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**DRAFT
PRELIMINARY RISK EVALUATION
BAKERY TANK RELEASE AND
MONITORING WELL MW-3
CARRS FOODLAND,
FAIRBANKS, ALASKA**

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Conventional Base Line Risk Assessment (RA)

Brownfield concept

Ⓟ Greenfield "

Human Health RA

Pathways ⇒ Ingestion _____

Use Fate & Transport Model to give indirect #'s

FOR A COMPLETE PATHWAY ⇒ NEED ⇒ Pt. of Release

Medium

Route

& Contact w/ Target

Components of B.L.R.A. ⇒

1) DATA COLLECTION & EVALUATION

PRG's ⇒ Preliminary Remediation Goals

(formulas in RAG's that set cleanup
levels)

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DRAFT
PRELIMINARY RISK EVALUATION
BAKERY TANK RELEASE AND MONITORING WELL MW-3
CARRS FOODLAND, FAIRBANKS, ALASKA

1.0 INTRODUCTION

Shannon & Wilson, Inc. has conducted a preliminary risk evaluation of the residual contamination observed during site investigations conducted by Shannon & Wilson, Inc. in the vicinity of the former bakery 500 gallon underground heating oil tank, which was removed from Carrs Foodland, 526 Gaffney Road, Fairbanks, Alaska, in 1991. This evaluation, authorized on April 5, 1995, was conducted in general accordance with the scope of services dated March 31, 1995 (Shannon & Wilson, Inc., 1995b).

The objective of the preliminary risk evaluation was to assess potential threats posed to human health and the environment, particularly for off-site receptors and, if appropriate, to provide a basis for obtaining an exemption from further environmental activity from the Alaska Department of Environmental Conservation (ADEC). Surrounding anthropogenic background conditions and the presence of multiple potential sources in the vicinity were also considered in this evaluation. To achieve the project objective, Shannon & Wilson, Inc. conducted a water well search, records search, vicinity visit, evaluation of the analytical data for samples from the vicinity of the bakery tank, and semi-quantitative preliminary risk evaluation.

The preliminary risk evaluation was conducted within the constraints of the scope of services and budget, using professional judgment and substantive portions of relevant risk assessment guidance. The primary guidance documents used include:

- ▶ ADEC guidance (ADEC, 1990a; ADEC, 1990b; ADEC, 1991)

- ▶ *Risk Assessment Guidance for Superfund*, including Volume 1, Part A: Volume II and supplemental guidance (U.S. Environmental Protection Agency [EPA] 1989; EPA, 1989b; EPA, 1991; EPA, 1993)
- ▶ *Framework for Ecological Risk Assessment* (EPA, 1992)
- ▶ *EPA Region 10 Supplemental Risk Assessment Guidance for Superfund* (EPA Region 10, 1991)
- ▶ *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, American Society for Testing and Materials (ASTM), 1994
- ▶ *Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter*, Massachusetts Department of Environmental Protection (MDEP), 1994
- ▶ Miscellaneous scientific literature

2.0 BACKGROUND AND SITE DESCRIPTION

Carrs Foodland store is located at 526 Gaffney Road in Fairbanks, Alaska (Figure 1). The former bakery tank, a 500 gallon heating oil underground storage tank (UST), was located along the north side of the building (Figure 2). Fuel oil No.2 is believed to have been stored in this tank. This property is in a largely commercial area, although residences are also located in the vicinity northwest of the site. The nearest surface water body downgradient of the site is the Chena River, about 3,000 feet away. Based on limited site data and regional trends, groundwater flows to the north/northwest, in the general direction of the Chena River. Seasonal flow slightly east of north may also be occurring.

In 1991, Locher Interests Limited removed the 500 gallon Underground Storage Tank (UST) from the Foodland property (Locher Interests Limited, 1991). Soil samples in the resultant excavation and stockpile were submitted for laboratory analysis. Results of samples collected from the west and east ends of the tank excavation indicated petroleum hydrocarbon contamination of 98.7 and 3,170 milligrams per kilogram (mg/kg), by extractable petroleum hydrocarbon (EPH) EPA Method 3550/8100 modified. Excavated soils were placed in "contaminated" and "clean" stockpiles. A composite sample from each stockpile was analyzed. Concentrations in the "contaminated" stockpile were 3,700 mg/kg total petroleum hydrocarbons (TPH) by 418.1, not greater than the detection limit of 0.5 mg/kg for benzene, and 0.058 mg/kg total benzene, toluene, ethylbenzene, and xylene (BTEX) by EPA Method 8020. Hence, much of the contaminated soil was excavated, but some residual petroleum contamination remained.

