	1.45E-02	NC	1.32E+00
Arsenic	7.62E+01	NC	NC	8.49E-01	NC	7.70E+01
Barium	7.55E-02	NC	NC	8.42E-04	NC	7.64E-02
Beryllium	5.48E-03	NC	NC	6.11E-05	NC	5.54E-03
Cadmium	1.86E+00	NC	NC	2.08E-02	NC	1.88E+00
Chromium VI	1.92E-01	NC	NC	2.14E-03	NC	1.94E-01
Chromium III	5.92E-03	NC	NC	6.59E-05	NC	5.98E-03
Cobalt	1.55E-01	NC	NC	1.73E-03	NC	1.57E-01
Copper	6.15E-02	NC	NC	6.85E-04	NC	6.21E-02
Iron	4.88E+01	NC	NC	5.44E-01	NC	4.93E+01
Lead	2.19E+01	NC	NC	2.44E-01	NC	2.22E+01
Manganese	3.42E-01	NC	NC	3.82E-03	NC	3.46E-01
Mercury	1.83E-01	NC	NC	2.04E-03	NC	1.85E-01
Selenium	6.58E-02	NC	NC	7.33E-04	NC	6.65E-02
Silver	3.29E-01	NC	NC	3.67E-03	NC	3.33E-01
Vanadium	1.23E+00	NC	NC	1.37E-02	NC	1.24E+00
Zinc	6.63E-02	NC	NC	7.39E-04	NC	6.70E-02
TOTAL	1.67E+02	9.28E-03	3.16E-01	1.86E+00	2.71E-01	1.69E+02

NC= Not of concern through this exposure route.

TABLE 6–49
Resident Lifetime Carcinogenic Risk
For Site 3

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS (mg/l)						
Aldrin	7.59E–06	NC	1.81E–05	1.16E–07	5.60E–06	3.14E–05
bis(2–ethylhexyl)phthalate	1.19E–06	NC	2.83E–06	1.81E–08	8.88E–07	4.93E–06
4,4– DDE	1.06E–07	NC	2.53E–07	1.62E–09	1.51E–05	1.55E–05
4,4– DDT	4.70E–07	NC	1.12E–06	7.17E–09	1.51E–05	1.67E–05
1,4– Dichlorobenzene	2.96E–06	5.96E–05	3.16E–06	4.51E–08	2.51E–09	6.58E–05
n–Nitrosodiphenylamine	7.29E–08	NC	3.47E–08	1.11E–09	3.54E–08	1.44E–07
INORGANICS (mg/l)						
Arsenic	2.17E–02	NC	NC	3.31E–04	NC	2.20E–02
Beryllium	6.40E–05	NC	NC	9.75E–07	NC	6.49E–05
TOTAL	2.18E–02	5.96E–05	2.55E–05	3.32E–04	3.67E–05	2.22E–02

NC= Not of concern through this exposure route.

TABLE 6-50
Resident Lifetime Carcinogenic Risk Distribution
For Site 3

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
ORGANICS (mg/l)						
Aldrin	0.03	NE	0.08	0.00	0.03	0.14
bis(2-ethylhexyl)phthalate	0.01	NE	0.01	0.00	0.00	0.02
4,4- DDE	0.00	NE	0.00	0.00	0.07	0.07
4,4- DDT	0.00	NE	0.01	0.00	0.07	0.07
1,4- Dichlorobenzene	0.01	0.27	0.01	0.00	0.00	0.30
n-NItrosodiphenylamine	0.00	NE	0.00	0.00	0.00	0.00
INORGANICS (mg/l)						
Arsenic	97.62	NE	0.00	1.49	0.00	99.10
Beryllium	0.29	NE	0.00	0.00	0.00	0.29
TOTAL	97.96	0.27	0.11	1.49	0.17	100.00

0.00 - Indictes that risk is less than 1/100 percent.
NE= Compound not evaluted through this route.

6-125

resident of Site 3 is 2.2E-02 or two-in-one-hundred. Approximately 98% of the total carcinogenic risk can be attributed to the ingestion of groundwater with virtually all of that attributable to the ingestion of arsenic (exposure to arsenic accounts for 99% of the total risk). All carcinogens evaluated for Site 3 exceed a risk of 1E-06.

Site 4 - Future Resident

Risk to the future off-site resident of Site 4 was evaluated for the exposure pathways presented in Figure 6-5. Hazard quotients and indices for the child and adult residents are presented in Tables 6-51 and 6-52. The total hazard indices for the child and adult residents are 6.7 and 2.3. The majority of the noncarcinogenic risk to both receptors results from the ingestion of groundwater, which accounts for 79% of the total for the child and 97% for the adult. The only chemical of concern that has a hazard index that exceeds one is iron, which has a hazard index of 5.01 for the child resident and 2.11 for the adult resident.

The lifetime carcinogenic risk to the future resident is 1.22E-04 (one-in-ten-thousand). The risk from exposure to trichloroethene and chloroform through all pathways is 1.21E-04, which accounts for 99% of the total risk. The most significant pathway for the Site 4 resident is inhalation of volatiles while showering. The carcinogenic risks and the distribution of those risks for all chemicals and pathways are presented in Tables 6-53 and 6-54. Those chemicals that exceed a risk of 1E-06 are listed below:

- Chloroform 2.79E-05 (24.33%)
- Trichloroethene 9.17E-05 (75.12%)

Site 5 - Future Resident

The noncarcinogenic health risks for the child and adult future residents of Site 5 are 298 and 126, and are presented in Tables 6-55 and 6-56. Approximately 98% of the child total hazard index and 99% of the adult total hazard index can be attributed to the ingestion groundwater. The chemicals of concern with a hazard index exceeding one are listed below for the child resident:

TABLE 6-51
CHILD HAZARD QUOTIENTS AND INDICES
FOR SITE 4

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS								
Aroclor-1260	ND	9.56E-02	4.13E-01	ND	ND	ND	ND	5.08E-01
bis(2-Ethylhexyl)phthalate	ND	7.91E-06	3.41E-05	ND	ND	ND	ND	4.20E-05
Carbon Disulfide	ND	4.79E-09	NA	ND	ND	ND	ND	4.79E-09
Chloroform	1.87E-02	ND	ND	2.83E-03	7.47E-04	4.16E-04	1.33E-03	2.40E-02
1,2-DCE	1.03E-01	ND	ND	1.10E-03	5.60E-04	2.30E-03	9.98E-04	1.08E-01
Methylene Chloride	ND	7.99E-07	1.92E-06	ND	ND	ND	ND	2.71E-06
Phenanthrene	ND	1.09E-06	4.69E-06	ND	ND	ND	ND	5.78E-06
Pyrene	ND	2.08E-06	8.97E-06	ND	ND	ND	ND	1.10E-05
Trichloroethene	2.59E-01	ND	ND	5.28E-03	1.74E-02	5.77E-03	3.10E-02	3.18E-01
INORGANICS								
Aluminum	ND	3.01E-01	NE	ND	ND	ND	ND	3.01E-01
Antimony	ND	6.47E-03	NE	ND	ND	ND	ND	6.47E-03
Arsenic	ND	4.16E-03	NE	ND	ND	ND	ND	4.16E-03
Barium	ND	6.51E-04	NE	ND	ND	ND	ND	6.51E-04
Beryllium	ND	2.01E-05	NE	ND	ND	ND	ND	2.01E-05
Cadmium	ND	2.30E-03	NE	ND	ND	ND	ND	2.30E-03
Chromium III	ND	1.30E-05	NE	ND	ND	ND	ND	1.30E-05
Chromium VI	ND	4.23E-04	NE	ND	ND	ND	ND	4.23E-04
Cobalt	ND	6.67E-04	NE	ND	ND	ND	ND	6.67E-04
Copper	ND	7.76E-04	NE	ND	ND	ND	ND	7.76E-04
Iron	4.86E+00	3.50E-02	NE	NE	NE	1.08E-01	NE	5.01E+00
Lead	ND	7.77E-01	NE	ND	ND	ND	ND	7.77E-01
Manganese	ND	3.37E-04	NE	ND	ND	ND	ND	3.37E-04
Mercury	ND	2.56E-03	NE	ND	ND	ND	ND	2.56E-03
Nickel	4.16E-02	2.06E-04	NE	NE	NE	9.26E-04	NE	4.27E-02
Selenium	4.47E-02	ND	ND	NE	NE	9.97E-04	NE	4.57E-02
Silver	ND	1.15E-04	NE	ND	ND	ND	ND	1.15E-04
Vanadium	ND	2.79E-03	NE	ND	ND	ND	ND	2.79E-03
Zinc	ND	1.40E-03	NE	ND	ND	ND	ND	1.40E-03
TOTAL	5.33E+00	1.23E+00	4.13E-01	9.21E-03	1.87E-02	1.19E-01	3.34E-02	7.15E+00

ND - COMPOUND NOT DETECTED.
NE - NOT EVALUATED.

TABLE 6-52
ADULT HAZARD QUOTIENTS AND INDICES
FOR SITE 4

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS						
Aroclor-1260	ND	ND	ND	ND	ND	0.00E+00
bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	0.00E+00
Carbon Disulfide	ND	ND	ND	ND	ND	0.00E+00
Chloroform	8.01E-03	6.54E-04	4.04E-04	8.92E-05	7.20E-04	9.87E-03
1,2-DCE	4.42E-02	2.53E-04	3.03E-04	4.93E-04	5.40E-04	4.58E-02
Methylene Chloride	ND	ND	ND	ND	ND	0.00E+00
Phenanthrene	ND	ND	ND	ND	ND	0.00E+00
Pyrene	ND	ND	ND	ND	ND	0.00E+00
Trichloroethene	1.11E-01	1.22E-03	9.41E-03	1.24E-03	1.68E-02	1.40E-01
INORGANICS						
Aluminum	ND	ND	ND	ND	ND	0.00E+00
Antimony	ND	ND	ND	ND	ND	0.00E+00
Arsenic	ND	ND	ND	ND	ND	0.00E+00
Barium	ND	ND	ND	ND	ND	0.00E+00
Beryllium	ND	ND	ND	ND	ND	0.00E+00
Cadmium	ND	ND	ND	ND	ND	0.00E+00
Chromium III	ND	ND	ND	ND	ND	0.00E+00
Chromium VI	ND	ND	ND	ND	ND	0.00E+00
Cobalt	ND	ND	ND	ND	ND	0.00E+00
Copper	ND	ND	ND	ND	ND	0.00E+00
Iron	2.08E+00	NE	NE	2.32E-02	NE	2.11E+00
Lead	ND	ND	ND	ND	ND	0.00E+00
Manganese	ND	ND	ND	ND	ND	0.00E+00
Mercury	ND	ND	ND	ND	ND	0.00E+00
Nickel	1.78E-02	NE	NE	1.98E-04	NE	1.80E-02
Selenium	1.92E-02	NE	NE	2.14E-04	NE	1.94E-02
Silver	ND	ND	ND	ND	ND	0.00E+00
Vanadium	ND	ND	ND	ND	ND	0.00E+00
Zinc	ND	ND	ND	ND	ND	0.00E+00
TOTAL	2.28E+00	2.13E-03	1.01E-02	2.55E-02	1.80E-02	2.34E+00

ND - COMPOUND NOT DETECTED.
NE - NOT EVALUATED.

TABLE 6-53
RESIDENT LIFETIME CARCINOGENIC RISK
FOR SITE 4

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS								
Aroclor-1260	ND	4.42E-07	1.91E-06	ND	ND	ND	ND	2.35E-06
bis(2-Ethylhexyl)phthalate	ND	1.90E-10	8.19E-10	ND	ND	ND	ND	1.01E-09
Chloroform	1.63E-06	ND	ND	2.80E-05	1.23E-08	4.04E-09	2.20E-08	2.97E-05
Methylene Chloride	ND	3.08E-11	ND	ND	ND	ND	ND	3.08E-11
Trichloroethene	2.99E-05	ND	ND	6.07E-05	3.81E-07	7.42E-08	6.79E-07	9.17E-05
INORGANICS								
Arsenic	ND	1.87E-07	ND	ND	ND	ND	ND	1.87E-07
Beryllium	ND	3.71E-08	ND	ND	ND	ND	ND	3.71E-08
Total	3.15E-05	6.66E-07	1.91E-06	8.87E-05	3.93E-07	7.83E-08	7.01E-07	1.24E-04

ND - COMPOUND NOT DETECTED.
NE - NOT EVALUATED.

TABLE 6–54
RESIDENT LIFETIME CARCINOGENIC RISK DISTRIBUTION
FOR SITE 4

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
ORGANICS								
Aroclor–1260	0.00	0.36	1.54	0.00	0.00	0.00	0.00	1.89
bis(2–Ethylhexyl)phthalate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chloroform	1.31	0.00	0.00	22.62	0.01	0.00	0.02	23.96
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichloroethene	24.10	0.00	0.00	48.95	0.31	0.06	0.55	73.97
INORGANICS								
Arsenic	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.15
Beryllium	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03
Total	25.42	0.54	1.54	71.56	0.32	0.06	0.57	100.00

0.00 – REPRESENTS RISK LESS THAN 1/100.

TABLE 6-55
Child Hazard Quotients and Indices
For Site 5

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS (mg/l)						
Benzene	1.70E-01	1.00E-02	8.33E-03	3.79E-03	1.48E-02	2.07E-01
bis(2-ethylhexyl)phthalate	1.78E-02	NE	6.40E-03	3.97E-04	1.14E-02	3.60E-02
Chlorobenzene	7.54E-03	1.15E-01	7.98E-04	1.68E-04	1.42E-03	1.25E-01
Chloroethane	1.11E-04	4.27E-04	2.19E-05	2.48E-06	3.91E-05	6.02E-04
Chloroform	5.11E-02	1.21E-05	2.04E-03	1.14E-03	3.64E-03	5.80E-02
1,4- Dichlorobenzene	4.30E-03	7.38E-03	6.94E-04	9.59E-05	1.24E-03	1.37E-02
1,1- Dichloroethane	1.73E-03	6.61E-03	5.36E-05	3.85E-05	9.56E-05	8.52E-03
1,2- Dichloroethane	2.29E-03	7.89E-03	4.43E-05	5.11E-05	7.89E-05	1.04E-02
1,2- Dichloroethene	4.14E-02	9.79E-04	2.24E-04	9.23E-04	4.00E-04	4.40E-02
Di-n- Butylphthalate	6.39E-04	NE	2.28E-04	1.42E-05	4.07E-04	1.29E-03
Ethylbenzene	8.95E-03	1.18E-02	1.18E-03	1.99E-04	2.10E-03	2.42E-02
Naphthalene	9.38E-02	NE	2.41E-02	2.09E-03	4.29E-02	1.63E-01
1,1,2,2- Tetrachloroethane	2.43E-02	2.31E-02	1.65E-03	5.41E-04	2.95E-03	5.25E-02
Trichlorethene	4.89E-02	2.51E-03	3.29E-03	1.09E-03	5.86E-03	6.16E-02
Vinyl Chloride	2.46E-01	9.20E-02	4.07E-04	5.48E-03	7.26E-04	3.44E-01
Xylene	1.53E-04	1.36E-02	2.13E-05	3.40E-06	3.81E-05	1.39E-02
INORGANICS (mg/l)						
Aluminum	2.14E+02	NC	NC	4.77E+00	NC	2.19E+02
Antimony	9.91E+00	NC	NC	2.21E-01	NC	1.01E+01
Barium	9.86E-02	NC	NC	2.20E-03	NC	1.01E-01
Beryllium	1.03E-01	NC	NC	2.30E-03	NC	1.06E-01
Cadmium	1.10E+00	NC	NC	2.46E-02	NC	1.13E+00
Chromium VI	2.10E+00	NC	NC	4.67E-02	NC	2.14E+00
Chromium III	6.39E-02	NC	NC	1.42E-03	NC	6.54E-02
Cobalt	9.95E-01	NC	NC	2.22E-02	NC	1.02E+00
Copper	6.55E-02	NC	NC	1.46E-03	NC	6.69E-02
Iron	4.35E+01	NC	NC	9.70E-01	NC	4.45E+01
Lead	1.76E+01	NC	NC	3.92E-01	NC	1.80E+01
Manganese	2.65E-01	NC	NC	5.90E-03	NC	2.71E-01
Mercury	3.75E-02	NC	NC	8.36E-04	NC	3.83E-02
Nickel	2.34E-01	NC	NC	5.22E-03	NC	2.40E-01
Zinc	1.47E-01	NC	NC	3.28E-03	NC	1.50E-01
TOTAL	2.91E+02	2.92E-01	4.95E-02	6.48E+00	8.82E-02	2.98E+02

NE= Compound not evaluated through this route.
NC= Not of concern through this exposure route.

TABLE 6-56
Adult Hazard Quotients and Indices
For Site 5

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS (mg/l)						
Benzene	7.29E-02	2.32E-03	4.50E-03	8.12E-04	8.02E-03	8.85E-02
bis(2-ethylhexyl)phthalate	7.63E-03	NE	3.46E-03	8.50E-05	6.17E-03	1.73E-02
Chlorobenzene	3.23E-03	2.67E-02	4.31E-04	3.60E-05	7.69E-04	3.12E-02
Chloroethane	4.78E-05	9.87E-05	1.19E-05	5.32E-07	2.11E-05	1.80E-04
Chloroform	2.19E-02	2.79E-06	1.10E-03	2.44E-04	1.97E-03	2.52E-02
1,4- Dichlorobenzene	1.84E-03	1.71E-03	3.75E-04	2.06E-05	6.69E-04	4.62E-03
1,1- Dichloroethane	7.40E-04	1.53E-03	2.90E-05	8.24E-06	5.17E-05	2.36E-03
1,2- Dichloroethane	9.84E-04	1.82E-03	2.39E-05	1.10E-05	4.27E-05	2.89E-03
1,2- Dichloroethene	1.78E-02	2.26E-04	1.21E-04	1.98E-04	2.16E-04	1.85E-02
Di-n- Butylphthalate	2.74E-04	NE	1.23E-04	3.05E-06	2.20E-04	6.20E-04
Ethylbenzene	3.84E-03	2.73E-03	6.35E-04	4.27E-05	1.13E-03	8.38E-03
Naphthalene	4.02E-02	NE	1.30E-02	4.48E-04	2.32E-02	7.69E-02
1,1,2,2- Tetrachloroethane	1.04E-02	NE	8.93E-04	1.16E-04	1.59E-03	1.30E-02
Trichlorethene	2.09E-02	5.79E-04	1.78E-03	2.33E-04	3.17E-03	2.67E-02
Vinyl Chloride	1.05E-01	2.13E-02	2.20E-04	1.17E-03	3.92E-04	1.28E-01
Xylene	6.55E-05	3.16E-03	1.15E-05	7.30E-07	2.06E-05	3.25E-03
INORGANICS (mg/l)						
Aluminum	9.17E+01	NC	NC	1.02E+00	NC	9.27E+01
Antimony	4.25E+00	NC	NC	4.73E-02	NC	4.29E+00
Barium	4.23E-02	NC	NC	4.71E-04	NC	4.27E-02
Beryllium	4.43E-02	NC	NC	4.93E-04	NC	4.48E-02
Cadmium	4.72E-01	NC	NC	5.26E-03	NC	4.78E-01
Chromium VI	8.99E-01	NC	NC	1.00E-02	NC	9.09E-01
Chromium III	2.74E-02	NC	NC	3.05E-04	NC	2.77E-02
Cobalt	4.26E-01	NC	NC	4.75E-03	NC	4.31E-01
Copper	2.81E-02	NC	NC	3.13E-04	NC	2.84E-02
Iron	1.87E+01	NC	NC	2.08E-01	NC	1.89E+01
Lead	7.53E+00	NC	NC	8.40E-02	NC	7.62E+00
Manganese	1.13E-01	NC	NC	1.26E-03	NC	1.15E-01
Mercury	1.61E-02	NC	NC	1.79E-04	NC	1.63E-02
Nickel	1.00E-01	NC	NC	1.12E-03	NC	1.02E-01
Zinc	6.30E-02	NC	NC	7.02E-04	NC	6.37E-02
TOTAL	1.25E+02	6.21E-02	2.67E-02	1.39E+00	4.77E-02	1.26E+02

NE= Compound not evaluated through this route.
NC= Not of concern through this exposure route.

- Aluminum 2.19E+02 (73%)
- Antimony 1.01E+01 (3%)
- Cadmium 1.13E+00 (0.4%)
- Chromium VI 2.14E+00 (1%)
- Cobalt 1.02E+00 (0.3%)
- Iron 4.45E+01 (15%)
- Lead 1.80E+01 (6%)

The chemicals of concern with a hazard index exceeding one for the adult resident are listed below:

- Aluminum 9.27E+01 (74%)
- Antimony 4.29E+00 (3%)
- Iron 1.89E+01 (15%)
- Lead 7.62E+00 (6%)

The carcinogenic risks and the distribution of those risks for the hypothetical future resident of Site 5 are presented in Tables 6-57 and 6-58 for all chemicals and pathways. The total lifetime carcinogenic risk for the future resident of Site 5 is 1.41E-03 (one-in-one-thousand). Exposure to vinyl chloride through all pathways accounts for the majority of the risk (42%), with inhalation while showering and groundwater ingestion representing the highest risk pathways (50% for shower inhalation and 48% for groundwater ingestion). All chemicals of concern except chloroform have a carcinogenic risk that exceeds 1E-06.

Site 7 - Future Resident

The hazard quotients and indices for the child and adult future residents of Site 7 are presented in Tables 6-59 and 6-60. The total hazard indices for the child and adult are 218 and 92, with exposure to the inorganic chemicals of concern accounting for the largest percentage of the total. The chemicals of concern with a hazard index exceeding one for the child are listed below:

- Aluminum 8.85E+01 (41%)
- Arsenic 2.79E+01 (13%)
- Iron 4.20E+01 (19%)

TABLE 6–57
Resident Lifetime Carcinogenic Risk
For site 5

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS (mg/l)						
Benzene	1.15E–06	2.32E–05	6.54E–08	1.75E–08	1.17E–07	2.46E–05
bis(2–ethylhexyl)phthalate	1.16E–06	NE	4.86E–07	1.77E–08	8.67E–07	2.53E–06
Chloroform	7.26E–07	1.19E–07	3.37E–08	1.11E–08	6.01E–08	9.50E–07
1,4– Dichlorobenzene	2.16E–06	4.36E–05	4.07E–07	3.30E–08	7.25E–07	4.69E–05
1,2– Dichloroethane	4.86E–06	8.84E–05	1.09E–07	7.41E–08	1.94E–07	9.36E–05
1,1,2,2– Tetrachloroethane	7.91E–06	8.02E–05	6.21E–07	1.21E–07	1.11E–06	8.99E–05
Trichlorethene	9.19E–07	2.88E–05	7.20E–08	1.40E–08	1.28E–07	2.99E–05
Vinyl Chloride	1.41E–04	4.43E–04	2.72E–06	2.15E–06	4.86E–06	5.94E–04
INORGANICS (mg/l)						
Beryllium	5.17E–04	NC	NC	7.88E–06	NC	5.25E–04
TOTAL	6.77E–04	7.07E–04	4.52E–06	1.03E–05	8.06E–06	1.41E–03

NC= Not of Concern through this exposure route.
NE= Compound not evaluated through this route.

TABLE 6–58
Resident Carcinogenic Risk Distribution
For Site 5

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
ORGANICS (mg/l)						
Benzene	0.08	1.65	0.00	0.00	0.01	1.75
bis(2–ethylhexyl)phthalate	0.08	NE	0.03	0.00	0.06	0.18
Chloroform	0.05	0.01	0.00	0.00	0.00	0.07
1,4– Dichlorobenzene	0.15	3.10	0.03	0.00	0.05	3.34
1,2– Dichloroethane	0.35	6.28	0.01	0.01	0.01	6.65
1,1,2,2– Tetrachloroethane	0.56	5.70	0.04	0.01	0.08	6.39
Trichlorethene	0.07	2.05	0.01	0.00	0.01	2.13
Vinyl Chloride	10.04	31.48	0.19	0.15	0.35	42.21
INORGANICS (mg/l)						
Beryllium	36.73	NE	NE	0.56	NE	37.29
TOTAL	48.11	50.26	0.32	0.73	0.57	100.00

0.00= Indicates that risk is less than 1/100 percent.
NE= Compound not evaluated through this route.

TABLE 6-59
Child Hazard Quotient and Indices
For Site 7

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS						
Benzoic acid	2.40E-04	NE	1.50E-05	5.34E-06	2.67E-05	2.87E-04
Bis(2-chloroisopropyl)ether	1.60E-03	NE	7.62E-05	3.56E-05	1.36E-04	1.85E-03
2-Butanone	1.13E-01	1.77E-02	2.87E-04	2.51E-03	5.13E-04	1.34E-01
Chlorobenzene	4.57E-02	7.00E-01	4.83E-03	1.02E-03	8.62E-03	7.60E-01
1,2-Dichloroethane	6.39E-04	2.20E-03	1.23E-05	1.42E-05	2.20E-05	2.89E-03
1,2-Dichloroethene	2.56E-02	6.04E-04	1.39E-04	5.70E-04	2.47E-04	2.71E-02
Heptachlor	1.28E-03	NE	4.34E-04	2.85E-05	7.74E-04	2.08E-03
1,1,2-Trichloroethane	1.52E-01	3.28E-02	1.13E-02	3.38E-03	2.01E-02	2.19E-01
1,1,2,2-Tetrachloroethane	3.92E-01	3.72E-01	2.67E-02	8.73E-03	4.75E-02	8.47E-01
INORGANICS						
Aluminium	8.66E+01	NC	NC	1.93E+00	NC	8.85E+01
Arsenic	2.73E+01	NC	NC	6.08E-01	NC	2.79E+01
Barium	2.05E-01	NC	NC	4.56E-03	NC	2.09E-01
Beryllium	1.62E-02	NC	NC	3.62E-04	NC	1.66E-02
Cadmium	6.96E-01	NC	NC	1.55E-02	NC	7.11E-01
Chromium VI	2.75E-01	NC	NC	6.13E-03	NC	2.81E-01
Chromium III	8.44E-03	NC	NC	1.88E-04	NC	8.63E-03
Copper	1.49E-01	NC	NC	3.32E-03	NC	1.52E-01
Iron	4.11E+01	NC	NC	9.15E-01	NC	4.20E+01
Lead	5.45E+01	NC	NC	1.21E+00	NC	5.57E+01
Manganese	2.49E-01	NC	NC	5.56E-03	NC	2.55E-01
Mercury	1.39E-01	NC	NC	3.10E-03	NC	1.42E-01
Nickel	1.32E-01	NC	NC	2.93E-03	NC	1.35E-01
Selenium	4.51E-02	NC	NC	1.01E-03	NC	4.61E-02
Zinc	8.69E-02	NC	NC	1.94E-03	NC	8.89E-02
	2.12E+02	1.13E+00	4.37E-02	4.73E+00	7.80E-02	2.18E+02

NC= Not of concern through this exposure route.
NE= Not evaluated.

TABLE 6–60
Adult Hazard Quotient and Indices
For Site 7

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS						
Benzoic acid	1.03E–04	NE	8.10E–06	1.14E–06	1.44E–05	1.26E–04
Bis(2–chloroisopropyl)ether	6.85E–04	NE	4.12E–05	7.63E–06	7.34E–05	8.07E–04
2–Butanone	4.82E–02	4.09E–03	1.55E–04	5.37E–04	2.77E–04	5.33E–02
Chlorobenzene	1.96E–02	1.62E–01	2.61E–03	2.18E–04	4.66E–03	1.89E–01
1,2–Dichloroethane	2.74E–04	5.08E–04	6.67E–06	3.05E–06	1.19E–05	8.04E–04
1,2–Dichloroethene	1.10E–02	1.40E–04	7.49E–05	1.22E–04	1.34E–04	1.14E–02
Heptachlor	5.48E–04	NE	2.35E–04	6.11E–06	4.18E–04	1.21E–03
1,1,2–Trichloroethane	6.50E–02	7.58E–03	6.10E–03	7.24E–04	1.09E–02	9.02E–02
1,1,2,2–Tetrachloroethane	1.68E–01	8.61E–02	1.44E–02	1.87E–03	2.57E–02	2.96E–01
INORGANICS						
Aluminium	3.71E+01	NC	NC	4.14E–01	NC	3.75E+01
Arsenic	1.17E+01	NC	NC	1.30E–01	NC	1.18E+01
Barium	8.77E–02	NC	NC	9.77E–04	NC	8.86E–02
Beryllium	6.96E–03	NC	NC	7.75E–05	NC	7.04E–03
Cadmium	2.98E–01	NC	NC	3.32E–03	NC	3.01E–01
Chromium VI	1.18E–01	NC	NC	1.31E–03	NC	1.19E–01
Chromium III	3.62E–03	NC	NC	4.03E–05	NC	3.66E–03
Copper	6.39E–02	NC	NC	7.12E–04	NC	6.46E–02
Iron	1.76E+01	NC	NC	1.96E–01	NC	1.78E+01
Lead	2.33E+01	NC	NC	2.60E–01	NC	2.36E+01
Manganese	1.07E–01	NC	NC	1.19E–03	NC	1.08E–01
Mercury	5.96E–02	NC	NC	6.65E–04	NC	6.03E–02
Nickel	5.64E–02	NC	NC	6.29E–04	NC	5.71E–02
Selenium	1.93E–02	NC	NC	2.16E–04	NC	1.96E–02
Zinc	3.73E–02	NC	NC	4.15E–04	NC	3.77E–02
	9.09E+01	2.60E–01	2.36E–02	1.01E+00	4.21E–02	9.23E+01

NC= Not of concern through this exposure route.
NE= Not evaluated.

- Lead 5.57E+01 (26%)

The chemicals of concern with a hazard index that exceeds one for the adult are listed below:

- Aluminum 3.75E+01 (41%)
- Arsenic 1.18E+01 (13%)
- Iron 1.78E+01 (19%)
- Lead 2.36E+01 (26%)

The lifetime carcinogenic risk and the distribution of the carcinogenic risk are presented in Tables 6-61 and 6-62 for the future Site 7 resident. The total lifetime risk for the resident is 5.21E-03 (five-in-one-thousand). The ingestion of arsenic in groundwater accounts for the majority of the carcinogenic risk (68%), with inhalation of 1,1,2,2-tetrachloroethane accounting for 25% of the total risk. All carcinogens evaluated for the Site 7 resident have a carcinogenic risk that exceeds 1E-06.

Site 10 - Future Resident

The hazard quotients and indices for the child and the adult future residents of Site 10 are presented in Table 6-63 and Table 6-64. The total hazard indices for the child and the adult are 220 and 93. Exposure to inorganic chemicals of potential concern through the groundwater ingestion pathway poses the greatest noncarcinogenic risk. The chemicals that have a hazard index exceeding one are listed below for the child resident:

- Aluminum 1.55E+02 (70%)
- Antimony 3.40E+00 (2%)
- Arsenic 2.79E+00 (1%)
- Cobalt 1.15E+00 (1%)
- Iron 1.45E+01 (7%)
- Lead 3.32E+01 (15%)
- Vanadium 8.04E+00 (4%)

TABLE 6–61
Resident Lifetime Carcinogenic Risk
For Site 7

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS						
1,2–Dichloroethane	1.35E–06	2.46E–05	3.04E–08	2.06E–08	5.42E–08	2.61E–05
Heptachlor	6.69E–07	NC	2.65E–07	1.02E–08	4.72E–07	1.42E–06
1,1,2–Trichloroethane	1.41E–05	2.53E–04	1.22E–06	2.15E–07	2.17E–06	2.71E–04
1,1,2,2–Tetrachloroethane	1.28E–04	1.29E–03	1.01E–05	1.95E–06	1.80E–05	1.45E–03
INORGANICS						
Arsenic	3.33E–03	NC	NC	5.08E–05	NC	3.38E–03
Beryllium	8.12E–05	NC	NC	1.24E–06	NC	8.25E–05
	3.56E–03	1.57E–03	1.16E–05	5.42E–05	2.07E–05	5.21E–03

NC = Not of oencern through this exposure route.

TABLE 6–62
Resident Lifetime Carcinogenic Risk Distribution
For Site 7

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
ORGANICS						
1,2–Dichloroethane	0.03	0.47	0.00	0.00	0.00	0.50
Heptachlor	0.01	0.00	0.01	0.00	0.01	0.03
1,1,2–Trichloroethane	0.27	4.86	0.02	0.00	0.04	5.20
1,1,2,2–Tetrachloroethane	2.45	24.80	0.19	0.04	0.35	27.82
INORGANICS						
Arsenic	63.90	0.00	0.00	0.97	0.00	64.87
Beryllium	1.56	0.00	0.00	0.02	0.00	1.58
	68.21	30.13	0.22	1.04	0.40	100.00

0.00= Indicates that risk is less than 1/100 percent.

TABLE 6–63
CHILD HAZARD QUOTIENTS AND INDICES
FOR SITE 10

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS							
Benzo(a)anthracene	ND	8.63E–07	3.72E–06	ND	ND	ND	4.59E–06
bis(2–Ethylhexyl)phthalate	6.39E–03	1.46E–06	6.31E–06	2.30E–03	1.42E–04	4.10E–03	1.29E–02
Chrysene	ND	1.44E–06	6.21E–06	ND	ND	ND	7.65E–06
Fluoranthene	ND	1.05E–06	4.55E–06	ND	ND	ND	5.61E–06
Methylene Chloride	ND	4.47E–07	1.07E–06	ND	ND	ND	1.52E–06
Phenanthrene	ND	2.72E–06	1.17E–05	ND	ND	ND	1.44E–05
Pyrene	ND	1.47E–06	6.34E–06	ND	ND	ND	7.82E–06
INORGANICS							
Aluminum	1.52E+02	1.71E–02	NE	NE	3.38E+00	NE	1.55E+02
Antimony	3.32E+00	3.84E–03	NE	NE	7.41E–02	NE	3.40E+00
Arsenic	2.73E+00	2.72E–03	NE	NE	6.08E–02	NE	2.79E+00
Barium	6.03E–02	3.77E–05	NE	NE	1.34E–03	NE	6.17E–02
Beryllium	6.83E–02	ND	ND	NE	1.52E–03	NE	6.98E–02
Cadmium	5.27E–01	ND	ND	NE	1.17E–02	NE	5.38E–01
Chromium III	2.27E–02	2.60E–06	NE	NE	5.05E–04	NE	2.32E–02
Chromium VI	7.37E–01	8.46E–05	NE	NE	1.64E–02	NE	7.54E–01
Cobalt	1.12E+00	5.84E–04	NE	NE	2.50E–02	NE	1.15E+00
Copper	3.04E–02	ND	ND	NE	6.78E–04	NE	3.11E–02
Iron	1.42E+01	1.81E–02	NE	NE	3.17E–01	NE	1.45E+01
Lead	3.25E+01	2.78E–02	NE	NE	7.24E–01	NE	3.32E+01
Manganese	7.74E–02	2.82E–04	NE	NE	1.72E–03	NE	7.94E–02
Mercury	ND	2.08E–04	NE	ND	ND	ND	2.08E–04
Nickel	3.23E–01	ND	ND	NE	7.19E–03	NE	3.30E–01
Selenium	2.05E–02	ND	ND	NE	4.56E–04	NE	2.09E–02
Vanadium	7.86E+00	4.93E–04	NE	NE	1.75E–01	NE	8.04E+00
Zinc	7.42E–02	3.57E–05	NE	NE	1.65E–03	NE	7.58E–02
Total	2.15E+02	7.12E–02	3.99E–05	2.30E–03	4.80E+00	4.10E–03	2.20E+02

TABLE 6-64
ADULT HAZARD QUOTIENTS AND INDICES
FOR SITE 10

	GROUNDWATER INGESTION	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS					
Benzo(a)anthracene	ND	NE	ND	ND	ND
bis(2-Ethylhexyl)phthalate	2.74E-03	9.56E-07	3.05E-05	2.22E-03	4.99E-03
Chrysene	ND	NE	ND	ND	ND
Fluoranthene	ND	NE	ND	ND	ND
Methylene Chloride	ND	NE	ND	ND	ND
Phenanthrene	ND	NE	ND	ND	ND
Pyrene	ND	NE	ND	ND	ND
INORGANICS					
Aluminum	6.50E+01	NE	7.25E-01	NE	6.58E+01
Antimony	1.42E+00	NE	1.59E-02	NE	1.44E+00
Arsenic	1.17E+00	NE	1.30E-02	NE	1.18E+00
Barium	2.58E-02	NE	2.88E-04	NE	2.61E-02
Beryllium	2.93E-02	NE	3.26E-04	NE	2.96E-02
Cadmium	2.26E-01	NE	2.52E-03	NE	2.28E-01
Chromium III	9.71E-03	NE	1.08E-04	NE	9.82E-03
Chromium VI	3.16E-01	NE	3.52E-03	NE	3.20E-01
Cobalt	4.81E-01	NE	5.36E-03	NE	4.87E-01
Copper	1.30E-02	NE	1.45E-04	NE	1.32E-02
Iron	6.09E+00	NE	6.79E-02	NE	6.16E+00
Lead	1.39E+01	NE	1.55E-01	NE	1.41E+01
Manganese	3.32E-02	NE	3.69E-04	NE	3.35E-02
Mercury	ND	NE	ND	ND	ND
Nickel	1.38E-01	NE	1.54E-03	NE	1.40E-01
Selenium	8.77E-03	NE	9.77E-05	NE	8.86E-03
Vanadium	3.37E+00	NE	3.75E-02	NE	3.41E+00
Zinc	3.18E-02	NE	3.54E-04	NE	3.21E-02
Total	9.23E+01	9.56E-07	1.03E+00	2.22E-03	9.34E+01

The chemicals of concern that have a hazard index exceeding one for the adult resident are listed below:

- Aluminum 6.58E+01 (70%)
- Antimony 1.44E+00 (2%)
- Arsenic 1.18E+00 (1%)
- Iron 6.16E+00 (7%)
- Lead 1.41E+01 (15%)
- Vanadium 3.41E+00 (4%)

The lifetime carcinogenic risk and carcinogenic risk distribution are presented in Table 6-65 and Table 6-66. The lifetime carcinogenic risk for Site 10 is 6.86E-04 (seven-in-ten-thousand). Approximately 100% of the carcinogenic risk results from exposure to arsenic (49.3%) and beryllium (50.52%). The risk from exposure to organic chemicals of concern accounts for less than 1% of the total risk. The chemicals of concern with a carcinogenic risk exceeding 1E-06 are listed below:

- Arsenic 3.38E-04 (49.30%)
- Beryllium 3.47E-04 (50.52%)

Site 11 - Future Resident

The hazard quotients and indices for the child and adult future residents of Site 11 are presented in Table 6-67 and 6-68. The total hazard index for the child is 81 and the total hazard index for the adult is 34. The ingestion of groundwater accounts for the greatest percentage of the noncarcinogenic risk for both the child (98%) and the adult (99%). Those compounds with a hazard index that exceeds one for the child resident are listed below:

- Iron 1.08E+01 (13%)
- Lead 1.33E+01 (17%)
- Mercury 5.51E+01 (68%)

Those compounds with a hazard index that exceeds one for the adult resident are listed below:

TABLE 6-65
RESIDENT LIFETIME CARCINOGENIC RISK
FOR SITE 10

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS							
Benzo(a)anthracene	ND	2.55E-08	1.10E-07	ND	ND	ND	1.36E-07
bis(2-Ethylhexyl)phthalate	4.16E-07	3.51E-11	1.51E-10	1.75E-07	6.35E-09	3.11E-07	9.09E-07
Chrysene	ND	4.25E-08	1.84E-07	ND	ND	ND	2.26E-07
Methylene Chloride	ND	1.73E-11	4.14E-11	ND	ND	ND	5.86E-11
INORGANICS							
Arsenic	3.33E-04	1.22E-07	NE	NE	5.08E-06	NE	3.38E-04
Beryllium	3.42E-04	ND	ND	NE	5.21E-06	NE	3.47E-04
TOTAL	6.75E-04	1.90E-07	2.94E-07	1.75E-07	1.03E-05	3.11E-07	6.86E-04

TABLE 6-66
RESIDENT LIFETIME CARCINOGENIC RISK DISTRIBUTION
FOR SITE 10

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS							
Benzo(a)anthracene	0.00	0.00	0.02	0.00	0.00	0.00	0.02
bis(2-Ethylhexyl)phthalate	0.06	0.00	0.00	0.03	0.00	0.05	0.13
Chrysene	0.00	0.01	0.03	0.00	0.00	0.00	0.03
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INORGANICS							
Arsenic	48.54	0.02	0.00	0.00	0.74	0.00	49.30
Beryllium	49.76	0.00	0.00	0.00	0.76	0.00	50.52
TOTAL	98.36	0.03	0.04	0.03	1.50	0.05	100.00

TABLE 6-67
Child Hazard Quoteint and Indices
For Site 11

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS (mg/l)						
bis(2-ethylhexyl)phthalate	9.59E-03	NE	3.45E-03	2.14E-04	6.15E-03	1.94E-02
Chloroform	2.32E-02	8.86E-03	9.26E-04	5.17E-04	1.65E-03	3.52E-02
INORGANICS (mg/l)						
Barium	4.87E-02	NC	NC	1.08E-03	NC	4.98E-02
Cadmium	4.87E-01	NC	NC	1.09E-02	NC	4.98E-01
Chromium VI	6.23E-01	NC	NC	1.39E-02	NC	6.37E-01
Chromium III	1.91E-02	NC	NC	4.26E-04	NC	1.95E-02
Iron	1.05E+01	NC	NC	2.35E-01	NC	1.08E+01
Lead	1.30E+01	NC	NC	2.89E-01	NC	1.33E+01
Manganese	2.99E-02	NC	NC	6.67E-04	NC	3.06E-02
Mercury	5.39E+01	NC	NC	1.20E+00	NC	5.51E+01
Vanadium	1.21E-01	NC	NC	2.71E-03	NC	1.24E-01
Zinc	2.60E-02	NC	NC	5.78E-04	NC	2.65E-02
TOTAL	7.88E+01	8.86E-03	4.38E-03	1.76E+00	7.80E-03	8.06E+01

NE= Compound not evaluated through this route.
NC= Not of concern through this exposure route.

TABLE 6-68
Adult Hazard Quoteint and Indices
For Site 11

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS (mg/l)						
bis(2-ethylhexyl)phthalate	4.11E-03	NE	1.86E-03	4.58E-05	3.32E-03	9.34E-03
Chloroform	9.95E-03	2.05E-03	5.01E-04	1.11E-04	8.93E-04	1.35E-02
INORGANICS (mg/l)						
Barium	2.09E-02	NC	NC	2.32E-04	NC	2.11E-02
Cadmium	2.09E-01	NC	NC	2.33E-03	NC	2.11E-01
Chromium VI	2.67E-01	NC	NC	2.97E-03	NC	2.70E-01
Chromium III	8.19E-03	NC	NC	9.13E-05	NC	8.28E-03
Iron	4.52E+00	NC	NC	5.04E-02	NC	4.57E+00
Lead	5.56E+00	NC	NC	6.20E-02	NC	5.62E+00
Manganese	1.28E-02	NC	NC	1.43E-04	NC	1.30E-02
Mercury	2.31E+01	NC	NC	2.57E-01	NC	2.34E+01
Vanadium	5.21E-02	NC	NC	5.80E-04	NC	5.26E-02
Zinc	1.11E-02	NC	NC	1.24E-04	NC	1.12E-02
TOTAL	3.38E+01	2.05E-03	2.37E-03	3.76E-01	4.22E-03	3.42E+01

NE= Compound not evaluated through this route.
NC= Not of concern through this exposure route.

- Iron 4.57E+00 (13%)
- Lead 5.62E+00 (16%)
- Mercury 2.34E+01 (68%)

The total lifetime carcinogenic risk for the future resident of Site 11 is 8.95E-05, with 98% of the total risk attributable to the inhalation of chloroform while showering. The risk from both carcinogens evaluated for this site exceeds 1E-06. The carcinogenic risks and the distribution of those risks for all pathways are presented in Table 6-69 and Table 6-70.

Site 19 - Future Resident

The noncarcinogenic risk to the child and adult future residents of Site 19 are presented in Table 6-71 and Table 6-72. The total hazard index for the child resident is 255 and the total for the adult is 101. Approximately 90% of the total noncarcinogenic risk for the child results from the ingestion of groundwater and approximately 98% of the adult noncarcinogenic risk results from groundwater ingestion. The chemicals that exceed a hazard index of one for the child are listed below:

- Aluminum 1.11E+02 (44%)
- Arsenic 5.36E+00 (2%)
- Cadmium 2.29E+00 (1%)
- Chromium VI 2.53E+00 (1%)
- Iron 4.25E+01 (17%)
- Lead 8.38E+01 (33%)
- Vanadium 4.73E+00 (2%)

The chemicals of concern that exceed a hazard index of one for the adult are listed below:

- Aluminum 4.71E+01 (47%)
- Arsenic 2.27E+00 (2%)
- Chromium VI 1.06E+00 (1%)
- Iron 1.80E+01 (18%)
- Lead 2.83E+01 (28%)
- Vanadium 2.01E+00 (2%)

TABLE 6-69
Resident Lifetime Carcinogenic Risk
For Site 11

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS (mg/l)						
bis(2-ethylhexyl)phthalate	6.25E-07	NE	2.62E-07	9.52E-09	4.67E-07	1.36E-06
Chloroform	3.29E-07	8.78E-05	1.53E-08	5.02E-09	2.73E-08	8.82E-05
TOTAL	9.54E-07	8.78E-05	2.77E-07	1.45E-08	4.94E-07	8.95E-05

NE= Compound not evaluated through this route.

TABLE 6–70
Resident Lifetime Carcinogenic Risk Distribution
For Site 11

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
ORGANICS (mg/l)						
bis(2–ethylhexyl)phthalate	0.70	NE	0.29	0.01	0.52	1.52
Chloroform	0.37	98.06	0.02	0.01	0.03	98.48
TOTAL	1.07	98.06	0.31	0.02	0.55	100.00

0.00= Indicates that risk is less than 1/100 percent.
NE= Compound not evaluated through this route.

TABLE 6-71
CHILD HAZARD QUOTIENTS AND INDICES
FOR SITE 19

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	DERMAL WHILE SHOWERING	HAZARD INDEX
ORGANICS											
bis(2-Ethylhexyl)phthalate	1.28E-02	ND	ND	ND	ND	ND	2.85E-04	8.20E-03	ND	4.60E-03	2.59E-02
4,4-DDE	2.81E-03	ND	ND	ND	ND	ND	6.27E-05	1.80E-03	ND	1.01E-03	5.69E-03
4,4-DDT	1.43E-02	ND	ND	ND	ND	ND	3.19E-04	9.16E-03	ND	5.14E-03	2.89E-02
Naphthalene	1.60E-02	ND	ND	ND	ND	ND	3.56E-04	7.28E-03	ND	4.08E-03	2.77E-02
INORGANICS											
Aluminum	1.09E+02	7.11E-02	NE	ND	ND	ND	2.42E+00	NE	ND	NE	1.11E+02
Antimony	ND	ND	ND	1.15E-01	1.11E-04	NE	ND	ND	1.88E-01	ND	3.03E-01
Arsenic	5.24E+00	3.20E-03	NE	ND	ND	ND	1.17E-01	NE	ND	NE	5.36E+00
Barium	1.21E-01	5.06E-04	NE	ND	ND	ND	2.69E-03	NE	ND	NE	1.24E-01
Beryllium	8.09E-02	1.92E-05	NE	ND	ND	ND	1.80E-03	NE	ND	NE	8.28E-02
Cadmium	2.19E+00	5.03E-03	7.24E-03	6.14E-03	1.48E-04	1.35E-03	4.87E-02	NE	3.84E-02	NE	2.29E+00
Chromium III	7.53E-02	6.21E-04	NE	ND	ND	ND	1.68E-03	NE	ND	NE	7.76E-02
Chromium VI	2.45E+00	2.02E-02	NE	ND	ND	ND	5.46E-02	NE	ND	NE	2.53E+00
Cobalt	6.45E-01	5.63E-04	NE	ND	ND	ND	1.44E-02	NE	ND	NE	6.60E-01
Copper	8.29E-02	2.89E-04	NE	ND	ND	ND	1.85E-03	NE	ND	NE	8.51E-02
Iron	4.16E+01	8.78E-03	NE	ND	ND	ND	9.26E-01	NE	ND	NE	4.25E+01
Lead	6.39E+01	1.53E+01	NE	2.07E+00	5.96E-03	NE	1.42E+00	NE	1.11E+00	NE	8.38E+01
Manganese	2.92E-01	1.91E-04	NE	ND	ND	ND	6.50E-03	NE	ND	NE	2.98E-01
Mercury	7.46E-02	1.92E-04	NE	ND	ND	ND	1.66E-03	NE	ND	NE	7.64E-02
Nickel	2.14E-01	ND	ND	ND	ND	ND	4.77E-03	NE	ND	NE	2.19E-01
Silver	ND	ND	ND	1.66E-03	1.00E-05	NE	ND	ND	7.16E-03	ND	8.84E-03
Vanadium	4.63E+00	8.97E-04	NE	ND	ND	ND	1.03E-01	NE	ND	NE	4.73E+00
Zinc	1.37E-01	2.21E-03	NE	ND	ND	ND	3.05E-03	NE	ND	NE	1.42E-01
TOTAL	2.30E+02	1.54E+01	7.24E-03	2.19E+00	6.22E-03	1.35E-03	5.13E+00	2.64E-02	1.35E+00	1.48E-02	2.55E+02

ND - NOT DETECTED IN THE MEDIUM.
NE - NOT EVALUATED.

TABLE 6-72
ADULT HAZARD QUOTIENTS AND INDICES
FOR SITE 19

	GROUNDWATER INGESTION	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	DERMAL WHILE SHOWERING	HAZARD INDEX
ORGANICS									
bis(2-Ethylhexyl)phthalate	5.48E-03	ND	ND	ND	6.11E-05	2.44E-05	ND	2.49E-03	8.05E-03
4,4-DDE	1.21E-03	ND	ND	ND	1.34E-05	4.95E-03	ND	5.47E-04	6.72E-03
4,4-DDT	6.14E-03	ND	ND	ND	6.84E-05	3.15E-02	ND	2.78E-03	4.04E-02
Naphthalene	6.85E-03	ND	ND	ND	7.63E-05	0.00E+00	ND	2.21E-03	9.13E-03
INORGANICS									
Aluminum	4.66E+01	ND	ND	ND	5.19E-01	NE	ND	NE	4.71E+01
Antimony	ND	1.23E-02	2.98E-05	NE	ND	ND	7.32E-02	ND	8.56E-02
Arsenic	2.25E+00	ND	ND	ND	2.50E-02	NE	ND	NE	2.27E+00
Barium	5.17E-02	ND	ND	ND	5.76E-04	NE	ND	NE	5.22E-02
Beryllium	3.47E-02	ND	ND	ND	3.86E-04	NE	ND	NE	3.51E-02
Cadmium	9.37E-01	6.58E-04	3.97E-05	8.35E-04	1.04E-02	NE	1.42E-02	NE	9.63E-01
Chromium III	3.23E-02	ND	ND	ND	3.60E-04	NE	ND	NE	3.26E-02
Chromium VI	1.05E+00	ND	ND	ND	1.17E-02	NE	ND	NE	1.06E+00
Cobalt	2.76E-01	ND	ND	ND	3.08E-03	NE	ND	NE	2.79E-01
Copper	3.55E-02	ND	ND	ND	3.96E-04	NE	ND	NE	3.59E-02
Iron	1.78E+01	ND	ND	ND	1.98E-01	NE	ND	NE	1.80E+01
Lead	2.74E+01	2.22E-01	1.60E-03	NE	3.05E-01	NE	4.06E-01	NE	2.83E+01
Manganese	1.25E-01	ND	ND	ND	1.39E-03	NE	ND	NE	1.26E-01
Mercury	3.20E-02	ND	ND	ND	3.56E-04	NE	ND	NE	3.23E-02
Nickel	9.18E-02	ND	ND	ND	1.02E-03	NE	ND	NE	9.28E-02
Silver	ND	1.78E-04	2.69E-06	NE	ND	ND	2.67E-03	ND	2.85E-03
Vanadium	1.98E+00	ND	ND	ND	2.21E-02	NE	ND	NE	2.01E+00
Zinc	5.86E-02	ND	ND	ND	6.53E-04	NE	ND	NE	5.93E-02
TOTAL	9.87E+01	2.35E-01	1.67E-03	8.35E-04	1.10E+00	3.64E-02	4.96E-01	8.02E-03	1.01E+02

ND - NOT DETECTED IN THE MEDIUM.
NE - NOT EVALUATED.

The total lifetime carcinogenic risk to the future resident of Site 19 is 1.06E-03 (one-in-one-thousand), with the greatest percentage (98%) resulting from the ingestion of groundwater. Approximately 60% of the total risk results from the ingestion of arsenic in groundwater. All of the carcinogens evaluated for Site 19 pose a risk greater than 1E-06. The risk from all compounds and pathways is presented in Table 6-73 and the distribution of the carcinogenic risk is presented in Table 6-74.

Site 20 - Future Resident

The pathways evaluated for the future resident of Site 20 are shown in Figure 6-11 and the hazard quotients for all pathways and chemicals are listed in Table 6-75. The total hazard index for the child, which is the only receptor evaluated at this site, is 3.96. Ingestion of lead in sediment accounts for the majority of the total noncarcinogenic risk (3.46 or 87%) and is the only chemical that exceeds a hazard index of one.

The lifetime carcinogenic risk and the carcinogenic risk distribution are presented in Table 6-76 and Table 6-77. The total carcinogenic risk for this site is 4.8E-04 with approximately 77% of the total risk attributable to dermal absorption from sediments. The following compounds exceed the regulatory benchmark of 1E-06 for exposure to carcinogens:

- Benzo(a)anthracene 5.7E-05 (11.99%)
- Benzo(a)pyrene 8.0E-05 (16.65%)
- Benzo(b)fluoranthene 8.3E-05 (17.32%)
- Benzo(k)fluoranthene 7.3E-05 (15.32%)
- Chrysene 7.6E-05 (15.99%)
- Dibenzo(a,h)anthracene 2.5E-05 (5.13%)
- Indeno(1,2,3-cd)pyrene 6.2E-05 (12.99%)
- Arsenic 3.6E-06 (0.76%)
- Beryllium 1.8E-05 (3.84%)

Site 26 - Future Resident

Risk to the future residents of Site 26 was evaluated for the pathways illustrated in Figure 6-11. The total hazard index for the child and adult future 2residents are 56 and 24, with

TABLE 6-73
RESIDENT LIFETIME CARCINOGENIC RISK
FOR SITE 19

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SOIL INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	DERMAL WHILE SHOWERING	TOTAL RISK
ORGANICS							
bis(2-Ethylhexyl)phthalate	8.33E-07	ND	ND	1.27E-08	6.22E-07	3.49E-07	1.82E-06
4,4-DDE	1.11E-07	ND	ND	1.70E-09	8.31E-08	4.66E-08	2.43E-07
4,4-DDT	5.66E-07	ND	ND	8.64E-09	4.22E-07	2.37E-07	1.23E-06
INORGANICS							
Arsenic	6.40E-04	1.44E-07	NE	9.76E-06	NE	ND	6.50E-04
Beryllium	4.05E-04	3.53E-08	NE	6.17E-06	NE	ND	4.11E-04
Cadmium	NE	NE	1.69E-08	NE	NE	NE	1.69E-08
TOTAL	1.05E-03	1.79E-07	1.69E-08	1.60E-05	1.13E-06	6.32E-07	1.06E-03

ND - NOT DETECTED IN THE MEDIUM.
NE - NOT EVALUATED.

TABLE 6-74
RESIDENT LIFETIME CARCINOGENIC RISK
FOR SITE 19

	GROUNDWAT. INGESTION	SEDIMENT INGESTION	SOIL INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	DERMAL WHILE SHOWERING	TOTAL
ORGANICS							
bis(2-Ethylhexyl)phthalate	0.08	0.00	0.00	0.00	0.06	0.03	0.17
4,4-DDE	0.01	0.00	0.00	0.00	0.01	0.00	0.02
4,4-DDT	0.05	0.00	0.00	0.00	0.04	0.02	0.12
INORGANICS							
Arsenic	60.15	0.01	0.00	0.92	0.00	0.00	61.08
Beryllium	38.03	0.00	0.00	0.58	0.00	0.00	38.61
Cadmium	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	98.32	0.02	0.00	1.50	0.11	0.06	100.00

ND – NOT DETECTED IN THE MEDIUM.
NE – NOT EVALUATED.
0.00 – REPRESENTS RISK LESS THAN 1/100 PERCENT.

TABLE 6-75
CHILD HAZARD QUOTIENTS AND INDICES
FOR SITE 20

	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	HAZARD INDEX
ORGANICS			
Antracene	4.47E-07	1.93E-06	2.38E-06
Benzo(a)anthracene	2.88E-05	1.24E-04	1.53E-04
Benzo(a)pyrene	4.00E-05	1.72E-04	2.12E-04
Benzo(b)fluoranthene	4.16E-05	1.79E-04	2.21E-04
Benzo(g,h,i)perylene	3.68E-05	1.59E-04	1.95E-04
Benzo(k)fluoranthene	3.68E-05	1.59E-04	1.95E-04
bis(2-Ethylhexyl)phthalate	3.72E-05	1.60E-04	1.97E-04
Butyl benzyl phthalate	1.13E-06	4.86E-06	5.99E-06
Chrysene	3.84E-05	1.66E-04	2.04E-04
Dibenzo(a,h)anthracene	1.23E-05	5.31E-05	6.54E-05
Di-n-Butylphthalate	9.35E-07	4.03E-06	4.97E-06
Fluoranthene	4.05E-05	1.75E-04	2.15E-04
Ideno(1,2,3-cd)pyrene	3.12E-05	1.34E-04	1.66E-04
Phenanthrene	1.17E-05	5.03E-05	6.20E-05
Pyrene	5.71E-05	2.47E-04	3.04E-04
INORGANICS			
Aluminum	3.52E-01	NA	3.52E-01
Antimony	5.39E-03	NA	5.39E-03
Arsenic	6.39E-03	NA	6.39E-03
Barium	1.73E-03	NA	1.73E-03
Beryllium	7.86E-04	NA	7.86E-04
Cadmium	7.19E-04	1.03E-03	1.75E-03
Chromium III	7.63E-05	NA	7.63E-05
Chromium VI	2.48E-03	NA	2.48E-03
Cobalt	1.28E-02	NA	1.28E-02
Copper	1.38E-02	NA	1.38E-02
Iron	8.31E-02	NA	8.31E-02
Lead	3.46E+00	NA	3.46E+00
Manganese	1.49E-03	NA	1.49E-03
Nickel	1.34E-02	NA	1.34E-02
Selenium	2.59E-04	NA	2.59E-04
Vanadium	3.10E-03	NA	3.10E-03
Zinc	6.59E-03	NA	6.59E-03
TOTAL	3.96E+00	2.82E-03	3.96E+00

NA - COMPOUND NOT DETECTED.

TABLE 6-76
RESIDENT LIFETIME CARCINOGENIC RISK
FOR SITE 20

	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	TOTAL RISK
ORGANICS			
Benzo(a)anthracene	1.08E-05	4.65E-05	5.73E-05
Benzo(a)pyrene	1.50E-05	6.46E-05	7.95E-05
Benzo(b)fluoranthene	1.56E-05	6.72E-05	8.27E-05
Benzo(k)fluoranthene	1.38E-05	5.94E-05	7.32E-05
bis(2-Ethylhexyl)phthalate	1.13E-08	4.87E-08	6.00E-08
Chrysene	1.44E-05	6.20E-05	7.64E-05
Dibenzo(a,h)anthracene	4.61E-06	1.99E-05	2.45E-05
Ideno(1,2,3-cd)pyrene	1.17E-05	5.04E-05	6.20E-05
INORGANICS			
Arsenic	3.64E-06	NE	3.64E-06
Beryllium	1.84E-05	NE	1.84E-05
	1.08E-04	3.70E-04	4.78E-04

NE - NOT EVALUATED.

