FORT RICHARDSON LANDFILL REPORT

ANCHORAGE, ALASKA

Contract No.: DACA85-88-D-0014
Delivery Order No. 18

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TABLE OF CONTENTS

Table of Contents (Cont.)

Table of Contents (Cont.)

LIST OF TABLES

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE), Alaska District, under Contract No. DACA85-88-D-0014 and Delivery Order No. 18, tasked Ecology and Environment, Inc. (E & E) to investigate the Fort Richardson landfill. The project is part of the Installation Restoration Program of the United States Department of Defense and implemented by the Directorate of Engineering and Housing (DEH) of the 6th Infantry Division (Light). DEH provides environmental management at Fort Richardson, including the implementation of the basewide groundwater monitoring program and the investigation of areas of potential hazardous waste contamination. The overall objective was to ensure that the Fort Richardson Landfill meets the requirements of Title 18, Alaska Administrative Code 60 (1987).

Sampling activities were designed to provide information on the hydrogeology and the potential leachates from the landfill, to install an appropriate detection monitoring system, and to obtain information necessary to assess requirements for remediation.

Aerial photography interpretation was utilized to identify potential sources of contamination within the landfill area; a geophysical survey was employed to assess the eastern and western boundaries, as well as the content of specific areas of the landfill; and a resistivity investigation was used to locate potential contamination plumes and correlate geologic soil layers. The incorporation of information obtained from these tasks reduced the number of monitoring wells installed to six from the eight proposed in the work plan.

Previous investigations conducted at the landfill determined that off-post migration of contaminants via surface or subsurface waters is not likely based on geologic evidence and information on contaminant sources. The closed disposal areas were not observed to be experiencing subsidence or leaching. Vegetation was beginning to grow over the closed disposal area. Residual hydrocarbon and fuel contamination was detected at a fire training pit constructed in the middle of the landfill. Human waste is presently being disposed of at the landfill under a current Alaska Department of Environmental Conservation (ADEC) permit.

The scope of work specified the writing of a comprehensive report incorporating the results of the chemical analyses with a risk evaluation and, if necessary, an assessment of remedial alternatives, and the design and specifications for remediation upon selection of the preferred alternative by DEH and USACE.

E & E drilled six boreholes, collected subsurface soil samples, and installed monitoring wells in each of the boreholes upon reaching groundwater. After the wells were developed, E & E sampled each newly installed well, and existing monitoring and drinking water wells.

The USACE oversaw the laboratory analyses of samples through its Quality Assurance Laboratory at Troutdale, Oregon; AmTest, Inc. of Redmond, Washington; and ARDL, Inc. of Mount Vernon, Illinois. The total number of samples submitted to these laboratories included: 11 soil samples, 7 groundwater samples, and 11 Quality Assurance/Quality Control (QA/QC) samples (1 groundwater sample, 1 soil sample, 8 trip blanks, and 1 rinsate sample).

The analyses conducted on these samples included volatile organic compounds (VOCs); base, neutral, and acid extractables (BNAs); total petroleum hydrocarbons (TPHs); chlorinated pesticides and polychlorinated biphenyls (Pest/PCBs); organophosphorus pesticides (OP-Pests); chlorinated herbicide and metals. Water samples were also analyzed for water quality parameters--including chemical oxygen demand, cyanide, ammonia nitrogen, nitrate and nitrite nitrogen, total organic carbon, alkalinity, chloride, corrosivity, methylene blue active substances, pH, total dissolved solids, sulfate, turbidity, and coliforms. All analyses were conducted using Environmental Protection Agency (EPA) approved methodologies.

QA reviews (included in Appendix E) were performed by the USACE Troutdale laboratory on all data. Results of these QA reviews indicated that all project data were deemed acceptable--with the exception of soil results for chlorinated herbicides, arsenic, and selenium. Presence of the analyte was confirmed, however, quantitation was questionable.

E & E's assessment of the analytical data for the different media revealed that there is no significant contamination in groundwater or subsurface soils in the areas sampled; however, more analytical data is needed to develop a statistical basis of comparison to make a determination of downgradient groundwater contamination.

The results of the risk evaluation indicate that the only pathway of concern is groundwater. However, the depth to the aquifer of concern ranges between 126 and 170 feet below ground surface, and no contaminants of concern have been detected in groundwater samples collected at the landfill. Hence, the risk is small that hazardous substances will migrate from the landfill to groundwater. The closest drinking water well is more than 1 mile away; therefore, contaminant concentrations would be significantly diluted during the travel time from the landfill to this well, and the likelihood of contamination from the landfill would be minimal.

This report discusses possible remedial action alternatives and the data required to implement these different technologies. These technologies include capping, surface water diversion, groundwater monitoring, groundwater diversion, and groundwater extraction. Engineering data is not available to implement either capping or surface water diversion, and the landfill is too large to consider groundwater diversion. Groundwater extraction is an impractical alternative at this time since no plume is apparent and the groundwater surrounding the landfill has not been fully characterized. Additional groundwater well installation in conjunction with monitoring is recommended to achieve characterization of the groundwater, to detect a plume, and to come into compliance with State of Alaska regulations.

Finally, the present report concludes with a number of recommendations bearing on bringing the landfill into compliance Alaska state regulations.

1. INTRODUCTION

Pursuant to United States Army Corps of Engineers (USACE), Alaska District, Contract No. DACA85-88-D-0014, Delivery Order No. 18, Ecology and Environment, Inc. (E & E) was tasked to investigate the Fort Richardson Landfill. The project was performed under the Installation Restoration Program (IRP) of the United States Department of Defense (DOD). The IRP is designed to identify, evaluate, and clean up hazardous waste contamination and groundwater pollution at DOD-owned installations.

The overall objective of the project is to ensure that the Fort Richardson Landfill meets the requirements of Title 18, Alaska Administrative Code 60 (1987). The scope of work (SOW) corresponds to the USACE site investigation (SI) follow-up.

The delivery order required E & E to perform the following standard IRP project tasks:

- verify the existence of a groundwater plume;
- develop work plans including a Sampling Analysis/Quality Assurance/Quality Control Plan, a Subsurface Exploration Plan, an Architect-Engineering Quality Control Plan, and a Site Health and Safety Plan;
- implement the work plans as a cooperative effort between USACE and E & E, using the USACE Quality Assurance Laboratory and other project laboratories to perform the sample analyses and to provide analytical data, and using MW Drilling of Anchorage, Alaska, to conduct all drilling and related activities;

- o develop a project report including an assessment of the data, a risk evaluation, and a preliminary assessment of remediation alternatives; and

- o design the preferred remediation alternative.

Prior to this investigation, a contaminant plume originating from the landfill had not been identified. The objective of the present investigation is to determine if the landfill is a source of groundwater contamination and, if it is, to ascertain what kind of remedial measures are necessary. This report does not include a complete site characterization, contaminant fate determination, or quantitative risk assessment, which may be necessary if and when soils and groundwater are discovered to be contaminated by hazardous substances.

Section 2 of this report presents a general description of the site and its environmental setting. Section 3 describes the previous investigations that were performed at the landfill and/or that produced data used to interpret contamination by the landfill. Section 4 describes the field investigation that provided the information and data that are presented and discussed in Section 5. Section 6 addresses the closure design and recommendations and conclusions are presented in Section 7.

2. BACKGROUND

2.1 SITE LOCATION

The 60-square-mile Fort Richardson installation is bounded by the Municipality of Anchorage to the southwest, Elmendorf Air Force Base (AFB) to the west, Eagle Bay and Knik Arm to the north, and the Chugach Mountains and State Park along the southern and eastern boundaries (Figure 2-1). The Glenn Highway bisects Fort Richardson.

2.2 SITE HISTORY

Fort Richardson was established on 168,000 acres in 1940 under the command of the Alaskan Defense Force (later reorganized as U.S. Army, Alaska). The largest troop (15,500 people) inhabited the Fort during World War II when Fort Richardson was used as a staging area and supply point.

Between 1946 and 1947, Fort Richardson was reduced in size to 88,000 acres. During the 1950s, the Fort was used to establish ground and air defense for Alaska, develop cold-weather and mountain warfare doctrine, and provide internal security.

Nike Hercules missiles were assigned to Alaska in 1959. Three batteries were established on or near Fort Richardson at Site Summit, Site Point, and Site Bay.

In 1959, Fort Richardson was divided between the Army and Air Force. The Army established a new cantonment area on the northern part of the installation and acquired additional land, while the Air Force established Elmendorf AFB on 32,500 acres of land in the southern portion of the installation.

Fort Richardson sustained approximately $17,000,000 in damages from the 1964 Good Friday earthquake. The most severe damage occurred at the Site Point Nike Hercules battery.

U.S. Army Forces Command (FORSCOM) assumed command of Alaskan units from Continental Army Command in 1973. Concurrently, the 172nd Infantry Brigade assumed control of Army units in Alaska. Currently, Fort Richardson remains under the command of FORSCOM and uses approximately 62,220 acres to perform its missions.

2.3 LANDFILL DESCRIPTION AND HISTORY

The Fort Richardson Landfill is an unlined landfill covering nearly 400 acres. It is located just north of Circle Road (approximately 3/4 mile north of the main cantonment area) (see Figure 2-2). The landfill is divided into six disposal areas that were systematically opened, used, and closed.

The landfill was a trench-and-fill operation; one trench was dug, while another was filled. The trenches are approximately 20 to 30 feet deep. During each workday, landfill material arrived by truck and was dumped into the trench. Bulldozers then crushed and compacted it. At the end of each workday, the face was covered with soil (AEHA 1983).

Disposal areas 1, 2, and 3, located on the east side of the landfill area, are known collectively as the "old landfill." The dates of operation of disposal area 1 are unknown; however, it is known to have closed prior to 1966. Disposal area 1 received an unknown quantity of sanitary refuse. The nature of the refuse and of the cover used to close this portion of the landfill are unknown. Disposal area 2 was opened after the closure of disposal area 1. Over 400,000 cubic meters (m^3) of sanitary waste was disposed into trenches until this area was closed in 1973. Disposal area 3 covered approximately 60 acres and operated from 1973 to 1977. Sanitary refuse was accepted for open-pit burning and disposal in this disposal area.

Disposal area 4 was opened in 1976. Construction rubble was accepted for surface disposal. The amount of refuse disposed and the date of closure are unknown. Environmental Science and Engineering

(ESE) noted that the cover on the old landfill and disposal area 4 were in good condition with some evidence of revegetation (1983). Leachates were not noted at the time of this inspection.

Disposal area 5, opened in 1982, was the first of the disposal areas to be permitted by the State of Alaska. This disposal area included an open pit for construction and demolition debris, piles for metal and wood, and an area for asbestos material. (During a site visit, E & E found the sign identifying asbestos disposal in disposal area 4 rather than 5.) Small amounts of explosives as well as toxic and infectious wastes were disposed of in this area (AEHA 1988, ESE 1983). This unit still accepted sanitary waste and mess hall grease after 1987.

In 1987, the Municipality of Anchorage began operating a regional landfill on land acquired from the Army and accepts solid waste from Fort Richardson (AEHA 1988).

Little is known about disposal area 6 near Loop Road. ESE reported evidence of past dumping but did not provide documentation (1983). The area was used for gravel pit(s). It is considered part of the Fort Richardson Landfill in the previously cited references.

Fire Training Pit 1 (FTP-1) is situated in the center of disposal area 1 (see Figure 3-1). Most of it has been covered by soil. The area is about 40 to 50 feet in diameter, unlined, and surrounded by a 1-foot berm (WCC 1989b). Approximately 1,500 to 2,000 gallons of used petroleum products, mixed with brake fluid and waste oils, were burned at the FTP-1 annually. An area adjacent to FTP-1 was also used as a drum storage area for unlabeled waste drums and waste fuel spills (WCC 1989b).

2.3.1 Waste Disposal at the Landfill

The history of landfilling at Fort Richardson is poorly documented. Estimates indicate that Fort Richardson generated approximately 400 to 500 tons of refuse per month. This equates to approximately 11,500 cubic yards of compacted solid waste and an additional 3,000 cubic yards of soil landfilled annually (AEHA 1983, 1988).

The ESE report (1983) states that approximately 200 gallons per year of paint wastes and waste acetone were generated from painting and repairing fiberglass sleds and office furniture. Reportedly, these wastes were disposed of in the landfill prior to 1981, but the location of this disposal is undocumented.

At the time of the environmental operational review (EOR), the U.S. Army Environmental Hygiene Agency (AEHA) reported active disposal at two grease pits and a human waste disposal trench (1988). The grease pits consisted of trenches 20 feet wide by 30 to 40 feet long, and 6 feet deep. AEHA described open trenches with 55-gallon drums and liquid grease floating on the surface of the base of the trench (1988). There was also evidence of petroleum-type grease and oil. Adjacent to the grease pits was a human waste disposal trench. Prior to the addition of waste and cover, this trench was about 5 feet wide, 30 feet long, and 15 feet deep. At the time of the EOR, the trench depth was 8 feet. The human waste disposal trench was included by the state in the permit for the sanitary landfill. The disposal area location is estimated to be in the center of the old landfill (disposal area 3), based on comparison of Figure F-2 in an AEHA Fort Richardson report (1988) and Figure 22-1 in an ESE report (1983). Woodward-Clyde Consultants describes a human waste disposal area trench south of disposal area 1 (1989a), but this is probably the same trench described above. The trench currently remains open for disposal of human wastes generated during field exercises.

The 1964 Good Friday earthquake caused extensive damage to the Site Point Nike Hercules battery (WCC 1989a). It is possible that the resulting debris and rubble from the Site Point battery was disposed of in the sanitary landfill.

2.4 ENVIRONMENTAL SETTING

The following sections describe the natural surroundings at Fort Richardson as well as relevant geologic, hydrogeologic, and meteorologic information.

2.4.1 Meteorology

Fort Richardson is located in a climatic transition zone between the maritime climate of the coast and the continental climate of interior Alaska. The mean annual temperature is 35° Fahrenheit (F); the mean monthly temperatures range from a low of 11.8°F in January to 58°F in July. The mean annual total precipitation is 14.7 inches, with almost half of the precipitation occurring in July, August, and September. The total precipitation includes a mean annual snowfall of 70 inches. The driest period occurs between January and May (ESE 1983).

Prevailing airflow originates from the south; however, from April to September, northerly winds blow at lower elevations. Mean wind speeds range from 5.9 to 8.4 miles per hour (ESE 1983).

2.4.2 Physiography

Fort Richardson is located primarily within the Cook Inlet-Susitna Lowland Section of the Coastal Trough physiographic province of Alaska. The province contains glaciated areas of ground moraines, drumlin fields, eskers, and outwash plains. Most of Fort Richardson lies less than 150 meters (m) above sea level and has a local relief of 15 to 75 m. Rolling upland areas near the bordering mountain ranges rise to about 1,000 m in altitude. The east-central and southeastern portions of the installation lie within the Kenai-Chugach Mountains section of the Pacific Border Range physiographic province. The topography in the Chugach Mountains section consists of discrete mountains separated by rounded valleys and eroded passes resulting from previous glaciation.

The northern section and the central section of Fort Richardson, where the landfill is located, feature flat to gently rolling, wooded terrain, including ponds and numerous streams leading from the mountains and uplands westward to Cook Inlet.

2.4.3 Ecology

The predominant vegetation type at Fort Richardson is varying aged stands of mixed coniferous/deciduous forest; there are at least seven other plant communities including mud flats, salt marshes, spruce bog, high brush vegetation, moist and alpine tundra, and barren zones present at the Fort (ESE 1983). The area around the landfill is characterized by mixed coniferous/deciduous forest.

The diverse plant communities provide habitats for a diverse wildlife population, including moose, bear, Dall sheep, swans, and waterfowl. The Fort Richardson area supports a migratory moose population of 600 individuals during the summer months (WCC 1989a). Bear habitat is abundant. Approximately 15 to 20 black bears dwell in the lowland area. Occasionally, nonresident brown bears have been seen in the area (WCC 1989a). Approximately 20 Dall sheep migrate into the southeastern portion of Fort Richardson during the spring and summer.

Other wildlife species present on the Fort include hundreds of ptarmigans, spruce grouse, river otters, beaver, coyotes, snowshoe hares, mink, porcupine, weasel, marten, lynx, and fox. During the winter, wolves occasionally visit the Eagle River Flats area, which is approximately 1.5 miles north of the landfill (WCC 1989a).

A diverse population of waterfowl species use Fort Richardson as a breeding and migratory staging area, particularly Eagle River Flats, Otter Lake Wildlife Area, and the McVeigh Marsh (ESE 1983). Raptors known to live at or use the Fort Richardson site include great-horned owls, hawk owls, short-eared owls, and goshawks (WCC 1989a).

Eagle River and Ship Creek, located 2 miles north and 3 miles south of the landfill, respectively, support annual salmon runs of various species. Several trout species and nongame fish species occur in lakes, ponds, and streams. The State of Alaska Department of Fish and Game maintains a fish-rearing (trout and salmon) station adjacent to Ship Creek and the Fort Richardson Power Plant (WCC 1989a).

No threatened or endangered species are known to reside on the Fort Richardson installation (ESE 1983).

2.4.4 Regional Geology

Pleistocene events, principally five glacial events, have shaped the upper Cook Inlet (Cederstrom et al. 1964). Glacial deposits of Wisconsin-age till, outwash, silt, and Pleistocene or younger alluvial fan deposits mantle the mountains and lowlands of this region. Early glaciers eroded some of the bedrock and much of the older unconsolidated materials in the area. Glacial moraines and associated glacial landforms remain after the most recent glaciers (Zenone and Anderson 1978). These repeated glacial events produced complex sequences of glacial and related deposits.

The Knik and Naptowne glacial events are responsible for most of the deposition in the Anchorage area. Most of the surficial deposits near Fort Richardson were formed during the Late Wisconsin glacial stage about 25,000 to 10,000 years ago (Zenone and Anderson 1978). These surficial deposits were derived from the Knik, Matanuska, and Eagle River valleys.

The Bootlegger Cove Formation, a Pleistocene marine deposit, is interbedded with Naptowne outwash deposits in the Anchorage area. It underlies most of Anchorage and probably most of Fort Richardson. The Formation consists of sand and gravel layers as well as clay facies. These sand and gravel layers act as aquifers and are usually confined by silt and clay layers west and south of Fort Richardson.

Bedrock in the Anchorage area lies approximately 300 feet below ground surface (bgs). It is composed of undifferentiated Mesozoic rocks, which outcrop to the east, in the Chugach Mountains.

2.4.5 Site Geology

The last major glaciation in the upper Cook Inlet extended to the area of the Fort Richardson Landfill. Remnants from the glaciation include the massive Elmendorf Moraine, alluvial fans, and a large proglacial outwash deposit (Schmoll and Dobrovolny 1972).

The Elmendorf moraine is a northeast-southwest trending terminal moraine representing the Naptowne glaciation, consisting of poorly sorted unconsolidated till with boulders, gravel, sand, and silt. This moraine represents the terminal margin of a glacier that once filled Cook Inlet. The main cantonment area at Fort Richardson is transected by the moraine. The southern boundary of the Elmendorf Moraine, about 60 feet high, forms the northern boundary of the landfill.

A large outwash plain formed along the margin of the Elmendorf Moraine by glacial meltwater. The outwash plain alluvium consists of gravel in the eastern portion of the installation and grades into sand to the west. The outwash plain has been a major source of sand and gravel for Fort Richardson. Schmoll and Dobrovolny (1972) mapped over 10 gravel pits in this deposit at the Fort. Their map shows that approximately 90% of the landfill is located within this deposit. The remainder of the landfill lies within material mapped as alluvial fans.

Glacial deposits north of the Elmendorf Moraine consist of stream-lined or fluted ridges of till. These deposits were formed by basal glacial processes including scouring and melt-out. Valleys between the ridges contain postglacial alluvium or glaciofluvial deposits (Schmoll and Dobrovolny 1972). Similar features of different composition are found south of the outwash from the Elmendorf Moraine. These deposits, probably the remnants of an older glaciation, are expected to underlie the glacial sequence at Fort Richardson.

2.4.5.1 Stratigraphy at the Landfill

The AEHA report (1983) states that the major glacial till stratigraphic unit at the landfill extends from the bedrock to the surface. It is a thick, coarse-grained, surficial deposit of gravel and sand, generally well bedded and well sorted. It has very little clay or silt, only 10% by volume. At approximately 30 feet bgs, a clay-rich zone approximately 1 foot thick occurs. Overlying this layer is a 1-foot zone of gravel and sand saturated with water. Overlying the glacial till is alluvial fan material from two small, unnamed valleys to the north. This material consists of coarse sand with little or no clay. No permafrost underlies the landfill area (AEHA 1983).

Drilling logs of wells FR-1, FR-2, and FR-3 from the Fort Richardson Landfill show that surficial deposits are more than 160 feet thick. FR-3 appears to encounter a wet zone at less than 70 feet, but the log is nondescriptive and inconsistent with mapped geology.

USGS well #1, also known as Well #1 AGD storage (Thomas 1990), is located directly south of the landfill and encounters water at 180 feet. The first 50 feet is sandy gravel, and the next 130 feet is glacial till. Bedrock was found at 468 feet bgs (Cederstrom et al. 1964). Clay interpreted to be part of the Bootlegger Cove Formation was encountered in this well at about 305 feet.

2.4.6 Hydrogeology

Major aquifers for the Anchorage area extend from the Chugach Mountains westward across the Anchorage basin (Cederstrom et al. 1964). Groundwater reservoirs are replenished by mountain runoff, direct infiltration of precipitation, and percolation from surface waters. The availability of water is dependent on the amount of local precipitation (Zenone and Anderson 1978).

Fort Richardson is believed to overlie a major portion of the recharge area for the confined aquifer that serves Anchorage. Groundwater recharge originates in the Chugach Mountains and probably involves the entire glacial outwash underlying the landfill and major portions of Fort Richardson south of the Elmendorf Moraine (Cederstrom et al. 1964).

Several aquifers probably exist below or near the Fort Richardson Landfill. Well logs from the Fort Richardson fish hatchery, located about 2 miles south of the landfill, range in depth from 38 to 144 feet deep. These logs, coupled with the proximity of Ship Creek, suggest that a shallow aquifer is hydraulically connected to the creek. Information is not available about the northern extent of this aquifer. Three wells, FR-1, FR-2, and FR-3, were installed along the western and eastern borders of the landfill during a previous investigation (AEHA 1983). The log of well FR-3 shows a wet zone at a depth of 61 feet and may explain reports of a shallow aquifer at the landfill. Groundwater flow was inferred to flow west-northwest at that site (Zenone and Anderson 1978).

Local groundwater flow in the landfill area is quite complex due to the presence of the Elmendorf Moraine. The Elmendorf Moraine in the vicinity of the landfill is a divide between three drainages. Water drains north-northwest toward Eagle River, west toward several lakes and Cook Inlet, and south-southwest toward Ship Creek. Where the actual change in the groundwater flow between the drainages is located and what effects seasonal fluctuations may have on it cannot be determined with the limited available data (Munter 1991). The groundwater flow was assumed to be southerly to southwesterly in the vicinity of the landfill based on E & E's interpretations made from aerial photographs and the topography of the outwash plain, which slopes toward Ship Creek. See Section 5.5.4 for current aquifer parameters.

A deeper aquifer below the Fort Richardson Landfill has been characterized by the three well logs of FR-1, FR-2, and USGS well #1 (Figure 2-2). Depth to the aquifer ranges between 131 to 185 feet. Well FR-3, over 1 mile east of FR-1 and FR-2, encountered an aquifer between 153 and 159 feet bgs. The aquifer material at this well (FR-

3)is a "gravelly silty sand with a slight amount of water," indicating that this may be a different aquifer than found at FR-2. However, the logs are not sufficiently detailed for such an interpretation.

2.4.6.1 Local Water Wells

Many shallow (23 feet to 144 feet deep) water wells are situated south of the landfill near Ship Creek. The nearest wells are USGS well #1, directly south of the landfill on Circle Road, and a shallow well (62 feet deep) about 1.5 miles south of the landfill near an athletic field. USGS well #1 reportedly has been plugged (Thomas 1990). The primary source of raw water for the central water supply system that serves the city of Anchorage and Fort Richardson is a reservoir located on Ship Creek approximately 7 miles upstream of the landfill.

2.4.6.2 Groundwater Quality

The groundwater quality in the Anchorage area is reportedly excellent (Cederstrom et al. 1964). Dissolved solids are low, hardness is moderate, and the concentrations of other constituents are also low. Groundwater hardness ranges from 8 to 130 parts per million (ppm). Calcium normally ranges from 20 to 35 ppm, and magnesium from about 5 to 15 ppm. In harder waters, the calcium and magnesium can reach as high as 138 ppm and 23 ppm, respectively. Sodium and potassium concentrations range from 3 to 12 ppm. Sulfate concentrations are low, generally less than 10 ppm, and chloride concentrations are similarly low. The pH tends to range from 7 to 8 standard units.

Groundwater quality has been monitored annually or semiannually using the existing monitoring wells (FR-1, FR-2, FR-3) since the landfill was issued its second permit in 1984 (see Figure 2-2). Analytical results of groundwater samples collected from these wells indicate that groundwater quality parameters are similar to the general groundwater quality for the Anchorage area as described by Cederstrom et al. (1964). Results from a Toxicity Procedure Extract (EPTOX) analysis performed in November 1983 detected nothing above the detection limit for any of the following analytes: arsenic, barium, cadmium, chromium, lead, mercury, selenium, or silver (AEHA 1983).

Groundwater-monitoring analytical data collected in 1985, 1986, and 1987 indicate that cadmium periodically exceeded the Environmental Protection Agency (EPA) primary drinking water maximum contaminant level (MCL) of 0.005 mg/L. Lead concentrations exceeded the MCL (0.05 mg/L) in samples analyzed in 1985. Chromium concentrations have regularly exceeded the MCL (0.1 mg/L). The data, however, are not consistent. Total coliform bacteria also exceeded the MCL (1 colony per 100 mL) in 1985 samples, but the results were not verified. Toxaphene, a persistent chlorinated herbicide, was detected in well FR-1 in June 1985 above the MCL of 5 µg/L. It was never detected again. In 1989, benzene was detected above the proposed MCL (0.005 mg/L), but the analytical results are questionable. No metals or pesticides were detected above MCLs in the 1989 monitoring.

Aluminum and iron were detected above secondary MCLs in FR-1, FR-2, and FR-3 in water samples collected in May 1990. Manganese was also detected in FR-2 and FR-3 above secondary MCLs. Again in September 1990, concentrations of iron exceeded secondary MCLs in all the wells; aluminum concentrations exceeded secondary MCLs in FR-2 and FR-3. Manganese was also detected in FR-3 above secondary MCLs in this round of sampling. No significant levels of volatile or semivolatile organic compounds were detected during 1990 sampling events. The 1991 sampling results are reported in section 5.

2.4.7 Surface Water Hydrology

The primary surface drainage features in the area are Eagle River and Ship Creek. Both originate in the Chugach Mountains and flow westerly across the Fort into the Knik Arm of Cook Inlet. Several streams in the southern portion of the Fort, the largest of which is Ship Creek, flow through the city of Anchorage before entering the Knik Arm. Eagle River is fed by turbid glacial meltwaters, and Ship Creek is sustained by snowmelt and rainwater runoff. The closest major body of surface water is Eagle River, several miles to the north and hydraulically upgradient. The flows for Eagle River and Ship Creek are variable, with maximum runoff occurring in August and June, respectively.

2.4.7.1 Surface Water Quality

Surface water studies conducted at Ship Creek in 1976 and 1981 indicate that all the water quality parameters meet both National Interim Primary and Secondary Drinking Water Regulations (ESE 1983). According to ESE, water quality of Ship Creek and Eagle River are comparable (1983). However, Eagle River carries a higher sediment load since its source is glacial meltwaters.

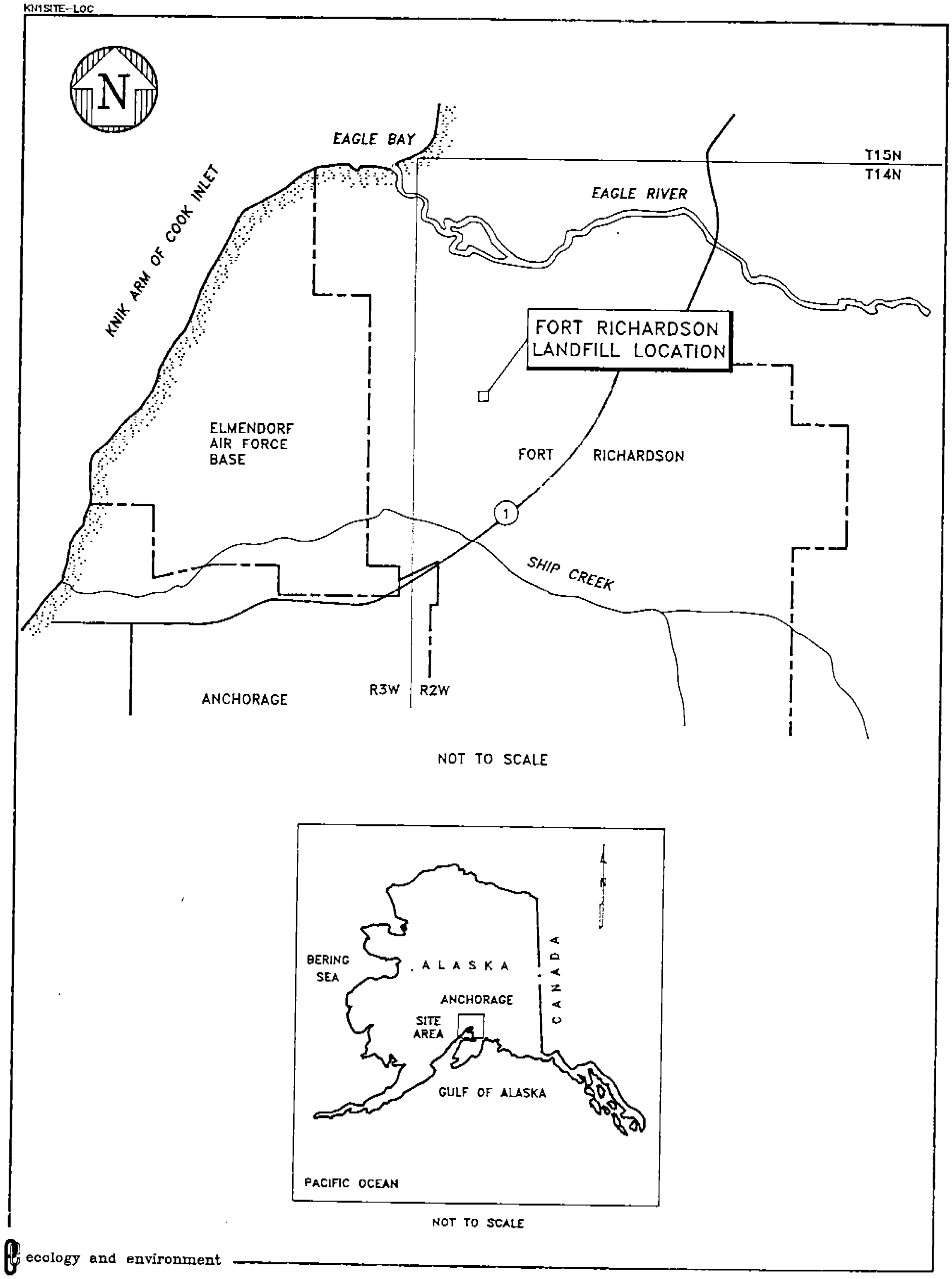

Figure 2-1 SITE LOCATION MAP
FORT RICHARDSON LANDFILL SITE
ANCHORAGE, ALASKA

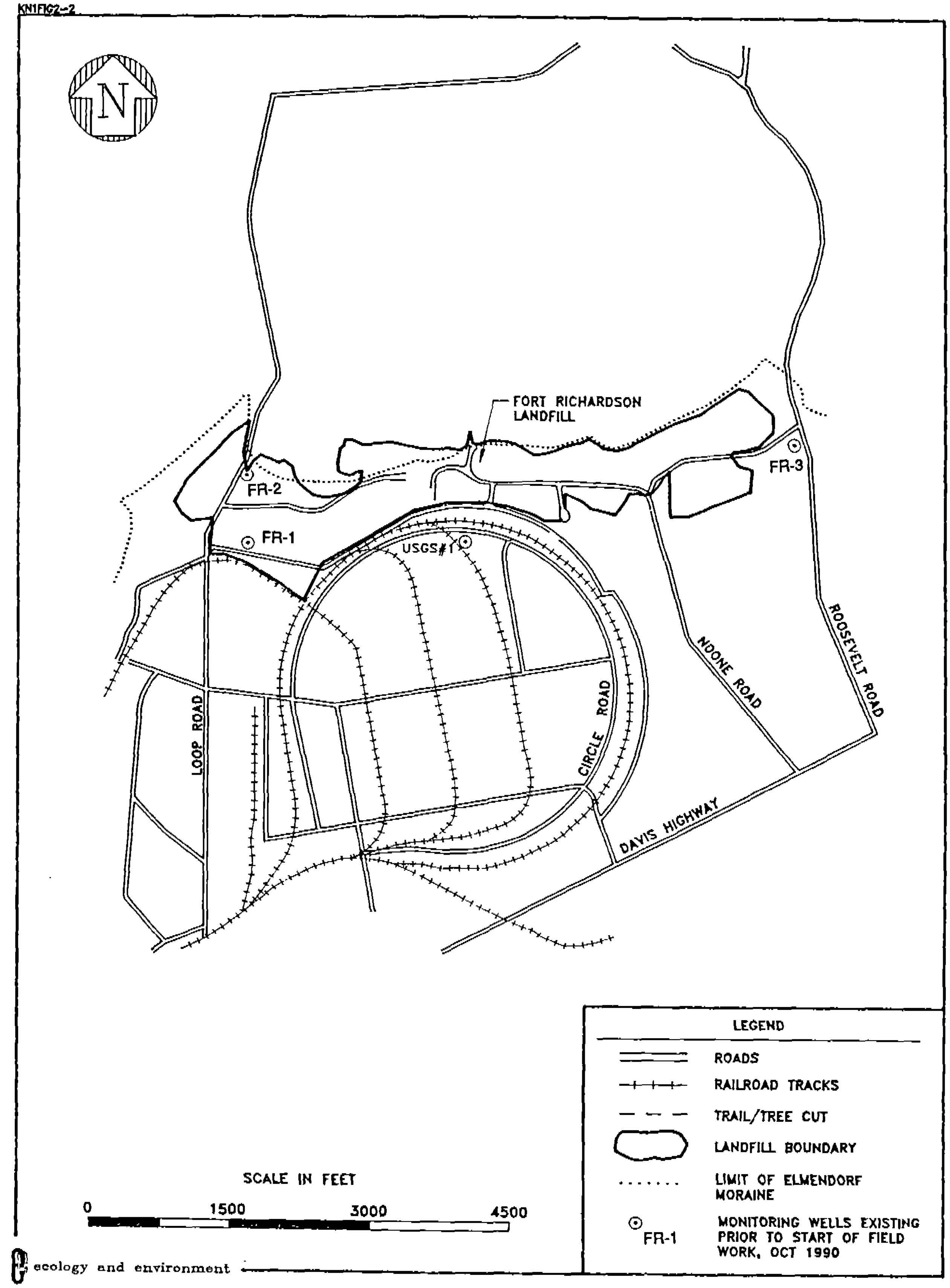

Figure 2-2 SITE MAP
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

3. PREVIOUS INVESTIGATIONS

This section summarizes previous investigation conducted at Fort Richardson as they pertain to the landfill.