In the summer of 1992, soil and groundwater sampling was conducted by Shannon & Wilson, Inc. in the vicinity of the former bakery tank. Soil samples from one boring were selected for submission for laboratory analysis, based on field screening results using a photoionization detector (PID). These samples were analyzed for petroleum hydrocarbons as diesel (DRPH) by EPA Method 3550/8100 modified, and for DRPH by toxicity characteristic leaching procedure (TCLP). In one soil sample and its duplicate, collected from a depth of 12.5 to 14 feet, 3,600 and 7,700 mg/kg of DRPH were detected. In a sample from a depth of 20 to 21.5 feet, DRPH

was detected at 140 mg/kg. The DRPH-TCLP result for a sample from 15 to 16.5 feet was 2.3 mg/l. These samples were collected within the zone of water table fluctuation. The DRPH observed is thought to have resulted from a release from the former bakery tank, or the piping system, or from overfills/spillage. No other chemical analyses of soil were conducted. Although surface soil samples were not analyzed in the lab, current surface contamination is not expected to be significant based on comparatively low PID readings, visual observations, and a lack of odor in the soil boring.

A monitoring well (MW-3) was installed at this location. Approximately 0.3 feet of floating free product accumulated in this well after installation. Its source is believed to be a release from the former bakery tank, its piping, or from overfills/spillage. Product was initially removed from the well by bailing, and long-term product recovery was attempted using a PetroTrap™. Although the PetroTrap™ did not recover any product, the product thickness dropped off rapidly with time (Table 1). By the spring of 1993 only a 0.25 to 0.5 inch was measured. By May 1993 only a trace remained. Free product levels gradually declined and were not observed, even at trace levels, by August of 1993.

To evaluate the impact or residual subsurface contamination on groundwater, quarterly groundwater sampling of monitoring well MW-3 for BTEX analysis was conducted between January 1994 and January 1995. Groundwater was also sampled in October 1995 and analyzed for volatile organic compounds by EPA Method 8260, and included alkylbenzenes, and for Polycyclic Aromatic Hydrocarbons (PAH) by EPA Method 8270. Results are presented in Tables 2 and 3. Benzene concentrations for the sample and the laboratory duplicate sample ranged from 8 to 38 $\mu\text{g}/\text{l}$, with an arithmetic mean of 25.2 $\mu\text{g}/\text{l}$. Concentrations of toluene, ethylbenzene, and xylenes were all less than maximum contaminant levels (MCLs). Alkylbenzene concentrations ranged from 5 to 200 $\mu\text{g}/\text{l}$, and noncarcinogenic PAH (nPAH) levels ranged from not above the detection limits to 190 $\mu\text{g}/\text{l}$. Carcinogenic PAHs (cPAH) were not reported above the detection limits. The analytical laboratory report for the October 1995 sample is included as Appendix B.

An evaluation of other chemicals detected elsewhere on the Carrs Foodland property is beyond the scope of this report; those detections are discussed only as they relate to the contaminants detected in the vicinity of the former bakery tank.

3.0 WATER WELL SEARCH

A records search of potential water well users within a ¼-mile radius, and in a downgradient direction from the bakery tank monitoring well MW-3, was conducted in an attempt to delineate dwellings in the potentially impacted area that may have their own water system. Available well data within this area were gathered from the United States Geological Survey (USGS) Water Resources Division, ADEC, and the State of Alaska Division of Land and Water Resources Management. Maps of the City of Fairbanks water distribution system were also obtained from the Municipal Utilities System (MUS). Dwellings or lots that did not show water service were noted on the maps, along with locations of wells identified from the information provided by the above-mentioned agencies. A field survey was then conducted to eliminate undeveloped lots, to verify the existence of buildings, and to note new dwellings on previously undeveloped lots. However, no door-to-door inquiries of residents were made. As a result of this search, no likely drinking water wells were identified within ¼ mile of monitoring well MW-3 and the former bakery tank. The closest identified potential drinking water well was located approximately 1,500 feet northeast from the former bakery tank (Figure 3). Possible use of closer wells for irrigation purposes was not ruled out.

4.0 RECORDS SEARCH

4.1 Data Sources Reviewed

Data sources reviewed included public records, maps, ADEC files, and Shannon & Wilson reports, and other reports on the Bakery Tank/Foodland Site. Specific data files and agency lists including the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), Resource Conservation and Recovery Act (RCRA) hazardous waste generators, and ADEC UST and contaminated sites lists were reviewed to obtain information regarding the presence of USTs, known release sites, and sites within a specified distance of the Carrs Foodland property.

Properties identified within specified distances from the site in the data sources that were reviewed are discussed below. Those properties, located crossgradient or upgradient are potential sources of off-site contamination that may contribute contaminants to monitoring well MW-3. Properties with leaking USTs and aboveground storage tanks (ASTs) are potential sources of groundwater contamination. Figure 4 shows some USTs and ASTs located in the site vicinity. Many of these contain heating oil and, like the bakery tank, are unlikely to be major sources of benzene. Data are not available to indicate if releases have occurred.

