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REPLY TO
ATTENTION OF:

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 898
ANCHORAGE, ALASKA 99506-0898

19 DEC 1997

CEPOA-EN-EE-AI (200-1c)

MEMORANDUM FOR Commander, U.S. Army Alaska, ATTN: APVR-RPW-EV (Mets),
600 Richardson, #6505, Bldg. 724, Fort Richardson, AK 99505-6505

SUBJECT: Landfill Closure Study, May 1997, Fort Richardson, Alaska

1. Enclosed for your use are copies of the subject document. This document contains sample results from the May 1997 monitoring event for the Fort Richardson Landfill.
2. As detailed in the attached memorandum it is recommended that the analyte list for monitoring events be reduced as shown in the table below.

Analyte List Comparison

Baseline List	Proposed Monitoring List
Conductivity	Conductivity
pH	pH
Temperature	Temperature
Total dissolved solids	Total dissolved solids
Turbidity	Turbidity
Nitrate + Nitrate	Nitrate + Nitrate
Chloride	Chloride
Sulfate	Sulfate
Total carbon	Total organic carbon
Gasoline range organics	Gasoline range organics
Volatile organic compounds	Aromatic volatile organic compounds
Selected metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, potassium, nickel, selenium, silver, sodium, thallium, vanadium and zinc)	Selected metals (arsenic, barium, cadmium, chromium, lead, mercury, potassium, selenium, silver, and sodium)
Diesel range organics	
Total recoverable petroleum hydrocarbons	
Alkalinity	
Chemical oxygen demand	
Chlorinated herbicides	
Cyanide	
Fecal coliform	
Langliers Index	
Nitrogen (Ammonia)	
Nitrogen (Total Kjeldahl)	
Organophosphorous Pesticides	
PCBs and chlorinated pesticides	
Polyaromatic hydrocarbons	
semivolatile organic compounds	
Surfactants	
Total organic carbon	

SUBJECT: Landfill Closure Study, May 1997, Fort Richardson, Alaska

3. If you have questions, please contact me at (907) 753-5613.

FOR THE COMMANDER:

SIGNED

BRIAN D. WEST, P.E.
Engineering Manager

Encl.
1 attach.

CF:
FTR Adm. File
FTR Rec. File

CONCUR:
Wallace

West/meh/5669/Brian/landfill.doc
5 Dec 97



LANDFILL CLOSURE STUDY
FORT RICHARDSON, ALASKA
May 1997

PREPARED BY THE
ALASKA DISTRICT U.S. ARMY CORPS OF ENGINEERS
MATERIALS AND INSTRUMENTATION SECTION
GEOTECHNICAL BRANCH

21 November 1997

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ACRONYMS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
bgs	below ground surface
COD	Chemical Oxygen Demand
DPW	Directorate of Public Works, Fort Richardson
DRO	Diesel Range Organics
GRO	Gasoline Range Organics
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSL	Mean Sea Level
PAH	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
ppb	parts per billion
ppm	parts per million
QA	Quality Assurance
QC	Quality Control
RBC	Risk-based Concentration
SVOC	Semivolatile Organic Compound
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TRPH	Total Recoverable Petroleum Hydrocarbons
ug/L	micrograms per liter
ug/kg	micrograms per kilogram
USARAK	United States Army, Alaska
VOC	Volatile Organic Compound

Executive Summary

This report presents the analytical results for groundwater sampling performed by the Technical Engineering Section of the U.S. Army Corps of Engineers, Alaska District, Environmental Engineering Branch (CEPOA-EN-EE-TE) in May 1997 at the Fort Richardson landfill. CEPOA-EN-EE-TE performed the sampling because other previously approved and scheduled projects prevented the Alaska District's Geotechnical Branch (CEPOA-EN-G) from scheduling the work within the required time frame. The work was performed at the request of the Alaska District's Environmental Engineering Branch, Active Installations Section (CEPOA-EN-EE-AD), on behalf of the Fort Richardson Department of Public Works (DPW), United States Army, Alaska (USARAK).

Water samples were collected from nine of thirteen monitoring wells located around the landfill and were analyzed for a wide variety of potential contaminants and water quality parameters. Three of the wells (AP-3011, AP-3012 and AP-3219) could not be sampled because the water table had dropped below their well screens. AP-3015 could not be sampled because its pump malfunctioned and repairs could not be performed prior to the expiration of the laboratory contracts.

With few exceptions, the data generated during this portion of the closure study is generally consistent with historical data for these wells. Low levels of non-fuel organic compounds were detected in some of the wells and two volatile organic compounds (benzene and chloroform), five total metals (arsenic, chromium, iron, lead and manganese) and the chlorinated pesticide, heptachlor, were detected at concentrations above a health-based MCL or RBC during this sampling event. This appears to be an isolated incident as evidenced by the fact that the only potential exceedance of an RBC or health-based MCL detected during the two previous sampling events was a total chromium detection that marginally exceeded the RBC for chromium VI at FR-3 during the November 1996 sampling event.

1.0 Introduction

This effort represents the third sampling event of the five-year biannual groundwater monitoring program designed to fulfill Alaska Department of Environmental Conservation (ADEC) landfill closure requirements. Water samples were collected from nine of thirteen monitoring wells located within and around the former Ft. Richardson landfill (see Figures 1 & 2) in May 1997. The samples were analyzed for volatile organic compounds (VOCs), gasoline range organic compounds (GRO), semi-volatile organic compounds (SVOC), polynuclear aromatic hydrocarbons (PAH), diesel range organic compounds (DRO), Total Recoverable Petroleum Hydrocarbons (TRPH), organochlorine pesticides, polychlorinated biphenyls (PCBs), chlorinated herbicides, organophosphorus pesticides, total and dissolved metals, total organic carbon (TOC), total dissolved solids (TDS), chemical oxygen demand (COD), ammonia, nitrate-nitrite, Kjeldahl nitrogen, cyanide, sulfate, chloride, alkalinity, turbidity, fecal coliform, methylene blue active substances and Langliers index. Three of the wells (AP-3011, AP-3012 and AP-3219) around the landfill could not be sampled because the water table had dropped below the bottom of their well screens. AP-3015 could not be sampled because its pump malfunctioned and repairs could not be performed prior to the expiration of the laboratory contracts

All of the wells included in this investigation have been periodically sampled during previous investigations. Prior to the commencement of the landfill monitoring program, most of the landfill wells were included in the basewide groundwater monitoring program that was implemented in 1989. With few exceptions, the data generated during this investigation generally agrees with that of previous investigations. Significant variations from historical data are described in the text discussing individual analytical results.