3.1 FIRE TRAINING PIT 1 1982 INVESTIGATION

Fire training pit 1 (FTP-1) on the Fort Richardson Landfill was investigated and described by Woodward-Clyde Consultants (1989b). It was the subject of a shallow soil gas survey and an IRP study (Delivery Order No. 14) under the present contract, along with other FTPs at Fort Wainwright and Fort Greely. The survey of the FTP discovered residual hydrocarbon and fuel contamination with maximum concentrations of 1,900 ppm benzene, toluene, ethylbenzene, and xylene (BTEX) and 110 ppm total petroleum hydrocarbons (TPH).

3.2 U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY 1983 INVESTIGATION

In 1983, the AEHA evaluated the Fort Richardson and Fort Wainwright solid waste disposal practices. At the time of the investigation, no groundwater monitoring wells had been installed. AEHA recommended that three wells be installed at Fort Richardson based on the Alaska Department of Environmental Conservation (ADEC) regulations for landfills. Groundwater monitoring wells FR-1, FR-2, and FR-3 were installed in 1985 in response to this recommendation. These wells were incorporated into the basewide groundwater monitoring program. AEHA also recommended a landfill compactor be used on landfill material instead of a bulldozer and that the permit be posted (1983).

3.3 ENVIRONMENTAL SCIENCE AND ENGINEERING 1983 INSTALLATION ASSESSMENT

In 1983, ESE conducted an Installation Assessment of Fort Richardson, Fort Greely, and Fort Wainwright to determine the presence of any toxic or hazardous material and to assess the potential for off-post contaminant migration. ESE found that blowing litter is not a problem at the landfill and that access to the landfill is controlled. Vegetation cover was beginning to grow. However, unauthorized dumping occurs along access roads and is periodically cleaned up (ESE 1983).

3.4 WOODWARD-CLYDE 1989 SAMPLING AND ANALYSIS PLAN

Woodward-Clyde Consultants developed a sampling and analysis plan in 1989 to be used as a planning tool for future groundwater monitoring at the Fort Richardson Landfill. The plan was prepared based on USACE environmental regulations for sampling and regulatory guidelines contained in RCRA, CERCLA, and Alaska Administrative Codes (AAC). The plan met the requirements for Phase I monitoring as proposed under rule 40 CFR Parts 257 and 258, EPA Subtitle D, Groundwater Monitoring Corrective Action Program for Municipal Solid Waste Landfills. The plan was developed in the event that should subsequent investigations provide information that would require the work to be done under CERCLA or other appropriate regulations, the data generated could still be utilized (WCC 1989a). The plan has not yet been used.

3.5 BASEWIDE GROUNDWATER MONITORING PROGRAM

The Basewide Groundwater Monitoring Program was implemented by USACE under the direction of the Directorate of Engineering and Housing (DEH) in 1989. A total of 17 groundwater monitoring wells were originally incorporated into the program, including landfill monitoring wells FR-1, FR-2, FR-3, and the Otter Lake well located downgradient from the landfill. Groundwater samples are collected semiannually and analyzed for fuel identification, metals, semivolatile organic and volatile organic compounds, organophosphorus pesticides, chlorinated pesticides, polychlorinated biphenyls, and water quality parameters. The analytical results are summarized in a report titled Groundwater Monitoring Network, Fort Richardson, Alaska (USACE).

3.6 E & E 1989 SITE RECONNAISSANCE

E & E performed a site reconnaissance on November 10, 1989. In the old landfill area (disposal areas 1, 2, and 3), no visible signs of the past landfill activities were observed beyond some surface irregularities (Figure 3-1). The old landfill area is covered and showing signs of revegetation. A borrow pit, located along the southeastern corner of the landfill, shows signs of limited dumping. The recent landfill area (disposal areas 4 and 5) lacks vegetative cover. The asbestos disposal area has a potential runoff problem due to its location on the lower southern side of the landfill. The extreme western portion of the landfill (disposal area 6) is designated for future disposal. The area is relatively flat and covered in places with natural vegetation. Evidence of past disposal practices (disposal area 6) was reported at the western boundary along Loop Road.

3.7 E & E REVIEW OF AERIAL PHOTOGRAPHS

E & E reviewed aerial photographs from the 1940s to the present to identify potential sources of contamination. The goals of the review were to clarify the historical record, identify areas of potential point sources, and provide information to guide geophysical exploration for siting of the monitoring wells.

A 1950 aerial photograph shows deep pits, probably gravel pits, east and west of Loop Road, coinciding with disposal area 6. Smoke in the same photograph suggests burning of disposed wastes on a portion of the area.

The 1957 aerial photograph (4 June 57, #00010) shows disturbance over most of the landfill area; that is, it approximates the boundary configuration of the modern landfill. The small scale of the photograph prevents an assessment of possible waste disposal activities. However, excavated pits appear in all disposal areas. The gravel borrow pits probably functioned as disposal areas.

The 1964 aerial photograph (#5/30/64-53) shows over 1,000 drums stacked in disposal area 1. In October 1964 (#9/7/64-819), approximately 100 drums remained in the area; there were signs of either oil spillage or a comparable material. A photograph from 1965 (5/16/65, #27) shows an extensive area of stained soils in the southern portion of disposal area 1 where there had been a pile of about 60 drums in 1964.

The examination of the aerial photographs does not prove that drums were discarded and buried at the landfill, but it does indicate that the landfill development was probably less systematic than described by government documents. In addition, the past disposal of large numbers of drums appears to be a possibility. Existing conditions prior to the start of the October 1990 fieldwork are shown on Figure 3-1.

3.8 E & E GEOPHYSICAL SURVEY

E & E conducted a geophysical survey using an EM-31 to determine the landfill's eastern and western boundary and its contents. In addition, E & E conducted an EM-34 survey and a resistivity investigation to identify potential hydrological flow patterns below the landfill. Each technique is described in the Subsurface Exploration Plan of the Work Plan (Part 2) (E & E 1990a). The results are discussed in Section 5.4.

The goal of the geophysical survey was to supplement the information to implement an effective drilling program; to reduce, if possible, the number of monitoring wells; and to refine the sampling plan based on the actual number of wells to be installed and their necessary depth.

Electromagnetic soundings were collected to a depth of approximately 100 feet and electrical resistivity soundings to a depth of 400 feet to detect clay or bedrock. The deep confining layer was used as the stratigraphic marker for correlating shallower geologic soil layers.

The EM-34 and deep resistivity investigations did not provide clear evidence of a contamination plume. Interpretation of the data revealed that the most abundant lithology underlying the site is resistive gravel units with some underlying layers of increased conductivity (sandy and clayey) at depths of 250 feet to 400 feet bgs. The depth to groundwater was not determined because of the small variance in the conductivity between the saturated and unsaturated zones.

Based on the results of both the deep resistivity and EM-34 surveys and with USACE concurrence, E & E selected to drill four downgradient monitoring wells instead of the proposed six wells, and one upgradient well instead of the proposed two wells (E & E 1990b). Another well was drilled as a result of a field decision, bringing the total of wells drilled to six.

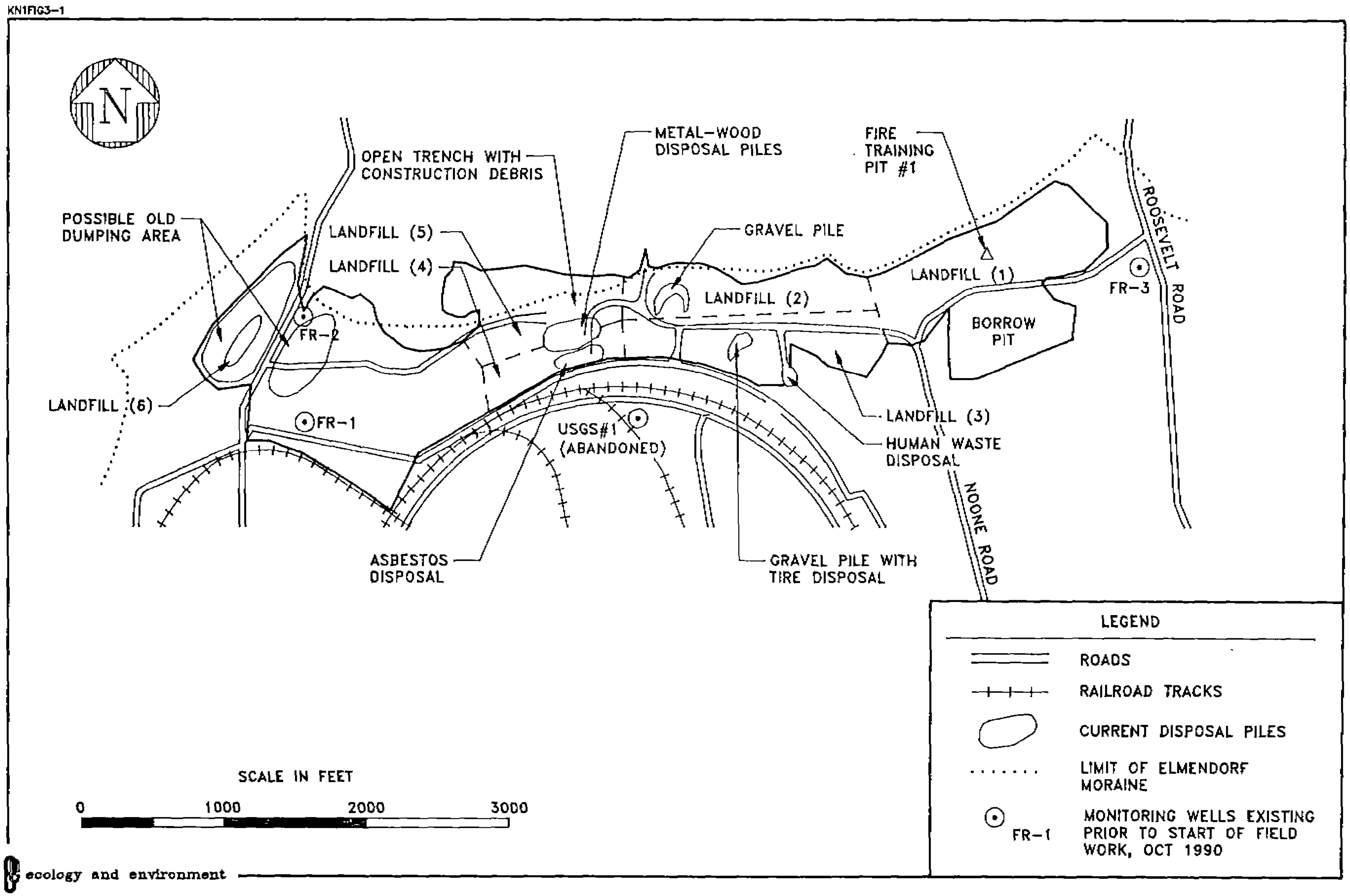

Figure 3-1 EXISTING CONDITIONS PRIOR TO START OF FIELDWORK, OCT. 1990
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

4. FIELD INVESTIGATION PROGRAM

4.1 ORGANIZATION AND DEVELOPMENT OF THE FIELD PROGRAM

The purpose of the Fort Richardson Landfill IRP project is to remediate the landfill in accordance with state and federal regulations. In order to accomplish this, the following tasks were to be performed:

- characterize the nature and extent of the release of hazardous wastes;
- identify potential threats to human health or to the environment; and
- design and implement remedial corrective action, if necessary.

The 1990-1991 fieldwork focused on the first task, characterization of releases. Specific fieldwork objectives were the identification and characterization of leachate plumes. To accomplish these tasks, E & E implemented a groundwater monitoring system consisting of six wells surrounding the landfill. Components of the fieldwork included:

- drilling boreholes,
- logging subsurface soil lithologies,
- sampling subsurface soil,
- installing monitoring wells, and
- sampling groundwater.

The field investigation was designed to help define local geology and hydrogeology, assess the current extent of hazardous waste contamination in soil and water, and provide a method to evaluate the potential for future contaminant migration. The system was designed to ensure that analytical results provide an accurate representation of groundwater quality at the background and downgradient wells, and to obtain sufficient data to determine if a statistically significant increase over background concentrations has occurred.

This section of the report will describe the technical approach, while the results are described in Section 5.

4.1.1 Data Quality Objectives

Quality Control (QC) samples were collected to assess potential errors introduced during sample collection, handling, and analysis. As part of the field Quality Assurance/Quality Control (QA/QC) program, field duplicate, aqueous trip blank, and equipment rinsate blank samples were collected.

Sample integrity was maintained by the field team during sampling activities. All samples were handled in accordance with United States Army Corps of Engineers Sample Handling Protocol for Low, Medium and High Concentration Samples of Hazardous Waste (1986).

Sample containers provided by USACE were in compliance with EPA guidance (Specifications and Guidance for the Preparation of Contaminant Free Containers, April 1989). Decontamination procedures consisted of an alconox-water rinse, tap-water rinse, triple hexane rinse, and a triple rinse of deionized water. Rinsate samples were collected to ensure cross-contamination did not occur during sample collection.

All data were evaluated for precision, accuracy, and completeness by the Corps of Engineers North Pacific Division (CENPD) Materials Laboratory in Troutdale, Oregon. Laboratory QC comprised at least 10% of each data set and consisted of blanks, duplicates/replicates, spikes, standards, and QC check samples. Control limits were defined by the particular analytical method as well as the QC acceptance criteria outlined in EPA's Test Methods For Evaluating Solid Wastes SW-846 (1986) and EPA's Method for Chemical Analysis of Water and Wastes (1983). All data generated were reviewed by comparison to the guidelines established in SW-846, Chapter 1 (Quality Control).

4.2 FIELDWORK AND SAMPLING PROGRAM

The purpose of the proposed fieldwork and sampling program was:

- to collect and analyze subsurface soil samples in order to determine the presence or absence of subsurface soil contamination;
- to analyze the lithology of subsurface soils at the landfill to further define subsurface conditions and evaluate potential subsurface groundwater migration pathways;
- to install groundwater monitoring wells and sample groundwater to determine the presence or absence of a leachate plume originating from the landfill; and
- to establish a network of groundwater monitoring wells in order to develop a database of groundwater quality data to be used in determining background and contaminated standards for groundwater at the landfill.

4.3 INVESTIGATIVE PROGRAM

The investigative program included the drilling of six soil borings, the collection of subsurface soil samples, the installation of groundwater monitoring wells, and groundwater sampling. The location of the AP soil borings and monitoring wells are depicted on Figure 4-1. A summary of the major field activities conducted at the site and the dates they were conducted are presented in Table 4-1.

4.3.1 Subsurface Soil Sampling

In October 1990, MW Drilling of Anchorage began subsurface exploration under the supervision of E & E. Six soil borings were drilled, sampled, and converted into groundwater monitoring wells, as shown on Figure 4-1. Soil borings were drilled using an Ingersoll Rand TA60 air rotary rig. A 10-5/8 inch outer diameter (O.D.) casing was advanced behind the drill bit by a drill-through air hammer providing 800 to 1,300 foot-pounds/blow at 360 blows per minute. Soil borings were sited outside of the landfill to avoid the risk of drilling through hazardous materials or creating vertical conduits for potential contamination migration. (Soil boring locations were selected based on results from the aerial photograph interpretation discussed in Section 3.7 and the subsurface geophysical investigations discussed in Section 3.8.)

Subsurface soil samples were collected using a split-spoon sampler. Sample depth, percent recovery, blow counts, and a visual description of the sample are recorded on the lithologic logs, which are included in Appendix C. Lithologic logging was also based on examination of the drill cuttings at 3-foot intervals during the drilling process. After the lithology of the sample was recorded, soil for volatile organic analysis was collected directly from the split-spoon sampler with a stainless steel spoon. The remainder of the sample was then homogenized in a stainless steel bowl and placed directly into prelabeled sample containers using a stainless steel spoon. A total of 11 subsurface soil samples were collected for analytical purposes. These samples were analyzed for volatile organic compounds (VOCs), base, neutral, and acid extractables (BNAs), metals, organochlorine pesticides/polychlorinated biphenyls (Pest/PCBs), organophosphorus pesticides (OP-Pest), and chlorinated herbicides (Cl-Herb).

A summary of these collected samples and their respective locations is included in Table 4-2. The majority of samples were collected during the drilling of soil borings AP3011 (Soil Boring 2) and AP3012 (Soil Boring 3), where numerous layers of fine-grained soils were encountered. During the drilling of AP3010 and AP3013, thick deposits of gravel were encountered, which prevented the collection of samples over great depths. The percentage of recovered material during sampling was low. Field observations indicate that large cobbles were pulverized during the advancement of the casing through much of the drilling process. Large pieces of fractured gravel often clogged the entrance of the split-spoon sampler, preventing the collection of an adequate volume of material for sample collection.

4.3.2 Monitoring Well Installation

Each soil boring was completed as a groundwater monitoring well with 4-inch inner diameter (I.D.) Schedule 80, flush-threaded polyvinyl chloride (PVC) casing and 0.010-inch continuously slotted screen. Construction details for each well are summarized in Appendix D. Upon borehole completion, the well screen (with centralizers) and PVC riser were installed within the casing to a depth specified by the on-site geologist. A silica sand filter pack (grade 8) was installed in the annular space adjacent to the screen with the filter pack extending at least 2 feet above the top of the screen. A bentonite pellet seal of at least 2 feet thick was then placed above the filter pack, and the remainder of the annular space was filled with bentonite slurry as the steel casing was withdrawn. Monitoring wells were completed above grade with locking steel casings cemented in place and protective guard posts installed around each well.

During the drilling of monitoring well AP3014, a shallow aquifer was encountered at 16 feet bgs. According to the USACE Geotechnical Branch, the shallow aquifer may be a protrusion of the Ship Creek aquifer advancing toward the western end of the landfill. Although the work plan called for monitoring well AP3014 to be screened in the deep aquifer, the decision was made to screen the well in the shallow aquifer in order to monitor the shallow groundwater quality. As a result, an additional monitoring well, AP3015, located approximately 40 feet southwest of AP3014, was installed through the shallow aquifer and screened in a deep aquifer in order to fulfill the requirements of the work plan. Groundwater was encountered at approximately 116 feet bgs during the drilling of this well. Construction of well AP3015 involved advancing a 10-inch casing to a depth of 60 feet. The samples collected revealed unsaturated material, indicating that drilling had proceeded to a depth beyond the lower limit of the shallow aquifer. The 10-inch casing was left undisturbed overnight, and inspection the following morning revealed that the shallow aquifer was adequately sealed off by the casing. An 8-inch casing was inserted into the 10-inch casing, and the annulus between the two casings was filled with bentonite slurry. Drilling continued by advancing the 8-inch casing while the 10-inch casing was left in place to prevent infiltration of water from the shallow aquifer into the soil boring. The boring was completed as a monitoring well, and the 8-inch casing was removed.

4.4 GROUNDWATER SAMPLING

The monitoring wells installed at the landfill were sampled in April and May 1991, approximately 6 weeks after they were developed (see Table 4-1). A total of six groundwater samples were collected from the recently installed monitoring wells at the landfill and one sample was collected at the USACE laboratory on Elmendorf AFB. Additionally two groundwater samples were collected from the existing the wells FR-1 and FR-3 (FR-2 was not sampled because its integrity appeared to have been destroyed by a vehicle: the well wizard top and casing were both broken). Four samples were collected from wells AP3010, AP3013, AP3014, and AP3015, which were installed by MW Drilling. Two of the wells (AP3011 and AP3012), installed during this field season, were dry during the time of sampling and additional inspections in August and September. Groundwater samples were analyzed for VOC, BNA, metals, Pest/PCB, OP-Pest, and Cl-Herb, chemical oxygen demand (COD), cyanide, ammonia nitrogen, nitrate and nitrite nitrogen, total organic carbon (TOC), alkalinity, chloride, corrosivity, methylene blue active substances (MBAS), pH, sulfate, turbidity, and coliform bacteria. A summary of the statistics for each of the wells installed is presented in Table 4-3.

4.4.1 Sample Collection Methodology

Sampling of the monitoring wells consisted of the following activities:

- o measuring of water level and total well depth (to calculate well volume);
- o purging of five volumes of standing water column with either a decontaminated Teflon bailer or a previously installed dedicated submersible pump;
- o recording any observable physical characteristics of the groundwater (e.g., color, sheen, flame ionization detector [FID] or photoionization detector [PID] reading, odor, turbidity);
- o noting weather conditions at the time of sampling (e.g., air temperature, wind direction, recent heavy rainfall, drought conditions);

- transferring water from the sample collection device to sample containers with care to avoid agitating the sample, which promotes the loss of volatile components;
- cooling volatile organic samples immediately following collection; and
- filtering samples from monitoring wells to be analyzed for dissolved metals in the field using a 0.45 micron polypropylene filter and preserved with nitric acid prior to shipment for analysis. The filtering equipment was decontaminated between samples to avoid cross-contamination.

Prior to sampling, static water level and total well depth were measured with a calibrated, weighted tape. Measurements were made from the top of the monitoring well casing.

The number of linear feet of static water (the standing water column) was determined by calculating the difference between the static water level and the total depth of the well.

4.5 EQUIPMENT DECONTAMINATION

The primary intent of field decontamination is to prevent cross-contamination of samples, to control the spread of contaminants to uncontaminated areas, and to prevent chemical exposure to the sampling team. The decontamination area was determined before initiating field-work. The locations were upwind and away from the suspected contaminant sources. The decontamination procedures for all stainless steel and Teflon sampling equipment consisted of a consecutive series of the following wash and rinses:

- nonphosphate detergent wash,
- potable water rinse,
- distilled water rinse (applied three times),
- methanol rinse, and
- air dry.

When possible, disposable sampling and personal protective equipment was used for field activities. Due to the number of samples collected, much of the sampling equipment used in the field was decontaminated between uses at different sample locations. The drill rig and associated equipment were demobilized to the drilling contractor's storage yard for decontamination following the completion of each monitoring well. The drill rig and equipment were decontaminated by steam cleaning and remobilized to the site. Nondisposable protective clothing was washed with a phosphorus-free detergent solution in water and rinsed with potable water. The cuttings developed during the drilling process were piled adjacent to the respective soil boring location.

4.6 LABORATORY PROGRAM

4.6.1 Laboratory Identification

A total of 12 soil samples, seven groundwater samples, and 11 QA/QC samples (one soil duplicate, one groundwater duplicate, one rinsate blank, and eight trip blanks) were collected during this investigation. The project samples were analyzed by Columbia Analytical Services, Kelso, Washington; ARDL, Inc., Mount Vernon, Illinois; and AmTest, Inc., Redmond, Washington. The QA samples were analyzed by the CENPD Materials Laboratory in Troutdale, Oregon. Each sample was labeled and sealed immediately after collection. Sample volume levels were marked on each liquid sample container. A 12-digit alphanumeric code was assigned to each sample as an identification number to track samples collected at the site. The sample code is broken down as follows:

Group	Digits	Time	Code Examples
(1)	1-2	Calendar Year	89, 90
(2)	3-4	Week (1-52)	06, 52
(3)	5-7	IRP identifying code	FRL (Fort Richardson Landfill)
(4)	8-10	Sample No.	010, 110
(5)	11-12	Sample type:	SL (soil)

Example: 90 28 FRL 010 SL = 1990, Week 28, Fort Richardson Landfill, Sample No. 10, Soil

After the sample was collected, pertinent information such as sample identification number, date and time of sample collection, sample collection method, description of sample, and any field measurements such as FID readings, pH, conductivity, etc., were recorded in the field notebook and initialed by the recorder.

4.6.2 Analytical Parameters

Analytical parameters for the investigation were decided upon based on 18 AAC 60, proposed federal regulations, and the results of past sampling efforts. In addition to the parameters required by state and federal regulations, the USACE decided that the samples should also be analyzed for selected organochlorine pesticides, OP-Pest, Cl-Herb, and BNA compounds. All analytes included in the project analytical program are listed in Appendix A. These constituents are often found at municipal solid waste landfill (MSWLF) leachates.

A discussion of how these parameters were selected is in Section 4.1 of the Fort Richardson Work Plan (E & E 1990a).

4.6.3 Analytical Test Methods and Procedures

Sample preparation and analysis were performed using methods described in Test Methods for Evaluating Solid Waste, EPA SW-846, Third Edition, September 1986, and Methods for Chemical Analysis of Water and Wastes, EPA 600/4-29-020, 1983.

Depending on the analytical requirements, water and soil samples were subjected to any of the following EPA SW-846 methods for sample preparation, digestion, or extraction procedures.

- Methods 3010, 3020, and 3050 outline acid digestion procedures for analyses of metals in water, soil, sediment, and waste by inductively coupled plasma (ICP) spectrophotometry, and atomic absorption (AA) spectrophotometry.
- Methods 3510 and 3550 outline procedures for quantitatively extracting nonvolatile and semivolatile compounds in water, soil, sediment, and waste samples.
- Method 5030 describes sample preparation and extraction of volatile organic compounds by purge-and-trap.

4.6.4 Quality Assurance/Quality Control (QA/QC) Samples

QA/QC samples were collected/prepared to assess potential errors introduced during sample collection, handling, and analyses. As part of the QA/QC program, one field duplicate water sample, one QA soil sample, one QA water sample, one sampling equipment rinsate blank sample, and eight trip blank samples were collected. A triple volume water sample was collected for laboratory matrix spike/matrix spike duplicate (MS/MSD) analysis. The triple volume MS/MSD water sample was collected for pesticide and BNA fractions only.

The soil matrix sample project laboratory was ARDL, Inc., Mount Vernon, Illinois. The soil matrix sample QA laboratories were AmTest, Inc., Redmond, Washington; Columbia Analytical Services, Inc., Kelso, Washington; and CENPD Materials Laboratory, Troutdale, Oregon. There were 12 soil samples, one equipment rinsate, and three trip blank samples collected.

Groundwater samples were analyzed by CENPD Materials Laboratory, Troutdale, Oregon, and Columbia Analytical Services, Inc., Kelso, Washington. Groundwater QA samples were analyzed at ARDL, Inc., Mount Vernon, Illinois. There were 7 groundwater samples including one duplicate and five trip blank water samples.

4.6.4.1 Field Duplicate Samples

One field duplicate water and one field duplicate soil sample were collected to verify the reproducibility of the date. The duplicate samples were handled, labeled, and documented in the same manner as associated samples, and were assigned unique laboratory numbers.

4.6.4.2 Trip Blank Samples

Two trip blank samples accompanied the soil sample shipments, and six trip blank samples accompanied the groundwater sample shipments. Trip blank samples were not identified to the analyzing laboratories but were labeled on the chain-of-custody form in the same manner as other water samples. All trip blanks were analyzed. The VOC analytes identified in the trip blank samples were determined to be present due to laboratory contamination. The absence of other VOC target analytes indicates no cross-contamination occurred during sample shipment or storage.

4.6.4.3 Sampling Equipment Blanks

Sampling equipment blanks, or rinsate samples, are collected to determine potential contamination of samples resulting from sample transfer devices (bailers, split spoons, mixing bowls, etc.). A soil sampling equipment rinsate sample was collected from a stainless steel mixing bowl and spoon used to composite soil samples prior to collection. Water samples were collected with dedicated pumps; therefore, no rinsate blank was collected. The sampling equipment rinsate sample was preserved in the same manner as the regular samples. The rinsate sample was not identified as such and was labeled in the same manner as other samples on the chain-of-custody forms.