Reports for several sites in the vicinity were obtained from ADEC files and reviewed. These reports, including reports prepared by Shannon & Wilson for the Carrs Foodland site, are listed in Appendix A.

4.2 National Priorities List (NPL) (Superfund) Sites

Fort Wainwright is the only NPL site within 1 mile of the Foodland site.

4.3 U.S. EPA CERCLIS Sites (3/7/95) (EPA, 1995a)

No sites within ½ mile of the subject site are listed on the CERCLIS list.

**4.4 U.S. EPA RCRA Generators Hazardous Waste Generator's Report (3/24/95)
(EPA, 1995c)**

ADEC Fairbanks North Star Borough on 9th Avenue and Cushman is listed as a non-regulated generator.

Fairbanks North Star Borough on 1300 Minnie Street is listed as a small-quantity generator.

Petroleum Sales AIC Soil Services on 328½ Illinois Street is listed as a transporter, status unknown, and a used-oil recycler.

Ron's Service on 101 Noble Street is listed as a nonregulated, large-quantity generator.

Russell's Union 76 on 205 3rd (Graehl) is listed as a large-quantity generator.

* Totem Services, Inc. on 768 Gaffney Road is listed as a large-quantity generator.

General Services Administration (GSA) Fairbanks on 101 12th Avenue is listed as a conditionally exempt generator and a self-transporter.

Willner's Fuel Distribution on 401 Driveway Street is listed as a used-oil recycler.

K & W Transportation on 1801 Phillips Field Road is listed as a nonregulated, small-quantity generator and a nonregulated, commercial transporter.

Saupe Enterprises, Inc. on 418 Illinois Street is listed as a large-quantity generator.

4.5 ADEC Contaminated Sites List (3/16/95) (ADEC, 1995)

The Carrs Foodland site, which includes the bakery tank site, is listed on the ADEC Contaminated Sites List. Other listed sites that are located within 1/4 mile of the bakery tank/Foodland site include the former Tesoro gasoline station, the federal building motor pool

equipment building (GSA UST site), and the Noble Street Texaco. These sites are described below.

4.5.1 Carrs Foodland Site

The bakery tank site, described in Section 2.0, is part of the Carrs Foodland site. A second boiler heating oil tank containing diesel was also located on this property. Both tanks were removed by Locher Interests Limited in 1991. Some contaminated soil was removed during excavations to remove the two tanks. Groundwater was not encountered during excavations for tank removals. Sampling of excavation walls indicated the presence of residual levels of diesel range petroleum at both locations, but the extent of contamination remaining was not fully defined. Analysis of soil samples collected in 1992, during subsequent installation of monitoring wells by Shannon & Wilson in the area of the former tanks, indicate that residual subsurface petroleum remains at the location of the former bakery tank; however, no residual diesel range petroleum was detected in the soil samples from the MW-2 boring at the location of the former boiler heating oil tank. Groundwater is found at 13 to 18 feet below the surface in on-site monitoring wells. Results of groundwater sampling from monitoring well MW-2, located in the area of the former boiler heating oil tank, reported benzene concentrations of $4 \mu\text{g/l}$, and toluene, ethylbenzene, and xylenes were not above detection limits. Trichloroethylene and tetrachloroethylene detected in monitoring well MW-1 were not considered, because they are beyond the scope of this evaluation and are not considered to be site-related.

4.5.2 Former 7-Eleven Tesoro Store #105, 1246 Noble Street

The former Tesoro Store #105 is located southeast and about 300 feet upgradient of the bakery tank site. Four USTs were decommissioned and removed at this site beginning in September 1989. These included a 6,000-gallon diesel tank, two 8,000-gallon gasoline tanks, and a 500-gallon used-oil tank. According to reports from April 1991 through May 1995 obtained from ADEC files, contaminated soil and groundwater were encountered during tank closure operations. Some, but not all, contaminated soil was removed during tank closure in 1989; subsequent excavation the following year was commenced to remove additional contaminated soil at the water table (about 14 feet) until "clean" soil was encountered, or until limited by the

Noble Street right-of-way. Piping and vent lines, as well as the pump island, were removed in 1990 along with additional contaminated soil. A hydrocarbon sheen and odor were detected with groundwater during the 1990 excavation and removal operation. Post-excavation analyses confirmed that most of the contaminated soil had been removed.

One groundwater sample collected in the excavation had a benzene concentration of 460 $\mu\text{g/L}$. A soil sample taken during the subsequent installation of monitoring wells in the immediate vicinity of the tank removal area (MW-2), at a depth of 15 to 16.5 feet, showed 1.09 mg/kg of BTEX and 4 mg/kg of volatile petroleum hydrocarbons (VPH). Groundwater samples collected in February 1991 from these monitoring wells showed elevated levels of BTEX beneath the former tank areas, including up to 3,200 $\mu\text{g/l}$ of benzene in monitoring well MW-2. By the end of 1991 BTEX concentrations were clearly declining. In May 1991 a well (MW-4) was installed downgradient and near the property line. Groundwater samples collected from this well in May 1991 contained 59 $\mu\text{g/l}$ benzene and did not contain toluene, ethylbenzene, or xylenes above detection limits. Over time, BTEX levels rose and then fell in monitoring well MW-4.