TABLE 6–77
RESIDENT LIFETIME CARCINOGENIC RISK DISTRIBUTION
FOR SITE 20

	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	TOTAL
ORGANICS			
Benzo(a)anthracene	2.26	9.73	11.99
Benzo(a)pyrene	3.13	13.52	16.65
Benzo(b)fluoranthene	3.26	14.06	17.32
Benzo(k)fluoranthene	2.88	12.44	15.32
bis(2–Ethylhexyl)phthalate	0.00	0.01	0.01
Chrysene	3.01	12.98	15.99
Dibenzo(a,h)anthracene	0.96	4.16	5.13
Ideno(1,2,3–cd)pyrene	2.44	10.54	12.99
INORGANICS			
Arsenic	0.76	NE	0.76
Beryllium	3.84	NE	3.84
	22.55	77.45	100.00

0.00 REPRESENTS A RISK LESS THAN 1/100.

approximately 97% resulting from the ingestion of groundwater for both receptors. The hazard quotients and indices for the child and adult are presented in Table 6-78 and 6-79. Those chemicals with a hazard index that exceeds one for the child receptor are listed below:

- 1,2-Dichloroethene 2.75E+00 (5%)
- Trichloroethene 2.76E+00 (5%)
- Antimony 7.89E+00 (14%)
- Iron 2.01E+01 (36%)
- Lead 1.66E+01 (30%)
- Silver 2.91E+00 (5%)

Those chemicals with a hazard index that exceeds one for the adult receptor are listed below:

- 1,2-Dichloroethene 1.16E+00 (5%)
- Trichloroethene 1.20E+00 (5%)
- Antimony 3.35E+00 (14%)
- Iron 8.52E+00 (36%)
- Lead 7.04E+00 (30%)
- Silver 1.24E+00 (5%)

The total lifetime carcinogenic risk to the future resident of Site 26 is 1.75E-03, with approximately 74% of the total risk resulting from the inhalation of trichloroethene while showering. The shower inhalation pathway represents the highest risk pathway, accounting for 88% of the total risk. The carcinogenic risk from each compound evaluated exceeds 1E-06. The carcinogenic risk and the distribution of the carcinogenic risk are presented in Table 6-80 and 6-81.

6.3.5 Uncertainty Analysis

The principal goal of the uncertainty analysis is to provide the appropriate decisionmakers (i.e., the risk managers) and the public with a discussion of the key assumptions made in the risk assessment that may have significantly influenced the estimate of risk. Uncertainty plays a part in all of the principal components of the risk assessment, including the contamination

characterization, exposure assessment, toxicity assessment, and risk characterization. This discussion investigates the sources of uncertainty and the associated overestimation or underestimation these factors may have had on the risk results.

The carcinogenic and noncarcinogenic risk estimates for the NWS Earle site are based on a number of assumptions that incorporate varying degrees of uncertainty resulting from many sources (EPA, 1986b), including :

- Environmental monitoring and data evaluation.
- Selection of and assumptions about scenarios of exposure.
- Choice of models for exposure and input parameters to these models.
- Choice of models for evaluation of toxicological data in dose-response assessment.

The following subsections discuss the uncertainties in each phase of the risk assessment and their effect on the estimated risks.

6.3.5.1 Contamination Characterization

There are many general sources of uncertainty that potentially exist in the contamination characterization that may significantly affect the estimate of risk, including the validity of sampling data; the comparison of site data to background; the use of unfiltered groundwater data for a residential exposure scenario; and the representation of the available data compared to the overall conditions at the site.

Data Validation

Three sampling rounds were conducted for the current phase of the remedial investigation for the sites evaluated in the risk assessment. The first phase of sampling, which involved groundwater, soil, and sediment, was the most complete. The second and third rounds of sampling were more selective and primarily served to confirm prior groundwater sampling

analytical results. Of the three rounds of data available for use in the risk assessment, only the first round was validated by an outside data validation contractor to ensure the accuracy and quality of the data. The second and third sampling rounds for the groundwater data were not validated. Although there is no reason to question the quality and accuracy of the results for the second and third sampling rounds, there is some uncertainty associated with the use of unvalidated data. The potential effects of using unvalidated data are difficult to predict in terms of the magnitude of the risk numbers; however, some data points may have been included that would result in inaccuracies.

Background Concentrations

In the absence of guidance from EPA Region II, the EPA Region IV criterion for background evaluation was used in this risk assessment. The criterion states that the average concentration of a downgradient sample must be at least two times higher than the average background for a given chemical in a specific medium to be considered as a site-related contaminant of concern. A conservative modification to this criterion was made in that if more than one analytical result for a downgradient sample exceeded the upgradient average, the compound was included as a site-related contaminant of concern regardless of the average concentration.

This criterion could be subject to criticism in certain cases. In particular, high sample concentrations of aluminum, iron, lead, and other metals were detected in groundwater that resulted in exceedingly high hazard indices for many sites. As metals are natural constituents of soils, and therefore, groundwater, it is questionable whether such "contamination" is site-specific and/or anthropogenic. There were insufficient data for statistical analysis to determine if the samples were truly greater than background; nevertheless, these "contaminants" were included as contaminants of concern on the basis of the above criterion. As a result, total noncarcinogenic risks to the worker and future resident are likely overestimated.

Using Site 3 as an example (the site with the highest noncarcinogenic and carcinogenic risk), it can be shown that exposure to metals in groundwater accounts the majority of the risk. For the child receptor, approximately 99% (396 of 399) of the total hazard index can be attributed to exposure to metals. With regard to the lifetime carcinogenic risk, exposure to arsenic, a metal, accounts for 99% of the total risk (2.20E-02 of 2.22E-02). Site 3 is typical of many other sites in that exposure to metals accounts for the majority of the risk. Until the question of what constitutes a background concentration for the metals is resolved, the risks associated with exposure to metals at the Station is a major source of uncertainty.

Unfiltered Groundwater

Current EPA guidance recommends the use of unfiltered groundwater samples to estimate exposure concentrations (EPA, 1989b). Although the use of unfiltered groundwater samples may be appropriate if unfiltered groundwater is potable, use of these samples to estimate exposure doses may result in an overestimate of the risk. Data from unfiltered groundwater samples is best used in conjunction with filtered data to discern whether contaminants are adsorbed to particulate matter or exist in the dissolved state. Unless it can be determined that unfiltered groundwater can be used by a resident, the use of these data to estimate exposure doses results in an unrealistic, inaccurate overestimation of the risk.

The turbidity (a measure of the particulate matter in water) of the samples taken from the monitoring wells at the Station was typical of shallow wells for that region because of the particulate matter in the groundwater. Water from a domestic well would be far less turbid because a domestic well would be placed in a deeper, cleaner saturated zone that had a much lower sediment concentration. The concentrations of metals from a domestic production well screened at an appropriate depth would also be far lower than those detected in the Station monitoring wells because of the lower concentration of particulate matter. The use of data from deeper wells would have resulted in a far lower and more realistic level of risk associated with ingestion of water from the RI sites.

Representativeness of Data

The intent of the remedial investigation was to characterize the nature and extent of contamination of various media that resulted from the disposal practices and work activities at the RI sites. To achieve this goal in a timely and cost-effective manner, the investigation focused on those areas of the sites that were known or suspected to be affected by chemical releases. In the absence of a representative sample population (i.e., an equally distributed number of data points from all portions of a particular site), the available data were assumed in the baseline risk assessment to be representative of the entire site. This assumption probably results in an overestimate of risk because it is assumed that the contaminated areas are representative of the entire site. Although it would be difficult to identify how greatly the use of biased sampling overestimates the risk at the RI sites, nonrepresentative data clearly skew the risk results toward higher values.

6.3.5.2 Exposure Assessment

In the assessment of risk, assumptions are made about rates of contact with contaminants, exposure frequencies, and body weights when empirical or site-specific data are lacking. EPA recommends the use of standard factors in risk assessments conducted under Superfund to promote consistency among risk assessments where assumptions must be made. Although the use of standard factors promotes comparability, their usefulness in accurately predicting risk is directly proportional to their applicability to the actual site-specific conditions. This subsection discusses, by exposure route, the uncertainties associated with assumptions used in the risk assessment. The future resident scenario (child and adult) is used as an example because the highest carcinogenic and noncarcinogenic risks were calculated for this scenario. However, much of the discussion on uncertainty for the future resident also applies to the other scenario (i.e., the current worker).

Groundwater Ingestion

Either the groundwater ingestion pathway or the inhalation of volatile compounds while showering pathway for the future resident (child and adult) accounted for a significant percentage of the noncarcinogenic and carcinogenic risk based on upper 95% exposure concentrations. It is important to note that the groundwater samples were obtained from the surficial-most aquifer. This aquifer is not currently used, or in the future likely to be used, as a source of drinking water. Drinking water to the Station is currently supplied by off-site wells associated with deeper aquifers, and it is likely that future residential development at the Station will utilize off-site sources or the deeper aquifer.

Site 19, which evaluated exposure to groundwater, soil, and sediment, demonstrates that the majority of noncarcinogenic and carcinogenic risk can be attributed to exposure to groundwater. Using the child hazard index as an example, it can be shown that the ingestion of groundwater accounts for 90% (230 of 255) of the total hazard index. With regard to lifetime carcinogenic risk, the ingestion of groundwater accounts for 98% (1.05E-03 of 1.06E-03) of the total risk. Exposure to groundwater accounts for the majority of risk in most scenarios. To obtain a more realistic estimate of risk at the RI sites, the risk from exposure to groundwater should be disregarded.

Dermal Absorption

The question of the likelihood and extent of dermal absorption of specific classes of chemicals is a significant source of uncertainty. Contaminants adsorbed onto soils and sediments are presumed to be less available for dermal absorption than pure compounds or solutions. To account for these differences, absorption factors for assessing dermal exposure to contaminants from soil and sediment were used when compound-specific data were not available. Compound-specific data were available from EPA Region II for PCBs (1-5%) and cadmium (0.1%). Additional information was obtained from Yang et al. (1989) on the dermal absorption of PAHs. The dermal absorption data from Yang et al. were used

to assess exposure to volatile and semivolatile compounds in the absence of compound-specific data. The extrapolation of these data to other compounds results in uncertainty because the behavior of these compounds is not known.

Chemical concentrations used in assessing risk through the dermal pathway were derived from soil and sediment samples collected in areas specifically thought to be contaminated. Consequently, the derived upper 95% confidence limit concentrations used to determine the exposure doses reflect this bias. Thus, it is likely that the carcinogenic and noncarcinogenic risks associated with the dermal absorption pathway are overestimated, although it is difficult to say by how much.

6.3.5.3 Toxicity Assessment

For a risk to exist, both exposure to the pollutants of concern and toxicity at the predicted exposure levels must exist. The toxicological uncertainties relate primarily to the methodology by which carcinogenic and noncarcinogenic criteria (i.e., reference doses and cancer slope factors) are developed. In many cases, toxicity data are extrapolated across species, as well as from high to low doses, in order to estimate safe exposure levels for humans.

Cancer Slope Factors

Although there is evidence to suggest some carcinogens may exhibit thresholds, the no-threshold theory of chemical carcinogenesis assumes there is no "safe" level (i.e., threshold) of exposure to any pollutant shown or suspected to cause cancer (an uncertainty). This implies that exposure to even a single molecule of a chemical may be associated with a finite risk, however small. The assumption is that even if relatively large doses of a pollutant were required to cause cancer in laboratory animals (much higher than a person would ever likely be exposed to over a lifetime), these exposure doses can be linearly extrapolated downward many orders of magnitude to estimate slope factors for humans. The slope factor is used to estimate an upper bound lifetime probability of an individual

developing cancer as a result of exposure to a particular level of carcinogen. The assumptions and methodology in determining human cancer slope factors, therefore, may likely result in an overestimate of actual cancer risk.

Additionally, the assumption that all carcinogens (whether A, B1, B2, or C) can cause cancer in humans is also conservative. Only an A carcinogen is unequivocally considered a human carcinogen. The other three classes are probable (B1, B2) or possible (C). In this risk assessment, all probable and possible carcinogens are given the same weight in the toxicity assessment (and consequently in the risk characterization) as true human carcinogens. This most likely overestimates real carcinogenic risk in the various scenarios.

Specific uncertainty in the estimation of carcinogenic is as follows:

- The EPA (ECAO) has withheld the oral cancer slope factor (which was last derived in 1991) for arsenic following questions as to the sufficiency of available data. The former oral cancer slope factor was used in this assessment in the calculation of carcinogenic risk in pathways involving ingestion of soil or groundwater. The use of this slope factor creates significant uncertainty in the estimation of carcinogenic risk from ingestion of arsenic. In regard to the uncertainty over the cancer slope factor for arsenic, EPA has stated that "...the uncertainties associated with ingested inorganic arsenic are such that estimates could be modified downwards as much as an order of magnitude, relative to risk estimates associate with most other carcinogens." (EPA, 1988b). Therefore, risk estimates for arsenic are likely to be overestimated by a factor of ten.

Reference Doses

In the development of RfDs for each chemical by exposure route, it is assumed that a threshold dose exists below which there is no potential for adverse health effects to the most sensitive individuals in the population. The RfD is typically derived from dose-response studies in animals in which a NOAEL (no-observed-adverse-effect level) or a LOAEL (lowest-observed-adverse-effect level) by the application of uncertainty factors of 10 each, and a modifying factor of up to 10 which accounts for a qualitative professional assessment of additional uncertainties in the available data (EPA, 1989b). The final degree of

extrapolation can range anywhere 10 to 10,000 and can result in a human threshold dose of one tenth to one ten-thousandth of the study dose. Therefore, the calculated RfD is likely overly protective, and its use probably results in an overestimation of noncarcinogenic risk.

TABLE 6-78
Child Hazard Quotient and Indices
For Site 26

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS						
1,1- Dichloroethene	1.92E-03	7.34E-03	6.38E-05	4.27E-05	1.14E-04	9.48E-03
1,2- Dichloroethene	2.59E+00	6.12E-02	1.40E-02	5.77E-02	2.50E-02	2.75E+00
Toluene	3.20E-04	4.29E-04	3.08E-05	7.12E-06	5.49E-05	8.41E-04
Trichlorethene	2.19E+00	1.12E-01	1.47E-01	4.88E-02	2.63E-01	2.76E+00
Vinyl Chloride	4.92E-02	1.84E-02	8.14E-05	1.10E-03	1.45E-04	6.89E-02
Xylene	9.27E-05	8.28E-03	1.29E-05	2.07E-06	2.31E-05	8.41E-03
INORGANICS						
Antimony	7.72E+00	NC	NC	1.72E-01	NC	7.89E+00
Barium	1.36E-01	NC	NC	3.03E-03	NC	1.39E-01
Beryllium	1.74E-02	NC	NC	3.88E-04	NC	1.78E-02
Cadmium	7.56E-01	NC	NC	1.68E-02	NC	7.72E-01
Chromium VI	1.28E-01	NC	NC	2.84E-03	NC	1.30E-01
Chromium III	3.92E-03	NC	NC	8.73E-05	NC	4.01E-03
Cobalt	1.49E-01	NC	NC	3.32E-03	NC	1.52E-01
Copper	6.79E-02	NC	NC	1.51E-03	NC	6.94E-02
Iron	1.97E+01	NC	NC	4.38E-01	NC	2.01E+01
Lead	1.62E+01	NC	NC	3.62E-01	NC	1.66E+01
Manganese	1.04E-01	NC	NC	2.31E-03	NC	1.06E-01
Mercury	2.28E-01	NC	NC	5.08E-03	NC	2.33E-01
Nitrate	1.05E-01	NC	NC	2.34E-03	NC	1.07E-01
Silver	2.85E+00	NC	NC	6.35E-02	NC	2.91E+00
Vanadium	6.93E-01	NC	NC	1.54E-02	NC	7.09E-01
Zinc	3.06E-02	NC	NC	6.82E-04	NC	3.13E-02
EXPLOSIVES						
RDX	2.00E-02	NC	2.77E-04	4.46E-04	1.48E-03	2.22E-02
TOTAL	5.37E+01	2.08E-01	1.62E-01	1.20E+00	2.90E-01	5.56E+01

NC= Not of Concern through this exposure route.

TABLE 6–79
Adult Hazard Quotients and Indices
For site 26

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
ORGANICS						
1,1– Dichloroethene	8.22E–04	1.70E–03	3.45E–05	9.16E–06	6.14E–05	2.62E–03
1,2– Dichloroethene	1.11E+00	1.41E–02	7.58E–03	1.24E–02	1.35E–02	1.16E+00
Toluene	1.37E–04	9.91E–05	1.66E–05	1.53E–06	2.97E–05	2.84E–04
Trichlorethene	9.39E–01	2.60E–02	7.97E–02	1.05E–02	1.42E–01	1.20E+00
Vinyl Chloride	2.11E–02	4.25E–03	4.40E–05	2.35E–04	7.85E–05	2.57E–02
Xylene	3.97E–05	1.91E–03	7.00E–06	4.43E–07	1.25E–05	1.97E–03
INORGANICS						
Antimony	3.31E+00	NC	NC	3.69E–02	NC	3.35E+00
Barium	5.83E–02	NC	NC	6.50E–04	NC	5.90E–02
Beryllium	7.45E–03	NC	NC	8.30E–05	NC	7.54E–03
Cadmium	3.24E–01	NC	NC	3.61E–03	NC	3.27E–01
Chromium VI	5.47E–02	NC	NC	6.09E–04	NC	5.53E–02
Chromium III	1.68E–03	NC	NC	1.87E–05	NC	1.70E–03
Cobalt	6.38E–02	NC	NC	7.11E–04	NC	6.46E–02
Copper	2.91E–02	NC	NC	3.24E–04	NC	2.94E–02
Iron	8.43E+00	NC	NC	9.39E–02	NC	8.52E+00
Lead	6.96E+00	NC	NC	7.75E–02	NC	7.04E+00
Manganese	4.44E–02	NC	NC	4.95E–04	NC	4.49E–02
Mercury	9.77E–02	NC	NC	1.09E–03	NC	9.88E–02
Nitrate	4.49E–02	NC	NC	5.01E–04	NC	4.54E–02
Silver	1.22E+00	NC	NC	1.36E–02	NC	1.24E+00
Vanadium	2.97E–01	NC	NC	3.31E–03	NC	3.00E–01
Zinc	1.31E–02	NC	NC	1.46E–04	NC	1.33E–02
EXPLOSIVES						
RDX	8.58E–03	NC	1.49E–04	9.57E–05	8.00E–04	9.63E–03
TOTAL	2.30E+01	4.81E–02	8.76E–02	2.57E–01	1.57E–01	2.36E+01

NC= Not of Concern through this exposure route.

TABLE 6–80
Resident Lifetime Carcinogenic Risk
For Site 26

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
ORGANICS						
1,1– Dichloroethene	2.68E–05	1.58E–04	1.04E–06	4.08E–07	1.85E–06	1.88E–04
Trichlorethene	4.12E–05	1.29E–03	3.23E–06	6.29E–07	5.76E–06	1.34E–03
Vinyl Chloride	2.83E–05	8.86E–05	5.45E–06	4.31E–07	9.72E–06	1.32E–04
INORGANICS						
Beryllium	8.70E–05	NC	NC	1.33E–06	NC	8.83E–05
EXPLOSIVES						
RDX	1.64E–06	NC	0.00E+00	2.34E–08	1.32E–07	1.79E–06
TOTAL	1.85E–04	1.54E–03	9.71E–06	2.82E–06	1.75E–05	1.75E–03

NC= Not of concern through this exposure route.

TABLE 6–81
Resident Lifetime Carcinogenic Risk Distribution.
For Site 26

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
ORGANICS						
1,1– Dichloroethene	1.53	9.03	0.06	0.02	0.11	10.74
Trichlorethene	2.35	73.66	0.18	0.04	0.33	76.56
Vinyl Chloride	1.61	5.05	0.31	0.02	0.55	7.56
INORGANICS						
Beryllium	4.96	0.00	0.00	0.08	0.00	5.04
EXPLOSIVES						
RDX	0.09	0.00	0.00	0.00	0.01	0.10
TOTAL	10.55	87.74	0.55	0.16	1.00	100.00

0.00– Indicates that risk is less than 1/100 percent.

6.4 ECOLOGICAL RISK ASSESSMENT

6.4.1 Introduction

The objectives of this ecological risk assessment are to identify and estimate the potential ecological impact associated with the potential exposure of fish and wildlife to chemicals of concern at NWS Earle. This assessment focuses on the potential impacts of chemicals of concern found in the soil and sediments to terrestrial and aquatic flora and fauna that inhabit or are potential inhabitants of the site. Eleven areas within the NWS Earle site have been identified as areas of potential ecological concern. These areas are evaluated in this assessment.

The process used to evaluate ecological risk approximately parallels that for evaluating human health risk. In both cases, the integration of information on chemical exposures with toxicity data for the chemicals of concern is used to estimate the potential risk from that exposure. Consequently, the principal tasks for this ecological assessment include the following:

- Selecting the chemicals of concern.
- Analyzing environmental receptors/pathways.
- Estimating exposure point concentrations and doses.
- Identifying environmental toxicity.
- Characterizing environmental risk.

The technical guidance for performance of the ecological risk assessment comes primarily from the following sources:

- Ecological Risk Assessment (EPA, 1986).
- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratories Reference (EPA, 1989a).
- Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (EPA, 1989b).
- Supplemental Risk Assessment Guidance for the Superfund Program, Part 2, Guidance for Ecological Risk Assessment (EPA, 1989).

- Summary Report on Issues in Ecological Risk Assessment (EPA, 1991).

In addition to the published guidance, this ecological risk assessment is also being conducted in accordance with a previously submitted and reviewed work plan for the performance of this assessment. This work plan was reviewed by the EPA Region II and NJDEPE. Agency comments were reviewed and incorporated in this assessment. The subsections that follow describe the approach used to evaluate potential environmental impacts associated with chemicals at the NWS Earle site. This assessment focuses on environmental receptors that may be affected directly or indirectly by chemicals associated with the site and the likelihood and extent of those effects.

6.4.2 Chemicals of Potential Concern

The selection of potential chemicals of concern employs a screening process that is used to reduce the number of chemicals requiring detailed evaluation in the ecological risk assessment. The chemicals of concern selected for the ecological evaluation may differ from the chemicals of concern for the human health evaluation because of differences in potential exposure pathways for the target receptors. Subsection 6.3 describes in detail the procedures used to select the potential chemicals of concern for both the human health and ecological risk evaluations. Selection of chemicals of concern was specific to each site and each medium evaluated (e.g., sediment and soil).

In general, inorganic chemicals of potential concern for the ecological assessment were selected based on a comparison of site-related chemical concentrations with published soil background concentrations. Although certain organic chemicals are ubiquitous in the environment (e.g. PAHs) or may be present due to nonsite related activities (e.g. DDT and its metabolites), it is nevertheless difficult to identify an adequate screening mechanism by which to conclusively exclude organics from most risk assessments. Consequently, all organic chemicals observed above detection limits were conservatively evaluated in this assessment. As a result, this assumption may result in an overestimation of the potential risk to flora and fauna from these chemicals.

In addition to the screening criteria discussed above and in Subsection 6.3, data used were limited to those areas which either currently serve as or could potentially serve as suitable habitat and therefore as pathways of exposure. For example, at Site 19 samples taken from graveled or paved areas were considered nonrepresentative of suitable ecological habitat and therefore were not included in the estimate of potential exposure to wildlife. As a result, the list of chemicals of potential concern for Site 19 in the ecological assessment differs from the chemicals evaluated for the human health assessment.

Tables 6-82 through 6-89 present the complete list of the chemicals of concern for the ecological evaluation by site and media. Chemical concentrations were neither detected nor analyzed for in the surface waters of these sites and therefore surface water was not included as an exposure pathway in the ecological risk assessment.

6.4.3 Exposure Assessment

An ecological exposure assessment evaluates the potential magnitude and frequency by which target species are exposed to site-related chemicals that have migrated through various pathways to terrestrial, aquatic, and wetland habitats. In addition, the assessment evaluates all routes of exposure (e.g. water, soil, sediment, plant and invertebrate ingestion) by which species inhabiting those areas may be exposed. The specific objectives of the exposure assessment are to:

- Identify habitats that have received or may receive chemicals from the site.
- Identify the plants, aquatic biota, and/or wildlife that utilize those habitats and that may be potentially exposed to the chemicals of concern.
- Select indicator or target species that best represent a reasonable maximum risk to aquatic and terrestrial biota at the site.
- Identify significant pathways/routes by which target species are potentially exposed.
- Identify exposure concentrations and predict exposure doses to selected target species.

Table 6-82

Chemicals of Concern for Site 2

Inorganics
Arsenic
Chromium
Iron
Selenium
Vanadium

Table 6-83

Chemicals of Concern for Site 4

Organics	Inorganics
Aroclor-1260	Aluminum
bis(2-Ethylhexyl)phthalate	Antimony
Carbon Disulfide	Arsenic
Methylene Chloride	Barium
Phenanthrene	Beryllium
Pyrene	Cadmium
	Chromium
	Cobalt
	Copper
	Iron
	Lead
	Manganese
	Mercury
	Nickel
	Silver
	Sodium
	Vanadium
	Zinc

Table 6-84

Chemicals of Concern for Site 10

Organics	Inorganics
Benzo(a)anthracene	Aluminum
bis(2-Ethylhexyl)phthalate	Antimony
Chrysene	Arsenic
Fluoranthene	Barium
Methylene Chloride	Chromium
Phenanthrene	Cobalt
Pyrene	Iron
	Lead
	Manganese
	Mercury
	Sodium
	Vanadium
	Zinc

Table 6-85

Chemicals of Concern for Site 11

Inorganics
Nitrate
Nitrite

Table 6-86

Chemicals of Concern for Site 19

Sediment	Soil
Inorganics	**Organics**
Aluminum	Methylene Chloride
Arsenic	
Barium	**Inorganics**
Beryllium	
Chromium	Antimony
Cobalt	Lead
Copper	Silver
Iron	
Lead	
Manganese	
Mercury	
Vanadium	
Zinc	

Table 6-87

Chemicals of Concern for Site 20

Organics	Inorganics
Anthracene	Antimony
Benzo(a)anthracene	Beryllium
Benzo(a)pyrene	Cadmium
Benzo(b)fluoranthene	Chromium
Benzo(g,h,i)perylene	Cobalt
Benzo(k)fluoranthene	Copper
bis(2-ethylhexyl)phthalate	Iron
Chrysene	Lead
Dibenzo(a,h)anthracene	Nickel
Di-n-Butylphthalate	Selenium
Fluoranthene	Zinc
Indeno(1,2,3-cd)pyrene	
Phenanthrene	
Pyrene	

Table 6-88

Chemicals of Concern for Site 22

Organics
Acenaphthene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzoic Acid
Benzo(k)fluoranthene
bis(2-ethylhexyl)phthalate
Chrysene
4,4-DDT
Dibenzo(a,h)anthracene
Di-n-Butylphthalate
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Phenanthrene
Pyrene
1,1,1-Trichloroethane
Inorganics
Cadmium
Chromium
Lead
Selenium

Table 6-89

Chemicals of Concern for Site 26

Inorganics
Nitrate
Nitrite

6.4.3.1 Habitat Evaluation/Potential Receptors

The initial step in the exposure assessment is to identify the on-site habitats that may be affected by chemicals of potential concern, and subsequently, to determine potential receptor organisms for those habitats.

NWS Earle is approximately 11,115 acres and is comprised of two distinct areas, Main Station (10,400 acres) and the Waterfront Station (550 acres). The remaining acreage consists of roads and railroad rights-of-way which link the two areas. The ecological risk assessment was performed on locations within the Main Station. The one site located at the Waterfront Station (Site 7) was determined to not have potential exposure pathways for ecological target receptors and therefore was not included in the ecological risk assessment. The Main Station is located in east central Monmouth County on New Jersey's outer coastal plain and is characterized as rolling with gentle slopes and swamps interspersed among the hills. The soils in this area are mainly infertile soils typical of this geographic region. As an ammunition depot, the area also includes many disturbed soils from excavation, filling, and construction activities. This area forms the headwaters of three of Monmouth County's major waterways, the Swimming River, Shark River, and Manasquan River.

The majority of the Main Station is wooded and the vegetation is typical of the infertile soils. Oak-pine and pine-oak types with scattered areas of oak-hickory typify the upland areas. The lowland areas are characterized by red maple swamps, Atlantic white cedar, abandoned cranberry bogs, streams, and manmade ponds. The Hockhockson swamp is composed of large red maples, sweet gum, black gum, and white pine. The understory is open with scattered American holly.

Areas of the Main Station that are not wooded are characterized by small storage mounds which are covered with native and exotic grasses; some large ammunition storage areas with herbaceous cover; residential and administrative areas consisting of pavement, buildings and manicured lawns; and a few open weedy fields.

Game animals and birds in the area include the white tailed deer, eastern cottontail, eastern gray squirrel, bobwhite quail, ruffed grouse, ring-necked pheasant, American woodcock, Canada geese, and several species of ducks. Furbearers include red and gray fox, raccoon, beaver, long-tailed weasel, muskrat, mink, Virginia opossum, and striped skunk. In addition, a host of invertebrates, fish, amphibians, reptiles, and other avian and mammalian nongame species also inhabit the area (Wray, 1990).

A specific detailed description of the habitat types and potential flora and fauna composition for each of the sites evaluated at NWS Earle follows. Table 6-90 provides a summary of the target receptors and exposure pathways chosen for each site.

Site 2 (Ordnance Demilitarization)

Site 2 is approximately 11 acres and is a shallow, nonvegetated, oval shaped sand pit with a high berm bordered by mixed woodlands (Figure 3-2). An elongated sand berm approximately 200 feet long and 15 feet high, oriented northeast to southwest, runs through the center of the site. Standing water and a few remnants of demilitarized or spent ordnance casings were observed in several depressions located at the base of the berm in the northeastern portion of the site. The shallow soils are generally characterized as sand, fine to coarse grained quartz, and some silt. The topography at the site slopes gently towards the north from approximately 125 feet above mean sea level (MSL) to approximately 90 feet MSL. The surface water body nearest to this site is a small tributary of Piney Brook located approximately one-half mile northeast (downgradient) of the site. Groundwater, sediment, and soils were sampled at this site.

This site, as it presently exists, is not considered suitable habitat for most terrestrial organisms. The lack of vegetation and organic matter in the immediate site vicinity reduces the potential habitat value for most terrestrial organisms. However, due to the proximity of the mixed woodlands, if this site were to be abandoned it is likely that the site may become an early successional field prior to the formation of a mixed woodland climax community. Because of the sandy soil condition at the site, the extent of grassy field

Table 6-90

Habitat Description, Exposure Pathways, and Potential Receptors — Summary

Site #	Habitat Description	Exposure Pathways	Potential Receptors	Target Species
2	early successional field	soil	small mammal	white-footed mouse
3	moderately vegetated grasses and scrub pines	NE	NE	NE
4	moderately vegetated grasses and scrub pines	sediment	aquatic organisms	benthic invertebrates
5	moderately vegetated grasses and scrub pines	NE	NE	NE
7	moderately vegetated grasses and scrub pines	NE	NE	NE
10	moderately vegetated grasses and scrub pines scarred areas surface water	sediment	aquatic organisms	benthic invertebrates
11	sparsely vegetated grasses and scrub pines scarred areas	soil	phytotoxicity	terrestrial plants
19	moderate/heavily vegetated woodland/wetland surface water	soil sediment plants earthworms	large mammal small mammal avian species phytotoxicity	white-tailed deer least shrew American woodcock terrestrial plants
20	sparsely vegetated grasses drainage depression	soil plants earthworms	small mammal avian species phytotoxicity	white-footed mouse American robin terrestrial plants
22	moderate vegetation drainage depression	soil earthworms plants	small mammal avian species phytotoxicity	least shrew American robin terrestrial plants
26	moderate vegetation	soil	phytotoxicity	terrestrial plants

development is uncertain. Nevertheless, at this seral stage potential exposure to successional field inhabitants is likely. Species expected to utilize this early field habitat include numerous insects and various small mammals, such as field mice and meadow voles. Moreover, at this stage the site would be expected to be frequented by certain raptor avian species such as the red-tailed hawk that would prey on the rodent community. This site will be evaluated in terms of future ecological use of an early successional field by a terrestrial vertebrate species (white-footed mouse).

Site 3 (Landfill)

Site 3 is approximately 5 acres of open area, moderately vegetated with grasses and scrub pines surrounded by mixed pine-oak woodlands (Figure 3-3). The area contains a few scarred areas, about 20 feet in diameter, where no vegetation exists. The topography across the site is relatively flat and is at an elevation of 120 to 125 feet above MSL. A broad drainage swale that exists outside of the southeastern boundary receives some surface runoff from the site. The landfill has been covered with native soil and very little exposure of the waste has been observed. There are no developed drainageways or gullies for transport of water from the site. The principle pathway of chemical migration is from chemicals reaching the groundwater table by direct contact with waste or percolation of precipitation through the waste; thus, groundwater was the only medium sampled at this site. The potential exposure pathways for target receptors at this site are expected to be negligible; therefore, an ecological risk assessment for this site was deemed inappropriate.

Site 4 (Landfill)

Site 4 is approximately 5 acres of open area, moderately vegetated with grasses and some scrub pines surrounded by mixed pine-oak woodlands (Figure 3-4). There are a few scarred areas where no vegetation exists. The site is bordered on the northwest by Macasser Road. The topography across the site slopes to the east from approximately 170 feet above MSL to approximately 150 feet MSL. A drainage swale running northeast to southwest borders the southeastern boundary of the site and receives groundwater discharge (spring) as well

as surface runoff from this portion of the site. The cover material used on the landfill is predominantly loose sand quarried from the surrounding area. The fill face is steepest, approximately 25 feet high on the east side of the site. A broad low lying area (with a tall stand of the common reed, Phragmites) exists along the drainage near the base of the fill face and extends beyond the northeastern boundary road.

The surface water bodies nearest to Site 4 include Lake Earle, which is located approximately 300 feet north, and a branch of Hockhockson Brook, which is located approximately 400 feet east of the site. Hockhockson Brook is classified as a "trout maintenance" waterbody (DNR, 1987). These surface water bodies receive flow from site surface drainage. However, the landfill is covered with fill material and therefore potential contamination of the surface water from runoff is not expected to occur. Groundwater and sediment were sampled at this site. Potential exposure pathways for Site 4 include only the sediment. Benthic invertebrates were evaluated for potential toxicity from exposure to chemicals in the sediments.

Site 5 (Landfill)

Site 5 is approximately 13 acres of open area, moderately vegetated with grasses and some scrub pines, surrounded by mixed pine-oak woodlands (Figure 3-5). The topography across the site gently slopes to the southwest from approximately 115 feet to approximately 105 feet above MSL. Railroad tracks border the southwestern boundary of the site. The original landfill appears to have been covered with loose sand apparently quarried from the surrounding area. Consequently, wildlife exposure to contaminated soil is unlikely. Surface water nearest to Site 5 is a branch of the Hockhockson Brook, which is located approximately 1,000 feet east of the site. It is unlikely that Site 5 serves as a source of recharge to the tributary. The potential exposure pathways for target receptors at this site are expected to be negligible and therefore an ecological risk assessment for this site was deemed inappropriate.

Site 7 (Landfill)

Site 7 is approximately 5 acres of open area, moderately vegetated with grasses and some scrub pines with the exception of a few scarred areas where no vegetation exists and is surrounded by mixed pine-oak woodlands (Figure 3-6). The site is bordered on three sides by an undeveloped dirt road. The topography across the site gently slopes to the west-southwest from approximately 165 feet above MSL to approximately 125 feet MSL. The original landfill appears to have been covered with predominantly loose sand apparently quarried from the surrounding area. Consequently, wildlife exposure to contaminated soils is unlikely. Brick piles and a large steel plate are located in the southeast corner of the site. The surface water body nearest to Site 7 is a branch of the head waters of Compton Creek, which is located approximately one half mile east of the site. The potential exposure pathways for target receptors at this site are expected to be negligible and therefore an ecological risk assessment for this site was deemed inappropriate.

Site 10 (Scrap Metal Landfill)

Site 10 is approximately 2 acres of open area, vegetated with grasses and some scrub pines, with the exception of a scarred area (~100 feet in diameter) in the center of the site where no vegetation exists (Figure 3-7). The site is surrounded by mixed pine-oak woodlands. The topography across the site is relatively flat at an average elevation of 110 feet above MSL. The site is bordered on the east by railroad tracks and on the east and northeast by a small stream which joins a branch of the head waters of Hockhockson Brook approximately 500 feet towards the northwest. It is likely that Site 10 serves as a source of recharge to the tributary. Based on information concerning previous use, volatile organics and total petroleum hydrocarbons were analyzed in the surface water. These chemicals were below detection limits and therefore this exposure pathway was not evaluated in the ecological risk assessment. The original landfill appears to have been covered with loose sand apparently quarried from the surrounding area. Consequently, wildlife exposure to contaminated soil is unlikely. Sediments were sampled at this site and potential toxicity to benthic invertebrates was evaluated.

Site 11 (Contract Ordnance Disposal)

Site 11 is approximately 2 acres of open area, sparsely vegetated with grasses and some small scrub pines near its perimeter, and surrounded by mixed pine-oak woodlands. There are a few small scarred areas where no vegetation exists (Figure 3-8). The topography across Site 11 slopes gradually to the northwest from approximately 100 feet above MSL to approximately 90 feet above MSL. The cover material used at the site is predominantly loose sand apparently quarried from the surrounding area. The surface water body nearest to Site 11 is a head water branch of Hockhockson Brook which is located approximately 1000 feet north (upgradient) of the site. It is unlikely that Site 11 serves as a source of recharge to the tributary. Soil was sampled for nitrate, nitrite, and petroleum hydrocarbons and was deemed the only potential exposure pathway for this site. Potential toxicity to plants from nitrate and nitrite concentrations in the soil was evaluated. Although this site was determined to be suitable for small terrestrial vertebrates, such as mice, voles, and rabbits, and avian species, such as robins, sparrows, and meadowlarks, insufficient mammalian and avian toxicity data for nitrate and nitrite exposure mediated by soil are available in the published literature.

Site 19 (Paint Chip and Sludge Disposal)

Site 19 is a raised circular area approximately 300 feet in diameter, surrounded by mixed woodlands (Figure 3-9). The site is bordered on the west by a branch of Mingamahone Brook and by wetlands on the north. The topography across the site is relatively flat, approximately 113 above MSL. Half of the site is paved and the remainder of the site is a gravel surface. A depression measuring approximately 50 feet in diameter and 15 feet deep is situated in the center of the site behind a barricade. Runoff collects in the depression and discharges through a culvert to a drainage ditch, which in turn empties into a branch of Mingamahone Brook located approximately 300 feet west of the site. Sediment and soil samples were collected and analyzed near the drainage area and were included in the ecological evaluation for this site. The area surrounding the drainage was determined to be suitable habitat for a large variety of terrestrial and aquatic vertebrates and

invertebrates and was approximately 5.5 acres in size. The drainage area was characterized by mixed woodlands, shrubs, grasses, and a variety of aquatic plants. Among the mammalian species expected to occur in this area include white-tailed deer, shrew, voles, opossum, and skunk. Among the avian species expected to occur include woodcock, red-winged blackbirds, and potentially a few species of ducks. Potential exposure pathways for this site include sediment and soil. Two mammalian species (white-tailed deer and least shrew) were chosen for evaluation for this site, and one avian species (American woodcock). Potential toxicity to terrestrial plants was evaluated. In addition, the potential environmental risk posed by exposure of invertebrates exposed to chemicals in the sediments of the surface waters was also evaluated.

Site 20 (Grit Blasting Area)

Site 20 includes a spent grit pile, shallow drainage and surrounding area behind Building 544 along Midway Road (Figure 3-10). The site is characterized by low grasses surrounded by mixed pine-oak woodlands to the southeast, and wetlands to the northeast. A small pile of blasting grit measuring approximately 10 feet in diameter and 1 foot high is located southwest of Building 544. A shallow drainage depression measuring approximately 300 feet in length and 0.5 to 1.5 feet deep runs the length of the site behind Building 544 and discharges towards the northeast to the marsh which is approximately 250 feet northeast of the center of the site. The surface water body nearest to the site is a headwater of Hockhockson Brook, which is located approximately 500 feet east of the site.

Sediment samples were taken along the drainage depression at this site. The sediments were classified as silty sand and gravel within the drainage and sandy loam and muck closer to the marsh. The sediments within the drainage depression receive water during storm events and therefore are not wet most of the time. This area provides limited suitable habitat for a small terrestrial vertebrate (e.g., mice, voles, rabbits) and avian species (e.g., robins, sparrows, meadowlarks) due to limited size and available vegetation.

Site 22 (Paint Chip Disposal Area)

Site 22 is approximately 50 square feet of discolored soils located behind Building D-2 along a shallow drainage way (Figure 3-11). The site is bordered on the north by railroad tracks and on the east by a marsh. The surface covering the site is predominantly sand and gravel. Traces of paint stains are barely evident in the surface materials. The shallow drainage depression measures approximately 275 feet long, 0.5 to 1 foot deep, and 10 feet wide. The drainage runs the length of the site and discharges towards the southeast to a marsh. The surface water body nearest to the site is a headwater of Hockhockson Brook, which is located approximately 250 feet to the southeast. Soil and sediment samples were collected along the drainageway and included in the ecological evaluation. Due to a relatively small size and limited vegetation cover, the only vertebrate species that could potentially receive substantial exposure at Site 22 are small mammals such as mice, shrew, and voles and avian species such as robins, sparrows, or meadowlarks.

Site 26 (Explosive "D" Washout Area)

Site 26 comprises a very small area approximately 200 feet by 200 feet in size bordered on the west by a branch of Mingamahone Brook and on the north by wetlands (Figure 3-12). Topography across the site is relatively flat, approximately 150 feet above MSL. A depression measuring approximately 30 feet in diameter and 10 feet deep is situated in the center of the site, approximately 75 feet behind Building GB-1. This depression is characterized by a dense growth of a variety of grasses. Surface water collects in the depression and drains via infiltration through the soils. Soil samples were collected and analyzed from this site and were included as a pathway of exposure for terrestrial plants. Because of the limited size of this site (30 feet by 10 feet, area of potential exposure), it was determined that potential exposure for a small mammal or bird species would be negligible; therefore these target receptors were not evaluated.

6.4.3.2 Selection of Target Species/Communities and Pathways of Exposure

This subsection presents the basis for the selection of target species and communities for evaluation in this assessment. In addition, exposure pathways are selected for each of the target species based on the assessment of the habitat types and the known chemical distributions at the site. All exposure pathways that are of little or no concern based on the analysis of site characteristics are eliminated. Focus is given to those pathways and species considered critical to the evaluation of ecological risk at NWS Earle.

The principal criteria used to select appropriate target species (States et al., 1978) include:

- Species that are threatened, endangered, or of special concern.
- Species that are valuable for recreational purposes.
- Species that are important to the well-being of either or both of the above groups.
- Species that are critical to the structure and function of the particular ecosystem in which they inhabit.
- Species that serve as indicators of an important change in the ecosystem.
- Availability of published exposure and toxicological data on potential species.

Factors that have gone into the exposure pathway selection process include:

- Local topography.
- Local land use.
- Site-specific habitat conditions.
- Surface water characteristics (physical, chemical, and biological).
- Surrounding terrestrial habitat.
- Surrounding aquatic/wetlands habitat.
- Review of contaminant migration.
- Persistence and mobility of migrating pollutants.

The discussion that follows discusses the justification for the selection of target species and communities, as well as the selection of potential exposure routes.

Endangered, Threatened or Special Concern Species

Table 6-91 presents a list of the threatened and endangered wildlife and plant species for the state of New Jersey. Specifically, this table presents those threatened or endangered species observed or expected at NWS Earle as the result of a rare species survey (Jenkins, 1988). No threatened or endangered mammals are currently listed for the NWS Earle site. Several bird, herptile, invertebrate, and plant species are listed as threatened or endangered for the State of New Jersey and have been observed or are expected to occur at the NWS Earle site. Justification for the selection or elimination of these species is discussed under specific individual headings in the following section.

Terrestrial Wildlife

It is assumed that exposure to terrestrial wildlife primarily occurs when the animals feed in those areas affected by site contamination. For this assessment, mammalian, and avian species with the greatest potential for exposure were evaluated. Species selected are representative of major foraging guilds and trophic levels that are present at NWS Earle. An ecological inventory of NWS Earle performed by NJDEPE, Division of Fish and Game (Jenkins, 1988) did not identify any mammalian threatened, endangered, or species of special concern. However, several avian species were listed as threatened, endangered or species of special concern.

Mammalian Species

The white-tailed deer (*Odocoileus virginianus*) was selected as a target mammal species only for Site 19. The white-tailed deer was not evaluated at sites that were characterized with only contaminated sediments and/or groundwater (Sites 3, 4, 5, 7, 10, 26) because potential exposure to the deer via these media would be expected to be negligible. Sites 2, 20, and 22 do not provide suitable habitat for a large mammal such as the white-tailed deer. At Site 11, soils were evaluated only for nitrite and nitrate. Insufficient mammalian toxicity data exist for these two chemicals and therefore this site was not evaluated. Site 19 is sufficiently

Table 6-91

Endangered or Threatened Species Observed or Expected at NWS Earle

	COMMON NAME	SCIENTIFIC NAME	USFWS	NJDEP	NHP	Observed at NWS Earle	Expected at NWS Earle
Birds	Pied-billed grebe	*Podilymbus podiceps*		E	S1	X	
	Red shouldered hawk	*Buteo lineatus*		T	S3	X	
	Merlin	*Falco columbarius*		T		X	
	Osprey	*Pandion haliaetus*		T	S3	X	
	Coopers Hawk	*Accipiter cooperii*		E	S2		X
	Barred Owl	*Strix varia*		T	S3	X	
Herptile	Pine Barrens Treefrog	*Hyla andersoni*		E	S4	X	
	Bog Turtle	*Clemmys muhlenbergi*		E	S3		X
Insects	Barren's Blue Damselfly	*Enallagma recurvatum*	C2		S3	X	
Plants	Pine Barrens Reed Grass	*Calamaovilfa brevipilis*	C2	T	S3	X	
	Barratt's Sedge	*Carex barrattii*	C2	T	S3	X	
	Knieskern's Beak Rush	*Rhynchospora knieskernii*	C1	T	S1	X	
	New Jersey Rush	*Juncus caesariensis*	C2	T	S2	X	
	Swamp Pink	*Helonias bullata*	E	T	S2	X	

USFWS - United States Fish and Wildlife Service
NJDEP - New Jersey Department of Environmental Protection
NHP - New Jersey Natural Heritage Program
E - Endangered species T- Threatened species
C1 - Have information to support listing C2 - Need more information to support listing
S1 - Critically imperiled in the state S2 - Imperiled in the state
S3 - Rare in the state S4 - Apparently secure in the state
S5 - Demonstrably secure in the state

large (5.5 acres) and provides suitable habitat for the deer. Deer present at the site could potentially be exposed through a number of exposure routes, which include:

- Ingestion of contaminated soil.
- Ingestion of contaminated browse.

Sufficient data are available to quantitatively evaluate exposure to the deer at Site 19. The white-tailed deer is also considered an abundant species and recreationally important at NWS Earle and thus is evaluated in this assessment for those exposure routes listed above.

The least shrew (*Cryptotis parva)* was chosen as a target species for Sites 19 and 22 because of its almost exclusive carnivorous habits, limited home range (≤1.5 acres), and its high rate of food intake relative to its small body size (consumes 60-100% of body weight per day). These two sites provided sufficient habitat for the shrew (early successional communities) and two routes of potential exposure (soil ingestion and invertebrate ingestion). In addition, the shrew is representative of an extensive and potentially diverse small mammal community that exists at NWS Earle. The shrew was not evaluated for the remaining sites because contact with the contaminated media at these sites (sediment and/or groundwater) was expected to be minimal (Sites 3, 4, 5, 7, 10, 11, 20, 26) or the habitat was not suitable for this particular species (Site 2 - early successional field with limited established soil invertebrates).

The white-footed mouse (*Peromyscus leucopus*) was chosen as a target species for Sites 2 and 20. These sites were characterized by potential exposure pathways (soil and vegetation) and suitable habitat for the white-footed mouse. Site 2 was evaluated in terms of future ecological succession. The white-footed mouse would be more likely to be found inhabiting an early successional field because of its herbivorous diet. The mouse was evaluated for site 2 for soil and vegetation ingestion. The home range of the mouse (1.3 acres) falls within the area of the site (11 acres); therefore, it was conservatively assumed that the mouse would obtain 100% of its daily diet from within this site. Site 20 was characterized by soils that are intermittently water logged and are an expected pathway of exposure. Site 20 was very limited in size (0.069 acres) and suitable available habitat. Therefore, the white-footed

mouse was selected as the target species and was evaluated for soil and vegetation ingestion based on the assumption that the mouse would obtain only 5% (0.069 acres/1.3 acres home range) of its daily diet from within this site.

Avian Species

Several species of birds are listed as endangered or threatened for the State of New Jersey (Table 6-91) and have been observed or are expected to occur at NWS Earle. However, species such as the red shouldered hawk, cooper's hawk and the barred owl prefer either moist lowland or dense woodland forests with neighboring open meadows or cultivated fields. Home ranges for these species range from 180 acres to 565 acres. Species such as the osprey and pied-billed grebe prefer habitats near large bodies of water or interior rivers or open lakes. Home ranges are unknown for the osprey and are estimated at approximately 20 acres for the grebe marshes. The sites selected for ecological evaluation do not meet most of these habitat requirements. Any exposure at these sites by these particular avian species would be on an extremely limited basis and would be very difficult to quantify. Therefore, these species were not evaluated in this ecological assessment. For the most part, the sites selected for ecological evaluation are limited in terms of area (less than 13 acres), suitable habitat, and exposure pathways for avian species.

The American woodcock (*Scolopax minor*) was chosen as a target species for Site 19. This site was characterized by potential exposure pathways (soil and earthworms) and provided suitable habitat for the woodcock. The woodcock prefers moist woodlands in early stages of succession, swamps, stream banks and bogs for breeding and fertile, moist soils that contain earthworms for feeding. A large percentage of its diet (50 to 90%) (DeGraaf and Rudis, 1986) consists of earthworms. The woodcock has the potential for bioaccumulation of chemicals through the ingestion of invertebrates, particularly earthworms. The woodcock has a limited home range, approximately 15 acres (Cade, 1985) and could be expected to obtain a percentage (37%) of its dietary intake from the site, which is approximately 5.5 acres. Although the woodcock is not a year-round resident at the site, it may be found at the site for 8 or 9 months of the year. The woodcock is representative of several

predominantly ground-foraging omnivorous species potentially inhabiting the site. For these reasons, the woodcock was chosen for evaluation through the ingestion of earthworms and soil. The remaining selected sites were determined to be unsuitable for the woodcock evaluation either because of lack of suitable habitat, choice of another more appropriate target species, or lack of potential exposure pathways.

The American robin (*Turdus migratorius*) was chosen as a target species for Sites 20 and 22. These sites were characterized by potential exposure pathways (soil and earthworms) and provided limited suitable habitat for the robin. The robin prefers grassy fields, orchards, lawns and gardens for feeding habitat and open woodlands and woodland edges, clearings and fields for breeding habitat. Major foods ingested by the robin include wild and cultivated fruits, earthworms and insects. The robin is expected to be one of the more maximally exposed bird species at these sites because of the potential for the bioaccumulation of chemicals through the ingestion of invertebrates, specifically earthworms. In addition, the robin has a limited home range, from 0.11 to 0.75 acres (Young, 1951; Collins and Boyajian, 1965) and thus could be expected to obtain a percentage of its dietary intake from these sites which are limited in area. The robin is also a potential year-round resident at these sites and is representative of several predominantly ground-foraging omnivorous species potentially inhabiting the site. For these reasons, the robin was chosen for evaluation through the ingestion of earthworms and soil at Sites 20 and 22. The remaining sites were determined to be unsuitable for the robin evaluation either because of lack of suitable habitat, selection of more appropriate target species, or lack of potential exposure pathways.

Reptiles and Amphibians

The bog turtle, *Clemmys muhlenbergi* and the pine barrens treefrog *Hyla andersoni* are the only herptile species listed as threatened or endangered for the State of New Jersey and at NWS Earle (Table 6-91). Selection of a herptile species as a target species was not performed for this ecological risk assessment because of the lack of published toxicological data for these species.

Aquatic Life

The assessment of ecological risk in the aquatic habitats was limited to sediments. For those surface waters potentially receiving contaminant migration from the site and for which data were available, no analyte levels were found to exceed detection limits. In order to assess potential adverse effects to aquatic life from exposure to sediments (i.e. continuously saturated), chemicals of concern identified in the sediments at Sites 4, 10, and 19 were compared with biological effect levels developed by the National Oceanic and Atmospheric Administration (NOAA). The biological effect level used in this assessment is an environmental Effect Range - Low (ER-L) value. The ER-L is the concentration that represents the lower tenth percentile of a range of sediment concentrations in which biological effects have been observed. It should be noted that there is a great deal of uncertainty associated with the comparison because these values were developed based on marine/estuarine test results.

Terrestrial Vegetation

Several species of plants are listed as endangered or threatened for the state of New Jersey and have been observed or are expected to occur at NWS Earle. Specific toxicological data are not currently available for these species. However, in order to evaluate potential phytotoxic effects at sites where soil data were collected, a direct comparison of soil concentrations with available phytotoxicity data was performed.

Summary

A summary of all exposure routes for each of the selected target species is presented in Table 6-92.

Table 6-92

Exposure Routes of Potential Concern to Ecological Receptors

	Site for Which Exposure was Evaluated							
	2	4	10	11	19	20	22	26
White–Tailed Deer								
– Incidental ingestion of soil					X			
– Ingestion of vegetation (browse)					X			
Least Shrew								
– Incidental ingestion of soil					X		X	
–Ingestion of soil invertebrates (earthworms)					X		X	
White–Footed Mouse								
– Ingestion of soil	X					X		
– Ingestion of vegetation	X					X		
American Woodcock								
– Ingestion of soil					X			
– Ingestion of soil invertebrates (earthworms)					X			
American Robin								
– Ingestion of soil						X	X	
– Ingestion of soil invertebrates (earthworms)						X	X	
Aquatic Biota								
– Direct contact with sediments		X	X		X			
Terrestrial Plants								
– Direct contact with soil	X			X	X		X	X

6.4.3.3 Estimation of Exposure Doses

This subsection discusses the methods by which chemical intakes are estimated for the selected target species chosen for evaluation. The models used to estimate exposure doses in milligrams of contaminant intake per kilogram of body weight per day (mg/kg-day) for the white-tailed deer, the least shrew, the white-footed mouse, the American woodcock, and the American robin are presented. The estimation of doses for aquatic life and terrestrial vegetation is not necessary because media (i.e., sediments and soil) concentrations presented in Subsection 6.2 are used to assess potential effects on these organisms. The upper 95% and mean concentrations in each medium are used as input values into the dose models or for comparison with criteria. Media concentrations used to assess potential exposure to ecological receptors are provided in Subsection 6.2. Exposure doses for all ecological receptors are presented in Appendix H.

White-Tailed Deer

White-tailed deer are assumed to be exposed to chemicals of concern through ingesting contaminated soil and contaminated browse at Site 19.

Ingestion of Chemicals in Soil

The model and assumptions used to calculate a soil ingestion dose for the white-tailed deer for Site 19 are presented in Table 6-93. As determined in previous studies, soil ingestion rates of deer vary seasonally and range from 7.7 g/day in summer to 29.6 g/day in spring. Based on these data, an average soil ingestion rate (SIR) of 16 g/day has been suggested (ICF/Clement, 1988). It was assumed that only a portion of this soil ingestion rate would occur at the site. Estimates of the fraction of soil ingestion obtained from a contaminated source (FI) are based on the area of the home range of the deer relative to the area of the site being evaluated (5.5 acres of suitable habitat excluding paved and graveled areas). Home ranges for white-tailed deer reported in the literature vary considerably and are dependent on the quality of habitat. Values as low as 40 acres (Banfield, 1974) and as high

Table 6-93

Model for Calculating Doses to White-Tailed Deer Through the Incidental Ingestion of Soil

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS * SIR * FI * CF}{BW}$$

Where:

CS	=	Chemical concentration in surface soil (mg/kg)
SIR	=	Soil ingestion rate (g/day)
FI	=	Fraction ingested from contaminated source (unitless)
BW	=	Body weight (kg)
CF	=	Conversion factor (kg/g)

Exposure Assumptions

CS	=	Surface soil exposure concentrations are presented in Section 6.2.
SIR	=	16 g/day (ICF/Clement, 1988)
FI	=	0.015 (based on exposure to site 19)[a,b]
BW	=	50 kg, average weight of an adult white-tailed deer (Doutt et al., 1977)
CF	=	0.001 kg/g

[a]Exposure was estimated separately based on exposure to the area of suitable deer habitat for site 19.
[b]The basis for this value is presented in the text (Subsection 6.4.1.3).

as 672 acres (Nelson and Mech, 1981) have been reported. The habitat in the site vicinity was considered to be of low to moderate quality; thus, the home range of the deer would be expected to lay toward the mid-level acreage estimates. A value of 356 acres was assumed based on a "best" conservative estimate. Based on these assumptions, the estimated fraction of soil ingestion at the site was calculated to be 1.5% (i.e., 5.5 acres of suitable habitat/356 acres home range) based on exposure to Site 19. Only soil samples from the expected areas of exposure (i.e., not paved or graveled area) were used in the calculation of the predicted exposure dose.

Ingestion of Chemicals in Browse/Plant Material

Estimates of chemical exposure through browse ingestion for the white-tailed deer were determined by approximating the uptake of chemicals from soil into browse and the amount of browse consumed daily by deer. Only those samples from areas of suitable habitat were included in the evaluation for Site 19. The first step in determining exposure to deer from the ingestion of browse was the prediction of chemical concentrations in browse. Contaminant concentrations in deer browse resulting from uptake from the soil was calculated using the following equation:

$$C_{browse} = C_{soil} \times PUF$$

Where:

C_{browse} = Contaminant concentration in browse (mg/kg).

C_{soil} = Contaminant concentration in soil (mg/kg).

PUF = Plant uptake factor (chemical-specific factor for root absorption and translocation to the edible vegetative portion of forage).

The plant uptake factors (PUFs) are reported in dry weight, which results in the calculation of dry weight browse concentrations. The plant uptake factors used for inorganics are based on transfer coefficients developed for vegetative growth (leaves and stems) by Baes et al. (1984). For organics, plant uptake factors were calculated using the following regression

equation developed to calculate the concentration factor of chemicals in aerial plant parts (Travis and Arms, 1988).

$$\log (PUF) = 1.588 - 0.578 \log K_{ow}$$

Where:

K_{ow} = Octanol-water partition coefficient

This regression equation is based on data from 29 chemicals, whose log K_{ow}s range from 1.15 to 9.35. Log K_{ow}s and PUFs used in this assessment are presented in Appendix H.

Once the concentration in deer browse was predicted, the dose of chemical received by deer through browse ingestion was determined based on the model and assumptions presented in Table 6-94. The fraction ingested from a contaminated source (FI) was assumed to be 1.5% for the remainder of the site discussed under "Ingestion of Contaminated Soil."

Total Exposure to Deer

Based on the previous discussion, the total exposure of deer to chemicals from Site 19 was derived as follows:

$$Dose_T = Dose_{soil} + Dose_{bro}$$

Where:

$Dose_T$ = Total dose (mg/kg-day).

$Dose_{soil}$ = Dose from soil ingestion (mg/kg-day).

$Dose_{bro}$ = Dose from browse ingestion (mg/kg-day).

Table 6-94

Model for Calculating Doses to White-Tailed Deer Through the Ingestion of Browse

$$\text{Browse Ingestion Dose (mg/kg-day)} = \frac{CBR * BRIR * FI}{BW}$$

Where:

CBR = Chemical concentration in browse (mg/kg dry weight)

BRIR = Browse ingestion rate (kg dry weight/day)

FI = Fraction ingested from contaminated source (unitless)

BW = Body weight (kg)

Exposure Assumptions

CBR = Browse concentrations are presented in Appendix E6.

BRIR = 1.8 kg dry weight/day (Magruder, 1975, as cited in Blair et al., 1977)

FI = 0.015 (based on exposure to the suitable habitat at site 19)[a,b]

BW = 50 kg, average weight of an adult white-tailed deer (Doutt et al., 1977)

[a]Exposure was estimated based on exposure to suitable deer habitat at site 19.
[b]The basis for this value is presented in the text (Subsection 6.4.1.3).

Least Shrew

The least shrew (*Cryptotis parva*) is assumed to be exposed to chemicals of concern through ingesting invertebrates that have bioconcentrated chemicals and ingesting chemicals in soil. The ecological risk to the least shrew was evaluated at Sites 19 and 22.

Ingestion of Chemicals in Invertebrates

The least shrew, like most shrews, is a voracious eater and feeds primarily on invertebrates such as spiders, insect eggs and larvae, millipedes, centipedes, sowbugs, and earthworms (Merritt, 1987). For this assessment, potential exposure to the shrew from chemicals of concern in its diet will be evaluated based on the consumption of earthworms and soil. Although the diet of the shrew does not consist entirely of earthworms, earthworms were used to represent the invertebrates in estimating exposure because (1) the earthworm is one of the few invertebrates for which chemical uptake can be estimated and (2) earthworms would be expected to significantly bioaccumulate chemicals found in the soil as a result of both dermal absorption and soil ingestion.