2.0 Environmental Setting

2.1 Location: Fort Richardson is located on the northeast side of the city of Anchorage in south-central Alaska. It is bound by the municipality of Anchorage to the southwest, Elmendorf Air Force Base to the west, Eagle Bay and Knik Arm (of Cook Inlet) to the north and the Chugach Mountains to the east and south (see Figure 1). The Fort Richardson landfill is located about 0.75 miles north of the main cantonment area just north of Circle Road (see Figure 2).

2.2 Landfill History: The Ft. Richardson Landfill is an unlined landfill covering about 400 acres. Its former use is characterized as a trench and fill operation where one trench is dug (approximately 20 to 30 feet deep) while another is simultaneously being filled and covered. It is not known exactly when landfilling operations began at this site, but the first portion of the landfill to be utilized is known to have been closed prior to 1966. The landfill accepted sanitary waste and mess hall grease after 1987, when the municipality of Anchorage began operating a regional landfill that now accepts the solid waste from Ft. Richardson. In addition to the disposal of sanitary solid wastes, the landfill accepted construction rubble, paint and solvent waste, grease and is the site of a former fire training pit and a human waste disposal trench area.

2.3 Area 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 preglacial outwash deposit.

The Elmendorf Moraine is a northeast-southwest-tending, terminal moraine representing the Naptowne glaciation and consists 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. This moraine

transects the main cantonment area at Fort Richardson. The southern boundary of the Elmendorf Moraine, about 60 feet high and forms the northern boundary of the landfill.

Glacial meltwater formed a large outwash plain along the margin of the Elmendorf Moraine. The outwash plain alluvium consists of gravel in the eastern portion of the installation and grades to sand to the west. Approximately 90% of the landfill lies within this deposit with the remainder located in areas mapped as alluvial fans.

Subsurface investigations performed at the Fort Richardson landfill indicate that surficial deposits consisting of interbedded glacial till, glaciofluvial and glaciolacustrine deposits extend to at least 240 feet below ground surface (bgs). A glacial till deposit consisting of silt, sand, gravel and cobbles occurs at the ground surface throughout the landfill area. No permafrost underlies the landfill.

North and west of the landfill, a glaciolacustrine deposit consisting of silt and clay occurs at approximately 45 feet bgs. Interbedded glacial till and glaciofluvial deposits underlie the glaciolacustrine deposits to a depth of at least 140 feet bgs.

South and east of the landfill, interbedded glacial till and glaciofluvial deposits extend to approximately 165 feet BGS. The glaciofluvial deposits consist of sand and gravel. These deposits are underlaid by a 10-foot thick glaciolacustrine deposit that was also encountered to the north of the landfill, but not to the northwest.

2.4 Groundwater: Groundwater at Fort Richardson exists as a deep confined aquifer, a shallow unconfined aquifer, and discontinuous zones of perched groundwater. The Bootlegger Cove formation described above constitutes much of the confining layer that separates the confined and unconfined aquifers. Depth to groundwater ranges from near the surface along Ship Creek (see Figure

1) to greater than 250 feet bgs along the thicker glacial deposits found in the northern section of Fort Richardson. Lenses of silt found 20 to 40 feet below ground surface often underlie perched groundwater. Wells installed in these zones of perched groundwater often become unproductive or poorly productive after development. Water is known to recharge the groundwater system of Fort Richardson in several ways. Groundwater seeps from bedrock fractures into the sediments along the Chugach Mountains to the east. Snowmelt and rainfall infiltrate to the groundwater. Streams feed groundwater in areas where the elevation of the stream is above the water table. Discharge of the aquifers is by groundwater flow into Knik Arm to the west, into streams (e.g., Ship Creek, Eagle River) that ultimately discharge into Knik Arm or to wells.

Groundwater within the unconfined aquifer is thought to flow in a direction trending to the northwest on the north side of Ship Creek and toward the southwest on the south side of Ship Creek. In the area directly adjacent to Ship Creek, the direction of flow appears to trend westward, parallel to the general downstream direction of Ship Creek. This is due to the fact that Ship Creek is a losing stream and is recharging the groundwater. The confined aquifer flow trends predominantly to the northwest.

Three aquifers were encountered during monitoring well installations at the Fort Richardson landfill. North and west of the landfill, a perched unconfined aquifer occurs at approximately 35 feet bgs. The lateral extent of this aquifer is not known; however, it is not believed to exist beneath the landfill and is likely a perennial water-bearing zone.

A second aquifer was encountered throughout the landfill area and has a groundwater potentiometric surface which occurs at approximately 170 to 178 feet above mean sea level (AMSL). Currently, eight monitoring wells (FR-1, FR-2, AP-3010, AP-3013, AP-3015, AP-3220, AP-3221 and

AP-3222) are screened between about 160 and 180 feet AMSL within this glacial till aquifer. This aquifer is the first non-perched groundwater encountered in borings in the vicinity of the landfill. Groundwater levels measured in wells that screen this aquifer indicate that this groundwater flows primarily to the northwest and the hydraulic gradient in the vicinity of the landfill is about 0.0025.

A third aquifer was encountered at about 204 feet AMSL within a gravely, silty sand overlying a six-foot thick silt layer located east of the landfill. This aquifer, which overlies the glacial till aquifer is not encountered elsewhere within or around the landfill. The lateral extent of this aquifer is not known and there does not appear to be a direct hydraulic connection with the glacial till aquifer. Well FR-3 is the only functioning well that is screened within this aquifer.

3.0 Field Activities

3.1 Sample Summary: Sampling began on 12 May, and concluded on 28 May 1997. All sampling was performed by Andy Ferguson, Engineer, CEPOA-EN-EE-TE, with the assistance of Bret Walters, chemist, CENPA-EN-G-MI, at wells AP-3220 and FR-1 (first wells to be sampled). Water samples were collected from nine wells located within and around the Ft. Richardson landfill as described in the closure plan for the Ft. Richardson landfill. Three of the wells (AP-3011, AP-3012 and AP-3219) included for sampling in the closure plan could not be sampled because the water table had dropped below their well screens. AP-3015 could not be sampled because its pump malfunctioned and repairs could not be performed prior to the expiration of the laboratory contracts.