TABLE 4-1
SUMMARY OF FIELD ACTIVITIES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

ACTIVITY	DATE
Geophysical Survey	July 9, 1990 - July 27, 1990
Site Reconnaissance	October 22, 1990
Monitoring Well Installation	October 23, 1990 - January 18, 1991
Well Development	March 1991
Groundwater Sampling	April 30, 1991 - March 21, 1991

TABLE 4-2
SAMPLE SUMMARY (SOIL SAMPLES)
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

SAMPLE NUMBER	DATE	MATRIX	LOCATION	ANALYSES PERFORMED
9043FRL001SL	10/23/90	Soil	AP3012	VOC, Metals, BNA, Pest/PCB
9043FRL002SL	10/26/90	Soil	AP3012	VOC, Metals, BNA, Pest/PCB, Cl-Herb, OP-Pest
9044FRL004SL	10/30/90	Soil	AP3012	VOC, Metals, BNA, Pest/PCB, Cl-Herb, OP-Pest
9044FRL005SL	11/1/90	Soil	AP3012	Same as 004SL
9046FRL006SL	11/14/90	Soil	AP3011	Same as 004SL
9046FRL007SL	11/17/90	Soil	AP3011	Same as 004SL
9047FRL008SL	11/19/90	Soil	AP3011	Same as 004SL
9047FRL009SL	11/19/90	Soil	AP3011	Same as 004SL
9103FRL010SL	1/15/91	Soil	AP3015	Same as 004SL
9103FRL011SL	1/16/91	Soil	AP3015	Same as 004SL
9103FRL013SL	1/17/91	Soil	AP3015	Same as 004SL
9103FRL014SL	1/17/91	Soil	AP3015 (Dup. of -013SL)	Same as 004SL
9044FRL004WTR	10/30/90	Water	Rinsate	Same as 004SL
9044FRL005WTR	11/1/90	Water	Trip Blank	VOC
9103FRL012WA	1/17/91	Water	Trip Blank	VOC
9103FRL015WA	1/17/91	Water	Trip Blank	VOC

Key:

VOC = Volatile Organic Compounds.
BNA = Base/Neutral/Acid Extractables.
Pest/PCB = Organochlorine pesticides/Polychlorinated Biphenyls.
OP-Pest = Organophosphorus Pesticides.
Cl-Herb = ChloRinated Herbicides.
Metals = As, Ba, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, K, Se, Ag, Na, Zn (plus Hg for Rinsate).

TABLE 4-2
SAMPLE SUMMARY (WATER SAMPLES)
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

SAMPLE NUMBER	DATE	MATRIX	LOCATION	ANALYSES PERFORMED
9118FRL001WA	5/6/91	Water	FR-3	VOC, BNA, Pest/PCB, OP-Pest, Metals (total and dissolved), TPH, Chloride, Sulfate, Turbidity, TDS, pH, Alkalinity, Corrosivity, Ammonia-Nitrogen, Nitrate-Nitrogen, Total Kjeldahl Nitrogen, COD, TOC, Cyanide, Coliform Bacteria, MBAS
9118FRL002WA	5/6/91	Water	FR-1	Same as above (001WA)
9119FRL003WA	5/8/91	Water	AP3013 (MW-4)	VOC, BNA, Pest/PCB, OP-Pest, Metals (total and dissolved), COD, TOC, Ammonia-Nitrogen, Nitrate-Nitrogen, Chloride, Alkalinity, Sulfate, Turbidity, TDS, Cyanide, Coliform Bacteria
9119FRL008WA	5/9/91	Water	AP3010 (MW-1)	Same as 003WA
9120FRL016WA	5/16/91	Water	AP3014 (MW-5)	Same as 003WA
9120FRL017WA	5/16/91	Water	AP3015 (MW-6)	Same as 003WA
9120FRL018WA	5/21/91	Water	POTW Corps Lab	Same as 003WA
9119FRL200WA	5/7/91	Water	Trip Blank	VOC
9119FRL201WA	5/9/91	Water	Trip Blank	VOC
9119FRL202WA	5/9/91	Water	Trip Blank	VOC
9120FRL204WA	5/16/91	Water	Trip Blank	VOC
9120FRL205WA	5/21/91	Water	Trip Blank	VOC

Key:

VOC = Volatile Organic Compounds.
BNA = Base/Neutral Acid Extractables.
Metals = Al, Sb, As, Ba, Bc, Ld, La, Lr, Lo, Lu, Fe, Pb, Mg, Mn, Hg, Ni, Ak, Sc, Ag, Na, Tl, V, Zn.
COD = Chemical Oxygen Demand.
TOC = Total Organic Carbon.
TDS = Total Dissolved Solids.
TPH = Total Petroleum Hydrocarbons (Modified 8015).
MBAS = Methylene Blue Active Substances.
Pest/PCB = Organochlorine pesticides/Polychlorinated Biphenyls.
Op-Pest = Organophosphorus pesticides.

TABLE 4-3
GROUNDWATER WELL STATISTICS
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

Well #

E & E DESIGNATION	PERMANENT CORPS NUMBER	TOP OF CASING ELEVATION (feet)	DEPTH TO GROUNDWATER[1] (feet)	TOTAL DEPTH OF WELL (feet)	GROUNDWATER ELEVATION[2] (feet)
MW - 1	AP-3010	403.03	228.1	234	174.9
MW - 2	AP-3011	340.41	126[3]	138	*
MW - 3	AP-3012	333.90	177[3]	191	*
MW - 4	AP-3013	311.63	136.2	150	175.4
MW - 5	AP-3014	296.53	18.7	30	277.8
MW - 6	AP-3015	294.15	120.7	126	173.5

1 = Depth to groundwater measured from top of casing, June 5, 1991.
2 = Elevation in feet above mean sea level.
3 = Depth to groundwater based on field observations made during drilling.
* = Dry well, dedicated pumps removed.

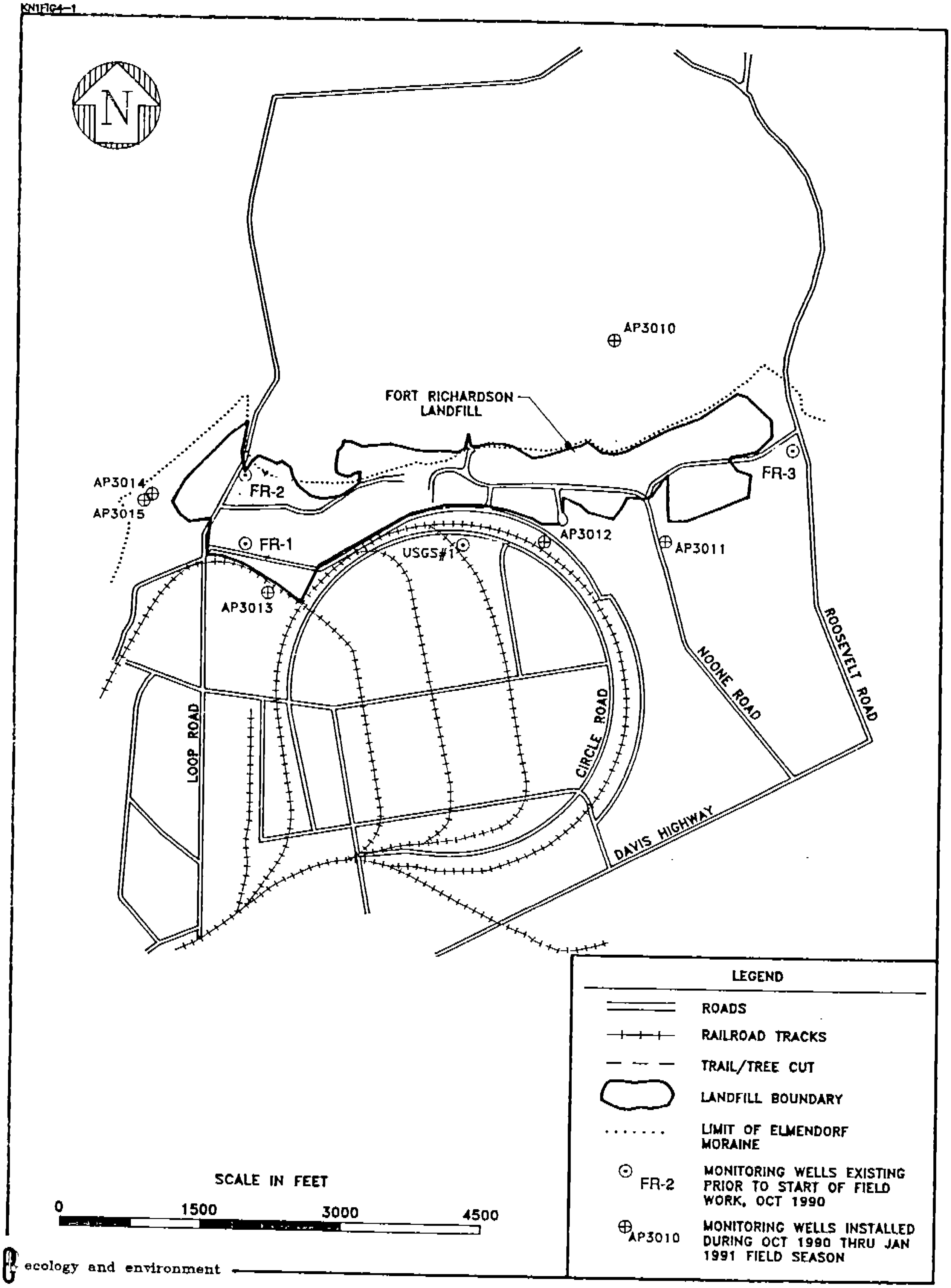

Figure 4-1 MONITORING WELL LOCATIONS
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

5. RESULTS AND SIGNIFICANCE OF FINDINGS

Analytical results from sampling activities conducted at the Fort Richardson Landfill are compiled in Tables 5-1 and 5-2 of this report. Corresponding sample locations are illustrated in Figure 4-1 and summarized in Table 4-2. A total of 11 soil samples was collected from October 1990 through January 1991, and seven groundwater samples were collected during the last week in April and the first week in May 1991 at the Fort Richardson Landfill. The rationale used to determine sample types, quantities, and locations is presented in Table 4-2, and the analytical methods are presented in Table 5-3.

Sampling was conducted by E & E personnel in accordance with the Fort Richardson Landfill Work Plan (E & E 1990a). The number and types of samples collected are as follows:

- o two water samples from two of the three existing monitoring wells (FR-1 and FR-3);
- o one water sample collected from the USACE laboratory potable water supply;
- o one water sample from four of the six monitoring wells installed during this project (AP3010, AP3013, AP3014 and AP3015); and
- o eleven subsurface soil samples from several of the monitoring wells installed during this project (AP3011, AP3012, and AP3013).

In addition, QA/QC samples were collected and analyzed:

- o nine QC samples (eight trip blanks and one equipment rinsate blank), and
- o one duplicate water and one duplicate soil sample.

Groundwater samples were analyzed for an extensive range of potential contaminants, including VOC, BNA, Pest/PCB, metals (both total and dissolved), OP-Pest, Cl-Herb, and up to 12 characteristics related to water quality (e.g., alkalinity, chloride, corrosivity, COD, ammonia-nitrogen, nitrate and nitrite-nitrogen, MBAS, pH, sulfate, turbidity, total dissolved solids [TDS], and coliform bacteria).

Soil samples were analyzed for VOC, BNA, Pest/PCB, OP-Pest, Cl-Herb, and metals.

Assumptions made throughout the discussions of the results are that water is contaminated if it exceeds EPA primary MCLs and that soil is contaminated if analyte concentrations are greater than three times background. The criteria for water are based upon drinking water standards, and the criteria for soil are based upon the criteria for an observed release used in the Hazard Ranking System (40 CFR Part 300 12/23/88). Table 5-4 lists the MCLs for drinking water.

5.1 QUALITY ASSURANCE/QUALITY CONTROL

5.1.1 Data Validation

Analytical data were reviewed by the CENPD Materials Laboratory in Troutdale, Oregon, and are presented in two reports titled "Chemical Quality Assurance Report, Fort Richardson Landfill" (March 25, 1991) and "Chemical Quality Assurance Report, Fort Richardson Landfill and Groundwater Monitoring" (August 13, 1991) (See Appendix E). All project data were deemed acceptable with the exception of the soil results for Cl-Herb, arsenic, and silver. All positive values reported by the laboratories for Cl-Herb, arsenic, and silver are flagged "J", estimated quantity. Presence of the analyte is confirmed, however, quantitation is estimated.

The project samples were analyzed by Columbia Analytical Services, Kelso, Washington; ARDL, Inc., Mount Vernon, Illinois; and AmTest Inc., Redmond, Washington. The QA samples were analyzed by the CENPD Materials Laboratory in Troutdale, Oregon.

5.1.1.1 Organic Data

The organic parameters analyzed for were: VOC, BNA, Pest/PCB, OP-Pest, Cl-Herb, and TPH. All organic data, with the exception of the soil results for Cl-Herb, were deemed acceptable by CENPD. Cl-Herb results are considered questionable due to unacceptable surrogate MS/MSD recoveries.

5.1.1.2 Inorganic Data

The inorganic parameters analyzed for were metals (total and dissolved), COD, cyanide, ammonia nitrogen, nitrate and nitrite nitrogen, TOC, alkalinity, chloride, corrosivity, MBAS, pH, sulfate, turbidity, TDS, and coliform bacteria. All project data were deemed acceptable with the exception of arsenic and silver results in the soil samples. These results were flagged "J", estimated quantity.

5.1.2 Laboratory Controls

Holding times were met for all analyses with the exception of one cyanide analysis and one set of BNA results for which re-extraction and reanalysis were required. Data quality was not affected.

Contamination detected in the laboratory method blanks included methylene chloride, chloroform, acetone, toluene, bis(2-ethylhexyl)-phthalate, di-n-butylphthalate, and iron. With the exception of iron, each of these is considered a common laboratory contaminant. All associated positive results were flagged "B," detected in the blank.

5.1.2.1 Trip Blanks

Trip blanks consisting of organic-free deionized water preserved with hydrochloric acid to a pH $\leq$ 2 accompanied the sample containers sent into the field from the time they left the E & E warehouse. Trip blanks were included in each shipment containing VOC samples. A total of eight trip blanks were analyzed for this project. Methylene chloride (42 µg/L), carbon tetrachloride (126 µg/L), 1,2-dichloropropane (1.2 µg/L), and chloromethane (34 µg/L) were detected in these samples. The methylene chloride is a result of laboratory contamination. No positive values were reported for carbon tetrachloride or 1,2-dichloropropane in any sample collected at the Fort Richardson Landfill. Chloromethane was detected in the potable water sample (018WA) at 166 µg/L. This value was flagged "R", rejected. No conclusive evidence exists to show that chloromethane was present. Results are presented in Table 5-5.

5.1.2.2 Sampling Equipment Blanks

Sampling equipment blanks, or rinsate samples, are collected to determine potential contamination of samples resulting from sample collection devices (augers, mixing bowls, stainless steel spoons, bailers, etc.). An aqueous rinsate blank was prepared from a stainless steel mixing bowl and spoon used to composite soil samples prior to collection. The rinsate was analyzed for all the targeted analytes. Results are presented in Table 5-1. Analytical results for the rinsate sample showed positive values for methylene chloride (6 µg/L), toluene (1 µg/L), bis(2-ethylhexyl)phthalate (1 µg/L), calcium (20 µg/L), iron (0.22 µg/L), magnesium (2.8 µg/L), sodium (1.8 µg/L), and zinc (0.32 µg/L).

5.1.2.3 Field Duplicates

Of the 11 soil samples and seven water samples collected at the Fort Richardson Landfill, one QA soil sample and one water sample were analyzed by the QA laboratory, Columbia Analytical Services. The data were classified as acceptable by CENPD.

5.2 ANALYTICAL RESULTS

The analytical results referred to in this section are tabulated in Tables 5-1 and 5-2 of this report. Table 4-2 describes the sample type and location for each sample collected during the investigation. A discussion of the data follows in subsequent paragraphs.

5.2.1 Organic Data Results

5.2.1.1 Volatile Organic Compounds

Samples collected for VOC analyses were analyzed by EPA Method 8240. Results are tabulated in Tables 5-1 and 5-2. Analyses were performed on both soil and water matrices. Soil samples contained methylene chloride (5-35 µg/kg), acetone (12-180 µg/kg), toluene (7-13 µg/kg), and total xylenes (sample 014SL, 17 µg/kg). Analytical results from associated laboratory method blanks showed positive results for methylene chloride, acetone, and toluene. As a result, the only positive VOC results not flagged "B" are the xylene (17 µg/kg), acetone (180 µg/kg), and toluene (13 µg/kg) results for sample 014SL.

The water sample 018WA contained chloromethane (166 µg/L) and carbon disulfide (7.2 µg/L). Chloromethane was detected in a trip blank not associated with this sample, but analyzed by the same laboratory. Sample 018WA is a potable water sample collected from the USACE laboratory on Elmendorf AFB. The carbon disulfide detected (7.2 µg/L) is near the detection limit (5 µg/L).

5.2.1.2 Base, Neutral, and Acid Extractables

Samples collected for BNA analyses were analyzed by EPA Method 8270. Results are tabulated in Tables 5-1 and 5-2. Analyses were performed on both soil and water matrices. Soil samples contained di-n-butylphthalate (32-110 µg/kg) and bis(2-ethylhexyl)phthalate (19-230 µg/kg), both of which were detected in associated laboratory method blanks. All positive results were flagged "JB" denoting estimated quantities due to either laboratory or sample container contamination.

The only targeted BNA analyte detected above the quantitation limit in a water sample was bis(2-ethylhexyl)phthalate (001WA, 8µg/L). Bis(2-ethylhexyl)phthalate is a common laboratory contaminant, and associated positive results were flagged "B," detected in the blank.

5.2.1.3 Organochlorine Pesticides and Polychlorinated Biphenyls

Samples collected for Pest/PCB analyses were analyzed by EPA Method 8080. Results are tabulated in Tables 5-1 and 5-2. Analyses were performed on both soil and water matrices. The only positive Pest/PCB result was found in soil sample 014SL and contained the pesticide β-BHC at a level of 4 µg/kg. Four µg/kg is below the contract required quantitation limit of 8 µg/kg for β-BHC. This amount of contamination, if actually present, is not considered significant. None of the Pest/PCB targeted analytes were detected above method quantitation limits in any water sample.

5.2.1.4 Organophosphorus Pesticides

Samples collected for OP-Pest analyses were analyzed by EPA Method 8140, results are tabulated in Tables 5-1 and 5-2. Analyses were performed on both soil and water matrices. No OP-Pests were detected above the method detection limit in any soil or water samples. However, CENPD considered these results questionable due to unacceptable surrogate and MS/MSD recoveries.

5.2.1.4 Chlorinated Herbicides

Samples collected for Cl-Herb analyses were analyzed by EPA Method 8150. Analytical results are presented in Tables 5-1 and 5-2. Analyses were performed on both soil and water matrices. No Cl-Herbs were detected above the method detection limit in any soil or water sample.

5.2.2 Inorganic Data Results

5.2.2.1 Metals

Both soil and water samples collected at the Fort Richardson Landfill were analyzed for metals. Analysis was performed by EPA approved SW-846 Methods in the 6000/7000 series (methods are parameter- and instrument-specific). The parameters analyzed for in the soil samples were arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, selenium, silver, sodium, and zinc. Groundwater samples underwent both total and dissolved metals analyses; they were analyzed for the same list of parameters as the soils with the addition of the following: mercury, aluminum, antimony, beryllium, cobalt, nickel, thallium, and vanadium. Analytical results are presented in Table 5-1 and 5-2. None of the Fort Richardson soil or water samples had values reported above MCL or the Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels.

5.2.2.2 Water Quality Parameters

Groundwater samples collected from both the previously existing wells and the wells installed as part of this site investigation were analyzed for the following water quality parameters: COD, cyanide, ammonia-nitrogen, nitrate and nitrite-nitrogen, TOC, alkalinity, chloride, corrosivity, MBAS, pH, TDS, sulfate, turbidity, and coliform bacteria. Results are presented in Table 5-2.

5.3 DISCUSSION OF RESULTS

5.3.1 Subsurface Soil Sampling

There were no discernible patterns of contaminant concentrations in the subsurface soil samples collected from the landfill. All of the positive results presented for the VOC and BNA analyses are considered common laboratory contaminants. There were no analytes detected above the method detection limit for the OP-Pest or the Cl-Herb analyses. One positive result was reported for β-BHC (4 µg/kg) in sample 014SL. The method detection limit was 3.0 µg/kg.

5.3.2 Groundwater Sampling

None of the contaminants found in the groundwater samples follow a discernible plume. The only organic contamination detected was oil in the TPH analysis; positive values were reported for samples collected from FR-1 (5,600 µg/L) and FR-3 (5,600 µg/L). Unfortunately, TPH (as fuel identification) was only performed on samples that were also part of the basewide groundwater sampling program; of the groundwater wells sampled at Fort Richardson Landfill, this included only FR-1 and FR-3. No inorganic contaminant results were reported that exceeded MCL or applicable or relevant and appropriate requirements (ARARs).

5.4 GEOPHYSICAL SURVEY RESULTS

A comprehensive geophysical survey was conducted during the summer of 1990. Details of the methodology and results can be found in Geophysical Surveys Report, Fort Richardson Landfill, Anchorage, Alaska (E & E 1990b).

As a result of the EM-31 survey, the eastern and western boundaries of the landfill were delineated. Areas identified on aerial photographs as possibly containing buried conductive materials were surveyed using the EM-31 and magnetic survey techniques. The surveys confirmed the presence of large amounts of conductive materials in two of the three potential locations.

EM-34 and resistivity (VES) surveys were used to identify potential leachate plumes emanating from the landfill. The resistivity survey incorporated deep vertical electrical soundings to define the vertical distribution of the electrical characteristics at selected locations.

No leachate plume was defined, but the data did suggest a homogenous lithology from the surface to the maximum depth of exploration. The resistivity data indicates that the most abundant lithology underlying the site is resistive gravel with some underlying layers of sand or clay at a depth of 250 to 400 bgs. The data collected during this survey and during the drilling has been integrated into cross-sections. The cross-section locations are shown in Figure 5-1, and cross-sections are shown in Figures 5-2 and 5-3. The EM-34 and resistivity survey locations are depicted in Figure 5-4. The lithologic information for groundwater monitoring wells FR-1 and FR-2 was recorded by a drilling contractor rather than a geologist. This information is included on the cross-sections to supplement the data collected by E & E. The geophysical data was supported by borehole log information as detailed in subsection 5.4.1. The perched aquifer that was encountered during the drilling of MW-5 and MW-6 was also identified in the resistivity data. Additionally, the geophysical data indicates that the lithology contains more sand and silt north of the drilled area. The results of the geophysical survey are presented in a report titled Report, Geophysical Survey, Fort Richardson Landfill (E & E 1990b).

5.4.1 Correlation between Resistivity Survey and Lithologic Logs

The results of the resistivity background survey conducted along the moraine north of the landfill indicate major lithologic changes up to a depth of approximately 350 feet. This layer may consist of a sandy gravel with some minor amounts of silt and clay. The results from the survey conducted along the western and eastern portions of the landfill indicate a dry, or semi-dry, gravelly lithologic unit. The lithology of soil boring AP3010, located upgradient of the landfill and approximately 1,100 feet south of the survey line, consists mostly of subrounded to angular gravels with a trace of fine sandy silts and fine to medium grained sands.

The results of the survey south of the landfill indicate a lithologic unit of predominantly gravel across the southeastern portion, while the southwestern portion shows some conductive layers at shallow depth. These layers may be associated with buried conductive materials and/or surface interferences. The lithology of soil borings AP3011 and

AP3012 located along survey lines southeast and south of the landfill, respectively, consists of gravel with occasional sand layers, while silt and/or silty gravel is encountered below 140 feet. In soil boring AP3012 a tight, dry clay with approximately 10% silt was encountered at 190 feet bgs. The lithology of soil boring AP3013, drilled along a survey line southwest of the landfill, consists of a clean, dry gravel to a depth of 140 feet, below which a saturated, well-graded sand layer is encountered.

5.5 PRELIMINARY RISK EVALUATION

This section briefly describes the wastes deposited at the Fort Richardson Landfill, the contaminants associated with those wastes, the potential migration and exposure pathways, and potential risks. The information presented constitutes a preliminary human health hazard evaluation and is not intended to be a quantitative baseline risk assessment.

5.5.1 Waste Characterization

The following wastes are known to have been disposed of at the Fort Richardson Landfill.

- sanitary wastes in disposal areas 1, 2, 3, and 5;
- construction wastes, including asbestos waste, in disposal areas 4 and 5;
- paint wastes and waste acetone, probably in the old landfill (disposal areas 1, 2, and 3);
- drummed fuels in disposal area 1; and
- explosives, and toxic and infectious wastes in disposal area 5.

In addition, used petroleum products were burned at the fire training pit in the center of disposal area 1. Other unknown wastes may also have been dumped in disposal areas 1 and 6.

5.5.2 Source and Release Characterization

The Fort Richardson Landfill is unlined. The landfill received bulk wastes that were dumped into excavated trenches, then compacted and covered. The nature of the landfill operations and photographic evidence showing stained soils indicate that contaminants have been released from wastes to the surrounding soils within the landfill.

The main source area, based on available information, seems to be disposal area 1. Contamination in disposal area 1 may include solvents, BTEX, and metals from waste paint, fuel, and other petroleum products; TPH from petroleum products; and polynuclear aromatic hydrocarbons (PAHs) from used petroleum products and from the burning of these materials at the fire training pit. Disposal area 5 could be a source area for contaminants associated with explosives such as RDX, HMX, or TNT. Other contaminants associated with sanitary wastes (disposal areas 1, 2, 3, and 5) that can affect groundwater quality include metals, nitrogenous compounds, phosphates, and sulfates. Health effect summaries for some of the potential contaminants are provided in Appendix B.

5.5.3 Expected Fate and Transport

The fate and transport of contaminants in the environment are influenced by both site- and chemical-specific factors. Metals are generally nonvolatile, and their environmental fate and transport depends largely on soil/water interactions. Metals tend to adsorb to soils. Unless they are present as soluble salts or complexes, most metals are immobile at usual soil pH ranges and become significantly leachable only if acidic solutions or chelating agents percolate through the soils. Metals mobility is also influenced by soil characteristics, such as clay content, organic carbon content, and oxidation-reduction potential, as well as by leachate and groundwater chemistry.

The mobility of organic contaminants varies widely depending on their physical properties. Many solvents and the BTEX compounds have moderate-to-high vapor pressures and moderate-to-high water solubilities. Near the soil surface, these compounds may be transported to ambient air by volatilization or to surface water by runoff. Solvents and BTEX in the subsurface can migrate to the ground surface via soil gas or to the groundwater via rain infiltration.

Explosives such as RDX, HMX, TNT, etc., generally have low vapor pressures, but moderate-to-high water solubilities. These compounds can migrate to surface water via runoff or to groundwater via rainwater infiltration. PAH compounds generally have low solubility, low vapor pressure, and a tendency to bind to organic carbon in soil. PAHs in soil are relatively immobile.

Many of the contaminants also undergo biotransformation or biodegradation in soil if environmental conditions are favorable (adequate microbial population, adequate supply of nutrients, necessary oxidizing or reducing conditions, etc.). If one or more of the necessary conditions is lacking, which is frequently the case at greater depths, significant biodegradation will not occur.

Site characteristics also affect the fate and transport of chemicals. The soil covering the landfill reduces the likelihood of contaminant migration in surface runoff and attenuates vapor emissions from volatile contaminants. Cooler temperatures also reduce rates of volatilization as well as biodegradation processes. The unlined landfill is located in a surficial deposit of gravel and sand with very little clay or silt content, which extends down to bedrock. Because of the high permeability and low organic content of the soils beneath the landfill, liquids and soluble contaminants leached by infiltrating rainwater will tend to migrate downward. However, the considerable depth to groundwater beneath the landfill (over 100 feet) and the small amount of precipitation (mean annual total precipitation of about 15 inches) suggests that significant concentrations of contaminants may not reach the groundwater. If these contaminants did reach groundwater, they could potentially migrate off site with the groundwater.

5.5.4 Contaminant Transport and Exposure Pathways

All wastes in the landfill are covered with clean soils, eliminating exposures by direct contact with waste or contaminated soils. Volatile contaminants in the subsurface soils could migrate via the soil gas to the ambient air, potentially exposing receptors at or downwind of the source to contaminants by the inhalation route. The landfill has no gas collection system.

Soluble contaminants could leach downward to the groundwater and eventually migrate off site. Given the considerable depth to groundwater and the low level of precipitation, it is unlikely that the groundwater will be significantly contaminated by the landfill. Even if contaminants reach the groundwater, it is highly unlikely that significant groundwater pathway exposures would occur. Groundwater flow in the vicinity of the landfill appears to be to the northwest. The nearest drinking-water well northwest of the landfill is located at a campground near Otter Lake about 1.5 miles away. The well is used by campers who generally remain in the area for only a few days. The Otter Lake well is sampled biannually as part of the basewide groundwater monitoring program. No contamination has been detected in the well to date.

Another downgradient well located 2.5 miles west-northwest of the landfill serves the Elmendorf AFB emergency command center. This facility is usually not occupied and is inaccessible to unauthorized personnel. Other known drinking water wells in the area are located south or southwest, upgradient of the landfill. The nearest of these, which is part of the Elmendorf AFB water supply and is also used by Fort Richardson, is about 1.5 miles southwest of the landfill. Because of the limited use of downgradient wells and the distance of these wells from the landfill, the possibility of significant exposures to site contaminants by this pathway seems extremely small.

Regionally, groundwater flows westward to the Knik Arm of the Cook Inlet. The Knik Arm is about 5 miles from the landfill and probably would not be affected by contaminants migrating from the site in groundwater.

5.5.5 Receptors

Based on the information available about the site, the only likely current potential exposure pathway seems to be inhalation of volatile contaminant vapors in ambient air. The main source area for volatiles, primarily paint solvent and BTEX compounds, is probably disposal area 1 at the east end of the landfill. Potential exposures would most likely occur in that area or downwind. Prevailing winds are southerly from April through August and northerly for the remainder of the year.

The landfill is currently owned and operated by the U.S. Army as part of the Fort Richardson Army Base. A chain-link fence surrounding the landfill and locked gates restrict entry by unauthorized visitors. Generally, only army personnel enter the site: those who operate the landfill and those who deliver waste. Current waste disposal activities take place in disposal areas 4 and 5, and possibly in disposal area 3. Other potential receptors near the site could include workers at the supply yard just south of landfill disposal areas 3, 4, and 5.

Residential populations located farther south have much less potential for exposure. The Fort cantonment area is located .75 miles south of the landfill, while the city of Anchorage is located over 3 miles to the southwest.

5.5.6 Risk Characterization

Any potential risks this landfill might presently pose would probably be associated with the inhalation of volatiles, mainly paint solvents and BTEX, that may have migrated to the ambient air. Potential receptors would include workers at the landfill and possibly workers at the nearby supply yard. Whether or not these potential risks are significant depends on a number of factors, including the concentrations of contaminants, the extent of the source area(s), the distance of receptors from the source, and the duration of potential exposures. Better characterization of the source areas and vapor emissions, perhaps by means of a soil gas survey, would provide a basis for estimating potential exposures and risks.

Groundwater pathway exposures are thought to be unlikely based on the small amount of rainfall, the considerable depth to groundwater, and the distances from the landfill to downgradient wells and their limited usage. The current groundwater investigation apparently did not include downgradient samples, and thus does not provide any information on the possible migration of landfill contaminants in the groundwater. Further investigation is needed to better define the direction of groundwater flow locally and to characterize the downgradient groundwater quality.

5.6 DATA GAPS

5.6.1 Hydrogeologic Data Gaps

A groundwater divide exists in the vicinity of Elmendorf Moraine adjacent to the landfill for groundwater flowing north-northwest, west, and south-southwest toward Ship Creek. Where the actual change in the groundwater flow between the drainages is located and what affects seasonal fluctuations may have on it cannot be determined with the limited available data. Groundwater at the western edge of the site is approximately 170 feet above mean sea level. The shallow gradient, the surface topography, and the highly permeable unconfined aquifer indicate that seasonal variations can cause minor fluctuations that easily shift the direction of groundwater flow.

The groundwater monitoring system designed in the work plan (E & E 1990a) assumed the groundwater flow to be southerly to southwesterly based on interpretations made from aerial photographs and the topography of the outwash plain, which slopes toward Ship Creek. It was assumed that AP3010 would represent upgradient conditions and that the other wells would be hydraulically downgradient of the landfill. However, once the wells were installed and the groundwater levels were measured, it was discovered that groundwater had a gradient toward the northwest.