The model and assumptions used to estimate daily doses for the shrew based on the ingestion of chemicals in earthworms are shown in Table 6-95. The least shrew has been reported to consume as much as 60-100% of its body weight on a daily basis. A midpoint of 80% was used as a consumption percentage. A body weight for the least shrew of 5.0 grams was assumed, based on the midpoint of a reported range of 4 to 6 grams (Merritt, 1987). Thus, an invertebrate ingestion rate of 4 grams per day was assumed (i.e., 80% of 5 grams). Approximately 100% of the dietary intake of the shrew is assumed to occur within Site 19, since the home range of the least shrew, which ranges from 0.4 to 0.57 acres (Merritt, 1987), falls within the area of Site 19 (5.5 acres). Approximately 12% of the dietary intake of the shrew is assumed to occur within Site 22 since the area of the site (0.06 acres) is well below the home range of the least shrew (~0.5 acres).

Table 6-95

Model for Calculating Doses to Shrew Through the Ingestion of Earthworms

$$\text{Invertebrate Ingestion Dose (mg/kg-day)} = \frac{CI * IR * FI}{BW}$$

Where:

CI	=	Chemical concentration in invertebrates (mg/kg)
IR	=	Invertebrate ingestion rate (kg/day)
FI	=	Fraction ingested from contaminated source (unitless)
BW	=	Body weight (kg)

Exposure Assumptions

CI	=	Invertebrate concentrations are presented in Appendix E7 and E11
IR	=	0.004 kg/day (Merritt, 1987)
FI	=	1 or 0.12 [a]
BW	=	.005 kg (Merritt, 1987)

[a]The home range of the shrew, 0.5 acres, falls within the area of site 19 (5.5 acres), and is a fraction of site 22 (0.06 acres/0.5 acres home range).

Concentrations in earthworms were calculated by multiplying soil concentrations by bioaccumulation factors (BAFs) that were found during a review of the scientific literature. For several chemicals, BAFs were calculated by comparing reported earthworm concentrations to specific soil concentrations as shown in the following equation:

$$\text{BAF} = \frac{\text{Earthworm Concentration}}{\text{Soil Concentration}} \quad (1)$$

Table H-2 provides a list of all the BAFs used in this assessment and their sources.

Ingestion of Chemicals in Soil

The ingestion of soil by the least shrew can occur during such behavior as preening, burrowing, or foraging. A soil ingestion rate of 1% of the dietary intake was assumed for the shrew, based on a similar assumption made by EPA (EPA, 1990). This value was arbitrarily chosen by EPA as a best estimate of soil ingestion for small mammals, based on a postulation by Young and Cockerman (1985) that beachmice living around a dioxin-contaminated area at Elgin Air Force Base in Florida had elevated dioxin liver concentrations due to their burrowing and preening behavior.

The model and assumptions used to estimate exposure doses for the shrew based on the ingestion of chemicals in soil are shown in Table 6-96. As with the invertebrate ingestion route, 100% and 12% of all soil ingestion is assumed to occur within Sites 19 and 22, respectively.

Table 6-96

Model for Calculating Doses to Shrew Through the Ingestion of Soil

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS * SIR * FI * CF}{BW}$$

Where:

CS = Chemical concentration in soil (mg/kg)

SIR = Soil ingestion rate (g/day)

FI = Fraction ingested from contaminated source (unitless)

BW = Body weight (kg)

CF = Conversion factor (kg/g)

Exposure Assumptions

CS = Soil exposure concentrations are presented in Subsection 6.2

SIR = 0.04 g/day[a]

FI = 1 or 0.12 [b]

BW = 0.005 kg (Merritt, 1987)

CF = 0.001 kg/g

[a]Assumed to be 1 percent of food intake (EPA, 1990)
[b]The home range of the shrew, 0.5 acres, falls within the area of site 19 (5.5 acres), and is a fraction of site 22 (0.06 acres/0.5 acres home range).

Total Exposure to Shrew

Based on the previous discussion, the total exposure of shrew to chemicals from Sites 19 and 22 was derived as follows:

$$Dose_T = Dose_{soil} + Dose_{inv}$$

Where:

$Dose_T$ = Total dose (mg/kg-day).

$Dose_{soil}$ = Dose from soil ingestion (mg/kg-day).

$Dose_{inv}$ = Dose from ingestion of invertebrates (mg/kg-day).

<u>White-Footed Mouse</u>

The white-footed mouse (*Peromyscus leucopus*) is assumed to be exposed to chemicals of concern through ingesting soil and contaminated vegetation at Sites 2 and 20.

Ingestion of Chemicals in Vegetation

Estimates of chemical exposure through vegetation ingestion for the white-footed mouse was determined by approximating the uptake of chemicals from soil into vegetative material and the amount of vegetative material consumed daily by the mouse. Consequently, the first step in determining exposure to the mouse from the ingestion of vegetation was the prediction of chemical concentrations in vegetation. The vegetative portion of the mouse's diet consists of mostly fruits and nuts and therefore differs from the assumed diet of white-tailed deer (mostly twigs and buds). Plant uptake factors (inorganics only) used for the white-footed mouse evaluation were based on the reproductive portion of the plant rather than the vegetative portion.

Contaminant concentrations in vegetation ingested by the white-footed mouse resulting from uptake from the soil were calculated using the following equation:

$$C_{browse} = C_{soil} \times PUF$$

Where:

C_{browse} = Contaminant concentration in browse (mg/kg).

C_{soil} = Contaminant concentration in soil (mg/kg).

PUF = Plant uptake factor (chemical-specific factor for root absorption and translocation to the edible reproductive portion of vegetation).

The PUFs are reported in dry weight, which results in the calculation of dry weight vegetation concentrations. The plant uptake factors used for inorganics are based on transfer coefficients developed for reproductive growth (fruits and nuts) by Baes et al. (1984). For organics, plant uptake factors were calculated using the methodology described previously in the discussion for the white-tailed deer.

Once the concentration in vegetation was predicted, the dose of chemicals received by the white-footed mouse through vegetation ingestion was determined based on the model and assumptions presented in Table 6-97. The white-footed mouse was assumed to obtain 100% of its dietary intake of vegetation from within Site 2 (11 acres) based on the home range of the mouse (1.3 acres). Approximately 5% of the dietary intake of vegetation was assumed to be obtained from within Site 20 (0.07 acres).

Ingestion of Chemicals in Soil

The model and assumptions used to calculate a soil ingestion dose for the white-footed mouse are presented in Table 6-98. The same percentages of total dietary intake from contaminated sources assumed for vegetation ingestion for Sites 2 and 20 were used for soil ingestion. A soil ingestion rate of 1% of the vegetative dietary intake was assumed for the white-footed mouse, based on a similar assumption made by EPA (1990). This value was arbitrarily chosen by EPA as a best estimate of soil ingestion for small mammals, based on a postulation by Young and Cockerman (1985) that beachmice living around a dioxin-contaminated area at Elgin Air Force Base in Florida had elevated dioxin liver concentrations due to their burrowing and preening behavior.

Table 6-97

Model for Calculating Doses to White-Footed Mouse Through the Ingestion of Vegetation

$$\text{Vegetation Ingestion Dose (mg/kg-day)} = \frac{CVEG * VEGIR * FI}{BW}$$

Where:

CVEG = Chemical concentration in vegetation (mg/kg dry weight)

VEGIR = Vegetation ingestion rate (kg dry weight/day)

FI = Fraction ingested from contaminated source (unitless)

BW = Body weight (kg)

Exposure Assumptions

CVEG = Vegetation concentrations are presented in Appendix E5 and E9.

VEGIR = 0.006 kg dry weight/day (Merritt, 1987).

FI = 1 or 0.05 [a]

BW = 0.02 kg, average weight of an adult white-footed mouse (Merritt, 1987).

[a]The home range of the white-footed mouse, 1.3 acres, falls within the area of site 2 (11 acres) and is a fraction of site 20 (0.069 acres/1.3 acres home range).

Table 6-98

Model for Calculating Doses to White-Footed Mouse Through the Ingestion of Soil

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS * SIR * FI * CF}{BW}$$

Where:

CS = Chemical concentration in soil (mg/kg)

SIR = Soil ingestion rate (g/day)

FI = Fraction ingested from contaminated source (unitless)

BW = Body weight (kg)

CF = Conversion factor (kg/g)

Exposure Assumptions

CS = Soil exposure concentrations are presented in Subsection 6.2

SIR = 0.06 g/day[a]

FI = 1 or 0.05 [b]

BW = 0.02 kg (Merritt, 1987)

CF = 0.001 kg/g

[a]Assumed to be 1 percent of food intake (EPA, 1990)
[b]The home range of the white-footed mouse, 1.3 acres, falls within the area of site 2 (11 acres), and is a fraction of site 20 (0.069 acres/1.3 acres home range).

Total Exposure to White-Footed Mouse

Based on the previous discussion, the total exposure of the white-footed mouse to chemicals from each specific site was derived as follows:

$$Dose_T = Dose_{soil} + Dose_{veg}$$

Where:

$Dose_T$ = Total dose (specific for each site) (mg/kg-day).
$Dose_{soil}$ = Dose from soil ingestion (mg/kg-day).
$Dose_{veg}$ = Dose from ingestion of vegetation (mg/kg-day).

American Woodcock

The American woodcock (*Scolopax minor*) is assumed to be exposed to chemicals of concern through the ingestion of invertebrates and soil at Site 19.

Ingestion of Chemicals in Invertebrates

For this assessment, potential exposure to the woodcock from chemicals of concern in its diet will be evaluated based on the consumption of earthworms and soil. Although the diet of the woodcock does not consist entirely of earthworms, earthworms were used to represent the invertebrates in estimating exposure because (1) the earthworm is one of the few invertebrates for which chemical uptake can be estimated and (2) earthworms would be expected to significantly bioaccumulate chemicals found in the soil as a result of both dermal absorption and soil ingestion.

The model and assumptions used to estimate daily doses for the woodcock are based on the ingestion of chemicals in earthworms shown in Table 6-99. The woodcock has been reported to have an average invertebrate ingestion rate of 0.136 kg/day. A body weight for the woodcock of 0.177 kg (Stickel et al., 1965) was assumed. Approximately 37% of the

Table 6-99

Model for Calculating Doses to Woodcock Through the Ingestion of Earthworms

$$\text{Invertebrate Ingestion Dose (mg/kg-day)} = \frac{CI * IR * FI}{BW}$$

Where:

CI	=	Chemical concentration in invertebrates (mg/kg)
IR	=	Invertebrate ingestion rate (kg/day)
FI	=	Fraction ingested from contaminated source (unitless)
BW	=	Body weight (kg)

Exposure Assumptions

CI	=	Invertebrate concentrations are presented in Appendix E8
IR	=	0.136 kg/day (Stickel et al., 1965)
FI	=	0.367 [a] (Cade, 1985)
BW	=	0.177 kg (Stickel et al., 1965)

[a]The home range of the woodcock, 15 acres, falls outside the area of site 19 (5.5 acres), and is therefore represented as a fraction of the site (5.5 acres/15 acres home range).

dietary intake of the woodcock is assumed to occur within Site 19 (5.5 acres) since the home range of the woodcock is estimated to be 15 acres (Cade, 1985).

Concentrations in earthworms were calculated as described under Least Shrew. Table H-2 provides a list of all the BAFs used in this assessment and their sources.

Ingestion of Chemicals in Soil

The woodcock may ingest soil inadvertently while consuming earthworms and other ground-dwelling prey and while preening. The model and assumptions used to calculate a soil ingestion dose for the woodcock are presented in Table 6-100. There are no available studies of soil ingestion rates in birds. However, in an EPA (1990) risk assessment, an estimate was made that soil ingestion rates for birds would fall between 0.1 and 10% of the diet, with 1% as a best estimate. Thus a soil ingestion rate of 1% of the dietary intake was assumed for the woodcock which would result in a soil intake rate of 1.36 g/day. The woodcock was expected to obtain 37% (see discussion for invertebrate ingestion) of its total dietary intake of soil from within Site 19.

Total Exposure to the Woodcock

Based on the previous discussion, the total exposure of the woodcock to chemicals from Site 19 was derived as follows:

$$Dose_T = Dose_{soil} + Dose_{inv}$$

Where:

$Dose_T$ = Total dose (mg/kg-day).

$Dose_{soil}$ = Dose from soil ingestion (mg/kg-day).

$Dose_{inv}$ = Dose from ingestion of invertebrates (mg/kg-day).

Table 6-100

Model for Calculating Doses to Woodcock Through the Ingestion of Soil

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS * SIR * FI * CF}{BW}$$

Where:

CS = Chemical concentration in soil (mg/kg)

SIR = Soil ingestion rate (g/day)

FI = Fraction ingested from contaminated source (unitless)

BW = Body weight (kg)

CF = Conversion factor (kg/g)

Exposure Assumptions

CS = Soil exposure concentrations are presented in Subsection 6.2

SIR = 1.36 g/day[a]

FI = 0.367 [b] (Cade, 1985)

BW = 0.177 kg (Stickle et al., 1965)

CF = 0.001 kg/g

[a]Assumed to be 1 percent of food intake (EPA, 1990)
[b]The home range of the woodcock, 15 acres, falls outside the area of site 19 (5.5 acres), and is therefore represented as a fraction of the site (5.5 acres/15 acres home range).

American Robin

The American robin (*Turdus migratorius*) is assumed to be exposed to chemicals of concern through the ingestion of invertebrates and soil from Sites 20 and 22.

Ingestion of Chemicals in Invertebrates

The American robin, like most members of the thrush family (Turdinae), is primarily a ground forager and feeds on fruits, insects and earthworms (Graber et al., 1971). For this ecological assessment, potential exposure to the robin from chemicals of concern in its diet will be evaluated based on the consumption of earthworms. As with the shrew and the woodcock, the diet of the robin does not consist entirely of earthworms; however, for this assessment it is assumed that earthworms are the primary source of all dietary exposure. The principle reasons for making this assumption are: (1) the earthworm is one of the few invertebrates for which chemical uptake can be estimated and (2) earthworms would be expected to significantly bioaccumulate chemicals found in the soil as a result of both dermal absorption and soil ingestion.

The model and assumptions used to estimated daily doses for the robin based on ingestion of chemicals of concern in invertebrates (i.e., earthworms) are shown in Table 6-101. The estimation of contaminant concentrations is described in the section on the Least Shrew. Table H-2 provides a list of all the BAFs used in this assessment and their sources.

In general, the average daily ingestion rate for most forest dwelling birds in temperate regions is approximately 25% of their total body weight (Welty, 1975). A body weight for the robin of 0.0773 kg was assumed, based on the average adult robin weight reported by Clench and Leberman (1978). Thus, an ingestion rate of 0.02 kg per day was assumed (i.e., 0.077 grams x 0.25). The dietary intake of the robin for Sites 20 and 22 is assumed to be approximately 16% and 14%, respectively, since the area for each site is below the average home range for the robin (0.07 acres for Site 20 and 0.06 acres for Site 22).

Table 6-101

Model for Calculating Doses to the Robin Through the Ingestion of Earthworms

$$\text{Invertebrate Ingestion Dose (mg/kg-day)} = \frac{CI * IR * FI}{BW}$$

Where:

CI	=	Chemical concentration in invertebrates (mg/kg)
IR	=	Invertebrate ingestion rate (kg/day)
FI	=	Fraction ingested from contaminated source (unitless)
BW	=	Body weight (kg)

Exposure Assumptions

CI	=	Invertebrate concentrations are presented in Appendix E10 and E12
IR	=	0.02 kg/day (Welty, 1975)
FI	=	0.16, or 0.14 [a] (Collins and Boyajian, 1965; Young, 1951)
BW	=	0.0773 kg (Clench and Leberman, 1978)

[a]The home range of the robin is a fraction of sites 20 (0.69 acres/0.43 acres home range) and 22 (0.06 acres/0.43 acres home range).

Ingestion of Chemicals in Soil

The robin may ingest soil inadvertently while consuming earthworms and other ground-dwelling prey and while preening. The model and assumptions used to calculate a soil ingestion dose for the robin are presented in Table 6-102. There are no available studies of soil ingestion rates in birds. However, in an EPA risk assessment, an estimate was made that soil ingestion rates for birds would fall between 0.1 and 10% of the diet, with 1% as a best estimate (EPA, 1990). Thus a soil ingestion rate of 1% of the dietary intake was assumed for the robin, which would result in a soil intake rate of 0.2 g/day. The robin was expected to obtain approximately 16% and 14% of its total dietary intake of soil from within Sites 20 and 22, respectively (see Ingestion of Chemicals in Invertebrates for a complete discussion).

Total Exposure to Robin

Based on the previous discussion, the total exposure of the robin to chemicals from Sites 20 and 22 was derived as follows:

$$Dose_T = Dose_{soil} + Dose_{inv}$$

Where:

$Dose_T$ = Total dose (mg/kg-day).

$Dose_{soil}$ = Dose from soil ingestion (mg/kg-day).

$Dose_{inv}$ = Dose from ingestion of invertebrates (mg/kg-day).

6.4.4 Toxicity Assessment

The toxicity assessment characterizes the toxicity of the chemicals of potential concern to ecological receptors. A comprehensive literature and database search was performed to identify relevant toxicological data for aquatic and terrestrial receptors. The data sources that were reviewed include:

Table 6-102

Model for Calculating Doses to the Robin Through the Ingestion of Soil

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS * SIR * FI * CF}{BW}$$

Where:

CS = Chemical concentration in soil (mg/kg)

SIR = Soil ingestion rate (g/day)

FI = Fraction ingested from contaminated source (unitless)

BW = Body weight (kg)

CF = Conversion factor (kg/g)

Exposure Assumptions

CS = Soil exposure concentrations are presented in Subsection 6.2

SIR = 0.2 g/day[a]

FI = 0.16, or 0.14 [b]

BW = 0.0773 kg (Collins and Boyajian, 1965; Young, 1951)

CF = 0.001 kg/g

[a]Assumed to be 1 percent of food intake (EPA, 1990)
[b]The home range of the robin is a fraction of sites 20 (0.069 acres/0.43 acres home range), and 22 (0.06/0.43 acres home range).

- Registry of Toxic Effects of Chemical Substances (RTECS)
- National Oceanic and Atmospheric Administration (NOAA)
- Quantitative Structure Activity Relationship (QSAR)
- Hazardous Substances Database (HSDB)
- Agrochemical Handbook
- Integrated Risk Information System (IRIS)
- Phytotox

Toxicity information obtained from these databases and other primary literature sources are presented throughout the following subsections.

The toxicity information was used in the development of critical toxicity values (i.e., acceptable daily intakes) (Stevens, 1988) for target species and ecological communities. Species-specific toxicity data for target wildlife species often were not available for the chemicals of potential concern. Thus, where possible, toxicity values from the literature were selected using the most closely related species. Toxicity values selected for the assessment were the lowest exposure doses reported to be toxic or the highest doses associated with no adverse effect. Data for chronic toxicity were preferentially used when available.

6.4.4.1 Toxicity to Terrestrial Wildlife

Because toxicity data for terrestrial wildlife are not nearly as complete as that found for laboratory and aquatic species, extrapolation of toxicity data from other animal studies is often necessary. Because of the uncertainty associated with these extrapolations, safety factors are applied to toxicological data to derive critical toxicity values (CTVs). The approach taken for this study to derive CTVs is provided in Table 6-103.

For those chemicals for which only acute lethality values were available, toxicity values for this assessment were derived by dividing the acute toxicity value by the appropriate safety factors. Based upon the guidance provided by the EPA (1986a), a median lethal dose (LD_{50}) may be extrapolated to an acute no-observable-effect-level (NOEL) by dividing the LD_{50} by a safety factor of 5. A safety factor of 5 was also applied in the extrapolation of a chronic

Table 6-103

Safety Factors Used to Derive Critical Toxicity Values for Terrestrial Target Organisms

Available Toxicity Endpoint	Target Toxicity Endpoint	Safety Factor
Acute Lethality (i.e., LD50)	Acute NOEL	5
Acute LOEL	Acute NOEL	5
Acute NOEL	Chronic NOEL	100
Chronic LOEL	Chronic NOEL	5
Within Phylogenetic Class Sensitivity (i.e., different species but same class)	Target Species Toxicity	5

For example, in developing a critical toxicity value for a white-tailed deer when the only data available is an LD_{50} for a rat, the following steps would be taken:

Rat LD_{50} for Compound X = 500 mg/kg.

(1) Acute Lethality → Acute NOEL $\frac{500 \text{ mg/kg}}{5} = 100 \text{ mg/kg}$

(2) Acute NOEL → Chronic NOEL $\frac{100 \text{ mg/kg}}{100} = 1 \text{ mg/kg}$

(3) Within Phylogenetic Class → Target Species CTV $\frac{1 \text{ mg/kg}}{5} = 0.2 \text{ mg/kg}$

lowest-observable-effect-level (LOEL) to a chronic NOEL. There is currently no EPA guidance available for the extrapolation of acute toxicity data to chronic NOELs. However, several studies have evaluated the relationship between LD_{50} values and chronic NOELs for the same chemical in small mammals (Venmen and Flaga, 1985; Layton et al., 1987) and have found that the ratio of LD_{50} to a chronic NOEL (LD50/NOEL) typically ranges from 10 to 1000. For the purpose of this ecological assessment, a safety factor of 500 (5 for LD_{50} → acute NOEL, and 100 for acute NOEL → chronic NOEL) was used to extrapolate from an LD_{50} concentration to a chronic NOEL. An additional safety factor of 5 was applied in these cases when the test species differed from the target species selected for the site.

White-Tailed Deer, Least Shrew, and White-Footed Mouse

Toxicity data specific for the white-tailed deer, least shrew, and the white-footed mouse were unavailable for chemicals of concern. CTVs for other chemicals were extrapolated from other mammalian studies, preferably data from species with similar diets and digestive systems. Data from domestic ruminants, like cattle, goats and sheep, were used for the white-tailed deer when available. Data from mouse and rats were used for the least shrew and white-footed mouse when available. The remaining chemical CTVs were derived from common laboratory species. Because of the uncertainty involved in these extrapolations, the safety factors previously described were applied to toxicological endpoints to derive the CTVs.

The CTVs and the toxicity data used to calculate the CTVs for the white-tailed deer are presented in Table 6-104. The CTVs and the toxicity data used to calculate the CTVs for the least shrew and the white-footed mouse are presented in Table 6-105.

American Woodcock and American Robin

Toxicity data specific for the American woodcock and American robin were unavailable for chemicals of concern. As a result, CTVs for chemicals of concern were extrapolated from

Table 6-104

Critical Toxicity Values for White–Tailed Deer

Chemical	Species	Effect	Dose (mg/kg BW)	CTV (mg/kg–day)	Reference
Organics					
Methylene Chloride	Rat	Chronic NOEL	5	1	ATSDR, 1989
Inorganics					
Antimony	Mouse	Chronic NOEL	0.35	0.07	ATSDR, 1991
Lead	Mule Deer	Chronic LOEL	0.04 [a]	0.04	Harrison & Dyer, 1984
Silver	Mouse	Chronic NOEL	18.1	3.62	ATSDR, 1990

[a] Converted from mg/day intake by dividing by the body weight of the test organism.

LOEL – Lowest Observe Effect Level

NOEL – No Observed Effects Level

Table 6-105

Critical Toxicity Values for White—Footed Mouse and Least Shrew

Chemical	Species	Effect	Dose (mg/kg BW)	CTV (mg/kg-day)	Reference
Organics					
Acenaphthene	Mouse	Chronic NOEL	175	35	IRIS, 1991
Acetone	Rat	Chronic NOEL	100	20	IRIS, 1992
Anthracene	Mouse	Chronic NOEL	1000	200	IRIS, 1991
Benzo(a)anthracene	Rat	Acute NOEL	150	0.3	ATSDR, 1989
Benzo(a)pyrene	Mouse	Acute LOEL	33.4	0.013	ATSDR, 1989
Benzo(b)fluoranthene*	Mouse	Acute LOEL	33.4	0.013	ATSDR, 1989
Benzo(g,h,i)perylene*	Mouse	Acute LOEL	33.4	0.013	ATSDR, 1989
Benzoic Acid	Rat	Acute LD50	1700	0.68	Verschueren, 1983
Benzo(k)fluoranthene*	Mouse	Acute LOEL	33.4	0.013	ATSDR, 1989
bis(2-ethylhexyl)phthalate	Mouse	Chronic NOEL	13	2.6	ATSDR, 1989
Chrysene*	Mouse	Acute LOEL	33.4	0.013	ATSDR, 1989
4,4-DDT	Goat	Acute LD50	1000	0.4	HSDB, 1991
Dibenzo(a,h)anthracene*	Mouse	Acute LOEL	33.4	0.013	ATSDR, 1989
Di-n-Butylphthalate	Rat	Chronic NOEL	110	22	NRC, 1977
Fluoranthene	Mouse	Chronic NOEL	125	25	IRIS, 1991
Fluorene	Mouse	Chronic NOEL	125	25	IRIS, 1991
Indeno(1,2,3-cd)pyrene*	Mouse	Acute LOEL	33.4	0.013	ATSDR, 1989
Methylene Chloride	Rat	Chronic NOEL	5	1	ATSDR, 1989
Phenanthrene	Rat	Acute LD50	700	0.28	Eisler, 1987
Pyrene	Mouse	Chronic NOEL	75	15	IRIS, 1991
1,1,1-Trichloroethane	Rat	Chronic NOEL	2.96	0.592	ATSDR, 1990
Inorganics					
Antimony	Mouse	Chronic NOEL	0.35	0.07	ATSDR, 1991
Arsenic	Rat	Chronic NOEL	0.7	0.14	ATSDR, 1989
Beryllium	Rat	Chronic NOEL	0.54	0.11	IRIS, 1991
Cadmium	Rat	Acute LD50	63	0.0252	ATSDR, 1991
Chromium	Rat	Chronic NOEL	2.4	0.48	IRIS, 1992
Cobalt	Rat	Chronic LOEL	4.2	0.168	ATSDR, 1991
Copper	Rat	Chronic NOEL	12.5	2.5	ATSDR, 1990
Iron	Mouse	Acute LD50	429	0.172	NRC, 1980
Lead	Rat	Chronic NOEL	0.014	0.003	ATSDR, 1988
Nickel	Rat	Acute LD50	136	0.05	NRC, 1980
Selenium	Rat	Chronic NOEL	0.025	0.005	ATSDR, 1989
Silver	Mouse	Chronic NOEL	18.1	3.62	ATSDR, 1990
Vanadium	Mouse	Chronic NOEL	0.54	0.11	ATSDR, 1991
Zinc	Rat	Chronic NOEL	16.3	3.26	ATSDR, 1989

* Used value for Benzo(a)pyrene, most conservative value for PAHs

LOEL – Lowest Observed Effects Level

LD50 – Dose which results in death in 50% of test organisms

MTL – Maximum Tolerance Level; value treated as a chronic NOEL

NOEL – No Observed Effects Level

other avian studies. Because of the uncertainty involved in these extrapolation, the safety factors previously described were applied to toxicological endpoints to derive the CTVs.

The CTVs and the toxicity data used to calculate the CTVs for the woodcock and the robin are presented in Table 6-106.

6.4.4.2 Toxicity to Terrestrial Vegetation

There is no current EPA guidance for quantitatively evaluating potential adverse effects to plants growing in contaminated soils. For this assessment, the phytotoxic potential of site-related chemicals was evaluated by comparing the soil concentrations to the concentrations reported in literature that caused adverse effects to plant growth, reproduction, or survival specifically for Sites 2, 11, 19, 20, 22, and 26. While phytotoxicity data are available for several of the chemicals of concern identified in surface soils, only data that reported toxicity based on growth medium concentrations were included in this assessment. Plant toxicity data are presented in Table 6-107.

6.4.4.3 Toxicity to Aquatic Life

Sediment

Although no sediment specific quality criteria are currently available, the toxicity of chemicals of potential concern identified in sediments to benthic and epibenthic life for Sites 4, 10 and 19 was primarily assessed by making the following comparison:

- Sediment contaminant concentrations were compared to sediment biological effect ranges published by the National Oceanic and Atmospheric Association (NOAA 1990).

The NOAA sediment effect values were developed to determine levels in concentrations of individual chemicals in which effects are likely to occur based upon established data. An ER-L represents concentrations above which adverse effects may begin or are predicted

Table 6-106

Critical Toxicity Values for American Robin and American Woodcock

Chemical	Species	Effect	Dose (mg/kg BW)	CTV (mg/kg-day)	Reference
Organics					
Acenaphthene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Acetone	Japanese quail	Acute NOEL	6440 [b]	13	Hill & Camardese, 1986
Anthracene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Benzo(a)anthracene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Benzo(a)pyrene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Benzo(b)fluoranthene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Benzo(g,h,i)perylene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Benzoic Acid	NDA	--	--	--	--
Benzo(k)fluoranthene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
bis(2-ethylhexyl)phthalate	NDA	--	--	--	--
Chrysene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
4,4-DDT	California quail	LD50	595	0.24	Hudson et al., 1984
Dibenzo(a,h)anthracene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Di-n-Butylphthalate	NDA	--	--	--	--
Fluoranthene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Fluorene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Indeno(1,2,3-cd)pyrene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Methylene Chloride	NDA	--	--	--	--
Phenanthrene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
Pyrene	Mallard	Chronic LOEL	381 [a]	15	Eisler, 1987
1,1,1-Trichloroethane	NDA	--	--	--	--
Inorganics					
Antimony	NDA	--	--	--	--
Arsenic	California quail	Acute LD50	47.6	0.019	Eisler, 1988
Beryllium	NDA	--	--	--	--
Cadmium	Am. black duck	Chronic LOEL	0.3816 [b]	0.015	Eisler, 1985
Chromium	Japanese quail	Acute NOEL	857 [b]	1.7	Hill & Camardese, 1986
Cobalt	Chicken	Chronic NOEL	0.55 [b]	0.109	NRC, 1980
Copper	Turkey	Chronic NOEL	6 [b]	1.2	NRC, 1980
Iron	NDA	--	--	--	--
Lead	Mallard	Chronic LOEL	2.39 [b]	0.096	Eisler, 1988
Nickel	Chicken	Chronic NOEL	30 [b]	6	NRC, 1980
Selenium	Mallard	Chronic NOEL	0.56 [b]	0.11	Eisler, 1985
Silver	NDA	--	--	--	--
Vanadium	NDA	--	--	--	--
Zinc	Chicken	Chronic NOEL	41 [b]	8.3	NRC, 1980

[a] Value based on mixture of PAHs, comprised primarily of phenanthrene, naphthalenes, and naphthene.
[b] Converted from ppm diet by multiplying the ingestion rate and dividing by the body weight of the test organism.

LOEL – Lowest Observed Effects Level
LD50 – Dose which results in death in 50% of test organisms
NOEL – No Observed Effects Level

Table 6-107

Terrestrial Plant Toxicity Data

Chemical	Species	Effect	Soil Concentration (mg/kg)	Reference
Organics				
Acenaphthene	Maize	37% decreased root size	0.925	Phytotox, 1991
Acetone	NDA	–	–	–
Anthracene	Maize	NOEL root size NOEL root respiration	17.82	Phytotox, 1991
Benzo(a)anthracene	NDA	–	–	–
Benzo(a)pyrene	NDA	–	–	–
Benzo(b)fluoranthene	NDA	–	–	–
Benzo(g,h,i)perylene	NDA	–	–	–
Benzoic Acid	NDA	–	–	–
Benzo(k)fluoranthene	NDA	–	–	–
bis(2-ethylhexyl)phthalate	NDA	–	–	–
Chrysene	NDA	–	–	–
4,4-DDT	Chrysanthemum	NOEL	2000[b]	Phytotox, 1991
Dibenzo(a,h)anthracene	Maize	47% decrease root size	27.84	Phytotox, 1991
Di-n-Butylphthalate	NDA	–	–	–
Fluoranthene	NDA	–	–	–
Fluorene	NDA	–	–	–
Ideno(1,2,3-cd)pyrene	NDA	–	–	–
Methylene Chloride	NDA	–	–	–
Phenanthrene	NDA	–	–	–
Pyrene	NDA	–	–	–
1,1,1-Trichloroethane	NDA	–	–	–
Inorganics				
Antimony	Unspecified	Phytotoxic	5	Kabata-Pendias, 1984
Arsenic	Unspecified	Phytotoxic	15	Kabata-Pendias, 1984
Beryllium	Unspecified	Phytotoxic	10	Kabata-Pendias, 1984
Cadmium	Unspecified	Phytotoxic	3	Kabata-Pendias, 1984
Chromium	Soybean	Phytotoxic	75	Kabata-Pendias, 1984

Table 6-107

Terrestrial Plant Toxicity Data
(Continued)

Cobalt	Unspecified	Phytotoxic	25	Kabata-Pendias, 1984
Copper	Ryegrass	Yield reduction	100	ASARCO, 1987
Iron	NDA	–	–	–
Lead	Unspecified	Phytotoxic	100	Kabata-Pendias, 1984
Nickel	Unspecified	Phytotoxic	100	Kabata-Pendias, 1984
Nitrate	NDA	–	–	–
Nitrite	NDA	–	–	–
Selenium	Unspecified	Phytotoxic	5	Kabata-Pendias, 1984
Silver	Unspecified	Phytotoxic	2	Kabata-Pendias, 1984
Zinc	Unspecified	Phytotoxic	70	Kabata-Pendias, 1984
Vanadium	Unspecified	Phytotoxic	50	Kabata-Pendias, 1984

among sensitive life stages and/or species or as determined in sublethal tests. A comparison is presented in Tables 6-120 through 6-121.

6.4.5 Risk Characterization

6.4.5.1 General Approach

The potential risk posed to ecological receptors (white-tailed deer, masked shrew, white-footed mouse, robin, woodcock, and aquatic life) was assessed by comparing estimated daily doses or media-specific concentrations with critical toxicity values. This comparison, described as a hazard quotient (HQ), was made for each chemical and is expressed as:

$$HQ = C_{med}/CTV_{med}$$

Where:

C_{med} = Concentration of a chemical in a medium.

CTV_{med} = Critical toxicity value for the same chemical in the same medium.

or

$$HQ = EDI/CTV_{ing}$$

Where:

EDI = Estimated daily intake of a chemical through a specific exposure route (i.e., soil or food ingestion) (mg/kg-day).

CTV_{ing} = Critical toxicity value for the same chemical through the ingestion route (mg/kg-day).

It is important to note that this methodology is not a measure of and cannot be used to determine quantitative risk, i.e., it does not predict the relative likelihood of adverse effects occurring. If the calculated hazard quotient (HQ) exceeds unity (i.e., >1), then it indicates that the species of concern may be at risk to an adverse effect from that chemical through that exposure route. Because critical toxicity values incorporate a number of safety factors,

critical toxicity value is exceeded, i.e., the hazard quotient exceeds unity, it does not necessarily indicate that an adverse effect will occur.

Exposures to the same chemical through multiple exposure routes are assumed to be cumulative. Consequently, a hazard index for a specific chemical (HI_{chem}) examines the potential for risk posed by a chemical through more than one exposure route. For example, the cumulative hazard index for an individual chemical in all media for a specific site was determined for deer as follows:

$$HI_{chem} = HQ_{soil} + HQ_{bro}$$

Where:

HI_{chem} = Hazard index for a chemical.

HQ_{soil} = Hazard quotient for the same chemical through soil ingestion.

HQ_{bro} = Hazard quotient for the same chemical through browse ingestion.

In addition, a cumulative hazard index (HI_{cum}) was calculated as follows to determine whether an organism could potentially be at risk due to exposure to all chemicals through all exposure routes for a individual site:

$$HI_{cum} = HI_{chem-1} + HI_{chem-2} + HI_{chem-3} \ldots + HI_{chem-n}$$

Where:

HI_{cum} = Cumulative hazard index for all chemicals through all routes of exposure.

HI_{chem-1} through HI_{chem-n} = Total chemical hazard index for each chemical of concern.

If the cumulative hazard index (HI_{cum}) is greater than 1, it is suggested that the total exposure to all contaminants of concern through all exposure routes may potentially pose a risk for adverse effects to the species of concern. However, as with the hazard quotient,

if the cumulative hazard index is greater than 1, this does not necessarily indicate that an adverse effect will occur.

The following is a discussion of the potential risks posed to aquatic life and terrestrial wildlife by NWS Earle site-related chemicals. Again, the risk is specific to the previously presented exposure scenarios. The principal uncertainties associated with this risk assessment include the estimation of exposure doses and the derivation of critical toxicity values. In most cases, in the absence of specific data conservative estimates that may overestimate potential risks were made.

6.4.5.2 Risk to Terrestrial Wildlife

Site 2

White-Footed Mouse

Under the current conditions at Site 2, potential wildlife habitat is extremely limited and therefore this assessment was conducted under the assumption of future succession of the site. Potential risk to the white-footed mouse was estimated by comparing the estimated daily intakes of chemicals of potential concern based on average and upper 95% soil concentrations with derived critical toxicity values.

The white-footed mouse was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in soil and vegetation based on a future successional field scenario. The average and upper 95% estimated daily intakes for the white-footed mouse for soil and vegetation ingestion are presented in Table H-3.

The average hazard indices for the white-footed mouse at Site 2 are presented in Table 6-108. As shown, the cumulative hazard index based on the average daily intake is 357. The following chemicals contributed approximately 100% to the cumulative hazard index through the soil ingestion pathway:

- Iron 352 (98.6%)
- Vanadium 3.51 (0.98%)

Table 6-108

Summary of Hazard Indices for the White—Footed Mouse
Site 2

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Vegetation Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Inorganics						
Arsenic	9.86E−02	1.52E−01	5.91E−02	9.13E−02	1.58E−01	2.43E−01
Chromium	8.75E−01	1.42E+00	3.94E−01	6.38E−01	1.27E+00	2.06E+00
Iron	3.20E+02	4.85E+02	3.20E+01	4.85E+01	3.52E+02	5.34E+02
Selenium	1.62E−01	3.00E−01	4.05E−01	7.50E−01	5.67E−01	1.05E+00
Vanadium	2.70E+00	3.98E+00	8.10E−01	1.19E+00	3.51E+00	5.18E+00
Cumulative Hazard Index:					**3.57E+02**	**5.42E+02**

- Chromium 1.27 (0.36%)

The upper 95% hazard indices for the white-footed mouse at Site 2 are presented in Table 6-108. As shown, the cumulative hazard index based on the upper bound intake is 542. Iron contributed to the majority (98.5%) of the cumulative hazard index through the soil ingestion pathway. As with the average hazard index, chromium and vanadium also exceeded metal specific CTVs.

The results of the evaluation of potential hazards to the white-footed mouse at Site 2 indicate that there is a potential for adverse effects to occur to the mouse as a result of exposure to specific chemicals of concern through the soil ingestion pathway at Site 2 if the site were allowed to progress to an early successional stage.

Site 19

White-Tailed Deer

Potential risk to the white-tailed deer was estimated by comparing the estimated daily doses of chemicals of potential concern based on average and upper 95% soil concentrations with critical toxicity values derived for the white-tailed deer for Site 19.

The white-tailed deer was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in soil and browse. The average and upper 95% estimated daily intakes for the white-tailed deer for soil and browse ingestion are presented in Table H-4.

The average hazard indices for the white-tailed deer at Site 19 are presented in Table 6-109. As shown in this table, the cumulative hazard index based on the average daily intake is 1.29E-02. The upper 95% hazard indices for white-tailed deer at Site 19 are presented in Table 6-109. As shown in this table, the cumulative hazard index is 1.77E-02.

Table 6-109

Summary of Hazard Indices for the White—Tailed Deer
Site 19

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Browse Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Methylene Chloride	1.44E−08	1.44E−08	1.11E−05	1.11E−05	1.11E−05	1.11E−05
Inorganics						
Antimony	2.13E−04	2.61E−04	4.78E−03	5.86E−03	5.00E−03	6.12E−03
Lead	1.30E−03	1.90E−03	6.56E−03	9.60E−03	7.86E−03	1.15E−02
Silver	7.16E−07	9.41E−07	3.22E−05	4.24E−05	3.29E−05	4.33E−05
Cumulative Hazard Index					1.29E−02	1.77E−02

The results of the evaluation of potential hazards to the deer at Site 19 indicate that there is little potential for adverse effects to occur to the deer as a result of exposure to chemicals of concern through soil and browse ingestion.

Least Shrew

Potential risk to the masked shrew was estimated by comparing the estimated daily doses of chemicals of potential concern based on average and upper 95% soil concentrations with critical toxicity values derived for the shrew.

The shrew was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in soil and in earthworms. The average and upper 95% estimated daily doses for the shrew for soil and earthworm ingestion are presented in Table H-5.

The average hazard indices for the Shrew at site 19 are presented in Table 6-110. As shown in the table, the cumulative hazard index based on average exposure is 404. Lead exceeded the chemical-specific critical toxicity value and contributed 99% of the cumulative hazard index. The majority of the hazard can be attributed to ingestion of earthworms.

The upper 95% hazard indices for the Shrew at site 19 are presented in Table 6-110. As shown in the table, the cumulative hazard index based on upper bound exposures is 590. Lead contributed approximately 100% of the cumulative hazard index. The majority of the hazard can be attributed to ingestion of earthworms.

The results of the evaluation of potential hazards to the shrew at Site 19 indicate that there is a potential for adverse effects to occur to the shrew as a result of exposure to lead through soil and invertebrate ingestion.

Table 6-110

Summary of Hazard Indices for the Least Shrew
Site 19

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Invertebrate Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Methylene Chloride	2.40E−05	2.40E−05	NE	NE	2.40E−05	2.40E−05
Inorganics						
Antimony	3.54E−01	4.34E−01	NE	NE	3.54E−01	4.34E−01
Lead	2.88E+01	4.21E+01	3.74E+02	5.48E+02	4.03E+02	5.90E+02
Silver	1.19E−03	1.57E−03	NE	NE	1.19E−03	1.57E−03
			Cumulative Hazard Index:		4.04E+02	5.90E+02

NE – Not evaluated due to lack of dose and/or CTV

American Woodcock

Potential risk to the American woodcock was evaluated at Site 19 only, and was estimated by comparing the estimated daily intakes of chemicals of potential concern based on average and upper 95% soil concentrations with critical toxicity values derived for the woodcock.

The woodcock was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in invertebrates and soil. The average and upper 95% estimated daily intakes for the woodcock for invertebrates and soil ingestion are presented in Table H-6.

The average and upper 95% hazard indices for the woodcock at Site 19 are presented in Table 6-111. As shown, the cumulative hazard index is 4.4 and 6.5, respectively. Lead contributed to 100% of the cumulative hazard index through the earthworm ingestion pathway.

The results of the evaluation of potential hazards to the woodcock at Site 19 indicate that there is a potential for adverse effects to occur to the woodcock as a result of exposure to lead through the earthworm ingestion pathway.

Site 20

White-footed Mouse

Potential risk to the white-footed mouse was estimated by comparing the estimated daily intakes of chemicals of potential concern based on average and upper 95% soil concentrations with derived critical toxicity values.

The white-footed mouse was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in soil and vegetation. The average and upper 95% estimated daily intakes for the white-footed mouse for soil and vegetation ingestion are presented in Table H-7.

Table 6-111

Summary of Hazard Indices for the American Woodcock
Site 19

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Invertebrate Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Methylene Chloride	NE	NE	NE	NE	NE	NE
Inorganics						
Antimony	NE	NE	NE	NE	NE	NE
Lead	3.17E−01	4.64E−01	4.12E+00	6.03E+00	4.44E+00	6.49E+00
Silver	NE	NE	NE	NE	NE	NE
			Cumulative Hazard Index:		4.44E+00	6.49E+00

NE – Not evaluated due to lack of dose and/or CTV

The average hazard indices for the white-footed mouse at Site 20 are presented in Table 6-112. As shown, the cumulative hazard index based on the average daily intake is 244. The following chemicals contributed approximately 99% to the cumulative hazard index:

- Lead 135 (55%)
- Iron 41.7 (17%)
- Zinc 34.7 (14%)
- Nickel 26.8 (11%)
- Copper 4.5 (1.8%)

The majority of the lead and iron risk can be attributed to both soil and vegetation ingestion. The majority of the copper, nickel, and zinc risk can be attributed to vegetation ingestion.

The upper 95% hazard indices for the white-footed mouse at Site 20 are presented in Table 6-112. As shown, the cumulative hazard index based on the upper bound daily intake is 359. The chemicals contributing to the majority of the cumulative hazard index are the same as those listed for the average cumulative index with the addition of selenium (hazard index of 1, 0.3% of total).

The same exposure pathways (i.e., soil ingestion, vegetation ingestion) that contributed to the majority of the risk are also the same for each chemical as stated for the average values with the addition of nickel (both soil and vegetation ingestion) and selenium (vegetation ingestion).

It should be noted that although none of the individual organic chemicals exceeded the critical toxicity value for that chemical a risk exists from the aggregate exposure to organic chemicals, based on upper 95% soil concentrations only, at the site particularly through ingestion of PAHs in vegetation.

The results of the evaluation of potential hazards to the white-footed mouse at Site 20 indicate that there is a potential for adverse effects to occur to the mouse as a result of exposure to specific chemicals of concern at Site 20 through soil or vegetation ingestion.

Table 6-112

Summary of Hazard Indices for the White—Footed Mouse
Site 20

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Vegetation Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Anthracene	1.94E−07	2.23E−07	8.42E−06	9.66E−06	8.61E−06	9.88E−06
Benzo(a)anthracene	5.10E−04	9.55E−04	4.42E−03	8.28E−03	4.93E−03	9.24E−03
Benzo(a)pyrene	1.62E−02	3.06E−02	7.03E−02	1.33E−01	8.66E−02	1.63E−01
Benzo(b)fluoranthene	1.73E−02	3.18E−02	7.51E−02	1.38E−01	9.24E−02	1.70E−01
Benzo(g,h,i)perylene	1.51E−02	2.82E−02	4.41E−02	8.25E−02	5.92E−02	1.11E−01
Benzo(k)fluoranthene	1.51E−02	2.82E−02	6.56E−02	1.22E−01	8.07E−02	1.50E−01
bis(2−Ethylhexyl)phthalate	6.12E−05	9.49E−05	2.87E−06	4.44E−06	6.41E−05	9.94E−05
Chrysene	1.59E−02	2.94E−02	1.38E−01	2.55E−01	1.54E−01	2.84E−01
Dibenzo(a,h)anthracene	6.43E−03	9.43E−03	1.27E−02	1.87E−02	1.92E−02	2.81E−02
Di−n−Butylphthalate	9.92E−07	1.41E−06	8.59E−06	1.22E−05	9.59E−06	1.36E−05
Fluoranthene	1.16E−05	2.15E−05	3.01E−04	5.59E−04	3.13E−04	5.80E−04
Indeno(1,2,3−cd)pyrene	1.27E−02	2.39E−02	3.71E−02	7.00E−02	4.98E−02	9.39E−02
Phenanthrene	2.39E−04	4.15E−04	1.04E−03	1.80E−03	1.27E−03	2.21E−03
Pyrene	2.04E−05	3.80E−05	5.29E−04	9.87E−04	5.50E−04	1.02E−03
Inorganics						
Antimony	5.46E−03	1.02E−02	7.10E−02	1.33E−01	7.64E−02	1.43E−01
Beryllium	7.67E−03	1.19E−02	4.99E−03	7.72E−03	1.27E−02	1.96E−02
Cadmium	5.69E−03	9.48E−03	3.70E−01	6.16E−01	3.75E−01	6.26E−01
Chromium	4.48E−02	6.14E−02	8.73E−02	1.20E−01	1.32E−01	1.81E−01
Cobalt	3.58E−02	5.83E−02	1.09E−01	1.77E−01	1.45E−01	2.35E−01
Copper	4.15E−02	6.80E−02	4.49E+00	7.37E+00	4.53E+00	7.44E+00
Iron	2.91E+01	4.17E+01	1.26E+01	1.81E+01	4.17E+01	5.98E+01
Lead	2.75E+01	3.83E+01	1.07E+02	1.49E+02	1.35E+02	1.88E+02
Nickel	9.94E−01	1.78E+00	2.58E+01	4.63E+01	2.68E+01	4.81E+01
Selenium	5.73E−02	8.60E−02	6.21E−01	9.32E−01	6.78E−01	1.02E+00
Zinc	8.87E−02	1.34E−01	3.46E+01	5.24E+01	3.47E+01	5.25E+01
Cumulative Hazard Index:					2.44E+02	3.59E+02

American Robin

Potential risk to the American robin was estimated by comparing the estimated daily intakes of chemicals of potential concern (average and upper 95%) with critical toxicity values derived for the robin.

The robin was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in soil and invertebrates. The average and upper 95% estimated daily intakes for the robin for soil and invertebrate ingestion are presented in Table H-8.

The average hazard indices for the robin at Site 20 are presented in Table 6-113. As shown, the cumulative hazard index is 73.5. The following chemicals contributed approximately 99% to the cumulative hazard index:

- Lead 31 (42.6%)
- Zinc 22.8 (31%)
- Selenium 7.7 (10%)
- Cadmium 7.2 (9.8%)
- Copper 2.7 (3.7%)
- Nickel 1 (1%)

The majority of the risk can be attributed to earthworm ingestion with the exception of lead where both soil and earthworm ingestion contributed to the total risk.

The upper 95% hazard indices for the robin at Site 20 are presented in Table 6-113. As shown in this table, the cumulative hazard index based on the upper bound daily intake is 109. The same chemicals contributed to the majority of the cumulative hazard index (99%) as those listed for the average cumulative index.

The results of the evaluation of potential hazards to the robin at Site 20 indicate that there is a potential for adverse effects to occur to the robin as a result of exposure to specific chemicals of concern at Site 20 through invertebrate and soil ingestion.

Table 6-113

Summary of Hazard Indices for the American Robin
Site 20

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Invertebrate Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Anthracene	6.73E−06	7.73E−06	6.73E−06	7.73E−06	1.35E−05	1.55E−05
Benzo(a)anthracene	2.65E−05	4.97E−05	7.95E−05	1.49E−04	1.06E−04	1.99E−04
Benzo(a)pyrene	3.67E−05	6.90E−05	3.30E−04	6.21E−04	3.67E−04	6.90E−04
Benzo(b)fluoranthene	3.92E−05	7.18E−05	3.14E−04	5.74E−04	3.53E−04	6.46E−04
Benzo(g,h,i)perylene	3.39E−05	6.35E−05	2.04E−04	3.81E−04	2.38E−04	4.44E−04
Benzo(k)fluoranthene	3.42E−05	6.35E−05	2.05E−04	3.81E−04	2.40E−04	4.44E−04
bis(2−ethylhexyl)phthalate	NE	NE	NE	NE	NE	NE
Chrysene	3.59E−05	6.62E−05	1.44E−04	2.65E−04	1.79E−04	3.31E−04
Dibenzo(a,h)anthracene	1.45E−05	2.13E−05	1.30E−04	1.91E−04	1.45E−04	2.13E−04
Di−n−Butylphthalate	NE	NE	NE	NE	NE	NE
Fluoranthene	5.02E−05	9.33E−05	1.00E−04	1.87E−04	1.51E−04	2.80E−04
Indeno(1,2,3−cd)pyrene	2.87E−05	5.38E−05	2.87E−04	5.38E−04	3.16E−04	5.92E−04
Phenanthrene	1.16E−05	2.01E−05	3.48E−05	6.04E−05	4.64E−05	8.06E−05
Pyrene	5.30E−05	9.88E−05	1.06E−04	1.98E−04	1.59E−04	2.96E−04
Inorganics						
Antimony	NE	NE	NE	NE	NE	NE
Beryllium	NE	NE	NE	NE	NE	NE
Cadmium	2.48E−02	4.14E−02	7.20E+00	1.20E+01	7.23E+00	1.20E+01
Chromium	3.29E−02	4.50E−02	6.25E−01	8.56E−01	6.57E−01	9.01E−01
Cobalt	1.44E−01	2.34E−01	NE	NE	1.44E−01	2.34E−01
Copper	2.25E−01	3.69E−01	2.47E+00	4.06E+00	2.69E+00	4.43E+00
Iron	NE	NE	NE	NE	NE	NE
Lead	2.23E+00	3.11E+00	2.90E+01	4.04E+01	3.13E+01	4.35E+01
Nickel	2.15E−02	3.86E−02	9.90E−01	1.77E+00	1.01E+00	1.81E+00
Selenium	6.77E−03	1.02E−02	7.65E+00	1.15E+01	7.66E+00	1.15E+01
Zinc	9.08E−02	1.37E−01	2.27E+01	3.43E+01	2.28E+01	3.44E+01
			Cumulative Hazard Index:		7.35E+01	1.09E+02

NE − Not evaluated due to lack of dose and/or CTV

Site 22

Least Shrew

Potential risk to the masked shrew was estimated by comparing the estimated daily doses of chemicals of potential concern (average and upper 95%) with critical toxicity values derived for the shrew.

The shrew was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in soil and in earthworms. The average and upper 95% estimated daily doses for the shrew for soil and earthworm ingestion are presented in Table H-9.

The average hazard indices for the shrew at Site 22 are presented in Table 6-114. As shown, the cumulative hazard index based on average daily intake is 194. The following chemicals contributed approximately 99% to the cumulative hazard index through the invertebrate ingestion pathway:

- Lead 69% (134)
- Selenium 22% (43.4)
- Cadmium 7.4% (14.4)
- Chromium 0.5% (1.04)

The upper 95% hazard indices for the shrew at Site 22 are presented in Table 6-114. As shown in the table, the cumulative hazard index based on upper bound exposure is 345. The following chemicals contributed approximately 99% to the cumulative hazard index through the invertebrate ingestion pathway:

- Lead 73% (251)
- Selenium 19% (65.1)
- Cadmium 7% (24.4)
- Chromium 0.4% (1.26)

It should also be noted that although none of the individual organic chemicals exceeded the critical toxicity value for that chemical, a risk exists from the aggregate exposure to organic chemicals at the site particularly through the ingestion of PAHs in earthworms.

Table 6-114

Summary of Hazard Indices for the Least Shrew
Site 22

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Invertebrate Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Acenaphthene	7.54E−06	8.23E−06	NE	NE	7.54E−06	8.23E−06
Anthracene	1.50E−06	2.98E−06	1.50E−06	2.98E−06	3.00E−06	5.96E−06
Benzo(a)anthracene	1.84E−03	3.97E−03	5.51E−03	1.19E−02	7.35E−03	1.59E−02
Benzo(a)pyrene	3.11E−02	5.38E−02	2.80E−01	4.85E−01	3.11E−01	5.38E−01
Benzo(b)fluoranthene	3.40E−02	6.68E−02	2.72E−01	5.34E−01	3.06E−01	6.01E−01
Benzo(g,h,i)perylene	2.79E−02	4.72E−02	1.67E−01	2.83E−01	1.95E−01	3.30E−01
Benzoic Acid	1.35E−03	1.69E−03	NE	NE	1.35E−03	1.69E−03
Benzo(k)fluoranthene	3.20E−02	6.50E−02	1.92E−01	3.90E−01	2.24E−01	4.55E−01
bis(2−ethylhexyl)phthalate	6.06E−05	9.23E−05	NE	NE	6.06E−05	9.23E−05
Chrysene	4.52E−02	9.08E−02	1.81E−01	3.63E−01	2.26E−01	4.54E−01
4,4−DDT	1.44E−05	2.40E−05	3.74E−03	6.24E−03	3.76E−03	6.26E−03
Dibenzo(a,h)anthracene	1.05E−02	1.62E−02	9.44E−02	1.46E−01	1.05E−01	1.62E−01
Di−n−Butylphthalate	3.53E−06	5.11E−06	NE	NE	3.53E−06	5.11E−06
Fluoranthene	5.48E−05	1.31E−04	1.10E−04	2.61E−04	1.65E−04	3.92E−04
Fluorene	7.83E−06	9.52E−06	NE	NE	7.83E−06	9.52E−06
Indeno(1,2,3−cd)pyrene	2.58E−02	4.41E−02	2.58E−01	4.41E−01	2.84E−01	4.85E−01
Phenanthrene	5.11E−03	1.39E−02	1.53E−02	4.17E−02	2.04E−02	5.57E−02
Pyrene	1.41E−04	2.11E−04	2.82E−04	4.22E−04	4.22E−04	6.34E−04
1,1,1−Trichloroethane	4.86E−06	4.86E−06	NE	NE	4.86E−06	4.86E−06
Inorganics						
Cadmium	4.95E−02	8.38E−02	1.44E+01	2.43E+01	1.44E+01	2.44E+01
Chromium	5.18E−02	6.28E−02	9.84E−01	1.19E+00	1.04E+00	1.26E+00
Lead	9.54E+00	1.79E+01	1.24E+02	2.33E+02	1.34E+02	2.51E+02
Selenium	3.84E−02	5.76E−02	4.34E+01	6.51E+01	4.34E+01	6.51E+01
			Cumulative Hazard Index:		1.94E+02	3.45E+02

NE – Not evaluated due to lack of dose and/or CTV

The results of the evaluation of potential hazards to the shrew at Site 22 indicate that there is a potential for adverse effects to occur to the shrew as a result of exposure to specific chemicals of concern at Site 22 through soil and invertebrate ingestion.

American Robin

Potential risk to the American robin was estimated by comparing the estimated daily intakes of chemicals of potential concern based on average and upper 95% soil concentrations with critical toxicity values derived for the robin.

The robin was assumed to be exposed to chemicals of potential concern through the ingestion of chemicals in soil and invertebrates. The average and upper 95% estimated daily intakes for the robin for soil and invertebrate ingestion are presented in Table H-10.

The average hazard indices for the robin at Site 22 are presented in Table 6-115. As shown in this table, the cumulative hazard index based on average daily intake is 11.5. Cadmium and lead contributed to the majority of the cumulative hazard index (93%) through the earthworm ingestion pathway.

The upper 95% hazard indices for the robin at Site 22 are presented in Table 6-115. As shown in this table, the cumulative hazard index based on upper bound daily intake is 19.6. Cadmium, lead and selenium contributed to the majority of the cumulative hazard index (99%) through the earthworm ingestion pathway.

The results of this evaluation of potential hazards to the robin at Site 22 indicate that there is a potential for adverse effects to occur to the robin as a result of exposure to specific chemicals of concern at Site 22 through the ingestion of earthworms.

Table 6-115
Summary of Hazard Indices for the American Robin
Site 22

Chemical	Hazard Indices for Soil Ingestion		Hazard Indices for Invertebrate Ingestion		Total Hazard Indices	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Acenaphthene	6.62E−06	7.22E−06	NE	NE	6.62E−06	7.22E−06
Anthracene	7.51E−06	2.12E−05	7.51E−06	2.12E−05	1.50E−05	4.24E−05
Benzo(a)anthracene	1.38E−05	2.98E−05	4.14E−05	8.95E−05	5.53E−05	1.19E−04
Benzo(a)pyrene	1.01E−05	1.75E−05	9.12E−05	1.58E−04	1.01E−04	1.75E−04
Benzo(b)fluoranthene	1.11E−05	2.18E−05	8.86E−05	1.74E−04	9.96E−05	1.96E−04
Benzo(g,h,i)perylene	9.10E−06	1.54E−05	5.46E−05	9.23E−05	6.37E−05	1.08E−04
Benzoic Acid	NE	NE	NE	NE	NE	NE
Benzo(k)fluoranthene	1.04E−05	2.12E−05	6.27E−05	1.27E−04	7.31E−05	1.48E−04
bis(2−ethylhexyl)phthalate	NE	NE	NE	NE	NE	NE
Chrysene	1.47E−05	2.96E−05	5.89E−05	1.18E−04	7.36E−05	1.48E−04
4,4−DDT	9.03E−06	1.50E−05	2.35E−03	3.91E−03	2.36E−03	3.93E−03
Dibenzo(a,h)anthracene	3.42E−06	5.29E−06	3.08E−05	4.77E−05	3.42E−05	5.29E−05
Di−n−Butylphthalate	NE	NE	NE	NE	NE	NE
Fluoranthene	3.44E−05	8.19E−05	6.87E−05	1.64E−04	1.03E−04	2.46E−04
Fluorene	4.91E−06	5.97E−06	NE	NE	4.91E−06	5.97E−06
Indeno(1,2,3−cd)pyrene	8.42E−06	1.44E−05	8.42E−05	1.44E−04	9.27E−05	1.58E−04
Phenanthrene	3.59E−05	9.77E−05	1.08E−04	2.93E−04	1.44E−04	3.91E−04
Pyrene	5.29E−05	7.94E−05	1.06E−04	1.59E−04	1.59E−04	2.38E−04
1,1,1−Trichloroethane	NE	NE	NE	NE	NE	NE
Inorganics						
Cadmium	3.13E−02	5.29E−02	9.07E+00	1.54E+01	9.10E+00	1.54E+01
Chromium	5.50E−03	6.67E−03	1.05E−01	1.27E−01	1.10E−01	1.33E−01
Lead	1.12E−01	2.11E−01	1.46E+00	2.74E+00	1.57E+00	2.95E+00
Selenium	6.56E−04	9.85E−04	7.42E−01	1.11E+00	7.42E−01	1.11E+00
			Cumulative Hazard Index:		1.15E+01	1.96E+01

NE − Not evaluated due to lack of dose and/or CTV

6.4.5.3 Risk Characterization for Vegetation

Potential effects to terrestrial plants inhabiting NWS Earle were assessed by comparing mean and upper 95% soil concentrations for chemicals of concern for each site to the lowest reported phytotoxic effect concentrations. The phytotoxic literature evaluated in this risk assessment focuses on the observed effects of chemical concentrations in the soil. Phytotoxic effects reported include the following: general phytotoxicity, reduction in crop yield, and decrease in root size and root respiration.