3.2 Sampling Procedures: Sampling was performed according to the procedures described in the closure plan and was consistent with the Sampling and Analysis Plan used for the Ft. Richardson Groundwater Monitoring Program, with the following notations. The dedicated submersible pump was

removed from AP-3220 during the June/July 1997 investigation because of the well's low recharge rate. As a result, AP-3220 well was bailed dry three consecutive times and sampled using single-use bailers. The recharge rate of the well was about 1.5 liters per day, thus the well was sampled over a period of 17 days. Data for the sample from this well should be viewed with caution.

Just prior to sampling, all wells, except AP-3220, were purged until physical parameters stabilized. Water conductivity, pH, oxidation-reduction potential, and temperature were measured periodically during purging of all wells, to monitor stabilization of the groundwater. Measurements of physical characteristics along with other well-specific information are included in the individual well's Sample Summary Form provided in Appendix A. All purge water and decontamination water was disposed of through the water treatment facility operated on Ft. Richardson by ENSR Consulting and Engineering of Anchorage, Alaska.

Sampling began immediately after well stabilization. The types of containers, preservatives used and the volume of sample collected met standard protocols. All containers were precleaned containers with teflon lined lids. Vials used to hold samples to be tested for volatiles were filled so that there was no headspace or trapped bubbles. Sufficient extra volume of one sample were sent to each laboratory for use as matrix spike and matrix spike duplicate samples.

3.3 QA/QC Samples: Quality assurance (QA) and quality control (QC) duplicates were collected for each method of analysis. QA and QC duplicates were collected so that a triplicate set of samples resulted. In this case, the triplicate sample set was collected at AP-3014 and was tested for the same analytes as the rest of the samples.

Trip blanks and rinsate blanks were also prepared, used and analyzed for this project. Results of primary and QA trip blanks indicate that cross contamination of volatile compounds during collection, shipment and storage was not likely. Very low levels of several analytes were detected in the rinsate blank. Though these detections may be evidence of low level cross contamination, it is more likely that the water used to prepare the blanks contained low levels of these analytes or, in some cases, that laboratory contamination contributed to their presence. Furthermore, the rinsate blank was collected approximately thirteen hours after the last sample was collected. Due to questionable data validity, no qualifications have been made to data that may have been impacted by rinsate blank results.

4.0 Analytical Results

4.1 Chemical Analyses: Data from the chemical analyses are reported in Tables 1 through 11 (Appendix A). In the tables, parts per million (ppm) are expressed as milligrams per liter (mg/L). Parts per billion (ppb) are expressed as micrograms per liter (ug/L). One ppm is equal to 1000 ppb. Where possible, reported concentrations are compared to federal or state Maximum Contaminant Levels (MCLs) and EPA Region III risk-based concentrations (RBCs).

4.2 Quality Assurance and Quality Control:

4.2.1 Data Quality Review: The complete chemical data packages, including the laboratories' internal quality control reports, are on file at CEPOA-EN-G-MI. The data and associated materials were reviewed by ETHIX, Inc., of Modesto, California. A copy of the resulting laboratory data quality report is included in Appendix C.

Laboratory data quality is summarized in the laboratory data quality report (attached as Appendix C). A significant portion of the data for this project has been qualified as estimated. The

majority of the qualifications are the result of problems associated with the submission of the samples to the laboratories. The impact on data usability is discussed in the text associated with specific test results.

4.2.2 Replicate Samples: A blind duplicate quality control (QC) sample was submitted to the primary laboratory, which analyzed the majority of the samples. Analysis of the QC duplicate sample provides a measure of intra-laboratory variations. An additional replicate sample was provided to an independent quality assurance (QA) laboratory, to provide an indicator of inter-laboratory accuracy. QC and QA duplicates are so noted in the data tables. QA and QC duplicate sets were submitted for each analytical method performed. Data from all replicate samples were analyzed by ETHIX as part of development of the laboratory data quality report. The three sets of data were carefully compared and tabulated. Nearly all of the data for duplicate samples are in agreement and are comparable. Any discrepancies are noted in the laboratory data quality report and included in the discussion of specific test results.

4.3 Chemical Results:

4.3.1 Volatile Organic Compounds: All of the samples were tested for VOCs by method 8260A. The data are presented in Table 1 of Appendix B. VOC data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) is considered to be estimated because the samples arrived at the laboratories at temperatures above 6° C.

Volatile organic compounds were reported at low levels in samples from all of the wells. Acetone, methylene chloride, naphthalene, toluene and 2-butanone were reported in various samples at estimated concentrations of up to 5, 0.15, 0.2, 1.2 and 0.4 ppb, respectively. However, each of these analytes was also reported in at least one of the associated method blanks and their presence, at the

reported concentrations, is likely due to laboratory contamination of the samples. Carbon disulfide was reported in the QA duplicate sample collected from AP-3014 at an estimated concentration of 0.27 ppb. The primary laboratory's carbon disulfide detection limits for the associated primary and QC duplicate samples is lower than the reported concentration, thus, the detection is likely the result of laboratory contamination. Three other common laboratory contaminants, chloroform, chloromethane and dichlorodifluoromethane, were reported in various samples analyzed by the primary laboratory at estimated concentrations of up to 0.2, 1.4 and 2.8 ppb, respectively. Though these analytes were not reported in any of the associated method blanks, they were not detected by the QA laboratory and their presence may also be attributable to laboratory contamination.

1,2,3-Trichlorobenzene, 1,2,4-trimethylbenzene, benzene, ethylbenzene and total xylenes were reported below their method reporting limits (MRLs) in the sample collected from AP-3010 at estimated concentrations of 0.2, 0.1, 0.4, 0.2 and 0.8 ppb, respectively. Only the benzene concentration of 0.4 ppb at AP-3010 and the chloroform concentration of 0.2 ppb at AP-3013, AP-3220, AP-3222, FR-1 and FR-2 exceeded an RBC. No concentrations exceeded a MCL. All method detection limits are below applicable regulatory levels.

The table, below, provides the maximum reported concentration and the associated RBCs and the State of Alaska's drinking water maximum contaminant level (MCL) for VOCs that have been detected during the most recent three samplings of the landfill wells. Concentrations which exceed an RBC or MCL have been highlighted.