Groundwater was encountered near the eastern end of the landfill at 125 feet bgs during the drilling of AP3011, and at 126 feet bgs during the drilling of AP3012. An additional well (FR-3) confirms the shallow groundwater layer at the southeast portion of the landfill. A confining layer of sandy silt with gravel was encountered immediately below groundwater during the drilling of wells AP3011 and AP3012. Drilling did not progress beyond the confining layer during the installation of AP3011; however, during the installation of AP3012, dry silts, sands, and gravels were encountered below the confining layer to a depth of approximately 170 feet bgs A conceptual potentiometric surface is shown on Figure 5-5.

TABLE 5-1
ANALYTICAL RESULTS FOR SOIL SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
units in mg/kg (ppm)

Sample Numbers Location Depth (Ft)	9043FRL001SL AP3012 48 - 49.5	9043FRL002SL AP3012 88 - 89.5	9044FRL004SL AP3012 152 - 154	9044FRL005SL AP3012 180 - 182	9046FRL006SL AP3011 39 -41	9046FRL007SL AP3011 120 - 122	9047FRL008SL AP3011 130 - 132	9047FRL009SL AP3011 136 - 138	9103FRL010SL AP3015 90-92
Metals									
Arsenic	2.7	1.5	3.8	3.7	3.8	3.6	4.1	1.0	3.7
Barium	33	38	33	40	32	27	40	25	29
Cadmium	0.53 U	0.49 U	0.54 U	0.59 U	0.53 U	0.57 U	0.56 U	0.52 U	0.50 U
Calcium	6050	21,000	8,760	10,100	10,800	11,900	12,600	6,310	9,300
Chromium	17	7.2	22	16	18	27	27	8.5	23
Copper	16	6.9	18	15	16	17	14	7.7	14
Iron	18,900	11,900	24,900	19,200	19,000	23,800	27,100	12,300	18,000
Lead	4.5	3.2	5.7	3.9	3.6	3.0	2.7	0.94	12
Magnesium	6,610	3,110	8,870	6,990	6,000	8,890	10,700	4,030	5,900
Manganese	400	250	500	450	460	480	540	270	360
Mercury	0.060 U	0.067 U	NA	NA	NA	NA	NA	NA	NA
Potassium	390	120	340	270	390	420	620	350	120
Selenium	0.47 U	0.44 U	0.49 U	0.53 U	0.52 U	0.59 U	0.57 U	0.49 U	0.45 U
Silver	1.1 U	1.0 U	1.1 U	1.2 U	1.1	1.7	1.3	1.0 U	1.0 U
Sodium	96	49 U	130	140	100	110	190	67	85
Zinc	34	17	42	35	31	41	45	22	28

See key on last page of table.

TABLE 5-1 (CONT.)
ANALYTICAL RESULTS FOR SOIL SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
units in mg/kg (ppm)

Sample Numbers Location Depth (Ft.)	9103FRL011SL AP3015 120 - 122	9103FRL013SL AP3015 Composite of drill cuttings	9103FRL014SL AP3015 Dup of 013SL Composite of drill cuttings
<u>Metals</u>			
Arsenic	4.5	3.5	8.5
Barium	18	35	130
Cadmium	0.53 U	0.051 U	0.5 U
Calcium	6,500	11,000	14,000
Chromium	23	28	34
Copper	10	15	28
Iron	21,000	26,000	26,000
Lead	5.9	7.7	3.7
Magnesium	7,400	9,400	8,700
Manganese	380	510	550
Mercury	NA	NA	NA
Potassium	180	320	680
Selenium	0.48 U	0.45 U	0.5 U
Silver	1.1 U	1.0 U	1.0 U
Sodium	99	110	200
Zinc	32	40	52

See key on last page of table.

TABLE 5-1 (CONT.)
ANALYTICAL RESULTS FOR SOIL SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
units in mg/kg (ppm)

Sample Numbers Location Depth (Ft.)	9043FRL001SL AP3012 48 - 49.5	9043FRL002SL AP3012 88 - 89.5	9044FRL004SL AP3012 152 - 154	9044FRL005SL AP3012 180 - 182	9046FRL006SL AP3011 39 - 41	9046FRL007SL AP3011 120 - 122	9047FRL008SL AP3011 130 - 132	9047FRL009SL AP3011 136 - 138	9103FRL010SL AP3015 90 - 92
Volatile Organic Compounds									
Methylene Chloride	5 JB	5 B	6 B	8 B	5 U	6 U	6 J	5 U	11 B
Acetone	14 B	12 B	16	44 B	16	17	26	12	10 U
Toluene	5 U	5 U	5 U	5 U	5 U	6 U	6 U	5 U	13
Xylenes	5 U	5 U	5 U	5 U	5 U	6 U	6 U	5 U	5 U
Base/Neutral/Acid Extractables									
Di-n-butylphthalate	73 J	330 U	32 JB	110 JB	350 U	390 U	390 U	340 U	340 U
Bis(2-ethylhexyl)-phthalate	340 U	41 J	180 JB	190 JB	19 JB	75 JB	110 JB	21 JB	230 JB
Pesticides/Polychlorinated Biphenyls									
β-BHC	9.4 U	9.1 U	9.9 U	11 U	9.7 U	11 U	11 U	9.3 U	9.3 U
Herbicides									
Dichloroprop	NA	29 J	27 J	25 J	5.4 J	15 J	15 J	8.8 J	11 J

See key on last page of table.

TABLE 5-1 (CONT.)
ANALYTICAL RESULTS FOR SOIL SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
units in mg/kg (ppm)

Sample Numbers Location Depth (Ft.)	9103FRL011SL AP3015 120 - 122	9103FRL013SL AP3015 Composite of drill cuttings	9103FRL014SL AP3015 Dup of 013SL Composite of drill cuttings
Volatile Organic Compounds			
Methylene Chloride	6	9 B	35 B
Acetone	11 U	11 U	180
Toluene	6 U	7	13
Xylenes	6 U	5 U	17
Base/Neutral/Acid Extractables			
Di-n-butylphathlate	370 U	350 U	350 U
Bis(2-ethylhexyl)-phthalate	59 J	350 U	350 U
Pesticides/Polychlorinated Biphenyls			
β-BHC	10 U	9.6 U	4
Herbicides			
Dichloroprop	23 J	16 J	NA

Key:

U = nondetected, value given is the detection limit; B = detected in blank; NA = not analyzed for; and J = estimated quantity.

Source: Ecology and Environment, Inc. 1991

TABLE 5-2
ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
(Results in μg/L unless otherwise specified)

Sample Number:	9118FRL001WA	9118FRL002WA	9119FRL003WA	9119FRL008WA	9120FRL016WA	9120FRL016WA Duplicate	9120FRL017WA	9120FRL018WA
Location:	FR-3	FR-1	AP3013	AP3010	AP3014	AP3014	AP3015	Pot. Water-Lab
Date Sampled:	5/6/91	5/6/91	5/8/91	5/9/91	5/16/91	5/16/91	5/16/91	5/21/91
Analyte:								
TPH (m-8015)								
Diesel	50 U	50 U	NA	NA	NA	NA	NA	NA
Jet Fuel	50 U	50 U	NA	NA	NA	NA	NA	NA
Gasoline	50 U	50 U	NA	NA	NA	NA	NA	NA
Kerosene	50 U	50 U	NA	NA	NA	NA	NA	NA
Mineral Spirits	50 U	50 U	NA	NA	NA	NA	NA	NA
Oil	5,600 (E)	5,500 (E)	NA	NA	NA	NA	NA	NA
OP-Pest (8140)	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U
VOCs (8240)								
Carbon Tetrachloride	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	5.0 U	1.0 U	1.0 U
1,2-Dichloropropene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	5.0 U	1.0 U	1.0 U
Chloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	43	1.0 U	166
Carbon Disulfide	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	5.0 U	1.0 U	7.2
BNAs (8270)								
Bis(2-ethylhexyl)phthalate	8	5 U	5 U	5 U	5 U	10 U	5 U	5 U

See key at end of table.

TABLE 5-2 (CONT.)
ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
(Results in µg/L unless otherwise specified)

Sample Number:	9118FRL001WA	9118FRL002WA	9119FRL003WA	9119FRL008WA	9120FRL016WA Duplicate	9120FRL016WA	9120FRL017WA	9120FRL018WA
Location:	FR-3	FR-1	AP3013	AP3010	AP3014	AP3014	AP3015	Pot. Water-Lab
Date Sampled:	5/6/91	5/6/91	5/8/91	5/9/91	5/16/91	5/16/91	5/16/91	5/21/91
Analyte:								
Pest/PCB								
Aldrin	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
α BHC	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.03 U	0.08 U	0.08 U
β BHC	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.06 U	0.08 U	0.08 U
δ BHC	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.09 U	0.08 U	0.08 U
γ BHC (Lindane)	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.04 U	0.08 U	0.08 U
Chlordane	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.14 U	0.10 U	0.10 U
4,4'-DDD	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.11 U	0.08 U	0.08 U
4,4'-DDE	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.04 U	0.08 U	0.08 U
4,4'-DDT	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.12 U	0.08 U	0.08 U
Dieldrin	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.02 U	0.08 U	0.08 U
Endosulfan I	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.14 U	0.04 U	0.04 U
Endosulfan II	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.04 U	0.08 U	0.08 U
Endosulfan sulfate	0.16 U	0.16 U	0.16 U	0.16 U	0.16 U	0.66 U	0.16 U	0.16 U
Endrin	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.06 U	0.08 U	0.08 U
Endrin Aldehyde	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.10 U	0.23 U	0.23 U
Heptachlor	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.03 U	0.04 U	0.04 U
Heptachlor Epoxide	0.83 U	0.83 U	0.83 U	0.83 U	0.83 U	0.83 U	0.83 U	0.83 U
Methoxychlor	1.76 U	1.76 U	1.76 U	1.76 U	1.76 U	1.8 U	1.76 U	1.76 U
Toxaphene	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	2.4 U	6.0 U	6.0 U
Arochlor - 1016	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.50 U	0.08 U	0.08 U
Arochlor - 1221	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.50 U	0.08 U	0.08 U
Arochlor - 1232	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.50 U	0.08 U	0.08 U
Arochlor - 1242	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.50 U	0.08 U	0.08 U
Arochlor - 1248	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	0.50 U	0.08 U	0.08 U
Arochlor - 1254	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	1.0 U	0.08 U	0.08 U
Arochlor - 1260	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	1.0 U	0.08 U	0.08 U

See key at end of table.

TABLE 5-2 (CONT.)
ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
(Results in µg/L unless otherwise specified)

Sample Number:	9118FRL001WA	9118FRL002WA	9119FRL003WA	9119FRL008WA	9120FRL016WA	9120FRL016WA	9120FRL017WA	9120FRL018WA
Location:	FR-3	FR-1	AP3013	AP3010	AP3014	AP3014	AP3015	Pot. Water-Lab
Date Sampled:	5/6/91	5/6/91	5/8/91	5/9/91	5/16/91	5/16/91	5/16/91	5/21/91
Analyte:								
Metals, Total								
Aluminum	91,000	50,000	410	500	<50	NA	990	50 U
Antimony	10 U	10 U	10 U	10 U	10 U	NA	10 U	10 U
Arsenic	8.8	6.7	5 U	5 U	5 U	NA	5 U	5 U
Barium	480	340	28	27	14	NA	15	10 U
Beryllium	2 U	2 U	2 U	2 U	2 U	NA	2 U	2 U
Cadmium	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U
Calcium	110,000	94,000	18,000	21,000	20,000	NA	20,000	15,000
Chromium	82	72	5 U	5 U	5 U	NA	5 U	5 U
Cobalt	30 U	30 U	30 U	30 U	30 U	NA	30 U	30 U
Copper	110	94	18	21	20	NA	20	16
Iron	96,000	81,000	1,100	1,500	1,100	NA	1,700	680
Lead	36	29	5 U	5 U	5 U	NA	5 U	5 U
Magnesium	36,000	32,000	5,400	34,000	4,900	NA	12,000	4,100
Manganese	2,200	2,100	990	700	1,600	NA	720	680
Mercury	0.23	0.2 U	0.2 U	0.2 U	0.2 U	NA	0.2 U	0.2 U
Nickel	130	65	10 U	11	10 U	NA	10 U	10 U
Potassium	10,000	7,000	890	1,400	2,500	NA	990	940
Selenium	5 U	5 U	5 U	5 U	5 U	NA	5 U	5 U
Silver	1 U	1 U	1 U	1 U	1 U	NA	1 U	1 U
Sodium	5,500	6,500	4,500	4,300	5,400	NA	3,400	6,400
Thallium	5 U	5 U	5 U	5 U	5 U	NA	5 U	5 U
Vanadium	160	130	<15	<15	<15	NA	<15	<15
Zinc	1,900	1,600	42	37	32	NA	57	83
Metals, Dissolved								
Aluminum	1,700	26,000	240	110	120	NA	50 U	50 U
Antimony	10 U	10 U	10 U	10 U	10 U	NA	10 U	10 U
Arsenic	5 U	6.2	5 U	5 U	5 U	NA	5 U	5 U
Barium	36	150	19	17	19	NA	16	10 U

See key at end of table.

FTR 0018860

TABLE 5-2 (CONT.)
ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
(Results in µg/L unless otherwise specified)

Sample Number:	9118FRL001WA	9118FRL002WA	9119FRL003WA	9119FRL008WA	9120FRL016WA	9120FRL016WA Duplicate	9120FRL017WA	9120FRL018WA
Location:	FR-3	FR-1	AP3013	AP3010	AP3014	AP3014	AP3015	Pot. Water-Lab
Date Sampled:	5/6/91	5/6/91	5/8/91	5/9/91	5/16/91	5/16/91	5/16/91	5/21/91
Analyte:								
Metals, Dissolved (cont.)								
Beryllium	2 U	2 U	2 U	2 U	2 U	NA	2 U	2 U
Cadmium	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U
Calcium	8,400	58,000	4,100	5,600	5,500	NA	23,000	800
Chromium	5 U	46	5 U	5 U	5 U	NA	5 U	5 U
Cobalt	30 U	30 U	30 U	30 U	30 U	NA	30U	30 U
Copper	10 U	58	10 U	10 U	10 U	NA	23	10 U
Iron	3,100	22,000	600	490	140	NA	730	30
Lead	5 U	26	5 U	5 U	5 U	NA	5 U	5 U
Magnesium	4,100	7,200	3,600	29,000	3,700	NA	10,000	3,200
Manganese	80	850	120	140	860	NA	130	90
Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	NA	0.2 U	0.2 U
Nickel	10 U	63	10 U	10 U	10 U	NA	10 U	10 U
Potassium	1,400	2,800	730	1,200	2,200	NA	870	800
Selenium	5 U	5 U	5 U	5 U	5 U	NA	5 U	5 U
Silver	1 U	1 U	1 U	1 U	1 U	NA	1 U	1 U
Sodium	1,900	3,200	2,700	3,100	4,200	NA	2,300	5,600
Thallium	5 U	5 U	5 U	5 U	5 U	NA	5 U	5 U
Vanadium	15 U	73	15 U	15 U	15 U	NA	15 U	15 U
Zinc	110	1,300	16	11	10 U	NA	26	48
Water Quality Parameters								
Chemical Oxygen Demand (mg/L)	101	139	7 (J)	10	12	NA	5 U	5 U
Cyanide (mg/L)	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	NA	0.01 U	0.01 U
Nitrogen, Ammonia (mg/L)	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	0.05 U	0.05 U

See key at end of table.

TABLE 5-2 (CONT.)
ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
(Results in $\mu g/L$ unles otherwise specified)

Sample Number:	9118FRL001WA	9118FRL002WA	9119FRL003WA	9119FRL008WA	9120FRL016WA	9120FRL016WA Duplicate	9120FRL017WA	9120FRL018WA
Location:	FR-3	FR-1	AP3013	AP3010	AP3014	AP3014	AP3015	Pot. Water-Lab
Date Sampled:	5/6/91	5/6/91	5/8/91	5/9/91	5/16/91	5/16/91	5/16/91	5/21/91
Water Quality Parameters (cont.)								
Nitrogen, Nitrate and Nitrite (mg/L)	119	150	122	0.3	136	NA	0.8	108
Nitrogen, Total Kjeldahl	0.1 U	0.2	0.4	0.6	NA	NA	NA	NA
Total Organic Carbon (mg/L)	5.1	7.0	1.0	0.9	2.8	NA	0.6	0.8
Alkalinity, as $CaCO_3$ (mg/L)	173.2	169	152.7	304.3	80.5	NA	186	103
Chloride (mg/L)	7.0	8.8	16.3	2.0	7.0	NA	8.5	4.15
Corrosivity, Langelier's Index	0.17	0.17	NA	NA	NA	NA	NA	NA
Methylene Blue Active Substances (mg/L)	0.025 U	0.025 U	NA	NA	NA	NA	NA	NA
pH	7.42	7.48	NA	NA	NA	NA	NA	
TDS (mg/L)	200	173	234	35	122	NA	251	140
Sulfate (mg/L)	5	4	13	11	13	NA	14	12.5
Turbidity (NTU)	670	660	0.36	37	0.81	NA	7.3	008
Coliforms (colonies/100 mL)	1 U	1 U	1 U	1 U	1 U	NA	1 U	1 U

Key:
U = nondetected, value given is the detection limit.
NA = not analyzed for.
B = detected in blank.
J = estimated quantity.

Source: Ecology and Environment, Inc. 1991

TABLE 5-3
SAMPLE ANALYTICAL METHODS/PROCEDURES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

Analtye	Matrix	Method Reference	Description of Method*	Minimum Detection Limit**	
Volatile Organic	soil	EPA 8240	Purge and Trap GC/MS	10	µg/kg
Compounds	water	EPA 8240	Purge and Trap GC/MS	10	µg/L
Base/Neutral/Acid	soil	EPA 8270	GC/MS	330	µg/kg
Extractables	water	EPA 8270	GC/MS	10	µg/L
Chlorinated Pesticides/	soil	EPA 8080	GC/ECD	2	µg/kg
Polychlorinated Biphenyls	water	EPA 8080	GC/ECD	0.05	µg/L
Organophosphorus	soil	EPA 8140	GC/FID	10	µg/kg
Pesticides	water	EPA 8140	GC/FID	0.1	µg/L
Chlorinated Herbicides	soil	EPA 8150	GC/ECD	250	µg/kg
	water	EPA 8150	GC/ECD	25	µg/L
Heavy Metals	soil	EPA 6010 and 7000 Series	ICP/GFAAS	5	µg/kg
	water	EPA 6010 and 7000 Series	ICP/GFAAS	5	µg/L
Mercury	soil	EPA 7471	Cold Vapor - Liquid	0.1	µg/kg
	water	EPA 7470	Cold Vapor - Liquid	0.2	µg/L
Ammonia Nitrogen	water	EPA 350.3	Potentiometric, Ion Selective Electrode	0.03	mg/L
Nitrate Nitrogen	water	EPA 352.1	Colorimetric/brucine	0.1	mg/L
Chloride	water	EPA 325.1	Titrimetric Mercuric Nitrate	1	mg/L
Chemical Oxygen Demand	water	EPA 410.4	Colorimetric-Low Concentration	5	mg/L
Sulfate	water	EPA 375.4	Turbidimetric	2	mg/L
Total Organic Carbon	water	EPA 415.1	Catalytic Comburtion, Infrared Detection	1	mg/L
Turbidity	water	EPA 180.1	Nephelometric turbidity	0.02	NTU
Alkalinity	water	EPA 310.1	Titrimetric pH 4.5	1	mg/L as $CaCO_3$
Total Dissolved Solids	water	EPA 160.1	Filterable Gravimetric Dried 181°C	10	mg/L
Corrosivity	water	APHA 2330[a]	Langelier's Index	NA	
Methylene Blue Active Substances	water	EPA 425.1	Extraction/Colorimetric	0.025	mg/L
Calcium	water	EPA 6010 and 7000 Series	ICP/GFAAS	10	mg/L
Sodium	water	EPA 6010 and 7000 Series	ICP/GFAAS	10	mg/L

* GC/MS - Gas chromatography/mass spectrophotometry.
GC/ECD - Gas chromatography with electron capture detection.
GC/FID - Gas chromatography with flame ionization detector.
ICP/GFAAS - Inductively coupled plasma or graphite furnace atomic absorption spectroscopy.

** Method detection limits are specified by the corresponding SW-846 method, mimimum detection limits are analyte- and sample-matrix specific, MDL listed are provided for guidance and may not always be achievable.

[a] American Public Health Association, "Standard Methods for the Examination of Water and Wastewater," 17th edition, 1989.

TABLE 5-4
FEDERAL AND STATE DRINKING WATER STANDARDS (MCLs)
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
Volumes are given in mg/L

Analyte Parameter	MCL	Proposed MCL	Secondary MCL	State MCL
Inorganics				
Alluminum	---	---	0.05-0.02	---
Antimony	---	0.01/0.005	---	---
Arsenic	0.05	---	---	0.05
Barium	2	---	---	1.0
Beryllium	---	0.01	---	---
Cadmium	0.005	---	---	0.010
Chromium	0.1	---	---	0.05
Chloride	---	---	250	---
Copper	---	---	1.0	---
Iron	---	---	0.3	---
Manganese	---	---	0.5	---
Mercury	0.002	---	---	0.002
Nickel	---	0.1	---	---
Nitrate (as N)	---	---	---	10 as N
Selenium	0.05	---	---	0.01
Silver	---	---	0.1	0.05
Sulfate	---	400/500	250	---
Thallium	---	0.002/0.001	---	---
Zinc	---	---	5	---

TABLE 5-4 (CONT.)
FEDERAL AND STATE DRINKING WATER STANDARDS (MCLs)
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA
Volumes are given in mg/L

Analyte Parameter	MCL	Proposed MCL	Secondary MCL	State MCL
Organics:				
Benzene	0.005	---	---	---
Benzo (a) pyrene	---	0.0002	---	---
Benzo (a) anthracene	---	0.0001	---	---
Benzo (b) fluoranthene	---	0.0002	---	---
Benzo (k) fluoranthene	---	0.0002	---	---
Bromoform	0.1	---	---	---
Carbon Tetrachloride	0.005	---	---	---
Chlordane	0.002	---	---	---
Chrysene	---	0.0002	---	---
Dalapon	---	0.2	---	---
Dibenzo (a,h) anthracene	---	0.0003	---	---
1,3-Dichlorobenzene	---	0.6	---	---
1,2-Dichlorobenzene	0.005	---	---	---
cis-1,2-dichloroethylene	0.07	---	---	---
trans-1,2-dichloroethylene	0.1	---	---	---
2,4-D	0.007	---	---	0.1
Dinoseb	---	0.007	---	---
Endrin	0.0002	0.0002	---	0.0002
Ethylbenzene	0.7	---	---	---
Heptachlor	0.004	---	---	---
Heptachlor Epoxide	0.0002	---	---	---
Indeno(1,2,3-c,d)pyrene	---	0.0004	---	---
Lindane	0.0002	---	---	0.0004
Methoxychlor	0.04	---	---	0.1
Pentachlorophenol	0.001	---	---	---
Styrene	0.1	---	---	---
Tetrachloroethylene	0.005	---	---	---
Toluene	1	---	---	---
Toxaphene	0.0003	---	---	0.005
1,1,2-Trichloroethane	0.2	---	---	---
Trichloroethylene	0.005	---	---	---
2,4,5-TP (silvex)	0.05	---	---	---
Vinyl Chloride	0.002	---	---	---
Xylenes (total)	10	---	---	---

TABLE 5-5
ANALYTICAL RESULTS FOR QUALITY ASSURANCE SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

(Results in μg/L)

Sample Number: Location:	9119FRL200WA trip blank	9119FRL201WA trip blank	9119FRL202WA trip blank	9120FRL204WA trip blank	9121FRL205WA trip blank	9103FRL015WA trip blank	9103FRL012WA trip blank	9044FRL005WA trip blank
Volatile Organic Compounds								
Carbon Tetrachloride	1.0 U	1.1	1.0 U	1.0 U	126	1.0 U	5.0 U	5.0 U
1,2-Dichloropropane	1.0 U	1.2	1.0 U	1.0 U	1.0 U	1.0 U	5.0 U	5.0 U
Chloromethane	1.0 U	1.0 U	1.0 U	34	1.0 U	5.0 U	10.0 U	10.0 U
Methylene Chloride	1.0 U	1.0 U	10.0 U	35	42	33 B	32 B	33 B

See key at end of table.

TABLE 5-5 (CONT.)
ANALYTICAL RESULTS FOR QUALITY ASSURANCE SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

(Results in µg/L)

Sample Numbers:	9044FRL004WA
Location:	rinsate
Metals	
Arsenic	0.0050 U
Barium	0.050 U
Cadmium	0.005 U
Calcium	20
Chromium	0.010 U
Copper	0.025 U
Iron	0.22
Lead	0.0022 U
Magnesium	0.015 U
Manganese	2.8
Mercury	0.0002 U
Potassium	0.56 U
Selenium	0.0050 U
Silver	0.010 U
Sodium	1.8
Zinc	0.32
Volatile Organic Compounds	
Methylene Chloride	6 B
Acetone	10 U
Toluene	1 JB
Xylenes	5 U
Base/Neutral/Acid Extractables	
Di-n-butylphathlate	10 U
Bis (2-ethylhexyl)-	1 JB
phthalate	1 JB

See key at end of table.

TABLE 5-5 (CONT.)
ANALYTICAL RESULTS FOR QUALITY ASSURANCE SAMPLES
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

(Results in μg/L)

Sample Numbers:	9044FRL004WA
Location:	rinsate
<u>Pesticides/Polychlorinated Biphenyls</u>	
β-BHC	0.06 U
<u>Herbicides</u>	
Dichloroprop	NA

Key:

U = nondetected, value given is the detection limit; B = detected in blank; NA = Not analyzed for; and J = estimated quantity.

Source: Ecology and Environment, Inc. 1992

KN1CROSSECT

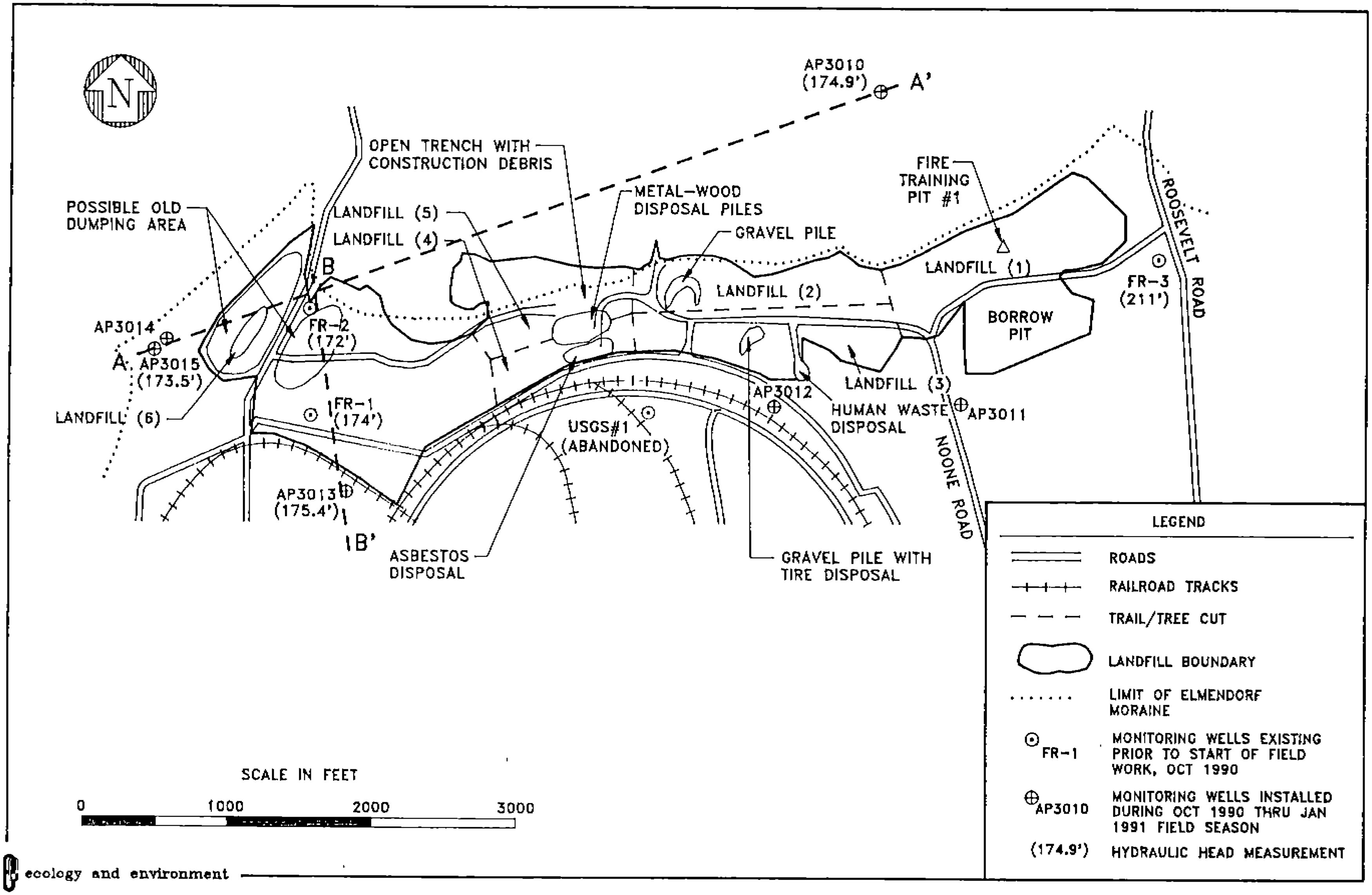

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Figure 5-1 CROSS SECTION LOCATIONS
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

FTR 0018869

KN1X-SEC-MW6

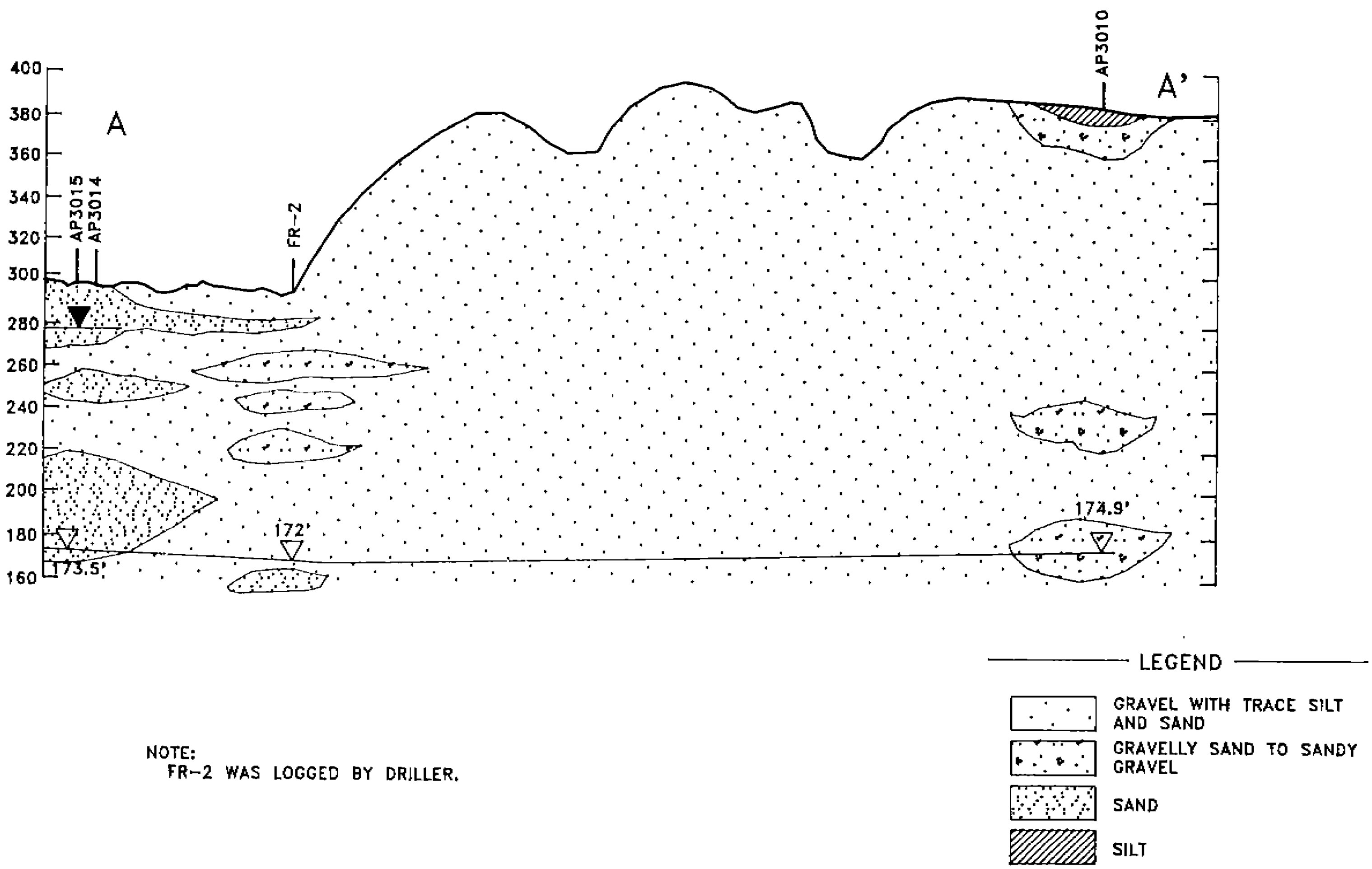

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Figure 5-2 CROSS-SECTION A – A'
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