Site 2

Results of the Site 2 evaluation indicate that chromium and vanadium were present in the soil at concentrations that may be potentially phytotoxic to some species of terrestrial plants (Table 6-116).

Site 11 and Site 26

Nitrate and nitrite were detected in the soils at Sites 11 and 26. Unfortunately, phytotoxicity information concerning the phytotoxicity of these chemicals in soil was not available in the published literature. However, nitrogen as nitrite (NO_2-N) is not readily taken up from the soil by most terrestrial plants and therefore its presence at Sites 11 and 26 is not expected to have any potential effects on the terrestrial plants of these sites. Nitrogen as nitrate (NO_3-N) is extremely soluble and is readily leached from soils. Because of the high requirement of plants for nitrogen and the loss of nitrate by leaching most agricultural plants require relatively high amounts nitrogen fertilizer. In addition, the upper 95% concentration of nitrate in soils for Sites 11 and 26 is 3.6 and 1.7 mg/kg, respectively. These concentrations do not represent nitrate concentrations that could potentially cause adverse effects on the terrestrial plant life of these two sites and frequently represent beneficial growth media concentrations for many species of terrestrial plants (Salisbury and Ross, 1978). Picric acid was also detected at Site 26 however no phytotoxicity data is available

Table 6-116

Phytotoxicity Values for Terrestrial Plants
Site 2

Chemical	Soil Concentration at Site 2 (mg/kg) Average	Upper 95%	Phytoxic Concentration (mg/kg)
Inorganics			
Arsenic	4.60E+00	7.10E+00	1.50E+01
Chromium	1.40E+02 *	2.27E+02 *	7.50E+01
Iron	1.83E+04	2.78E+04	NE
Selenium	2.70E−01	5.00E−01	5.00E+00
Vanadium	9.90E+01 *	1.46E+02 *	5.00E+01

* Concentrations in soil at site 2 exceed reported literature phytotoxic concentrations

NE – Not evaluated due to lack of phytotoxicity data

in the literature to evaluate this chemical and its potential adverse effects on the terrestrial plant life of Site 26.

Site 19 and Site 22

Results of the Site 19 and Site 22 evaluation indicate that the chemicals present in the soils at these sites do not exceed the phytotoxic concentrations that were found in the literature (Table 6-117 and 6-118, respectively).

Summary

Phytotoxicity information was not available for several chemicals at many of the sites and therefore a complete evaluation could not be made. In addition, phytotoxicity is frequently species-specific and is influenced by many physical and chemical parameters. Experimental conditions used in these studies may differ from the environmental conditions at these sites and therefore phytotoxic concentrations may vary when evaluated on a site-specific basis.

6.4.5.4 Risk to Aquatic Life

Sediments

Potential risks to aquatic benthic and epibenthic life inhabiting the sediments were assessed by comparing mean and upper 95% sediment concentrations for chemicals of concern for Sites 4, 10, and 19 to NOAA biological effect levels. The results of these comparisons are presented in Tables 6-119 through 6-121.

Site 4

As shown in Table 6-115, the following chemicals exceeded the NOAA's 10% effects ranges level for either or both of the average or upper 95% concentrations:

- Aroclor-1260
- Pyrene
- Phenanthrene
- Antimony

Table 6-117

Phytotoxicity Values for Terrestrial Plants
Site 19

Chemical	Soil Concentration Site 19 (mg/Kg) Average	Upper 95%	Phytotoxic Concentration (mg/kg)
Organics			
Methylene Chloride	3.00E−03	3.00E−03	NE
Inorganics			
Antimony	3.10E+00	3.80E+00	5.00E+00
Lead	1.08E+01	1.58E+01	1.00E+02
Silver	5.40E−01	7.10E−01	2.00E+00

* Maximum value is used for upper 95% value when sample number is less than three

NE – Not evaluated due to lack of data

Table 6-118

Phytotoxicity Values for Terrestrial Plants
Site 22

Chemical	Soil Concentration** Site 22 (mg/Kg) Average	Upper 95%	Phytotoxic Concentration (mg/kg)
Organics			
Acenaphthene	2.75E−01	3.00E−01 *	9.25E−01
Anthracene	3.12E−01	8.80E−01	1.78E+01
Benzo(a)anthracene	5.74E−01	1.24E+00	NE
Benzo(a)pyrene	4.21E−01	7.29E−01	NE
Benzo(b)fluoranthene	4.60E−01	9.04E−01	NE
Benzo(g,h,i)perylene	3.78E−01	6.39E−01	NE
Benzoic Acid	9.59E−01	1.20E+00 *	NE
Benzo(k)fluoranthene	4.34E−01	8.80E−01	NE
bis(2−ethylhexyl)phthalate	1.64E−01	2.50E−01 *	NE
Chrysene	6.12E−01	1.23E+00	NE
4,4−DDT	6.00E−03	1.00E−02 *	2.00E+03
Dibenzo(a,h)anthracene	1.42E−01	2.20E−01 *	2.78E+01
Di−n−Butylphthalate	8.10E−02	1.17E−01	NE
Fluoranthene	1.43E+00	3.40E+00	NE
Fluorene	2.04E−01	2.48E−01	NE
Indeno(1,2,3−cd)pyrene	3.50E−01	5.97E−01	NE
Phenanthrene	1.49E+00	4.06E+00	NE
Pyrene	2.20E+00	3.30E+00 *	NE
1,1,1−Trichloroethane	3.00E−03	3.00E−03	NE
Inorganics			
Cadmium	1.30E+00	2.20E+00	3.00E+00
Chromium	2.59E+01	3.14E+01	7.50E+01
Lead	2.98E+01	5.60E+01	1.00E+02
Selenium	2.00E−01	3.00E−01	5.00E+00

* Maximum value is used for upper 95% value when upper 95% is greater than maximum or when insufficient number of samples

** Soil concentrations do not exceed phytotoxic values available

NE – Not evaluated due to lack of data

Table 6-119

Comparison of Sediment Concentrations to Sediment Effect Levels
Site 4

Chemical	Sediment Effect Level NOAA ER-L	Sediment Concentration (mg/kg) Average	Upper 95%
Organics			
Aroclor-1260	0.05	0.573 *	1,40 *
bis(2-Ethylhexyl)phthalate	NA	0.167	0.33
Carbon Disulfide	NA	0.003	0.004
Methylene Chloride	NA	0.06	0.109
Phenanthrene	0.225	0.231 *	0.376 *
Pyrene	0.35	0.247	0.361 *
Inorganics			
Aluminum	NA	4117	11941
Antimony	2	2.5 *	5.4 *
Arsenic	33	0.9	2.6
Barium	NA	32	95
Beryllium	NA	0.11	0.21
Cadmium	5	1.8	4.8
Chromium	80	12.1	31.5
Cobalt	NA	1.3	3.2
Copper	70	18.2	59.9
Iron	NA	7179	18989
Lead	35	53 *	162 *
Manganese	NA	30.1	70.2
Mercury	0.15	0.5 *	1.6 *
Nickel	30	3	8.6
Silver	1	0.7	1.2 *
Sodium	NA	37.3	57.1
Vanadium	NA	14	40.7
Zinc	120	197 *	582 *

NOAA ER-L – National Oceanic And Atmospheric Administration Effects Range representing the lower 10 percentile data

* Sediment concentrations exceed the NOAA ER-L

NA – NOAA ER-L value not available

Table 6-120

Comparison of Sediment Concentrations to Sediment Effect Levels
Site 10

Chemical	Sediment Effect Level NOAA ER-L	Sediment Concentration (mg/kg) Average	Upper 95%
Organics			
Benzo(a)anthracene	0.40	0.110	0.278
bis(2-Ethylhexyl)phthalate	NA	0.172	0.334
Chrysene	0.40	0.118	0.281
Fluoranthene	0.60	0.126	0.272
Methylene Chloride	NA	0.020	0.072
Phenanthrene	0.225	0.154	0.290 *
Pyrene	0.35	0.122	0.276
Inorganics			
Aluminum	NA	553	735
Antimony	2	1.7	3.9 *
Arsenic	33	0.7	2.2
Barium	NA	4.3	6.2
Chromium	80	3.9	7.5
Cobalt	NA	1.2	3.5
Iron	NA	5503	11766
Lead	35	4.6	6.5
Manganese	NA	27.5	73.6
Mercury	0.15	0.08	0.15 *
Sodium	NA	35.9	49.3
Vanadium	NA	4.6	8.4
Zinc	120	13.7	15.5

NOAA ER-L - National Oceanic And Atmospheric Administration Effects Range representing the lower 10 percentile data

* Sediment concentrations exceed the NOAA ER-L

NA - NOAA ER-L value not available

Table 6-121

Comparison of Sediment Concentrations to Sediment Effect Levels
Site 19

Chemical	Sediment Effect Level NOAA ER–L	Sediment Concentration (mg/kg) Average	Upper 95%
Inorganics			
Aluminum	NA	2130	3395
Arsenic	33	1.6	2.3
Barium	NA	46.2	87.1
Beryllium	NA	0.11	0.24
Chromium	80	686	1922*
Cobalt	NA	2*	3.6
Copper	70	17.4	31.2
Iron	NA	3636	5288
Lead	35	1486*	3195*
Manganese	NA	39.8	40
Mercury	0.15	0.08	0.13
Vanadium	NA	10	16.7
Zinc	120	439*	1143*

NOAA ER–L – National Oceanic And Atmospheric Administration Effects Range representing the lower 10 percentile data

* Sediment concentrations exceed the NOAA ER–L

NA – NOAA ER–L value not available

- Lead
- Silver
- Mercury
- Zinc

These results indicate a potential for adverse effects to occur to the benthic life at Site 4 due to the concentrations of these specific chemicals in the sediment.

Site 10

As shown in Table 6-120, the following chemicals exceeded the NOAA's 10% effects ranges level for the upper 95% concentrations:

- Phenanthrene
- Antimony
- Mercury

These results indicate a potential for adverse effects to occur to the benthic life at Site 10 due to the concentrations of these specific chemicals in the sediment.

Site 19

As shown in Table 6-121, the following chemicals exceeded the NOAA's 10% effects ranges level for either or both of the average or upper 95% concentrations:

- Cadmium
- Cobalt
- Zinc
- Chromium
- Lead

These results indicate a potential for adverse effects to occur to the benthic life at Site 19 due to the concentrations of these specific chemicals in the sediment.

6.4.5.5 Uncertainty Analysis

An ecological risk assessment, like a human health risk assessment, is subject to a wide variety of uncertainties. Virtually every step in the risk assessment process involves numerous assumptions which contribute to the total uncertainty in the final evaluation of risk.

In the exposure assessment, for example, a number of assumptions went into the selection of target species. In the absence of site-specific ecological assessments, general consideration was given to the habitat type of the site. Although it is true that one may expect a certain species to frequent a given habitat and that species selection can be based on this general knowledge, the full ecological potential of a given area cannot be realized until a more formal study is conducted. Consequently, assumptions about the ecological dynamics at a site are qualitative at best.

Numerous assumptions are made in order to estimate daily intakes for selected target species (i.e., white-tailed deer, least shrew, American woodcock, and American robin). Since limited site-specific information was available, assumptions were made regarding ingestion rates, frequency of exposure, and exposure point locations. In general, an effort was made to use assumptions that were conservative, yet realistic. The lack of exposure factors, such as earthworm BAFs, resulted in several chemicals of concern not being included in the invertebrate ingestion pathway evaluation.

The interpretation and application of toxicological data in the toxicity assessment are probably the greatest sources of uncertainty in an ecological risk assessment. Frequently, data from literature sources are not specific to the target species selected; therefore, extrapolation of the data to the species of concern is necessary. When extrapolating ecological data, every effort was made to use data for the most closely related species to the target organism. Even so, species sensitivities may vary even among closely related species. Variations in species sensitivity may be due to differences in some of the following factors:

toxicity, tolerance thresholds, toxic symptoms exhibited, time period until toxic effects are observed, and metabolism of ingested chemical.

In calculating CTVs, safety factors are applied to toxicity data to account for differences in species and difference in toxicological endpoints (e.g., LD50, NOEL, LOEL). One of the safety factors which is applied has been recommended by the EPA (1986) for use in extrapolating acute LD50s to acute NOELs. The remaining safety factors have been developed after reviewing species' specific acute and chronic toxicity data or are based on best professional judgment. Thus, there are uncertainties resulting from the use of safety factors. The absence of toxicity criteria or guidance values (i.e., CTVs, AWQC, avian toxicity data, etc.) results in chemicals of concern not being included in the total risk evaluation.

The following text provides a brief discussion of the primary uncertainties associated with the risk evaluation of each target species and with estimation of risk to terrestrial plants and aquatic life.

White-Tailed Deer

Exposure Assessment:

- The home range size (356 acres) was based on a professional judgement of habitat quality in vicinity of site 19 and on cited home ranges in the literature.
- Plant uptake and resultant chemical concentrations in browse (forage) are dependent on such factors as plant species, site-specific conditions (i.e., soil type, soil Ph, soil organic content), chemical species, etc. The plant-uptake factors used in this assessment are based primarily on the vegetative portion of plants. The daily diet of the deer may include other portions of plants such as mast. The conclusion that no hazard existed at Site 19 for the white-tailed deer due to chemical concentrations in browse is uncertain.

Toxicity Assessment/Risk Characterization:

- Specific toxicity data for the white-tailed deer were not available for any of the chemicals of concern; therefore, interspecies extrapolation was required for the majority of chemicals of concern.

- It was assumed that toxicity information based on studies with ruminants is a more accurate indicator of potential effects to deer than toxicity data taken from laboratory mouse or rat studies. Consequently, where available these data were used preferentially

Least Shrew

Exposure Assessment:

- It was assumed that the least shrew is present at Sites 19 and 22. This assumption is based on the similarity between habitat conditions at these sites and descriptions of least shrew habitat in the scientific literature.

- The diet of the least shrew in a given location is based on food availability and can consist of the following organisms: insects, insect larvae, spiders, slugs, snails, earthworms, and occasionally small amounts of organic matter. The assumption that a shrew's diet at Sites 19 and 22 is exclusively earthworms is probably not accurate; however, data are not available to estimate chemical concentration in other probable food sources.

- The assumption that the shrew will obtain 100% of its diet from within Site 19 and 12% of its diet from within Site 22 was based on the home range of the shrew reported in the literature and the size of each of the sites. This assumption may result in an underestimate or overestimate of the potential exposure to the shrew.

- Earthworm BAFs were developed from a review of the literature. Beyer (1990) discusses some of the difficulties with interpreting literature dealing with chemical concentrations in earthworms; the following list illustrates some of the primary problems associated with applying literature-based BAFs to a given site:

  - Environmental variables, such as soil characteristics, obscure the underlying relationship between concentrations in soils and in earthworms.

  - Earthworms probably regulate copper, selenium, and zinc concentrations in their tissue.

- Earthworms selectively feed on plant debris and soil organic matter, and, consequently, soil concentrations may not represent true exposure concentrations.

- It is not known how available the metals and other inorganics in earthworm tissue are to predators.

- Different earthworm species bioaccumulate chemicals at different rates.

- The uncertainty associated with estimating chemical concentrations in earthworms is particularly significant given that the majority of the risk to the least shrew is associated with earthworm ingestion.

Toxicity Assessment/Risk Characterization:

- No toxicity data were available specifically for shrew species; therefore, it was assumed that rat and mouse toxicity data were the most appropriate data available.

White-Footed Mouse

Exposure Assessment:

- It was assumed that the white-footed mouse is present at Sites 2 and 20. This assumption is based on the similarity between habitat conditions at these sites and description of white-footed mouse habitat in the scientific literature.

- The assumption that the mouse will obtain 100% of its diet from within Site 2 and 5% of its diet from within Site 20 was based on the home range of the mouse reported in the literature and the size of each of the sites. This assumption may result in an underestimate or overestimate of the potential exposure to the white-footed mouse.

- Plant uptake and resultant chemical concentrations in vegetation are dependent on such factors as plant species, site-specific conditions (i.e., soil type, soil Ph, soil organic content), chemical species, etc. The plant-uptake factors used in this assessment are based primarily on the reproductive portion of plants. The daily diet of the mouse may include other portions of plants such as roots or stems. The conclusion that a hazard exists at Site 20 for the white-footed mouse due to chemical concentrations in vegetation is uncertain.

Toxicity Assessment/Risk Characterization:

- Specific toxicity data for the white-footed mouse were not available for any of the chemicals of concern; therefore, interspecies extrapolation was required for the majority of chemicals of concern.

American Woodcock

Exposure Assessment:

- As with the least shrew, the woodcock's normal diet consists of earthworms (50 to 90% of diet) and beetle larvae, flies and other insects form the remaining balance of the diet. Bioaccumulation data is not available to estimate the chemical concentration in insects; therefore, the assumption that earthworms make up 100% of the woodcock's diet was used. This assumption probable results in a conservative estimate of potential risk.

- The assumption that the woodcock will obtain 37% of its diet from within Site 19 was based on the home range of the woodcock reported in the literature and the size of the site. This assumption may result in an overestimate of the potential exposure to the woodcock based on the suitability of the available habitat.

- Earthworm BAFs uncertainties (see least shrew discussion).

Toxicity Assessment/Risk Characterization:

- Toxicity data for avian species are extremely limited; therefore, the potential cumulative hazard calculated for the woodcock does not reflect its total exposure to chemicals of concern. Consequently, for those chemicals for which no avian toxicity data were available, this resulted in an underestimate of the cumulative risk posed by site contaminants.

American Robin

Exposure Assessment:

- As with the least shrew, the robin's normal diet consists of a variety of different food items. A robin's typical daily intake may consist of fruit, insects and earthworms. For Sites 20 and 22 the assumption that the robin's diet would be composed of 100% earthworms may not be accurate. Other more

available food items may be preferred at these sites. However, for all of these sites, it is doubtful that food items such as fruit and insects would have chemical concentrations in their tissue as high as those of the earthworm.

- Sites 20 and 22 consist of drainage areas with surrounding grass. Since the foraging preference of the robin is lawns, gardens and short grassy fields, it is doubtful that 100% of the robin's daily intake would come from these sites. The percentage of daily intake at these sites was estimated based on home range values in the literature and available site area.

- Earthworm BAFs uncertainties (see Least Shrew discussion).

Toxicity Assessment/Risk Characterization:

- Toxicity data for avian species are extremely limited; therefore, the potential cumulative hazard calculated for the robin does not reflect its total exposure to chemicals of concern. Consequently, for those chemicals for which no avian toxicity data were available, this resulted in an underestimate of the cumulative risk posed by site contaminants.

Terrestrial Plants

- Limited phytotoxicity data were available for chemicals of concern in the soil; therefore, this portion of the assessment does not reflect the total potential hazard.

- Since phytotoxic effects are plant species specific and directly related to ambient conditions (i.e., soil type, soil pH, moisture content etc.), comparison of literature-based phytotoxic concentrations in soil to sites 2, 19, and 22 soil concentrations is extremely simplistic and may not accurately illustrate potential hazards.

Sediments

- Sediments were defined as those soils that were either continuously saturated (stream sediments) or that were saturated on a periodic basis (drainage ditch). The extent to which periodically saturated sediments in drainage ditches or similar habitats could support a viable benthic community is unknown. Consequently, for those sites for which periodically saturated soils were evaluated, the risk may be largely overestimated.

- The use of the NOAA based biological effect levels (ER-Ls) for evaluating the potential impacts of reported contaminant concentrations in Sites 4, 10, and 19 has associated with it the following basic uncertainties:

  - Most of the ER-L values used were derived from marine or estuarine studies; their applicability to freshwater situations like those found at Sites 4, 10 and 19 is uncertain.

  - The confidence level for the ER-L values used for many of the sediment contaminants of concern is low, because of the variability in the study results used to develop the values.

  - The subtle effects of complex mixtures of contaminants in sediments are not necessarily addressed by chemical specific effect levels.

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SECTION 7

APPLICABLE OR RELEVANT AND APPROPRIATE ENVIRONMENTAL AND PUBLIC HEALTH REQUIREMENTS (ARARs)

SECTION 7

APPLICABLE OR RELEVANT AND APPROPRIATE ENVIRONMENTAL AND PUBLIC HEALTH REQUIREMENTS (ARARs)

U.S. EPA policy, as reflected in the Superfund Amendments and Reauthorization Act of 1986 (SARA) and in the National Contingency Plan (NCP), provides that the development and evaluation of remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund) must include a comparison of alternative site responses able to meet applicable or relevant and appropriate federal and state environmental and public health requirements (ARARs).

ARARs are defined as follows:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.
- Relevant and Appropriate Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site.

Identification of ARARs is performed on a site-specific basis. Neither CERCLA, SARA, nor the NCP provides across-the-board standards for determining whether a particular remedy will produce an adequate cleanup at a particular site. Rather, the process recognizes that each site will have unique characteristics that must be evaluated and compared to those requirements that apply under the given circumstances. Under SARA, permits for compliance with the Resource Conservation and Recovery Act (RCRA), National Pollutant Discharge Elimination System (NPDES), and Clean Air Act (CAA) regulations for on-site remedial actions are not required. CERCLA and SARA, however, do require that the selected alternative meet relevant and appropriate regulations where

possible. The remedial action selected must meet all enforceable and applicable requirements unless a waiver from specific requirements has been granted. A waiver from a specific ARAR can be granted for an alternative under the following circumstances:

a. The alternative is an interim measure and will become part of a total remedial action that will meet ARARs.

b. Compliance with the ARAR is technically impractical from an engineering perspective.

c. Compliance with the ARAR will result in a greater risk to human health and the environment than other alternatives.

d. The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through the use of another method or approach.

e. With respect to a state ARAR, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state.

f. For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment.

ARARs are divided into the following categories:

- Chemical-Specific Requirements are health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances pollutants, or contaminants. These limits may take the form of cleanup levels or discharge levels.

- Location-Specific Requirements are restrictions on activities that are based on the characteristics of a site or its immediate environment. An example is a restriction on development of wetlands.

- Action-Specific Requirements are controls or restrictions on particular types of activities in related areas such as hazardous waste management or wastewater treatment. An example is RCRA incineration standards.

The chemical-specific, location-specific, and action-specific ARARs for the NWS Earle site are summarized in Tables 7-1, 7-2, and 7-3, respectively, and are described in more detail in the following subsections.

7.1 CHEMICAL-SPECIFIC ARARs FOR THE NWS EARLE SITE

"Chemical-specific requirements set health or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants" (52 FR 32496). These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or indicate a safe level of discharge that may be incorporated in a remedial activity.

7.1.1 Resource Conservation and Recovery Act Requirements (RCRA)

No conclusive evidence exists that RCRA hazardous waste (i.e., waste regulated under RCRA Subtitle C) was disposed of at NWS Earle. Further, the U.S. Navy ceased disposal operations at the sites prior to the enactment of RCRA Subtitle C. Due to the lack of evidence of disposal of RCRA hazardous waste, RCRA would not be considered applicable. However, RCRA standards may be considered relevant and appropriate for groundwater at the time of cleanup because the constituents encountered at the sites are sufficiently similar to RCRA spent solvent wastes. Similarly, RCRA standards may be considered relevant and appropriate to soils at the time of cleanup because the soils exhibit concentrations of heavy metals which are expected to exceed toxicity characteristic leaching procedure (TCLP) regulatory limits. Regulations promulgated under this act generally establish technology-based requirements for active or proposed hazardous waste facilities. RCRA requirements include, for example, groundwater protection, closure, and minimum technology requirements for hazardous waste treatment, storage, and disposal (TSD) facilities.

The RCRA regulations contain health-based groundwater protection standards for corrective action at permitted hazardous waste facilities. These groundwater protection standards

Table 7-1

Chemical-Specific ARARs for the NWS Earle Site

New Jersey Drinking Water Regulations
Resource Conservation and Recovery Act
Federal Drinking Water Standards
Federal Surface Water Quality Criteria
New Jersey Water Quality Standards
New Jersey Pretreatment Regulations
New Jersey Soil and Groundwater Cleanup Standards

Table 7-2

Location-Specific ARARs for the NWS Earle Site

National Historic Preservation Act
Endangered Species Act
Endangered and Non-Game Species Act
Fish and Wildlife Coordination Act
Protection of Wetlands (Executive Order 11990)
New Jersey Freshwater Wetlands Protection Act
Federal Water Pollution Control Act
Safe Drinking Water Act (SDWA)

Table 7-3

Action-Specific ARARs for the NWS Earle Site

Discharge of Treatment System Effluent
Excavation
Air Emission Standards for Process Vents
Surface Water Control
Treatment (in a Unit)
Land Disposal
Offsite Treatment
Coastal Zone Management Act
New Jersey Coastal Zone Management Rules
New Jersey Resource Conservation and Recovery Act
New Jersey Pollutant Discharge Elimination System
New Jersey Noise Control Act
New Jersey Requirements for permitting wells
New Jersey Regulations on Permits and Certificates: Air-Stripping Equipment

Table 7-4

RCRA Maximum Constituent Concentration for Groundwater Protection

Parameter	Concentration (mg/L)
Arsenic	0.05
Barium	1
Cadmium	0.01
Chromium	0.10
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05

Source: 40 CFR 264.94

establish maximum concentration limits for selected organic and inorganic constituents that are identical to the Maximum Contaminant Levels (MCLs) established for these chemicals under the Safe Drinking Water Act (SDWA). Table 7-4 presents RCRA maximum concentration limits for the parameters of potential concern at this facility. **These limits are applied at the specific point of compliance unless background levels for the particular chemical already exceed the maximum concentration limit.**

Any remedial alternative that includes off-site treatment or disposal would involve the transportation of contaminated material to a RCRA-permitted facility. In addition, any land disposal activities would be subject to the RCRA land disposal restrictions (1986). An on-site TSD facility, used in site remediation, will require compliance with RCRA standards. Finally, because this facility is located adjacent to wetlands and in Pinelands (see Subsection 7.2.5), remedial actions should comply with the RCRA location requirement that the facility is designed, constructed, operated, and maintained to avoid adversely affecting these areas.

7.1.2 Federal Drinking Water Standards

Under the SDWA, EPA established regulations to protect the public from contaminants in drinking water. These SDWA regulations are not considered applicable but relevant and appropriate for the NWS Earle site because no residential wells are located in the vicinity of the site. However, the possibility of off-site transport of contaminated surface soils, via natural and manmade drainages to tributaries of the Swimming River, Manasquan River, and the Shark River, exists and could potentially impact local drinking water supplies. The National Interim Primary Drinking Water Standards, established under the SDWA, are promulgated as MCLs. An MCL represents the maximum allowable level of a constituent in public water systems. Table 7-5 presents the MCLs established for constituents both identified and potentially present at the NWS Earle site. Maximum contaminant level goals (MCLGs), where available, are also shown in Table 7-5. MCLGs are non-enforceable, health-based concentrations at which no known or anticipated adverse effects will occur with an adequate margin or safety. MCLs, as opposed to MCLGs, are usually adopted as ARARs. MCLGs will be included as to-be-considered materials (TBCs).

Table 7-5

Federal Drinking Water Standards

Parameter	Secondary Drinking Water MCL (mg/L)	SDWA MCLG (mg/L)[a]	SDWA MCL (mg/L)
Aluminum	0.05		
Arsenic			0.05
Barium		2	2
Cadmium		0.005	0.005
Chromium		0.1	0.1
Copper	1	1.3	
Iron	0.3		
Lead		0	0.05
Manganese	0.05		
Mercury		0.002	0.002
Selenium		0.05	0.05
Silver	0.1		
Zinc	5		
Nitrate (as N)		10	10
Nitrite (as N)		1	1
Total Nitrate + Nitrite (as N)		10	10
Benzene		0	0.005
Chlordane		0	0.002
o-Dichlorobenzene		0.6	0.6
p-Dichlorobenzene		0.075	0.075
1,2-Dichloroethane		0	0.005
1,1-Dichloroethylene		0.007	0.007
c-1,2-Dichloroethylene		0.07	0.07
t-1,2-Dichloroethylene		0.1	0.1
2,4-DNT		0.07	0.07

Table 7-5

Federal Drinking Water Standards (Continued)

Parameter	Secondary Drinking Water MCL (mg/L)	SDWA MCLG (mg/L)[a]	SDWA MCL (mg/L)
Ethylbenzene		0.7	0.7
Monochlorobenzene		0.1	0.1
Pentachlorophenol		0	0.001
PCBs		0	0.0005
Tetrachloroethylene		0	0.005
Toluene		1	1
1,1,1-Trichloroethane		0.2	0.2
Trichloroethylene		0	0.005
Vinyl Chloride		0	0.002
Xylenes (Total)		10	10

[a]Non-zero MCLGs are ARAR in areas where groundwater is classified as a current or potential source of drinking water.

Sources: 40 CFR 141.11-16; 40 CFR 143; 40 CFR 141.50-51; 40 CFR 141.60-62

7.1.3 New Jersey Drinking Water Regulations (NJAC 7:10)

MCLs for drinking water have been established under the New Jersey Safe Drinking Water Act (NJSA 58:12A-1). MCLs for constituents both identified and potentially present at the NWS Earle facility are summarized in Table 7-6. The New Jersey MCLs are generally equal to or more stringent than SDWA MCLs and may address constituents for which SDWA MCLs have not been established. For constituents not addressed under NJAC 7:10, the state adopts national drinking water regulations. This standard is considered to be relevant and appropriate to the NWS Earle site.

7.1.4 Federal Surface Water Quality Criteria

The provisions of 40 CFR 131 [Clean Water Act (CWA)] state that remedial actions shall attain federal surface water quality criteria where they are relevant and appropriate. Federal surface water quality criteria have been published for 65 pollutants listed as toxic under the CWA. These criteria are unenforceable guidelines that may be used by states to set surface water quality standards but are included as TBCs. 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 reflect local conditions.

The water quality criteria are generally provided for different surface water use designations. Concentrations are specified that, if not exceeded, should protect most aquatic life against acute toxicity or chronic toxicity (24-hr average). For many chemical compounds, specific criteria have not been established because of insufficient data. Table 7-7 provides the most recent water quality criteria for those pollutants designated as toxic under CWA. Water quality criteria for the protection of aquatic life and the protection of human health (fish and water consumption) are presented. Federal water quality criteria will be compared with New Jersey surface water quality standards. For the parameters in which both federal and state standards have been established, the more stringent standard will be considered the appropriate standard.

Table 7-6

New Jersey Drinking Water Regulations (NJAC 7:10)

Parameter	Primary Standard MCL (NJAC 7:10 - 16.7) (mg/L)	Secondary Standard MCL (NJAC 7:10 - 7.1) (mg/L)
Copper		1
Iron		0.3
Manganese		0.05
Zinc		0.5
Benzene	0.001	
Chlordane	0.0005	
Chlorobenzene	0.004	
o-Dichlorobenzene	0.6	
m-Dichlorobenzene	0.6	
1,2-Dichloroethane	0.002	
1,1-Dichloroethylene	0.002	
1,2-Dichloroethylene; (cis and trans)	0.01	
Methylene Chloride	0.002	
PCBs	0.0005	
Trichlorobenzenes; (1,2,4-TCB)	0.008	
1,1,1-Trichloroethane	0.026	
Trichloroethylene	0.001	
Vinyl Chloride	0.002	
Xylenes	0.044	

Table 7-7

Federal Water Quality Criteria[a]

Parameter	Freshwater Aquatic Life Acute/Chronic (mg/L)	Human Health Water and Fish Ingestion (Units/L)
Acenaphthene	1.7/0.52	
Aldrin	0.003/--	0.074 ng
Antimony	9.0/1.6	146 ug
Arsenic		2.2 ng
Arsenic (V)	0.85/0.048	
Arsenic (III)	0.36/0.19	
Benzene	5.3/--	0.86 ug
Beryllium	0.13/0.0053	6.8 ng
Cadmium	0.0039/0.0011[b]	10 ug
Chlordane	0.0024/0.0000043	0.46 ng
Chlorinated Benzenes	0.25/0.05	
Chloroform	28.9/1.24	0.19 ug
Chromium (VI)	0.016/0.011	50 ug
Chromium (III)	1.7/0.21[b]	170 mg
Copper	0.018/0.012[b]	
Cyanide	0.022/0.0052	200 ug
DDT	0.0011/0.000001	0.024 ng
DDT Metabolite (DDE)	1.05/--	
1,2-Dichloroethane	118/20	0.94 ug
Dichloroethylenes	11.6/--	0.033 ug
Dieldrin	0.0025/0.0000018	0.071 ng
Dinitrotoluene	0.33/0.23	
Ethylbenzene	32/--	1.4 mg
Flouranthene	3.96/--	42 ug
Lead	0.082/0.0032[b]	50 ug
Mercury	0.0024/0.000012	144 ng
Naphthalene	2.3/0.62	

Table 7-7

Federal Water Quality Criteria[a] (Continued)

Parameter	Freshwater Aquatic Life Acute/Chronic (mg/L)	Human Health Water and Fish Ingestion (Units/L)
Nickel	1.4/0.16[b]	13.4 ug
Nitrosamines	5.85/--	
Pentachlorophenol	0.02/0.013[c]	1.01 mg
Phenol	10.2/2.56	3.5 mg
Selenium	0.28/0.036	10 ug
Silver	0.0041/0.00012[b]	50 ug
Thallium	1.4/0.04	13 ug
Toluene	17.5/--	14.3 mg
1,1,1-Trichloroethane		18.4 mg
Trichloroethylene	45/21.9	2.7 ug
Vinyl Chloride		2 ug
Zinc	0.12/0.11[b]	

[a]These are unenforceable goals; to-be-considered.
[b]Water hardness dependent.
[c]pH dependent.

Sources: U.S. EPA Quality Criteria for Water 1986, EPA 440/5-86-001, May 1986

7.1.5 New Jersey Water Quality Standards (NJAC 7)

The State of New Jersey regulates discharge to waters of the state in accordance with the regulations of the New Jersey Pollutant Discharge Elimination System (NJPDES) (NJAC 7:14A). Standards have been established for NJPDES permits addressing discharges to groundwater under the New Jersey Water Pollution Control Act (NJSA 58:10A). These standards are summarized in Table 7-8.

Table 7-8

New Jersey Groundwater Protection Standards (NJAC 7:14A - 6.15)

Parameter	MCL (mg/L)
Arsenic	0.05
Barium	1
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05

The New Jersey Department of Environmental Protection and Energy (NJDEPE) has also developed surface water (NJAC 7:9-4) and groundwater (NJAC 7:9-6) quality criteria in accordance with the New Jersey Water Pollution Control Act and the New Jersey Water Quality Planning Act (NJSA 58:11A). These regulations specify the classification of various state waters and provide the conditions and procedures for obtaining the appropriate permits. Additionally, these regulations prohibit the degradation of water quality within the Pinelands area.

Under the New Jersey Water Pollution Control Act, the state has set criteria for surface water based on classification. The streams and brooks found on the main base at the NWS Earle site have been classified by NJDEPE as FW2 (general freshwater). Available New Jersey surface water quality standards (NJAC 7:9-4:14) for selected chemical constituents both identified and potentially present at this site are listed in Table 7-9. Standards have also been established for New Jersey groundwater quality criteria (NJAC 7:9-6.6) and are included in Table 7-9. These water quality standards serve as the basis for establishing NJDEPE effluent standards. In addition to these standards, Discharges of Petroleum and other Hazardous Substances (NJAC 7:1E) prohibits the discharge of any oils and other hazardous substances into the waters of the state. These regulations are considered applicable to treatment discharges that may be generated at the NWS Earle site.

7.1.6 New Jersey Pretreatment Regulations

The New Jersey Pretreatment Regulations (NJAC 7:9-5) contain effluent standards for toxic discharges to surface waters. These regulations also contain minimum treatment requirements for discharge to surface waters. Because the NWS Earle site is located in the Atlantic Coastal Plain Watershed and the streams and brooks at NWS Earle are classified as FW2, BOD_5 removal for any discharge to these streams must be 95%. This is the minimum removal level allowed. Levels over 4-hour periods may exceed average conditions, but still must comply with a minimum 95% of removal. Additionally, the concentration of BOD_5 must not exceed 15 mg/l. Additionally, since this site is within the Pinelands area, effluent discharge may not degrade existing water quality. This regulation is applicable to any treatment discharges that may be generated during remediation.

7.2 LOCATION-SPECIFIC ARARs FOR THE EARLE NAVAL BASE

Location-specific requirements "set restrictions on activities depending on the characteristics of a site or its immediate environs" (52 FR 32496). In determining the use of these location-specific ARARs for selection of remedial actions at CERCLA sites, one must investigate the jurisdictional prerequisites of each of the regulations. Basic definitions,

Table 7-9

New Jersey Water Quality Standards (NJAC 7:9)

Parameter	Surface Water Quality Criteria[a] (NJAC 7:9-4.14) (mg/L)	Groundwater Quality Criteria[b] (NJAC 7:9-6.6) Primary (mg/L)	Secondary (mg/L)
Aldrin/Dieldrin	0.0000019	0.000003	
Arsenic	0.05	0.05	
Barium	1	1	
Cadmium	0.01	0.01	
Chromium	0.05		
Chromium (VI)		0.05	
Copper			1
Cyanide		0.2	
DDT + Metabolites	0.000001	0.000001	
Iron			0.3
Lead	0.05	0.05	
Manganese			0.05
Mercury	0.002	0.002	
Phenol		3.5	0.3
PCBs	0.000014	0.000001	
Selenium	0.01	0.01	
Silver	0.05	0.05	
Zinc			5

[a]Standards for FW2 classified waters.
[b]Standards for GWs classified waters; assumes total dissolved solids (TDS, natural background) concentration is less than or equal to 500 mg/L.

exemptions, etc., should be analyzed on a site-specific basis to confirm the correct application of the requirements.

7.2.1 National Historic Preservation Act (16 USC 470 et seq.)

The National Historic Preservation Act is applicable to those properties included in, or eligible for, the National Register of Historic Places. This ARAR requires that action be taken to preserve historic properties. Planning of action to minimize the harm to national historic landmarks is required. The state 1-A Cultural Resources Survey will identify any historic landmarks within the NWS Earle site as required by EPA.

7.2.2 Endangered Species Act (16 USC 1531 et seq.) and the Endangered and Non-Game Species Act (NJSA 23:2A-1 et seq.)

The Endangered Species Act of 1973 is applicable if endangered species or threatened species are present. This Act requires that action be performed to conserve endangered species or threatened species. Activities must not destroy or adversely modify the critical habitat upon which endangered species or threatened species depend. Title 23 of the New Jersey Statutes vests the responsibility for the propagation, protection, and preservation of fish, birds, and game animals in the NJDEPE Division of Fish, Game, and Wildlife. Included in this title is the Endangered and Non-Game Species Act. It regulates the conservation, management, enhancement, and protection of endangered species and non-game species of wildlife. Site 11 of the NWS Earle site harbors the threatened plant species Rhynchospora Knieskernii, and thus this regulation is applicable.

7.2.3 Fish and Wildlife Coordination Act (16 USC 661 et seq.)

The purposes of the Fish and Wildlife Coordination Act are to conserve and promote conservation of fish and wildlife and their habitats. The act pertains to activities that modify a stream or river and affect fish or wildlife. Actions must be taken to protect those fish and wildlife resources affected by site activities. Activities involving drainage from the site into

area streams and brooks could be affected by this ARAR. This act is, therefore, considered to be applicable.

7.2.4 Protection of Wetlands (Executive Order 11990)

This regulatory requirement pertains to wetlands as defined in Section 7 of the Executive Order. Activities performed in a wetland area are required to take actions to minimize the destruction, loss, or degradation of the wetland. As portions of the NWS Earle are within wetland areas, this regulation is applicable.

7.2.5 New Jersey Freshwater Wetlands Protection Act (NJSA 13:9B-1 et seq.)

This act requires a permit for any "regulated activity" resulting in any disturbance of a wetland area. Regulated activities include draining, dredging, excavation, soil removal, discharge of liquid wastes, and any construction alteration resulting in a disturbance of the water table or water level. This ARAR would apply for any activity disturbing the wetland areas of the NWS Earle site. On-site groundwater extraction may result in a change in the water table in the wetland, hence a permit may be required under this ARAR.

7.3 ACTION-SPECIFIC ARARs FOR THE NWS EARLE SITE

Action-specific ARARs are usually technology-or activity-based requirements or limitations on actions taken with respect to site remediation. These requirements are triggered by the particular activities that are selected to accomplish the cleanup. The action-specific requirements do not in themselves determine which remedial alternative is selected; rather they indicate how a selected alternative must be implemented.

7.3.1 Discharge of Treatment System Effluent

The discharge of treatment system effluent regulations have been established under the CWA. Under these regulations, the use of the best available technology (BAT)

economically achievable is required to control toxic and nonconventional pollutants, and the use of the best conventional pollutant control technology (BCT) is required to control conventional pollutants (40 CFR 122.44 (a)). Technology-based limitations, however, may be determined on a case-by-case basis.

Compliance with applicable federally approved state water quality standards must be demonstrated (40 CFR 122.44 (d) and 40 CFR 131.4). These standards may be in addition to or more stringent than other federal standards under the CWA.

A Best Management Practices program must be developed and implemented to prevent the release of toxic constituents to surface waters (40 CFR 125.100). According to 40 CFR 125.104, this program must:

- Establish specific procedures for the control of toxic and hazardous pollutant spills.
- Include a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a potential for equipment failure.
- Assure proper management of solid and hazardous waste in accordance with regulations promulgated under RCRA.

To assure compliance under 40 CFR 122.44 (i), the discharge must be monitored for the following:

- Mass of each pollutant.
- Volume of effluent.
- Frequency of discharge and other measurements as appropriate.

In addition, approved test methods for the waste constituents to be monitored must be followed (40 CFR 136). Detailed requirements for analytical procedures and quality control are provided and sample preservation procedures, container materials, and maximum allowable holding times are prescribed.

Finally, under 40 CFR 122.41 (d+e), the following additional substantial conditions must be complied with:

- Duty to mitigate any adverse effects of any discharge.
- Proper operation and maintenance of the treatment system.

7.3.2 Excavation

Movement of excavated materials to new location and placement in or on land may trigger land disposal restrictions (40 CFR 268) for the excavated waste or closure requirements for the unit in which the waste is being placed (40 CFR 264.228,258). In addition, the area from which materials are excavated may require cleanup to levels established by closure requirements.

Closure requirements under 40 CFR 264.110 may apply to soil from excavation. These requirements state that the owner or operator of a hazardous waste management facility must close it in a matter that:

- Minimizes the need for further maintenance.
- Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.
- Complies with the closure requirements of 40 CFR 264, Subpart G, including, but not limited to, the requirements for containers (40 CFR 264.178), tank systems (40 CFR 264.197), surface impoundments (40 CFR 264.228), waste piles (40 CFR 264.258), land treatment (40 CFR 264.280), landfills (40 CFR 264.310), incinerators (40 CFR 264.351), and miscellaneous units (40 CFR 264.601-603).

7.3.3 Air Emission Standards for Process Vents (40 CFR 264.1030)

Air emission standards pertaining to process vents of operations, including air or steam stripping operations, that manage hazardous waste with organic concentrations of at least

10 ppm by weight are outlined in 40 CFR 264.1030. The operator shall either reduce organic emissions from all affected process vents at the facility below 1.4 kg/hr and 2800 kg/year, or reduce, by use of a control device, total organic emissions from all affected process vents at the facility by 95 weight percent.

7.3.4 Surface Water Control

For waste piles (40 CFR 264.251 (c)+(d)), land treatment facilities (40 CFR 264.273 (c)+(d)), and landfills (40 CFR 264.301 (f)+(g)), the owner or operator must prevent runon and control and collect runoff from a 24-hour 25 year storm. They must also prevent over-topping of surface impoundment (40 CFR 264.221(c)).

7.3.5 Treatment or Storage (In a Unit)

The design and operating standards for a unit in which hazardous waste is treated or stored are specified for the following units:

- Containers (40 CFR 264.170-178)
- Tanks (40 CFR 264.190-199)
- Surface Impoundments (40 CFR 264.220-231)
- Waste Piles (40 CFR 264.250-259)
- Land Treatment Unit (40 CFR 264.270-283)
- Landfills (40 CFR 264.300-317)
- Incinerators (40 CFR 264.340-351)
- Corrective Action Management Units (40 CFR 264.552-553)
- Miscellaneous Treatment Units (40 CFR 264.601)
- Thermal Treatment Units (40 CFR 265.70)
- Process Vents (40 CFR 264.1030-1037)
- Containment Buildings (40 CFR 264.1100-1103)

7.3.6 Land Disposal

The land disposal restrictions (40 CFR 268) are applicable when land disposal of specific RCRA Subtitle C wastes occurs. As previously indicated, the presence of heavy metals in soils, and solvents in groundwater suggests the presence of a RCRA characteristic or listed

waste. The land disposal restrictions may therefore be considered relevant and appropriate to remedial actions involving land disposal. To satisfy the requirements of the land disposal restrictions, waste must be treated to Best Demonstrated Available Technology (BDAT) levels prior to land disposal.

7.3.7 Off-Site Treatment (40 CFR 262)

Transport of hazardous wastes to an off-site facility are regulated under RCRA (40 CFR 262). Standards set under 40 CFR 262 include procedures for manifesting, transporting, and recordkeeping. To be in compliance with OSWER Directive Number 9834.11, the offsite facility accepting the wastes must be permitted under RCRA; conforming to the standards identified in Subsection 7.3.5. The land disposal restrictions (40 CFR 268) may also be triggered during offsite treatment actions.

7.3.8 Actions within the Coastal Zone

If actions considered in the FS affect any land or natural resource within the coastal zone, such action will be subject to the regulations promulgated under the Coastal Zone Management Act (16 USC 1451), and the New Jersey Coastal Zone Management Rules (CZMR) (NJAC 7:7E-1.1). The CZMR identifies 48 types of special coastal areas which merit focused attention, and further describes activities which are restricted or prohibited within these areas. Rules covering activities within general land areas are also discussed.

7.3.9 New Jersey Action-Specific ARARs

New Jersey received final authorization under Section 3006 of RCRA to operate a hazardous waste program in lieu of the federal hazardous waste program, effective on 24 February 1985. In many respects, New Jersey's list of hazardous wastes is more extensive than EPA's and includes certain wastes that EPA does not identify. The New Jersey regulations are also more stringent than the federal RCRA regulations with respect to inspection and monitoring requirements, financial responsibility requirements, disclosure

requirements in the application for permits, and in other aspects of the hazardous waste management program. The New Jersey RCRA regulations are found in NJAC 7:26, Hazardous Waste Regulations.

The regulation of water pollution in New Jersey is governed by the Water Pollution Control Act, which prohibits the discharge of any pollutant into waters of the state without a valid permit. The act provides NJDEPE with broad authority to achieve a stated goal of the act: to restore, enhance, and maintain the integrity of New Jersey's waters. A second goal of the Act is to provide NJDEPE with sufficient authority to qualify to administer the discharge permit system required under the federal Water Pollution Control Act. To this end, NJDEPE has developed a regulatory program that governs the discharge of pollutants to surface waters and incorporates all the necessary requirements of the federal act. NJDEPE has been authorized by EPA to administer the federal water pollution program. In addition to regulating discharges to surface waters, the New Jersey Act also prohibits discharging to groundwater without a permit; thus, NJDEPE's regulatory program extends to groundwater releases. Finally, NJDEPE's water pollution control regulations govern the discharge of industrial pollutants to municipal or privately owned treatment works.

The New Jersey Water Pollution Control Regulations are found in NJAC 7:14A (NJPDES). It is noted that because the NWS Earle site is regulated by CERCLA/SARA, obtaining an NJPDES permit may not be necessary; however, compliance with the substantive requirements of this permit must be demonstrated prior to any remedial activities involving discharge of water to a surface water body.

The emission of air pollutants into the outdoor atmosphere is regulated by the state pursuant to the federal CAA and the New Jersey Air Pollution Control Act (APCA). The APCA covers any equipment capable of causing an emission of an air contaminant to the outdoor atmosphere that is installed or altered after 15 June 1967. The primary agency with the power to implement and enforce the APCA is the NJDEPE. Regulations pursuant to the APCA have been promulgated by NJDEPE. Regulations applicable to the NWS Earle

site include permitting of air-stripping equipment (NJAC 7:27-8.2) and discharging of toxic volatile organic substances (NJAC 7:27-17).

New Jersey Regulations on Permits and Certificates require a permit for air-stripping equipment, unless applied as a water treatment and the concentration of each toxic substance included in NJAC 7:27-17 does not exceed 100 ppb by weight and total concentration volatile organic substances does not exceed 3500 ppb by weight. Furthermore, any source operation that has the potential to emit any toxic substance at a rate greater than 0.1 lb/hr requires a permit. As noted for the NJPDES, and CERCLA/SARA on-site remedial activities do not require a permit; however, compliance with the substantive requirements of a permit is required. Depending on the treatment alternative selected, these emission standards may serve as relevant and appropriate ARARs to the NWS Earle site.

The New Jersey Noise Control Act created the Noise Control Council, which assists and advises the NJDEPE in adopting and enforcing rules and regulations necessary to abate noise in the community. Substantive noise regulations are adopted and enforced by NJDEPE. Under NJAC 29:1, maximum limits allowable for sound from any industrial, commercial, public service, or community service facility are specified. These action-specific ARARs may be applicable to remediation activities on the NWS Earle site.

Finally, under NJAC 7:9-7, the general requirements for permitting wells are specified. In addition, NJAC 7:9-9 specifies the general requirements for sealing of abandoned wells. These action-specific ARARs may be relevant and applicable to remediation activities on the NWS Earle site.

7.4 TO-BE-CONSIDERED MATERIALS (TBCs) FOR THE NWS EARLE SITE

In addition to legally binding laws and regulations, federal and state environmental and public health programs issue nonpromulgated, unenforceable advisories or guidance that are not legally binding. These TBCs should be evaluated along with ARARs. TBCs can include

health advisories, reference doses and potency factors, proposed rules, guidance materials, or policy documents. When evaluating TBCs, professional judgement is required based upon the latest available information. The TBCs for the NWS Earle site are summarized in Table 7-10. The SDWA MCLGs, CWA Guidelines, and New Jersey Soil and Groundwater Cleanup Standards are discussed in Subsections 7.1.2, 7.1.4, and 7.1.7, respectively.

7.4.1 New Jersey Cleanup Guidelines

NJDEPE has developed soil, groundwater, and sediment cleanup guidelines for the cleanup of hazardous waste sites. They were officially proposed 3 February 1992 in the New Jersey Register. These guidelines are to be used in evaluating possible cleanup requirements by NJDEPE. The guidelines for appropriate contaminants in soil and groundwater are listed in Tables 7-11 and 7-12, respectively. Furthermore, NJDEPE has issued sediment screening level values to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Sediment screening level values are presented in Table 7-13. These soils, groundwater, and sediment guidelines are to be used in evaluating possible cleanup requirements by NJDEPE.

Table 7-10

TBCs for the NWS Earle Site

World Health Organization Guidelines
Federal Drinking Water Act MCLGs
Clean Water Act Guidelines
New Jersey Soil Cleanup Objectives
New Jersey Groundwater Cleanup Objectives
New Jersey Sediment Cleanup Guidelines

7.4.2 Federal Toxics Criteria for Those States Not Fully Complying with Clean Water Act (CWA) Section 303(c)(2)(B) (56 FR 58420)

Under Section 303(c)(2)(B) of CWA (40 CFR 131), EPA identified three options that could be used by a state to meet the requirements that the state adopt toxic pollutant criteria. These options are:

1. Adopt statewide numeric criteria in state Water Quality Standards for all CWA Section 307(a) toxic pollutants for which EPA has developed criteria guidance, regardless of whether the pollutants are known to be present.

2. Adopt chemical-specific numeric criteria for priority toxic pollutants that are the subject of CWA Section 304(a) criteria guidance where the state determines based on available information that the pollutants are present or discharged and can reasonably be expected to interfere with designed uses.

3. Adopt a procedure to be applied to a narrative water quality standard provision prohibiting toxicity in receiving waters. Such procedures would be used by the state in calculating derived numeric criteria, which must be used for all purposes under Section 303(c) of the CWA. These criteria need to address CWA Section 307(a) toxic pollutants at a minimum.

For states not in compliance with the above options, the EPA has proposed rulemaking that would promulgate chemical-specific, numeric criteria for priority toxic pollutants to be included in 40 CFR 131. EPA's preliminary assessment has determined that the State of New Jersey is not in full compliance with CWA Section 303(c)(2)(B). Table 7-14 summarizes the proposed federal toxics criteria for the State of New Jersey.

Table 7-11

NJDEPE Soil Cleanup Standards

Parameter	Residential Surface (mg/kg)	Non-Residential Surface (mg/kg)	Subsurface (mg/kg)
Acenaphthene	3,400	10,000	100
Acetone	1,000	1,000	50
Acrylonitrile	1	5	100
Aldrin	0.040	0.17	50
Anthracene	10,000	10,000	500
Antimony	14	340	
Arsenic (Total)	20	20	
Barium	600	26,000	
Benzene	3	13	
3,4-Benzofluoranthene Benzo(b)fluoranthene	0.66	2.5	500
Benzo(a)anthracene	0.66	2.5	500
Benzo(a)pyrene (BaP)	0.66	0.66	100
Benzo(k)fluoranthene	0.66	2.5	500
Benzo(ghi)perylene	0.66	2.5	500
Benzyl Alcohol	10,000	10,000	50
Beryllium	2	2	
Bis(2-chloroethyl) ether	1	3	1
Bis(2-chloroisopropyl) ether	2,300	10,000	10
Bis(2-ethylhexyl) phthalate	49	210	100
Bromodichloromethane (Dichlorobromomethane)	5	22	1
Bromotorm	86	370	1
Bromomethane	790	1,000	1
2-Butanone (MEK)	1,000	1,000	50
Butylbenzyl phthalates	10,000	10,000	100
Cadmium	1	100	
Carbon tetrachloride	2	4	1
Chlorobenzene	37	690	1
Chloroform	19	28	1
4-Chloro-3-methyl phenol (p-Chloro-m-cresol)	10,000	10,000	100
Chloromethane	520	1,000	10
2-Chlorophenol	280	5,200	50
Chrysene	0.66	2.5	500
Copper	600	600	
Cyanide	280	5,200	
4,4'-DDD (p,p-TDE)	3	12	100
4,4'-DDE	2	9	100
4,4'-DDT	2	9	100
Dibenz(a,h)anthracene	0.66	0.66	500
Dibromochloromethane (Chlorodibromomethane)	110	1,000	1
Di-n-butyl phthalate	5,700	10,000	100
Di-n-octyl phthalate	1,100	10,000	100
1,2-Dichlorobenzene	5,100	10,000	50
1,3-Dichlorobenzene	5,100	10,000	100
1,4-Dichlorobenzene	280	1,200	100
3,3'-Dichlorobenzidine	2	7	100
1,1-Dichloroethane	1,000	1,000	1
1,2-Dichloroethane	6	24	1
1,1-Dichloroethene	51	940	10
1,2-Dichloroethene (trans)	960	10,000	50
1,2-Dichloroethene (cis)	79	1,500	50
2,4-Dichlorophenol	170	5,200	10
1,3-Dichloropropene (cis and trans)	4	5	1
Dieldrin	0.042	0.18	50
Diethyl phthalate	10,000	10,000	50
2,4-Dimethyl phenol	1,100	10,000	50
Dimethyl phthalate	10,000	10,000	50
2,4-Dinitrophenol	110	2,100	10
2,4-Dinitrotoluene	1	4	10

Table 7-11

Proposed NJDEPE Soil Cleanup Standards (Continued)

Parameter	Residential Surface (mg/kg)	Non-Residential Surface (mg/kg)	Subsurface (mg/kg)
Endosulfan	3	52	50
Endrin	17	310	50
Ethylbenzene	1,000	1,000	100
Fluoranthene	2,300	10,000	500
Fluorene	2,300	10,000	100
Fluoride	1,100	10,000	
Heptachlor	0.15	0.65	500
Hexachlorobenzene	0.42	2	50
Hexachlorobutadiene	11	210	50
Hexachlorocyclopentadiene	400	7,300	100
Hexachloroethane	1,700	10,000	100
Indeno(1,2,3-cd)pyrene	0.66	2.5	500
Isophorone	1,100	10,000	10
Lead (Total)	100	600	
Lindane	0.52	2.2	1
Methoxychlor	280	5,200	500
Mercury (Total)	14	260	
4-Methyl-2-pentanone (MIBK)	1,000	1,000	50
Methylene chloride	49	170	10
Naphthalene	230	4,200	100
Nickel (Soluble salts)	250	2,400	
Nitrobenzene	1	520	50
N-Nitrosodiphenylamine	140	590	100
N-Nitrosodi-n-propylamine	0.66	0.66	1
PCBs (Polychlorinated biphenyls)	0.45	2	100
Pentachlorophenol	1,700	10,000	100
Phenol	10,000	10,000	50
Pyrene	1,700	10,000	500
Selenium (Total)	1	1,000	
Silver	40	2,000	100
Styrene	23	97	1
1,1,1,2-Tetrachloroethane	260	440	1
1,1,2,2-Tetrachloroethane	34	70	1
Tetrachloroethylene	9	37	1
Thallium	2	2	
Toluene	1,000	1,000	500
Toxaphene	0.62	2.7	100
1,2,4-Trichlorobenzene	1,100	10,000	100
1,1,1-Trichloroethane	210	3,800	50
1,1,2-Trichloroethane	23	420	1
Trichloroethene (TCE)	23	100	1
2,4,5-Trichlorophenol	5,600	10,000	50
2,4,6-Trichlorophenol	62	260	50
Vanadium	380	7,000	
Vinyl chloride	2	7	1
Xylenes (Total)	360	6,300	10
Zinc	1,500	1,500	

Table 7-12

Proposed NJDEPE Groundwater Cleanup Standards for Class II-A Groundwaters

Parameter	Concentration (mg/L)
Acenaphthene	0.4
Acetone	0.7
Aldrin	0.00004
Anthracene	2.0
Antimony	0.02
Benz(a)anthracene	0.01
Benzo(a)pyrene (BaP)	0.02
Benzo(b)fluoranthene	0.01
Benzo(k)fluoranthene	0.02
Bis(2-chlorosopropyl)ether	0.3
Bis(2-ethylhexyl)phthalate	0.03
Butylbenzyl phthalates	0.1
Cadmium	0.004
Chlorobenzene	0.005
Chloroform	0.006
Chrysene	0.02
4,4'-DDD (p,p"-TDE)	0.0001
4,4'-DDE	0.0001
4,4'-DDT	0.0001
Di-n-butyl phthalate	0.9
Dibenz(a,h)anthracene	0.02
1,4-Dichlorobenzene	0.07
1,1-Dichloroethane	0.07
1,2-Dichloroethane	0.002
1,1-Dichloroethylene	0.002
1,1-Dichloroethylene (cis)	0.01
1,2-Dichloroethylene (trans)	0.1
Dieldrin	0.00003
Diethyl phthalate	5.0

Table 7-12

Proposed NJDEPE Groundwater Cleanup Standards for Class II-A Groundwaters (Continued)

Parameter	Concentration (mg/L)
2,4-Dinitrotoluene	0.01
Ethylbenzene	0.7
Fluoranthene	0.3
Fluorene	0.3
Methylene chloride	0.003
Naphtahalene	0.03
Nickel (Soluble salts)	0.1
N-Nitrosodiphenylamine	0.02
N-Nitrodosi-n-propylamine	0.02
Pyrene	0.2
Thallium	0.01
Toluene	1.0
Trichloroethane	0.001
1,1,1-Trichloroethane	0.03
1,1,2-Trichloroethane	0.003
Vinyl chloride	0.002
Xylenes (Total)	0.04
Zinc	5.0

Table 7-13

NJDEPE Sediments Screening Level Values*

Parameter	ER-L (mg/kg)	ER-M (mg/kg)
Antimony	2	25
Arsenic	33	85
Cadmium	5	9
Chromium	80	145
Copper	70	390
Lead	35	110
Mercury	0.15	1.3
Nickel	30	50
Silver	1	2.2
Zinc	120	270
Polynuclear Aromatic Hydrocarbons		
Acenaphthene	0.15	0.65
Anthracene	0.085	0.96
Benzopyrene	0.4	2.5
Chrysene	0.4	2.8
Flouranthene	0.6	3.6
2-Methylnaphthalene	0.065	0.67
Napththalene	0.34	2.1
Phenanthrene	0.225	1.38
Pyrene	0.35	2.2
Total PAH	4	35
Pesticides		
Chlordane	0.0005	0.006

* The ER-L and ER-M are reference numbers used to identify the presence of contamination exceeding levels potentially harmful to aquatic life. Effects Range-Low (ER-L) represents a concentration above which biological effects begin or are predicted for sensitive life species and stages. Effects Range-Medium (ER-M) represents a concentration above which biological effects are frequent or always observed among most species. These are only screening levels, and specific cleanup objectives are to be developed on a case-by-case basis. These are unenforceable goals.