Detected Analyte	Well/Maximum Concentration (July 96) (µg/L)	Well/Maximum Concentration (Nov 96) (µg/L)	Well/Maximum Concentration (May 97) (µg/L)	Region III RBC (µg/L)	MCL (µg/L)
1,1,1-trichloroethane	AP-3222/0.03 R	ND(1.0)	ND(0.5)	790	200
1,2,3-trichlorobenzene	ND(0.3)	ND(1.0)	AP-3010/0.2 J	NA	NA
1,2,4-trimethylbenzene	ND(0.061)	ND(1.0)	AP-3010/0.1 J	300	NA
2-butanone	AP-3220/2.1	ND(10)	AP-3010/0.4 J	1900	NA
acetone	AP-3220/19	ND(10)	AP-3010/5 J,b	3700	NA
benzene	AP-3014/0.062R	ND(1.0)	AP-3010/0.4 J	0.36	5
bromodichloromethane	ND(0.018)	ND(1.0)	AP-3220/0.04 J	0.17	100*
carbon disulfide	AP-3220/0.55 b	ND(1.0)	AP-3014/0.27 J	1000	NA
chloroform	FR-1/0.15 R	ND(1.0)	5 wells/0.2 J	0.15	100*
chloromethane	ND(0.027)	ND(1.0)	AP-3221/0.4 J	1.4	NA
dichlorodifluoromethane	FR-3/5.2	FR-3/4.3	AP-3221/2.8	390	NA
ethylbenzene	AP-3013/0.032R	ND(1.0)	AP-3010/0.2 J	1300	700
methylene chloride	AP-3222/4.5 J	AP-3013/3.1 b	AP-3014/0.15 J	4.1	NA
naphthalene	ND(0.24)	ND(1.0)	2 Wells/0.2 J,b	1500	NA
toluene	AP-3220/0.3	ND(1.0)	AP-3010/1.2 J,b	750	1000
total xylenes	AP-3013/0.077R	ND(1.0)	AP-3010/0.8	12000	10000
trichlorofluoromethane	AP-3220/0.066 J	ND(1.0)	ND(0.5)	1300	NA

J: Estimated Value

NA: None Available

*: MCL is for sum of trihalomethanes

b: Analyte was detected in method blank

ND: None detected (MRL in parentheses)

R: Data point rejected based on laboratory QC failures

Only a very few, well documented, laboratory contaminants were detected during VOC analysis of the samples collected from these wells during the November 1996 sampling of these wells. The detection limits achieved by the laboratories during the previous events are comparable. Isolated and/or inconsistent low-level detections of VOC analytes during discrete portions of a long term monitoring program should be viewed in the context of historical data. Most of the VOCs detected during the landfill monitoring program are common laboratory contaminants. These detections have also been, for the most part, very random with respect to both analytes and concentrations detected and the locations with detectable concentrations. Since VOCs can easily contaminate samples during collection, it is also important to mention the possibility of field contamination of the samples. Though not indicated by trip blank results, the possibility of field contamination of the samples is elevated by the fact that the sampling was performed by relatively inexperienced personnel.

4.3.2 Gasoline Range Organic Compounds: All of the samples were tested for GRO by method AK-101. Data are presented in Table 2 of Appendix B. GRO data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) is considered to be estimated because the samples arrived at the laboratory at temperatures above 6° C.

No GRO were reported in any of the samples collected from these wells during May 1997. GRO were reported in the samples from eight of the wells at up to 0.584 ppm during the November 1996 sampling of the landfill wells. The lack of GRO in the most recently collected samples supports the conclusion that the previously reported GRO concentrations were the result of laboratory contamination.

4.3.3 Diesel Range Organic Compounds: All of the samples were tested for DRO by method AK-102. Data are presented in Table 2 of Appendix B. DRO data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) is considered to be estimated because the samples arrived at the laboratory at temperatures above 6° C. Additionally, the sample from FR-1 is also considered to be estimated due to surrogate recovery failures.

DRO were reported in the samples from six of the wells (AP-3010, AP-3014, AP-3220, AP-3221, FR-1 and FR-3) at up to 0.311 ppm. For the second consecutive sampling event, the highest DRO concentration was found in the sample from AP-3220. The sample collected from AP-3220, in November 1996, had a reported concentration of 0.400 ppm. The chromatograms for these detections do not resemble those representative of typical DRO and what is quantitated is probably not fuel. Similar concentrations would have been detected, if present, in the samples collected from this well during the June 1996 investigation, but were not. No RBC or MCL exists for DRO.

4.3.4 Total Recoverable Petroleum Hydrocarbons: All of the samples were tested for TRPH by method 418.1. Data are presented in Table 2 of Appendix B. TRPH data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) is considered to be estimated because the samples arrived at the laboratory at temperatures above 6° C.

TRPH was reported in the sample from AP-3220 at 1 ppm. Similar contaminant concentrations would have been detected during the two previous investigations, but were not. No RBC or MCL exists for TRPH.

4.3.5 Semi-Volatile Organic Compounds: All of the samples were tested for SVOCs by method 8270B. Data are presented in Table 3 of Appendix B. SVOC data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) is considered to be estimated because the samples arrived at the laboratory at temperatures above 6° C. Additionally, the acenaphthene data for the samples from AP-3010, AP-3013, AP-3221, AP-3222, FR-2 and FR-3; and the 1,2,4-trichlorobenzene, 1,4-dichlorobenzene and n-nitrosodi-n-propylamine for one of the duplicate samples (-04WA) from AP-3014 are considered estimates as a result of various quality control failures.

The only SVOC detected was di-n-butyl phthalate. It was detected below its MRL in the sample from AP-3220 at an estimated concentration of 2 ppb. Similar concentrations may not have been detected, if present, in the samples collected from this well during previous investigations. No RBC or MCL exists for di-n-butyl phthalate. All method detection limits are below applicable regulatory levels.

4.3.6 Polynuclear Aromatic Hydrocarbons: All of the samples were tested for PAHs by method 8310. Data are presented in Table 4 of Appendix B. PAH data for samples from five of the

wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) is considered to be estimated because the samples arrived at the laboratory at temperatures above 60° C. Additionally, the sample from AP-3221 arrived at the laboratory with a broken lid and the associated data should also be considered estimated.

Phenanthrene was the only PAH detected at any of the wells. It was reported at a concentration of 0.057 ppb in the QA duplicate collected at AP-3014. No MCL or RBC exists for phenanthrene. All method detection limits are below applicable regulatory levels.

4.3.7 Chlorinated Herbicides: All of the samples were tested for chlorinated herbicides by method 8151. Data are presented in Table 5 of Appendix B. Chlorinated herbicide data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) are qualified as estimated in the data tables because the samples arrived at the laboratory at temperatures above 60° C. However, due to the physical and chemical properties of the analytes, the impact on data usability is probably negligible. Additionally, the data for the QA duplicate (-05WA) from AP-3014 was extracted one day past the required holding time and should be considered estimated. The silvex data for the sample from FR-1 is rejected based on laboratory control sample failures and should not be used for any purpose.