Various other investigative and remedial activities (air sparging, nutrient addition) have since taken place at the Tesoro site. Most recently, a draft risk assessment and addendum (ES&E, 1993; and Environmental Fate and Risk, Inc., 1995) have been submitted to ADEC (it has not yet received agency review). These documents state that remedial efforts had reached a point of diminishing returns. They also state that the available data suggest BTEX constituents are migrating northwest, under the Carrs Foodland parking lot. The groundwater flow is reported to range from North 20° West to North 65° West. Benzene levels in groundwater samples collected in 1994 were as high as 100 $\mu\text{g/l}$ in MW-2 (below the former gasoline tank and piping). Up to 28 $\mu\text{g/l}$ of benzene was detected in groundwater collected from wells MW-5, MW-6, and MW-7, located downgradient on the Carrs Foodland property, although benzene was not detected in groundwater samples collected from those wells in 1994. Reported modeling results indicate that the plume from the Tesoro site is unlikely to migrate substantially further than about 250 feet downgradient of the UST excavation area. Given the uncertainties and imprecision generally associated with groundwater modeling, and given that the location of

monitoring well MW-3 is roughly 300 feet downgradient, it is possible that contaminants from the Tesoro release may have migrated to monitoring well MW-3.

4.5.3 Federal Building Motor Pool Equipment Building, 101 12th Avenue

This property is located about 1,400 feet east of the bakery tank site. A former 10,000-gallon gasoline tank and a 500-gallon used-oil tank were located at the General Services Administration (GSA) UST site. The 10,000-gallon UST was found to be leaking, and groundwater contamination was found. Relatively low concentrations of BTEX and total petroleum hydrocarbons (TPH) were detected in soil samples above a depth of 10 feet. However, at 15 feet (within the zone of water table fluctuation) up to 3,840 mg/kg of TPH, 240 mg/kg of benzene, and 2,610 mg/kg total BTEX was detected in a soil sample adjacent to the gasoline UST.

Groundwater sampling of monitoring wells began in 1991. Benzene concentrations in six monitoring wells ranged from not above the detection limit in the upgradient well to 5,080 µg/l. Toluene and ethylbenzene compounds were also detected above the maximum contaminant levels (MCLs) in one of the wells. Concentrations at on-site downgradient wells were somewhat lower (e.g., benzene levels detected in 1994 and 1995 vary from 8.9 µg/l to 1,200 µg/l).

4.5.4 Former Russell's Noble Street Texaco, 1200 Noble Street

This property is located about 200 feet east to northeast of the bakery tank site. According to the November 8, 1994, report Underground Storage Tank Closure Site Assessment, Noble Street Texaco, 1200 Noble Street, Fairbanks, Alaska, soil contamination was discovered following excavation of two 10,000-gallon gasoline USTs in the fall of 1994. Some gasoline and benzene contamination in soil were found at the water table. Detection in soil of up to 6,300 mg/kg gasoline and 2.4 mg/kg benzene were reported. Groundwater analytical results were not available, although groundwater sampling was recommended.

4.6 ADEC UST Database (March 30, 1995)

ADKO Cleaners, 407 Gaffney Road: one 500-gallon Chevron Thinner 325 UST is registered at this facility, located upgradient of the bakery tank site.

Russell's Noble Street Texaco, 1200 Noble Street: one 500-gallon used-oil UST is registered at this facility, located crossgradient of the bakery tank site.

Wilbur Brothers Mechanical, 1240 Noble Street: one 1,000-gallon gasoline UST is registered at this facility as temporarily out of use for an unspecified reason. This site is upgradient of the bakery tank site.

Fairbanks Toll Center, Alascom, 260 Gaffney Road: one 2,000-gallon diesel UST is registered as removed at this facility.

5.0 SITE AND VICINITY VISIT

in vicinity

Dennis Peterson, a Shannon & Wilson, Inc. geologist, conducted visits to the subject site and vicinity to identify USTs and other potential sources of contamination. At least 14 underground heating oil tanks were identified in the vicinity, one of these tanks had a severely bent fill and vent pipe and a copper pipe entering the vent pipe. This UST with the damaged fill and vent pipe was located almost due south of monitoring well MW-3. ADKO Cleaners and Coin King Laundromat located south of Carrs Foodland had drums that contain, or contained, dry-cleaning fluid. A 500-gallon UST containing thinner was also present. A flammables building, the contents of which are unknown, was located near the southeastern edge of the Fairbanks Rescue Mission property.