Source: NJDEP, Division of Hazardous Site Mitigation, Guidance for Sediment Quality Evaluations final draft, March 1991

Table 7-14

Federal Toxics Criteria for New Jersey (56 FR 58420)[a]

Parameter	Freshwater Aquatic Life Criterion Concentration Maximum (A)/Continuous (B) (mg/L)	Human Health Water and Fish Ingestion (C) (Units/L)
Antimony	--	14 ug
Arsenic	0.36/0.19	18 ng
Beryllium	--	7.7 ng
Cadmium	0.0039/0.0011[b]	--
Chromium (III)	1.7/0.21[b]	--
Chromium (VI)	0.016/0.011	--
Copper	0.018/0.012[b]	1.3 mg
Lead	0.082/0.0032[b]	--
Mercury	0.0024/0.000012	0.14 ug
Nickel	1.4/0.16[b]	610 ug
Selenium	0.02/0.005	--
Silver	0.0041/--[b]	--
Thallium	--	1.7 ug
Zinc	0.12/0.11[b]	--
Cyanide	0.022/0.0052	700 ug
Benzene	--	1.2 ug
Chlorobenzene	--	680 ug
Chloroform	--	5.7 ug
1,2-Dichloroethane	--	0.38 ug
1,1-Dichloroethylene	--	57 ng
Ethylbenzene	--	3.1 mg
1,1,2,2-Tetrachloroethane	--	0.17 ug
Toluene	--	6.8 mg
t-1,2-Dichloroethylene	--	700 ug
1,1,2-Trichloroethane	--	0.6 ug
Vinyl Chloride	--	2 ug
Pentachlorophenol	0.02/0.013[c]	.28 ug
Phenol	--	21 mg

Table 7-14

Federal Toxics Criteria for New Jersey (56 FR 58420)[a] (Continued)

Parameter	Freshwater Aquatic Life Criterion Concentration Maximum (A)/Continuous (B) (mg/L)	Human Health Water and Fish Ingestion (C) (Units/L)
Acenaphthene	--	1.2 mg
Anthracene	--	9.6 mg
Benzo(a)Anthracene	--	2.8 ng
Benzo(a)Pyrene	--	2.8 ng
Benzo(b)Flouranthene	--	2.8 ng
Benzo(ghi)Perylene	--	2.8 ng
Benzo(k)Flouranthene	--	2.8 ng
Chrysene	--	2.8 ng
Dibenzo(a,h)Anthracene	--	2.8 ng
Diethyl Phthalate	--	23 mg
Di-n-Butyl Phthalate	--	2.7 mg
2,4-Dinitrotoluene	--	0.11 ug
Flouranthene	--	300 ug
Flourene	--	1.3 mg
Indeno(1,2,3-cd)Pyrene	--	2.8 ng
N-Nitroso-Di-n-Propylamine	--	5 ng
N-Nitrosodiphenylamine	--	5 ug
Phenanthrene	--	2.8 ng
Pyrene	--	960 ug
Aldrin	--	0.13
Chlordane	--	0.57
4,4-DDT	--	0.59 ng
4,4-DDE	--	0.59 ng
4,4-DDD	--	0.83 ng
Dieldrin	--	0.14 ng
PCB-1242	--	0.044 ng
PCB-1254	--	0.044 ng

Table 7-14

Federal Toxics Criteria for New Jersey (56 FR 58420)[a] (Continued)

Parameter	Freshwater Aquatic Life Criterion Concentration Maximum (A)/Continuous (B) (mg/L)	Human Health Water and Fish Ingestion (C) (Units/L)
PCB-1221	--	0.044 ng
PCB-1232	--	0.044 ng
PCB-1248	--	0.044 ng
PCB-1260	--	0.044 ng
PCB-1016	--	0.044 ng

[a]Nonpromulgated; officially proposed 19 November 1991.
[b]Water hardness dependent.
[c]pH dependent.

A Criterion Maximum Concentration; highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (1-hour average) without deleterious effects.

B Criterion Continuous Concentration; highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4-days) without deleterious effects.

C Criteria based on 10E-6 risk for carcinogens.

-- No standard provided.

SECTION 8

IDENTIFICATION AND SCREENING OF TECHNOLOGIES

SECTION 8
IDENTIFICATION AND SCREENING OF TECHNOLOGIES

8.1 INTRODUCTION

The objective of this screening is to identify the remedial technologies best suited for further consideration in developing remedial alternatives for the sites at NWS Earle. The focus of the screening process is to eliminate, based on information obtained in the remedial investigation, technologies that are not feasible because they may prove difficult to implement or have severe limitations that would prevent the achievement of remedial objectives. The technologies are considered according to their effectiveness and feasibility in relation to site and waste characteristics.

General response actions have been identified for the sites at NWS Earle. These actions and associated remedial technologies are presented in Table 8-1. Some of these technologies, such as thermal treatment, have various methods of implementation. Each method is discussed and screened separately.

Potential technologies are screened using the following process. First, a brief description of the technology is presented. Then the effectiveness and implementability of the technology in relation to site, waste, and technology characteristics are discussed. The effectiveness evaluation focuses on reliability of the technology, including its stage of development and performance. The discussion of implementability involves primarily technical and institutional concerns. Finally, the costs of implementing a particular technology are discussed on a relative basis. Capital and operating and maintenance (O&M) costs are generally qualified as low, moderate, or high relative to process options of the same technology type. Based on these considerations, a recommendation is then made to retain or eliminate the technology for further consideration.

Table 8-1

Response Actions and Associated Remedial Technologies

General Response Action	Remedial Technology
Soils	
No Action	None
Institutional Controls	Land Use Restrictions Access Restrictions
Removal	Excavation
Containment	Capping Surface Controls - Sedimentation Basins/Ponds - Regrading, Revegetation, and Diversion
Disposal	On-Site Landfill Off-Site Landfill
Treatment	Physical/Chemical - Soil Washing - Stabilization - Critical Fluid Extraction - Dechlorination
	Biological - Landfarming - Composting - Aerobic/Anaerobic Bioreclamation
	In Situ - Bioreclamation - Vitrification - In Situ Volatilization
	Thermal - Rotary Kiln - Infrared Incineration - Fluidized Bed/Circulating Bed - High Temperature, Electrically Powered, Pyrolytic Reactors - Molten Salt Destruction - Plasma Arc

Table 8-1

Response Actions and Associated Remedial Technologies (Continued)

General Response Action	Remedial Technology
Groundwater	
No Action	None
Institutional Controls	Groundwater Monitoring Access Restrictions
Extraction/Removal	Groundwater Collection and Pumping Interception Trenches, Ditches, and Drains
Containment	Vertical Barriers Horizontal Barriers
Treatment	Physical/Chemical - Chemical Neutralization - Precipitation - Ultraviolet Radiation/Ozone/Hydrogen Peroxide - Electrochemical Treatment - Ion Exchange - Ultrafiltration - Reverse Osmosis - Electrodialysis - Activated Carbon Adsorption - Flocculation - Steam Stripping - Air Striping - Filtration Biological - Aerobic Biological Treatment In Situ - In Situ Biodegradation

8.2 SOIL AND SEDIMENT TECHNOLOGIES

8.2.1 No Action

Description - Under the no action alternative, no remedial action would take place at the sites. Current contamination would be left in place, and no changes in contaminant levels would be expected except those resulting from natural processes (i.e., leaching, weathering, or biodegradation). Public access to the site is currently restricted.

Effectiveness - The no action alternative may not result in the attainment of risk-based cleanup criteria or prevention of migration of contamination from the soils to the groundwater. The dominant degradation mechanisms for most of the organic compounds are photolysis and biotransformation. Contaminants that are exposed to sunlight at the surface may degrade fairly rapidly; however, the larger extent of contamination which remains under the surface is not affected by these mechanisms. The biodegradation/ biotransformation of the organic compounds may occur over time by natural processes, but the extent and rate are difficult to predict. The rate of natural degradation is believed to be rather slow, occurring over many years. Inorganic compounds such as metals do not degrade and remain in the soils.

Implementability - The no action alternative can be readily implemented since it would not require any future commitment of resources.

Cost - There is no cost associated with this alternative.

Recommendation - No action will be retained for further consideration as required under the National Contingency Plan. It will function as a baseline to which other technologies can be compared.

8.2.2 Limited Action Consisting of Land Use Restrictions and Access Restrictions

Description - As with no action, this option does not remediate the contaminants that may be present at the site; however, it does involve restricting the use of the site or annotating the property deed to alert concerned parties of the presence of hazardous materials at the site (should it be sold) and to specify that the affected soils and sediments may not be disturbed.

At the present time, public access to the installation is controlled. Additional access restrictions would include installation of a chain link fence around the individual sites within the base. Periodic maintenance of the fences would be required.

Effectiveness - This option would prove effective in limiting the future exposure of potential receptors to site contaminants by restricting land use and access; however, it does not reduce the toxicity, mobility, or volume of contaminated materials as preferred under SARA.

Implementability - This option can be readily implemented with nominal legal actions for deed restrictions. The chain link fence for the individual sites can be readily obtained from many commercial sources and installed using conventional equipment.

Cost - The cost of this option is minimal.

Recommendation - This option will be retained for further consideration as a limited or minimal action technology.

8.2.3 Excavation

Description - Excavation would involve the physical removal of contaminated soils. Once removed, the materials would be managed to minimize or prevent future contact with potential receptors. The excavated soils may be treated to remove or immobilize contaminants or may be left untreated for ultimate disposal. The excavation may be filled,

as necessary, with the original materials after appropriate treatment or with clean fill materials obtained elsewhere, depending on applicable regulatory requirements.

Effectiveness - A major advantage of this technology is that the source of contamination will be removed to the action level. Sampling must be performed to verify this. Removal of the source will benefit the local environment in the long term and minimize potential risks to public health emanating from the site. During excavation activities, the health and safety of workers must be addressed by employing dust suppression measures. Excavation can be accomplished with commonly used construction equipment such as a backhoe, front-end loader, bulldozer, clamshell, or dragline.

Implementability - Site conditions generally dictate whether excavation can proceed in a quick, efficient, and cost-effective manner. Some slope stabilization may be needed for deeper excavations since the sandy soils may cave in as they are excavated. For sites located close to the water table, contingency measures such as shoring and slope stabilization may be required.

If large surface areas are considered, excavation activities would require careful grading and may result in surface runoff that requires monitoring, collection, and sediment control measures. Surface runoff must be controlled, or if not controlled, must meet state water quality standards. Additionally, air emissions would require compliance with the National Ambient Air Quality Standards of the Clean Air Act.

Cost - The cost of this technology is moderate to high depending on volume, characterization of the waste, and technical difficulties, such as shoring and slope stabilization. The excavation of relatively small volumes of surficial material, such as that found in the ordnance disposal and sand blasting/paint chip disposal sites, may be very cost effective. Excavation may be much less cost effective for the solid waste landfills at NWS Earle.

Recommendation - This technology will be retained for further consideration in combination with other soil disposal/treatment technologies.

8.2.4 Capping

Description - Capping consists of covering the contaminated soils with isolation materials. When a low permeability cap is used, the infiltration of precipitation and surface water is prevented, and the leaching of contaminants is reduced or minimized.

A variety of materials can be employed in the construction of a cap, including synthetic membranes such as high-density polyethylene (HDPE), a natural, low-permeability material such as clay, and construction materials such as concrete or asphalt. Generally, a combination of materials is employed to provide maximum protection as a "multilayer" cap. This type of cap, in fact, is used for sites that are required to comply with RCRA standards. Multilayer caps generally include a higher permeability surface covering over the low-permeability layer. Vegetation on this surface covering controls erosion.

Effectiveness - When properly installed, capping is a well proven technology that can be expected to minimize contribution of soils contamination to groundwater contamination. In addition, it isolates the waste from direct contact at the surface of potential receptors.

Hazardous waste/membrane compatibility is an important consideration when capping is suggested for a site. If the waste and the membrane are not compatible, then the membrane may degrade and allow rainwater and surface water to permeate the cap. Soluble hazardous constituents can then mobilize and leach from the soils to the groundwater.

Other important considerations are distance from the affected soils to groundwater and the type of soils that contain the hazardous constituents. For the cap to be fully effective, sufficient distance between the water table and the contaminated soils must be maintained so that the groundwater, even at elevated levels, does not contact the affected soils.

Although multilayer caps are typically preferred, single-layer caps are acceptable under some circumstances. They may also be suitable as interim measures pending final response.

Implementability - Installation of a cap over contaminated soils can be readily implemented if the appropriate materials are available and site conditions are satisfactory. In the case of the solid waste landfills, capping may be effective because the large volumes of waste are mostly inert and not in contact with the groundwater table. The sandy soils at these sites allow high levels of infiltration. The landfills are located in controlled, secure areas in this base.

Proper implementation of a cap system includes security and maintenance programs. A security program would ensure that unwanted external influences, such as vehicular traffic and other possible encroachments, do not damage the integrity of the cap. A maintenance program would have to be managed for the life of the cap and includes inspection, mowing, revegetation, erosion control measures, and management of runoff water. A properly designed, constructed, and maintained cap can have a useful life of at least 20 years and can extend for a significantly longer period of time.

Cost - Capital cost for implementation of this technology is moderate; however, maintenance costs can be substantial because the site would require security, proper cap maintenance, and runoff management for the life of the cap.

Recommendation - This technology will be retained for further consideration.

8.2.5 Sedimentation Basins/Ponds

Description - Sedimentation basins/ponds are used to collect and control suspended solids that are entrained in stormwater runoff. By impeding stormwater flow, time is allowed for gravitational settling of the solids. A sedimentation basin/pond is constructed by placing an earthen dam across a drainage channel or by excavating and installing an impoundment for a controlled water discharge.

Effectiveness - This technology is a proven and effective means to control sediment transport. Sediment transport is of particular concern since significant migration of

contaminated and uncontaminated soils can occur during a storm event, especially when the site is in a disturbed state and more prone to erosion. The use of sedimentation basins/ponds effectively accomplishes the following:

- Downgradient settling of sediment prior to stormwater discharge.
- Downgradient temporary storage of water for testing of the stormwater runoff.
- Control or elimination of surface water runoff.
- Upgradient collection of potential surface water runon.

Implementability - This technology is readily implemented since it employs conventional engineering and construction practices. Sedimentation basins/ponds must be designed with sufficient storage capacity for the expected stormwater runoff/runon. Installation of geotextile silt fencing may be used as a supplemental measure for controlling the transportation of suspended sediments.

Cost - The costs associated with construction of sedimentation basins/ponds are similar to those associated with diversion technologies, which are low.

Recommendation - Sedimentation basins/ponds will not be retained for further consideration as a primary remediation technology; however, this method can be considered in combination with other technologies.

8.2.6 Regrading, Revegetation, and Diversion

Description - Surface regrading and revegetation will promote controlled runoff, enhance evapotranspiration, and reduce potential soil erosion on-site. When used in conjunction with diversion ditches and swales or dikes and berms, site grading can effectively isolate the contaminated area from surface water runon and excessive infiltration by channeling and diverting the surface water flow. At this site, the primary objective is to minimize sediment transport of contaminated surface soils and prevent direct contact with potential receptors during remedial activities. When remedial activities are completed, surface regrading and revegetation will promote restoration of the site to its original natural state.

Effectiveness - Regrading, revegetation, and construction of diversion ditches, swales, dikes, and berms are proven and effective means to eliminate surface water runon, promote surface water runoff, reduce infiltration of water into the subsurface, and minimize erosion. This technology is particularly useful when combined with other remedial technologies. During the excavation of contaminated soils, proper measures must be taken to control erosion and the subsequent transport of contaminated sediment. If a cap is installed, this technology will minimize erosion and damage to the cap. If a treatment technology is set up on-site, proper grading for siting a treatment unit will be required along with diversion of surface water away from the treatment area to prevent contact with the temporarily stored contaminated materials.

Implementability - This technology is readily implemented since it employs conventional engineering and construction practices. Over time, maintenance and repair of the constructed system may be required to ensure peak performance.

State and local regulations often contain requirements for the performance of surface water management systems. Numerous methods are available for determining design characteristics to meet these requirements.

Cost - The cost for this technology is relatively low, with costs dependent on the volume of soil moved and the type of construction materials used.

Recommendation - The surface water management technologies will not be retained for further consideration as a primary remediation technology; however, they can be considered in combination with other technologies.

8.2.7 On-Site and Off-Site Landfill/Disposal

Description - Disposal of contaminated soils and sediments in a landfill that meets RCRA requirements for hazardous waste landfills would effectively contain the wastes and provide long-term security against additional groundwater contamination or direct exposure of

sensitive populations to the waste. Two potential alternatives for contaminated soil at the NWS Earle sites consist of 1) the disposal of materials off-site in an existing, permitted RCRA landfill if these materials are considered hazardous and 2) disposal of materials in a newly constructed on-site landfill.

In the off-site alternative, soils contaminated above the target action level that are considered hazardous would be excavated, loaded onto trucks, and hauled to the nearest RCRA landfill that would accept these soils. An appropriate amount of backfill would be required to restore the site to its previous grades.

In the on-site alternative, a landfill would be constructed at an appropriate location on the NWS Earle installation. This location would likely be at the higher elevations of the facility where the landfill would be situated safely above the water table. Construction of the landfill would include site and foundation preparation, installation of a double liner system, and installation of a leachate detection and collection system in compliance with RCRA. The contaminated soils would then be excavated and staged for placement in the landfill. Following disposal of the soils, a RCRA-level closure would be required that includes multilayer cap installation and maintenance.

If soils are treated prior to land disposal, certain requirements may be waived by the EPA Regional Administrator. Such requirements may include the installation of a double liner system, a leak detection system, multilayer cap, or other appurtenances.

Effectiveness - The disposal of excavated soils in a RCRA-compliant landfill is a straightforward approach to management of the contaminated soils. It is an effective means for reducing the exposure of potential receptors to the contaminants and for preventing contamination of the groundwater.

However, for off-site disposal, the contaminated material must be transported over public roads to the landfill; therefore, there is a public exposure risk associated with this

technology. For on-site disposal, most of the health risks are associated with construction of the landfill where dust and particulate generation must be controlled.

Although this technology would be effective in reducing the mobility of the contaminants, it does not reduce their toxicity or volume. According to SARA, technologies that accomplish all three of these criteria are preferred.

Implementability - For off-site disposal, the affected soils and sediments must be appropriately characterized prior to acceptance at the landfill. Since there is limited landfill capacity across the nation, it may be difficult to obtain acceptance. Transportation of the material to an off-site facility would require compliance with Department of Transportation (DOT) shipping regulations and may require compliance with RCRA manifesting and disposal criteria if the soils and sediments are considered hazardous. Physically, this technology can be readily implemented and involves the use of conventional earthmoving and transportation equipment.

For on-site disposal, siting the landfill will be a primary concern. It appears that there is sufficient space at the facility to install a landfill. However, the shallow groundwater present in the area may prevent implementation of this technology.

Cost - The costs for on-site or off-site landfilling are expected to be moderate to high. The relative costs of on-site versus off-site disposal will be determined in large part by the volume of material to be disposed of.

Recommendation - Off-site and on-site disposal in a landfill will be retained for further consideration.

8.2.8 Soil Washing

Description - Soil washing at NWS Earle would involve excavating soils for subsequent treatment on-site. This technology includes a number of methods for removing

contaminants by contacting soil particles with reagents that are usually water/surfactant or water/solvent solutions. Specifically, the purpose of soil washing is to "wash" contamination off coarse soils and to remove the fines, which typically contain a major portion of the contamination. The fine particles exhibit the largest surface area to which contaminants can adhere. Treatment is usually performed using a multi-staged batch process. As noted, this soil wash operation applies to excavated soil, although a conceptually similar process may be feasible in situ.

Depending upon the efficiency of the extraction, the extraction solutions used, and the required soil treatment criteria, the washed soil may be deemed nonhazardous and reburied on-site or off-site. Treatment of the wash solutions containing the fines and the contaminants would be required.

Effectiveness - The effectiveness of the soil washing process for the NWS Earle soils must be determined by a treatability study. This treatability study would identify optimal reagents, removal efficiencies, and waste volumes generated. Reagent solutions that have potential use for the removal of organic compounds include water, acids, caustics, and some surfactants or combinations thereof. Reagents that show promise in removing metals include water, acids, and complexing agents such as EDTA or citrate buffer. Because of the variety of contaminants to be removed, single reagent extraction may not be sufficient, and multiple steps may be required.

Implementability - The soil washing process is currently being marketed by a number of vendors with mobile units. As noted previously, a treatability study would be required to determine optimal conditions. The desired wash solution would be one that is nontoxic to human health and the environment so that, when the treated soils are backfilled on-site, residual wash solution will not pose any health threats.

In this technology, it is likely that the elutriate stream would require treatment and disposal; therefore, implementation of this technology must involve the consideration of additional treatment or disposal options for this stream.

Cost - Because at this stage potential extraction reagents range from water to relatively expensive reagents or combinations thereof, the total cost of this particular technology may depend upon the results of the site-specific testing program. However, relative to other treatment technologies, costs for soil washing are expected to be moderate.

Recommendation - Soil washing will be retained for further consideration as it can be effective for a variety of contaminants.

8.2.9 Stabilization

Description - Stabilization is a treatment process used to immobilize hazardous waste constituents in a solid matrix through mixing with additives and binders. Application at the NWS Earle site would involve excavation of the contaminated soils and sediments and conversion of these materials to a solid mass that would immobilize leachable contaminants. Stabilization technologies are partial remedial measures. Stabilized materials must be properly disposed of in an off-site permitted landfill or in an on-site landfill that complies with applicable and appropriate regulations.

Various stabilization techniques have been used to stabilize contaminated liquids and solids (Tittlebaum el al., 1985). Some are described below:

- Cement-Based Processes - Wet wastes and sludges are combined with Portland cement and proprietary additives. The mixture solidifies, developing low permeability and high structural strength in 7 to 28 days, and can be disposed in a landfill.

- Lime-Based or Pozzolanic Processes - A fine-grained aluminous, siliceous material is mixed with lime, water, and the waste constituents. A solidified mass forms in 7 to 28 days that has low permeability and moderate structural strength.

- Thermosetting Organic Polymer - A monomer is mixed with a catalyst and the waste. A polymer is formed, which entraps the waste in a solid matrix.

Effectiveness - Solidification/stabilization has been used successfully to immobilize waste materials. Laboratory bench-scale or pilot-scale tests would be required to confirm the feasibility of the technology (i.e., show that the contaminants are fully immobilized) and to determine the optimal binding materials for the site soils and sediments.

Stabilization is a process that reduces the mobility of contaminants, but does not destroy them. The results of testing are not clear, but some potential for migration appears to remain following stabilization. Therefore, the risk of exposure resulting from leaching contaminants at low rates over the long term still exists. Although stabilization does not destroy contaminants, it may be a valid interim measure to reduce the exposure potential in conjunction with final treatment or disposal options (i.e., stabilization prior to landfilling).

Implementability - Some solidification/stabilization technologies experience a volume reduction; however, with other technologies and certain matrices, the immobilized waste volume may increase, even double. This would affect on-site and off-site disposal options since the amount of space required would be increased.

This technology could be implemented on-site using conventional mixing and construction equipment. Typically, stabilization processes have been applied to liquids and sludges. To treat the soils at NWS Earle, it may be necessary to add a significant amount of water to obtain an optimal moisture content or other additive to attain the appropriate fluidity.

Cost - The cost for the stabilization of soils and sediments using cement or pozzolanic techniques is relatively low.

Recommendation - This technology will be retained for further consideration.

8.2.10 Critical Fluid Extraction

Description - The critical fluid solvent extraction process utilizes the properties of critical fluids to dissolve and/or extract organic compounds from solids. Carbon dioxide and

propane have been used by different vendors as the extraction solvent. The basic steps that comprise the process are as follows:

- The contaminated soils and sediments are fed to the extractor.
- The solvent is compressed to approach its critical point and is fed to the extractor. Up to 99% of the organic compounds from the soil are dissolved and/or extracted by the solvent.
- The organic compound-laden solvent stream is discharged to a separator for solvent recovery.
- Due to the reduced pressure in the separator, the solvent vaporizes. This solvent vapor is collected, compressed, and recycled to the extractor as fresh liquified solvent.
- The organic compounds are drawn off the separator and disposed of as wastewater.

Effectiveness - Critical fluid extraction was proven effective in removing certain organic compounds from soil to levels below 1 mg/kg during a field demonstration. Among these compounds are benzene, toluene, xylene, ethylbenzene, phenanthrene, anthracene, flouranthene, pyrene, 2-methylnaphthalene, acenaphthylene, and fluorene. Other organic compounds have also been extracted by this process. The effectiveness of removal of the organic compounds in the NWS Earle soils is dependent on their initial concentrations in the soil and the site soil characteristics.

Implementability - A treatability study would be needed prior to installation of a unit on-site. This study would indicate whether the extraction can be effectively accomplished in a single stage, or whether multiple stages are required to extract the organic compounds.

Pretreatment may be required for the soils, such as screening particles to less than 5 millimeters (mm) and reducing or separately treating those particles that are larger in size. Leachable metals present in the soils may have to be immobilized. Lime may have to be added to adjust the pH to between 6 and 8, the range necessary for effective extraction.

Cost - The cost for implementing this technology at the NWS Earle site is expected to be high since it is an emerging technology and may require a significant amount of labor and maintenance to prevent excessive downtime.

Recommendation - As this technology has shown success for various organic compounds, it will be retained for further consideration.

8.2.11 Dechlorination

Description - Dechlorination treatment involves the addition of chemical reagents (typically glycol and/or alkali metal based) to break apart or structurally rearrange chlorinated compounds. This technique was developed by Galson Research Corporation (Galson) with assistance from EPA. This soil treatment is targeted for chlorinated biphenyls, dioxins, and dibenzofurans.

After reaction with the reagent, the excess solution is decanted and the soils are washed two or three times with water. The decontaminated soils are then discharged from the process for disposal on-site or off-site. Subsequent treatment of the washwater may be required.

Effectiveness - The chemical dechlorination of soils contaminated with chlorinated aromatics has been demonstrated at the laboratory scale and in field tests, but has not been shown in full scale operation. Initial findings show significant reductions in contaminant levels. This technology has not been demonstrated for the contaminants of concern at the NWS Earle site.

Implementability - Galson currently has reactors for treatment and lab-scale services available. Laboratory testing is required for implementation.

Cost - The cost for the system is expected to be relatively high.

Recommendation - As this technology is not applicable to the contaminants of concern at the NWS Earle site, it will not be retained for further consideration.

8.2.12 Landfarming and Composting

Description - Landfarming is the process by which effected soils are removed and spread over an area to enhance naturally occurring processes. These natural processes include volatilization, aeration, biodegradation, and photolysis.

Landfarming at NWS Earle would involve excavating the affected soils and applying them to a specified area of the installation set aside for this process. If necessary, the pH of the soil could be adjusted with lime to provide a neutral pH. At neutral pH, naturally occurring metals would not be highly mobile, and bacterial processes and growth would be supported. Agricultural fertilizer could be added if the site is deficient in nutrients such as nitrogen, phosphorus, potassium, or trace elements. The soils would be tilled and cultivated at regular intervals to enhance biodegradation by increasing contact between organic compounds and microorganisms and to supply air for aerobic biodegradation.

Composting is similar to landfarming, because both processes rely on the destruction of compounds through microbial metabolism. Composting is a proven technology for achieving the accelerated biodegradation of select industrial and municipal wastes under controlled conditions. This technique has also been demonstrated on a small scale for the remediation of explosives- and pesticide-contaminated soil.

Three general categories of compost systems are used windrow, static pile, and in-vessel. In the windrow method, the most commonly used technique, the mixture to be composted is piled in long rows (windrows) that are turned periodically by mechanical means to increase the exposure of organic matter to oxygen. The static pile (forced aeration) approach utilizes a blower to aerate the mixture to be composted. The mixture is placed on a base of wood chips or other suitable material in which a network of aeration pipes has been constructed. Oxygen is then introduced by blowing or drawing air through the pile.

In-vessel composting, which is currently being developed, occurs in closed containers where environmental conditions can be controlled.

The process flow is similar for all three composting systems. The material to be composted is mixed with a bulking agent or agents such as wood chips, straw, horse manure, sawdust, leaves, or paper. The bulking agent can serve as a source of carbon, nutrients, or microbes. In addition, it increases porosity and aeration. Once the mixture to be composted is in place, it undergoes a self-heating process caused by microbial activity.

After composting, the treated material is usually cured for about 30 days. During this period, additional decomposition as well as stabilization, pathogen destruction, and degassing take place (WESTON, 1988).

Effectiveness - Several studies have shown that a majority of nitroaromatic compounds can be biologically degraded, particularly in the presence of a nutrient or supplemental carbon source. Studies have also shown the successful degradation of pesticides by composting. The degradation of other organic compounds has not been as thoroughly investigated.

Landfarming and composting are still in the developmental stage for treatment of nitroaromatic and organic compounds. These technologies have been extensively used for the treatment of industrial and municipal waste sludges. Their effectiveness on the compounds present in the NWS Earle soils and the products of degradation must be determined by bench- and pilot-scale treatability studies.

Both landfarming and composting are designed to treat organic compounds. If metals are a concern, these technologies must be implemented in combination with one that addresses metals.

Implementability - As noted previously, treatability studies would have to be conducted to determine the feasibility of these technologies at NWS Earle. For both methods, a significant area of the facility would have to be set aside to facilitate proper landfarming or

composting techniques. The time required to achieve adequate degradation is not known and could only be determined by bench-scale and field testing.

The winters in New Jersey can be very cold and can present significant technical difficulties for both landfarming and composting. For landfarming, microbial activity would likely be reduced, and tilling the ground would not be possible if it is frozen. For composting, the piles would have to be covered for heat retention. Lined pads and leachate collection and treatment systems may be required for composting facilities and landfarming staging areas. Exemptions to these requirements may be granted by the U.S. EPA and/or New Jersey state agencies if the area is protected from precipitation, no free liquids are present, the area is protected from runon, the design is such that wind dispersal of wastes is controlled, and no leachate is generated.

Composting requires the addition of a bulking agent. Therefore, after composting is completed, although the contaminant has been degraded, there is an increase in waste volume. This waste volume must be disposed of either on-site or off-site.

Land disposal restrictions may prove to be a significant detriment to the implementation of these technologies. Since there is uncertainty as to the applicability of land ban restrictions, RCRA characteristic site testing (including TCLP) would be needed to determine whether or not hazardous wastes are present.

Cost - The costs for landfarming and composting are expected to be low relative to other treatment technologies.

Recommendation - Due to the potential of land ban restrictions weather constraints and large land area requirements, landfarming will not be retained. Composting, however, will be retained for further consideration.

8.2.13 Bioreclamation

Description - In situ biological treatment, also referred to as bioreclamation, is a technique for treating contaminated soils in place by aerobic or anaerobic microbial degradation. This is accomplished by the addition of oxygen (during aerobic treatment) or ammonia (during anaerobic treatment) and nutrients to soil to enhance the natural biodegradation of organic compounds by microorganisms, resulting in the breakdown and detoxification of organic contaminants. These microorganisms can be naturally occurring, specially adapted, or genetically engineered. Nutrients and, if necessary, oxygen or ammonia are delivered to the soils through injection wells or an infiltration system.

Effectiveness - As noted previously, biodegradation of some organic compounds has been documented in laboratory studies and field tests; however, this method has not been implemented on a full-scale basis for the contaminants of concern at this site. In addition, the breakdown products have not been fully analyzed and may be toxic. The effectiveness of bioreclamation at NWS Earle would have to be determined by a treatability study so that the extent of destruction of the specific organic contaminants of concern and the byproducts of degradation could be better understood. The degradation products may or may not be toxic.

Bioreclamation is sensitive to a number of environmental factors, which include availability of trace nutrients, oxygen concentration, oxidation/reduction potential, pH, degree of water saturation, and temperature. These factors would have to be closely monitored and controlled during operation.

Bioreclamation is not designed to treat inorganic compounds that may be present in soils. If there is metal contamination, this technology would need to be implemented in combination with a technology that could address metals.

Implementability - Controlling flow through the subsurface zone is essential for implementation of this technology. Recovery wells must be placed to ensure complete

capture of the enriched/treated groundwater and to prevent transport of mobilized contaminants and potentially toxic degradation products beyond the treatment zone. Adequate flow control is more readily achieved in homogeneous soils than heterogeneous soils. The shallow water table present throughout the NWS Earle site may make this process difficult to control. Prior to implementation, bench- or pilot-scale tests would be required to determine the feasibility of bioreclamation for the contaminants of concern under site conditions and to determine design and operating parameters.

Cost - The cost of this technology is expected to be moderate.

Recommendation - This technology will be retained for further consideration.

8.2.14 Vitrification

Description - In situ vitrification is a process where in-place soils are converted to a durable, glass-like material as they are heated to extreme temperatures. This conversion is achieved by passing an electrical current through the subject soils that, in turn, produces temperatures in excess of 3,100°F.

The basic design of an in situ vitrification system consists of four electrodes driven into the soil in a square configuration. The electrodes can be constructed of either graphite or molybdenum with spacings up to 20 feet. When an electric current is passed through these electrodes, the temperatures of the effected soil increase until the soil vitrifies. The maximum achievable melt depth varies inversely with increasing electrode spacing.

In the process, most of the organic constituents in the soils are pyrolyzed in the melt or migrate to the surface, where they combust in the presence of oxygen. The off-gases are collected in a hood and directed to an off-gas cleaning train. Inorganic compounds in the soil are effectively bound in the solidified glass. The bulk leach rate of the nitrified mass is reported to be significantly slower than in granite, marble, or bottle glass.

Effectiveness - This is a developing technology that has been tested primarily to treat soils contaminated with radioactive materials. Large-scale testing (400 to 800 tons of vitrified mass) has included the successful treatment of soils contaminated with metals, polychlorinated biphenyls (PCBs), and organic compounds associated with electroplating wastes; however, this technology has not been proven on a large scale as a means to treat hazardous wastes. Demonstrations have shown treatment to be most effective for soils contaminated with a combination of metals and organics. The coarse soils and combination of contaminants present make this treatment technology promising for application at the NWS Earle site.

Implementability - Currently, Geo-Safe Corporation is marketing a full-scale mobile vitrification unit. This unit requires a 3,000 to 4,160-V source. This power supply is readily available at most electrical substations. The needed process equipment is readily installed. Geo-Safe currently has contracts for two full-scale remediation projects (3,000 to 4,000 cubic yards each), but neither is yet underway.

Bench- and/or pilot-scale testing is needed to determine implementability of this process at the NWS Earle site. During this testing, the effect of the shallow groundwater table on the effectiveness and operating costs of the system would be determined.

Cost - The cost for this technology is expected to be high because of the intensive energy requirements.

Recommendation - Because it is used to treat both metals and organic contamination, this technology will be retained.

8.2.15 In Situ Volatilization (ISV)

Description - ISV or soil venting is an emerging technology for in-place soil treatment. It is primarily applicable to the treatment of unsaturated, VOC-contaminated soils. ISV treatment removes VOCs from the soil by mechanically drawing air through the soil pore

spaces. VOCs volatilize into the air as the air moves through the soil. The VOC-laden air is then collected and discharged or is treated, depending on the amount and types of contaminants present.

ISV is accomplished by the installation of an array of vents in the contaminated portion of the unsaturated (vadose) zone. These vents are essentially wells that are completed in the vadose zone. The vents are manifolded to the suction side of air blowers (vacuum pumps), creating a negative pressure in the vents and piping to draw air from the soil. Each vent is valved and can be adjusted to the desired flow rate. Using these valves, an ISV system has the flexibility to withdraw air from the most contaminated areas (thereby maximizing the mass removal rate) or to operate at a lower mass emission rate as may be required by the emissions treatment system.

VOCs are released from the soil matrix into the air being drawn through the soil toward the vents and are discharged through the blower. Depending upon the concentration of the VOCs in the air, emissions controls may be required. Vapor phase carbon treatment of the air stream is a common emissions control technology, particularly for chlorinated solvent contaminants.

Effectiveness - In order to operate efficiently, the unsaturated soil must have a permeability that is sufficient to allow air movement through the soil. Porous soils are ideal for ISV remedial treatment, although contaminant removal has been established in silty clay soils when high vacuum pressures were applied (Metzer et al., 1987). The natural soils at the NWS Earle site are primarily sandy and thus are porous.

At present, ISV is evaluated on the basis of the total amount of contaminant removed from the soil. Specific soil cleanup standards have not been determined. Column leaching tests of the treated soils have been useful in determining the final soil treatment levels, estimating cleanup times, and evaluating the potential of pulse opeation. Although the early results of ISV applications are extremely promising, the exact range of soil and contaminant types where ISV is applicable and its effectiveness are currently being defined.

Bench- and/or pilot-scale testing would be required to determine the effectiveness of ISV treatment for the contaminants of concern given the specific conditions at the NWS Earle site.

Implementability - This technology would involve the installation of a number of "well vents" across the site that must be manifolded to air blowers and subsequently an emission control system. Soil excavation is not required. Since the groundwater at NWS Earle is relatively shallow, this technology may have only limited application.

Cost - The cost for ISV treatment is expected to be moderate.

Recommendation - It is recommended that the ISV process be retained for further consideration.

8.2.16 Rotary Kiln

Description - A rotary kiln is a cylindrical, refractory-lined shell mounted at a slight incline from the horizontal plane. This cylinder is rotated to facilitate mixing of wastes with combustion air and to promote the transfer of wastes through the reactor. A rotary kiln incineration system includes the waste feed system, the rotary kiln incinerator where kiln temperatures reach a maximum of 1,800 °F, the auxiliary fuel feed system, an afterburner that destroys gaseous products produced within the kiln at temperatures as high as 2,200 °F, and air pollution control systems.

Industrial and hazardous waste rotary kiln designs are marketed by a number of vendors in both mobile and transportable applications for on-site use. In addition, a number of off-site commercial facilities are available for incineration in stationary rotary kilns. Mobile incinerators are transported intact to the site. Transportable systems are delivered to the site and assembled. Mobile and transportable units rely on the same technologies as a stationary rotary kiln. The mobile incineration units have capacities ranging from 1 to 5 tons/hour for dry solids feed. Mobilization and demobilization require approximately one

week for these systems. Transportable systems have capacities ranging from 5 to 25 tons/hour for dry solids feed. Mobilization and demobilization require approximately 4 to 6 weeks for these systems.

At the NWS Earle site, the contaminated soils and sediments would be excavated and treated on-site or transported off-site for treatment. If treated on-site, the treated materials and fly ash would be disposed on-site after they are analyzed for compliance with treatment.

Effectiveness - The rotary kiln system is a high-temperature process that has been proven to be effective in incinerating even the most difficult to burn organic compounds. Both on-site and off-site stationary rotary kilns have demonstrated the 99.99% destruction and removal efficiency (DRE) required for hazardous waste incinerators under RCRA.

Implementability - This technology can be implemented either on-site or off-site. The on-site option would involve transporting an incinerator to the site. A suitable location and pad would have to be prepared for the units. A trial burn would likely be required. The small size of the mobile and transportable units necessitates that the feed soil be screened with a maximum top size of 6 inches. A shredder can be used to reduce oversize material. Implementing the off-site option would require acceptance at a permitted treatment facility and transportation of the excavated materials.

Cost - Costs for this technology are expected to be high when compared to other nonthermal on-site treatment technologies.

Recommendation - This technology, both on-site and off-site options, will be retained for further consideration.

8.2.17 Infrared Incineration

Description - Infrared incineration (developed by Shirco Infrared Systems, Inc. and now owned and operated by Ecova Co.) employs a rectangular chamber constructed of carbon

steel lined with ceramic fiber blankets. Waste materials are conveyed through the furnace on a woven wire belt while radiant energy is provided by silicon carbide heating elements positioned above the conveyor. The wastes are gently agitated as they pass through the furnace by means of rotary rakes. The furnace temperature is approximately 1,600 °F. An afterburner is used to further treat the furnace off-gases. The afterburner temperature is approximately 2,300 °F. The infrared incineration system consists of a mobile unit that can be set up on-site. The complete process includes a feed conveyor, rotary air lock, metering conveyor, furnace, ash discharge system, afterburner, and gas cleaning train.

Effectiveness - The infrared incinerator has proven reliable for the on-site incineration of difficult to burn soils, including dioxin-contaminated soils. A trial burn at the Times Beach, Missouri, dioxin site achieved a 99.9999% DRE in July 1985. In addition, it has demonstrated the RCRA-required 99.99% DRE on other principal organic hazards constituents (POHC) such as creosote and pentachlorophenol. Since the infrared incineration process has demonstrated success for the destruction of various organic constituents and dioxin, a difficult to destroy organic compound, it is expected that it can also be successful with the organic compounds found at NWS Earle. A trial burn will be needed to determine the effectiveness of this technology for the organic contaminants at the NWS Earle site.

Implementability - The infrared incineration system has been demonstrated on contaminated soils; however, there is a size limitation for incoming feed. Typically, the particle size of the waste should not exceed 1 to 2 inches; therefore, a shredder may be needed. In past testing, this technology has exhibited mechanical problems due to the complexity of its moving parts. These types of problems can lead to excessive down times in processing.

The availability of a mobile unit is uncertain since there are few vendors for this technology. It is likely that a test run or trial burn will be required before implementation to determine sufficient combustion of the organic compounds in the off-gas stream.

Cost - The cost of this technology is expected to be higher than that for rotary kiln incineration because it has not been as extensively tested and requires more soils pretreatment.

Recommendation - This process will be retained for further consideration.

8.2.18 Fluidized Bed/Circulating Bed

Description - Fluidized bed incineration is characterized by a combustion zone composed of granular refractory materials that are fluidized by air directed upward through the bed. Liquids, waste sludge, or granular solids (with auxiliary fuel as needed) are introduced into the bottom of the bed by pumps or screw feeders or through pneumatic injection. The purpose of the fluidized bed is to promote mixing and instantaneous heat transfer into the cold reactant. Air velocities in the reactor range from 1 to 8 feet per second (fps). Treated solids may be retained as part of the bed or exit with combustion gases, depending on the size of the particles. Exhausts go through a secondary afterburner to destroy vapor-phase residuals. Solids are removed through a bed drain system. Particles elutriated out of the vessel with the off-gas are captured in a cyclone, while acidic gases are neutralized in a wet scrubber system.

The circulating bed incineration technique is a variation of the traditional fluidized bed method. This technology utilizes high air velocities to circulate bed material and combustible waste. Air jets transport the material upward through the reaction zone to the top of the combustion chamber. From the top of the combustion chamber, the material drops to a hot cyclone where off-gases are separated from the solids circulation loop. The solids drop through the hot cyclone and are refed, along with the new waste, into the bottom of the combustion chamber with a water-cooled screw conveyor. The entire loop is kept at a constant temperature between 1,450 °F and 1,600 °F. This technique allows for combustion to take place along the entire loop rather than solely within the length of the fluidized bed column.

Effectiveness - Mobile fluidized bed incinerators have demonstrated 99.99% destruction of one of the most difficult to destroy organic hazardous compounds, carbon tetrachloride. Other compounds destroyed with this efficiency include freon, malathion, PCBs, dichlorobenzene, aromatic nitrile, trichloroethene, and others. Other organic compounds are also expected to be effectively treated. In addition, a transportable circulating bed combustor has been permitted under the Toxic Substances Control Act (TSCA) to burn polychlorinated biphenyls (PCBs).

Fluidized bed incineration systems are especially suited to treating contaminated soils. The abrasive action of the bed provides good heat and oxygen transfer and scrubs organic compounds from the refractory soil particles. This turbulence results in the reduction of organic compounds to small, easily oxidized particles. Problems are associated with disposal of the residual ash for soils containing high metal concentrations.

Implementability - Mobile fluidized bed and transportable circulating bed combustors are currently marketed by a number of vendors. A trial burn would be required to determine sufficient combustion of nitroaromatic compounds in the off-gas stream. A suitable location and pad would have to be prepared for the unit. Fluidized bed technologies require that the feed soil materials be screened with a maximum 1 to 2 inches. A shredder can be used to reduce the size of rejected material.

Cost - The cost of this technology is expected to be high when compared to other treatment technologies.

Recommendation - Fluidized bed/circulating bed incineration will be retained for further consideration.

8.2.19 High Temperature, Electrically Powered, Pyrolytic Reactors

Description - An electrically-heated pyrolytic reactor called the Advanced Electric Reactor (AER) has been developed that provides intense thermal radiation in the near infrared

region at temperatures up to 5,500 °F. A porous, hollow graphite core is used to radiate heat to reactants where they are thermally degraded. This core is heated to incandescence by carbon electrodes located between the core and the outer vessel. Feed reactants are transported through the reactor core and isolated from the rest of the reactor by means of a gaseous blanket formed by nitrogen flowing radially inward through the porous core.

Two post-reactor treatment zones include an insulated vessel to provide additional residence time at 2,000 °F for 5 to 10 seconds and a water-cooled vessel to lower the wastestream temperature to below 1,000 °F. Solids exiting the second post-reactor treatment zone are collected in a sealed bin. Solids remaining in the gas are removed by way of a cyclone followed by a baghouse for fine particle removal.

An electric pyrolyzer has recently been developed by Westinghouse that uses electrical energy to achieve temperatures in the vicinity of 3,000 °F in a pyrolyzer reaction chamber. These temperatures reduce and destroy organic compounds. Ash is drawn out of the reaction chamber as a molten residue, which when cooled, produces a glass-like solid. Feed rate is monitored and controlled by a screw feeder that empties to a bucket elevator. The bucket elevator places the material in the reaction chamber. Residence time is controlled by monitoring reactor temperature and off-gas mass flow rates. Molten residues are drawn off periodically when these monitoring parameters indicate destruction is complete. This technology is currently capable of processing approximately 5 tons per 24-hour day.

Effectiveness - The AER has demonstrated successful treatment of various hazardous wastes. It has shown 99.9999% DRE for octachlorodibenzo-p-dioxin and carbon tetrachloride and PCBs, which are difficult to destroy organic compounds; therefore, it is expected to be successful for the organic compounds of concern at the NWS Earle site.

The electric pyrolyzer is in the early developmental stage and has not been extensively tested for organic compound destruction; however, due to the system's high operating temperature, it is expected to show satisfactory destruction of waste materials.

Implementability - The AER is currently not being marketed by any firm and, therefore, is not commercially available. The electric pyrolyzer is no longer marketed by Westinghouse and is not commercially available.

Cost - The cost of these technologies are expected to be very high due to their energy intensive nature and anticipated technical difficulties.

Recommendation - Because the AER and the electric pyrolyzer cannot be readily implemented and are not commercially available, they will not be retained for further consideration.

8.2.20 Molten Salt Destruction

Description - This technology utilizes liquid salt at an average temperature of 1,450 °F. The salt is typically composed of 10% sodium carbonate and 10% sodium sulfate. Waste is fed to the bottom of a vessel containing molten salt and air, where a high rate of heat transfer promotes rapid destruction. Hydrocarbons are oxidized to carbon dioxide and water, while other constituents may react with the salt bed to form a number of inorganic salts. Gases formed during combustion must pass through the molten salt prior to release from the combustion chamber. Acidic gases, such as chlorine, are absorbed by the salt bed. Inorganic salts must be removed to maintain the bed's ability to absorb these gases. Similarly, ash concentrations must be kept below 20% of the bed material to maintain fluidity of the bed. The salt can be recycled by quenching the material in water. Ash may then be removed through filtration while the salt is dissolved. The buildup of inorganic salts is addressed by replacement of the bed material. Bed recycle and replacement requirements are highly dependent on waste feed characteristics.

Effectiveness - This technology is in its early developmental stages, and, as a result, its effectiveness on organic compounds has not been fully determined. Testing on bench-scale units has indicated successful destruction of organic compounds and a portable 500 pound per hour (lb/hr) unit has been constructed for pilot-scale use. Additional research and

development must be conducted before this technology can be implemented on a large scale for site cleanup.

Implementability - This technology has not been developed to the point where it can be implemented for a large-scale sitewide cleanup. In addition, molten salt destruction is not suitable for wastes with a high ash content because frequent bed recycling and replacement would be required. Soils typically contain a high ash content and, therefore, the contaminated media at the NWS Earle site would not be amenable to this type of treatment.

Cost - Costs are not available for the application of this technology; however, because of the high ash content of soils which necessitates frequent bed recycle and replacement, the costs are assumed to be high.

Recommendation - Because this technology cannot be implemented on a large scale and because it is not amenable to waste types with a high ash content (soils typically have a high ash content), it will not be retained for further consideration.

8.2.21 Plasma Arc

Description - Plasma arc treatment is a thermal technology that utilizes the heat generated from a plasma torch to decontaminate metal and organic contaminated waste. This is accomplished by melting metal-bearing solids and, in the process, thermally destroying organic contaminants. Upon cooling the molten soil forms a hard glass-like non-leachable mass. The major components of the process are the plasma torch, rotating reactor well, afterburner, secondary combustion chamber, and off-gas treatment system.

During process operation, contaminated soils and sediments are placed in a bulk screw feeder and gradually fed into the reactor well. The plasma arc is used to heat the materials to temperatures on the order of 3,000 °F, volatilizing organic contamination from the soil. Any combustible gases remaining after volatilization and oxidation are incinerated by an

afterburner located downstream. The exhaust from the furnace is passed through a gas treatment system.

Effectiveness - Plasma arc treatment is a developmental process which has thus far been demonstrated only on a pilot-scale. Bench- and/or pilot-scale testing would be needed to determine the design and process parameters for the contaminants of concern at the NWS Earle site. Tests in Switzerland has shown the process to be effective in binding lead, chromium, nickel, and zinc in the resultant slag.

Implementability - Plasma arc torches are readily available from a wide variety of vendors. However, in order to implement this process on a full-scale, pilot testing first would be needed to determine its applicability at the NWS Earle site.

A portable plasma reactor is currently available from Retech, Inc. Even the portable unit, however, requires extensive set-up. A permit was issued to Retech in 1991 for a pilot plant in Montana.

Cost - Compared to other thermal treatments, the cost of a plasma arc system is expected to be high.

Recommendation - This technology will be retained for further consideration due to its potential applicability to organic compound and metals contamination.

8.3 GROUNDWATER TECHNOLOGIES

8.3.1 No Action (With No Groundwater Monitoring)

Description - Under the no action alternative, no remedial measures for groundwater would be implemented at the NWS Earle site. Any contaminated groundwater would remain uncontrolled, allowing for possible human exposure by means of drinking water supplies drawn from the water-bearing zones in the area.

Effectiveness - For sites where groundwater contamination occurs, this option may achieve remedial action objectives in part or all of the affected area through natural dispersion and dilution of contaminants.

Implementability - This option is readily implementable.

Cost - No costs are incurred in implementing this option.

Recommendation - This option is required for consideration by the NCP and will be retained for further consideration. It will function as a baseline to which other technologies can be compared.

8.3.2 Institutional Actions

Description - Groundwater monitoring would involve long-term periodic sampling and analysis of existing monitoring wells and selected off-site residential wells. Additional monitoring wells would be installed, if required. Monitoring would establish a measure of protection of human health where potable water supplies are not already affected. Remedial response actions could then be implemented in the event contaminant concentrations threaten human health and the environment. Access restrictions/security measures may be implemented to protect contact with and ingestion of contaminated groundwater.

Effectiveness - This technology is useful for documenting conditions in the vicinity of the site, although it does not reduce environmental impacts.

Implementability - Installation and sampling of monitoring wells is conventional and easily implemented, although this does involve a long-term commitment to regular sampling and monitoring with response, if required. When the groundwater is contaminated, the use of this technology alone is generally not acceptable to public or local governments.

Cost - Low costs are expected in implementing this technology since it involves only installation and monitoring of wells.

Recommendation - This process option is potentially applicable and will be retained for further consideration.

8.3.3 Groundwater Collection and Pumping

8.3.3.1 Wells

Description - Groundwater withdrawal is used to recover contaminants and prevent the migration of contaminants by controlling the groundwater flow system. This is accomplished by the construction of a series of pumping recovery wells that are screened in the affected water-bearing zones. The groundwater can then be treated on- or off-site and returned through injection wells or discharged to surface waters.

Generally, there are two basic concepts for groundwater remediation through use of pumping wells: groundwater recovery wells and groundwater interception wells. Recovery wells are typically placed near source areas to retrieve relatively high concentrations of contaminants from the affected groundwater in that location without necessary providing total hydraulic control. Interception wells are usually placed downgradient of the source area and spaced so that their cones of depression overlap to provide a hydraulic barrier to lateral groundwater flow. Usually contaminants are more dilute in interception wells than in recovery wells.

Effectiveness - The entire NWS Earle site is underlaid by stratified unconsolidated coastal plain sediments of varying permeabilities. These conditions are generally favorable to using wells; however, screen depth, pumping rate, and well spacing would have to be carefully designed on a site-by-site basis to meet the desired objectives. Depending on the plume extent, several pumping wells may be required to recover the groundwater contaminants. Even with a commitment to long-term pumping, cleanup goals may not be attainable due

to a number of factors, particularly contaminant attenuation. Groundwater is naturally recharged from precipitation and moderate pumping would not deplete the system.

Implementability - This technology uses conventional well installation practices. There are no major institutional obstacles to groundwater collection by this method. The limiting factor is usually treatment discharge criteria.

Cost - Cost for installing and pumping wells is expected to be low. However, the cost of treatment to meet discharge criteria can be higher.

Recommendation - This technology will be retained for use in conjunction with groundwater treatment methods.

8.3.3.2 Interception Trenches, Ditches, and Drains

Description - Interception trenches, ditches, and drains are used to intercept lateral migration of contaminants in the groundwater by collecting the groundwater "passively" under low flow conditions, or "actively" under high flow conditions for removal and/or treatment. This is accomplished by the construction of a subsurface trench, ditch, or "French" drain system that intercepts and collects shallow groundwater, which is then pumped out. An interception trench is functionally an elongated well.

Highly permeable materials (e.g., gravel beds) are often used in the trenches as a part of a subsurface drainage system to convey flow to a collection sump. Subsurface drains can be used essentially to provide a hydraulic barrier similar to a closely spaced line of groundwater extraction wells. In low permeability material, this may be the only practical way to achieve hydraulic control.

Effectiveness - This technology would achieve hydraulic control of contaminant migration in shallow groundwater systems. Trenches are usually limited in depth, and unless they are keyed to underlying impermeable stratum, contaminated groundwater could flow under the

trench. Also, at low flow groundwater already downgradient of the trench would not be recovered.

Implementability - This technology uses conventional engineering and construction practices. Interception trench drains could be constructed to collect groundwater in the shallow water table utilizing readily available equipment and technology. The depth of the trench would be determined for each individual site. The trenches must be at least as deep as the most shallow groundwater table, which occurs 10 to 25 feet bgs for most of the sites at the NWS Earle facility.

Cost - This technology is often cost effective for low permeability, shallow groundwater. Costs rise dramatically with depth of the trench.

Recommendation - This groundwater collection technology will be retained for further consideration. This technology would have to be used in conjunction with other remedial responses to treat the groundwater.

8.3.4 Subsurface Controls

8.3.4.1 Vertical Barriers

Description - Where waste is in direct contact with the groundwater, vertical subsurface barriers to groundwater flow are passive control measures designed to direct lateral groundwater flow around contaminated areas, therefore minimizing groundwater impact and contaminant migration from the site.

These subsurface barriers can be slurry walls, grout curtains, or other physical, low-permeability boundaries such as sheet piling. Such subsurface walls and curtains are typically constructed in place and keyed into an existing low-permeability clayey or silty layer to ensure that heavier-than-water contaminants do not migrate under the barrier. Systems can partially or completely surround the site. Some pumping is usually required to handle

the diverted water (which is not contaminated) or prevent "bath tubbing" within the enclosed area caused by vertical or lateral infiltration.

Slurry walls are the most common subsurface barrier. In comparison with other barrier types, they are relatively inexpensive to construct and are effective in reducing groundwater flow in unconsolidated materials. Installation of a slurry wall involves construction of a trench under a slurry that usually is comprised of a mixture of bentonite and water. The slurry prevents collapse of the trench and forms a filter cake on sidewalls that prevents fluid losses to the surrounding ground. Once the trench is constructed, an engineered soil mixture is combined with the slurry to backfill the trench and form the wall. Slurry walls are often used in conjunction with capping systems and groundwater pumping. The cap prevents surface water penetration into the contaminated area, and groundwater pumping relieves some of the pressure buildup against the wall.

Like slurry walls, grout curtains are subsurface barriers constructed in unconsolidated material. They are constructed by pressure injecting grouting material through a pipe at various intervals to form a wall. In actual field testing, this method has shown significant difficulties in forming a continuous wall.

Sheet piling involves driving steel sheet piling into the ground to form a subsurface wall. Sheets are interlocked before insertion and are driven a few feet at a time the entire length of the wall until the whole wall is driven to the desired depth. Deflection of piles may occur when driving the piles into the ground, which can render less effective in diverting groundwater.

Effectiveness - When a low-permeability clayey or silt layer is present below a site, a subsurface barrier, such as a slurry wall, can be very effective and is well proven. There are no continuous clay or impermeable layers present below any of the sites at NWS Earle and groundwater occurs at depths of 10 to 20 ft bgs. Therefore, it is expected that this technology would be ineffective as a barrier to groundwater penetrating contaminated soils.

Implementability - Most vertical barrier walls are proven methods for the containment of contamination and can be installed using conventional construction techniques. The length and depth of the wall will dictate the equipment required. Typically, a backhoe is used to dig the trench. For very deep walls, a clamshell may be used. Some groundwater pumping is usually required to deal with the diverted water.

Cost - Vertical barriers are relatively expensive to construct and maintain.

Recommendation - This technology will not be retained for further consideration because a continuous impermeable layer is not present at shallow depths beneath the sites and a vertical barrier would not prove very effective in containing contaminants.

8.3.4.2 Horizontal Barriers

Description - Horizontal barriers are subsurface barriers designed to prevent the downward migration of contaminants to the groundwater and to keep the groundwater beneath the contaminated materials from contacting them.

The use of this technology is in the developmental stages. Two methods currently being tested are grout injection and block displacement. In grout injection, a jet nozzle is inserted into the ground to the level at which the barrier is to be constructed. A high pressure stream of water and air is applied to erode away some soils. The nozzle is rotated so that the eroded area forms a circle. This area is then filled with grout. The procedure is repeated many times until all the circles, which should be overlapping, cover the intended barrier area.

Block displacement first involves the installation of a slurry wall around the contaminated area. Numerous holes are then bored through the site. At the bottom of each hole is a notch that extends radially from the hole. When grout is continuously added to the hole, the pressure causes horizontal fractures to extend from the notch and the grout then fills these fractures. When the grout from many fractures and holes begins to form a continuous

barrier, further pumping increases the thickness of the barrier and actually lifts up the contaminated block. This block is lifted in direct proportion to the amount of grout injected.

Effectiveness - The effectiveness of either horizontal barrier technique is questionable. These techniques are developmental, and very little detailed analysis of applications and limitations has been reported. The block displacement technique has been laboratory tested and field demonstrated, but the process is still being refined. It has not been applied at a hazardous waste site. With the ground injection technique, there is a possibility of gaps, and verification of wall integrity is difficult. The waste at the NWS Earle site is not in contact with groundwater; therefore, it is not advisable to divert infiltration after it passes through the waste. Capping can be used to intercept the water before it comes in contact with the contaminated soil.

Implementability - This technology may not be readily implemented since it is still in the developmental stages and a qualified vendor may not be available for installation activities. It appears that specialized equipment may be needed for both the grout injection and block displacement techniques.

Cost - As cost data are not available for these barrier methods, it is not possible to determine what their relative costs would be when compared to other construction technologies.

Recommendation - This technology will not be retained for further consideration since it is still in the developmental stages and its effectiveness has not been proven.

8.3.5 Groundwater Treatment

8.3.5.1 Chemical Neutralization

Description - Chemical treatment for neutralization of contaminated groundwater involves the addition of a neutralizing agent (acid or base) to adjust the pH of the liquid stream.

This technology may be applied alone to treat waste acids or alkalides (bases) or it can be used as part of another treatment process.

Effectiveness - Chemical neutralization of liquid streams is a conventional, demonstrated technology. By addition of acids or bases, the pH of the influent stream can be adjusted to neutrality.

Implementability - As chemical neutralization is a standard, straightforward process with conventional equipment requirements, it is readily implementable.

Cost - The cost for chemical neutralization is low.

Recommendation - This alternative will be retained for potential use in combination with other technologies.