2,4-D was the only chlorinated herbicide detected. It was reported below its MRL at about 0.7 ppb in the sample from AP-3013 and at its MRL in the sample from FR-3 at 1 ppb. Similar concentrations would have been detected, if present, in the samples collected from this well during the two previous investigations, but were not. The MCL and RBC for 2,4-D in drinking water are 70 and 61 ppb, respectively. All method detection limits are below applicable regulatory levels.

4.3.8 Organophosphorus Pesticides: All of the primary samples were tested for organophosphorus pesticides by method 8141. The QA duplicate sample was analyzed by method 8140. These methods are comparable and data are presented in Table 6 of Appendix B. Organophosphorus pesticide data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) are qualified as estimated in the data tables because the samples arrived at the laboratory at temperatures above 6° C. However, due to the physical and chemical properties of the analytes, the impact on data usability is probably negligible.

Ethoprop was the only chlorinated herbicide detected. It was reported well below its method reporting limit (MRL) in one of the duplicate samples (-04WA) from AP-3014 at an estimated concentration of 0.02 ppb. Similar concentrations would have been detected, if present, in the samples collected from this well during the two previous investigations, but were not. No MCL of RBC exists for ethoprop. All method detection limits are below applicable regulatory levels.

4.3.9 Organochlorine Pesticides and PCBs: All of the samples were tested for organochlorine pesticides and PCBs by method 8081. Data are presented in Table 7 of Appendix B. Organochlorine pesticide and PCB data for samples from five of the wells (AP-3013, AP-3014, AP-3220, AP-3222 and FR-2) are qualified as estimated in the data tables because the samples arrived at the laboratory at temperatures above 6° C. However, due to the physical and chemical properties of the analytes, the impact on data usability is probably negligible. Though no aldren was detected, the aldren data for wells AP-3010, AP-3221 and FR-3 is considered estimated because re-analysis, subsequent to surrogate recovery failure, was performed after holding time expiration. All organochlorine pesticide and PCB results for the sample collected from AP-3220 have been rejected as a result of no surrogate recovery and should not be used.

Heptachlor and alpha-BHC were the only organochlorine pesticides detected. No PCBs were detected. Heptachlor was detected in the sample from AP-3010 at an estimated concentration of 0.005 ppb. The MCL and RBC for heptachlor in drinking water are 0.4 and 0.0023 ppb, respectively. Alpha-BHC was detected in the sample from AP-3221 at an estimated concentration of 0.001 ppb. No MCL or RBC exists for alpha-BHC. Similar concentrations would have been detected, if present, in the samples collected from this well during the two previous investigations, but were not. All method detection limits are below applicable regulatory levels.

4.3.10 Total Metals: Data are included in Table 8 of Appendix B. Unfiltered samples of water were analyzed for the 23 Target Analyte List (TAL) metals. Many of the metals were detected in samples from most of the wells. Detected concentrations were compared to available primary MCLs, action levels, RBCs and secondary MCLs. Primary MCLs, action levels and RBCs are intended to protect human health while secondary MCLs are intended to preserve the aesthetic quality of drinking water. Detected concentrations and available MCLs, action levels and RBCs are summarized in the table below.

Metal (Total)	MCL (ug/L)	RBC (ug/L)	Number of detections/ highest level detected (ug/L)	Well/level (ug/L) that exceeded MCL or RBC
Aluminum	200 ^d	37000	6/21400	AP-3010/2420 AP-3013/1040 AP-3014/12500 AP-3220/18100 AP-3221/3920 FR-3/21400
Arsenic	50	11	6/15	AP-3220/15
Barium	2000	2600	9/78	None
Chromium	100 ^a	180 ^b	5/575	FR-3/575
Cobalt	NA	2200	3/29	None
Copper	1000 ^d	1500	5/47	None
Iron	300 ^d	11000	9/36300	AP-3010/6510 AP-3013/2060 AP-3014/21300 AP-3220/31700 AP-3221/5850 FR-3/36300
Lead	15 ^c	NA	6/17	FR-3/17
Manganese	50 ^d	180	6/998	AP-3010/150 AP-3013/58 AP-3014/998 AP-3220/538 AP-3221/117 FR-3/755
Mercury	2	11	1/0.2J	None
Nickel	100	730	4/436	FR-3/436
Sodium	250000 ^d	NA	9/28000	None
Thallium	2	NA	1/1 J	None
Vanadium	NA	260	6/71	None
Zinc	5000 ^d	11000	9/844	None

a: Not differentiated between chromium III and chromium VI.
b: RBC is for chromium VI; RBC for chromium III is 37000 ug/L.
c: No MCL for lead; 15 ug/L is action level at the tap.
d: Secondary MCL to protect aesthetics of drinking water.

J: estimated concentration
NA: not available.
ND: not detected; method reporting limit in parentheses.

Calcium, magnesium and potassium were detected in most of the wells at concentrations up to 117000, 31700 and 4300 ppb, respectively. These metals are not included in the table because there are no MCLs or RBCs associated with them. Total metal concentrations exceeding an associated primary MCL or RBC were reported in samples from AP-3014 (iron and manganese), AP-3220 (arsenic, iron and manganese) and FR-3 (chromium, iron and lead).

During the November 1996 sampling of these wells, only the chromium concentration in the sample from FR-3 exceeded a primary MCL or RBC. It should be noted that the referenced RBC is for chromium VI. The RBC for chromium III is 37000 ppb. The analytical method used does not differentiate between chromium VI and chromium III, but it is very unlikely that significant concentrations of chromium VI were present in the samples. All duplicate data for total metals are in agreement with the following exceptions. The primary and QC duplicate results for aluminum and arsenic do not agree with the QA duplicate results. The primary's laboratory data is accepted based on blind duplicate agreement. All method detection limits are equal to or below applicable regulatory levels.

4.3.11 Dissolved Metals: Data are presented in Table 9 of Appendix B. Samples were field filtered into clean, preserved containers. Thus, reported concentrations represent the amount of dissolved metals in the sample. No MCLs or RBCs were exceeded in any of the filtered samples. All method detection limits are equal to or below applicable regulatory levels.