Although the status of most of the tanks and other potential sources is unknown, there appears to be a high potential for subsurface petroleum contamination and perhaps other types of contamination, based on the observed potential sources in the area.

6.0 PRELIMINARY RISK EVALUATION

The information presented above was considered in evaluating the potential threats to human health and the environment posed by chemicals present in soil at the former bakery tank and groundwater in monitoring well MW-3. The risk assessment process consists of the following steps:

- Data Evaluation and Identification of Chemicals of Potential Concern (COPC)
- Exposure Assessment
- Toxicity Assessment
- Fate and Transport Evaluation
- Risk Characterization
- Uncertainty Analysis

6.1 Data Evaluation and Identification of COPCs

The limited data, described in Section 2.0, is sufficient to conduct a semiquantitative assessment of the potential threat to human health and the environment. However, the uncertainty associated with the risk assessment is higher than it would be if more data were available. Data quality from other studies could not be evaluated.

Although no surface soil samples were analyzed in a laboratory, available field data and observations suggest that there is no surface soil contamination at the site of the former bakery tank. However, contamination exists at a depth near to, and below, the water table. The fuel type is thought to have been fuel oil No. 2 which is consistent with the analytical data results eluting in the diesel range. As described in Section 2.0, BTEX, noncarcinogenic PAHs, and alkylbenzenes were detected in groundwater samples from monitoring well MW-3.

Petroleum products are complex mixtures of large numbers of chemicals. Because evaluation of every constituent is not practical or possible, it is common practice to look at individual indicator compounds, surrogates, whole mixtures, or some combination of these to assess

transport and risk. The appropriateness of each method is influenced by site-specific conditions. A whole mixture approach was deemed inappropriate since the only complete exposure pathway involves groundwater, where only the more mobile constituents are likely to be present. Fuel oil No. 2 is typically comprised of about 75 percent paraffins (aliphatic compounds such as the largely immobile, insoluble alkanes) and 25 percent aromatic hydrocarbons (MDEP, 1994). Most of these aromatic hydrocarbons have two or more rings, although about one-fifth of the aromatic hydrocarbons are alkylated benzenes (MDEP, 1994).

Although paraffins and cPAHs are potential COPC in soils, a complete exposure pathway warranting quantitative evaluation was not identified for this medium (see section 6.2). Therefore, the more mobile aromatic constituents of fuel oil No. 2 (alkylbenzenes and low molecular weight PAHs) were selected as COPC for groundwater. Benzene is not commonly considered a COPC at petroleum sites contaminated with fuel oils such as fuel oil No. 2, because benzene is found in low concentrations in fresh product (ASTM, 1994) and even lower levels in weathered environments. However, because BTEX were detected in groundwater from monitoring well MW-3, BTEX compounds were retained as COPC.

For those PAHs and alkylbenzenes that lack toxicity data in Integrated Risk Information System (IRIS), 1995 or Health Effects Assessment Summary Tables (HEAST), 1994, the range of available toxicity values for other chemicals within each of these groups was used as a surrogate in the uncertainty section. In the case of naphthalene, the withdrawn IRIS value was used.

6.2 Exposure Assessment

Chemicals in the environment only pose a potential threat if exposure can occur. This exposure assessment evaluates the potential for and magnitude of exposure. Given the depth of known contamination and suspected limited volume, volatile release to the air is expected to be minimal.

6.2.1 Characterization of Exposure Setting

The former bakery tank, a heating-oil UST, was located adjacent to the north side of the Carrs Foodland store at 526 Gaffney Road in Fairbanks, Alaska. This property is in a mixed commercial and residential area. Most of the property is paved or covered by structures, with the exception of limited landscaping, and no substantial habitat for ecological receptors is present. The area of the former bakery tank is not paved, although access to the bakery tank area is restricted by a 6-foot-high wood fence. Known contamination is located at depth and not available for direct contact. Future use of the property is not expected to differ from the current use as a grocery store.

Because there are contaminants in soil at the water table and in groundwater, downgradient transport to off-site receptors is a possibility. Based on limited site data and regional trends, groundwater flows to the north/northwest, although seasonal flow slightly east of north may also occur. The nearest surface water body downgradient of the site is the Chena River, located about 3,000 feet away. Groundwater is thought to discharge to the river, at least seasonally. Therefore, recreationists and aquatic receptors could be exposed if contaminants migrated to the river at significant levels. In addition, if there are any drinking water or irrigation wells downgradient of the site, residents or gardeners could potentially be exposed. There are no known drinking water wells within ¼ mile of the site. The possibility that irrigation wells may be located closer was not ruled out. Because municipal water is widely available in the area and the naturally-occurring groundwater quality is poor, future installation of drinking water wells in the area is unlikely.

6.2.2 Conceptual Site Model

For an exposure pathway to be complete and exposure to occur, there must be a source and mechanism of chemical release, a retention or transport medium, a point of contact with the exposure medium, and an exposure route at the exposure point. These elements of a conceptual model for the bakery tank site are described below.