8.3.5.2 Precipitation

Description - Chemical precipitation is a physio-chemical process in which a dissolved contaminant is transformed into an insoluble solid, facilitating its subsequent removal from the liquid phase by sedimentation or filtration. The process usually involves: (1) adjustment of pH in order to shift the chemical equilibrium to a point that no longer favors solubility, (2) addition of the chemical precipitant, and (3) flocculation in which precipitate particles agglomerate into larger particles.

Effectiveness - The most common existing application of precipitation for the treatment of hazardous waste is the removal of toxic heavy metals from aqueous hazardous waste. This includes the removal of arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Other potential applications include the removal of precipitable substances from certain nonaqueous liquids, such as waste organic solvents.

The precipitation process, followed by one or more solid or liquid separation steps, produces an aqueous effluent, which may require further treatment, and a sludge containing the removed contaminants. Sludge is typically dewatered and landfilled. Various chemical fixation and stabilization processes may be required to decrease the potential for the environmental release of heavy metals from sludges.

Implementability - Equipment requirements include a reaction tank and agitator, chemical storage tanks, and chemical feed pumps. Precipitation may be done on a batch or continuous basis.

Cost - This technology generally involves low capital costs since it involves conventional equipment.

Recommendation - This technology is potentially applicable and will be retained for further consideration.

8.3.5.3 Ultraviolet Radiation/Ozone/Hydrogen Peroxide

Description - The application of this technology to groundwater remediation utilizes ultraviolet light and/or ozone and/or hydrogen peroxide to completely oxidize organics. This technology is applicable to aromatic and unsaturated hydrocarbons. It is not well suited for degrading saturated hydrocarbons. The most cost-effective usage of this treatment is for dilute streams containing a minimum of nontarget oxidizable compounds.

Effectiveness - Ultraviolet radiation/ozone/hydrogen peroxide treatment is a conventional, demonstrated technology. It has been proven effective for groundwater treatment for a variety of halogenated aliphatics. The effectiveness of this technology for the groundwater at the NWS Earle site would have to be evaluated with a bench or pilot study. In particular, the need for pretreatment would be evaluated.

Implementability - The equipment necessary for ultraviolet/ozone/hydrogen peroxide treatment is readily available. In all cases, a reaction tank is needed. Ultraviolet light, an ozone generator and/or a hydrogen peroxide feed system are also required. The related pumps, mixers, and flow meters are all standard items. Prior to implementation, bench- or pilot-scale tests would be required to determine the feasibility of using ultraviolet radiation, ozone, or hydrogen peroxide treatment. Additionally, the need for pretreatment would have to be determined. This technology may be effective as a polishing step for other treatment methods.

Cost - The cost for ultraviolet radiation/ozone/hydrogen peroxide treatment is considered to be moderate. The exact cost of the system would be dependent on the need for pretreatment.

Recommendation - This technology will be retained for further investigation.

8.3.5.4 Electrochemical Treatment

Description - Electrochemical treatment of groundwater utilizes an electrical current to precipitate heavy metals. A charged metal plate releases a ferrous ion into solution which then acts as a scavenger for heavy metals. The process for heavy metal removal is adsorption/coprecipitation onto the insoluble iron cation. Downstream of the electrochemical cell, the resulting sludge is separated from the treated effluent in a clarifier. The sludge must then be disposed separately. This process is patented by Andco Environmental Processes, Inc. (Andco). Andco has demonstrated greater than 99% reduction in lead, tin, cadmium, silver, palladium, molybdenum, zinc, copper, nickel, iron, chromium, vanadium, aluminum, antimony, and arsenic concentrations.

Effectiveness - Although most widely used in the treatment of industrial wastestreams, electrochemical treatment has been demonstrated for groundwater remediation. A bench- or pilot-scale study would be needed to determine the effectiveness of this treatment for the NWS Earle contaminants.

Implementability - Andco has a mobile treatment system available for use. Prior to implementation, bench- or pilot-scale tests would be required to determine the feasibility of electrochemical treatment for the contaminants of concern.

Cost - The cost of electrochemical treatment is expected to be moderate.

Recommendation - This technology will be retained for further investigation.

8.3.5.5 Ion Exchange

Description - Ion exchange is a process that reversibly exchanges ions in solutions with ions retained on a reactive solid material called the ion exchange resin. Because the reaction is reversible, it is possible to regenerate the ion exchange resin. The overall process yields two output streams: one main purified product stream and a small solution of the "spent" regenerant containing a high concentration of the removed ions.

Effectiveness - Wastes typically treated by this process contain metallic anions and cations; inorganic anions such as halides, sulfates, and cyanides; organic acids such as carboxylics, sulfonics, and phenols; and organic bases such as amines. In practice, this technology has been applied mostly to metals or inorganics treatment.

There are practical limitations of the ion exchange process that restrict the treatment of wastestreams containing greater than 50 ppm suspended solids (without pretreatment) and 2,500 ppm organic concentrations (similar to carbon adsorption but significantly lower than the upper organic concentration limit). Pretreatment methods such as mixed-media (i.e., sand) filtration can be used to remove solids.

Implementability - Pilot-scale treatability studies would be required to confirm the feasibility of and to determine the design and operating parameters for ion exchange. Multiple stages and, therefore, extensive studies may be necessary. Mobile ion exchange units are available

for onsite treatment. This process may be most effective as a polishing step for other treatment methods.

Cost - Capital costs for installing ion-exchange systems are generally low compared to other technologies. Operating costs are strongly affected by waste strength.

Recommendation - This technology will be retained for further investigation.

8.3.5.6 Ultrafiltration

Description - Ultrafiltration is a pressure-activated membrane process that rejects all colloidal, particulate, and high molecular weight matter. High molecular weight solutes or colloids are separated from a suspension or solution through the use of semipermeable, polymeric membranes. The process has been successfully applied to both homogeneous solutions and colloidal suspensions, which are difficult to separate practically by other techniques.

Effectiveness - Ultrafiltration is a practical treatment technology for separating and, if desirable, recovering solutes of molecular weight treater than 500 to 1,000 or suspended materials from an aqueous stream. Ultrafiltration is commonly used to remove emulsified oils, metals, and proteins from aqueous wastes.

This technology generally serves to provide a greatly reduced volume of hazardous waste that may require further processing for ultimate disposal, such as stabilization prior to landfilling or incineration.

Implementation - Pilot studies are recommended for system design and for determination of operating parameters. Mobile units for on-site treatment are not yet available.

Cost - Costs associated with this technology are generally low to moderate, although periodic fouling of the membrane may constitute considerable replacement costs.

Recommendation - This technology will not be retained for further consideration since this process rejects only colloidal particles and permits the passage of salts and other electrolytes through the membrane. This technology will not effectively remove dissolved metals found at the NWS Earle site.

8.3.5.7 Reverse Osmosis

Description - Reverse osmosis (RO) utilizes the properties of semi-permeable membranes, which permit the passage of liquid (solvents) but not dissolved materials (solutes) to effect separation. This process is used for the removal of ionic constituents. In operation, pressure is used to reverse the natural osmotic process and cause the solvent to pass through the membrane from the concentrated to the dilute side, resulting in the production of a clean (permeate) stream, and a lower, but not insignificant, volume of a concentrate (reject) stream, that may require further treatment.

The membranes used in the reverse osmosis process are susceptible to fouling by certain chemical species. The cost of membrane replacement can be a significant component of total operating cost for this system, as is the price to remove these deleterious species and avoid membrane damage.

Effectiveness - The reverse osmosis process has typically been used for treatment of brackish waters and aqueous metal wastes (plating baths), but innovative technologies have made it very effective in treating other forms of contaminants in groundwater such as PCBs, other chlorinated organics, and insecticides or herbicides. Concentration levels or organics generally range in the milligram per liter level for the feed and 10 to 50 micrograms per liter for the permeate (effluent).

Implementability - The application of reverse osmosis to a hazardous wastestream must be carefully evaluated on a pilot or bench-scale basis because of the potential for the chemicals to react with the membranes leading to deterioration or destruction. Mobile, self-containing reverse osmosis systems are now available for on-site treatment.

Cost - Capital costs for reverse osmosis systems are low to moderate. Operating and maintenance costs depend primarily on power costs and periodic membrane replacement (due to fouling) costs, and are relatively insensitive to waste strength.

Recommendation - This technology is potentially applicable and will be retained for further consideration.

8.3.5.8 Electrodialysis

Description - Electrodialysis is a treatment process that utilizes semipermeable membranes for separation. In contradiction to reverse osmosis processes, the solutes, rather than the solvents, pass through the membrane. The driving force for separation is a direct current electrical potential applied across the membrane, and only charged (ionic) species are removed.

In operation, alternating layers of cationic-selective and anionic-selective membranes are arranged in a cell through which the influent water flows. The externally applied voltage causes anions to migrate toward the anodic terminal and cations to migrate toward the cathodic terminal. In so doing, anions, for example, will pass through anionic selective membranes and be stopped by cationic membranes. The arrangements of membranes in the cell results in the production in alternate channels of dilute and concentrated streams. As with reverse osmosis, liquid recovery is not complete, and some volume of concentrated solution must be rejected and subsequently treated.

Effectiveness - Electrodialysis is a conventional, demonstrated technology. It has been used most widely in the desalination field, but has also been used for hazardous waste treatment. Although electrodialysis is a proven technology, its effectiveness for application at the NWS Earle site should be evaluated with a bench- or pilot-scale study. As with reverse osmosis, the membranes are susceptible to fouling. Since many membranes operate in a stack, it is a time-consuming, labor-intensive process to clean or replace fouled membranes. Frequent

fouling of the membranes could significantly hinder the effectiveness of this treatment method. Pretreatment may be required to reduce fouling.

Implementability - Electrodialysis is an established technology, available in skid-mounted units. Prior to implementation, however, bench- or pilot-scale studies would have to be conducted to determine membrane type, fouling potential of the groundwater, and operating parameters.

Cost - Although the cost of electrodialysis treatment would be highly dependent on the results of bench- or pilot-scale studies for the specific parameters encountered at the NWS Earle site, the cost is generally expected to be moderate to high.

Recommendation - This technology is potentially applicable and will be retained for further consideration.

8.3.5.9 Activated Carbon Adsorption

Description - The activated carbon process is one of the most frequently applied technologies for the removal of trace organic compounds from an aqueous solution. Adsorption is a surface phenomenon in which soluble molecules from a solution are bonded onto a particular substrate. Activated carbon (with a surface to mass volume ratio ranging from 500 to 1,400 square meters/gram (m^2/gm)) is a good adsorbent for effective removal of organic compounds.

Effectiveness - Carbon adsorption processes have been used extensively to treat industrial wastewaters containing dissolved organic materials and certain inorganic constituents. There are practical limitations of this process that restrict the treatment of wastestreams that contain greater than 50 parts per million (ppm) suspended solids (without pretreatment) and 10,000 ppm organic concentrations. Pretreatment methods such as mixed media (i.e., sand) filtration can be used to remove solids. The exhausted carbon will contain all of the waste constituents removed from the wastestreams. The carbon must be regenerated (on-site or

off-site), treated, or disposed of in a secure landfill. Thermal regeneration of the spent carbon is the most common method currently used.

Implementability - The majority of carbon treatment systems use cylindrical pressure vessels, which contain the activated carbon. Gravity flow and multicolumns in series are the most commonly designed contacting systems. Carbon contacting beds can be skid-mounted and placed on flat-bed trucks or railcars for transport to various sites. Additional equipment that may be required includes pumps and piping, backwash equipment, carbon transfer equipment, and a carbon regeneration system (if cost-effective). Activated carbon units are marketed by numerous vendors and are readily available.

Cost - Costs for carbon contact systems can range from low to moderate. Total operating costs are primarily dependent on the carbon usage and replacement rate.

Recommendation - This well-proven technology is effective for the removal of organic contaminants and will be retained for further consideration.

8.3.5.10 Flocculation

Description - Flocculation treatment involves the addition of a chemical flocculating agent (lime, alum, iron salts, polymers) followed by a rapid, then slow physical mixing sequence to effect the agglomeration of fine suspended particles to larger settleable particles. This treatment method is used primarily for the precipitation of inorganics, particularly the removal of metals as hydroxides or sulfides.

Effectiveness - Flocculation is a conventional, demonstrated technology for the removal of inorganics from water in industrial and municipal applications. Chemical addition must be carefully controlled in order to operate in the optimal pH range for precipitation of metals. Also, excess flocculating agent is undesirable as they tend to be corrosive to tanks.

Implementability - Typically, flocculation is accomplished in a series of two tanks. These tanks and the associated mixers are readily available from many vendors. Prior to implementation, bench- or pilot-scale studies would be needed to characterize the necessary chemical additions and to determine system operating parameters.

Cost - The cost for flocculation treatment is expected to be low to moderate.

Recommendation - As flocculation is a well-established, effective technology for inorganic treatment, it will be retained for further evaluation.

8.3.5.11 Steam Stripping

Description - Steam stripping is accomplished by introducing steam into the liquid stream in a packed or tray tower. Fractional distillation is effected via evaporation. This technique is suitable for the removal of volatile organic compounds with low water solubilities (such as chlorinated hydrocarbons and aromatics), hydrogen, sulfide, and ammonia, as well as semi-volatile chlorinated aromatics, ketones, and alcohols. Subsequent condensation of the vapor stream after it is blown through the liquid results in a concentrated wastestream. This stream requires treatment and appropriate disposal. Additionally, the air emissions associated with the process require treatment.

Effectiveness - Steam stripping is a conventional, demonstrated technology that has been proven effective for the removal of various organic contaminants in the chemical industry. To date, it has been used only for groundwater treatment in special cases. The effectiveness of the process for removal of the particular contaminants at the NWS Earle site would have to be evaluated through bench- or pilot-scale studies. As part of this study, the tendency of the column to foul or scale should be determined.

Implementability - Steam stripping is a well-established technology, but is energy intensive. Equipment needed would include air and water condensers, electric or oil-fired boilers, storage equipment, and a residue removal system.

Cost - The cost of steam stripping is expected to be moderate.

Recommendation - Due to the needed treatment of two streams (air and condensed steam) and the energy intensive nature of this process, steam stripping is rarely selected when air stripping is a possible alternative. Therefore, this technology will not be considered further.

8.3.5.12 Air Stripping

Description - Air stripping is a mass transfer separation process in which air is introduced to effect phase transfer from liquid to air. Volatile organic compounds with low water solubilities (such as chlorinated hydrocarbons and aromatics), hydrogen sulfide, and ammonia are efficiently transferred from the liquid to the air phase via this process. Volatile organic air emissions are a concern with this method.

Effectiveness - Air stripping is a conventional, demonstrated process for the removal of organic contamination including chlorinated hydrocarbons. The effectiveness of this treatment for the specific contaminants of concern at this site would have to be evaluated through bench- or pilot-scale tests.

Implementability - The needed equipment is readily available from many vendors and can be quickly installed. Design and operating parameters would be determined through bench- or pilot-scale testing. Additionally, tests would be needed to determine the required air emissions control.

Cost - The cost of air stripping is expected to be moderate.

Recommendation - This technology will be retained for further consideration.

8.3.5.13 Filtration

Description - Filtration is a separation process to remove suspended solids from a liquid stream. Filtration is accomplished by passing the influent stream through a porous medium (typically sand). The driving force for flow can be gravity or pressure applied with a pump. Periodic filter backwashing to remove trapped solids is required. The wastestream from this regeneration must be treated and disposed.

Effectiveness - Filtration is a conventional, demonstrated technology. As suspended solids are not of concern for groundwater treatment at the NWS Earle site, filtration would not be an effective primary treatment technology. However, filtration is an effective treatment when used in conjunction with inorganic removal systems.

Cost - Although the cost of filtration systems vary with equipment size and application, it is generally expected to be a low cost technology.

Recommendation - Although filtration is not applicable as a primary treatment technology, it will be retained for further consideration as secondary treatment in conjunction with other technologies.

8.3.5.14 Aerobic Biological Treatment

Description - Aerobic biological treatment methods use microorganisms to detoxify or decompose biodegradable organics in aqueous wastestreams. This technology consists of conventional activated sludge processes as well as modifications of these processes, including sequencing batch reactors, rotating biological contactors (RBC), and trickling filters. Traditional reactors use a suspended biomass, which is subsequently separated with a portion being recycled. Other reactors (RBC and trickling filter) use a film biomass attached to a support medium.

Effectiveness - Aerobic biological reactors can treat aqueous wastestreams contaminated with nonhalogenated organics or certain halogenated organics. The addition of powdered activated carbon may permit the treatment of aqueous wastestreams contaminated at low to moderate levels with pesticides and herbicides, halogenated hydrocarbons, and halogenated solvents. Low levels of heavy metals are often removed through adsorption by, and concentrated in, the biomass. Biological reactors can be used effectively for groundwater treatment because of the relative stability of groundwater characteristics. Other technologies, such as carbon adsorption, ultrafiltration and, others that are described in the following subsections, can be used to complete groundwater treatment, if necessary.

For groundwater that contains relatively low levels of contaminants, the biomass may not receive the necessary nutrients for survival. These nutrients may have to be added to the process. Additionally, the biomass population may be so small that for suspended biomass systems, the downstream separation process cannot function and the necessary biomass recycle does not occur. For this reason, attached growth systems operate more effectively at low contaminant concentrations than do suspended growth systems.

Settled sludge or excess biomass residues may contain elevated levels of nondegradable organics or heavy metals. Sludge will require dewatering and may be shipped offsite for disposal at a treatment and disposal facility. As an alternative, it could be incinerated should such an approach be used for site soils.

Implementability - Mobile biological reactors are relatively simple systems and are readily transportable. Several companies have developed mobile biological reactors that are well suited to treatment or aqueous wastestreams contaminated at low levels with organics. Careful monitoring of the biodegradation process and water quality parameters is necessary. An onsite laboratory may be required for this purpose. Laboratory or pilot-scale testing is suggested.

Cost - Costs for aerobic biological treatment can be a small fraction of the cost for comparable chemical/physical systems. This is due to the simplicity of the process and the

use of self-sustaining microorganisms as the primary treatment process. More complicated wastestreams will require more expensive multi-step treatment trains.

Recommendation - Attached growth biological treatment systems will be retained for further consideration.

8.3.5.15 In Situ Biodegradation

Description - In situ biological treatment is a technique for treating contaminated soils and groundwater in place by microbial degradation. Addition of oxygen and nutrients to the groundwater enhances the natural biodegradation of organic compounds by microorganisms, resulting in the breakdown and detoxification of the organic contaminants. These microorganisms can either be naturally occurring, specially adapted, or genetically engineered. Usually, oxygen and nutrients are delivered to the groundwater through injection wells. A system of collection wells is used so that treatment can occur for groundwater circulating through the contaminant plume area.

Effectiveness - To date, in situ biodegradation has been applied to sites contaminated with readily biodegradable, nonhalogenated organics, primarily gasoline. Waste types where in situ biodegradation has been applied include gasoline and fuel soils, hydrocarbon solvents (e.g., benzene, toluene), nonhalogenated aromatics, and alcohols, ketones, ethers, and glycol. Heavy metals concentrations will not likely be significantly affected. In situ biodegradation is generally inhibited by halogenated organics, elevated levels of metals, acids, or caustics.

The long-term effects of nutrient introduction on groundwater must be evaluated, and final contaminant reduction is generally not predictable. Furthermore, biological processes may enhance contaminant mobility and toxicity.

Implementability - For in situ biodegradation, injection wells would be installed using conventional construction techniques. Following positive evaluation of site environmental factors and waste characteristics, systems for introduction of nutrients and oxygen (through

wells) into the groundwater would be developed. These may include pumping and recirculation or infiltration galleries for replacement of groundwater.

Water quality characteristics must be monitored at regular intervals, and nutrient and oxygen supplies must be adjusted. Biodegradation may continue for several months, and final results may not be apparent for 1 to 2 years. Contaminant levels in water may not drop below designated action levels.

Maintaining extraction and injection flow can be very difficult because of the natural iron content of the groundwater. Also precipitation is generated by changes in water chemistry and bacterial growth on the well screens. As discussed for in situ soil remediation (which often proceeds concurrently with aquifer remediation), a major factor in implementing this and other in situ groundwater processes is the control of flow through the treatment zone to ensure treatment of all contaminated areas and prevent unwanted migration of either contamination or added reagents. Aquifer permeabilities are very variable on a local scale.

Cost - In situ biodegradation may produce acceptable results. Although costs are difficult to generalize, operations and maintenance can be very high.

Recommendation - In situ biodegradation will not be retained for further consideration based on the technical difficulties associated with implementing this technology.

8.4 SUMMARY OF TECHNOLOGIES

Table 8-2 provides a summary list of the technologies evaluated and recommendations for retaining these technologies. Technologies that are retained will be combined to form preliminary alternatives that address the contamination, if any, at each of the NWS Earle sites.

Table 8-2

Summary of Technology Screening

Medium	Technology	Retained (Y/N)
Soils	No Action	Y[1]
	Limited Action Consisting of Land Use Restrictions and Access Restrictions	Y
	Excavation	Y
	Capping	Y
	Sedimentation Basins/Ponds	Y
	Regrading, Revegetation, and Diversion	Y
	On-Site Landfill	Y
	Off-Site Landfill	Y
	Soil Washing	Y
	Stabilization	Y
	Critical Fluid Extraction	Y
	Dechlorination	N
	Landfarming	N
	Composting	Y
	Bioreclamation	Y
	Vitrification	Y
	In Situ Volatilization	Y
	Rotary Kiln Incineration	Y
	Infrared Incineration	Y
	Fluidized Bed/Circulating Bed	Y
	High Temperature, Electrically Powered Pyrolytic Reactors	N
	Molten Salt Destruction	N
	Plasma Arc	Y

[1]Retained for further consideration as required by the NCP.

Table 8-2

Summary of Technology Screening (Continued)

Medium	Technology	Retained (Y/N)
Groundwater	No Action	Y[1]
	Institutional Actions	Y
	Groundwater Collection and Pumping	Y
	Interception Trenches, Ditches, and Drains	Y
	Vertical Barriers	N
	Horizontal Barriers	N
	Chemical Neutralization	Y
	Precipitation	Y
	Ultraviolet Radiation/Ozone/Hydrogen Peroxide	Y
	Electrochemical Treatment	Y
	Ion Exchange	Y
	Ultrafiltration	N
	Reverse Osmosis	Y
	Electrodialysis	Y
	Activated Carbon Adsorption	Y
	Flocculation	Y
	Steam Stripping	N
	Air Stripping	Y
	Filtration	Y
	Aerobic Biological Treatment	Y
	In Situ Biodegradation	N

[1]Retained for further consideration as required by the NCP.

APPENDIX E

METHODOLOGY FOR CALCULATING CHEMICAL CONCENTRATIONS IN GARDEN FRUITS AND VEGETABLES

E.1 INTRODUCTION

This appendix describes the methodology that was used to estimate the chemical concentrations in garden fruits/vegetables for the contaminants of concern through the vegetable ingestion pathway. Three categories of edible plants grown in home gardens were evaluated: root vegetables, leafy vegetables, and garden fruits. The chemical concentration in fruits and vegetables were estimated using the following general equation:

Chemical Concentration in Plant (mg/kg)	=	Chemical Concentration in Soil (mg/kg)	x	Uptake Factor (unitless)

The uptake factor is defined as the ratio of the chemical concentration in the plant to the chemical concentration in soil under equilibrium conditions. The approach used to calculate chemical concentrations in garden fruits and vegetables is described below.

E.2 DEVELOPMENT OF UPTAKE FACTORS FOR GARDEN FRUITS AND VEGETABLES

The uptake factors used for the chemicals of concern in soil were based on transfer coefficients developed by Baes et al. (1984) for vegetative and non-vegetative/reproductive parts of plants. The transfer coefficients for vegetative plant parts were used to estimate the chemical concentration of contaminants in leafy vegetables (lettuce). The transfer coefficients for non-vegetative/reproductive plant parts were used to estimate the chemical concentrations in garden fruits (tomatoes) and root crops (carrots).

Because the transfer coefficients are expressed in terms of kg of dry plant and vegetable/fruit ingestion rates are expressed as wet weight, the transfer coefficients were adjusted for the water content of the plant. Leafy vegetables were assumed to have a water content of 95% (Baes et al., 1984). As a result, the transfer coefficients for vegetative plant parts were multiplied by 5%, the percent dry matter of lettuce. For tomatoes and carrots, the transfer factors for non-vegetative/reproductive plant parts were multiplied by 6% and

12%, respectively, which are the percents of dry matter for these vegetables. The transfer factors for the garden fruits and vegetables that were evaluated for the contaminants of concern are presented in Table E-1.

Table E-1

Uptake Factors for Garden Fruits and Vegetables

Parameter	Leafy Vegetables	Garden Fruits	Root Vegetables
Antimony	1.00E-02	1.80E-03	3.60E-03
Arsenic	2.00E-03	3.60E-04	7.20E-04
Cadmium	2.75E-02	9.00E-03	1.80E-02
Chromium III	3.75E-04	2.70E-04	5.40E-04
Chromium VI	3.75E-04	2.70E-04	5.40E-04
Iron	2.00E-04	6.00E-05	1.20E-04
Lead	2.25E-03	5.40E-04	1.80E-03
Nitrate	NA*	NA	NA
Selenium	1.25E-03	1.50E-03	3.00E-03
Silver	2.00E-02	6.00E-03	1.20E-02
Vanadium	2.75E-04	1.80E-04	3.60E-04

*NA - Uptake factor not available.

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Baes, C., R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture.* Prepared by Oak Ridge National Laboratory for the U.S. Department of Energy. ORNL-5786.

APPENDIX F

MODEL FOR CALCULATING EXPOSURE DOSES FROM INHALATION WHILE SHOWERING

87-42.6

INHALATION EXPOSURES TO VOLATILE ORGANIC CONTAMINANTS IN THE SHOWER

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NTRODUCTION

Over the past few years, the potential importance of inhalation xposures to volatile organic chemicals (VOCs) through the use of contaminated ousehold water supplies has been recognized. Due to their strong tendency to olatilize, VOCs present in tap water may be readily released into indoor air s a result of showering, bathing, dishwashing, laundering, and ooking.[1,2,3] Several researchers have already concluded that inhalation xposures to volatile compounds released during typical water uses in the home ay be as large as or larger than exposures from water ingestion.[1,3,4,5,6] f particular concern to human health is the potential for elevated VOC xposures to occur in the confined space of the shower. Detailed empirical ata on the levels of VOCs released into shower room air are, however, carce.[1,7] Andelman and his colleagues, relying on experiments conducted sing trichloroethylene and chloroform in a scaled-down model shower, are esponsible for the bulk of the data that are currently available.

Exposure modeling may provide the best means of estimating inhalation xposures to VOCs while showering. Such modeling can be validated to a imited extent at present using Andelman's data and will be further validated n the future with whatever reliable data become available.

The purpose of this paper is to expand on previous work in which we eveloped a dynamic model for the behavior of VOCs in shower water.[8] In his paper we present a model that estimates exposures to VOCs in the shower, oth while showering and after the shower has been turned off. The model has een programmed using Microsoft C and is run on an IBM PC. Typically a model un, including data input, takes less than one minute.

Previous efforts to estimate exposures to VOCs in the shower have relied pon the simple assumption that a certain percentage of VOC in water is eleased into air (e.g., 40-100%).[2,4,5] Our model, unlike the previous pproaches, takes into account many of the variable factors that influence the elease of VOCs from water and their subsequent buildup in shower room air. he kinetic model presented in this paper estimates VOC air concentrations and he magnitude of chemical exposures for the duration of exposure.

ETHODOLOGY

Inhalation exposures to VOCs are modeled by estimating the rate of hemical release into the air (generation rate), the buildup (shower on) and ecay (shower off) of VOCs in shower room air, and the quantity of airborne OCs inhaled while the shower is both on and off.

Estimation of the rate of VOC release into the air is based upon Liss nd Slater's[9] adaptation of the two-film gas-liquid mass transfer theory hich has been described in our previous paper.[8] The two-film boundary heory provides the basis for estimating the overall mass transfer coefficient K_L) for each VOC of interest according to the following equation:

$$K_L = (1/k_l + RT/Hk_g)^{-1} \quad (1)$$

where

- K_L = overall mass transfer coefficient (cm/hr),
- H = Henry's Law Constant (atm-m^3/mol-K),
- RT = 2.4×10^{-2} atm-m^3/mole (gas constant of 8.2×10^{-5} atm-m^3/mol-K times absolute temperature of 293 K),
- k_g = gas-film mass transfer coefficient (cm/hr), and
- k_l = liquid-film mass transfer coefficient (cm/hr).

Equation 1 describes the mass transfer rate of a compound at an air-water interface where diffusion may be limited by both liquid- and gas-phase resistances. For most VOCs, however, with Henry's Law Constants greater than 1×10^{-3} atm-m^3/mol-K, mass transfer is limited by only liquid-phase resistance.[10]

Typical values of k_l (20 cm/hr) and k_g (3,000 cm/hr), which have been measured for CO_2 and H_2O, respectively,[9] may be used to estimate VOC-specific values for these parameters:

$$k_{g(VOC)} = k_g(H_2O)(18/MW_{VOC})^{0.5} \quad (2)$$

$$k_{l(VOC)} = k_l(CO_2)(44/MW_{VOC})^{0.5} \quad (3)$$

where

- MW = molecular weight (g/mol).

The mass transfer coefficient, K_L, is adjusted to the shower water temperature, T_s, according to a semi-empirical equation developed to estimate the effect of temperature on oxygen mass-transfer rate:[11]

$$K_{aL} = K_L(T_l\mu_s/T_s\mu_l)^{-0.5}$$

where

- K_{aL} = adjusted overall mass transfer coefficient (cm/hr),
- T_l = calibration water temperature of K_L (K),
- T_s = shower water temperature (K),
- μ_l = water viscosity at T_l (cp), and
- μ_s = water viscosity at T_s (cp).

The concentration leaving the shower droplet, C_{wd}, is obtained from an integrated rate equation based on a mass-balance approach:

$$C_{wd} = C_{wO}(1-\exp[-K_{aL}t_s/60d]) \quad (5)$$

where

C_{wd} = concentration leaving shower droplet after time t_s (μg/l),
C_{w0} = shower water concentration (μg/l),
d = shower droplet diameter (mm), and
t_s = shower droplet drop time (sec).

The term $K_{aL}/60d$ combines both the rate of transfer and the available interfacial area across which volatilization can occur. The value 1/60d equals the specific interfacial area, 6/d, for a spherical shower droplet of diameter d multiplied by conversion factors (hr/3600 sec and 10 mm/cm).

Inherent in equation 5 is the assumption that the shower water is immediately disaggregated into droplets of equal size and that volatilization occurs from each droplet only between the time it is released from the shower head until it impacts the shower bottom. In reality, the shower water will disaggregate into droplets of different diameters and will also agglomerate into layers as it runs over the showering individual and impacts nearby surfaces. The model presented in this paper does not take into account volatilization from these "non-droplet" air-water surfaces, many of which increase the residence time during which volatilization could occur (relative to an unimpeded droplet). In addition, this model does not estimate the additional volatilization from water as it drains from the shower bottom. Volatilization from water running over a showering individual and draining from the shower bottom may, however, contribute significantly to overall VOC air concentrations in the shower.[12] By not taking into account volatilization from water running down nearby surfaces and the showering individual and draining from the shower bottom, our model is more likely to underestimate than overestimate indoor VOC air concentrations and exposures.

The VOC generation rate in the shower room, S, can then be calculated by the equation:

$$S = C_{wd}(FR)/SV \qquad (6)$$

where

S = indoor VOC generation rate (μg/m^3-min),
FR = shower water flow rate (l/min), and
SV = shower room air volume (m^3).

A simple one-box indoor air pollution model was used to estimate VOC air concentrations in the shower room. This model can be expressed as a differential equation describing the rate of change of the indoor pollutant concentration with time:

$$dC_a/dt = -RC_a + S \qquad (7)$$

where

C_a = indoor VOC air concentration (μg/m^3), and
R = air exchange rate (min^{-1}).

This indoor air model assumes instantaneous mixing of the shower room air and no chemical decay of VOCs once they are released into the indoor air. It is likely, however, that air concentrations of VOCs will be higher immediately adjacent to the shower spray (i.e., within the individual's breathing zone) than in the rest of the shower room. As a result, the model may underestimate inhalation exposures during showering by assuming a completely mixed indoor environment. Because modeling the incremental exposure due to showering only is the focus of this paper, it is also assumed that the initial VOC air concentration indoors before the shower is turned on is zero (i.e., there are no other sources of VOCs contributing to indoor air pollutant levels).

In the model, the air exchange rate is kept constant throughout the exposure period. The generation rate is allowed only two values, off (i.e., zero) and on. In general, both the air exchange rate and the generation rate may vary over time; however, for the short periods modeled in this paper (no more than one or two hours), we consider that the assumptions of constant air exchange and generation rates are likely to be valid.

When equation 7 is integrated, the time-dependent indoor concentration can be estimated as follows:

$$C_a(t) = (S/R)(1 - \exp[-Rt]) \text{ for } t \le D_s$$

and

$$C_a(t) = (S/R)(\exp[RDs] - 1)\exp(-Rt) \quad \text{for } t > D_s$$

where

$C_a(t)$ = indoor air VOC concentration at time t (μg/m^3),
D_s = shower duration (min), and
t = time (min).

The inhalation exposure per shower can then be calculated according to the equation:

$$E_{inh} = [Vr/(BW)(10^6)] \int_0^{D_t} C_a(t)dt$$

where

E_{inh} = inhalation exposure per shower (mg/kg/shower),
VR = ventilation rate (l/min),
BW = body weight (kg), and
D_t = total duration in shower room (min).

This equation can be solved as:

$$E_{inh} = (Vr)(S)/[(BW)(R)(10^6)]\left(D_s - 1/R + \exp(-RD_s)/R\right)$$

for the duration of the shower, and as:

$$E_{inh} = (Vr)(S)/[(BW)(R)(10^6)] \cdot \left(D_s + \exp(-RD_t)/R - \exp[R(D_s - D_t)]/R\right)$$

for both the duration of the shower and the duration in the room after the shower is turned off.

MODEL APPLICATION I. COMPARISON WITH EXPERIMENTAL RESULTS

The only experimental data currently available and sufficiently detailed to apply in our model have been developed by Andelman et al.[1] Experimental data presented by these researchers for trichloroethylene (TCE) were input into our model (Table I) to predict indoor air concentrations and to compare these with the measured levels. Figure I shows that our model's estimates of air concentrations compare favorably with Andelman's results for both the buildup and decay of concentrations in shower room air. The model only slightly underpredicts indoor air concentrations. This difference is not surprising since the model does not, as has been described, take into account volatilization from water after it has impacted on nearby surfaces or as it drains from the shower bottom. This comparison also indicates that for short exposure periods (e.g., less than 20 minutes), the modeled air concentrations may approximate actual concentrations quite well.

MODEL APPLICATION II. SENSITIVITY OF AIR CONCENTRATIONS TO INPUT PARAMETERS

To determine the sensitivity of our model to several important input parameters, we examined the changes in estimated air concentrations associated with different air exchange rates, shower water concentrations, and water temperatures. We focused on only one VOC, TCE, in this model application. Cothern et al.[4] estimate that as many as 212,000 and 128,000 individuals in the United States may be using public water supplies containing >10-20 µg/l and >70-80 µg/l TCE, respectively. To make our results comparable with these estimates, we assumed two shower water concentrations of 15 µg/l and 75 µg/l. Three air exchange rates, 0.5, 1.0, and 1.5 hr^{-1}, were used to simulate leaky, average, and tight homes, respectively.[13] The changes in air concentrations associated with four shower water temperatures, 35°, 40°, 45°, and 50°C, were also evaluated. Table II lists the values of the input parameters used to develop the information presented in this sensitivity analysis (Figures II and III).

Figure II illustrates the effects of changing air exchange rates and TCE water concentrations on TCE air concentrations in the shower room. As expected, predicted indoor air concentrations are highly sensitive to water concentrations. Figure II shows that as the water concentration increases from 15 µg/l to 75 µg/l (a factor of five), air concentrations also increase by about a factor of five or more. As the air exchange rate increases from 0.5 hr^{-1} to 1.5 hr^{-1}, indoor air concentrations are

predicted to decrease, and the differences between air levels become increasingly large with time.

Figure III shows the impact that different shower water temperatures have on indoor air concentrations. As water temperature increases, predicted air concentrations increase. After the shower has been on for 60 minutes, every 5°C increase in water temperature increases indoor TCE air levels by approximately 0.08 mg/m^3. For shorter shower durations, however, the effect of changing temperature is less pronounced, with every 5°C increase in water temperature increasing indoor air concentrations by approximately 0.03 mg/m^3 at 20 minutes and 0.02 mg/m^3 at 10 minutes.

These results indicate that the model presented in this paper behaves expected; it predicts that indoor air levels increase as water concentratio increase, air exchange rates decrease, and water temperatures increase. Th effects of changing these variables become increasingly important with time after the shower has been turned on. However, for short shower durations (e.g., less than 20 minutes), water concentration appears to have a greater impact on indoor air levels than air exchange rate or water temperature. In addition, the increase in air concentration with time appears to be approximately linear for short shower durations.

MODEL APPLICATION III. COMPARATIVE RISK ASSESSMENT

In order to estimate potential human VOC inhalation exposures and risks from showering, we applied our model to five VOCs that have been found in U.S. public water supplies;[4,14] TCE, chloroform, tetrachloroethylene, vinyl chloride, and benzene. Benzene and vinyl chloride have been classified by EPA as Group A carcinogens—human carcinogens based on adequate evidence from human studies. The remaining three chemicals have been classified as Group B2 carcinogens—probable human carcinogens based on inadequate evidence from human studies and adequate evidence from animal studies., Two plausible exposure scenarios were evaluated. The two scenarios differ with respect to three variables: water concentration, shower duration, and air exchange rate. For the lower bound exposure scenario, the water concentration, shower duration, and air exchange rate were assumed to be 15 µg/l, 10 minutes, and 1.5 hr^{-1}, respectively. For the upper bound exposure scenario, the values for these three variables were assumed to be 75 µg/l, 15 minutes, and 0.5 hr^{-1}, respectively. Table III summarizes the input parameters used in this comparative risk assessment. These exposure scenarios are clearly not applicable to all homes and individuals, but they are probably representative of conditions that may exist in some homes in the United States.

Figure IV compares the estimated exposures for the five VOCs. The predicted exposures for the upper bound exposure scenario are approximately an order of magnitude larger than the exposures for the lower bound exposure scenario. The largest exposures are predicted for vinyl chloride, the VOC with the largest Henry's Law Constant and lowest molecular weight. The next largest exposures are predicted for benzene, a chemical with the next smallest molecular weight but the second smallest Henry's Law Constant. Both of these chemical-specific parameters are important factors affecting exposure. This figure also shows that exposures received over an assumed five minute period in the shower room after the shower has been turned off are almost as large as exposures received while showering for 10 or 15 minutes.

The potential excess upper bound lifetime cancer risks associated with these estimated exposures are shown in Table IV. These calculations assume that an individual takes one 10- or 15-minute shower per day for a 70-year lifetime. The excess lifetime risks are highest for chloroform, $2x10^{-5}$ and $2x10^{-4}$ for the lower bound and upper bound exposure scenarios, respectively. The predicted risks are lowest for tetrachloroethylene, $3x10^{-7}$ and $3x10^{-6}$, respectively.

The risks associated with inhaling VOCs in the shower for the two exposure scenarios are compared in Table V to the risks associated with ingestion of tap water at the same water concentrations (15 µg/l and 75 µg/l). It is important to recognize that all the VOCs evaluated except chloroform are more potent by ingestion than by inhalation. In calculating ingestion exposures, it was assumed that an individual drinks 2 liters of water per day for a 70-year lifetime. Table V shows that the ingestion cancer risks range from the same order of magnitude as the inhalation risks to approximately two orders of magnitude greater than the inhalation risks. For example, the risks associated with ingestion of chloroform in drinking water are essentially the same as the risks associated with chloroform inhalation in the shower room. For vinyl chloride, the ingestion risks are about two orders of magnitude greater than the inhalation risks. Thus, for the specific shower exposure scenarios evaluated in this comparative risk assessment, the estimated risks associated with the inhalation of VOCs in the shower room may be as large as the risks associated with VOC ingestion, depending on the particular chemical.

SUMMARY AND CONCLUSIONS

A kinetic model which can be used to estimate inhalation exposures to VOCs in the shower, both while showering and after the shower has been turned off, has been presented in this paper. Inhalation exposures to VOCs are modeled by estimating the rate of VOC release from water into air, the buildup (shower on) and decay (shower off) of VOCs in shower room air, and the quantity of airborne VOCs inhaled while the shower is both on and off.

The model was validated with one set of experimental data for TCE presented by Andelman et al.[1] The predicted air concentrations compared very favorably with the experimental results. In subsequent model runs, the predicted air concentrations were observed to be particularly sensitive to changes in shower water concentration and air exchange rate, but, in comparison, less sensitive to changes in water temperature.

Potential risks associated with inhalation in shower room air of five VOCs that have been measured in U.S. drinking water supplies were estimated for two plausible exposure scenarios. The lower bound exposure scenario assumed a 15 µg/l water concentration, a 10 minute shower, and an air exchange rate of 1.5 hr^{-1}. The upper bound exposure scenario assumed a 75 µg/l water concentration, a 15 minute shower, and an air exchange rate of 0.5 hr^{-1}. All other input variables, except those that are chemical specific, were held constant. The exposures and excess lifetime cancer risks estimated for the upper bound exposure scenario were approximately one order of magnitude greater than the exposures and risks estimated for the lower bound exposure scenario. Excess upper bound lifetime cancer risks were highest for chloroform, ranging from $2x10^{-5}$ to $2x10^{-4}$ for the lower bound and upper bound exposure scenarios, respectively.

These inhalation risks were compared to the risks associated with daily ingestion of 2 liters of water per day at the same concentrations, 15 µg/l and 75 µg/l. For the specific shower exposure scenarios evaluated, the estimated inhalation risks in the shower room were equivalent to the risks associated with ingestion for chloroform, but were two orders of magnitude lower than the ingestion risks for vinyl chloride.

Based on this analysis, our model can be applied to estimate inhalation exposures to VOCs in shower room air. The model has been validated with one set of experimental laboratory data in this paper, but additional data, particularly collected in the home, is required to conduct a more thorough validation. Further research is also needed to characterize more accurately the model's input parameters.

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NOTE TO EDITORS

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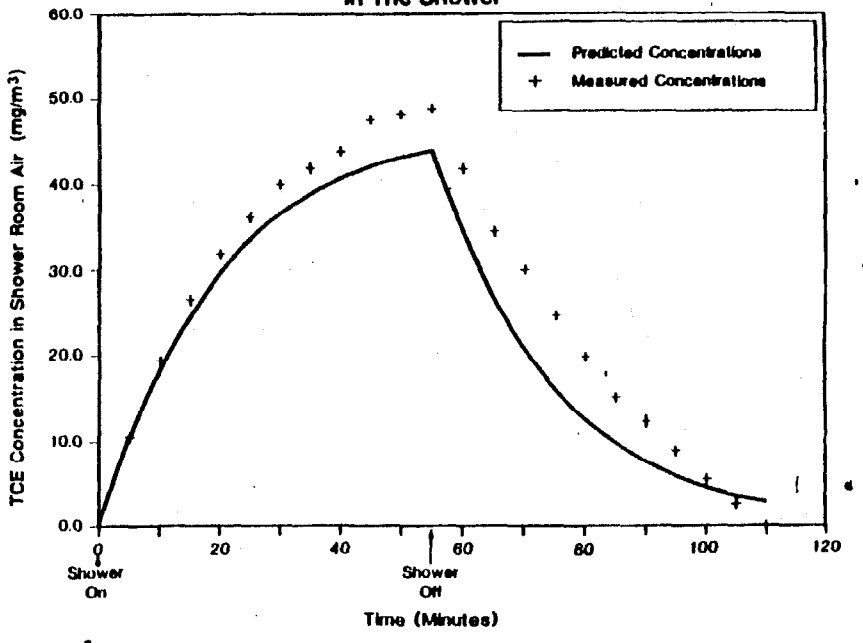
Table I. Model Application Using Experimental Data From Andelman et al.[1]

Input Parameter	Value
Andelman's data:	
Chemical	Trichloroethylene
Shower water concentration	2,000 μg/l[a]
Shower water temperature	43°C (316 K)
Shower water flow rate	0.3 l/min
Droplet diameter	0.25 mm
Droplet drop time	0.5 sec[b]
Air flow rate	0.005 m^3/min
Shower chamber volume	0.1 m^3
Shower duration	55 min
Duration after shower	55 min
Other model input data:	
Molecular weight	131 g/mol
Henry's Law Constant	1.0×10^{-2} atm-m^3/mol-K
Water viscosity	0.6178 cp

[a]Measured range 1,500-2,900 μg/l.
[b]Measured range 0.25-0.75 sec.

Figure I
Comparison Of Predicted And Measured*
Trichloroethylene Air Concentrations
In The Shower



*Source Of Measured Data: Andleman et al.[1]

Table II. Input Parameters for Sensitivity Analysis of Shower Room Air Concentrations

Input Parameter	Value: Figure II	Value: Figure III
Chemical	TCE	TCE
Molecular weight	131 g/mol	131 g/mol
Henry's Law Constant	1.0×10^{-2} atm-m^3/mol-K	1.0×10^{-2} atm-m^3/mol-K
Shower water concentration	15, 75 µg/l	75 µg/l
Shower water temperature	45°C	35°, 40°, 45°, 50°C
Water viscosity	0.596 cp	0.7194, 0.6529, 0.5996, 0.5468 cp
Shower water flow rate	10 l/min	10 l/min
Droplet diameter	1 mm	1 mm
Droplet drop time	2 sec	2 sec
Air exchange rate	0.5, 1.0, 1.5 hr^{-1}	1.0 hr^{-1}
Shower room air volume	6 m^3	6 m^3
Shower duration	60 min	60 min
Duration in room after shower turned off	60 min	60 min

Figure II

Effect Of Different Air Exchange Rates And TCE Water Concentrations On TCE Air Concentrations In The Shower

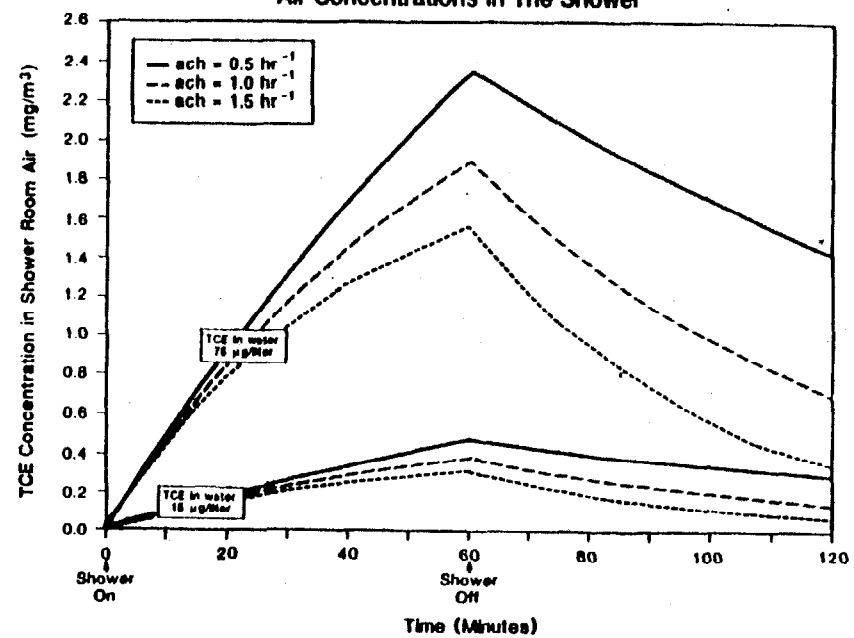


Figure III

Effect Of Different Water Temperatures On Trichloroethylene Air Concentrations In The Shower

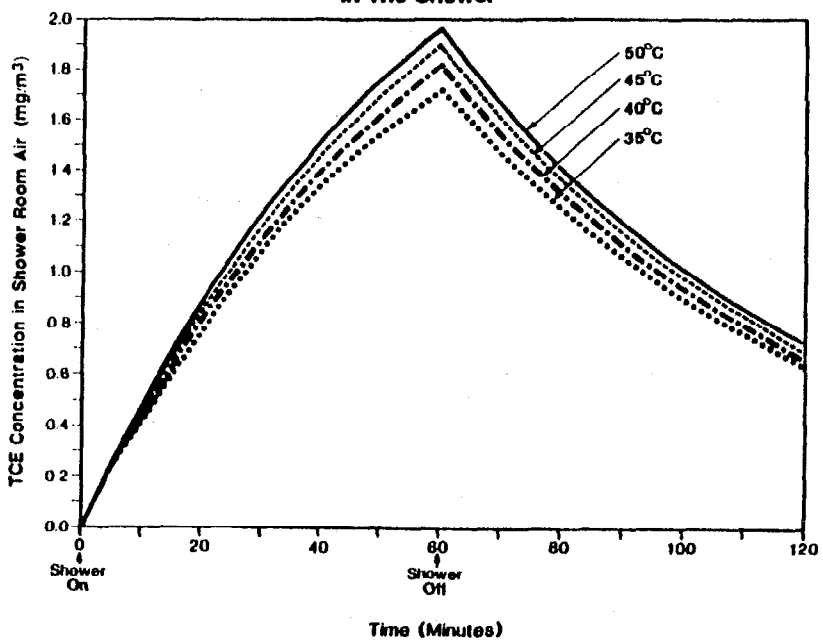


Table III. Input Parameters for Comparative Risk Assessment of Exposure to Five Volatile Organic Chemicals in Shower Room Air

Input Parameter	Value
Chemical (Henry's Law Constant, molecular weight)	Benzene (78 g/mol, 5.5×10^{-3} atm-m^3/mol-K) Chloroform (119 g/mol, 2.87×10^{-3} atm-m^3/mol-K) Tetrachloroethylene (166 g/mol, 2.6×10^{-2} atm-m^3/mol-K) Trichloroethylene (131 g/mol, 1.0×10^{-2} atm-m^3/mol-K) Vinyl chloride (63 g/mol, (8.2×10^{-2} atm-m^3/mol-K)
Shower water concentration	75 µg/l (upper bound scenario) 15 µg/l (lower bound scenario)
Shower water temperature	45°C (318 K)
Water viscosity	0.596 cp
Shower water flow rate	10 l/min
Droplet diameter	1 mm
Droplet drop time	2 sec
Air exchange rate	0.5 hr^{-1} (upper bound scenario) 1.5 hr^{-1} (lower bound scenario)
Shower room air volume	6 m^3
Shower duration	15 min (upper bound scenario) 10 min (lower bound scenario)
Duration in room after shower is turned off	5 min
Ventilation rate	15 l/min
Inhalation absorption factor	1.0
Body weight	70 kg
Cancer potency factor for inhalation [EPA weight of evidence classification for carcinogenic effects][a]	Benzene-2.6×10^{-2} (mg/kg/day)$^{-1}$ [A] Chloroform-8.1×10^{-2} (mg/kg/day)$^{-1}$ [B2] Tetrachloroethylene-1.7×10^{-3} (mg/kg/day)$^{-1}$ [B2] Trichloroethylene-4.6×10^{-3} (mg/kg/day)$^{-1}$ [B2] Vinyl chloride-2.5×10^{-2} (mg/kg/day)$^{-1}$ [A]

[a][A] = human carcinogen based on adequate evidence from human studies; [B2] = probable human carcinogen based on inadequate evidence from human studies and adequate evidence from animal studies.

Figure IV
Comparison of Inhalation Exposures to Five Volatile Organic Compounds in the Shower

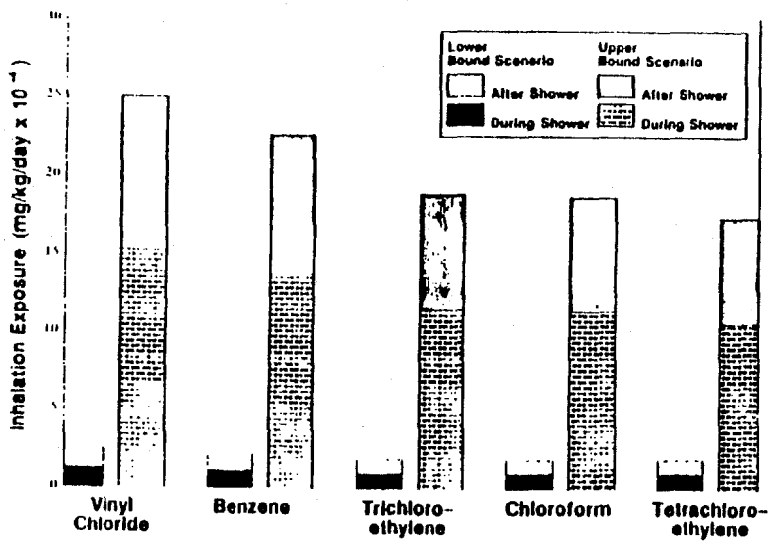


Table IV. Comparative Risk Assessment for Inhalation of Five Volatile Organic Compounds in Shower Room Air

Chemical	Exposure (mg/kg/day)[a]		Cancer Potency Factor for Inhalation (mg/kg/day)$^{-1}$	Excess Lifetime Cancer Risk	
	Lower Bound Scenario[b]	Upper Bound Scenario[c]		Lower Bound Scenario[b]	Upper Bound Scenario[c]
Benzene	2.24×10^{-4}	2.26×10^{-3}	2.6×10^{-2} [A][d]	6×10^{-6}	6×10^{-5}
Chloroform	1.86×10^{-4}	1.88×10^{-3}	8.1×10^{-2} [B2][d]	2×10^{-5}	2×10^{-4}
Tetrachloroethylene	1.73×10^{-4}	1.75×10^{-3}	1.7×10^{-3} [B2][d]	3×10^{-7}	3×10^{-6}
Trichloroethylene	1.87×10^{-4}	1.89×10^{-3}	4.6×10^{-3} [B2][d]	9×10^{-7}	9×10^{-6}
Vinyl chloride	2.48×10^{-4}	2.50×10^{-3}	2.5×10^{-2} [A][d]	6×10^{-6}	6×10^{-5}

[a]Assumes one shower per day over a 70-year lifetime.

[b]Lower-case scenario: Water concentration = 15 µg/l, ach = 1.5 hr^{-1}, 10-minute shower, and 5 minutes in shower room after shower off. See Table III for all input parameter values.

[c]Upper-case scenario: Water concentration = 75 µg/l, ach = 0.5 hr^{-1}, 15-minute shower, and 5 minutes in shower room after shower off. See Table III for all input parameter values.

[d]EPA weight of evidence classification for carcinogenic effects (see Table III).

Table V. Comparison of Excess Lifetime Cancer Risks Associated With Inhalation of VOCs in Shower Room Air and Ingestion of VOCs in Tap Water

Chemical	Range of Excess Lifetime Cancer Risks[a]	
	Inhalation[b]	Ingestion[c]
Benzene	6×10^{-6} - 6×10^{-5}	2×10^{-5} - 1×10^{-4}
Chloroform	2×10^{-5} - 2×10^{-4}	3×10^{-5} - 2×10^{-4}
Tetrachloroethylene	3×10^{-7} - 3×10^{-6}	2×10^{-5} - 1×10^{-4}
Trichloroethylene	9×10^{-7} - 9×10^{-6}	5×10^{-6} - 2×10^{-5}
Vinyl Chloride	6×10^{-6} - 6×10^{-5}	1×10^{-3} - 5×10^{-3}

[a]Lower value in range assumes water concentration = 15 µg/l; upper value in range assumes water concentration = 75 µg/l.

[b]Assumes one 10- or 15-minute shower per day for a 70-year lifetime. Detailed exposure conditions are shown in Table III.

[c]Assumes ingestion of 2 liters of water per day over a 70-year lifetime.

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Table F-1

Molecular Weights and Henry's Law Constants
for Contaminants Evaluated through Shower Inhalation

Parameter	Molecular Weight (g/mole)	Reference	Henry's Law Constant (atm-m3/mole)	Reference or Source
Benzne	78	EPA, 1986	0.00559	EPA, 1986
Benzoic Acid	122	Howard, 1989	0.00559	Howard, 1989
2-Butanone	72	EPA, 1986	0.0000274	EPA, 1986
Chlorobenzene	113	EPA, 1986	0.00372	EPA, 1986
Chloroethane	64.5	Merck & Co., Inc., 1983	0.148	Schnoor, 1987
Chloroform	119	EPA, 1986	0.00287	EPA, 1986
1,4-Dichlorobenzene	147	EPA, 1986	0.00289	EPA, 1986
1,1-Dichloroethane	99	EPA, 1986	0.00431	EPA, 1986
1,2-Dichloroethane	99	EPA, 1986	0.000978	EPA, 1986
Ethylbenzene	106	EPA, 1986	0.00643	EPA, 1986
1,1,2,2-Tertachloroethane	167	EPA, 1986	0.000381	EPA, 1986
Toluene	92	EPA, 1986	0.00637	EPA, 1986
1,1,2-Trichloroethane	133	EPA, 1986	0.00117	EPA, 1986
Trichloroethane	133	EPA, 1986	0.0144E-02	EPA, 1986
Vinyl Chloride	63	EPA, 1986	0.0819	EPA, 1986
Xylene	106	EPA, 1986	0.00704	EPA, 1986

APPENDIX G

EXPOSURE DURATION-AVERAGED AND LIFETIME-AVERAGED DOSES FOR ALL SCENARIOS

TABLE G-1
CHILD EXPOSURE DURATION - AVERAGED DOSES
FOR SITE 2
(mg/kg-day)

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	TOTAL DOSE
ORGANICS												
Benzene	1.79E-04	ND	ND	ND	ND	ND	3.99E-06	1.41E-05	ND	3.37E-04	7.88E-06	5.42E-04
bis(2-Ethylhexyl)phthalate	6.39E-05	ND	ND	ND	ND	ND	1.42E-06	2.05E-05	ND	NE	1.15E-05	9.74E-05
Chloroform	2.43E-04	ND	ND	ND	ND	ND	5.41E-06	1.56E-05	ND	3.68E-04	8.75E-06	6.41E-04
INORGANICS												
Aluminum	1.78E+00	4.94E-03	NE	ND	ND	ND	3.97E-02	NE	NE	NE	NE	1.83E+00
Arsenic	ND	3.60E-06	NE	9.08E-05	2.24E-07	NE	ND	ND	2.96E-05	ND	ND	1.24E-04
Barium	8.18E-03	4.84E-06	NE	ND	ND	ND	1.82E-04	NE	ND	NE	NE	8.37E-03
Beryllium	3.20E-04	5.75E-07	NE	ND	ND	ND	7.12E-06	NE	ND	NE	NE	3.27E-04
Cadmium	ND	5.75E-07	4.14E-08	ND	ND	ND	ND	ND	ND	ND	ND	6.17E-07
Chromium III	4.43E-02	1.18E-04	NE	2.50E-03	6.15E-06	NE	9.88E-04	NE	3.73E-04	NE	NE	4.83E-02
Chromium VI	7.21E-03	1.92E-05	NE	4.06E-04	1.00E-06	NE	1.61E-04	NE	6.07E-05	NE	NE	7.86E-03
Cobalt	4.47E-04	6.71E-07	NE	ND	ND	ND	9.97E-06	NE	ND	NE	NE	4.58E-04
Copper	1.60E-03	8.44E-06	NE	ND	ND	ND	3.56E-05	NE	ND	NE	NE	1.64E-03
Iron	6.64E+00	1.98E-02	NE	3.56E-01	8.76E-04	NE	1.48E-01	NE	1.53E-02	NE	NE	7.18E+00
Lead	2.94E-03	1.29E-05	NE	ND	ND	ND	6.55E-05	NE	ND	NE	NE	3.02E-03
Manganese	1.58E-02	5.08E-06	NE	ND	ND	ND	3.52E-04	NE	ND	NE	NE	1.61E-02
Mercury	2.24E-05	ND	ND	ND	ND	ND	4.99E-07	NE	ND	NE	NE	2.29E-05
Nickel	1.81E-03	ND	ND	ND	ND	ND	4.03E-05	NE	ND	NE	NE	1.85E-03
Nitrate	7.24E-02	7.67E-07	NE	3.96E-05	9.77E-08	NE	1.61E-03	NE	NA	NE	NE	7.41E-02
Selenium	ND	ND	ND	6.39E-06	1.58E-08	NE	ND	ND	4.85E-06	ND	ND	1.13E-05
Vanadium	4.15E-02	1.01E-04	NE	1.87E-03	4.60E-06	NE	9.26E-04	NE	1.90E-04	NE	NE	4.46E-02
Zinc	5.74E-02	1.28E-05	NE	ND	ND	ND	1.28E-03	NE	ND	NE	NE	5.87E-02
EXPLOSIVES												
1,3,5-Trinitrobenzene	1.66E-04	ND	ND	ND	ND	ND	3.70E-06	3.20E-06	ND	NE	1.80E-06	1.75E-04
2,4-Dinitrotoluene	7.67E-05	ND	ND	ND	ND	ND	1.71E-06	2.42E-06	ND	NE	1.36E-06	8.22E-05
HMX	5.18E-05	ND	ND	ND	ND	ND	1.15E-06	2.14E-07	ND	NE	1.20E-07	5.33E-05
Picric Acid	1.34E-04	ND	ND	ND	ND	ND	2.99E-06	9.35E-06	ND	NE	5.25E-06	1.52E-04
RDX	1.62E-04	ND	ND	ND	ND	ND	3.62E-06	1.88E-06	ND	NE	1.05E-06	1.69E-04
Tetryl	7.35E-05	ND	ND	ND	ND	ND	1.64E-06	2.97E-06	ND	NE	1.66E-06	7.98E-05

ND = COMPOUND NOT DETECTED.
NE = COMPOUND NOT EVALUATED IN THE MEDIUM.
NA = HEALTH CRITERIA NUMBER NOT AVAILABLE FOR THE MEDIUM.