4.3.12 Water Quality Parameters: All of the samples were also tested for group of water quality parameters. These analytes include alkalinity, chloride, chemical oxygen demand, cyanide, langliers index, methylene blue active substances (MBAS), ammonia nitrogen, total Kjeldahl nitrogen, nitrate-nitrite, sulfate, fecal coliform, total organic carbon, total dissolved solids and

turbidity. Analyses with non-restrictive holding times (greater than 48 hours) were performed by the primary and QA laboratories. Data are presented in Table 10 of Appendix B. Analyses with short holding times (less than 48 hours) were performed by Northern testing laboratories, Anchorage, Alaska. Data are presented in Table 11 of Appendix B. Many of the results have been qualified due to holding time exceedances and out of control sample cooler temperatures.

Primary MCLs are available for cyanide (0.2 ppm) and nitrate-nitrite (10 ppm). Secondary MCLs are available for chloride (250 ppm), MBAS (0.5 ppm), sulfate (250 ppm) and total dissolved solids (500 ppm). No primary or secondary MCLs were exceeded. No cyanide or fecal coliform were detected in any of the samples. The results for the remaining analytes are consistent with historical data generated for these wells. All primary and QA laboratory data agree and are comparable with the following exceptions. The QA duplicate sample data for chemical oxygen demand and total kjeldahl nitrogen do not agree with the associated primary and/or the QC duplicate sample data. In each case, the primary and QC duplicate data agree within a factor of three. However, the primary and QC sample data for total kjeldahl nitrogen are considered low estimates. The primary laboratory's data for chemical oxygen demand is accepted based on blind duplicate agreement. The QA laboratory's data for total kjeldahl nitrogen is accepted based on superior quality control results. The QC duplicate data for chloride and sulfate do not agree with the associated primary and QA duplicate sample data. Primary and QA data agree within a factor of three and is accepted based on blind duplicate agreement.

4.3.13 Field Data: Conductivity, pH, temperature and oxidation and reduction potential were measured in the field and are included in the sample summary forms in Appendix A. Associated data generally agree with field data from previous investigations and fall within expected ranges.

5.0 Conclusions

With few exceptions, data indicate that the groundwater quality in the area continues to be good. Two VOCs (benzene and chloroform), five total metals (arsenic, chromium, iron, lead and manganese) and the chlorinated pesticide, heptachlor, were detected at concentrations above a health-based MCL or RBC during this sampling event. However, the only potential exceedance of an RBC or health-based MCL detected during the two previous sampling events was a total chromium detection that marginally exceeded the RBC for chromium VI at FR-3 during the November 1996 sampling event.

It is possible that sampling procedures may have contributed to several of the elevated concentrations reported for the latest round of sampling. The majority of the data discrepancies that resulted from the latest data set are associated with VOC and total metal results. VOCs, if present in the air during collection, may have been absorbed by the water. Total metal results are highly dependent on the amount of metals contained in suspended particles and, thus, can vary with significantly with sampling technique. Isolated and/or inconsistent low-level detections of analytes resulting from a variety of sources are virtually inevitable on a project of this size and scope. Such detections should be considered carefully with respect to previous data and the possibility of external sources of contamination. In this case, it appears that sampling technique probably contributed to the elevation of several metal results and sampling technique and documented and undocumented laboratory contamination contributed to the detections of several non-metallic analytes that were not previously detected.

6.0 References

Alaska Department of Environmental Conservation, Title 18 Alaska Administrative Code Chapter 70 (18 AAC 70), Water Quality Standards, 16 March 1996.

Alaska Department of Environmental Conservation, Title 18 Alaska Administrative Code Chapter 80 (18 AAC 80), Drinking Water, 10 November 1994.

Ecology and Environment, Inc., Closure Plan, Ft. Richardson Landfill, October 1995

United States Army Corps of Engineers (USACE), memorandum CENPA-EN-G dated 13 November 1996, subject: Final Chemical Data Report, Summer 1996, Ft. Richardson landfill, Alaska.

USACE, memorandum CENPA-EN-G dated March 1996, subject: Final Chemical Data Report, Landfill Closure Study (November 1996), Ft. Richardson, Alaska.

USACE, memorandum CENPA-EN-G dated 10 May 1996, subject: Final Chemical Data Report, Groundwater Study (Fall 1995), Ft. Richardson, Alaska.

USACE, ER 1110-1-263, Chemical Data Quality Management for Hazardous Waste Remedial Activities, April 1996.

USACE, memorandum CENPA-EN-G-MI dated 8 April 1994, subject: Work Plan, Groundwater Monitoring, Ft. Richardson, AK.

United States Environmental Protection Agency, Region III Risk-Based Concentration Table, April 1997.