6.2.2.1 Sources and Release Mechanisms

The bakery tank is a historical primary source that no longer exists. Based on PID readings and the absence of odor, no secondary source of surface soil contamination appears to exist. Historical releases from the bakery tank, associated piping, overfills/spills primarily to subsurface soil, and releases from upgradient and crossgradient off-site facilities, with subsequent transport in groundwater, constitute potential secondary sources of contamination. The bakery tank is believed to have contained fuel oil No. 2, which is comprised primarily of C10-C20-range aliphatic hydrocarbons, PAHs (primarily lower molecular weight, noncarcinogenic PAHs), and alkylated benzenes. Fuel oil No. 2 also contains low levels of BTEX compounds. Some possible off-site sources of contaminants were identified in Section 4.0. Of these, upgradient and crossgradient USTs, from which gasoline and other petroleum releases are known to have occurred, are also considered possible additional sources of the BTEX and other chemicals detected in groundwater in monitoring well MW-3.

6.2.2.2 Retention Medium or Transport Mechanisms

Subsurface soil is a retention medium for petroleum contaminants, especially the higher molecular weight PAHs and the aliphatic compounds, such as alkanes, that tend to strongly adsorb to soil, be insoluble in water, and have relatively low vapor pressures. These compounds are considered immobile in soil. Over time, lower molecular weight PAHs (IPAHs), alkylated benzenes, and certain aliphatic hydrocarbons such as shorter-chained alkanes may migrate from soil to groundwater and/or to indoor or outdoor air. Contaminants transported in groundwater from upgradient sources may adsorb to soil within the water table. Contaminants from fuel releases from the bakery tank or from other upgradient sources may be subsequently transported to downgradient irrigation wells, drinking water wells, or surface water. Contaminants in groundwater may be ingested or inhaled following release to the air during household water use. Contaminants reaching irrigation water or surface water may subsequently enter the food chain or be released to the air.

6.2.2.3 Exposure Pathways

Probable, possible, and nonviable (incomplete or not substantial) exposure pathways associated with site contaminants are identified below by receptor. Exposure may occur through three primary routes: ingestion, inhalation, and dermal contact.

6.2.2.3.1 Probable Exposure Pathways

No probable exposure pathways were identified.

6.2.2.3.2 Possible Exposure Pathways

The following exposure pathway is considered possible, but unlikely:

Exposure of downgradient residents using groundwater as a source of drinking and household water: Dispersion, adsorption to downgradient soil within the water column, chemical and biological degradation, and volatilization processes will likely reduce concentrations reaching the nearest well identified in the well search, which is over ¼ mile away. Thus, it is unlikely that toxicologically significant levels of contaminants would reach a receptor. However, this possibility is considered further. Exposure routes for this potential receptor include ingestion of groundwater and inhalation of volatile chemicals released from groundwater during household water use. Dermal exposure to groundwater is not considered, but is not expected to be significant relative to the other routes of exposure.

6.2.2.3.3 Nonviable Exposure Pathways

The following exposure pathways are considered nonviable and are not considered further:

On-site exposure of ecological receptors: Because most of the property is paved or covered by structures, with the exception of limited landscaping, there is no substantial habitat for ecological receptors. Therefore, on-site ecological exposure pathways are incomplete.

On-Site Exposure of Human Receptors: Although quantitative evaluation of on-site exposure is beyond the scope of this assessment, the potential for on-site exposure is discussed qualitatively. On-site exposure to contaminants associated with the former bakery tank area is unlikely to be substantial.

Direct contact with surface soil may be an incomplete exposure pathway, based on available field data and observations that suggest that there is no surface soil contamination associated with the former bakery tank. Even if some surface contamination is present, there is little potential for exposure because access to the former bakery tank area is restricted by a 6-foot fence. If select workers occasionally enter this area through a service access door or a trespasser scales the fence, intake via direct contact with surface soil or inhalation of chemicals released to air from surface or subsurface soils is not expected to be substantial, given the short duration and intermittent nature of exposure.

Contamination is known to exist in the groundwater and subsurface soils beneath the former bakery tank. The current water source for the property is the city water supply and subsurface soils cannot be accessed without digging or excavation. Future use of groundwater is very unlikely given current use of the city water supply. Future disturbance of subsurface soil is unlikely because of the proximity of the former tank area to the grocery store structure and the difficulty in accessing this area with large equipment. Therefore, on-site exposure directly to these media is not occurring.

If volatile organic compounds (VOCs) are released from soil and groundwater to overlying outdoor air or adjacent soil gas, they may migrate beyond the fence boundaries. Given that the levels of VOCs are unknown in subsurface soil and are relatively low in groundwater, these media may not be a viable source of release to soil gas or overlying ambient air. Further, any VOCs released to outdoor air would be rapidly dispersed and should not pose a threat.