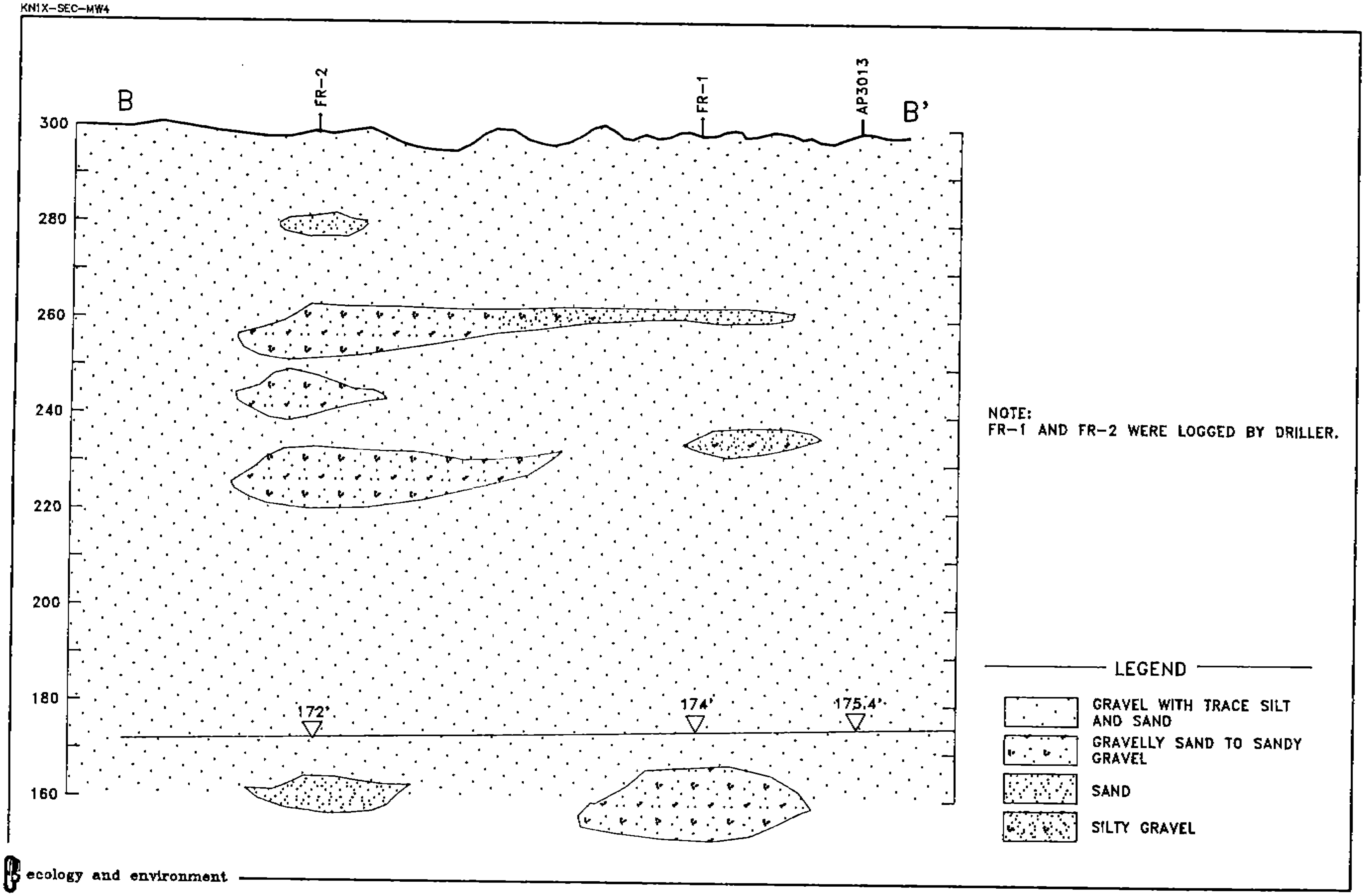

Figure 5-3 CROSS-SECTION B-B'
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

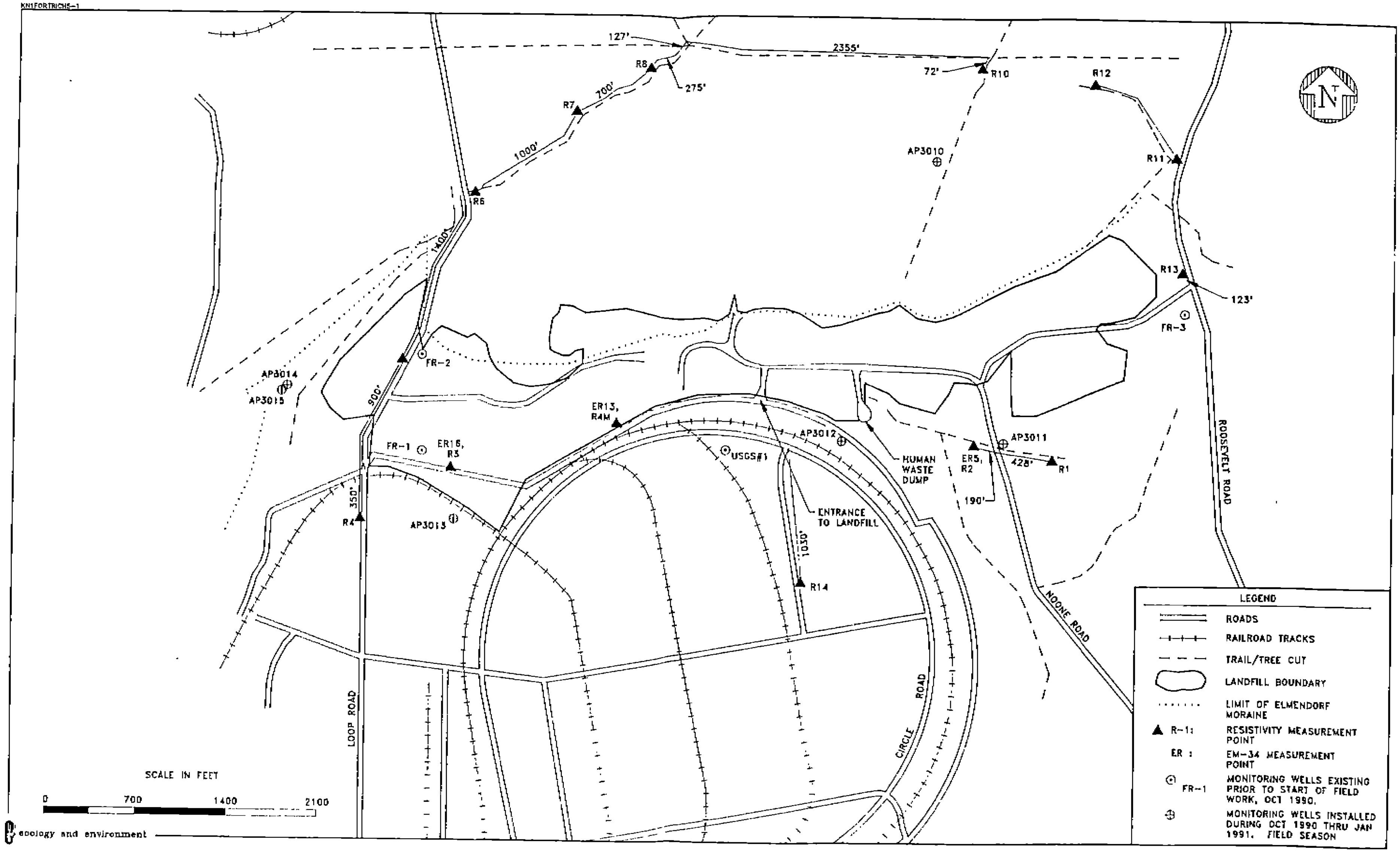

Figure 5-4 LOCATION MAP - RESISTIVITY SOUNDING FORT RICHARDSON LANDFILL ANCHORAGE, ALASKA

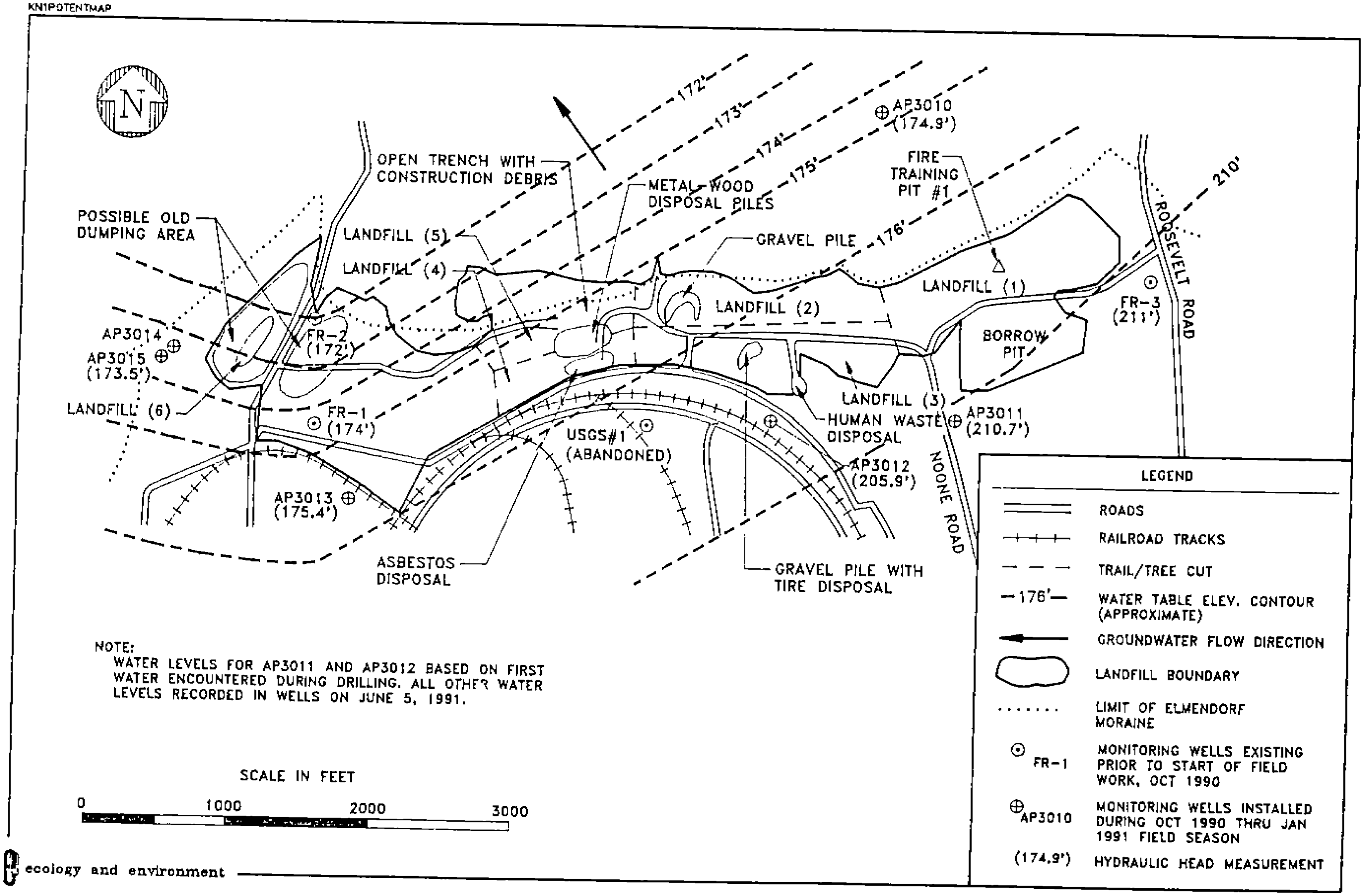

Figure 5-5 CONCEPTUAL POTENTIOMETRIC SURFACE MAP
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

6. CLOSURE DESIGN

The objective of the IRP program at the Fort Richardson Landfill is to identify, evaluate, and clean up hazardous waste contamination and groundwater pollution. Typical remedial objectives for landfills include:

- o mitigation of surface erosion and seeps,
- o prevention of significant leachate generation from the infiltration of precipitation and runoff, and
- o prevention of off-site leachate migration via groundwater.

Based on field observations at the Fort Richardson Landfill, there is no surface erosion, seepage, or migration of contamination from the site via surface water. The landfill appears to have an adequate depth of cover and is naturally revegetating. Since site soils are highly permeable, precipitation infiltrates vertically rather than flowing overland. Intermittent overland flow may occur as a result of seasonal events, such as heavy precipitation or spring melt; however, the impact of these types of seasonal events on surface erosion and contaminant migration at the landfill is considered minimal.

Although records of disposal practices at the landfill prior to 1982 are poorly documented, there is no evidence of Resource Conservation and Recovery Act (RCRA)-regulated waste disposal. As a result, the Fort Richardson Landfill closure is designed to satisfy the State of Alaska landfill monitoring and closure requirements as specified in the Alaska Administrative Code (AAC), Title 18, Section 60.

6.1 APPLICABLE REGULATIONS

Since there is no documented evidence of disposal of RCRA-regulated hazardous waste at the landfill, federal regulations do not apply to the closure. However, the State of Alaska regulations (18 AAC 60) apply to the closure of all landfills within the state. Since there is no documented evidence of the disposal of either drilling wastes or fluid or soluble drilling wastes, the state regulated requirements can be summarized as follows:

- provide final cover and vegetation;
- for at least 5 years, provide a monitoring program and maintain the facility; and
- prepare and submit written documentation of the results of both monitoring and maintenance/repair operations.

Required monitoring includes:

- suitable groundwater monitoring if groundwater is within 50 feet of the surface, or
- suitable vadose zone monitoring if groundwater is more than 50 feet from the surface.

Groundwater is more than 50 feet from the surface; therefore, vadose zone monitoring is required. However, to date ADEC has not established guidelines for vadose zone monitoring (e.g., FID/PID, Tenax, or Tedlar) or result interpretation. Groundwater protection is the ultimate goal of the state program, therefore E & E proposes a system of groundwater monitoring to ensure that groundwater quality in the vicinity of the landfill is not degraded. The proposed system involves installation of more monitoring wells and regular groundwater sampling. This system will provide an added measure of protection and goes beyond regulations requirements.

6.2 DESCRIPTION OF CLOSURE DESIGN

Based on the site characteristics, environmental setting, types/concentrations of contaminants detected, and the current understanding of the groundwater flow direction, the most economical closure design for the landfill involves the installation of two additional downgradient monitoring wells and one additional upgradient monitoring well. Two monitoring wells will be installed along the northern boundary of the landfill, downgradient (northwest) of disposal areas 2 through 5. The third well will be located upgradient of the landfill adjacent to monitoring well AP3012, a dry well installed during the 1990/1991 field season. This well should be screened in the shallow aquifer at approximately 125 feet bgs. The final decision on the location and screening depth of the upgradient monitoring well will be made by geologist with knowledge of the site-specific conditions.

The screened interval of each monitoring well should be at least 20 feet long, allowing 10 feet of screen to extend above the water table into the vadose zone since groundwater elevation fluctuates. Data collected from these wells will provide downgradient and background water quality data as well as assist in the development of a more accurate model of groundwater flow patterns at the landfill. Proposed groundwater monitoring well locations are shown on Figure 6-1.

All the wells at the landfill should be sampled seasonally for the first 2 years to establish a statistical database for the landfill's groundwater quality. Monitoring samples should be collected according to the terms of the permit. Analytical parameters for the baseline and monitoring samples are listed in 18 AAC 60.310. These include water quality parameters, purgeable aromatics and hydrocarbons, as well as metals.

6.3 COST ESTIMATE

This cost estimate has been developed based on the drilling and monitoring well installation costs during the 1990/1991 winter field season. Installation of three monitoring wells is estimated to require 30 days, which includes mobilization and decontamination time. Estimated drilling depth of the proposed upgradient well adjacent to AP3012 is approximately 200 feet bgs, while the depths of the proposed downgradient monitoring wells are approximately 180 feet bgs. Analytical costs for the initial sampling of the wells are included in the Table 6-1, as well as the cost to produce a work plan and final report. It is assumed that costs for subsequent sampling and laboratory analyses will be incorporated into the basewide monitoring program.

TABLE 6-1

CLOSURE DESIGN COST ESTIMATE
FORT RICHARDSON SANITARY LANDFILL
ANCHORAGE, ALASKA

Activity	Rate	Sum
Mobilization/ Demobilization	Lump sum	$10,000
Drilling	560 LF x $28/LF	$15,680
Truck Rental	$98/hr x 10 hr/day x 30 days	$29,400
Dedicated Pumps	3 pumps at $2,000/pump (includes riser and valve work)	$6,000
Oversight	2 people x 10 hr/day x 30 days (rate approx. = $51.17/hr)	$31,000
Health & Safety Equipment	OVA and Explosimeter	$1,200
Laboratory Analysis	3 Sieve Analyses x $65/sample	$195
	3 water samples x $1,590/sample	$4,770
	2 MS/MSD samples x $1,590/sample	$3,180
	1 Rinsate x $1,590/sample	$1,590
	1 Trip Blank x $250/sample	$250
	Shipping	$250
Reports	Work Plan	$20,000
	Final	$30,000
Subtotal		$153,515
Contingency at ± 15%		$23,027
Total Estimated Cost		$176,542

KEY: LF = Linear Feet
OVA = Organic Vapor Analyzer
MS/MSD = Matrix Spike/Matrix Spike Duplicate

Source: Ecology and Environment, Inc. 1991

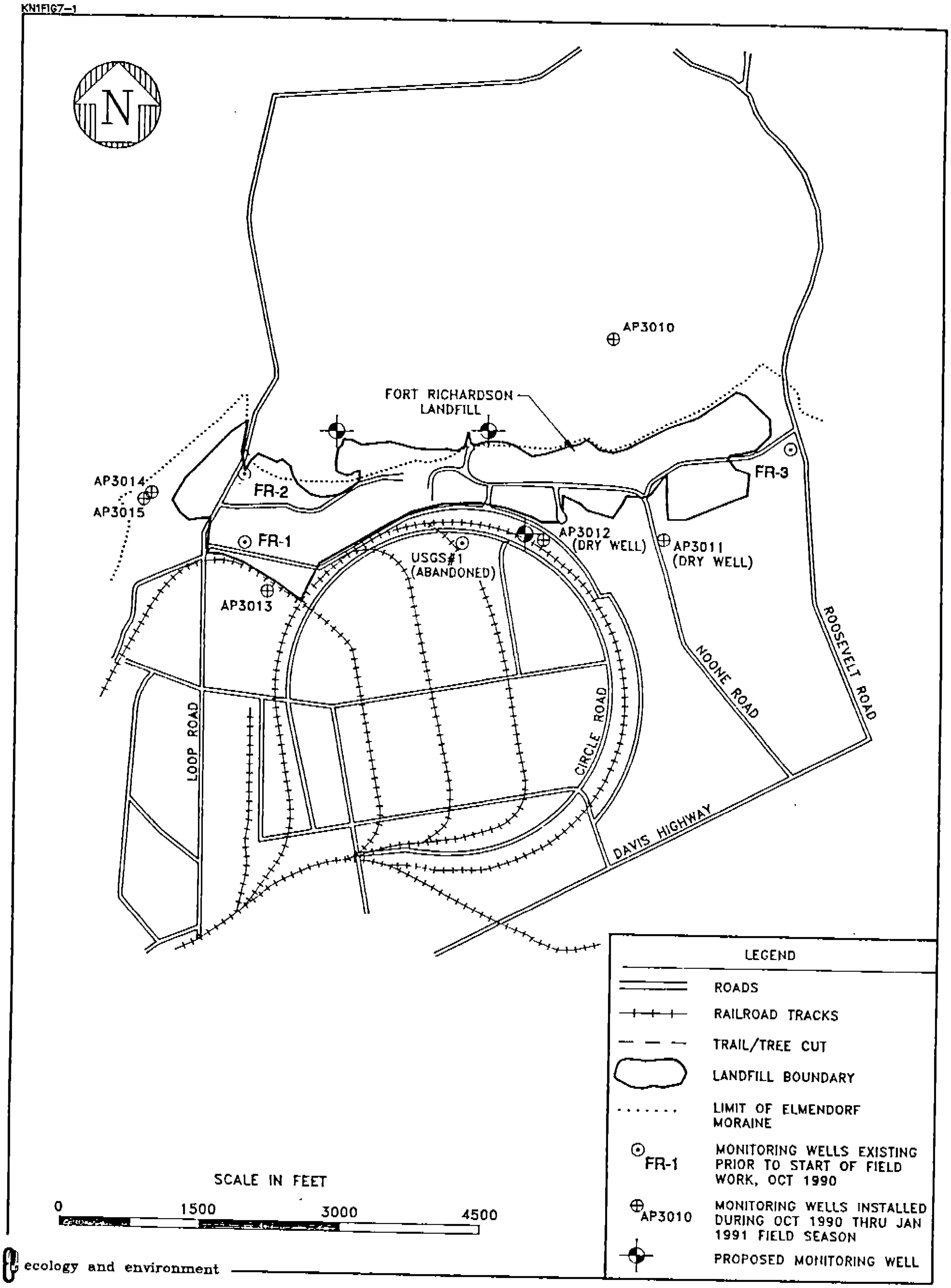

Figure 6-1 RECOMMENDED MONITORING WELL LOCATIONS
FORT RICHARDSON LANDFILL
ANCHORAGE, ALASKA

7. RECOMMENDATIONS AND CONCLUSIONS

7.1 SITE CHARACTERIZATION

The Fort Richardson Landfill is an unlined landfill covering approximately 400 acres. It is located just north of Circle Road. The landfill is a trench-and-fill operation, divided into six disposal areas that were systematically opened, used, and closed. The history of landfilling at Fort Richardson is poorly documented. Approximately 11,500 cubic yards of compacted solid waste and an additional 3,000 cubic yards of soil were landfilled annually (AEHA 1983, 1988). Human waste is presently being disposed of at the landfill under a current ADEC permit.

The landfill is located in an area that features flat to gently rolling, wooded terrain, including ponds and numerous streams. No surface water is present on the site. The landfill is bounded on the north by the Elmendorf Moraine, a northeast-southwest trending terminal moraine consisting of poorly sorted, unconsolidated till with boulders, gravel, sand, and silt. The majority of the landfill sits on a large outwash plain formed along the margin of the Elmendorf Moraine by glacial meltwater. The remainder of the landfill lies within alluvial fans.

The landfill is underlain by a thick, coarse-grained, surficial deposit of gravel and sand. No permafrost underlies the landfill area (AEHA 1983). Drilling logs from the landfill indicate that surficial deposits extend to at least 160 feet bgs. Bedrock was found at 468 feet bgs in a well directly south of the landfill (Cederstrom et al. 1964). Fort Richardson is believed to overlie a major portion of the recharge area for the confined aquifer that serves Anchorage. Groundwater recharge originates in the Chugach Mountains and probably involves the entire glacial outwash underlying the landfill and major portions of Fort Richardson south of the Elmendorf Moraine.

Analytical results from subsurface soil and groundwater sampling do not indicate that contaminants are migrating from the landfill. After analyzing the groundwater elevation data, it was discovered that the groundwater gradient was to the northwest, which was not anticipated in the work plan. If this is the true groundwater gradient and not a seasonal fluctuation, then only one well is downgradient of the landfill. Analytical results from a groundwater well at the Otter Lake campground downgradient of the landfill from sampling conducted in 1990 show no indication of contamination.

7.2 RECOMMENDATIONS

Based on the information presented in Sections 5 and 6, the following recommendations are being made in order to bring the landfill into compliance with state regulations and provide additional data should remedial action be required in the future. These recommendations include:

- the installation of two downgradient and one upgradient groundwater monitoring wells;
- annual elevation surveys of all monitoring wells at the landfill;
- quarterly measurement of the groundwater elevations of all monitoring wells at the landfill;
- establishment of a groundwater quality database for the landfill based on the analytical results of baseline and monitoring samples;
- the incorporation of all monitoring wells at the landfill into the basewide groundwater monitoring program; and
- the implementation of a survey program to track settlement rates of each landfill disposal area.

To date, there is no documented evidence of groundwater contamination in either the upgradient or downgradient directions from the landfill. However, the existing data is insufficient to make a judgment on groundwater flow patterns and whether contaminants are migrating from the landfill. Therefore, it is anticipated that the installation of three additional monitoring wells will provide the integral data required to make a definitive conclusion regarding groundwater flow patterns and potential contaminant releases. Annual measurement of well elevations will detect possible vertical movement attributed to frost heave or settlement. Due to the flat groundwater gradient at the landfill, minor elevation changes in monitoring wells could distort the calculated groundwater elevation and, therefore, indicate incorrect flow patterns. The human waste disposal at the landfill is in compliance with a current ADEC permit, and no coliform bacteria have been detected in groundwater samples. Therefore, no recommendations will be made concerning this practice.

E & E recommends that quarterly groundwater elevations be recorded for each of the monitoring wells at the landfill to determine if seasonal fluctuations have any effect on the direction of groundwater flow. The periodic measurement of groundwater levels will provide data to develop potentiometric surface maps that can be used to make a definitive determination as to groundwater flow patterns.

In addition, all monitoring wells at the landfill should be incorporated into the basewide groundwater monitoring program. This will provide comprehensive laboratory analyses on a semiannual basis and satisfy state regulations.

The final recommendation is that USACE implement a program to measure the settlement rates of the landfill. Should future groundwater monitoring indicate a hazardous waste release from the landfill, data related to settlement will be necessary for the design of a cap system. As discussed in Section 2.3, little or no data is available concerning the type, quantity, and compaction rates of wastes disposed in the different areas of landfill.

> "Various studies have shown that about 90% of the ultimate settlement in a landfill occurs within the first 5 year period. Settlement depends on the initial compaction, characteristics, degree of composition and the effects of consolidation of the wastes. The height of the completed fill will also influence the initial compaction and the degree of consolidation." (Eliassen, R.: Decomposition of Landfills, American Journal of Public Health, Vol. 32, no. 3, 1942).

Trenching or drilling into the landfill to collect data for the calculation of settlement data is not feasible since there is evidence of ordnance disposal. It is recommended that at least one monument be installed in each of the disposal areas and periodically surveyed to detect elevation changes. This information will be used to estimate landfill settlement rates should a future contaminant release occur and dictate the need for remedial action.

This closure program will be relatively easy to implement and requires minimal maintenance and costs, and allows for future unobstructed remedial actions at the site, if deemed necessary.

7.3 CONCLUSIONS

As part of the IRP, the U.S. Army has embarked on a investigative program to ensure that the Fort Richardson Landfill is in compliance with all applicable state and federal regulations and that it poses no threat to the public health or the environment. The first component of the investigation involved the installation of groundwater monitoring wells in 1985. Currently, seven functioning monitoring wells surround the landfill and are sampled semiannually.

The results of chemical analyses and lithologic logging reveal that more information is required to make a definitive determination if there is contaminant migration from the Fort Richardson Landfill. Although contaminant concentrations are not considered significant in either groundwater or subsurface soil samples, the size of the analytical database is too small to draw definitive conclusions.

Given the state of the data and the existing conditions at the landfill, the preferred closure method is the installation of additional groundwater monitoring wells and the incorporation of these wells into the basewide groundwater monitoring program. This closure program brings the landfill into compliance with ADEC regulations and provides data for the implementation of remedial action should the future need arise.

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APPENDIX A

SUBSURFACE SOIL AND GROUNDWATER TEST PARAMETERS

SUBSURFACE SOIL AND GROUNDWATER TEST PARAMETERS
Fort Richardson Landfill
Anchorage, Alaska

Matrix	Analysis	Method Number*
WATER	Conventional	
	Temperature (in field)	
	Conductivity (in field)	
	pH (in field)	
	Redox Potential (in field)	
	Turbidity (in field)	
	Total Dissolved Solids (TDS)	160.1
	Total Alkalinity	310.1
	Corrosivity	9040
	Chemical Oxygen Demand (COD)	410.4
	Bicarbonate	403
	Total Organic Carbon (TOC)	415.1
	Methylene Blue Active Substances	425.1
	Total Coliform Bacteria	9131
	Ammonia Nitrogen	350.3
	Nitrate Nitrogen	352.1
	Total Kjeldahl Nitrogen	351.3
	Chloride	325.1
	Sulfate	375.4
	Cyanide	9010
	Dissolved Metals	
	Arsenic	7060
	Barium	6010, 7080
	Cadmium	6010
	Calcium	6010, 7140
	Chromium	6010, 7191
	Copper	6010, 7210
	Iron	6010
	Lead	7421
	Magnesium	6010
	Manganese	7450
	Mercury	7470
	Potassium	7610
	Selenium	7740
	Silver	6010, 7760
	Sodium	6010
	Zinc	7950

* Method Numbers listed include alternatives for certain metals.

** Compounds are listed individually in Appendix C.

SUBSURFACE SOIL AND GROUNDWATER TEST PARAMETERS
Fort Richardson Landfill
Anchorage, Alaska

Matrix	Analysis	Method Number*
	Radiation	
	Radium 226 and 228	9320
SOIL AND WATER	Organics	
	VOC **	8240
	B/N/A Extractables **	8270
	Chlorinated Pesticides/PCB's**	8080
	Organophosphorous Pesticides **	8140
	Chlorinated Herbicides **	8150
SOIL	Total Metals	
	As for water above, with exception of mercury	7470

* Method Numbers listed include alternatives for certain metals.
** Compounds are listed individually in Appendix C.

APPENDIX B

HEALTH EFFECTS SUMMARIES

FOR CONTAMINANTS OF POTENTIAL CONCERN

The health effects summaries describe potential toxic properties for many of the chemicals of potential concern at the Fort Richardson Landfill. In most cases, the information for these summaries is drawn from the Public Health Statement in the Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profile for the chemical.

Aliphatic Petroleum Hydrocarbons (Alkanes: C-8 to C-13)

Aliphatic petroleum hydrocarbons (PHCs) is a term used to refer to a mixture of long chain hydrocarbon compounds derived from petroleum and which are often components of petroleum products. In general, aliphatic PHCs are regarded as having a low potential for toxicity and there is no evidence that aliphatic PHCs are mutagenic or carcinogenic. Aliphatic PHCs with five or more carbons produce narcosis and central nervous system disturbances and can irritate the lungs at high airborne concentrations. The straight chain aliphatic PHCs appear to be more toxic than their branched chain isomers. The most toxic aliphatic is n-hexane, which was chosen as a surrogate for the evaluation of aliphatic PHCs at the site. Choosing potentially the most toxic aliphatic to evaluate the group adds a conservative, health protective bias to the risk estimates.