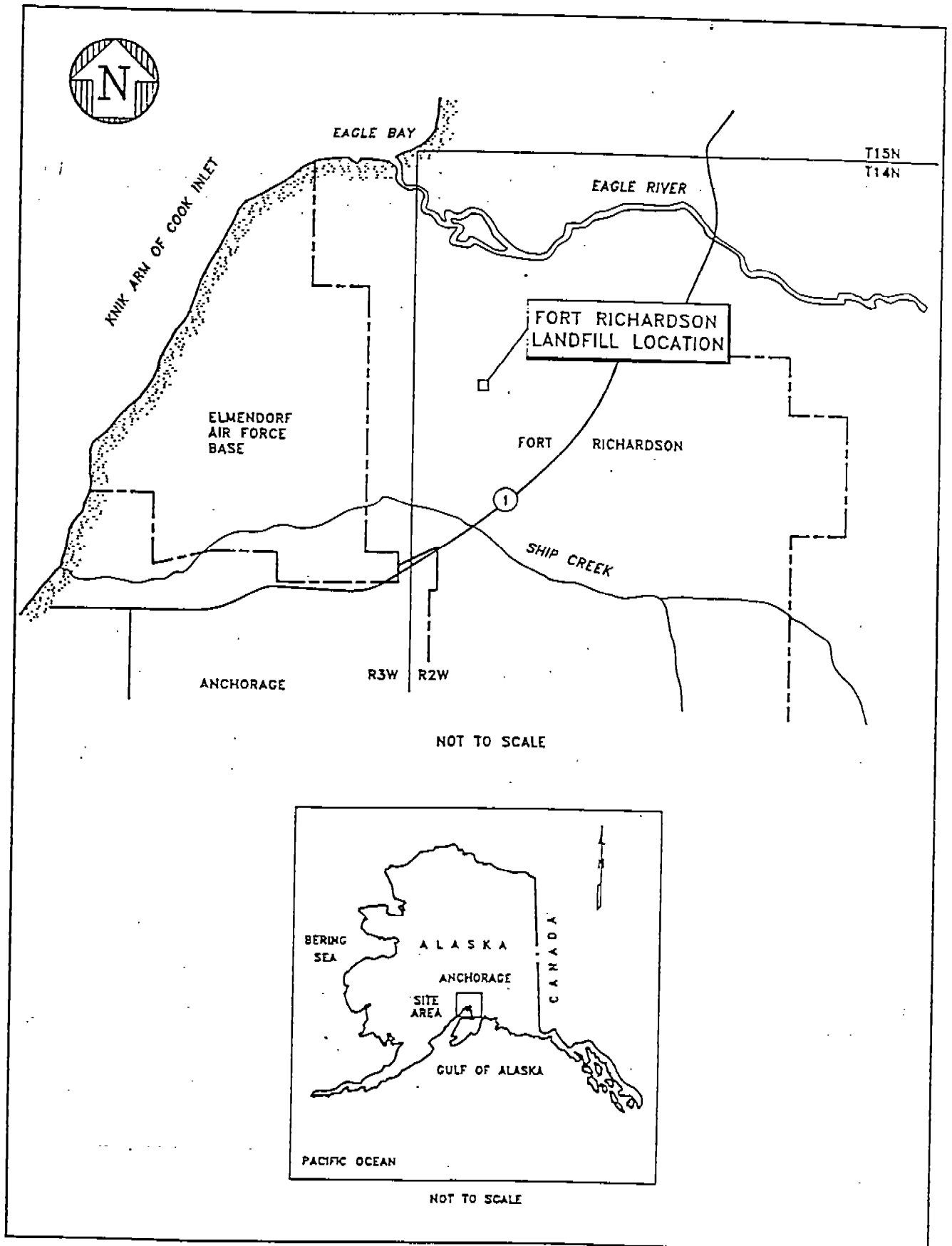
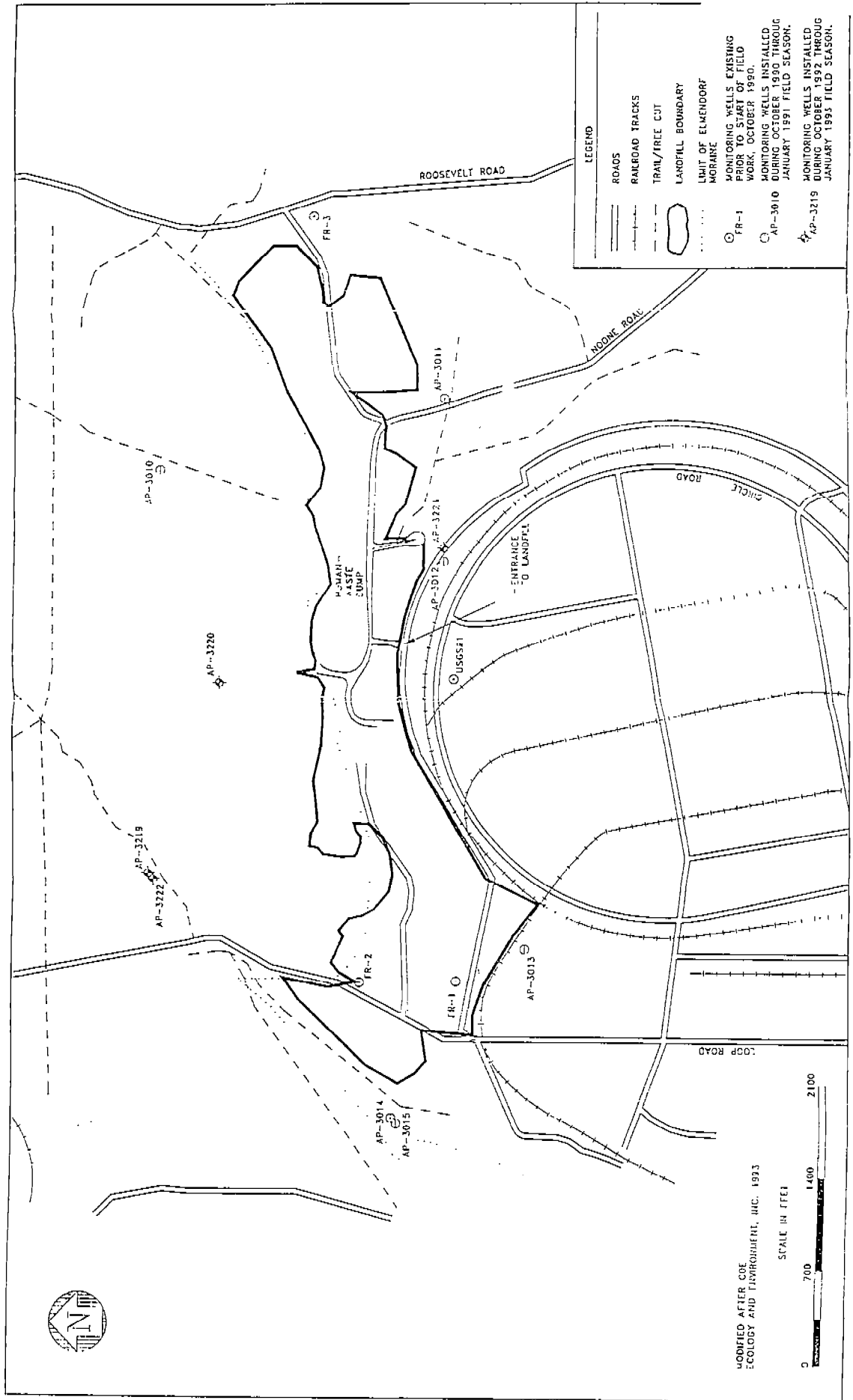


Figure 1
FORT RICHARDSON LANDFILL SITE
ANCHORAGE, ALASKA



APPENDIX A
Sample Summary Forms

AP-3010**Landfill Wells, Ft. Richardson****22 May 1997****Sampling Point:** 4-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump (Grundfos RediFlow II); PVC riser; Homelight 4000 watt, 240 volt, 8 hp generator, Grundfos BMI/MP1 voltage control box; Teflon sampling tube.