Theoretically, migration and accumulation of VOCs in indoor air via horizontal and/or vertical migration from soil gas to and through cracks that may exist in the structure's concrete slab foundation could occur. However, measurable levels of VOCs are not expected to reach indoor air for the following reasons: (1) the volume of viable source limited and is small relative to the structure size, (2) the source area is not located beneath the building or its foundation (though the source area has not been fully delineated, contaminated soil and groundwater at the former bakery tank is overlain by soil and potentially, to a limited extent, by the building or its foundation), (3) because known contamination is primarily near or within the saturated zone; the competing process of dissolution in percolating water and groundwater and adsorption to soil reduces the potential for migration of VOCs from deep soil or groundwater to the air above or soil gas adjacent to the former bakery tank area, and (4) the continuous opening and closing of doors typical of a grocery store setting and the associated air exchange would further reduce any low levels of VOCs that may reach indoor air.

Exposure of aquatic receptors in the Chena River: Because of the distance to the Chena River (about 3,000 feet, or more than ½ mile), processes such as dispersion, readsorption, volatilization, and degradation are likely to have reduced chemical concentrations at the discharge point to below measurable levels. Concentrations would be further reduced by mixing within the river. Therefore, exposure of aquatic receptors was considered an incomplete pathway.

Exposure of recreationists using the Chena River, or those possibly using the river as a source of drinking water: Because of the distance to the Chena River (about 3,000 feet), measurable levels of contaminants from the site are not expected to reach the river.

Exposure of downgradient gardeners using groundwater for irrigation: This pathway is considered nonviable because the only COPCs likely to migrate off the site (e.g., IPAHS, BTEX, and some alkyl benzenes) would not tend to accumulate in irrigated soils, due to

their tendency to volatilize in surface environments. Significant exposure via inhalation is not expected because of rapid dispersion in air and limited likely exposure time, unless large volumes of water are being used for irrigation.

Exposure of downwind residents or workers: Because there are no known contaminants in surface soil, downwind particulate transport is not considered viable. Because volatile chemicals (e.g., BTEX and IPAHS) migrating from soil or groundwater and subsequently released to outdoor air would rapidly disperse, they are unlikely to reach downwind receptors at significant levels.

6.2.2.4 Point of Contact with the Contaminated Medium

Surface soil contamination does not appear to exist; therefore, direct contact with surface soil or with wind-borne particulates is not of concern. Direct contact with subsurface soil is not possible unless actions are taken to expose or relocate these soils. This is unlikely given the proximity of the source area to the building. Because there is no viable habitat on site, ecological receptors will not regularly contact contaminated media unless contaminants are transported via groundwater to the Chena River. Because contaminants are not expected to reach the river at measurable concentrations, no further evaluation was conducted for ecological receptors. Similarly, although recreationalists may come into contact with river water, sediment, and biota, they are unlikely to be exposed to contaminants from the site. Exposure to groundwater will only occur if a drinking water or irrigation well exists within a contaminant plume. The closest drinking water well is more than ¼-mile downgradient and is unlikely to be affected from the bakery tank release, but is retained as the only potential contact point warranting evaluation. The possible presence of irrigation wells located closer to the site was not ruled out. However, because of the limited length of likely exposure to and low bioaccumulation potential of the COPCs, further evaluation on exposure via irrigation wells was not conducted.

6.2.3 Development of Exposure Point Concentrations

Because the only potentially complete exposure pathway likely to be significant involves contaminant transport through groundwater, the most mobile constituents are of the greatest concern. Analytical data are available for IPAHS, alkylbenzenes, and BTEX, the more mobile constituents of fuel oil No. 2. Because only a limited amount of data are available, rigorous statistical treatment of data was not possible. However, sampling (MW-3) was targeted at groundwater underlying the suspected residual source area. A hypothetical receptor at this location would have a considerably higher level of exposure than the nearest known receptor which is located over ¼ mile away. Detected concentrations of PAHs and alkyl benzenes from a single recent round of groundwater sampling at MW-3 were used as exposure point concentrations (EPCs). For VOCs detected in the October 1995 sample and duplicate, the average concentration of each chemical detected in the duplicate pair was used. Results of the groundwater monitoring over six periods at MW-3 were averaged (Table 2) to develop EPCs for BTEX constituents, as recommended in Environmental Protection Agency (EPA) guidance (EPA, 1993). The highest detectible concentration between the sample result and the laboratory duplicate result for each analyte were used to develop the EPCs.

6.2.4 Exposure Parameters

Because this is a preliminary risk evaluation, site-specific estimates of intake were not derived; rather, standard EPA Region 10 residential default exposure parameters that take into account drinking water ingestion and inhalation of released volatile chemicals were used (EPA Region 10, 1991). These are listed in Table 4.