Ingestion of n-hexane may cause nausea, vertigo, bronchial and general intestinal irritation, and central nervous system effects. Unconsciousness can result from central nervous system depression. After exposure to 800 ppm for 15 minutes, n-hexane has been shown to irritate the eyes and mucous membranes and skin contact can cause irritation and dryness. Chronic exposure to n-hexane vapors may result in damage to the peripheral nervous system, and symptoms such as numbness to the fingers and toes. If exposure continues, paralysis characterized by impaired walking and grasping may result. Concentrations of n-hexane associated with nerve damage have not been firmly established but symptoms have been observed in humans exposed to concentrations ranging from 10 to 200 ppm for 9-12 months.

Arsenic

Arsenic is a naturally-occurring element usually found combined with one or more elements such as oxygen, chlorine, or sulfur. Arsenic is widely distributed in the environment from natural sources, but higher concentrations have been found associated with chemical waste, smelting of copper and other metals, fossil fuel combustion, and pesticide use. Exposure to arsenic may occur from inhalation of air and ingestion of drinking water or accidental ingestion of soil containing arsenic during gardening or play activity.

Arsenic may be an essential element enhancing growth and development in certain animal species, and it has been suggested that arsenic also may be an essential element for humans, although this is the subject of continuing research. Chronic arsenic overexposure may cause body weight changes, changes in the blood, and liver and kidney damage. In humans, epidemiologic studies and case reports have documented that arsenic is associated with tumors of the skin, lungs, genital organs, and visual organs.

Barium

Barium is a naturally-occurring element which is used commercially in the form of barium compounds. Industrial applications include use in the metallurgic, paint, glass, and electronics industries, as well as for medicinal purposes.

Barium can enter the body by breathing air or ingesting food or water containing barium or its compounds. Ingestion of soluble barium compounds may result in effects such as vomiting and diarrhea. Barium salts may act as a muscle stimulant, especially for the heart muscle, and may constrict blood vessels, resulting in an increased blood pressure. Concentrations above 0.51 mg/kg resulted in a significant increase in blood pressure. Ingestion of 550 to 600 mg is reportedly fatal to humans; however, adverse effects associated with inhalation of barium dusts have not been well characterized.

Benzene

Benzene has a long history of industrial use most notably as a solvent and as a starting material for the synthesis of other chemicals.

Benzene is readily absorbed by inhalation and ingestion but is relatively poorly absorbed through the skin. Since benzene is quite volatile, inhalation is the most likely route of exposure.

Benzene is toxic to the blood-forming organs and the immune system. Excessive exposure (inhalation of concentrations of 10 to 100 ppm) can result in anemia, a weakened immune system, and headaches. Occupational exposure to benzene may also be associated with spontaneous abortions and miscarriages (supported by limited animal data) and certain developmental abnormalities such as low birth weight, delayed bone formation, and bone marrow toxicity. Benzene is regarded as a human carcinogen based on numerous studies documenting excess leukemia mortality among occupationally exposed workers.

Cadmium

Cadmium is a naturally-occurring element in the earth's crust. Cadmium has several industrial applications but it is used mostly in metal plating, and the manufacture of pigments, batteries, and plastics. Humans are exposed to small quantities of cadmium widely distributed in air, water, soil, and food. Cadmium can enter the body by absorption from the stomach or intestines after ingestion of food or water, or by absorption from the lungs after inhalation. Very little cadmium enters the body through the skin.

Cadmium can cause a number of adverse health effects. Ingestion of high doses causes severe irritation to the stomach, leading to vomiting and diarrhea, while inhalation can lead to severe irritation of the lungs. Such high exposures, however, are extremely rare. Long-term low level exposure to cadmium may result in more serious effects. By the inhalation route, long-term exposure to levels of 0.1 mg/m^3 may increase the risk of lung disease such as emphysema. These same levels are also associated with the development of kidney injury. Inhalation of air containing 1 $\mu g/m^3$ of cadmium is associated with a lung cancer risk of about 2 in 1,000. Long-term intake of up to about 0.005 mg/kg/day is believed to have little risk of causing injury to kidney or other tissues. Ingestion of cadmium is not believed to pose a cancer risk.

Chromium

Chromium is a naturally-occurring element used industrially in making steel and other alloys. Chromium compounds are used in refractory brick for the metallurgical industry and in metal plating, manufacture of pigments, and other processes. Exposure to chromium can result from inhalation of air containing chromium-bearing particles and ingestion of water or food containing chromium. Chromium is considered an essential nutrient which helps to maintain normal glucose, cholesterol, and fat metabolism. The minimum daily requirement of chromium for optimal health has not been established, but a daily ingestion of 20-500 μg/day has been estimated to be safe and adequate.

There are two major forms of chromium which differ in their effects. One form, chromium VI, is irritating and short-term high-level exposure can result in adverse effects at the site of contact, such as ulcers of the skin, irritation and perforation of the nasal mucosa, and irritation of the gastrointestinal tract. Minor to severe damage to the mucous membranes of the respiratory tract and to the skin have resulted from occupational exposure to as little as 0.1 mg/m^3 chromium VI compounds. Chromium VI may also cause adverse effects in the kidney and liver and long-term occupational exposure to low levels of chromium VI compounds has been associated with lung cancer in humans.

The second form of chromium, chromium III, does not result in these effects and is the form thought to be an essential nutrient.

Copper

Copper is a naturally-occurring element which is used to make electrical wiring and some water pipes and is a component of alloys such as bronze and brass. Copper is an essential element at low dose levels but may induce toxic effects at high dose levels. Copper may enter the body by breathing air, drinking water, or eating food containing copper, and by skin contact with soil, water, and other copper-containing substances. Long-term overexposure to copper dust can irritate the nose, mouth, and eyes and cause headaches, dizziness, nausea, and diarrhea. Ingestion of higher than normal concentrations of copper can cause vomiting, diarrhea, stomach cramps, and nausea. Liver and kidney damage and possibly death may occur if exposure continues. Concentrations of 3 mg/L in water caused liver damage in infants drinking the water for 9 months. Ingestion of water containing concentrations of 30 mg/L one time by adult humans caused vomiting, diarrhea, and stomach cramps.

Ethylbenzene

Ethylbenzene is an organic chemical which occurs naturally in coal tars and petroleum. It is also found in man-made products such as paints, inks, and insecticides. Gasoline contains approximately 2% ethylbenzene by weight. Ethylbenzene is readily absorbed into the body following inhalation, or eating or drinking contaminated food or water. Ethylbenzene as a liquid can be absorbed by the skin, but vapors are not as readily absorbed. Humans exposed to levels of ethylbenzene as low as 460 ppm in the air for short periods of time have complained of eye and throat irritation.

The MRL of 0.29 ppm of ethylbenzene in air was derived from long-term exposure studies in animal. At concentrations higher than the MRL, effects observed included birth defects in rats and biochemical changes in the brains of rabbits. Exposure of mice to concentrations greater than 1,200 ppm resulted in death.

Lead

Lead is a naturally occurring metal that is used in such processes as the manufacture of storage batteries and production of ammunition, and in miscellaneous metal products (e.g., sheet lead, solder, and pipes) and various chemical compounds, including gasoline additives. Lead can enter the body via ingestion and inhalation. Although it may also enter the body through the skin, dermal absorption of inorganic lead compounds is much less significant than its absorption by either of the other two routes of exposure. Children comprise the segment of the population considered to be at greatest risk of adverse health effects from exposure to lead.

The most serious effects associated with markedly elevated blood levels are severe neurotoxic effects that include irreversible brain damage. For most adults, such damage does not occur until blood lead levels exceed 100 to 120 micrograms per deciliter (μg/dl). At these levels and, for chronically occupationally exposed adults, levels as low as 40 to 50 μg/dl, high blood pressure, severe gastrointestinal symptoms, and effects on several other organ systems are often found. In children, the higher blood lead levels produce encephalopathy leading to marked neurological deficits such as mental retardation and/or death.

Chronic kidney disease is also evident at these levels. Lower levels of lead in the blood can cause an impairment of heme synthesis in bloodforming organs and a variety of subtle neurological effects.

Manganese

Manganese is a naturally-occurring element used in the steel industry, metallurgical processing, and as a component of dry cell batteries. Manganese is an essential element and is a co-factor for a number of enzymatic reactions. A World Health Organization committee concluded that an intake of 2-3 mg/day was adequate for adults. Absorption of manganese from the gastrointestinal tract is controlled by homeostatic mechanisms. Following inhalation exposure, manganese absorption into the bloodstream occurs only if particles are sufficiently small to be able to penetrate deep into the lungs. In humans, manganese dusts and compounds have relatively low oral and dermal toxicity, but may cause a variety of toxic effects if inhaled. Chronically inhaled manganese dust may result in a psychiatric disorder characterized by irritability, difficulty in walking, and speech disturbances. Acute inhalation exposure has been associated with respiratory disease. Ambient air concentrations associated with toxicity in miners ranged from 0.5 to 46 mg/m^3 and exposure ranged from 9 months to 16 years.

Nickel

Nickel is a naturally-occurring metal that is found in small quantities in the earth's crust. Nickel and its compounds can be detected in all parts of the environment. Nickel is used industrially in making various steels and alloys and in electroplating. Exposure to nickel and nickel compounds includes inhalation of dust and particles, ingestion from food and drinking water, and absorption through the skin. Very small amounts of nickel have been shown to be essential to some species of animals and may be essential to humans.

Exposure to high levels of nickel and nickel compounds may cause adverse effects on the lungs and immune system. Nickel compounds can also affect the kidneys, blood, and growth. By inhalation, nickel refinery dust, including nickel subsulfide, causes cancer in the lung, nasal cavity, and voice box in humans. Nickel carbonyl is carcinogenic in animals and therefore may be carcinogenic in humans. It is not known if other nickel compounds are carcinogenic.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs contain only carbon and hydrogen and consist of two or more fused benzene rings in linear, angular or cluster arrangements. PAHs are formed during the incomplete burning of fossil fuel, garbage, or any organic matter and may be carried into the air on dust particles and distributed into water and soil. Exposure may occur by inhalation of dust or particles, drinking water or accidental ingestion of soil or dust particles containing PAHs. Smoking or charcoal-broiling food can cause PAHs to be formed in the food which may be absorbed through the digestive tract.

Some of the PAHs are known carcinogens and potential health effects caused by PAHs are usually discussed in terms of the individual PAH compound's carcinogenic or noncarcinogenic effects. Proliferating tissues, such as the intestinal epithelium, bone marrow, lymphoid organs, and testes, seem to be especially susceptible targets. Concentrations of 150 mg/kg or more administered to laboratory animals have been shown to inhibit body growth. In general, no apparent reproductive, teratogenic, embryotoxic, and fetotoxic effects would be expected at background levels of PAHs. Cancer has been found in animals breathing approximately 1.25 μg Benzo(a)pyrene (one of the potentially carcinogenic PAHs) m^3/day, eating 5 mg/kg B(a)P per day or having 0.05 mg/kg B(a)P applied to their skin throughout their lives. These levels are at least 1,000 times higher than those to which humans are normally exposed. B(a)P was chosen as the surrogate for evaluation of the toxicity of all of the carcinogenic PAHs in this assessment.

Toluene

Toluene is used as a solvent in the production of a variety of products and as a constituent in the formulation of automotive and aviation fuels. Toluene can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It may also enter the body through the skin. Toluene may cause irritation of the eyes, respiratory tract, and skin, fatigue, weakness, confusion, headache, dizziness, and drowsiness. These symptoms have been reported in association with occupational exposure to airborne concentrations of toluene ranging from 50 ppm (189 mg/m^3) to 1,500 ppm (5,660 mg/m^3). These symptoms generally increase in severity with increases in toluene concentration.

Xylenes

Xylenes are natural components of coal tar and petroleum. The majority of xylenes used commercially are man-made. There are three isomers of xylene (ortho-, meta-, and para-xylene), which can occur as a mixture and are referred to herein as xylenes. Xylenes are used in solvent mixtures and cleaning agents, and as an ingredient in airplane fuel and gasoline. Exposure to xylene may occur by breathing xylene fumes, or eating or drinking xylene-contaminated food or water. Xylene is rapidly absorbed following inhalation or ingestion. Short-term exposure of humans to high levels of xylene (100-299 ppm) causes irritation of the skin, eyes, nose and throat, increased reaction time to a visual stimulus, impaired memory, stomach discomfort, and possible changes in the liver and kidneys. Long-term exposure of laboratory animals to xylene in air (12-800 ppm) resulted in changes in the cardiovascular system, changes in liver weights, and hearing loss.

No studies were located regarding the long-term effects of inhalation or ingestion of xylene by humans. Xylene may be fatal if large enough concentrations are inhaled or ingested. Ingestion of 5,000 ppm of xylene in food by laboratory rats resulted in impaired visual function. Decreased body weight and increased numbers of birth defects in unborn rats were observed at higher concentrations.

Zinc

Zinc is an essential element and its absorption from the gastro-intestinal tract is regulated by homeostatic mechanisms. Zinc appears to be toxic only at levels at least an order of magnitude greater than the recommended daily allowance. Toxicity appears to result from an overload of the homeostatic mechanism for absorption and excretion of zinc. Symptoms of overexposure may include severe diarrhea, abdominal cramping, nausea, and vomiting. Inhalation of zinc fumes or dusts has been associated with a condition called "metal fume fever" characterized by flu-like symptoms including throat irritation, body aches, weakness, and fatigue.

APPENDIX C

LITHOLOGIC LOGS

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 1 OF 3
	LOCATION COORD N. 124,858.14	E. 130,780.78
	DRILLING AGENCY OTHER (M-W Drilling) COE	
HOLE NO. FIELD MW-1 / HOLE NO. AP3010 PERMANENT	NAME OF DRILLER Steve Syren	WEATHER -5°F, clear

TYPE OF HOLE	TOTAL DEPTH OF HOLE
TEST PIT ___ AUGER HOLE X CHURN DRILL ___	234 feet

SIZE AND TYPE OF BIT	DATUM FOR ELEVATION SHOWN	TYPE OF EQUIPMENT
Tricone Button 9 7/8 in	X MSL 403.03	Ingersoll-Rand Cyclone Model TH-60

TOTAL # OF SAMPLES	TYPE OF SAMPLES	DEPTH TO GROUNDWATER	DATE HOLE STARTED	DATE HOLE COMPLETED
5	split-spoon	228 feet	12/09/90	12/18/90

ELEVATION TOP OF HOLE	INSPECTOR	CHIEF SOILS SECTION	CHIEF GEOTECHNICAL BRANCH
	E & E	Jerry Raychel	Del Thomas

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
				OL		Organic silt and angular gravel, approx. 1.0 inch; dry; no odor; 0 ppm.
10		10 8 8 9		GW		Gravel, fine to 1.0 inch; some silt and organic material; dry; no odor, 0 ppm.
20				GW		No sample collected.
30		NR		GW		Gravel, fine to 1.0 inch; some silt and organic material; dry; no odor; 0 ppm.
40		NR		GW		Coarse gravel and cobbles; dry; no odor; 0 ppm.
50		NR		GW		Lithology remains unchanged from 40-100 feet; coarse gravel, gray color, subrounded; dry; no odor; 0 ppm. (Skip to 100 foot level)
100		NR		GW		Gravel, gray, fine to 1.0 inch, subangular/sub-

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 2 OF 3
	HOLE NO. FIELD MW-1	HOLE NO. AP3010 PERMANENT

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
						rounded; trace silt; powdered gravel; rock flour; dry; no odor; 0 ppm.
110						Resume vertical scale of 1 inch = 10 feet.
120		10 14 14 15		GW		Gravel, pea to 1 inch, gray; dry; no odor; 0 ppm.
130		17 16 18 23		GP		Gravel, pea sized to 0.5 inch, gray, subrounded to subangular; dry; no odor; 0 ppm. Switch from air rotary to foam.
140		6 11 38		GW		Gravel, fine to 1.5 inch, moist; some fine to coarse sand; gravel is subrounded to subangular; trace silt; dry; no odor; 0 ppm.
150		13 12 14 13		GW		Gravel, rounded to subrounded, fine to 0.75 inch, some sand and silt; wet due to drilling fluid; no odor; 0 ppm.
160		NR		GW		Gravel, as above.
170		9 28		GW		Gravel, fine to 0.5 inch, subrounded to subangular; some silty sand, fine to medium grained; no odor; 0 ppm.
180		NR		GW		Ground as above.

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 3 OF 3
	HOLE NO. FIELD MW-1	HOLE NO. PERMANENT AP3010

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSIFICATION	MAX SIZE	DESCRIPTION AND REMARKS
190		NR		GP		Gravel, fine to 1 inch; minor coarse sand; no odor; 0 ppm.
200		6 7 6 5		GW		Gravel, fine to 0.5 inch, subangular to angular; some silty sand, fine to medium grained; no odor; 0 ppm.
210						No sample collected.
220						No sample collected.
	▽					**GROUNDWATER: 228 feet**
230		13 12 14		GW		Gravel, fine to 0.5 inch, angular; drilling foam and sand mixed throughout gravel; no odor; 0 ppm. **BOTTOM OF HOLE: 234 feet**
240						
250						
260						
270						

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill		SHEET 1 OF 2
	LOCATION COORD	N. 122,685.88	E. 131,266.80
	DRILLING AGENCY	OTHER (M-W Drilling)	COE
..LE NO. HOLE NO. AP3011 FIELD MW-2 PERMANENT	NAME OF DRILLER Steve Syren		WEATHER 0°F to 10°F
TYPE OF HOLE TEST PIT ___ AUGER HOLE ___ CHURN DRILL X		TOTAL DEPTH OF HOLE 138 feet	

SIZE AND TYPE OF BIT	DATUM FOR ELEVATION SHOWN	TYPE OF EQUIPMENT
Tricone Button 9 7/8 in	X MSL 340.41	Ingersoll-Rand Cyclone Model TH-60

TOTAL # OF SAMPLES	TYPE OF SAMPLES	DEPTH TO GROUNDWATER	DATE HOLE STARTED:	DATE HOLE COMPLETED:
14	split-spoon	126 feet	11/13/90	11/19/90

ELEVATION TOP OF HOLE	INSPECTOR	CHIEF SOILS SECTION	CHIEF GEOTECHNICAL BRANCH
	E & E	Jerry Raychel	Del Thomas

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSIFICATION	MAX SIZE	DESCRIPTION AND REMARKS
				GP		Gravel, blue gray, poorly sorted, poorly consolidated, subrounded, pea sized to cobbles; approximately 10% light brown silt.
				GM		Silty gravel, light brown, well sorted gravel as above.
10		9 9 10 10		GP		Gravel, blue gray, poorly sorted, rounded, pea sized to 1.0 inch; some light brown silt; dry; no odor; 0 ppm.
20		4 4 5 5				Gravel, poorly sorted, pea to 1 inch, blue gray color; minor sand; dry; no odor; 0 ppm.
30		12 12 13 13				Silty sand; appears to be pulverized drilling flour and not representative; dry; no odor; 0 ppm.
40		11 11 11 12		GM		Brown silty sandy gravel, poorly sorted, subangular, mostly pea sized; dry; no odor; 0 ppm.
50		6 6 6 6		GW		Gravel 70%, sand 30%; medium sorting; brown; dry; no odor; 0 ppm.
60		NR		GW		Gravel, subrounded, dark gray, fine to 1.0 inch

NR - not recorded

NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 2 OF 2
	HOLE NO. FIELD MW-2	HOLE NO. PERMANENT AP3011

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSIFICATION	MAX SIZE	DESCRIPTION AND REMARKS
						diameter, subrounded; dry; no odor; 0 ppm.
70		12 12 13 13		GW		Gravel, subrounded, well graded, fine to 1.0 inch diameter; much pulverized gravel and rock flour from drilling and casing advancement; dry; no odor; 0 ppm.
80		6 6 6 6		GW		Gravel, as above; dry; no odor; 0 ppm.
90		7 8 8 6		GW		Gravel, as above; dry; no odor; 0 ppm.
100		8 9 9 9		GW		Gravel, medium sorted to 1.0 inch diameter; approximately 20% sand, medium grained, medium sorted, angular, micaceous; dry; no odor; 0 ppm.
110		5 6 6 6		GW		Gravel as above but with 10% silt, dark brown, argillaceous unconsolidated; dry; no odor; 0 ppm.
120		8 9 9		GW		Gravel as above; dry; no odor; 0 ppm.
	∇	9				**GROUNDWATER: 126 feet**
130		6 6 6 6		GW		Gravel as above; wet; no odor; 0 ppm.
140		8 8 8 8		GM		Silty sandy gravel, pea sized to 3/4 inch diameter, subrounded; sandy silt is brown, medium sorted, subrounded; wet; no odor; 0 ppm. **BOTTOM OF HOLE: 138 feet**

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 1 OF 3
	LOCATION COORD N. 122,734.83	E. 130,150.54
	DRILLING AGENCY OTHER (M-W Drilling)	COE
FIELD ᴊLE NO. MW-3 / HOLE NO. AP3012 PERMANENT	NAME OF DRILLER Steve Syren	WEATHER Mid-20°F, cloudy

TYPE OF HOLE	TOTAL DEPTH OF HOLE
TEST PIT ___ AUGER HOLE ___ CHURN DRILL ___	191 feet

SIZE AND TYPE OF BIT	DATUM FOR ELEVATION SHOWN	TYPE OF EQUIPMENT
Tricone Button 9 7/8 in	X MSL 333.90	Ingersoll-Rand Cyclone Model TH-60

TOTAL # OF SAMPLES	TYPE OF SAMPLES	DEPTH TO GROUNDWATER	DATE HOLE STARTED	DATE HOLE COMPLETED
19	split-spoon	177 feet	10/22/90	11/02/90

ELEVATION TOP OF HOLE	INSPECTOR	CHIEF SOILS SECTION	CHIEF GEOTECHNICAL BRANCH
	E & E	Jerry Raychel	Del Thomas

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSIFICATION	MAX SIZE	DESCRIPTION AND REMARKS
				GW		Gravel, gray, fine to 2 inch diameter, rounded to angular; 20% silty sand, gray to light brown, fine to medium grained; dry; no odor 0 ppm.
10		4 4 4		GW		Sample 8.0-9.5 feet as above; dry; no odor; 0 ppm.
20		20 20		GW		Gravel as above; dry; no odor; 0 ppm.
30		25 25		GP		Gravel, pea sized to 1 inch diameter, rounded to angular; 20% silt, dry, brown.
				GM		Silty gravel, pea sized to 1 inch diameter, rounded to angular; silt brown; 10% clay.
40		4 5 5		GW		Gravel, well graded, pea sized to 1.0 inch, rounded to angular, loose, moist; no odor; 0 ppm.
50		23 34 20		GW		Gravel as above; dry; no odor; 0 ppm.
60		6 6		GM		Silty gravel, well sorted, pea sized to 0.5 inch diameter; gray green silt, moist; no odor;

NR - not recorded

NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG					PROJECT: Fort Richardson Landfill	SHEET 2 OF 3
					HOLE NO. FIELD MW-3	HOLE NO. AP3012 PERMANENT
DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
		6				0 ppm.
70		2 2 3		GM		At 73.0 feet, cuttings blown from hole are sand, no gravel, some gray green silt.
80		14 21 26		GW		Gravel, 0.5-1.0 inch diameter, rounded to subanglar, light gray, dry; no odor; 0 ppm.
90		10 10 21		GW		Gravel, fine to 1.0 inch diameter, rounded to subangular, dry; no odor; 0 ppm.
100		7 7 6		GW		Gravel, as above; dry; no odor; 0 ppm.
110		NR		GW		Gravel, as above; approximately 20% silt; dry; no odor; 0 ppm.
120	▽	43 13		GW		43 blows on granite boulder that was cored through; remaining sample as above. Gravel, well graded, gray green, fine to .75 inch diameter; approximately 5% silt, dark green, very fine; dry; no odor; 0 ppm. Shallow aquifer at 124 ft. Gravel, as above; saturated; no odor; 0 ppm.
130		17 31 31				
140		24 20 22		SM		Silty sand, gray to dark greenish brown; dry; no odor; 0 ppm.

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 3 OF 3
	HOLE NO. FIELD MW-3	HOLE NO. AP3012 PERMANENT

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSIFICATION	MAX SIZE	DESCRIPTION AND REMARKS
150		8 14		SM		Gravelly silt, gray, dark green; gravel is 1 in., subrounded, medium sorted; dry; no odor; 0 ppm.
		14 21 21		SM		As above.
160		24 32 32		SM		Silt and gravel as above; dry; no odor; 0 ppm.
170		34 34 24		SM		Silt, dark green, poorly consolidated; saturated; no odor; 0 ppm.
	∇	75 25		SM		**GROUNDWATER: 177.0 feet** Silt as above.
180						
190		30 46		CL		Clay; approximately 10% silt, dark gray, tight, dry. **BOTTOM OF HOLE: 191.0 feet**
200						
210						
220						
230						

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 1 OF 3
	LOCATION COORD N. 122,334.54	E. 127,027.00
	DRILLING AGENCY OTHER (M-W Drilling) COE	
LE NO. HOLE NO. AP3013 FIELD MW-4 PERMANENT	NAME OF DRILLER Larry Swihort	WEATHER 10°F, clear

TYPE OF HOLE	TOTAL DEPTH OF HOLE
TEST PIT ___ AUGER HOLE ___ CHURN DRILL X	150 feet

SIZE AND TYPE OF BIT	DATUM FOR ELEVATION SHOWN	TYPE OF EQUIPMENT
Tricone Button 9 7/8 in	X MSL 311.63	Ingersoll-Rand Cyclone Model TH-60

TOTAL # OF SAMPLES	TYPE OF SAMPLES	DEPTH TO GROUNDWATER	DATE HOLE STARTED	DATE HOLE COMPLETED
9	SS	140 feet	11/26/90	12/07/90

ELEVATION TOP OF HOLE	INSPECTOR	CHIEF SOILS SECTION	CHIEF GEOTECHNICAL BRANCH
	E & E	Jerry Raychel	Del Thomas

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
				GW		Gravel, blue gray, well graded, fine to cobbles.
10		18 18		GW		Gravel as above; dry; no odor; 0 ppm.
20		17 10		GW		Gravel, well graded, up to one inch; dry; no odor; 0 ppm.
30		16 13		GW		Gravel, fine to 1.0 inch diameter, subrounded to subangular; trace sand, medium to coarse, brown; dry; no odor; 0 ppm.
40		18 20		GW		As above; dry; no odor; 0 ppm.
50						No sample collected.
60		NR		GW		Gravel, fine to 1 inch diameter, trace fine sand,

NR - not recorded

NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 2 OF 3
	HOLE NO. FIELD MW-4	HOLE NO. AP3013 PERMANENT

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
						dry; no odor; 0 ppm.
70		17 18		GP		Gravel, clean, fine to 1.0 inch diameter, subrounded to subangular; dry; no odor; 0 ppm.
80						No sample collected.
90						No sample collected.
100						No sample collected.
110		25 28		GW		Gravel, fine to pea sized, subrounded to angular; trace flour from drill bit; dry; no odor; 0 ppm.
120		NR		GW		Gravel as above; dry; no odor; 0 ppm.
130		20 22		GP		128 feet begin using foam. Gravel, pea sized to 2.0 inch diameter, subrounded to angular; no fines; dry; no odor; 0 ppm.
140	∇	12 18		GP		**GROUNDWATER: 140.0 feet** Gravel, fine to pea sized; no fines; no odor; 0 ppm.