TABLE G-2
ADULT EXPOSURE DURATION - AVERAGED DOSES
FOR SITE 2
(mg/kg-day)

	GROUNDWATER INGESTION	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	TOTAL DOSE
ORGANICS										
Benzene	7.67E-05	ND	ND	ND	8.55E-07	7.60E-06	ND	7.79E-05	4.26E-06	1.67E-04
bis(2-Ethylhexyl)phthalate	2.74E-05	ND	ND	ND	3.05E-07	1.11E-05	ND	NE	6.22E-06	4.50E-05
Chloroform	1.04E-04	ND	ND	ND	1.16E-06	8.43E-06	ND	8.51E-05	4.73E-06	2.04E-04
INORGANICS										
Aluminum	7.64E-01	ND	ND	ND	8.52E-03	NE	ND	NE	NE	7.73E-01
Arsenic	ND	9.73E-06	5.99E-08	NE	ND	ND	1.16E-05	ND	ND	2.13E-05
Barium	3.51E-03	ND	ND	ND	3.91E-05	NE	ND	NE	NE	3.55E-03
Beryllium	1.37E-04	ND	ND	ND	1.53E-06	NE	ND	NE	NE	1.39E-04
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Chromium III	1.90E-02	2.67E-04	1.65E-06	NE	2.12E-04	NE	1.30E-04	NE	NE	1.96E-02
Chromium VI	3.09E-03	4.35E-05	2.68E-07	NE	3.44E-05	NE	2.12E-05	NE	NE	3.19E-03
Cobalt	1.92E-04	ND	ND	ND	2.14E-06	NE	ND	NE	NE	1.94E-04
Copper	6.85E-04	ND	ND	ND	7.63E-06	NE	ND	NE	NE	6.93E-04
Iron	2.84E+00	3.81E-02	2.35E-04	NE	3.17E-02	NE	5.72E-03	NE	NE	2.92E+00
Lead	1.26E-03	ND	ND	ND	1.40E-05	NE	ND	NE	NE	1.27E-03
Manganese	6.77E-03	ND	ND	ND	7.54E-05	NE	ND	NE	NE	6.84E-03
Mercury	9.59E-06	ND	ND	ND	1.07E-07	NE	ND	NE	NE	9.70E-06
Nickel	7.75E-04	ND	ND	ND	8.64E-06	NE	ND	NE	NE	7.84E-04
Nitrate	3.10E-02	4.25E-06	2.62E-08	NE	3.46E-04	NE	NA	NE	NE	3.14E-02
Selenium	ND	6.85E-07	4.22E-09	NE	ND	ND	1.64E-06	ND	ND	2.33E-06
Vanadium	1.78E-02	2.00E-04	1.23E-06	NE	1.98E-04	NE	6.66E-05	NE	NE	1.83E-02
Zinc	2.46E-02	ND	ND	ND	2.74E-04	NE	ND	NE	NE	2.49E-02
EXPLOSIVES										
1,3,5-Trinitrobenzene	7.12E-05	ND	ND	ND	7.94E-07	1.73E-06	ND	NE	9.71E-07	7.47E-05
2,4-Dinitrotoluene	3.29E-05	ND	ND	ND	3.66E-07	1.31E-06	ND	NE	7.34E-07	3.53E-05
HMX	2.22E-05	ND	ND	ND	2.47E-07	1.16E-07	ND	NE	6.49E-08	2.26E-05
Picric Acid	5.75E-05	ND	ND	ND	6.41E-07	5.06E-06	ND	NE	2.84E-06	6.61E-05
RDX	6.96E-05	ND	ND	ND	7.75E-07	1.02E-06	ND	NE	5.70E-07	7.19E-05
Tetryl	3.15E-05	ND	ND	ND	3.51E-07	1.60E-06	ND	NE	9.00E-07	3.44E-05

ND = COMPOUND NOT DETECTED IN THE MEDIUM.
NE = COMPOUND NOT EVALUATED IN THE MEDIUM.
NA = HEALTH CRITERIA NUMBER NOT AVAILABLE FOR THE MEDIUM.

TABLE G-3
RESIDENT LIFETIME - AVERAGED EXPOSURE DOSES
FOR SITE 2
(mg/kg-day)

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SOIL INGESTION	SOIL INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	TOTAL DOSE
ORGANICS										
Benzene	4.16E-05	ND	ND	ND	6.35E-07	3.81E-06	ND	4.15E-04	2.14E-06	4.63E-04
bis(2-Ethylhexyl)phthalate	1.49E-05	ND	ND	ND	2.27E-07	5.56E-06	ND	0.00E+00	3.12E-06	2.38E-05
Chloroform	5.65E-05	ND	ND	ND	8.62E-07	4.23E-06	ND	4.53E-04	2.37E-06	5.17E-04
INORGANICS										
Arsenic	ND	3.08E-07	1.11E-05	3.97E-08	ND	ND	6.50E-06	ND	ND	1.80E-05
Beryllium	7.44E-05	4.93E-08	ND	ND	1.13E-06	NE	ND	NE	NE	7.55E-05
Cadmium	ND	NE	ND	ND	ND	ND	ND	ND	ND	0.00E+00
Chromium VI	NE	NE	NE	1.78E-07	NE	NE	1.25E-05	NE	NE	1.26E-05
Nickel	NE	ND	ND	ND	NE	NE	ND	NE	NE	0.00E+00
								NE	NE	
EXPLOSIVES										
2,4-Dinitrotoluene	1.78E-05	ND	ND	ND	2.72E-07	6.57E-07	ND	NE	3.68E-07	1.91E-05
RDX	3.78E-05	ND	ND	ND	5.76E-07	5.09E-07	ND	NE	2.86E-07	3.91E-05
TOTAL										

ND = COMPOUND NOT DETECTED.
NE = COMPOUND NOT EVALUATED IN THE MEDIUM.

TABLE G-4
WORKER EXPOSURE DURATION – AVERAGED EXPOSURE DOSES
FOR SITE 2
(mg/kg-day)

	SOIL INGESTION	SOIL INHALATION	TOTAL DOSE
INORGANICS			
Arsenic	3.47E-06	4.28E-08	3.52E-06
Chromium III	9.55E-05	1.18E-06	9.67E-05
Chromium VI	1.55E-05	1.92E-07	1.57E-05
Iron	1.36E-02	1.68E-04	1.38E-02
Nitrate	1.52E-06	1.87E-08	1.54E-06
Selenium	2.45E-07	3.01E-09	2.48E-07
Vanadium	7.14E-05	8.80E-07	7.23E-05

TABLE G-5
WORKER LIFETIME – AVERAGE EXPOSURE DOSES
FOR SITE 2

	SOIL INGESTION	SOIL INHALATION	TOTAL DOSE
INORGANICS			
Arsenic	1.24E-06	1.53E-08	1.26E-06
Chromium VI	NE	6.84E-08	6.84E-08
TOTAL			

Table G-6
Child Exposure Duration-Averaged Doses
For Site 3
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
Aldrin	1.92E-06	NA	3.45E-07	4.27E-08	6.07E-07	2.91E-06
bis(2-ethylhexyl)phthalate	3.65E-04	NA	6.57E-05	8.13E-06	1.17E-04	5.56E-04
Chlorobenzene	8.31E-04	3.81E-05	7.91E-05	1.85E-05	1.41E-04	1.11E-03
1,4- Dichlorobenzene	5.30E-04	2.02E-03	7.69E-05	1.18E-05	1.37E-04	2.77E-03
Diethylphthalate	2.56E-04	NA	1.77E-05	5.70E-06	3.16E-05	3.11E-04
Di-n- Butylphthalate	2.56E-04	NA	4.56E-05	5.70E-06	8.14E-05	3.88E-04
4,4- DDE	1.34E-06	NA	2.41E-07	2.99E-08	4.30E-07	2.04E-06
4,4- DDT	5.95E-06	NA	1.07E-06	1.32E-07	1.90E-06	9.05E-06
Ethylbenzene	7.48E-03	2.68E-05	8.85E-04	1.67E-04	1.58E-03	1.01E-02
2-Methylnaphthalene	3.20E-04	NA	5.22E-05	7.12E-06	9.31E-05	4.72E-04
4-Methylphenol	2.21E-03	NA	7.96E-05	4.93E-05	1.42E-04	2.48E-03
Naphthalene	3.09E-03	NA	1.11E-04	6.90E-05	7.04E-04	3.98E-03
n-Nitrosodiphenylamine	6.39E-05	NA	2.30E-06	1.42E-06	1.33E-05	8.10E-05
Toluene	3.42E-03	1.18E-02	2.96E-04	7.62E-05	5.28E-04	1.62E-02
Xylene	1.91E-02	2.45E-04	2.40E-03	4.26E-04	4.28E-03	2.65E-02
INORGANICS (mg/l)						
Aluminum	5.98E-01	NA	NA	1.33E-02	NA	6.12E-01
Antimony	1.21E-03	NA	NA	2.71E-05	NA	1.24E-03
Arsenic	5.33E-02	NA	NA	1.19E-03	NA	5.45E-02
Barium	1.23E-02	NA	NA	2.75E-04	NA	1.26E-02
Beryllium	6.39E-05	NA	NA	1.42E-06	NA	6.54E-05
Cadmium	2.17E-03	NA	NA	4.84E-05	NA	2.22E-03
Chromium VI	2.24E-03	NA	NA	5.00E-05	NA	2.29E-03
Chromium III	1.38E-02	NA	NA	3.08E-04	NA	1.41E-02
Cobalt	8.31E-04	NA	NA	1.85E-05	NA	8.50E-04
Copper	5.31E-03	NA	NA	1.18E-04	NA	5.42E-03
Iron	2.96E+01	NA	NA	6.60E-01	NA	3.03E+01
Lead	5.11E-03	NA	NA	1.14E-04	NA	5.23E-03
Manganese	7.99E-02	NA	NA	1.78E-03	NA	8.17E-02
Mercury	1.28E-04	NA	NA	2.85E-06	NA	1.31E-04
Selenium	7.67E-04	NA	NA	1.71E-05	NA	7.84E-04
Silver	3.84E-03	NA	NA	8.56E-05	NA	3.93E-03
Vanadium	2.00E-02	NA	NA	4.46E-04	NA	2.05E-02
Zinc	3.09E-02	NA	NA	6.90E-04	NA	3.16E-02

NA= Compound not detected in the medium.

Table G-7
AdultExposure Duration-Averaged Doses
For Site 3
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
Aldrin	8.22E-07	NA	4.61E-07	9.16E-09	3.28E-07	1.62E-06
bis(2-ethylhexyl)phthalate	1.56E-04	NA	8.77E-05	1.74E-06	6.33E-05	3.09E-04
Chlorobenzene	3.56E-04	7.35E-06	2.00E-04	3.97E-06	7.62E-05	6.43E-04
1,4- Dichlorobenzene	2.27E-04	4.67E-04	1.94E-04	2.53E-06	7.41E-05	9.65E-04
Diethylphthalate	1.10E-04	NA	4.47E-05	1.22E-06	1.71E-05	1.73E-04
Di-n- Butylphthalate	1.10E-04	NA	1.15E-04	1.22E-06	4.40E-05	2.70E-04
4,4- DDE	5.75E-07	NA	6.09E-07	6.41E-09	2.33E-07	1.42E-06
4,4- DDT	2.55E-06	NA	2.69E-06	2.84E-08	1.03E-06	6.29E-06
Ethylbenzene	3.21E-03	6.62E-06	2.23E-03	3.57E-05	8.53E-04	6.33E-03
2-Methylnaphthalene	1.37E-04	NA	1.32E-04	1.53E-06	5.03E-05	3.21E-04
4-Methylphenol	9.48E-04	NA	2.01E-04	1.06E-05	7.67E-05	1.24E-03
Naphthalene	1.33E-03	NA	2.81E-04	1.48E-05	3.81E-04	2.00E-03
n-Nitrosodiphenylamine	2.74E-05	NA	5.80E-06	3.05E-07	7.20E-06	4.07E-05
Toluene	1.47E-03	2.74E-03	7.48E-04	1.63E-05	2.86E-04	5.25E-03
Xylene	8.19E-03	5.66E-05	6.06E-03	9.13E-05	2.32E-03	1.67E-02
INORGANICS (mg/l)						
Aluminum	2.56E-01	NA	NA	2.86E-03	NA	2.59E-01
Antimony	5.21E-04	NA	NA	5.80E-06	NA	5.26E-04
Arsenic	2.28E-02	NA	NA	2.55E-04	NA	2.31E-02
Barium	5.29E-03	NA	NA	5.89E-05	NA	5.35E-03
Beryllium	2.74E-05	NA	NA	3.05E-07	NA	2.77E-05
Cadmium	9.32E-04	NA	NA	1.04E-05	NA	9.42E-04
Chromium VI	9.62E-04	NA	NA	1.07E-05	NA	9.72E-04
Chromium III	5.92E-03	NA	NA	6.59E-05	NA	5.98E-03
Cobalt	3.56E-04	NA	NA	3.97E-06	NA	3.60E-04
Copper	2.27E-03	NA	NA	2.53E-05	NA	2.30E-03
Iron	1.27E+01	NA	NA	1.41E-01	NA	1.28E+01
Lead	2.19E-03	NA	NA	2.44E-05	NA	2.22E-03
Manganese	3.42E-02	NA	NA	3.82E-04	NA	3.46E-02
Mercury	5.48E-05	NA	NA	6.11E-07	NA	5.54E-05
Selenium	3.29E-04	NA	NA	3.66E-06	NA	3.32E-04
Silver	1.65E-03	NA	NA	1.83E-05	NA	1.66E-03
Vanadium	8.58E-03	NA	NA	9.56E-05	NA	8.67E-03
Zinc	1.33E-02	NA	NA	1.48E-04	NA	1.34E-02

NA= Compound not detected in the medium.

TABLE G-8
Resident Lifetime-- Averaged Exposure Dose
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
Aldrin	4.46E-07	NE	5.31E-07	6.80E-09	1.65E-07	1.15E-06
bis(2-ethylhexyl)phthalate	8.49E-05	NE	1.01E-04	1.29E-06	3.17E-05	2.19E-04
4,4- DDE	3.12E-07	NA	3.72E-07	8.70E-07	7.09E-06	8.64E-06
4,4- DDT	1.38E-06	NA	1.64E-06	2.11E-08	2.22E-05	2.52E-05
1,4- Dichlorobenzene	1.23E-04	2.49E-03	1.18E-04	1.88E-06	9.41E-08	2.73E-03
n-NItrosodiphenylamine						
INORGANICS (mg/l)						
Arsenic	1.24E-02	NA	NA	1.89E-04	NE	1.26E-02
Beryllium	1.49E-05	NA	NA	2.27E-07	NE	1.51E-05
TOTAL						

NA= Compund not detected in the medium.
NE= Compound not evaluted through this route.

TABLE G-9
CHILD EXPOSURE DURATION – AVERAGED DOSES
FOR SITE 4
(mg/kg-day)

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS								
Aroclor-1260	ND	5.74E-08	1.44E-06	ND	ND	ND	ND	1.50E-06
bis(2-Ethylhexyl)phthalate	ND	1.36E-08	3.41E-07	ND	ND	ND	ND	3.55E-07
Carbon Disulfide	ND	4.11E-11	1.03E-09	ND	ND	ND	ND	1.08E-09
Chloroform	2.92E-03	ND	ND	2.83E-04	6.72E-06	4.16E-06	1.20E-05	3.23E-03
1,2-DCE	1.61E-02	ND	ND	1.75E-03	5.04E-06	2.30E-05	8.99E-06	1.79E-02
Methylene Chloride	ND	4.11E-09	1.03E-07	ND	ND	ND	ND	1.08E-07
Phenanthrene	ND	2.79E-09	7.03E-08	ND	ND	ND	ND	7.31E-08
Pyrene	ND	5.34E-09	1.34E-07	ND	ND	ND	ND	1.40E-07
Trichloroethene	2.98E-02	ND	ND	2.90E-03	1.15E-04	4.24E-05	2.05E-04	3.30E-02
INORGANICS								
Aluminum	ND	4.91E-04	4.12E-01	ND	ND	ND	ND	4.12E-01
Antimony	ND	2.22E-07	1.86E-04	ND	ND	ND	ND	1.86E-04
Arsenic	ND	1.07E-07	8.97E-05	ND	ND	ND	ND	8.98E-05
Barium	ND	3.90E-06	3.28E-03	ND	ND	ND	ND	3.28E-03
Beryllium	ND	8.63E-09	7.24E-06	ND	ND	ND	ND	7.25E-06
Cadmium	ND	1.97E-07	1.66E-07	ND	ND	ND	ND	3.63E-07
Chromium III	ND	1.11E-06	9.34E-04	ND	ND	ND	ND	9.35E-04
Chromium VI	ND	1.81E-07	1.52E-04	ND	ND	ND	ND	1.52E-04
Cobalt	ND	1.32E-07	1.10E-04	ND	ND	ND	ND	1.10E-04
Copper	ND	2.46E-06	2.07E-03	ND	ND	ND	ND	2.07E-03
Iron	1.98E+01	7.80E-04	6.55E-01	NE	NE	2.82E-02	NE	2.05E+01
Lead	ND	6.66E-06	5.59E-03	ND	ND	ND	ND	5.59E-03
Manganese	ND	2.88E-06	2.42E-03	ND	ND	ND	ND	2.42E-03
Mercury	ND	6.58E-08	5.52E-05	ND	ND	ND	ND	5.52E-05
Nickel	1.30E-02	3.53E-07	2.97E-04	NE	NE	1.85E-05	NE	1.33E-02
Selenium	3.50E-03	ND	ND	NE	NE	4.99E-06	NE	3.50E-03
Silver	ND	4.93E-08	4.14E-05	ND	ND	ND	ND	4.14E-05
Vanadium	ND	1.67E-06	1.40E-03	ND	ND	ND	ND	1.41E-03
Zinc	ND	2.39E-05	2.01E-02	ND	ND	ND	ND	2.01E-02

ND – COMPOUND NOT DETECTED.
NE – NOT EVALUATED.

TABLE G-10
ADULT EXPOSURE DURATION - AVERAGED DOSES
FOR SITE 4
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS						
Aroclor-1260	ND	ND	ND	ND	ND	0.00E+00
bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	0.00E+00
Carbon Disulfide	ND	ND	ND	ND	ND	0.00E+00
Chloroform	1.87E-04	6.54E-05	3.64E-06	8.92E-07	6.48E-06	2.63E-04
1,2-DCE	1.03E-03	4.06E-04	2.72E-06	4.93E-06	4.86E-06	1.45E-03
Methylene Chloride	ND	ND	ND	ND	ND	0.00E+00
Phenanthrene	ND	ND	ND	ND	ND	0.00E+00
Pyrene	ND	ND	ND	ND	ND	0.00E+00
Trichloroethene	1.90E-03	6.70E-04	6.23E-05	9.08E-06	1.11E-04	2.75E-03
INORGANICS						
Aluminum	ND	ND	ND	ND	ND	0.00E+00
Antimony	ND	ND	ND	ND	ND	0.00E+00
Arsenic	ND	ND	ND	ND	ND	0.00E+00
Barium	ND	ND	ND	ND	ND	0.00E+00
Beryllium	ND	ND	ND	ND	ND	0.00E+00
Cadmium	ND	ND	ND	ND	ND	0.00E+00
Chromium III	ND	ND	ND	ND	ND	0.00E+00
Chromium VI	ND	ND	ND	ND	ND	0.00E+00
Cobalt	ND	ND	ND	ND	ND	0.00E+00
Copper	ND	ND	ND	ND	ND	0.00E+00
Iron	1.26E+00	NE	NE	6.04E-03	NE	1.27E+00
Lead	ND	ND	ND	ND	ND	0.00E+00
Manganese	ND	ND	ND	ND	ND	0.00E+00
Mercury	ND	ND	ND	ND	ND	0.00E+00
Nickel	8.31E-04	NE	NE	3.97E-06	NE	8.35E-04
Selenium	2.24E-04	NE	NE	1.07E-06	NE	2.25E-04
Silver	ND	ND	ND	ND	ND	0.00E+00
Vanadium	ND	ND	ND	ND	ND	0.00E+00
Zinc	ND	ND	ND	ND	ND	0.00E+00

ND - COMPOUND NOT DETECTED.
NE - NOT EVALUATED.

TABLE G-11
RESIDENT LIFETIME - AVERAGED EXPOSURE DOSES
FOR SITE 4

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS								
Aroclor-1260	ND	5.74E-08	1.24E-07	ND	ND	ND	ND	1.81E-07
bis(2-Ethylhexyl)phthalate	ND	1.36E-08	2.93E-08	ND	ND	ND	ND	4.28E-08
Chloroform	2.67E-04	ND	ND	3.48E-04	1.82E-06	6.63E-07	3.25E-06	6.21E-04
Methylene Chloride	ND	4.11E-09	8.87E-09	ND	ND	ND	ND	1.30E-08
Trichloroethene	2.72E-03	ND	ND	3.57E-03	3.12E-05	6.75E-06	5.57E-05	6.38E-03
INORGANICS								
Arsenic	ND	1.07E-07	7.68E-06	NE	NE	ND	NE	7.79E-06
Beryllium	ND	8.63E-09	6.21E-07	NE	NE	ND	NE	6.29E-07
Total								

ND - COMPOUND NOT DETECTED.
NE - NOT EVALUATED.

TABLE G-12
Child Exposure Duration- Averaged Doses
For site 5
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
Benzene	1.70E-04	6.51E-04	7.49E-06	3.79E-06	1.34E-05	8.46E-04
bis(2-ethylhexyl)phthalate	3.56E-04	NA	6.40E-05	7.94E-06	1.14E-04	5.42E-04
Chlorobenzene	1.51E-04	5.77E-04	1.44E-05	3.36E-06	2.56E-05	7.71E-04
Chloroethane	3.18E-04	1.22E-03	5.64E-06	7.08E-06	1.01E-05	1.56E-03
Chloroform	5.11E-04	1.21E-06	1.84E-05	1.14E-05	3.28E-05	5.75E-04
1,4- Dichlorobenzene	3.87E-04	1.48E-03	5.62E-05	8.63E-06	1.00E-04	2.03E-03
1,1- Dichloroethane	1.73E-04	6.61E-04	4.83E-06	3.85E-06	8.61E-06	8.51E-04
1,2- Dichloroethane	2.29E-04	7.89E-04	3.98E-06	5.11E-06	7.10E-06	1.03E-03
1,2- Dichloroethene	4.14E-04	1.59E-03	2.02E-06	9.23E-06	3.60E-06	2.01E-03
Di-n- Butylphthalate	6.39E-05	NA	1.14E-05	1.42E-06	2.03E-05	9.71E-05
Ethylbenzene	8.95E-04	3.43E-03	1.06E-04	1.99E-05	1.89E-04	4.64E-03
Naphthalene	3.75E-04	NA	4.82E-05	8.36E-06	8.59E-05	5.18E-04
1,1,2,2- Tetrachloroethane	1.70E-04	3.26E-04	1.04E-05	3.79E-06	1.86E-05	5.28E-04
Trichloroethene	3.59E-04	1.38E-03	2.18E-05	8.01E-06	3.88E-05	1.80E-03
Vinyl Chloride	3.20E-04	1.22E-03	4.76E-06	7.12E-06	8.49E-06	1.56E-03
Xylene	3.06E-04	1.17E-03	3.84E-05	6.81E-06	6.85E-05	1.59E-03
INORGANICS (mg/l)						
Aluminum	4.07E+00	NA	NA	9.06E-02	NA	4.16E+00
Antimony	3.96E-03	NA	NA	8.83E-05	NA	4.05E-03
Barium	6.90E-03	NA	NA	1.54E-04	NA	7.06E-03
Beryllium	5.17E-04	NA	NA	1.15E-05	NA	5.28E-04
Cadmium	5.51E-04	NA	NA	1.23E-05	NA	5.63E-04
Chromium VI	1.05E-02	NA	NA	2.34E-04	NA	1.07E-02
Chromium III	6.39E-02	NA	NA	1.42E-03	NA	6.54E-02
Cobalt	2.29E-03	NA	NA	5.10E-05	NA	2.34E-03
Copper	2.42E-03	NA	NA	5.40E-05	NA	2.48E-03
Iron	1.13E+01	NA	NA	2.52E-01	NA	1.16E+01
Lead	1.76E-03	NA	NA	3.92E-05	NA	1.80E-03
Manganese	2.65E-02	NA	NA	5.90E-04	NA	2.71E-02
Mercury	1.13E-05	NA	NA	2.51E-07	NA	1.15E-05
Nickel	4.69E-03	NA	NA	1.04E-04	NA	4.79E-03
Zinc	2.94E-02	NA	NA	6.55E-04	NA	3.01E-02

NE= Compound not evaluated through this route.
NA= Compound not detected in the medium.

TABLE G-13
Adult Exposure Duration- Averaged Doses
For site 5
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
Benzene	7.29E-05	1.51E-04	4.05E-06	8.12E-07	7.22E-06	2.35E-04
bis(2-ethylhexyl)phthalate	1.53E-04	NA	3.46E-05	1.70E-06	6.17E-05	2.51E-04
Chlorobenzene	6.47E-05	1.33E-04	7.76E-06	7.20E-07	1.38E-05	2.20E-04
Chloroethane	1.36E-04	2.81E-04	3.05E-06	1.52E-06	5.43E-06	4.27E-04
Chloroform	2.19E-04	2.79E-07	9.93E-06	2.44E-06	1.77E-05	2.50E-04
1,4- Dichlorobenzene	1.66E-04	3.41E-04	3.04E-05	1.85E-06	5.42E-05	5.94E-04
1,1- Dichloroethane	7.40E-05	1.53E-04	2.61E-06	8.24E-07	4.65E-06	2.35E-04
1,2- Dichloroethane	9.84E-05	1.82E-04	2.15E-06	1.10E-06	3.84E-06	2.88E-04
1,2- Dichloroethene	1.78E-04	3.67E-04	1.09E-06	1.98E-06	1.95E-06	5.49E-04
Di-n- Butylphthalate	2.74E-05	NA	6.17E-06	3.05E-07	1.10E-05	4.49E-05
Ethylbenzene	3.84E-04	7.92E-04	5.72E-05	4.27E-06	1.02E-04	1.34E-03
Naphthalene	1.61E-04	NA	2.60E-05	1.79E-06	4.64E-05	2.35E-04
1,1,2,2- Tetrachloroethane	7.29E-05	7.53E-05	5.63E-06	8.12E-07	1.00E-05	1.65E-04
Trichloroethene	1.54E-04	3.18E-04	1.18E-05	1.72E-06	2.10E-05	5.06E-04
Vinyl Chloride	1.37E-04	2.83E-04	2.58E-06	1.53E-06	4.59E-06	4.29E-04
Xylene	1.31E-04	2.71E-04	2.08E-05	1.46E-06	3.70E-05	4.61E-04
INORGANICS (mg/l)						
Aluminum	1.74E+00	NA	NA	1.94E-02	NA	1.76E+00
Antimony	1.70E-03	NA	NA	1.89E-05	NA	1.72E-03
Barium	2.96E-03	NA	NA	3.30E-05	NA	2.99E-03
Beryllium	2.21E-04	NA	NA	2.47E-06	NA	2.24E-04
Cadmium	2.36E-04	NA	NA	2.63E-06	NA	2.39E-04
Chromium VI	4.49E-03	NA	NA	5.01E-05	NA	4.54E-03
Chromium III	2.74E-02	NA	NA	3.05E-04	NA	2.77E-02
Cobalt	9.81E-04	NA	NA	1.09E-05	NA	9.92E-04
Copper	1.04E-03	NA	NA	1.16E-05	NA	1.05E-03
Iron	4.85E+00	NA	NA	5.40E-02	NA	4.90E+00
Lead	7.53E-04	NA	NA	8.40E-06	NA	7.62E-04
Manganese	1.13E-02	NA	NA	1.26E-04	NA	1.15E-02
Mercury	4.82E-06	NA	NA	5.37E-08	NA	4.88E-06
Nickel	2.01E-03	NA	NA	2.24E-05	NA	2.03E-03
Zinc	1.26E-02	NA	NA	1.40E-04	NA	1.27E-02

NE= Compound not evaluated through this route.
NA= Compound not detected in the medium.

TABLE G-14
Resident Lifetime – Averaged Exposure Doses
For Site 5
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
Benzene	3.96E-05	8.01E-04	2.03E-06	6.03E-07	3.62E-06	8.47E-04
bis(2-ethylhexyl)phthalate	8.28E-05	NE	1.74E-05	1.26E-06	3.10E-05	1.32E-04
Chloroform	1.19E-04	1.48E-06	4.98E-06	1.81E-06	8.88E-06	1.36E-04
1,4- Dichlorobenzene	9.01E-05	1.82E-03	1.52E-05	1.37E-06	2.72E-05	1.95E-03
1,2- Dichloroethane	5.34E-05	9.71E-04	1.08E-06	8.14E-07	1.93E-06	1.03E-03
1,1,2,2- Tetrachloroethane	3.96E-05	4.01E-04	2.82E-06	6.03E-07	5.03E-06	4.49E-04
Trichlorethene	8.36E-05	1.69E-03	5.90E-06	1.27E-06	1.05E-05	1.79E-03
Vinyl Chloride	7.44E-05	1.51E-03	1.29E-06	1.13E-06	2.30E-06	1.59E-03
INORGANICS (mg/l)						
Beryllium	7.03E-04	NA	NA	1.07E-05	NA	7.13E-04
TOTAL	1.29E-03	7.19E-03	5.07E-05	1.96E-05	9.04E-05	8.64E-03

NA= Compound not detected in the medium.
NE= Compound not evaluated through this route.

TABLE G-15
Child Exposure Duration – Average Doses
For Site 7
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS						
Benzoic acid	9.59E-04	NA	3.00E-05	2.14E-05	5.34E-05	1.06E-03
Bis(2-chloroisopropyl)ether	6.39E-05	NA	2.74E-06	1.42E-06	4.89E-06	7.30E-05
2-Butanone	5.63E-03	1.59E-03	1.29E-05	1.25E-04	2.31E-05	7.38E-03
Chlorobenzene	9.14E-04	3.50E-03	8.70E-05	2.04E-05	1.55E-04	4.67E-03
1,2-Dichloroethane	6.39E-05	2.20E-04	1.11E-06	1.42E-06	1.98E-06	2.88E-04
1,2-Dichloroethene	2.56E-04	9.79E-04	1.25E-06	5.70E-06	2.22E-06	1.24E-03
Heptachlor	6.39E-07	NE	1.08E-07	1.42E-08	1.93E-07	9.55E-07
1,1,2-Trichloroethane	1.06E-03	3.67E-03	7.11E-05	2.36E-05	1.27E-04	4.96E-03
1,1,2,2-Tetrachloroethane	2.74E-03	5.25E-03	1.68E-04	6.11E-05	2.99E-04	8.52E-03
INORGANICS						
Aluminium	1.65E+00	NA	NA	3.67E-02	NA	1.68E+00
Arsenic	8.18E-03	NA	NA	1.82E-04	NA	8.37E-03
Barium	1.43E-02	NA	NA	3.19E-04	NA	1.46E-02
Beryllium	8.12E-05	NA	NA	1.81E-06	NA	8.30E-05
Cadmium	3.48E-04	NA	NA	7.75E-06	NA	3.56E-04
Chromium VI	1.37E-03	NA	NA	3.06E-05	NA	1.41E-03
Chromium III	8.44E-03	NA	NA	1.88E-04	NA	8.63E-03
Copper	5.52E-03	NA	NA	1.23E-04	NA	5.64E-03
Iron	1.07E+01	NA	NA	2.38E-01	NA	1.09E+01
Lead	5.45E-03	NA	NA	1.21E-04	NA	5.57E-03
Manganese	2.49E-02	NA	NA	5.56E-04	NA	2.55E-02
Mercury	4.17E-05	NA	NA	9.30E-07	NA	4.27E-05
Nickel	2.63E-03	NA	NA	5.87E-05	NA	2.69E-03
Selenium	2.26E-04	NA	NA	5.03E-06	NA	2.31E-04
Zinc	1.74E-02	NA	NA	3.88E-04	NA	1.78E-02

NA= Compound not detected in the medium.

TABLE G-16
Adult Exposure Duration- Average Doses
For Site 7
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS						
Benzoic acid	4.11E-04	NA	1.62E-05	4.58E-06	2.89E-05	4.61E-04
Bis(2-chloroisopropyl)ether	2.74E-05	NA	1.48E-06	3.05E-07	2.64E-06	3.18E-05
2-Butanone	2.41E-03	3.68E-04	6.99E-06	2.69E-05	1.25E-05	2.83E-03
Chlorobenzene	3.92E-04	8.09E-04	4.70E-05	4.37E-06	8.39E-05	1.34E-03
1,2-Dichloroethane	2.74E-05	5.08E-05	6.00E-07	3.05E-07	1.07E-06	8.02E-05
1,2-Dichloroethene	1.10E-04	2.26E-04	6.74E-07	1.22E-06	1.20E-06	3.39E-04
Heptachlor	2.74E-07	NE	5.86E-08	3.05E-09	1.05E-07	4.40E-07
1,1,2-Trichloroethane	4.55E-04	8.49E-04	3.84E-05	5.07E-06	6.85E-05	1.42E-03
1,1,2,2-Tetrachloroethane	1.18E-03	1.21E-03	9.08E-05	1.31E-05	1.62E-04	2.66E-03
INORGANICS						
Aluminium	7.05E-01	NA	NA	7.86E-03	NA	7.13E-01
Arsenic	3.51E-03	NA	NA	3.91E-05	NA	3.55E-03
Barium	6.14E-03	NA	NA	6.84E-05	NA	6.21E-03
Beryllium	3.48E-05	NA	NA	3.88E-07	NA	3.52E-05
Cadmium	1.49E-04	NA	NA	1.66E-06	NA	1.51E-04
Chromium VI	5.89E-04	NA	NA	6.56E-06	NA	5.96E-04
Chromium III	3.62E-03	NA	NA	4.03E-05	NA	3.66E-03
Copper	2.36E-03	NA	NA	2.63E-05	NA	2.39E-03
Iron	4.58E+00	NA	NA	5.10E-02	NA	4.63E+00
Lead	2.33E-03	NA	NA	2.60E-05	NA	2.36E-03
Manganese	1.07E-02	NA	NA	1.19E-04	NA	1.08E-02
Mercury	1.79E-05	NA	NA	1.99E-07	NA	1.81E-05
Nickel	1.13E-03	NA	NA	1.26E-05	NA	1.14E-03
Selenium	9.67E-05	NA	NA	1.08E-06	NA	9.78E-05
Zinc	7.45E-03	NA	NA	8.30E-05	NA	7.54E-03

NA= Compound not detected in the medium.

TABLEG–17
Resident Lifetime– Averaged Exposure Doses
For Site 7
(mg/kg–day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS						
1,2–Dichloroethane	1.49E–05	2.71E–04	3.01E–07	2.27E–07	5.36E–07	2.87E–04
Heptachlor	1.49E–07	NA	2.94E–08	2.27E–09	5.24E–08	2.33E–07
1,1,2–Trichloroethane	2.47E–04	4.52E–03	1.93E–05	3.76E–06	3.43E–05	4.83E–03
1,1,2,2–Tetrachloroethane	6.38E–04	6.46E–03	4.55E–05	9.73E–06	8.11E–05	7.24E–03
INORGANICS						
Arsenic	1.90E–03	NA	NA	2.90E–05	NA	1.93E–03
Beryllium	1.89E–05	NA	NA	2.88E–07	NA	1.92E–05

NA= Compound not detected in the medium.

TABLE G-18
CHILD EXPOSURE DURATION – AVERAGED DOSES
FOR SITE 10
(mg/kg –day)

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS							
Benzo(a)anthracene	ND	2.59E-08	5.59E-08	ND	ND	ND	8.18E-08
bis(2-Ethylhexyl)phthalate	1.28E-04	2.92E-08	6.31E-08	2.30E-05	2.85E-06	4.10E-05	6.69E-05
Chrysene	ND	4.32E-08	9.31E-08	ND	ND	ND	1.36E-07
Fluoranthene	ND	4.22E-08	9.10E-08	ND	ND	ND	1.33E-07
Methylene Chloride	ND	2.68E-08	5.79E-08	ND	ND	ND	8.48E-08
Phenanthrene	ND	8.15E-08	1.76E-07	ND	ND	ND	2.57E-07
Pyrene	ND	4.41E-08	9.52E-08	ND	ND	ND	1.39E-07
INORGANICS							
Aluminum	2.88E+00	3.24E-04	NE	NE	6.43E-02	NE	6.46E-02
Antimony	1.33E-03	1.53E-06	NE	NE	2.96E-05	NE	3.12E-05
Arsenic	8.18E-04	8.15E-07	NE	NE	1.82E-05	NE	1.91E-05
Barium	4.22E-03	2.64E-06	NE	NE	9.40E-05	NE	9.67E-05
Beryllium	3.41E-04	ND	ND	NE	7.61E-06	NE	7.61E-06
Cadmium	2.63E-04	ND	ND	NE	5.87E-06	NE	5.87E-06
Chromium III	2.27E-02	2.60E-06	NE	NE	5.05E-04	NE	5.07E-04
Chromium VI	3.69E-03	4.23E-07	NE	NE	8.22E-05	NE	8.26E-05
Cobalt	2.58E-03	1.34E-06	NE	NE	5.76E-05	NE	5.89E-05
Copper	1.13E-03	ND	ND	NE	2.51E-05	NE	2.51E-05
Iron	3.69E+00	4.69E-03	NE	NE	8.23E-02	NE	8.70E-02
Lead	3.25E-03	2.78E-06	NE	NE	7.24E-05	NE	7.52E-05
Manganese	7.74E-03	2.82E-05	NE	NE	1.72E-04	NE	2.01E-04
Mercury	ND	6.23E-08	NE	ND	ND	ND	6.23E-08
Nickel	6.46E-03	ND	ND	NE	1.44E-04	NE	1.44E-04
Selenium	1.02E-04	ND	ND	NE	2.28E-06	NE	2.28E-06
Vanadium	5.50E-02	3.45E-06	NE	NE	1.23E-03	NE	1.23E-03
Zinc	1.48E-02	7.14E-06	NE	NE	3.31E-04	NE	3.38E-04

ND – COMPOUND NOT DETECTED.
NE – NOT EVALUATED.

TABLE G–19
ADULT EXPOSURE DURATION – AVERAGED DOSES
FOR SITE 10
(mg/kg –day)

	GROUNDWATER INGESTION	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS					
Benzo(a)anthracene	ND	ND	ND	ND	ND
bis(2–Ethylhexyl)phthalate	5.48E–05	1.24E–05	6.11E–07	2.22E–05	9.00E–05
Chrysene	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Methylene Chloride	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND
INORGANICS					
Aluminum	1.24E+00	NE	1.38E–02	NE	1.25E+00
Antimony	5.70E–04	NE	6.35E–06	NE	5.76E–04
Arsenic	3.51E–04	NE	3.91E–06	NE	3.55E–04
Barium	1.81E–03	NE	2.01E–05	NE	1.83E–03
Beryllium	1.46E–04	NE	1.63E–06	NE	1.48E–04
Cadmium	1.13E–04	NE	1.26E–06	NE	1.14E–04
Chromium III	9.71E–03	NE	1.08E–04	NE	9.82E–03
Chromium VI	1.58E–03	NE	1.76E–05	NE	1.60E–03
Cobalt	1.11E–03	NE	1.23E–05	NE	1.12E–03
Copper	4.82E–04	NE	5.37E–06	NE	4.88E–04
Iron	1.58E+00	NE	1.76E–02	NE	1.60E+00
Lead	1.39E–03	NE	1.55E–05	NE	1.41E–03
Manganese	3.32E–03	NE	3.69E–05	NE	3.35E–03
Mercury	ND	ND	ND	ND	ND
Nickel	2.77E–03	NE	3.08E–05	NE	2.80E–03
Selenium	4.38E–05	NE	4.88E–07	NE	4.43E–05
Vanadium	2.36E–02	NE	2.63E–04	NE	2.39E–02
Zinc	6.36E–03	NE	7.08E–05	NE	6.43E–03

ND – COMPOUND NOT DETECTED.
NE – NOT EVALUATED.

TABLE G-20
RESIDENT LIFETIME – AVERAGED DOSES
FOR SITE 10

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS							
Benzo(a)anthracene	ND	2.22E-09	4.79E-09	ND	ND	ND	7.01E-09
bis(2-Ethylhexyl)phthalate	2.97E-05	2.51E-09	5.41E-09	6.23E-06	4.54E-07	1.11E-05	4.76E-05
Chrysene	ND	3.70E-09	7.98E-09	ND	ND	ND	1.17E-08
Methylene Chloride	ND	2.30E-09	4.97E-09	ND	ND	ND	7.27E-09
INORGANICS							
Arsenic	1.90E-04	6.99E-08	NE	NE	2.90E-06	NE	1.93E-04
Beryllium	7.94E-05	ND	ND	NE	1.21E-06	NE	8.06E-05
TOTAL							

TABLE G-21
Child Exposure Duration- Averaged Doses
For Site 11
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
bis(2-ethylhexyl)phthalate	1.92E-04	NE	3.45E-05	4.27E-06	6.15E-05	2.92E-04
Chloroform	2.32E-04	8.86E-04	8.34E-06	5.17E-06	1.49E-05	1.15E-03
INORGANICS (mg/l)						
Barium	3.41E-03	NA	NA	7.59E-05	NA	3.48E-03
Cadmium	2.44E-04	NA	NA	5.43E-06	NA	2.49E-04
Chromium VI	3.11E-03	NA	NA	6.94E-05	NA	3.18E-03
Chromium III	1.91E-02	NA	NA	4.26E-04	NA	1.95E-02
Iron	2.74E+00	NA	NA	6.11E-02	NA	2.80E+00
Lead	1.30E-03	NA	NA	2.89E-05	NA	1.33E-03
Manganese	2.99E-03	NA	NA	6.67E-05	NA	3.06E-03
Mercury	1.62E-02	NA	NA	3.60E-04	NA	1.65E-02
Vanadium	8.50E-04	NA	NA	1.89E-05	NA	8.69E-04
Zinc	5.19E-03	NA	NA	1.16E-04	NA	5.31E-03

NE= Compund not evaluated through this route.
NA= Compound is not detected in the medium.

TABLE G-22
Adult Exposure Duration- Averaged Doses
For Site 11
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
bis(2-ethylhexyl)phthalate	8.22E-05	NE	1.86E-05	9.16E-07	3.32E-05	1.35E-04
Chloroform	9.95E-05	2.05E-04	4.51E-06	1.11E-06	8.03E-06	3.18E-04
INORGANICS (mg/l)						
Barium	1.46E-03	NA	NA	1.63E-05	NA	1.48E-03
Cadmium	1.04E-04	NA	NA	1.16E-06	NA	1.06E-04
Chromium VI	1.33E-03	NA	NA	1.49E-05	NA	1.35E-03
Chromium III	8.19E-03	NA	NA	9.13E-05	NA	8.28E-03
Iron	1.18E+00	NA	NA	1.31E-02	NA	1.19E+00
Lead	5.56E-04	NA	NA	6.20E-06	NA	5.62E-04
Manganese	1.28E-03	NA	NA	1.43E-05	NA	1.30E-03
Mercury	6.93E-03	NA	NA	7.72E-05	NA	7.01E-03
Vanadium	3.64E-04	NA	NA	4.06E-06	NA	3.68E-04
Zinc	2.22E-03	NA	NA	2.48E-05	NA	2.25E-03

NE= Compund not evaluated through this route.
NA= Compound is not detected in the medium.

TABLE G-23
Resident Lifetime- Averaged Exposure Doses
For Site 11
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS (mg/l)						
bis(2-ethylhexyl)phthalate	4.46E-05	NE	9.35E-06	6.80E-07	1.67E-05	7.13E-05
Chloroform	5.40E-05	1.09E-03	2.26E-06	8.23E-07	4.03E-06	1.15E-03
TOTAL	9.86E-05	1.09E-03	1.16E-05	1.50E-06	2.07E-05	1.22E-03

NA= Compound not detected in the medium.
NE= Compound not evaluated through this route.

TABLE G-24
CHILD EXPOSURE DURATION - AVERAGED DOSES
FOR SITE 19
(mg/kg-day)

	GROUNDWATER INGESTION	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	DERMAL WHILE SHOWERING	TOTAL DOSE
ORGANICS											
bis(2-Ethylhexyl)phthalate	2.56E-04	ND	ND	ND	ND	ND	5.70E-06	8.20E-05	ND	4.60E-05	3.89E-04
4,4-DDE	1.41E-06	ND	ND	ND	ND	ND	3.13E-08	4.51E-07	ND	2.53E-07	2.14E-06
4,4-DDT	7.16E-06	ND	ND	ND	ND	ND	1.60E-07	2.29E-06	ND	1.28E-06	1.09E-05
Naphthalene	6.39E-05	ND	ND	ND	ND	ND	1.42E-06	1.46E-05	ND	8.16E-06	8.81E-05
INORGANICS											
Aluminum	2.06E+00	1.35E-03	NE	ND	ND	ND	4.60E-02	NE	ND	NE	2.11E+00
Antimony	ND	ND	ND	4.60E-05	1.13E-07	NE	ND	ND	7.52E-05	ND	1.21E-04
Arsenic	1.57E-03	9.59E-07	NE	ND	ND	ND	3.50E-05	NE	ND	NE	1.61E-03
Barium	8.44E-03	3.54E-05	NE	ND	ND	ND	1.88E-04	NE	ND	NE	8.66E-03
Beryllium	4.05E-04	9.59E-08	NE	ND	ND	ND	9.02E-06	NE	ND	NE	4.14E-04
Cadmium	1.09E-03	5.03E-06	3.62E-07	6.14E-06	1.51E-08	6.76E-08	2.44E-05	NE	3.84E-05	NE	1.17E-03
Chromium III	7.53E-02	6.21E-04	NE	ND	ND	ND	1.68E-03	NE	ND	NE	7.76E-02
Chromium VI	1.23E-02	1.01E-04	NE	ND	ND	ND	2.73E-04	NE	ND	NE	1.26E-02
Cobalt	1.48E-03	1.29E-06	NE	ND	ND	ND	3.31E-05	NE	ND	NE	1.52E-03
Copper	3.07E-03	1.07E-05	NE	ND	ND	ND	6.84E-05	NE	ND	NE	3.15E-03
Iron	1.08E+01	2.28E-03	NE	ND	ND	ND	2.41E-01	NE	ND	NE	1.10E+01
Lead	6.39E-03	1.53E-03	NE	2.07E-04	5.10E-07	NE	1.42E-04	NE	1.11E-04	NE	8.38E-03
Manganese	2.92E-02	1.91E-05	NE	ND	ND	ND	6.50E-04	NE	ND	NE	2.98E-02
Mercury	2.24E-05	5.75E-08	NE	ND	ND	ND	4.99E-07	NE	ND	NE	2.29E-05
Nickel	4.28E-03	ND	ND	ND	ND	ND	9.55E-05	NE	ND	NE	4.38E-03
Silver	ND	ND	ND	8.31E-06	2.05E-08	NE	ND	ND	3.58E-05	ND	4.41E-05
Vanadium	3.24E-02	6.28E-06	NE	ND	ND	ND	7.22E-04	NE	ND	NE	3.31E-02
Zinc	2.74E-02	4.41E-04	NE	ND	ND	ND	6.10E-04	NE	ND	NE	2.84E-02

ND - NOT DETECTED IN THE MEDIUM.
NE - NOT EVALUATED.

TABLE G-25
ADULT EXPOSURE DURATION - AVERAGED DOSES
FOR SITE 19
(mg/kg-day)

	GROUNDWATER INGESTION	SOIL INGESTION	SOIL INHALATION	SOIL DERMAL CONTACT	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HOMEGROWN PRODUCE INGESTION	DERMAL WHILE SHOWERING	TOTAL DOSE
ORGANICS									
bis(2-Ethylhexyl)phthalate	1.10E-04	ND	ND	ND	1.22E-06	4.43E-05	ND	2.49E-05	1.80E-04
4,4-DDE	6.03E-07	ND	ND	ND	6.72E-09	2.44E-07	ND	1.37E-07	9.90E-07
4,4-DDT	3.07E-06	ND	ND	ND	3.42E-08	1.24E-06	ND	6.94E-07	5.03E-06
Naphthalene	2.74E-05	ND	ND	ND	3.05E-07	7.87E-06	ND	4.41E-06	4.00E-05
INORGANICS									
Aluminum	8.85E-01	ND	ND	ND	9.86E-03	NE	ND	NE	8.95E-01
Antimony	ND	4.93E-06	3.04E-08	NE	ND	ND	2.93E-05	ND	3.43E-05
Arsenic	6.74E-04	ND	ND	ND	7.51E-06	NE	ND	NE	6.81E-04
Barium	3.62E-03	ND	ND	ND	4.03E-05	NE	ND	NE	3.66E-03
Beryllium	1.73E-04	ND	ND	ND	1.93E-06	NE	ND	NE	1.75E-04
Cadmium	4.68E-04	6.58E-07	4.05E-09	4.18E-08	5.22E-06	NE	1.42E-05	NE	4.89E-04
Chromium III	3.23E-02	ND	ND	ND	3.60E-04	NE	ND	NE	3.26E-02
Chromium VI	5.25E-03	ND	ND	ND	5.86E-05	NE	ND	NE	5.31E-03
Cobalt	6.36E-04	ND	ND	ND	7.08E-06	NE	ND	NE	6.43E-04
Copper	1.32E-03	ND	ND	ND	1.47E-05	NE	ND	NE	1.33E-03
Iron	4.63E+00	ND	ND	ND	5.16E-02	NE	ND	NE	4.68E+00
Lead	2.74E-03	2.22E-05	1.37E-07	NE	3.05E-05	NE	4.06E-05	NE	2.83E-03
Manganese	1.25E-02	ND	ND	ND	1.39E-04	NE	ND	NE	1.26E-02
Mercury	9.59E-06	ND	ND	ND	1.07E-07	NE	ND	NE	9.70E-06
Nickel	1.84E-03	ND	ND	ND	2.05E-05	NE	ND	NE	1.86E-03
Silver	ND	8.90E-07	5.48E-09	NE	ND	ND	1.34E-05	ND	1.43E-05
Vanadium	1.39E-02	ND	ND	ND	1.55E-04	NE	ND	NE	1.40E-02
Zinc	1.17E-02	ND	ND	ND	1.31E-04	NE	ND	NE	1.19E-02

ND - NOT DETECTED IN THE MEDIUM.
NE - NOT EVALUATED.

TABLE G-26
RESIDENT LIFETIME - AVERAGED EXPOSURE DOSES
FOR SITE 19

	GROUNDWAT. INGESTION	SEDIMENT INGESTION	SOIL INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	DERMAL WHILE SHOWERING	TOTAL DOSE
ORGANICS							
bis(2-Ethylhexyl)phthalate	5.95E-05	ND	ND	9.07E-07	2.22E-05	1.25E-05	9.51E-05
4,4-DDE	3.27E-07	ND	ND	4.99E-09	1.22E-07	6.85E-08	5.23E-07
4,4-DDT	1.67E-06	ND	ND	2.54E-08	6.21E-07	3.48E-07	2.66E-06
INORGANICS							
Arsenic	3.66E-04	8.22E-08	NE	5.58E-06	NE	ND	3.72E-04
Beryllium	9.41E-05	8.22E-09	NE	1.44E-06	NE	ND	9.56E-05
Cadmium	NE	NE	2.68E-09	NE	NE	NE	2.68E-09
TOTAL							

TABLE G-27
CHILD EXPOSURE DURATION – AVERAGED DOSES
FOR SITE 20

	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	TOTAL DOSE
ORGANICS			
Antracene	1.34E-07	2.90E-07	4.24E-07
Benzo(a)anthracene	8.63E-07	1.86E-06	2.73E-06
Benzo(a)pyrene	1.20E-06	2.59E-06	3.78E-06
Benzo(b)fluoranthene	1.25E-06	2.69E-06	3.94E-06
Benzo(g,h,i)perylene	1.10E-06	2.38E-06	3.48E-06
Benzo(k)fluoranthene	1.10E-06	2.38E-06	3.48E-06
bis(2-Ethylhexyl)phthalate	7.43E-07	1.60E-06	2.35E-06
Butyl benzyl phthalate	2.25E-07	4.86E-07	7.12E-07
Chrysene	1.15E-06	2.48E-06	3.63E-06
Dibenzo(a,h)anthracene	3.69E-07	7.97E-07	1.17E-06
Di-n-Butylphthalate	9.35E-08	2.02E-07	2.95E-07
Fluoranthene	1.62E-06	3.49E-06	5.11E-06
Ideno(1,2,3-cd)pyrene	9.35E-07	2.02E-06	2.95E-06
Phenanthrene	3.50E-07	7.55E-07	1.11E-06
Pyrene	1.71E-06	3.70E-06	5.41E-06
INORGANICS			
Aluminum	6.68E-03	NE	6.68E-03
Antimony	2.16E-06	NE	2.16E-06
Arsenic	1.92E-06	NE	1.92E-06
Barium	1.21E-04	NE	1.21E-04
Beryllium	3.93E-06	NE	3.93E-06
Cadmium	7.19E-07	5.17E-08	7.71E-07
Chromium III	7.63E-05	NE	7.63E-05
Chromium VI	1.24E-05	NE	1.24E-05
Cobalt	2.95E-05	NE	2.95E-05
Copper	5.12E-04	NE	5.12E-04
Iron	2.16E-02	NE	2.16E-02
Lead	3.46E-04	NE	3.46E-04
Manganese	1.49E-04	NE	1.49E-04
Nickel	2.68E-04	NE	2.68E-04
Selenium	1.29E-06	NE	1.29E-06
Vanadium	2.17E-05	NE	2.17E-05
Zinc	1.32E-03	NE	1.32E-03

NE – NOT EVALUATED.

TABLE G-28
RESIDENT LIFETIME - AVERAGED EXPOSURE DOSES
FOR SITE 20

	SEDIMENT INGESTION	SEDIMENT DERMAL CONTACT	TOTAL
ORGANICS			
Benzo(a)anthracene	7.40E-08	1.60E-07	2.34E-07
Benzo(a)pyrene	1.03E-07	2.22E-07	3.24E-07
Benzo(b)fluoranthene	1.07E-07	2.31E-07	3.37E-07
Benzo(k)fluoranthene	9.45E-08	2.04E-07	2.98E-07
bis(2-Ethylhexyl)phthalate	6.37E-08	1.37E-07	2.01E-07
Chrysene	9.86E-08	2.13E-07	3.11E-07
Dibenzo(a,h)anthracene	3.16E-08	6.83E-08	9.99E-08
Ideno(1,2,3-cd)pyrene	8.01E-08	1.73E-07	2.53E-07
INORGANICS			
Arsenic	1.64E-07	NE	1.64E-07
Beryllium	3.37E-07	NE	3.37E-07

NE - NOT EVALUATED.

TABLE G-29
Child Exposure Duration- Averaged Doses
For Site 26
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS						
1,1- Dichloroethene	1.92E-04	7.34E-04	5.74E-06	4.27E-06	1.02E-05	9.46E-04
1,2- Dichloroethene	2.59E-02	9.91E-02	1.26E-04	5.77E-04	2.25E-04	1.26E-01
Toluene	6.39E-05	2.45E-04	5.54E-06	1.42E-06	9.88E-06	3.25E-04
Trichlorethene	1.61E-02	6.17E-02	9.76E-04	3.59E-04	1.74E-03	8.09E-02
Vinyl Chloride	6.39E-05	2.45E-04	9.53E-07	1.42E-06	1.70E-06	3.13E-04
Xylene	1.85E-04	7.10E-04	2.33E-05	4.13E-06	4.16E-05	9.64E-04
INORGANICS						
Antimony	3.09E-03	NA	NA	6.88E-05	NA	3.16E-03
Barium	9.53E-03	NA	NA	2.12E-04	NA	9.74E-03
Beryllium	8.69E-05	NA	NA	1.94E-06	NA	8.89E-05
Cadmium	3.78E-04	NA	NA	8.42E-06	NA	3.86E-04
Chromium VI	6.38E-04	NA	NA	1.42E-05	NA	6.52E-04
Chromium III	3.92E-03	NA	NA	8.73E-05	NA	4.01E-03
Cobalt	3.43E-04	NA	NA	7.64E-06	NA	3.50E-04
Copper	2.51E-03	NA	NA	5.60E-05	NA	2.57E-03
Iron	5.11E+00	NA	NA	1.14E-01	NA	5.23E+00
Lead	1.62E-03	NA	NA	3.62E-05	NA	1.66E-03
Manganese	1.04E-02	NA	NA	2.31E-04	NA	1.06E-02
Mercury	6.84E-05	NA	NA	1.52E-06	NA	6.99E-05
Nitrate	1.05E-02	NA	NA	2.34E-04	NA	1.07E-02
Silver	1.43E-02	NA	NA	3.18E-04	NA	1.46E-02
Vanadium	4.85E-03	NA	NA	1.08E-04	NA	4.96E-03
Zinc	6.12E-03	NA	NA	1.36E-04	NA	6.26E-03
Explosives						
RDX	6.01E-05	NA	4.15E-07	1.34E-06	2.22E-06	6.41E-05

"NA= Compound not detected in the medium.

Table G-30
Adult Exposure Duration- Averaged Doses
For Site 26
(mg/kg-day)

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS						
1,1- Dichloroethene	8.22E-05	1.70E-04	3.10E-06	9.16E-07	5.53E-06	2.62E-04
1,2- Dichloroethene	1.11E-02	2.29E-02	6.82E-05	1.24E-04	1.22E-04	3.43E-02
Toluene	2.74E-05	5.66E-05	2.99E-06	3.05E-07	5.34E-06	9.26E-05
Trichlorethene	6.90E-03	1.43E-02	5.28E-04	7.69E-05	9.41E-04	2.27E-02
Vinyl Chloride	2.74E-05	5.66E-05	5.15E-07	3.05E-07	9.18E-07	8.57E-05
Xylene	7.95E-05	1.64E-04	1.26E-05	8.85E-07	2.25E-05	2.80E-04
INORGANICS						
Antimony	1.32E-03	NA	NA	1.47E-05	NA	1.34E-03
Barium	4.08E-03	NA	NA	4.55E-05	NA	4.13E-03
Beryllium	3.73E-05	NA	NA	4.15E-07	NA	3.77E-05
Cadmium	1.62E-04	NA	NA	1.80E-06	NA	1.64E-04
Chromium VI	2.73E-04	NA	NA	3.05E-06	NA	2.76E-04
Chromium III	1.68E-03	NA	NA	1.87E-05	NA	1.70E-03
Cobalt	1.47E-04	NA	NA	1.64E-06	NA	1.48E-04
Copper	1.08E-03	NA	NA	1.20E-05	NA	1.09E-03
Iron	2.19E+00	NA	NA	2.44E-02	NA	2.22E+00
Lead	6.96E-04	NA	NA	7.75E-06	NA	7.04E-04
Manganese	4.44E-03	NA	NA	4.95E-05	NA	4.49E-03
Mercury	2.93E-05	NA	NA	3.27E-07	NA	2.96E-05
Nitrate	4.49E-03	NA	NA	5.01E-05	NA	4.54E-03
Silver	6.11E-03	NA	NA	6.81E-05	NA	6.18E-03
Vanadium	2.08E-03	NA	NA	2.32E-05	NA	2.10E-03
Zinc	2.62E-03	NA	NA	2.92E-05	NA	2.65E-03
Explosives						
RDX	2.58E-05	NA	2.24E-07	2.87E-07	1.20E-06	2.75E-05

"NA= Compound not detected in the medium.