Casing top/water: 232.58 ft

Casing top/bottom: 235.58 ft (from records)

Purge Volume: 25 L

Purge Rate: 1.0 L/min (380 Hz)

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 8.0 °C

pH: 7.53

Conductivity: 0.55 millimhos/cm

Redox Potential: 145 millivolts

Odor: None Noticeable

Appearance: light brown

Sample Number: 97LFGM01WA

Time of Sampling: 19:30

Rate of Sampling: slowest unbroken flow (less than 1L/min)

AP-3013**Landfill Wells, Ft. Richardson****25 May 1997****Sampling Point:** 4-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump (Grundfos RediFlow II); PVC riser; Homelight 5000 watt, 240 volt generator, Grundfos BMI/MP1 voltage control box; Teflon sampling tube.

Casing top/water: 141.75 ft

Casing top/bottom: 150.00 ft (from record)

Purge Volume: 61 L

Purge Rate: 1.0 L/min (330 Hz)

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 5.8 °C

pH: 6.96

Conductivity: 0.38 millimhos/cm

Redox Potential: 119 millivolts

Odor: None Noticeable

Appearance: clean

Sample Number: 96FRL06GW, -07GW and -08GW

Time of Sampling: 13:30

Rate of Sampling: Slowest sustainable non turbulent flow

AP-3014**Landfill Wells, Ft. Richardson****29 May 1997****Sampling Point:** 4-inch Monitoring Well**Equipment:** Disposable bailer

Casing top/water: 21.20 ft

Casing top/bottom: 31.1 ft (from records)

Purge Volume: 73 L

Purge Rate: 1.0 L/min (108 Hz)

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 6.0 °C

pH: 6.9

Conductivity: 0.194 millimhos/cm

Redox Potential: 142 millivolts

Odor: None Noticeable

Appearance: clear

Sample Number: 97LFGM04WA, -05WA and -06WA

Time of Sampling: 17:20

Rate of Sampling: less than 1L/min

AP-3220**12-29 May 1997****Landfill Well, Ft. Richardson****Sampling Point:** 4-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump was removed.

Sample was collected using a disposable bailer.

Casing top/water: 231.35 ft

Casing top/bottom: 243.4 ft (from records)

Purge Volume: Bailed dry three times

Purge Rate: <1.00 L/min

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 7.6 °C

pH: 7.9

Conductivity: 0.505 millimhos/cm

Redox Potential: 139 millivolts

Odor: None Noticeable

Appearance: Cloudy

Sample Number: 97LFGM09WA

Time of Sampling: 15:20 on 12 May - 14:15 on 29 May 1997

Rate of Sampling: about 1.5 L/day

AP-3221**Landfill Wells, Ft. Richardson****22 May 1997****Sampling Point:** 4-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump (Grundfos RediFlow II); PVC riser; Homelight 4000 watt, 240 volt generator, Grundfos BMI/MP1 voltage control box; Teflon sampling tube.

Casing top/water: 160.61 ft

Casing top/bottom: 180.00 ft (from record)

Purge Volume: 144 L

Purge Rate: 1.5 L/min (288 Hz)

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 9.6 °C

pH: 7.09

Conductivity: 0.702 millimhos/cm

Redox Potential: 160 millivolts

Odor: None Noticeable

Appearance: brown/cloudy

Sample Number: 97LFGW02WA

Time of Sampling: 15:05

Rate of Sampling: Slowest sustainable non turbulent flow

AP-3222**25 May 1997****Landfill Well, Ft. Richardson****Sampling Point:** 4-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump (Grundfos RediFlow II); PVC riser; Homelight 4000 watt, 240 volt generator, Grundfos BMI/MP1 voltage control box; Teflon sampling tube.

Casing top/water: 133.70 ft

Casing top/bottom: 141 ft (from records)

Purge Volume: 54 L

Purge Rate: 1.0 L/min (240 Hz)

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 6.2 °C

pH: 7.01

Conductivity: 0.4 millimhos/cm

Redox Potential: 190 millivolts

Odor: None Noticeable

Appearance: Clear

Sample Number: 97LFGM11WA

Time of Sampling: 8:30

Rate of Sampling: slowest unbroken flow (less than 1L/min)

FR-1**13 May 1997****Landfill Wells, Ft. Richardson****Sampling Point:** 2-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump (Grundfos RediFlow II); PVC riser; Homelight 5000 watt, 240 volt, generator, Grundfos BMI/MP1 voltage control box; Teflon sampling tube.

Casing top/water: 137.30 ft

Casing top/bottom: 149.00 ft (from record)

Purge Volume: 41 L

Purge Rate: 1.0 L/min (260 Hz)

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature:	9.1 °C
pH:	7.08
Conductivity:	0.415 millimhos/cm
Redox Potential:	186 millivolts
Odor:	None Noticeable
Appearance:	clear

Sample Number: 97LFGM03WA

Time of Sampling: 16:32

Rate of Sampling: Slowest sustainable non turbulent flow

FR-2**25 May 1997****Landfill Wells, Ft. Richardson****Sampling Point:** 2-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump (Grundfos RediFlow II); PVC riser; Homelight 5000 watt, 240 volt, generator, Grundfos BMI/MP1 voltage control box; Teflon sampling tube.

Casing top/water: 152.85 ft

Casing top/bottom: 167.0 ft (from record)

Purge Volume: 27 L

Purge Rate: 1.0 L/min

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 6.6 °C

pH: 6.58

Conductivity: 0.464 millimhos/cm

Redox Potential: 145 millivolts

Odor: None Noticeable

Appearance: clear

Sample Number: 9LFGM10WA

Time of Sampling: 10:30

Rate of Sampling: Slowest sustainable non turbulent flow.

FR-3**23 May 1997****Landfill Wells, Ft. Richardson****Sampling Point:** 2-inch Monitoring Well**Equipment:** Dedicated 2-inch stainless steel submersible pump (Grundfos RediFlow II); PVC riser; Homelight 4000 watt, 240 volt, 8 hp generator, Grundfos BMI/MP1 voltage control box; Teflon sampler.

Casing top/water: 152.10 ft

Casing top/bottom: 171.70 ft (from records)

Purge Volume: 39 L

Purge Rate: 1.0 L/min (290-300 Hz)

Sampled By: A. Ferguson

Physical Parameters and Observations at time of Sample Collection

Temperature: 7.3 °C

pH: 7.52

Conductivity: 0.364 millimhos/cm

Redox Potential: 120 millivolts

Odor: None Noticeable

Appearance: Brown/cloudy

Sample Number: 96LFR05GW

Time of Sampling: 10:50

Rate of Sampling: Slowest sustainable non turbulent flow (< 1L/min)