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Fort Richardson Landfill | SHEET 3 OF 3

HOLE NO. FIELD MW-4 | HOLE NO. PERMANENT AP3013

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
150		20 18		SW		Sand, fine to very coarse; trace silt and gravel; pea sized to 1.0 inch, rounded; no odor; 0 ppm. **BOTTOM OF HOLE: 150.0 feet**
160						
170						
180						
190						
200						
210						
220						
230						

NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill LOCATION COORD N. 123,102.19 DRILLING AGENCY OTHER (M-W Drilling) COE	SHEET 1 OF 1 E. 125,799.56
HOLE NO. FIELD MW-5 HOLE NO. AP3014 PERMANENT	NAME OF DRILLER Larry Swihort	WEATHER 10-15°F, partly cloudy

TYPE OF HOLE	TOTAL DEPTH OF HOLE
TEST PIT ___ AUGER HOLE ___ CHURN DRILL X	30 feet

SIZE AND TYPE OF BIT	DATUM FOR ELEVATION SHOWN	TYPE OF EQUIPMENT
Tricone Button 9 7/8 in	X MSL 296.53	Ingersoll-Rand Cyclone Model TH-60

TOTAL # OF SAMPLES	TYPE OF SAMPLES	DEPTH TO GROUNDWATER	DATE HOLE STARTED	DATE HOLE COMPLETED
1	SS	16 feet	12/19/90	12/21/90

ELEVATION TOP OF HOLE	INSPECTOR	CHIEF SOILS SECTION	CHIEF GEOTECHNICAL BRANCH
	E & E	Jerry Raychel	Del Thomas

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSIFICATION	MAX SIZE	DESCRIPTION AND REMARKS
10		NR		GP		Gravel, pea sized to 2 inch diameter, larger fraction subrounded, smaller fraction subangular, dark brownish gray, moderate sorting; dry; no odor; 0 ppm.
	▽					**GROUNDWATER: 16.0 feet**
20		14 14 10 15		GP		Gravel as above; saturated; no odor; 0 ppm.
30		NR		GP		**BOTTOM OF HOLE: 30.0 feet** Sandy gravel; sand is subangular, poory sorted, fine to coarse; gravel to 1 inch diameter, subangular to angular; saturated; no odor; 0 ppm.
40						
50						* Each blow count for 12 inces of penetration NR - not recorded OVA (Organic Vapor Analyzer) used to field screen samples. OVA reading (in ppm) at end of description,
60						

NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY NORTH PACIFIC DIVISION U.S. ARMY ENGINEER DISTRICT, ALASKA EXPLORATION LOG	PROJECT: Fort Richardson Landfill	SHEET 1 OF 2
HOLE NO. FIELD MW-6	HOLE NO. AP3015 PERMANENT	LOCATION COORD N. 123,084.25 E. 125,773.36
	DRILLING AGENCY OTHER (M-W Drilling) COE	
	NAME OF DRILLER Larry Swihort	WEATHER 10°F, partly cloudy

TYPE OF HOLE	TOTAL DEPTH OF HOLE
TEST PIT ___ AUGER HOLE ___ CHURN DRILL X	126 feet

SIZE AND TYPE OF BIT	DATUM FOR ELEVATION SHOWN	TYPE OF EQUIPMENT
	X MSL 294.15	Ingersoll-Rand Cyclone Model TH-60

TOTAL # OF SAMPLES	TYPE OF SAMPLES	DEPTH TO GROUNDWATER	DATE HOLE STARTED	DATE HOLE COMPLETED
7	SS	116 feet	01/04/91	01/16/91

ELEVATION TOP OF HOLE	INSPECTOR	CHIEF SOILS SECTION	CHIEF GEOTECHNICAL BRANCH
	E & E	Jerry Raychel	Del Thomas

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
						AP3015 location approximately 30 feet from AP3014, which is 30.0 feet deep. Therefore, no sampling until 40.0 feet below ground surface.
10						10 inch casing advanced through upper aquifer. Sample collected at 40.0 feet bgs. At 60.0 feet, 8 inch casing inserted in 10 inch casing and annulus between casings filled with volclay grout. Sampling then done as 8 inch casing is advanced.
20	▽					
30						
40		20 20 38		SM		Silty sand, dark brown, fine; dry; no odor; 0 ppm.
50						No sample collected.
60		20		GW		Gravel, fine to 1.0 inch diameter, subrounded to

NR - not recorded

NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION
U.S. ARMY ENGINEER DISTRICT, ALASKA
EXPLORATION LOG

PROJECT: Fort Richardson Landfill | SHEET 2 OF 2

HOLE NO. FIELD MW-6 | HOLE NO. PERMANENT AP3015

DEPTH IN FEET	GROUND WATER	BLOW COUNTS	SOIL LEGEND	CLASSI-FICATION	MAX SIZE	DESCRIPTION AND REMARKS
		37				subangular; approximately 20% fine to coarse sand, brown; dry; no odor; 0 ppm.
70						Cuttings are sandy gravel. No sample collected.
80		50 50		GP		Gravel, 0.5 inch diameter, rounded; approximately 20% sand and silt; approximately 6 inch thick coal seam encountered at 78.0 feet; dry; no odor; 0 ppm.
90		23 18		GW		Gravel with some silt and sand; well graded fine to .75 inch diameter gravel; well graded, fine to coarse sand, grayish brown; dry; no odor; 0 ppm.
100		48 52		SP		Fine to medium sand; trace of pea sized gravel; dry; no odor; 0 ppm.
110		56 33		SW		Sand fine to very coarse; trace silt; some subrounded to subangular gravel, fine to 1.0 inch diameter; dry; no odor; 0 ppm.
	∇					**GROUNDWATER: 116.0 feet**
120		23		SW		Sand, saturated, medium to very coarse, with some fine to pea sized gravel, subangular to rounded; sample is dark greenish brown; no odor; 0 ppm.
130		10 25				No recovery. **BOTTOM OF HOLE: 126.0 feet**
140						

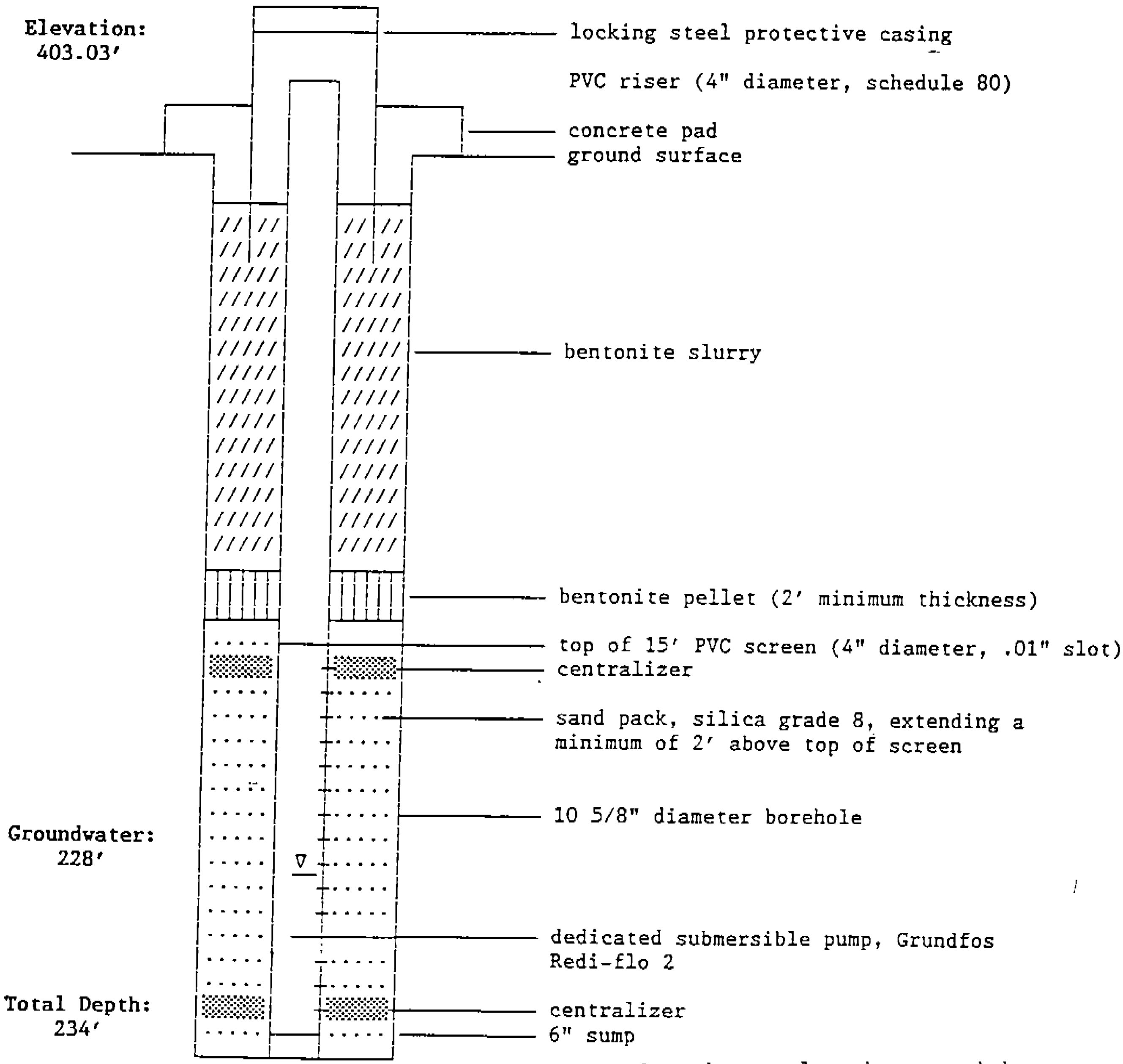
NR - not recorded
OVA (Organic Vapor Analyzer) used to field screen samples.
OVA reading (in ppm) at end of description.
NOTE: Description of lithology based on split spoon sample conditions. Large gravel, cobbles and boulders are present based on field observations during drilling.

APPENDIX D

MONITORING WELL CONSTRUCTION DIAGRAMS

MONITORING WELL DIAGRAMS
Fort Richardson Landfill

AP3010

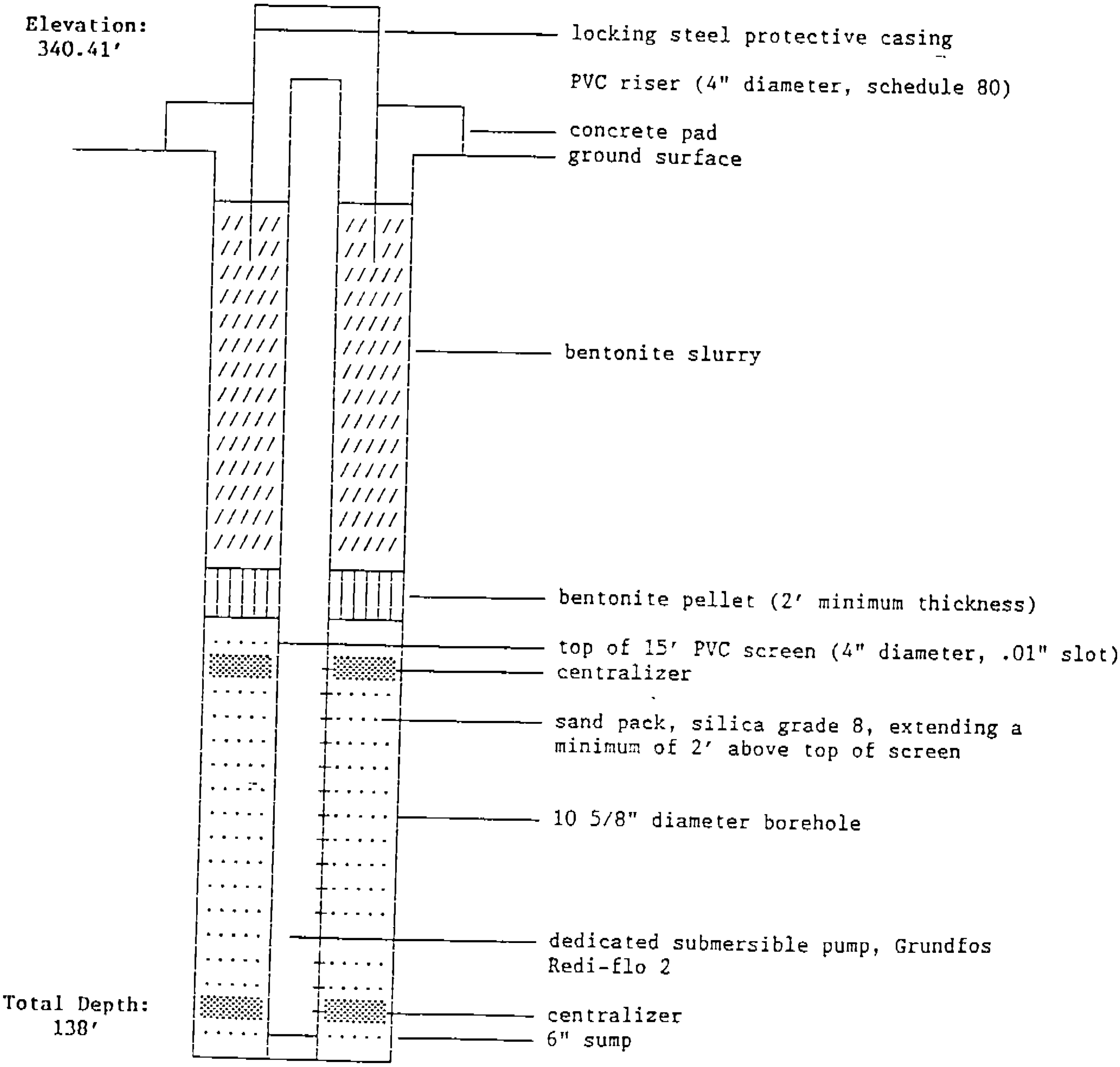


Note: Groundwater elevation recorded on June 5, 1991.

(not to scale)

MONITORING WELL DIAGRAMS
Fort Richardson Landfill

AP3011

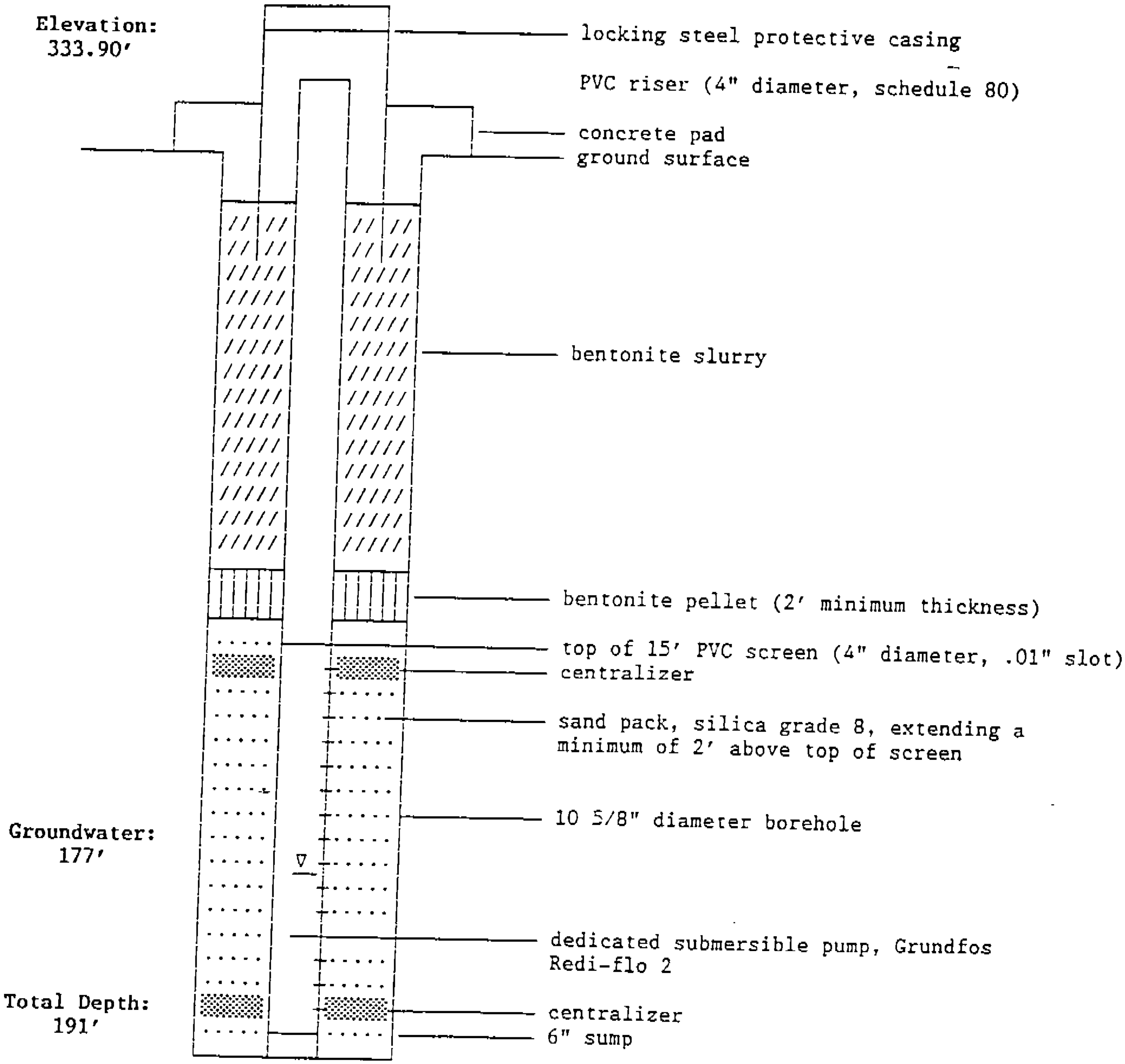


Note: Groundwater encountered at 126′ during drilling. Well is dry.

(not to scale)

MONITORING WELL DIAGRAMS
Fort Richardson Landfill

AP3012

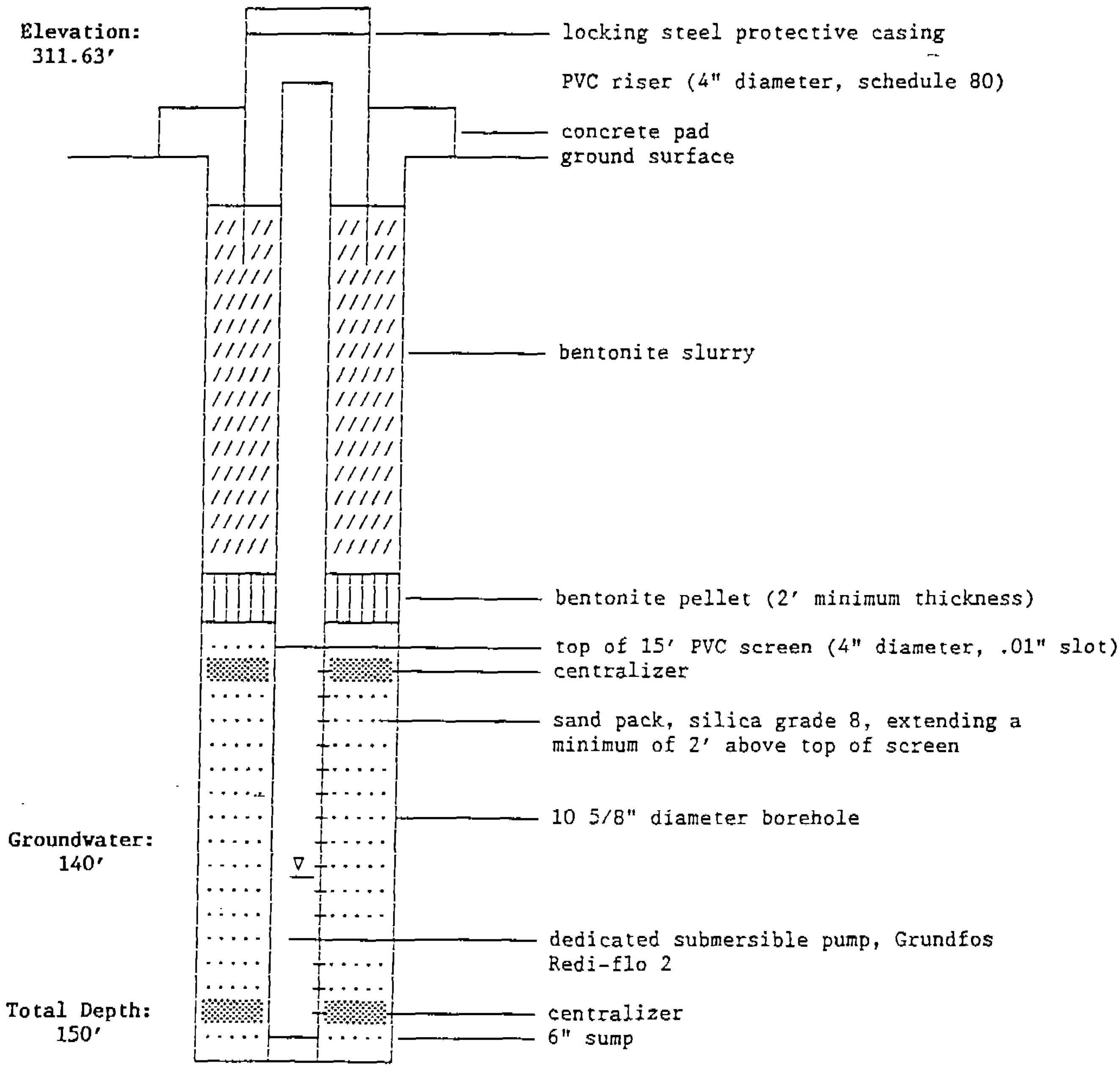


Note: Groundwater encountered at 177′ during drilling. Well is dry.

(not to scale)

MONITORING WELL DIAGRAMS
Fort Richardson Landfill

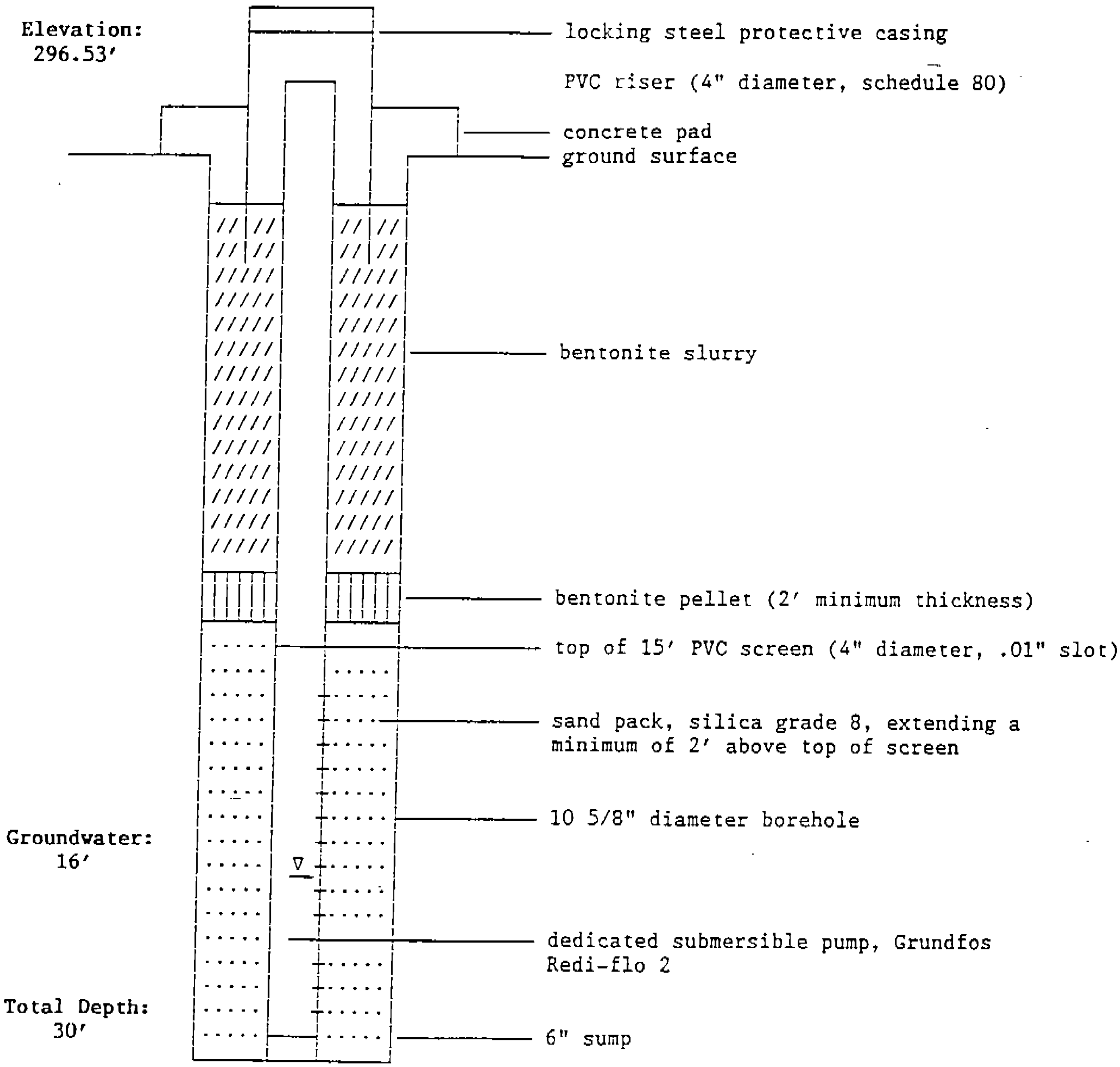
AP3013



(not to scale)

MONITORING WELL DIAGRAMS
Fort Richardson Landfill

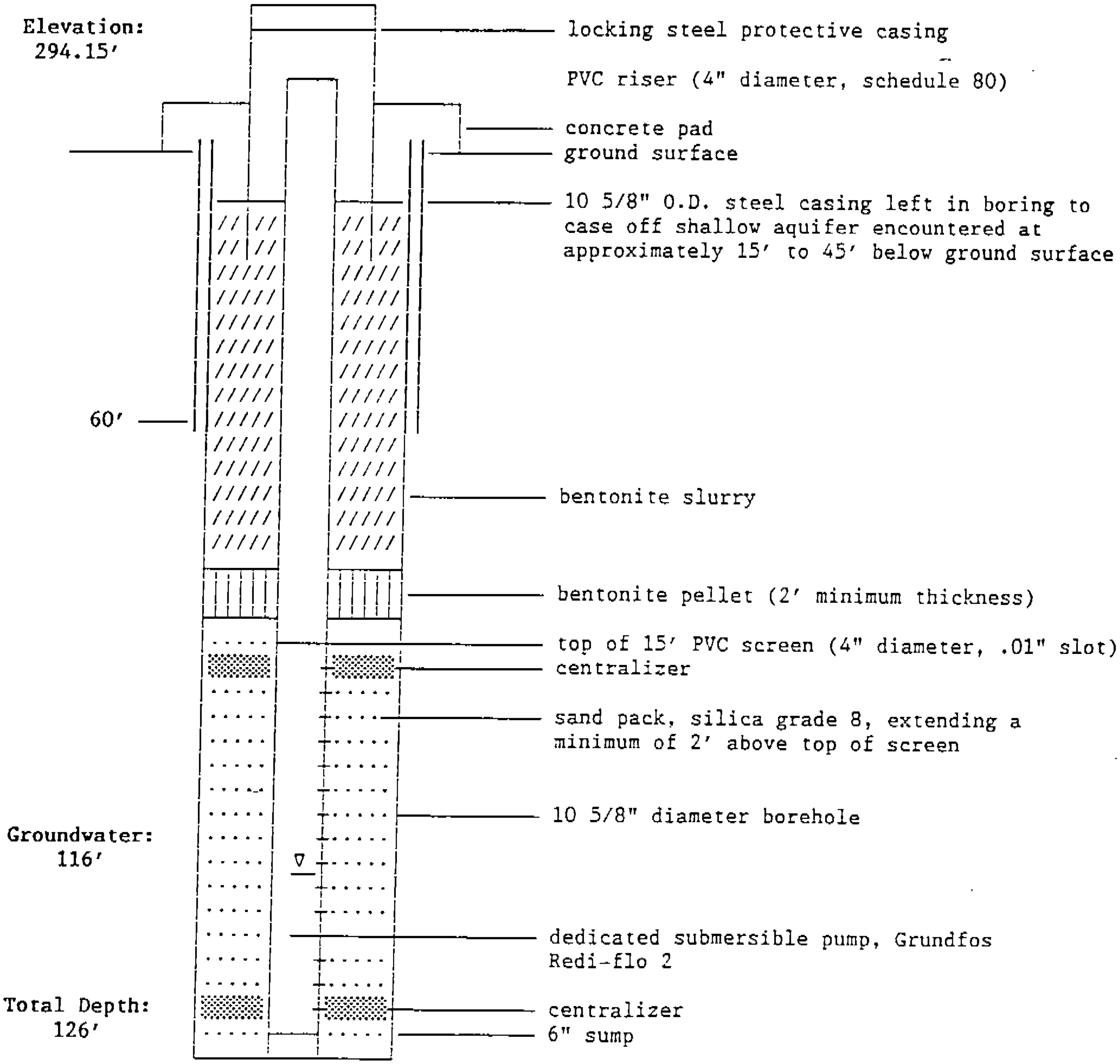
AP3014



(not to scale)

MONITORING WELL DIAGRAMS
Fort Richardson Landfill

AP3015



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APPENDIX E
CHEMICAL QUALITY ASSURANCE REPORTS
AND CHAIN-OF-CUSTODIES

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION MATERIALS LABORATORY
CORPS OF ENGINEERS
1491 N.W. GRAHAM AVENUE
TROUTDALE, OREGON 97060-9503

March 25, 1991

Lynn Fischer
Ecology and Environment, Inc.
1057 W. Fireweed, Suite 102
Anchorage, Alaska 99503

Dear Madam:

Enclosed are results of analyses of environmental samples collected from the Ft. Richardson Landfill project sampled by Ecology and Environment, Inc., on October 23, 1990 through January 17, 1991. Included are:

a. Chemical Quality Assurance Report.

b. Report numbers 837, 844, 854 and 876 from ARDL, Inc.

c. Report number K910363 from Columbia Analytical Services, Inc.

d. Report dated February 27, 1991 from AmTest, Inc.

e. Report dated February 19, 1991 from Corps of Engineers, North Pacific Division Materials Laboratory.

f. Chain of Custody and Cooler Receipt forms.

The enclosed data completes all analysis requested to date for this site.

Please contact Dr. Ajmal Ilias or Ms. Pamela Swann at (503)665-4166 if you have any questions.

Sincerely,

James A. Paxton, Director
CENPD Materials Laboratory

Enclosures

Copy Furnished:
North Pacific Division, Geotechnical/HTRW Division

CENPD-PE-GT-L (90-HM-241) 25 Mar 91

CHEMICAL QUALITY ASSURANCE REPORT

FT. RICHARDSON LANDFILL

1. SUMMARY:

a. The project laboratory's data are acceptable, with the following qualifications:

1) The acetone, methylene chloride and phthalates found at or below detection limits are due to laboratory contamination and should be excluded from the site evaluation.

2) Chlorinated herbicide data of ARDL report 854 are questionable due to unacceptable surrogate, matrix spike (MS) and matrix spike duplicate (MSD) recoveries. Since data agree with the QA data, that of samples 9046FRL006SL, -007SL, -008SL and -009SL are still usable for site evaluation.

3) All ARDL silver recoveries were outside QC limits, while the arsenic recovery was zero in report 854. Arsenic data of report 854 and all silver data should be considered an estimate. The data were accepted based on acceptable recoveries found in the laboratory control samples.

b. All comparable project and QA data agree and are acceptable except for acetone found in the QA sample of Table II-1, which could be due to some sort of field or laboratory contamination.

2. BACKGROUND: The samples were collected October 23, 26, 30, November 1, 14, 17, 19, 1990 and January 15 through 17, 1991 and were received by the analytical laboratories on October 29, November 6, 26, 1990 and January 21 through 23, 1991.

3. OBJECTIVES:

a. Eleven soil samples and one water sample were collected from various locations around the site to determine the extent of chemical contamination which may be present due to Department of Defense activities.

b. One quality assurance (QA) sample and two trip blanks were submitted to evaluate the project laboratory's data.

4. PROJECT ORGANIZATION:

a. The samples were collected by Ecology and Environment, Inc., Anchorage, Alaska.

b. The project samples were analyzed by ARDL, Inc., Mt. Vernon, Illinois.

c. The QA samples were analyzed by AmTest, Inc., Redmond, Washington, Columbia Analytical Services, Inc., Kelso, Washington and Corps of Engineers North Pacific Division Materials Laboratory, Troutdale, Oregon.

CENPD-PE-GT-L (90-HM-241)

5. ANALYTICAL REFERENCES:

	Number	Title	Date
a.	SW-846, Third Edition	Test Methods for Evaluating Solid Waste	11/86
b.	EPA-600/4-79-020	Methods for Chemical Analysis of Water and Wastes	3/83

6. PROJECT LABORATORY'S DATA:

a. Surrogates: One surrogate each, identical to analytes of interest, were used in the analysis of organochlorine pesticides/PCB's and chlorinated herbicides, three in volatiles (VOC) and six in semi-volatile (BNA) organics. Surrogate recoveries in VOC, BNA, and pesticide/PCB's were within QC limits and acceptable except one surrogate in two BNA and one in one pesticide/PCB report, which were marginally above QC limits but are acceptable. Surrogate recoveries of chlorinated herbicides in ARDL reports 837 and 876 were within advisory limits and acceptable. Surrogates of this parameter in report 854 were low; analytes may not have been detected if present in small quantities. No surrogate recoveries were submitted with organophosphorous pesticides.

b. MS and MSD: MS and MSD of VOC, BNA and chlorinated pesticides/PCB's were within QC limits except for two out of twelve for pesticide/PCB analyses in report 854 and one in report 876, which were above QC limits. Data were not affected as no analytes of interest were detected. Four out of sixteen and eight out of sixteen MS and MSD of chlorinated herbicides were below advisory limits in reports 837 and 876, respectively. Data of these reports should be considered estimates. MS and MSD of this parameter in report 854 ranged from zero to 38-percent, which is not acceptable. No MS or MSD were submitted with organophosphorous pesticides. The MS recoveries of all metals were within QC limits except silver in all reports, selenium in 844, arsenic, chromium, copper and lead in 854 and copper in 876. Arsenic data of report 854 and all silver data are questionable. The remaining data with MS recoveries outside QC limits were accepted based on acceptable laboratory control and other MS recoveries.

c. Laboratory Duplicates: Relative percent differences (RPD) of all methods were within QC limits except some metals. RPD of calcium and manganese in report 837 and calcium, manganese and zinc in 854 were above QC limits. No laboratory duplicate analyses were submitted for organophosphorous pesticides.

d. Laboratory Blanks: Acetone and methylene chloride were reported below detection limits in reports 837 and 844 and methylene chloride in 876, bis(2-Ethylhexyl)phthalate in two BNA blanks and di-n-butylphthalate in the blank of report 844. Laboratory blanks of the other parameters were free from targeted analytes and are acceptable.

CENPD-PE-GT-L (90-HM-241)

e. Detection Limits and Holding Times: Detection limits and holding times met method requirements and are acceptable.

f. Trip Blanks: Trip blanks are shown in Table I. Methylene chloride was found in trip blanks due to laboratory contamination. No other targeted VOC's were detected, indicating no cross-contamination was encountered during shipment or storage.

g. Blind Duplicates: None submitted.

h. Overall Evaluation of the Project Data: Organophosphorous pesticide data was not completely evaluated due to lack of internal QC. The chlorinated herbicide data of report 854 was questionable due to low surrogate recoveries. Silver data in all reports and arsenic in one report is questionable due to unacceptable MS recoveries. Methylene chloride and acetone detected in VOC samples and phthalates in BNA samples are due to laboratory contamination.

7. EVALUATION OF THE QA LABORATORIES' DATA: Methylene chloride and chloroform were detected in the VOC laboratory blanks. All surrogate recoveries were within QC limits and are acceptable. MS and MSD of all methods were within QC limits except six out of six MS recoveries of organophosphorous pesticides, which were above upper QC limits. Data were accepted based on acceptable surrogate and MSD recoveries. MS recoveries of all metals were within QC limits except for lead, which was 60-percent. Detection limits and holding times met method requirements and are acceptable. Overall, all QA data are acceptable.