TABLE G-31
Resident Lifetime -Averaged Exposure Doses
For Site 26

	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL DOSE
ORGANICS						
1,1- Dichloroethene	4.46E-05	9.04E-04	1.56E-06	6.80E-07	2.77E-06	9.54E-04
Trichlorethene	3.75E-03	7.59E-02	2.65E-04	5.71E-05	4.72E-04	8.05E-02
Vinyl Chloride	1.49E-05	3.01E-04	2.58E-07	2.27E-07	4.60E-07	3.17E-04
INORGANICS						
Beryllium	2.02E-05	NA	NA	3.08E-07	NA	2.05E-05
EXPLOSIVES						
RDX	1.49E-05	NA	1.12E-07	2.13E-07	6.01E-07	1.52E-05
TOTAL	3.84E-03	7.71E-02	2.67E-04	5.86E-05	4.76E-04	8.18E-02

NA= Compound not detected in the medium.

APPENDIX H

EXPOSURE DATA FOR ECOLOGICAL RISK ASSESSMENT

H-1
Plant Uptake Factors (PUFs) for White-Tailed Deer
Browse Concentration Estimations

Chemical	Log Kow/Bv*	Reference	PUF
Organics			
Acetone	-0.24	EPA, 1986	53.3
Methylene Chloride	1.30	EPA, 1986	6.86
Inorganics			
Antimony	0.20[a]	Baes et al., 1984	0.20
Cadmium	0.55[a]	Baes et al., 1984	0.55
Lead	0.045[a]	Baes et al., 1984	0.045
Silver	0.40[a]	Baes et al., 1984	0.40

* Log Kow used in determining PUF for organics, Bv used is determining PUF for inorganics.
[a] Bv value used for inorganics is for vegetative portion of plant which is representative of browse.

H-1 (Continued)
Plant Uptake Factors (PUFs) for White-Footed Mouse
Vegetation Concentration Estimations

Chemical	Log Kow/Bv*	Reference	PUF
Organics			
Anthracene	4.45	EPA, 1986	0.10
Benzo(a)anthracene	5.60	EPA, 1986	0.02
Benzo(a)pyrene	6.06	EPA, 1986	0.01
Benzo(b)fluoranthene	6.06	EPA, 1986	0.01
Benzo(g,h,i)perylene	6.51	EPA, 1986	6.76E-03
Benzo(k)fluoranthene	6.06	EPA, 1986	0.01
bis(2-Ethylhexyl)phthalate	9.61	Schnoor, 1987	1.08E-04
Chrysene	5.61	EPA, 1986	0.02
Dibenzo(a,h)anthracene	6.80	EPA, 1986	4.57E-03
Di-n-Butylphthalate	5.60	EPA, 1986	0.02
Fluoranthene	4.90	EPA, 1986	0.06
Ideno(1,2,3-cd)pyrene	6.50	EPA, 1986	6.76E-03
Phenanthrene	4.46	EPA, 1986	0.10
Pyrene	4.88	EPA, 1986	0.06
Inorganics			
Antimony	0.030	Baes et al., 1984	0.03
Arsenic	0.006	Baes et al., 1984	0.006
Beryllium	0.0015	Baes et al., 1984	0.0015
Cadmium	0.15	Baes et al., 1984	0.15
Chromium	0.0045	Baes et al., 1984	0.0045
Cobalt	0.007	Baes et al., 1984	0.007
Copper	0.25	Baes et al., 1984	0.25
Iron	0.001	Baes et al., 1984	0.001
Lead	0.009	Baes et al., 1984	0.009
Nickel	0.060	Baes et al., 1984	0.06
Selenium	0.025	Baes et al., 1984	0.025
Vanadium	0.003	Baes et al., 1984	0.003
Zinc	0.90	Baes et al., 1984	0.90

Log Kow used in determining PUF for organics, Bv used in determining PUF for inorganics.
* Bv value used for inorganics is for reproductive portion of the plant.

H-2
Earthworm Bioaccumulation Factors (BAF) for Chemicals of Potential Concern in Soil

Chemical	BAF	Reference
Organics		
Acenaphthene	NDA	Marquerie et al., 1987
Acetone	NDA	--
Anthracene	0.01[1]	Marquerie et al., 1987
Benzo(a)anthracene	0.03[1]	Marquerie et al., 1987
Benzo(a)pyrene	0.09[1]	Marquerie et al., 1987
Benzo(b)fluoranthene	0.08[1]	Marquerie et al., 1987
Benzo(g,h,i)perylene	0.06[1]	Marquerie et al., 1987
Benzoic Acid	NDA	--
Benzo(k)fluoranthene	0.06[1]	Marquerie et al., 1987
bis(2-ethylhexyl)phthalate	NDA	--
Chrysene	0.04[1]	Marquerie et al., 1987
4,4-DDT	2.6	Gish, 1970
Dibenzo(a,h)anthracene	0.09[1]	Marquerie et al., 1987
Di-n-Butylphthalate	NDA	--
Fluoranthene	0.02[1]	Marquerie et al., 1987
Fluorene	NDA	--
Ideno(1,2,3-cd)pyrene	0.1[1]	Marquerie et al., 1987
Methylene Chloride	NDA	--
Phenanthrene	0.03[1]	Marquerie et al., 1987
Pyrene	0.02[1]	Marquerie et al., 1987
1,1,1-Trichloroethane	NDA	--
Inorganics		
Antimony	NDA	--
Beryllium	NDA	--
Cadmium	2.9[1]	Beyer & Cromartie, 1987

H-2 (Cont'd)
Earthworm Bioaccumulation Factors (BAF) for Chemicals of Potential Concern in Soil

Chemical	BAF	Reference
Chromium	0.19[1]	Beyer & Cromartie, 1987
Cobalt	NDA	--
Copper	0.11[1]	Beyer & Cromartie, 1987
Iron	NDA	--
Lead	0.13[1]	Beyer & Cromartie, 1987
Nickel	0.46[1]	Kabata-Pendias, 1984
Selenium	11.3[1]	Beyer et al., 1987
Silver	NDA	--
Vanadium	NDA	--
Zinc	2.5[1]	Beyer & Cromartie, 1987

[1] Converted from dry to wet weight basis by dividing by 4 (Beyer & Gish, 1980)

H–3
White–footed Mouse Exposure through Soil Ingestion
Site 2

Chemical	Soil Concentration at Site 2 (mg/kg)		Estimated Daily Intake (mg/kg–day)	
	Average	Upper 95%	Average	Upper 95%
Inorganics				
Arsenic	4.60E+00	7.10E+00	1.38E–02	2.13E–02
Chromium	1.40E+02	2.27E+02	4.20E–01	6.81E–01
Iron	1.83E+04	2.78E+04	5.50E+01	8.35E+01
Selenium	2.70E–01	5.00E–01	8.10E–04	1.50E–03
Vanadium	9.90E+01	1.46E+02	2.97E–01	4.38E–01

H–3 (Continued)
White–footed Mouse Exposure through Vegetation Ingestion
Site 2

Chemical	Soil Concentration Site 2 (mg/kg) Mean	Soil Concentration Site 2 (mg/kg) Upper 95%	Plant Uptake Factor	Vegetation Concentration (mg/kg) Mean	Vegetation Concentration (mg/kg) Upper 95%	Estimated Daily Intake (mg/kg–day) Mean	Estimated Daily Intake (mg/kg–day) Upper 95%
Inorganics							
Arsenic	4.60E+00	7.10E+00	6.00E–03	2.76E–02	4.26E–02	8.28E–03	1.28E–02
Chromium	1.40E+02	2.27E+02	4.50E–03	6.30E–01	1.02E+00	1.89E–01	3.06E–01
Iron	1.83E+04	2.78E+04	1.00E–03	1.83E+01	2.78E+01	5.50E+00	8.35E+00
Selenium	2.70E–01	5.00E–01	2.50E–02	6.75E–03	1.25E–02	2.03E–03	3.75E–03
Vanadium	9.90E+01	1.46E+02	3.00E–03	2.97E–01	4.38E–01	8.91E–02	1.31E–01

H–3 (Continued)
Summary of Exposure Doses for the White–footed Mouse
Site 2
(mg/kg–day)

Chemical	Soil Ingestion		Vegetation Ingestion		Total Estimated Daily Intake	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Inorganics						
Arsenic	1.38E–02	2.13E–02	8.28E–03	1.28E–02	2.21E–02	3.41E–02
Chromium	4.20E–01	6.81E–01	1.89E–01	3.06E–01	6.09E–01	9.87E–01
Iron	5.50E+01	8.35E+01	5.50E+00	8.35E+00	6.05E+01	9.18E+01
Selenium	8.10E–04	1.50E–03	2.03E–03	3.75E–03	2.84E–03	5.25E–03
Vanadium	2.97E–01	4.38E–01	8.91E–02	1.31E–01	3.86E–01	5.69E–01

H–4
White–tailed Deer Exposure through Soil Ingestion
Site 19

Chemical	Soil Concentration Site 19 (mg/Kg) Average	Upper 95%	Estimated Daily Dose (mg/kg–day) Average	Upper 95%
Organics				
Methylene Chloride	3.00E–03	3.00E–03	1.44E–08	1.44E–08
Inorganics				
Antimony	3.10E+00	3.80E+00 *	1.49E–05	1.82E–05
Lead	1.08E+01	1.58E+01	5.18E–05	7.58E–05
Silver	5.40E–01	7.10E–01 *	2.59E–06	3.41E–06

* Maximum value is used for upper 95% value when sample number is less than three

H–4 (Continued)
White–tailed Deer Exposure through Browse Ingestion
Site 19

Chemical	Soil Concentration Site 19 (mg/Kg) Average	Soil Concentration Site 19 (mg/Kg) Upper 95%	Plant Uptake Factor	Browse Concentration (mg/Kg) Average	Browse Concentration (mg/Kg) Upper 95%	Estimated Daily Intake (mg/kg–day) Average	Estimated Daily Intake (mg/kg–day) Upper 95%
Organics							
Methylene Chloride	3.00E–03	3.00E–03	6.86E+00	2.06E–02	2.06E–02	1.11E–05	1.11E–05
Inorganics							
Antimony	3.10E+00	3.80E+00 *	2.00E–01	6.20E–01	7.60E–01	3.35E–04	4.10E–04
Lead	1.08E+01	1.58E+01	4.50E–02	4.86E–01	7.11E–01	2.62E–04	3.84E–04
Silver	5.40E–01	7.10E–01 *	4.00E–01	2.16E–01	2.84E–01	1.17E–04	1.53E–04

* Maximum value is used for upper 95% value when sample number is less than three

H–4 (Continued)
Summary of Exposure Doses for the White–tailed Deer
Site 19
(mg/kg–day)

Chemical	Soil Ingestion		Browse Ingestion		Total Dose	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Methylene Chloride	1.44E–08	1.44E–08	1.11E–05	1.11E–05	1.11E–05	1.11E–05
Inorganics						
Antimony	1.49E–05	1.82E–05	3.35E–04	4.10E–04	3.50E–04	4.29E–04
Lead	5.18E–05	7.58E–05	2.62E–04	3.84E–04	3.14E–04	4.60E–04
Silver	2.59E–06	3.41E–06	1.17E–04	1.53E–04	1.19E–04	1.57E–04

H–5
Estimation of Contaminant Concentrations in Earthworms for Least Shrew – Site 19

Chemical	Soil Concentration Site 19 (mg/Kg) Average	Soil Concentration Site 19 (mg/Kg) Upper 95%	Earthworm BAF	Earthworm Concentration (mg/Kg) Average	Earthworm Concentration (mg/Kg) Upper 95%
Organics					
Methylene Chloride	3.00E–03	3.00E–03	NBAF	NE	NE
Inorganics					
Antimony	3.10E+00	3.80E+00 *	NBAF	NE	NE
Lead	1.08E+01	1.58E+01	1.30E–01 a	1.40E+00	2.05E+00
Silver	5.40E–01	7.10E–01 *	NBAF	NE	NE

* Maximum value is used for upper 95% value when sample number is less than three

a – Converted from dry to wet weight basis by dividing by 4 (Beyer & Gish, 1980)

NBAF – No bioaccumulation factor available

NE – Not evaluated due to lack of data

H–5 (Continued)
Estimation of Exposure to the Least Shrew through Earthworm Ingestion
Site 19

Chemical	Earthworm Concentration (mg/Kg)		Estimated Daily Intake (mg/kg–day)	
	Average	Upper 95%	Average	Upper 95%
Organics				
Methylene Chloride	NE	NE	NE	NE
Inorganics				
Antimony	NE	NE	NE	NE
Lead	1.40E+00	2.05E+00	1.12E+00	1.64E+00
Silver	NE	NE	NE	NE

NE – Not evaluated due to lack of earthworm bioaccumulation factor

H–5 (Continued)
Estimation of Exposure to the Least Shrew through Soil Ingestion
Site 19

Chemical	Soil Concentration Site 19 (mg/Kg) Average	Soil Concentration Site 19 (mg/Kg) Upper 95%	Estimated Daily Intake (mg/kg–day) Average	Estimated Daily Intake (mg/kg–day) Upper 95%
Organics				
Methylene Chloride	3.00E–03	3.00E–03	2.40E–05	2.40E–05
Inorganics				
Antimony	3.10E+00	3.80E+00 *	2.48E–02	3.04E–02
Lead	1.08E+01	1.58E+01	8.64E–02	1.26E–01
Silver	5.40E–01	7.10E–01 *	4.32E–03	5.68E–03

* Maximum value used when sample number was less than three

H–5 (Continued)
Summary of Estimated Daily Intakes for the Least Shrew
Site 19
(mg/kg–day)

Chemical	Soil Ingestion		Invertebrate Ingestion		Total Estimated Daily Intake	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Methylene Chloride	2.40E–05	2.40E–05	NE	NE	2.40E–05	2.40E–05
Inorganics						
Antimony	2.48E–02	3.04E–02	NE	NE	2.48E–02	3.04E–02
Lead	8.64E–02	1.26E–01	1.12E+00	1.64E+00	1.21E+00	1.77E+00
Silver	4.32E–03	5.68E–03	NE	NE	4.32E–03	5.68E–03

NE – Not evaluated due to lack of data

H-6
Estimation of Contaminant Concentrations in Earthworms for American Woodcock – Site 19

Chemical	Soil Concentration Site 19 (mg/Kg) Average	Soil Concentration Site 19 (mg/Kg) Upper 95%	Earthworm BAF	Earthworm Concentration (mg/Kg) Average	Earthworm Concentration (mg/Kg) Upper 95%
Organics					
Methylene Chloride	3.00E-03	3.00E-03	NBAF	NE	NE
Inorganics					
Antimony	3.10E+00	3.80E+00 *	NBAF	NE	NE
Lead	1.08E+01	1.58E+01	1.30E-01 a	1.40E+00	2.05E+00
Silver	5.40E-01	7.10E-01 *	NBAF	NE	NE

* Maximum value is used for upper 95% value when sample number is less than three

a – Converted from dry to wet weight basis by dividing by 4 (Beyer & Gish, 1980)

NBAF – No bioaccumulation factor available

NE – Not evaluated due to lack of data

H–6 (Continued)
Estimation of Exposure to the American Woodcock
through Earthworm Ingestion
Site 19

Chemical	Earthworm Concentration (mg/Kg)		Estimated Daily Intake (mg/kg–day)	
	Average	Upper 95%	Average	Upper 95%
Organics				
Methylene Chloride	NE	NE	NE	NE
Inorganics				
Antimony	NE	NE	NE	NE
Lead	1.40E+00	2.05E+00	3.96E–01	5.79E–01
Silver	NE	NE	NE	NE

NE – Not evaluated due to lack of earthworm bioaccumulation factor

H–6 (Continued)
Estimation of Exposure to the American Woodcock through Soil Ingestion
Site 19

Chemical	Soil Concentration Site 19 (mg/Kg) Average	Soil Concentration Site 19 (mg/Kg) Upper 95%	Estimated Daily Intake (mg/kg–day) Average	Estimated Daily Intake (mg/kg–day) Upper 95%
Organics				
Methylene Chloride	3.00E–03	3.00E–03	8.45E–06	8.45E–06
Inorganics				
Antimony	3.10E+00	3.80E+00 *	8.73E–03	1.07E–02
Lead	1.08E+01	1.58E+01	3.04E–02	4.45E–02
Silver	5.40E–01	7.10E–01 *	1.52E–03	2.00E–03

* Maximum value used when sample number was less than three

H–6 (Continued)
Summary of Estimated Daily Intakes for the American Woodcock
Site 19
(mg/kg–day)

Chemical	Soil Ingestion Average	Soil Ingestion Upper 95%	Invertebrate Ingestion Average	Invertebrate Ingestion Upper 95%	Total Estimated Daily Intake Average	Total Estimated Daily Intake Upper 95%
Organics						
Methylene Chloride	8.45E–06	8.45E–06	NE	NE	8.45E–06	8.45E–06
Inorganics						
Antimony	8.73E–03	1.07E–02	NE	NE	8.73E–03	1.07E–02
Lead	3.04E–02	4.45E–02	3.96E–01	5.79E–01	4.26E–01	6.23E–01
Silver	1.52E–03	2.00E–03	NE	NE	1.52E–03	2.00E–03

NE – Not evaluated due to lack of data

H–7
White–footed Mouse Exposure through Soil Ingestion
Site 20

Chemical	Soil Concentration at Site 20 (mg/kg) Average	Upper 95%	Estimated Daily Intake (mg/kg–day) Average	Upper 95%
Organics				
Anthracene	2.44E–01	2.80E–01 [a]	3.89E–05	4.46E–05
Benzo(a)anthracene	9.60E–01	1.80E+00 [a]	1.53E–04	2.87E–04
Benzo(a)pyrene	1.33E+00	2.50E+00 [a]	2.11E–04	3.98E–04
Benzo(b)fluoranthene	1.42E+00	2.60E+00 [a]	2.25E–04	4.14E–04
Benzo(g,h,i)perylene	1.23E+00	2.30E+00 [a]	1.96E–04	3.66E–04
Benzo(k)fluoranthene	1.24E+00	2.30E+00 [a]	1.97E–04	3.66E–04
bis(2–Ethylhexyl)phthalate	1.00E+00	1.55E+00 [a]	1.59E–04	2.47E–04
Chrysene	1.30E+00	2.40E+00 [a]	2.07E–04	3.82E–04
Dibenzo(a,h)anthracene	5.25E–01	7.70E–01 [a]	8.36E–05	1.23E–04
Di–n–Butylphthalate	1.37E–01	1.95E–01 [a]	2.18E–05	3.11E–05
Fluoranthene	1.82E+00	3.38E+00 [a]	2.89E–04	5.37E–04
Indeno(1,2,3–cd)pyrene	1.04E+00	1.95E+00 [a]	1.65E–04	3.11E–04
Phenanthrene	4.20E–01	7.30E–01 [a]	6.69E–05	1.16E–04
Pyrene	1.92E+00	3.58E+00 [a]	3.05E–04	5.69E–04
Inorganics				
Antimony	2.40E+00	4.50E+00	3.82E–04	7.17E–04
Beryllium	5.30E+00	8.20E+00	8.44E–04	1.31E–03
Cadmium	9.00E–01	1.50E+00	1.43E–04	2.39E–04
Chromium	1.35E+02	1.85E+02	2.15E–02	2.95E–02
Cobalt	3.78E+01	6.15E+01	6.02E–03	9.79E–03
Copper	6.51E+02	1.07E+03	1.04E–01	1.70E–01
Iron	3.14E+04	4.50E+04	5.00E+00	7.17E+00
Lead	5.18E+02	7.21E+02	8.25E–02	1.15E–01
Nickel	3.12E+02	5.59E+02	4.97E–02	8.90E–02
Selenium	1.80E+00	2.70E+00	2.87E–04	4.30E–04
Zinc	1.82E+03	2.75E+03	2.89E–01	4.38E–01

[a] Maximum value is used for upper 95% value when there are insufficient number of samples to calculate

H-7 (Continued)
White-footed Mouse Exposure through Vegetation Ingestion
Site 20

Chemical	Soil Concentration Site 20 (mg/kg) Mean	Soil Concentration Site 20 (mg/kg) Upper 95%	Plant Uptake Factor	Vegetation Concentration (mg/kg) Mean	Vegetation Concentration (mg/kg) Upper 95%	Estimated Daily Intake (mg/kg-day) Mean	Estimated Daily Intake (mg/kg-day) Upper 95%
Organics							
Anthracene	2.44E-01	2.80E-01 [a]	1.00E-01	2.44E-02	2.80E-02	1.68E-03	1.93E-03
Benzo(a)anthracene	9.60E-01	1.80E+00 [a]	2.00E-02	1.92E-02	3.60E-02	1.32E-03	2.48E-03
Benzo(a)pyrene	1.33E+00	2.50E+00 [a]	1.00E-02	1.33E-02	2.50E-02	9.14E-04	1.73E-03
Benzo(b)fluoranthene	1.42E+00	2.60E+00 [a]	1.00E-02	1.42E-02	2.60E-02	9.76E-04	1.79E-03
Benzo(g,h,i)perylene	1.23E+00	2.30E+00 [a]	6.76E-03	8.31E-03	1.55E-02	5.74E-04	1.07E-03
Benzo(k)fluoranthene	1.24E+00	2.30E+00 [a]	1.00E-02	1.24E-02	2.30E-02	8.52E-04	1.59E-03
bis(2-Ethylhexyl)phthalate	1.00E+00	1.55E+00 [a]	1.08E-04	1.08E-04	1.67E-04	7.45E-06	1.16E-05
Chrysene	1.30E+00	2.40E+00 [a]	2.00E-02	2.60E-02	4.80E-02	1.79E-03	3.31E-03
Dibenzo(a,h)anthracene	5.25E-01	7.70E-01 [a]	4.57E-03	2.40E-03	3.52E-03	1.66E-04	2.43E-04
Di-n-Butylphthalate	1.37E-01	1.95E-01 [a]	2.00E-02	2.74E-03	3.90E-03	1.89E-04	2.69E-04
Fluoranthene	1.82E+00	3.38E+00 [a]	6.00E-02	1.09E-01	2.03E-01	7.53E-03	1.40E-02
Indeno(1,2,3-cd)pyrene	1.04E+00	1.95E+00 [a]	6.76E-03	7.00E-03	1.32E-02	4.83E-04	9.10E-04
Phenanthrene	4.20E-01	7.30E-01 [a]	1.00E-02	4.20E-03	7.30E-03	2.90E-04	5.04E-04
Pyrene	1.92E+00	3.58E+00 [a]	6.00E-02	1.15E-01	2.15E-01	7.94E-03	1.48E-02
Inorganics							
Antimony	2.40E+00	4.50E+00	3.00E-02	7.20E-02	1.35E-01	4.97E-03	9.32E-03
Beryllium	5.30E+00	8.20E+00	1.50E-03	7.95E-03	1.23E-02	5.49E-04	8.49E-04
Cadmium	9.00E-01	1.50E+00	1.50E-01	1.35E-01	2.25E-01	9.32E-03	1.55E-02
Chromium	1.35E+02	1.85E+02	4.50E-03	6.08E-01	8.33E-01	4.19E-02	5.74E-02
Cobalt	3.78E+01	6.15E+01	7.00E-03	2.65E-01	4.31E-01	1.83E-02	2.97E-02
Copper	6.51E+02	1.07E+03	2.50E-01	1.63E+02	2.67E+02	1.12E+01	1.84E+01
Iron	3.14E+04	4.50E+04	1.00E-03	3.14E+01	4.50E+01	2.17E+00	3.11E+00
Lead	5.18E+02	7.21E+02	9.00E-03	4.66E+00	6.49E+00	3.22E-01	4.48E-01
Nickel	3.12E+02	5.59E+02	6.00E-02	1.87E+01	3.35E+01	1.29E+00	2.31E+00
Selenium	1.80E+00	2.70E+00	2.50E-02	4.50E-02	6.75E-02	3.11E-03	4.66E-03
Zinc	1.82E+03	2.75E+03	9.00E-01	1.64E+03	2.48E+03	1.13E+02	1.71E+02

[a] Maximum value is used for upper 95% value when there are insufficient number of samples to calculate

H-7 (Continued)
Summary of Exposure Doses for the White-footed Mouse
Site 20
(mg/kg-day)

Chemical	Soil Ingestion		Vegetation Ingestion		Total Estimated Daily Intake	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Anthracene	3.89E-05	4.46E-05	1.68E-03	1.93E-03	1.72E-03	1.98E-03
Benzo(a)anthracene	1.53E-04	2.87E-04	1.32E-03	2.48E-03	1.48E-03	2.77E-03
Benzo(a)pyrene	2.11E-04	3.98E-04	9.14E-04	1.73E-03	1.13E-03	2.12E-03
Benzo(b)fluoranthene	2.25E-04	4.14E-04	9.76E-04	1.79E-03	1.20E-03	2.21E-03
Benzo(g,h,i)perylene	1.96E-04	3.66E-04	5.74E-04	1.07E-03	7.70E-04	1.44E-03
Benzo(k)fluoranthene	1.97E-04	3.66E-04	8.52E-04	1.59E-03	1.05E-03	1.95E-03
bis(2-Ethylhexyl)phthalate	1.59E-04	2.47E-04	7.45E-06	1.16E-05	1.67E-04	2.58E-04
Chrysene	2.07E-04	3.82E-04	1.79E-03	3.31E-03	2.00E-03	3.69E-03
Dibenzo(a,h)anthracene	8.36E-05	1.23E-04	1.66E-04	2.43E-04	2.49E-04	3.65E-04
Di-n-Butylphthalate	2.18E-05	3.11E-05	1.89E-04	2.69E-04	2.11E-04	3.00E-04
Fluoranthene	2.89E-04	5.37E-04	7.53E-03	1.40E-02	7.82E-03	1.45E-02
Indeno(1,2,3-cd)pyrene	1.65E-04	3.11E-04	4.83E-04	9.10E-04	6.48E-04	1.22E-03
Phenanthrene	6.69E-05	1.16E-04	2.90E-04	5.04E-04	3.57E-04	6.20E-04
Pyrene	3.05E-04	5.69E-04	7.94E-03	1.48E-02	8.25E-03	1.54E-02
Inorganics						
Antimony	3.82E-04	7.17E-04	4.97E-03	9.32E-03	5.35E-03	1.00E-02
Beryllium	8.44E-04	1.31E-03	5.49E-04	8.49E-04	1.39E-03	2.15E-03
Cadmium	1.43E-04	2.39E-04	9.32E-03	1.55E-02	9.46E-03	1.58E-02
Chromium	2.15E-02	2.95E-02	4.19E-02	5.74E-02	6.34E-02	8.69E-02
Cobalt	6.02E-03	9.79E-03	1.83E-02	2.97E-02	2.43E-02	3.95E-02
Copper	1.04E-01	1.70E-01	1.12E+01	1.84E+01	1.13E+01	1.86E+01
Iron	5.00E+00	7.17E+00	2.17E+00	3.11E+00	7.16E+00	1.03E+01
Lead	8.25E-02	1.15E-01	3.22E-01	4.48E-01	4.04E-01	5.63E-01
Nickel	4.97E-02	8.90E-02	1.29E+00	2.31E+00	1.34E+00	2.40E+00
Selenium	2.87E-04	4.30E-04	3.11E-03	4.66E-03	3.39E-03	5.09E-03
Zinc	2.89E-01	4.38E-01	1.13E+02	1.71E+02	1.13E+02	1.71E+02

H-8
Estimation of Contaminant Concentrations in Earthworms for American Robin – Site 20

Chemical	Soil Concentration Site 20 (mg/Kg) Average	Soil Concentration Site 20 (mg/Kg) Upper 95%	Earthworm BAF	Earthworm Concentration (mg/Kg) Average	Earthworm Concentration (mg/Kg) Upper 95%
Organics					
Anthracene	2.44E-01	2.80E-01 *	1.00E-02 [a]	2.44E-03	2.80E-03
Benzo(a)anthracene	9.60E-01	1.80E+00 *	3.00E-02 [a]	2.88E-02	5.40E-02
Benzo(a)pyrene	1.33E+00	2.50E+00 *	9.00E-02 [a]	1.20E-01	2.25E-01
Benzo(b)fluoranthene	1.42E+00	2.60E+00 *	8.00E-02 [a]	1.14E-01	2.08E-01
Benzo(g,h,i)perylene	1.23E+00	2.30E+00 *	6.00E-02 [a]	7.38E-02	1.38E-01
Benzo(k)fluoranthene	1.24E+00	2.30E+00 *	6.00E-02 [a]	7.44E-02	1.38E-01
bis(2-ethylhexyl)phthalate	1.00E+00	1.55E+00 *	NBAF	NE	NE
Chrysene	1.30E+00	2.40E+00 *	4.00E-02 [a]	5.20E-02	9.60E-02
Dibenzo(a,h)anthracene	5.25E-01	7.70E-01 *	9.00E-02 [a]	4.73E-02	6.93E-02
Di-n-Butylphthalate	1.37E-01	1.95E-01 *	NBAF	NE	NE
Fluoranthene	1.82E+00	3.38E+00 *	2.00E-02 [a]	3.64E-02	6.76E-02
Indeno(1,2,3-cd)pyrene	1.04E+00	1.95E+00 *	1.00E-01 [a]	1.04E-01	1.95E-01
Phenanthrene	4.20E-01	7.30E-01 *	3.00E-02 [a]	1.26E-02	2.19E-02
Pyrene	1.92E+00	3.58E+00 *	2.00E-02 [a]	3.84E-02	7.16E-02
Inorganics					
Antimony	2.40E+00	4.50E+00	NBAF	NE	NE
Beryllium	5.30E+00	8.20E+00	NBAF	NE	NE
Cadmium	9.00E-01	1.50E+00	2.90E+00 a	2.61E+00	4.35E+00
Chromium	1.35E+02	1.85E+02	1.90E-01 a	2.57E+01	3.52E+01
Cobalt	3.78E+01	6.15E+01	NBAF	NE	NE
Copper	6.51E+02	1.07E+03	1.10E-01 a	7.16E+01	1.18E+02
Iron	3.14E+04	4.50E+04	NBAF	NE	NE
Lead	5.18E+02	7.21E+02	1.30E-01 a	6.73E+01	9.37E+01
Nickel	3.12E+02	5.59E+02	4.60E-01 a	1.44E+02	2.57E+02
Selenium	1.80E+00	2.70E+00	1.13E+01 a	2.03E+01	3.05E+01
Zinc	1.82E+03	2.75E+03	2.50E+00 a	4.55E+03	6.88E+03

* Maximum value is used for upper 95% value when upper 95% is greater than maximum or when insufficient number of samples to calculate

a – Converted from dry to wet weight basis by dividing by 4 (Beyer & Gish, 1980)

NBAF – No bioaccumulation factor available

NE – Not evaluated due to lack of data

H-8 (Continued)
Estimation of Exposure to the American Robin through Earthworm Ingestion
Site 20

Chemical	Earthworm Concentration (mg/Kg)		Estimated Daily Intake (mg/kg-day)	
	Average	Upper 95%	Average	Upper 95%
Organics				
Anthracene	2.44E-03	2.80E-03	1.01E-04	1.16E-04
Benzo(a)anthracene	2.88E-02	5.40E-02	1.19E-03	2.24E-03
Benzo(a)pyrene	1.20E-01	2.25E-01	4.96E-03	9.31E-03
Benzo(b)fluoranthene	1.14E-01	2.08E-01	4.70E-03	8.61E-03
Benzo(g,h,i)perylene	7.38E-02	1.38E-01	3.06E-03	5.71E-03
Benzo(k)fluoranthene	7.44E-02	1.38E-01	3.08E-03	5.71E-03
bis(2-ethylhexyl)phthalate	NE	NE	NE	NE
Chrysene	5.20E-02	9.60E-02	2.15E-03	3.97E-03
Dibenzo(a,h)anthracene	4.73E-02	6.93E-02	1.96E-03	2.87E-03
Di-n-Butylphthalate	NE	NE	NE	NE
Fluoranthene	3.64E-02	6.76E-02	1.51E-03	2.80E-03
Indeno(1,2,3-cd)pyrene	1.04E-01	1.95E-01	4.31E-03	8.07E-03
Phenanthrene	1.26E-02	2.19E-02	5.22E-04	9.07E-04
Pyrene	3.84E-02	7.16E-02	1.59E-03	2.96E-03
Inorganics				
Antimony	NE	NE	NE	NE
Beryllium	NE	NE	NE	NE
Cadmium	2.61E+00	4.35E+00	1.08E-01	1.80E-01
Chromium	2.57E+01	3.52E+01	1.06E+00	1.46E+00
Cobalt	NE	NE	NE	NE
Copper	7.16E+01	1.18E+02	2.96E+00	4.87E+00
Iron	NE	NE	NE	NE
Lead	6.73E+01	9.37E+01	2.79E+00	3.88E+00
Nickel	1.44E+02	2.57E+02	5.94E+00	1.06E+01
Selenium	2.03E+01	3.05E+01	8.42E-01	1.26E+00
Zinc	4.55E+03	6.88E+03	1.88E+02	2.85E+02

NE – Not evaluated due to lack of earthworm bioaccumulation factor

H-8 (Continued)
Estimation of Exposure to the American Robin through Soil Ingestion
Site 20

Chemical	Soil Concentration Site 20 (mg/Kg) Average	Soil Concentration Site 20 (mg/Kg) Upper 95%	Estimated Daily Intake (mg/kg-day) Average	Estimated Daily Intake (mg/kg-day) Upper 95%
Organics				
Anthracene	2.44E-01	2.80E-01 *	1.01E-04	1.16E-04
Benzo(a)anthracene	9.60E-01	1.80E+00 *	3.97E-04	7.45E-04
Benzo(a)pyrene	1.33E+00	2.50E+00 *	5.51E-04	1.03E-03
Benzo(b)fluoranthene	1.42E+00	2.60E+00 *	5.88E-04	1.08E-03
Benzo(g,h,i)perylene	1.23E+00	2.30E+00 *	5.09E-04	9.52E-04
Benzo(k)fluoranthene	1.24E+00	2.30E+00 *	5.13E-04	9.52E-04
bis(2-ethylhexyl)phthalate	1.00E+00	1.55E+00 *	4.14E-04	6.42E-04
Chrysene	1.30E+00	2.40E+00 *	5.38E-04	9.94E-04
Dibenzo(a,h)anthracene	5.25E-01	7.70E-01 *	2.17E-04	3.19E-04
Di-n-Butylphthalate	1.37E-01	1.95E-01 *	5.67E-05	8.07E-05
Fluoranthene	1.82E+00	3.38E+00 *	7.53E-04	1.40E-03
Indeno(1,2,3-cd)pyrene	1.04E+00	1.95E+00 *	4.31E-04	8.07E-04
Phenanthrene	4.20E-01	7.30E-01 *	1.74E-04	3.02E-04
Pyrene	1.92E+00	3.58E+00 *	7.95E-04	1.48E-03
Inorganics				
Antimony	2.40E+00	4.50E+00	9.94E-04	1.86E-03
Beryllium	5.30E+00	8.20E+00	2.19E-03	3.39E-03
Cadmium	9.00E-01	1.50E+00	3.73E-04	6.21E-04
Chromium	1.35E+02	1.85E+02	5.59E-02	7.66E-02
Cobalt	3.78E+01	6.15E+01	1.56E-02	2.55E-02
Copper	6.51E+02	1.07E+03	2.69E-01	4.43E-01
Iron	3.14E+04	4.50E+04	1.30E+01	1.86E+01
Lead	5.18E+02	7.21E+02	2.14E-01	2.98E-01
Nickel	3.12E+02	5.59E+02	1.29E-01	2.31E-01
Selenium	1.80E+00	2.70E+00	7.45E-04	1.12E-03
Zinc	1.82E+03	2.75E+03	7.53E-01	1.14E+00

* Maximum value used when sample number was less than three or when upper 95% exceeded maximum

H-8 (Continued)
Summary of Estimated Daily Intakes for the American Robin
Site 20
(mg/kg-day)

Chemical	Soil Ingestion		Invertebrate Ingestion		Total Estimated Daily Intake	
	Average	Upper 95%	Average	Upper 95%	Average	Upper 95%
Organics						
Anthracene	1.01E-04	1.16E-04	1.01E-04	1.16E-04	2.02E-04	2.32E-04
Benzo(a)anthracene	3.97E-04	7.45E-04	1.19E-03	2.24E-03	1.59E-03	2.98E-03
Benzo(a)pyrene	5.51E-04	1.03E-03	4.96E-03	9.31E-03	5.51E-03	1.03E-02
Benzo(b)fluoranthene	5.88E-04	1.08E-03	4.70E-03	8.61E-03	5.29E-03	9.69E-03
Benzo(g,h,i)perylene	5.09E-04	9.52E-04	3.06E-03	5.71E-03	3.56E-03	6.66E-03
Benzo(k)fluoranthene	5.13E-04	9.52E-04	3.08E-03	5.71E-03	3.59E-03	6.66E-03
bis(2-ethylhexyl)phthalate	4.14E-04	6.42E-04	NE	NE	4.14E-04	6.42E-04
Chrysene	5.38E-04	9.94E-04	2.15E-03	3.97E-03	2.69E-03	4.97E-03
Dibenzo(a,h)anthracene	2.17E-04	3.19E-04	1.96E-03	2.87E-03	2.17E-03	3.19E-03
Di-n-Butylphthalate	5.67E-05	8.07E-05	NE	NE	5.67E-05	8.07E-05
Fluoranthene	7.53E-04	1.40E-03	1.51E-03	2.80E-03	2.26E-03	4.20E-03
Indeno(1,2,3-cd)pyrene	4.31E-04	8.07E-04	4.31E-03	8.07E-03	4.74E-03	8.88E-03
Phenanthrene	1.74E-04	3.02E-04	5.22E-04	9.07E-04	6.95E-04	1.21E-03
Pyrene	7.95E-04	1.48E-03	1.59E-03	2.96E-03	2.38E-03	4.45E-03
Inorganics						
Antimony	9.94E-04	1.86E-03	NE	NE	9.94E-04	1.86E-03
Beryllium	2.19E-03	3.39E-03	NE	NE	2.19E-03	3.39E-03
Cadmium	3.73E-04	6.21E-04	1.08E-01	1.80E-01	1.08E-01	1.81E-01
Chromium	5.59E-02	7.66E-02	1.06E+00	1.46E+00	1.12E+00	1.53E+00
Cobalt	1.56E-02	2.55E-02	NE	NE	1.56E-02	2.55E-02
Copper	2.69E-01	4.43E-01	2.96E+00	4.87E+00	3.23E+00	5.32E+00
Iron	1.30E+01	1.86E+01	NE	NE	1.30E+01	1.86E+01
Lead	2.14E-01	2.98E-01	2.79E+00	3.88E+00	3.00E+00	4.18E+00
Nickel	1.29E-01	2.31E-01	5.94E+00	1.06E+01	6.07E+00	1.09E+01
Selenium	7.45E-04	1.12E-03	8.42E-01	1.26E+00	8.43E-01	1.26E+00
Zinc	7.53E-01	1.14E+00	1.88E+02	2.85E+02	1.89E+02	2.86E+02

NE - Not evaluated due to lack of data

H-9
Estimation of Contaminant Concentrations in Earthworms for Least Shrew – Site 22

Chemical	Soil Concentration Site 22 (mg/Kg) Average	Upper 95%	Earthworm BAF	Earthworm Concentration (mg/Kg) Average	Upper 95%
Organics					
Acenaphthene	2.75E-01	3.00E-01 *	NBAF	NE	NE
Anthracene	3.12E-01	6.21E-01	1.00E-02 [a]	3.12E-03	6.21E-03
Benzo(a)anthracene	5.74E-01	1.24E+00	3.00E-02 [a]	1.72E-02	3.72E-02
Benzo(a)pyrene	4.21E-01	7.29E-01	9.00E-02 [a]	3.79E-02	6.56E-02
Benzo(b)fluoranthene	4.60E-01	9.04E-01	8.00E-02 [a]	3.68E-02	7.23E-02
Benzo(g,h,i)perylene	3.78E-01	6.39E-01	6.00E-02 [a]	2.27E-02	3.83E-02
Benzoic Acid	9.59E-01	1.20E+00 *	NBAF	NE	NE
Benzo(k)fluoranthene	4.34E-01	8.80E-01	6.00E-02 [a]	2.60E-02	5.28E-02
bis(2-ethylhexyl)phthalate	1.64E-01	2.50E-01 *	NBAF	NE	NE
Chrysene	6.12E-01	1.23E+00	4.00E-02 [a]	2.45E-02	4.92E-02
4,4-DDT	6.00E-03	1.00E-02 *	2.60E+00	1.56E-02	2.60E-02
Dibenzo(a,h)anthracene	1.42E-01	2.20E-01 *	9.00E-02 [a]	1.28E-02	1.98E-02
Di-n-Butylphthalate	8.10E-02	1.17E-01	NBAF	NE	NE
Fluoranthene	1.43E+00	3.40E+00	2.00E-02 [a]	2.86E-02	6.81E-02
Fluorene	2.04E-01	2.48E-01	NBAF	NE	NE
Indeno(1,2,3-cd)pyrene	3.50E-01	5.97E-01	1.00E-01 [a]	3.50E-02	5.97E-02
Phenanthrene	1.49E+00	4.06E+00	3.00E-02 [a]	4.47E-02	1.22E-01
Pyrene	2.20E+00	3.30E+00 *	2.00E-02 [a]	4.40E-02	6.60E-02
1,1,1-Trichloroethane	3.00E-03	3.00E-03	NBAF	NE	NE
Inorganics					
Cadmium	1.30E+00	2.20E+00	2.90E+00 a	3.77E+00	6.38E+00
Chromium	2.59E+01	3.14E+01	1.90E-01 a	4.92E+00	5.97E+00
Lead	2.98E+01	5.60E+01	1.30E-01 a	3.87E+00	7.28E+00
Selenium	2.00E-01	3.00E-01	1.13E+01 a	2.26E+00	3.39E+00

* Maximum value is used for upper 95% value when upper 95% is greater than maximum or when insufficient number of samples to calculate

a – Converted from dry to wet weight basis by dividing by 4 (Beyer & Gish, 1980)

NBAF – No bioaccumulation factor available

NE – Not evaluated due to lack of data

H-9 (Continued)
Estimation of Exposure to the Least Shrew through Earthworm Ingestion
Site 22

Chemical	Earthworm Concentration (mg/Kg) Average	Earthworm Concentration (mg/Kg) Upper 95%	Estimated Daily Intake (mg/kg-day) Average	Estimated Daily Intake (mg/kg-day) Upper 95%
Organics				
Acenaphthene	NE	NE	NE	NE
Anthracene	3.12E-03	6.21E-03	3.00E-04	5.96E-04
Benzo(a)anthracene	1.72E-02	3.72E-02	1.65E-03	3.57E-03
Benzo(a)pyrene	3.79E-02	6.56E-02	3.64E-03	6.30E-03
Benzo(b)fluoranthene	3.68E-02	7.23E-02	3.53E-03	6.94E-03
Benzo(g,h,i)perylene	2.27E-02	3.83E-02	2.18E-03	3.68E-03
Benzoic Acid	NE	NE	NE	NE
Benzo(k)fluoranthene	2.60E-02	5.28E-02	2.50E-03	5.07E-03
bis(2-ethylhexyl)phthalate	NE	NE	NE	NE
Chrysene	2.45E-02	4.92E-02	2.35E-03	4.72E-03
4,4-DDT	1.56E-02	2.60E-02	1.50E-03	2.50E-03
Dibenzo(a,h)anthracene	1.28E-02	1.98E-02	1.23E-03	1.90E-03
Di-n-Butylphthalate	NE	NE	NE	NE
Fluoranthene	2.86E-02	6.81E-02	2.74E-03	6.54E-03
Fluorene	NE	NE	NE	NE
Indeno(1,2,3-cd)pyrene	3.50E-02	5.97E-02	3.36E-03	5.73E-03
Phenanthrene	4.47E-02	1.22E-01	4.29E-03	1.17E-02
Pyrene	4.40E-02	6.60E-02	4.22E-03	6.34E-03
1,1,1-Trichloroethane	NE	NE	NE	NE
Inorganics				
Cadmium	3.77E+00	6.38E+00	3.62E-01	6.12E-01
Chromium	4.92E+00	5.97E+00	4.72E-01	5.73E-01
Lead	3.87E+00	7.28E+00	3.72E-01	6.99E-01
Selenium	2.26E+00	3.39E+00	2.17E-01	3.25E-01

NE – Not evaluated due to lack of earthworm bioaccumulation factor

H-9 (Continued)
Estimation of Exposure to the Least Shrew through Soil Ingestion
Site 22

Chemical	Soil Concentration Site 22 (mg/Kg) Average	Upper 95%	Estimated Daily Intake (mg/kg-day) Average	Upper 95%
Organics				
Acenaphthene	2.75E-01	3.00E-01 *	2.64E-04	2.88E-04
Anthracene	3.12E-01	6.21E-01	3.00E-04	5.96E-04
Benzo(a)anthracene	5.74E-01	1.24E+00	5.51E-04	1.19E-03
Benzo(a)pyrene	4.21E-01	7.29E-01	4.04E-04	7.00E-04
Benzo(b)fluoranthene	4.60E-01	9.04E-01	4.42E-04	8.68E-04
Benzo(g,h,i)perylene	3.78E-01	6.39E-01	3.63E-04	6.13E-04
Benzoic Acid	9.59E-01	1.20E+00 *	9.21E-04	1.15E-03
Benzo(k)fluoranthene	4.34E-01	8.80E-01	4.17E-04	8.45E-04
bis(2-ethylhexyl)phthalate	1.64E-01	2.50E-01 *	1.57E-04	2.40E-04
Chrysene	6.12E-01	1.23E+00	5.88E-04	1.18E-03
4,4-DDT	6.00E-03	1.00E-02 *	5.76E-06	9.60E-06
Dibenzo(a,h)anthracene	1.42E-01	2.20E-01 *	1.36E-04	2.11E-04
Di-n-Butylphthalate	8.10E-02	1.17E-01	7.78E-05	1.12E-04
Fluoranthene	1.43E+00	3.40E+00	1.37E-03	3.27E-03
Fluorene	2.04E-01	2.48E-01	1.96E-04	2.38E-04
Indeno(1,2,3-cd)pyrene	3.50E-01	5.97E-01	3.36E-04	5.73E-04
Phenanthrene	1.49E+00	4.06E+00	1.43E-03	3.90E-03
Pyrene	2.20E+00	3.30E+00 *	2.11E-03	3.17E-03
1,1,1-Trichloroethane	3.00E-03	3.00E-03	2.88E-06	2.88E-06
Inorganics				
Cadmium	1.30E+00	2.20E+00	1.25E-03	2.11E-03
Chromium	2.59E+01	3.14E+01	2.49E-02	3.01E-02
Lead	2.98E+01	5.60E+01	2.86E-02	5.38E-02
Selenium	2.00E-01	3.00E-01	1.92E-04	2.88E-04

* Maximum value used when sample number was less than three or when upper 95% exceeded maximum

H-9 (Continued)
Summary of Estimated Daily Intakes for the Least Shrew
Site 22
(mg/kg-day)

Chemical	Soil Ingestion Average	Soil Ingestion Upper 95%	Invertebrate Ingestion Average	Invertebrate Ingestion Upper 95%	Total Estimated Daily Intake Average	Total Estimated Daily Intake Upper 95%
Organics						
Acenaphthene	2.64E-04	2.88E-04	NE	NE	2.64E-04	2.88E-04
Anthracene	3.00E-04	5.96E-04	3.00E-04	5.96E-04	5.99E-04	1.19E-03
Benzo(a)anthracene	5.51E-04	1.19E-03	1.65E-03	3.57E-03	2.20E-03	4.76E-03
Benzo(a)pyrene	4.04E-04	7.00E-04	3.64E-03	6.30E-03	4.04E-03	7.00E-03
Benzo(b)fluoranthene	4.42E-04	8.68E-04	3.53E-03	6.94E-03	3.97E-03	7.81E-03
Benzo(g,h,i)perylene	3.63E-04	6.13E-04	2.18E-03	3.68E-03	2.54E-03	4.29E-03
Benzoic Acid	9.21E-04	1.15E-03	NE	NE	9.21E-04	1.15E-03
Benzo(k)fluoranthene	4.17E-04	8.45E-04	2.50E-03	5.07E-03	2.92E-03	5.91E-03
bis(2-ethylhexyl)phthalate	1.57E-04	2.40E-04	NE	NE	1.57E-04	2.40E-04
Chrysene	5.88E-04	1.18E-03	2.35E-03	4.72E-03	2.94E-03	5.90E-03
4,4-DDT	5.76E-06	9.60E-06	1.50E-03	2.50E-03	1.50E-03	2.51E-03
Dibenzo(a,h)anthracene	1.36E-04	2.11E-04	1.23E-03	1.90E-03	1.36E-03	2.11E-03
Di-n-Butylphthalate	7.78E-05	1.12E-04	NE	NE	7.78E-05	1.12E-04
Fluoranthene	1.37E-03	3.27E-03	2.74E-03	6.54E-03	4.11E-03	9.80E-03
Fluorene	1.96E-04	2.38E-04	NE	NE	1.96E-04	2.38E-04
Indeno(1,2,3-cd)pyrene	3.36E-04	5.73E-04	3.36E-03	5.73E-03	3.70E-03	6.30E-03
Phenanthrene	1.43E-03	3.90E-03	4.29E-03	1.17E-02	5.73E-03	1.56E-02
Pyrene	2.11E-03	3.17E-03	4.22E-03	6.34E-03	6.34E-03	9.50E-03
1,1,1-Trichloroethane	2.88E-06	2.88E-06	NE	NE	2.88E-06	2.88E-06
Inorganics						
Cadmium	1.25E-03	2.11E-03	3.62E-01	6.12E-01	3.63E-01	6.15E-01
Chromium	2.49E-02	3.01E-02	4.72E-01	5.73E-01	4.97E-01	6.03E-01
Lead	2.86E-02	5.38E-02	3.72E-01	6.99E-01	4.01E-01	7.53E-01
Selenium	1.92E-04	2.88E-04	2.17E-01	3.25E-01	2.17E-01	3.26E-01

NE – Not evaluated due to lack of data

H-10
Estimation of Contaminant Concentrations in Earthworms for American Robin – Site 22

Chemical	Soil Concentration Site 22 (mg/Kg) Average	Soil Concentration Site 22 (mg/Kg) Upper 95%	Earthworm BAF	Earthworm Concentration (mg/Kg) Average	Earthworm Concentration (mg/Kg) Upper 95%
Organics					
Acenaphthene	2.75E-01	3.00E-01 *	NBAF	NE	NE
Anthracene	3.12E-01	8.80E-01	1.00E-02 [a]	3.12E-03	8.80E-03
Benzo(a)anthracene	5.74E-01	1.24E+00	3.00E-02 [a]	1.72E-02	3.72E-02
Benzo(a)pyrene	4.21E-01	7.29E-01	9.00E-02 [a]	3.79E-02	6.56E-02
Benzo(b)fluoranthene	4.60E-01	9.04E-01	8.00E-02 [a]	3.68E-02	7.23E-02
Benzo(g,h,i)perylene	3.78E-01	6.39E-01	6.00E-02 [a]	2.27E-02	3.83E-02
Benzoic Acid	9.59E-01	1.20E+00 *	NBAF	NE	NE
Benzo(k)fluoranthene	4.34E-01	8.80E-01	6.00E-02 [a]	2.60E-02	5.28E-02
bis(2-ethylhexyl)phthalate	1.64E-01	2.50E-01 *	NBAF	NE	NE
Chrysene	6.12E-01	1.23E+00	4.00E-02 [a]	2.45E-02	4.92E-02
4,4-DDT	6.00E-03	1.00E-02 *	2.60E+00	1.56E-02	2.60E-02
Dibenzo(a,h)anthracene	1.42E-01	2.20E-01 *	9.00E-02 [a]	1.28E-02	1.98E-02
Di-n-Butylphthalate	8.10E-02	1.17E-01	NBAF	NE	NE
Fluoranthene	1.43E+00	3.40E+00	2.00E-02 [a]	2.86E-02	6.81E-02
Fluorene	2.04E-01	2.48E-01	NBAF	NE	NE
Indeno(1,2,3-cd)pyrene	3.50E-01	5.97E-01	1.00E-01 [a]	3.50E-02	5.97E-02
Phenanthrene	1.49E+00	4.06E+00	3.00E-02 [a]	4.47E-02	1.22E-01
Pyrene	2.20E+00	3.30E+00 *	2.00E-02 [a]	4.40E-02	6.60E-02
1,1,1-Trichloroethane	3.00E-03	3.00E-03	NBAF	NE	NE
Inorganics					
Cadmium	1.30E+00	2.20E+00	2.90E+00 a	3.77E+00	6.38E+00
Chromium	2.59E+01	3.14E+01	1.90E-01 a	4.92E+00	5.97E+00
Lead	2.98E+01	5.60E+01	1.30E-01 a	3.87E+00	7.28E+00
Selenium	2.00E-01	3.00E-01	1.13E+01 a	2.26E+00	3.39E+00

* Maximum value is used for upper 95% value when upper 95% is greater than maximum or when insufficient number of samples to calculate

a – Converted from dry to wet weight basis by dividing by 4 (Beyer & Gish, 1980)

NBAF – No bioaccumulation factor available

NE – Not evaluated due to lack of data

H-10 (Continued)
Estimation of Exposure to the American Robin through Earthworm Ingestion
Site 22

Chemical	Earthworm Concentration (mg/Kg)		Estimated Daily Intake (mg/kg-day)	
	Average	Upper 95%	Average	Upper 95%
Organics				
Acenaphthene	NE	NE	NE	NE
Anthracene	3.12E-03	8.80E-03	1.13E-04	3.18E-04
Benzo(a)anthracene	1.72E-02	3.72E-02	6.22E-04	1.34E-03
Benzo(a)pyrene	3.79E-02	6.56E-02	1.37E-03	2.37E-03
Benzo(b)fluoranthene	3.68E-02	7.23E-02	1.33E-03	2.61E-03
Benzo(g,h,i)perylene	2.27E-02	3.83E-02	8.19E-04	1.38E-03
Benzoic Acid	NE	NE	NE	NE
Benzo(k)fluoranthene	2.60E-02	5.28E-02	9.40E-04	1.91E-03
bis(2-ethylhexyl)phthalate	NE	NE	NE	NE
Chrysene	2.45E-02	4.92E-02	8.84E-04	1.78E-03
4,4-DDT	1.56E-02	2.60E-02	5.63E-04	9.39E-04
Dibenzo(a,h)anthracene	1.28E-02	1.98E-02	4.61E-04	7.15E-04
Di-n-Butylphthalate	NE	NE	NE	NE
Fluoranthene	2.86E-02	6.81E-02	1.03E-03	2.46E-03
Fluorene	NE	NE	NE	NE
Indeno(1,2,3-cd)pyrene	3.50E-02	5.97E-02	1.26E-03	2.16E-03
Phenanthrene	4.47E-02	1.22E-01	1.61E-03	4.40E-03
Pyrene	4.40E-02	6.60E-02	1.59E-03	2.38E-03
1,1,1-Trichloroethane	NE	NE	NE	NE
Inorganics				
Cadmium	3.77E+00	6.38E+00	1.36E-01	2.30E-01
Chromium	4.92E+00	5.97E+00	1.78E-01	2.15E-01
Lead	3.87E+00	7.28E+00	1.40E-01	2.63E-01
Selenium	2.26E+00	3.39E+00	8.16E-02	1.22E-01

NE – Not evaluated due to lack of earthworm bioaccumulation factor

H-10 (Continued)
Estimation of Exposure to the American Robin through Soil Ingestion
Site 22

Chemical	Soil Concentration Site 22 (mg/Kg) Average	Upper 95%	Estimated Daily Intake (mg/kg-day) Average	Upper 95%
Organics				
Acenaphthene	2.75E-01	3.00E-01 *	9.93E-05	1.08E-04
Anthracene	3.12E-01	8.80E-01	1.13E-04	3.18E-04
Benzo(a)anthracene	5.74E-01	1.24E+00	2.07E-04	4.48E-04
Benzo(a)pyrene	4.21E-01	7.29E-01	1.52E-04	2.63E-04
Benzo(b)fluoranthene	4.60E-01	9.04E-01	1.66E-04	3.26E-04
Benzo(g,h,i)perylene	3.78E-01	6.39E-01	1.36E-04	2.31E-04
Benzoic Acid	9.59E-01	1.20E+00 *	3.46E-04	4.33E-04
Benzo(k)fluoranthene	4.34E-01	8.80E-01	1.57E-04	3.18E-04
bis(2-ethylhexyl)phthalate	1.64E-01	2.50E-01 *	5.92E-05	9.03E-05
Chrysene	6.12E-01	1.23E+00	2.21E-04	4.44E-04
4,4-DDT	6.00E-03	1.00E-02 *	2.17E-06	3.61E-06
Dibenzo(a,h)anthracene	1.42E-01	2.20E-01 *	5.13E-05	7.94E-05
Di-n-Butylphthalate	8.10E-02	1.17E-01	2.92E-05	4.22E-05
Fluoranthene	1.43E+00	3.40E+00	5.16E-04	1.23E-03
Fluorene	2.04E-01	2.48E-01 *	7.36E-05	8.95E-05
Indeno(1,2,3-cd)pyrene	3.50E-01	5.97E-01	1.26E-04	2.16E-04
Phenanthrene	1.49E+00	4.06E+00	5.38E-04	1.47E-03
Pyrene	2.20E+00	3.30E+00 *	7.94E-04	1.19E-03
1,1,1-Trichloroethane	3.00E-03	3.00E-03	1.08E-06	1.08E-06
Inorganics				
Cadmium	1.30E+00	2.20E+00	4.69E-04	7.94E-04
Chromium	2.59E+01	3.14E+01	9.35E-03	1.13E-02
Lead	2.98E+01	5.60E+01	1.08E-02	2.02E-02
Selenium	2.00E-01	3.00E-01	7.22E-05	1.08E-04

* Maximum value used when sample number was less than three or when upper 95% exceeded maximum

H-10 (Continued)
Summary of Estimated Daily Intakes for the American Robin
Site 22
(mg/kg-day)

Chemical	Soil Ingestion Average	Soil Ingestion Upper 95%	Invertebrate Ingestion Average	Invertebrate Ingestion Upper 95%	Total Estimated Daily Intake Average	Total Estimated Daily Intake Upper 95%
Organics						
Acenaphthene	9.93E-05	1.08E-04	NE	NE	9.93E-05	1.08E-04
Anthracene	1.13E-04	3.18E-04	1.13E-04	3.18E-04	2.25E-04	6.35E-04
Benzo(a)anthracene	2.07E-04	4.48E-04	6.22E-04	1.34E-03	8.29E-04	1.79E-03
Benzo(a)pyrene	1.52E-04	2.63E-04	1.37E-03	2.37E-03	1.52E-03	2.63E-03
Benzo(b)fluoranthene	1.66E-04	3.26E-04	1.33E-03	2.61E-03	1.49E-03	2.94E-03
Benzo(g,h,i)perylene	1.36E-04	2.31E-04	8.19E-04	1.38E-03	9.55E-04	1.61E-03
Benzoic Acid	3.46E-04	4.33E-04	NE	NE	3.46E-04	4.33E-04
Benzo(k)fluoranthene	1.57E-04	3.18E-04	9.40E-04	1.91E-03	1.10E-03	2.22E-03
bis(2-ethylhexyl)phthalate	5.92E-05	9.03E-05	NE	NE	5.92E-05	9.03E-05
Chrysene	2.21E-04	4.44E-04	8.84E-04	1.78E-03	1.10E-03	2.22E-03
4,4-DDT	2.17E-06	3.61E-06	5.63E-04	9.39E-04	5.65E-04	9.42E-04
Dibenzo(a,h)anthracene	5.13E-05	7.94E-05	4.61E-04	7.15E-04	5.13E-04	7.94E-04
Di-n-Butylphthalate	2.92E-05	4.22E-05	NE	NE	2.92E-05	4.22E-05
Fluoranthene	5.16E-04	1.23E-03	1.03E-03	2.46E-03	1.55E-03	3.69E-03
Fluorene	7.36E-05	8.95E-05	NE	NE	7.36E-05	8.95E-05
Indeno(1,2,3-cd)pyrene	1.26E-04	2.16E-04	1.26E-03	2.16E-03	1.39E-03	2.37E-03
Phenanthrene	5.38E-04	1.47E-03	1.61E-03	4.40E-03	2.15E-03	5.86E-03
Pyrene	7.94E-04	1.19E-03	1.59E-03	2.38E-03	2.38E-03	3.57E-03
1,1,1-Trichloroethane	1.08E-06	1.08E-06	NE	NE	1.08E-06	1.08E-06
Inorganics						
Cadmium	4.69E-04	7.94E-04	1.36E-01	2.30E-01	1.37E-01	2.31E-01
Chromium	9.35E-03	1.13E-02	1.78E-01	2.15E-01	1.87E-01	2.27E-01
Lead	1.08E-02	2.02E-02	1.40E-01	2.63E-01	1.51E-01	2.83E-01
Selenium	7.22E-05	1.08E-04	8.16E-02	1.22E-01	8.17E-02	1.22E-01

NE - Not evaluated due to lack of data