8. QA/QC COMPARISONS: All comparisons are shown in Tables II-1 through II-6. All data agree except acetone in Table II-1, which could be due either to the QA laboratory's lab contamination or was encountered during sampling, shipment or storage.

9. LESSONS LEARNED/PROBLEMS ENCOUNTERED:

a. Only one set of QA/QC samples were collected. QA/QC samples should be collected at a rate of ten-percent or at least one, whichever is greater, for each matrix type.

b. No blind duplicates were collected.

c. Insufficient volumes of soil and water samples were collected for the multiple analyses parameters requested.

d. Samples were sent to CENPD's contract laboratory without advance notification. Recommend that project manager should request CENPD notify analytical laboratories prior to submitting samples.

CENPD-PE-GT-P (90-MM-241)

COMPARISON OF PROJECT AND QA RESULTS

TRIP BLANKS

TABLE I

Project: FT. RICHARDSON LANDFILL Matrix: water Sample Prefix: 9103FRL
Project Laboratory: ARDL, Inc. QA Laboratory: AmTest, Inc.

Method: Volatile Organics (EPA 8240) Units: ug/Kg (ppb)

Analytes Detected	Project Lab -012WA	Detection Limits	QA Lab -015WA	Detection Limits
Methylene chloride	32B	5	33B	5
Tentatively Identified Compounds				
	ND		ND	

ND = None detected
B = Found in laboratory blank as well as sample

SUMMARY: The methylene chloride found in both trip blanks is probably due to laboratory contamination.

CENPD-PE-GT-L (90-HM-241)

COMPARISON OF PROJECT AND QA RESULTS

TABLE II

Project: FT. RICHARDSON LANDFILL Matrix: soil
Project Laboratory: ARDL, Inc. Sample Prefix: 9103FRL

1. Method: Volatile Organics (EPA 8240) Units: ug/Kg (ppb)
QA Laboratory: AmTest, Inc.

Analytes Detected	Project Lab -013SL	Detection Limits	QA Lab -014SL	Detection Limits
Methylene chloride	9B	5	35B	5
Toluene	7	5	13	5
Acetone	ND	11	180	10
Xylenes	ND	5	17	5

Tentatively Identified Compounds

	ND		ND	
Percent Solid	94.0		85.7	

ND = None detected
B = Found in laboratory blank as well as sample

SUMMARY: The project and QA data agree within a factor of four for 34 out of 35 analytes. The acetone disagreement could be due either to laboratory contamination or was encountered during shipping or storage. The methylene chloride reported by both laboratories is probably due to laboratory contamination.

2. Method: Semi-Volatile Organics (EPA 8270) Units: ug/Kg
QA Laboratory: AmTest, Inc.

Analytes Detected	Project Lab -013SL	Detection Limits	QA Lab -014SL	Detection Limits
	ND	350-1700	ND	330-1600

Tentatively Identified Compounds

4-Methyl-3-penten-2-one	130	ND
1,1,2,2-Tetrachloroethane	ND	590
Cyclododecane	ND	140
Unknowns	11, from 120-22000	7, from 140-350

SUMMARY: The project and QA data agree for all 65 targeted analytes and are acceptable.

CENPD-PE-GT-L (90-HM-241)
Table II

3. Method: Pesticides/PCB's (EPA 8080) Units: ug/Kg
QA Laboratory: AmTest, Inc.

Analytes Detected	Project Lab -013SL	Detection Limits	QA Lab -014SL	Detection Limits
beta-BHC	ND	9.6	4.0	8.0

SUMMARY: Data agree and are acceptable. Comparisons below detection limits are not significant.

4. Method: Organophosphorous Pesticides (EPA 8140) Units: ug/Kg
QA Laboratory: Columbia Analytical Services, Inc.

Analytes Detected	Project Lab -013SL	Detection Limits	QA Lab -014SL	Detection Limits
	ND	10	ND	50-200

SUMMARY: The project and QA data agree and are acceptable.

5. Method: Chlorinated Herbicides (EPA 8150) Units: ug/Kg
QA Laboratory: Columbia Analytical Services, Inc.

Analytes Detected	Project Lab -013SL	Detection Limits	QA Lab -014SL	Detection Limits
Dichloroprop	16J	---	ND	100

--- = Not reported
J = Estimated value, found at less than instrument detection limit

SUMMARY: The project and QA data agree. The dichloroprop was added to the sample as a surrogate and should not be considered as a targeted herbicide.

CENPD-PE-GT-L (90-HM-241)
Table II

6. Method: Metals, Total Units: mg/Kg (ppm)
QA Laboratory: CENPD-PE-GT-L

Analytes Detected	Project Lab -013SL	Detection Limits	QA Lab -014SL	Detection Limits
Arsenic	3.5	---	8.5	1
Barium	35	---	130	2
Cadmium	ND	0.051	ND	0.5
Calcium	11000	---	14000	50
Chromium	28	---	34	0.5
Copper	15	---	28	1
Iron	26000	---	26000	3
Lead	7.7	---	3.7	0.3
Magnesium	9400	---	8700	50
Manganese	510	---	550	1
Potassium	320	---	680	50
Selenium	ND	0.45	ND	0.3
Silver	ND	1.0	ND	1
Sodium	110	---	200	50
Zinc	40	---	52	1

SUMMARY: The project and QA data agree within a factor of four to each other or their detection limits and are acceptable.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION MATERIALS LABORATORY
CORPS OF ENGINEERS
1491 N.W. GRAHAM AVENUE
TROUTDALE, OREGON 97060-9503

August 13, 1991

Lynn Fischer
Ecology and Environment, Inc.
1057 W. Fireweed, Suite 102
Anchorage, Alaska 99503

Dear Ms. Fischer:

Enclosed are copies of the original Quality Assurance data, along with the Chemical Quality Assurance Report, for the Ft. Richardson Groundwater Monitoring and Landfill projects. Note that no QA samples were submitted for the Groundwater Monitoring project.

The original project data were submitted on July 26, 1991.

This completes all work requested for these projects.

Please contact Dr. Ajmal Ilias or Ms. Pamela Swann at (503) 665-4166 if you have any questions.

Sincerely,

Timothy J. Seeman

Timothy J. Seeman, Director
CENPD Materials Laboratory

Enclosure

CENPD-PE-GT-L (90-HM-241a)

CHEMICAL QUALITY ASSURANCE REPORT

FT. RICHARDSON LANDFILL AND GROUNDWATER MONITORING

1. SUMMARY:

a. Project data of the Landfill project were evaluated based on the project laboratories' internal QC data, except for volatile and semi-volatile organics and pesticides/PCB's, where QA data were available.

b. All Groundwater Monitoring data were evaluated based on the project laboratories' internal QC data.

c. Blind duplicates for both the projects were missing, and no QA samples for any parameters of interest were submitted with the Groundwater Monitoring project.

d. All project data of both the projects are acceptable, except for the methylene chloride and chloromethane data due to their presence in the trip blanks.

e. Project and QA data of the Landfill project, in Tables II-1 through II-3, agree and are acceptable.

2. BACKGROUND: The samples were collected on April 30, May 6-9, 15, 16 and 21, 1991 and were received by the analytical laboratories on May 2, 8-10, 13-18, 20 and 24, 1991.

3. OBJECTIVES:

a. Twenty-one water samples were collected to determine the extent of chemical contamination on the site.

b. One quality assurance (QA) sample and six trip blanks were submitted to evaluate the project laboratories' data.

4. PROJECT ORGANIZATION:

a. The samples were collected by Ecology and Environment, Inc., Anchorage, Alaska.

b. The project samples were analyzed by North Pacific Division Laboratory, Troutdale, Oregon and Columbia Analytical Services, Inc. (CAS), Kelso, Washington.

c. The QA sample was analyzed by ARDL, Inc., Mt. Vernon, Illinois.

CENPD-PE-GT-L (90-HM-241a)

5. ANALYTICAL REFERENCES:

	Number	Title	Date
a.	SW-846, Third Edition	Test Methods for Evaluating Solid Waste	11/86
b.	EPA 600/4-79-020	Methods for Chemical Analysis of Water and Wastes	3/83
c.	CENPD-PE-GT-L Proposed Modified Method 8015	Fuel Quantitation and Identification	1989
	1) Method D-3328-78	Annual Book of ASTM Standards, Part 31	1980
	2) Method D-2600	Annual Book of ASTM Standards, Part 24	1980

6. EVALUATION OF THE PROJECT LABORATORIES' DATA:

I. Evaluation of the Ft. Richardson Landfill Data:

a. Surrogate Recoveries: One, one, one, three and seven surrogates identical to analytes of Methods 8080, 8140, Modified 8015, 8240 and 8270, were used, respectively. All surrogates were within QC limits and are acceptable except for one out of six BNA surrogates for sample 9118FRL02WA was below QC limits, but is acceptable.

b. Matrix Spike (MS) and Matrix Spike Duplicates (MSD): MS and MSD of all methods were within QC limits and are acceptable. Since only one or two samples were submitted in each shipment of the landfill sampling, the project laboratory did not perform MS and MSD for all parameters of interest. Data are acceptable based on limited MS and MSD and surrogate recoveries. All MS recoveries of metals and non-metallics were within QC limits except for antimony. Data of this analyte were accepted based on acceptable standard materials recovery.

c. Laboratory Blanks: All processed blanks were free from targeted analytes and are acceptable.

d. Detection Limits: All detection limits met method requirements and are acceptable.

e. Holding Times: All analytes were done within EPA specified holding times except cyanide, which was expired by one day in CAS report K912645 and the reanalysis of one BNA sample in K912729. Holding time expiration of the cyanide sample did not seriously affect the data. The BNA data were not affected as initial and reanalysis data agree and are comparable.

f. Laboratory Duplicates: Relative percent differences (RPD's) of all methods were within limits and are acceptable except RPD of total organic carbon (TOC) in CAS report K912607 and one out of two RPD's of iron in CENPD's report. The TOC data should be considered estimates for the sample submitted in CAS report K912607 and the iron data were accepted based on other acceptable RPD's.

g. Project Blind Duplicates: No blind duplicates were collected with this tier of sampling.

h. Trip Blanks: Trip blanks are shown in Table I. Methylene chloride was found in two out five landfill trip blanks, which could have been encountered during sampling, shipping or storage.

i. Overall Evaluation of the Project Landfill Data: All data are acceptable.

II. Evaluation of the Project Laboratories' Groundwater Monitoring Data:

a. Surrogates: Surrogate recoveries of methods 8080, Modified 8015, 8140, 8240 and 8270 were within QC limits and are acceptable, except that the surrogate of sample 03WA for Modified 8015 was below advisory limits. Low levels of fuels may not have been detected, if present at all.

b. Matrix Spike (MS) and Matrix Spike Duplicates (MSD): MS and MSD of methods Modified 8015, 8140, 8080 and 8240 and MS of metals and non-metallics were within QC limits, except for antimony, which was marginally below lower QC limits. Data were accepted based on acceptable recovery found in reference material. No MS or MSD of method 8270 were submitted with either CAS report. The MS and MSD of Modified 8015, 8140, and 8260 were not submitted with CAS report K912400, probably due to the low number of samples submitted during this tier of sampling and analysis. Data were accepted based on acceptable surrogate recoveries.

c. Laboratory Duplicates: RPD's of all methods were within QC limits except for TOC in CAS report K912709 and one out of two RPD of iron in the CENPD's reports. Data of TOC should be considered an estimate, while that of iron were accepted based on other acceptable RPD.

d. Method Detection Limits and Holding Times: All met method requirements and are acceptable.

e. Laboratory Blanks: All method blanks were free from targeted analytes and are acceptable.

CENPD-PE-GT-L (90-HM-241a)

f. Trip Blanks: The trip blank is shown in Table I. Methylene chloride and chloromethane were found. These data should be treated with caution.

g. Blind Duplicates: Not submitted for any parameters of interest.

h. Overall Evaluation of the Project Groundwater Monitoring: All data are acceptable except for data of methylene chloride and chloromethane due to their presence in the trip blank.

7. QA/QC Comparisons:

I. Landfill: Comparisons are given in Tables II-1 through II-3. Data in these tables agree and are acceptable. The Organophosphorous pesticide comparisons were not possible due to the QA laboratory's subcontract laboratory's lab accident. See Case Narrative of ARDL report 919. No QA or QC samples were collected other than volatiles, semi-volatiles, chlorinated pesticides/PCB's and organic phosphorus pesticides.

II. Groundwater Monitoring: No QA/QC samples were collected for any parameter of interest. Therefore, no comparisons were made.

9. Lessons Learned/Problems Encountered:

a. Sediments were found in filtered samples of dissolved metals, indicating incomplete filtration.

b. No blind duplicates were collected with either Landfill or Groundwater Monitoring sampling rounds.

c. Only a limited number of QA samples were collected with the Landfill sampling.

d. No QA samples were collected with the Groundwater Monitoring sampling.

CENPD-PE-GT-L (90-HM-241a)

PROJECT TRIP BLANKS

TABLE I

Project: FT. RICHARDSON LANDFILL AND GROUNDWATER MONITORING Matrix: water Sample Prefix: 91
Project Laboratory: Southwest Lab of Oklahoma QA Laboratory: * Units: ug/L (ppb)

Method: Volatile Organics (EPA 8240)

Analytes Detected	-19FRL200WA	-19FRL201WA	-19FRL202WA	-20FRGW203WA	-20FRL204WA	-21FRL205WA	Detection Limits
Carbon tetrachloride	ND	1.1	ND	ND	ND	ND	1.0
1,2-Dichloropropane	ND	1.2	ND	ND	ND	ND	1.0
Methylene chloride	ND	ND	ND	37	35	42	10
Chloromethane	--	--	--	300	--	--	
Tentatively Identified Compounds							
	ND	ND	ND	ND	ND	ND	

* = No trip blanks were submitted to the QA laboratory
ND = None detected
-- = Not reported

SUMMARY: Methylene chloride was found in three out of six trip blanks, which could be due to field contamination, as the project laboratory volatile laboratory blanks were free from methylene chloride. The chloromethane found in sample FRGW203WA could have been encountered during sample dilution in the laboratory. The other two analytes found in one trip blank are close to laboratory detection limits and are not significant.

CENPD-PE-GT-L (90-HM-241a)

COMPARISON OF PROJECT AND QA RESULTS

TABLE II

Project: Ft. Richardson Landfill and Groundwater Monitoring
Matrix: water Sample Number: 9120FRL016WA Units: ug/L (ppb)
QA Laboratory: ARDL, Inc.

1. Method: Volatile Organics (EPA 8240)
   Project Laboratory: CAS

Analyte Detected	Project Lab	Detection Limits	QA Lab	Detection Limits
Methylene chloride	ND	10	4JB	--
Tentatively Identified Compounds				
Unknowns	ND		2 @ 4 & 19	

ND = None detected
-- = Not reported
J = Analyte detected below method detection limit
B = Analyte detected in blank as well as sample

SUMMARY: The project and QA data agree for all 35 targeted analytes and are acceptable. The methylene chloride detected in the QA trip blank was below detection limits and not significant.

2. Method: Semi-Volatile Organics (EPA 8270)
   Project Laboratory: CAS

Analyte Detected	Project Lab	Detection Limits	QA Lab	Detection Limits
	ND	5-20	ND	10-50
Tentatively Identified Compounds				
Unknowns	ND		2 @ 15 & 620	

SUMMARY: The project and QA data agree for all 65 targeted analytes and are acceptable.

CENPD-PE-GT-L (90-HM-241a)
Table II

3. Method: Pesticides/PCB's (EPA 8080)
Project Laboratory: CENPD-PE-GT-L

Analyte Detected	Project Lab	Detection Limits	QA Lab	Detection Limits
	ND	0.04-1.76	ND	0.03-2.40

SUMMARY: The project and QA data agree for all 27 targeted analytes and are acceptable.

FT RICH LANDFILL
BASEWIDE GW SAMPLING

ecology and environment, inc.
368 PLEASANTVIEW DRIVE, LANCASTER, NEW YORK 14086, TEL. 716/684-8060
International Specialists in the Environment

CHAIN-OF-CUSTODY RECORD

Page 1 of

Project No.:	Project Name:	Project Manager:
KN1	FT RICH LANDFILL / BASEWIDE GW STUDY	MICHAEL SCHMITZER
Samplers: (Signatures) L Fischer		Field Team Leader: LA FISCHER

STATION NUMBER	DATE	TIME	COMP	GRAB	AIR	EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CON-TAINERS	VOCs - 8240	BNA - 8270	Pcb/PCB - 8080	Organophos Pest 8140	Metals 6000-7000	TPH - Mod 8015	[illegible]	pH alkalinity [illegible]	[illegible]	COD/TOC - 415.1	Cyanide	Coliforms	Methylene Blue Active	REMARKS
FR-3	5-6-91	1340		X			9118FRL01WA	~~14~~ 13	2	1	1	1	1	1	1	1	1	1	1	1		
FR-1	5-6-91	1640		X			9118FRL02WA	~~14~~ 13	2	1	1	1	1	1	1	1	1	1	1	1		
Well K	5-6-91	1130		X			9118FRGW03WA	1			1											
FR-3	5-6-91	1340		X			9118FRL101WA	1					1									
FR-1	5-6/91	1640		X			9118FRL102WA	1					1									
200 WA	5-7-91	1000		X			9118FRL200WA	1	2													

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CHAIN-OF-CUSTODY RECORD

Page 1 of _

Project No.:	Project Name:	Project Manager:
KNI	F. Rich Landfill	Michael Schmetzer

Samplers: (Signatures) L. Fischer

Field Team Leader: L. A. Fischer

STATION NUMBER	DATE	TIME	COMP	GRAB	AIR	EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	VOCs - 8240	BNA - 8270	Pest/PCB - 8080	Organophos Pest 8140	Metals	COD/TOC	Ammonia N, Nitrate/Nitrite N	Chloride, Sulfate	Turbidity, TDS, TSS	Cyanide	Coliforms	REMARKS
FREE MW-4	5-?-91	1610		X			9117 FRL 002 WA	11	2	1	1	1	1	1	1	1	1	1		
FREE MW-	5-?-91			X			[illegible]	11	2	1	1	1	1	1	1	1	1	1		[illegible] 5-9-91
FREE MW-4	5-8-91	1610		X			9117 FRL 102 WA	1					1							
FREE MW-	5-?-91			X			[illegible]	1					1							[illegible] 5-9-91
	5-9-91	0930		X			9114 FRL 201 WA	2	2											

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International Specialists in the Environment

CHAIN-OF-CUSTODY RECORD

Page 1 of

Project No.: KN1

Project Name: Ft. Rich Landfill

Project Manager: Michael Schmetzer

Samplers: (Signature) L.F. S.W. [signature], L. Fischer

Field Team Leader: L.A. Fischer

STATION NUMBER	DATE	TIME	SAMPLE TYPE: COMP	SAMPLE TYPE: GRAB	SAMPLE TYPE: AIR	SAMPLE INFORMATION / EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	VOCs 8240	BNA 8270	Pest/PCB 8080	Organo-phos. Pest. 8140	Metals 6000-7000	TOC/TOX 410.5/415.1	Ammonia Nitrogen 350.2 / Nitrate Nitrite 353	Chloride, Alkalinity, Sulfate	Turbidity, TDS	Cyanide, Coliforms	REMARKS
FREE MW-1	5-9-91	12:20		X			9113FRL008WA	11	2	1	1	1	1	1	1	1	1	1	
~~[illegible]~~	5-9-91	0920					9119FRL202WA	2	2										

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[signature]	5-10-91 / 0950					Federal Express
Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	BL/Airbill Number: 0405585633 ~~666256753~~ S.W.
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Ft. Rich. Landfill Sampling

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CHAIN-OF-CUSTODY RECORD

Project No.: KN1
Project Name: Ft. Rich Landfill
Project Manager: Michael Schmetzer
Samplers: (Signatures) [signature] [signature]
Field Team Leader: L.A. Fischer

STATION NUMBER	DATE	TIME	SAMPLE TYPE: COMP	SAMPLE TYPE: GRAB	SAMPLE TYPE: AIR	SAMPLE INFORMATION: EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CON-TAINERS	VOCs - 8240	BNA - 8270	Pest./PCB 8080	Organophos. Pest 8140	Metals 6000-7000	COD/TOC 410.5/415.1	Ammonia Nitrogen/Nitrate Nitrite 350.3/353.1	Chloride, Alkalinity, Sulfate	Turbidity, TDS	Cyanide	Coliform	REMARKS
FREE MW-5	5-16-91	0950		X			9120FRL 016WA	33	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	1	1	1		
FREE MW-6	5-11-91	0950		X			9120 FRL 017WA	11	2	1	1	1	1	1	1	1	1	1		
	5-16-91	0950		X			9120 FRL 204 WA	2	2											
	5-11-91	0950		X		Dissolved Metals 9120FRL016WA	9120 FRL0116 WA	1					1							
	5-11-91	0950		X		Dissolved Metals 9120FRL017WA	9120 FRL 0117 WA	1					1							

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[signature]	5-16-91					Federal Express
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Ft Rich Landfill

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CHAIN-OF-CUSTODY RECORD

Page 1 of

Project No.:	Project Name:	Project Manager:
KNI	Ft Richardson Landfill	Michael Schnitzer
Samplers: (Signatures)		Field Team Leader:
[illegible signature]		L. A. Fischer

STATION NUMBER	DATE	TIME	COMP	GRAB	AIR	SAMPLE INFORMATION / EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	VOCs - 8240	BNA - 8270	Pest/PCB 8080	Organophos Pest 8140	Metals 6010-7000	(BOD)/TOC 415.1	Ammonia Nitrogen 350.3 / Nitrate Nitrite	Chloride, Alkalinity 352.1	Turbidity, TDS	Cyanide / Lithium	REMARKS
~~5-21-91~~	~~0900~~			X	S.W.		018 S.W												
FTW	5-21-91	0920		X			9121FRL ~~017~~ WA	11	2	1	1	1	1	1	1	1	1	1	VOC vials pres'd to pH 2 w/ HCl [illegible]
XXX	5-21-91	0900		X			9121 FRL 205 WA	2	2										VOC vials pres'd to pH 2 [illegible]
FTW	5-21-91	0920		X		Dissolved metals 9121FRL017WA	9121FRL ~~017~~ WA 0118	1					1						metals samples [illegible] pH

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Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	BL/Airbill Number: 6662563375 — Date: 5-2[illegible]
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F. Rich - Basewide GW Sampling

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CHAIN-OF-CUSTODY RECORD

Page 1

Project No.: KNI
Project Name: BASEWIDE GW SAMPLING
Project Manager: MICHAEL SCHMETZER
Samplers: (Signatures) L. Fischer, J. Wolfe
Field Team Leader: L. A. Fischer

STATION NUMBER	DATE	TIME	COMP	GRAB	AIR	EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	VOCs 8240	BNA 8270	Pest/PCB 8080	Organophos Pest 8140	Metals 6000-7000	TPH - Mod 8015	Chloride, sulfate	Alkalinity, TDS	Turbidity, pH	Ammonia N, Nitrate-N, Nitrite	Corrosivity	CrVI/TOC	Methylene Active Sub	REMARKS
Otter LK							9120 FRGW010WA	12	2	/	/	/	/	/	/	/	/	/	/			
Fort Well							9120 FRGW011WA	12	2	/	/	/	/	/	/	/	/	/	/			
A-6							9120 FRGW012WA	12	2	/	/	/	/	/	/	/	/	/	/			
A-1							9120 FRGW013WA	12	2	/	/	/	/	/	/	/	/	/	/			
Well B							9120 FRGW014WA	12	2	/	/	/	/	/	/	/	/	/	/			
AK2121							9120 FRGW015WA	12	2	/	/	/	/	/	/	/	/	/	/			
XXX							9120 FRGW203WA	2	2	/	/	/	/	/	/	/	/	/	/			
Otter LK						= dissolved metals 9120FRGW010WA	9120 FRGW110WA	1					1									
Fort Well						= dissolved metals 9120 FRGW011WA	9120 FRGW111WA	1					1									
A-6						= dissolved metals 9120 FRGW012WA	9120 FRGW112WA	1					1									
A-1						= dissolved metals 9120 FRGW013WA	9120 FRGW113WA	1					1									
Well B						= dissolved metals 9120 FRGW014WA	9120 FRGW114WA	1					1									
AK2121						= dissolved metals 9120FRGW015WA	9120 FRGW115WA	1					1									

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J. Wolfe	5/15/91 - 1032					Federal Express
Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	BL/Airbill Number: 6662563541
Relinquished By: (Signature)	Date/Time:	Received For Laboratory By: (Signature)	Relinquished By: (Signature)	Date/Time:	Received For Laboratory By: (Signature)	Date: 5.15.91

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CHAIN-OF-CUSTODY RECORD

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Project No.:	Project Name:	Project Manager:
KN1	BASEWIDE GW SAMPLING	MICHAEL SCHMETZER
Samplers: (Signatures)	L. Fisher, [signature], Christopher [signature]	Field Team Leader: L. A. FISHER

STATION NUMBER	DATE	TIME	COMP	GRAB	AIR	EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	VOCs - 8240	BNA - 8270	Pest/PCB - 8080	Organophos Pest - 8140	Metals - 6000-7000	TPH - M.U 8015	Alkalinity 310.1 TDS 160.1 Cl, Temp, pH 9040	Ammonia N, Nitrate N 353	Tox, N 350	Cap/TOC - 9060/415.1	Chloride/Sulfate 325.1/375.4	Methylene Blue Active Sub 425.1	REMARKS
WELL C	4/30/91	1020		X		Water - low	91FRGW01WA	12	2	1	1	1	1	1	1	1	1	1	1	
WELL E	4/30/91	1030		X		Water - low	91FRGW02WA	12	2	1	1	1	1	1	1	1	1	1	1	
WELL K	4/30/91	1035		X		Water - low	91FRGW03WA	12	2	1	1	1	1	1	1		1	1	1	
SURFW #1	4/30/91	1330		X		Water - low	91FRGW04WA	12	2	1	1	1	1	1	1	1	1	1	1	
SURFW #1	4/30/91	1330		X		Water - low	91FRGW05WA	12	2	1	1	1	1	1	1	1	1	1	1	
SURFW #1	4/30/91	1330		X		Water - low	91FRGW06WA	12	2	1	1	1	1	1	1	1	1	1	1	
SURFW #2	4/30/91	1400		X		Water - low	91FRGW07WA	12	2	1	1	1	1	1	1	1	1	1	1	
OXWA	4/29/91	0805		X		Water - low	91FRGW08WA	2	2			LAF								
WELL C	4/30/91	1020		X		Water - low	91FRGW101WA	1					1							
WELL E	4/30/91	1030		X		Water - low	91FRGW102WA	1					1							
WELL K	4/30/91	1035		X		Water - low	91FRGW103WA	1					1							
SURFW #1	4/30/91	1330		X		Water - low	91FRGW104WA	1					1							
SURFW #1	4/30/91	1330		X		Water - low	91FRGW105WA	1					1							
SURFW #1	4/30/91	1330		X		Water - low	91FRGW106WA	1					1							
SURFW #2	4/30/91	1400		X		Water - low	91FRGW107WA	1					1							

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L. Fisher	5-1-91 / 1205					FEDERAL EXPRESS
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CHAIN-OF-CUSTODY RECORD

Project No.:	Project Name:	Project Manager:
KN1000	Fort Richardson Landfill	Jack Stickney

Samplers: (Signatures)	Field Team Leader:
Kimberley Cramer / Jack Stickney (by KFC for JFS)	Jack Stickney

STATION NUMBER	DATE	TIME	COMP	GRAB	AIR	SAMPLE INFORMATION – EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	40ml / VOCs	8oz / Metals	8oz / BNAs / Chlorinated Pesticides PCBs	8oz / Organophosphorus Pesticides	Chlorinated Herbicides		REMARKS
MW 1	10/25	1500		✓		medium level / fuel	9043FRL001SL	4	2	1	1				1 wk holding time from
MW 1	10/26	1000		✓		medium level / fuel	9043FRL002SL	5	2	1	1	1			" " " " "

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K. Cramer	[illegible]					Fed Ex
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CHAIN-OF-CUSTODY RECORD

Project No.:	Project Name:	Project Manager:
KN 1000	Fl Richardson Landfill	Jack Stickney
Samplers: (Signature)		Field Team Leader:
[signature] [signature]		Terry Dickson.

STATION NUMBER	DATE	TIME	SAMPLE TYPE: COMP	SAMPLE TYPE: GRAB	SAMPLE TYPE: AIR	SAMPLE INFORMATION: EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	Organophosphorous Pest + Cl-Herb ((method 8140 8150))	BNA (8270) Cl-Pest/PCB (8080)	VOC	Al, Ba, Cd, Cr, Cu, Fe, Pb, Mg, Mn, Hg, K, Se, Ag, Na, Zn	Ag Ba Cd Ca Cr Cu Fe Pb Mg Mn K Se As Na Zn		REMARKS
MW#3	11/1	1100		X		Low	9044-FRL-004-SL	5	X[1]	X[1]	X[2]		X[1]		} no Hg analysis in soil (method 6000: 7000 series)
"	11/01	1300		X		Low	9044-FRL-005-SL	5	X[1]	X[1]	X[2]		X[1]		
"	10/30	1400		X		Low	9044-FRL-004-WA	6	X[1]	X[2]	X[2]	X[1]			(Rinsate)

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CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project No.:	Project Name:	Project Manager:
[illegible]	[illegible]	[illegible]

Samplers: (Signatures)	Field Team Leader:
[illegible]	Terry Dickson

STATION NUMBER	DATE	TIME	SAMPLE TYPE: COMP	SAMPLE TYPE: GRAB	SAMPLE TYPE: AIR	SAMPLE INFORMATION: EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	40 ml VOC [illegible]	[illegible]	[illegible]	[illegible]	[illegible]		REMARKS
MW2	[illegible]	[illegible]		✓		[illegible]	[illegible]	6	[illegible]	1	1	1	1		[illegible]
MW 2	11/7/90	830		✓		"	9046 FRL007SL	6	2	1	1	1	1		of 5°F
Mw 2	11/9/90	930		✓		"	9047 FRL008 SL	6	2	1	1	1	1		
MW2	[illegible]	[illegible]		✓		[illegible]	[illegible]	6	[illegible]	1	1	1			

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Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Relinquished By: (Signature)	Date/Time:	Received By: (Signature)
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CHAIN-OF-CUSTODY RECORD

Page 1 of

Project No.:	Project Name:	Project Manager:
KN1000	Fort Richardson Landfill	Michael Schmetzer
Samplers: (Signature) Rebecca Archit[illegible]		Field Team Leader: Rebecca Architzel

STATION NUMBER	DATE	TIME	COMP	GRAB	AIR	EXPECTED COMPOUNDS (Concentration)*	STATION LOCATION	NUMBER OF CONTAINERS	40-ml = VOC (8240)	8-oz = Chlorinated Herbicides (8150)	8-oz = Organophosphorus pesticides (8140)	8-oz = Total Metals (6000 + 7000 Series)	8-oz = BNA (8270)	Chlor. pesticides/PCBs (8080)	REMARKS
MW6	1/15/91	10:05		X		Low	9103 FRL 010 SL	6	2	1	1	1	1		} No Hg analysis in soil (Me 6000 + 7000 Series)
MW6	1/16/91	10:00		X		"	9103 FRL 011 SL	5	2	1	1	1			
	1/17/91	11:15		X		"	9103 FRL 012 WA	2	2						– preserved w/4 drops HCl
	1/17/91	12:40		X		"	9103 FRL 013 SL	6	2	1	1	1	1		– No Hg analysis
															Samples collected at
															outside temp. of 10-[illegible]

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Rebecca Archit[illegible]	1/17/91 13:30	Federal Express	Federal Express	~~1/17/91~~ (RJA)		Federal Express
Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	Relinquished By: (Signature)	Date/Time:	Received By: (Signature)	BL/Airbill Number: 964132541 / Date: 1/17/91
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