6.3 Toxicity Assessment

Chemicals produce two primary classes of toxic effects, namely, carcinogenic and noncarcinogenic. Individual chemicals may produce one or both types of effects. EPA classifies chemicals by carcinogenicity into one of five groups (EPA, 1994), including:

Group A	Human Carcinogen - adequate evidence of carcinogenicity to humans
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Group B	Probable human carcinogen - for B1 carcinogens there is limited evidence in humans; for B2 carcinogens there is sufficient evidence in animals with inadequate or no evidence in humans
Group C	Possible human carcinogen - limited evidence in animals and inadequate or no evidence in humans
Group D	Not classifiable - inadequate or no evidence
Group E	Noncarcinogen - no evidence of carcinogenicity based on adequate studies

Acute and chronic exposure to chemicals may result in a large range of effects other than cancer, from a transient headache or eye irritation to serious, even fatal, health impacts. Among these impacts are adverse effects on the skin, central nervous system, liver, kidneys, blood, reproductive system, and developing fetuses.

Evaluating the toxicity of petroleum mixtures is complicated by uncertainties about the type of petroleum present on site, and the large number of constituents that make up a given petroleum product. The potential carcinogenic and noncarcinogenic effects of petroleum products in general, fuel oil No. 2 in particular, certain individual constituents of fuel oil No. 2, and BTEX are discussed below.

6.3.1 Petroleum Products

Petroleum products consist primarily of aliphatic hydrocarbons (e.g., paraffins, such as heptane; cycloparaffins or naphthenes, such as methylcyclopentane; and alkenes or olefins, such as 1,3-butadiene), monocyclic aromatic hydrocarbons (e.g., benzene, toluene, ethylbenzene, xylenes, and other alkylated benzenes), polycyclic aromatic hydrocarbons (e.g., benzo(a)pyrene and naphthalene), and additives (Norman, 1991).

The toxicity of most petroleum mixtures has not been well characterized. In general, the aromatic constituents are the most toxic components of petroleum (Norman, 1991). Many of the aromatics are carcinogenic, including benzene and several higher molecular weight PAHs, such as benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. Ethylbenzene, toluene, xylenes, naphthalene, and certain other lower molecular weight PAHs exhibit noncarcinogenic toxic effects. The aliphatic hydrocarbons are generally less toxic, although some are associated with central nervous system (CNS) depression and kidney damage. Most petroleum products are irritants. The lighter distillates, such as gasoline or stoddard solvent, tend to contain a higher percentage of volatile aromatics, whereas PAHs are found at increasing levels in the heavier distillates (Norman, 1991). The carcinogenic PAHs tend to distill at temperatures higher than required to produce middle distillates such as fuel oil No. 2 (Millner, 1992, and Weaver, 1988). Hence, the concentration of carcinogenic PAHs in light and middle distillates is normally low (Millner, 1992).

6.3.2 Fuel Oil No. 2

Fuel oil No. 2 is typically comprised of about 75 percent paraffins and 25 percent aromatic hydrocarbons (MDEP, 1994). Most of these aromatic hydrocarbons have two or more rings, although about one-fifth of the aromatic hydrocarbons are alkylated benzenes (MDEP, 1994). Fuel oil No. 2 is considered a Group D carcinogen, which is unclassifiable as to its carcinogenicity. Some of its constituents may be carcinogenic, but the majority of the constituents produce noncarcinogenic effects.

Because petroleum products such as fuel oil No. 2 are complex mixtures of large numbers of chemicals, evaluation of every constituent is not practical or possible. Therefore, it is common practice to look at individual indicator compounds, surrogates, whole mixtures, or some combination of these to assess toxicity. Because the only complete significant exposure pathway being evaluated involves contaminant leaching to and migration in groundwater, only the more mobile constituents are of concern. Therefore, a whole mixture surrogate approach for fuel oil No. 2 was deemed to be inappropriate. Most aliphatic hydrocarbons strongly adsorb to soil and

are not water soluble. They are considered relatively immobile, although the shorter-chained aliphatic hydrocarbons may volatilize. However, most aliphatic hydrocarbons with ten or more carbon atoms, such as those found in fuel oil No. 2, are considered immobile in the subsurface unless dissolved in nonaqueous phase liquid (NAPL) due to low water solubilities, low vapor pressures, and strong adsorption to soil. Aromatic hydrocarbons of the same molecular weight are more water soluble than aliphatic hydrocarbons. Therefore, only aromatic hydrocarbons were evaluated further using analytical data for BTEX, other alkylated benzenes, and PAHs. Carcinogenic PAHs (cPAHs) were not detected probably because of the very low mobility of the higher molecular weight cPAHs and their low concentrations in fuel oil No. 2.

6.3.3 Individual Fuel Oil Constituents and BTEX

The toxic effects of some individual fuel oil No. 2 constituents are described qualitatively below. The toxic effects of BTEX compounds are also described.

6.3.3.1 Benzene

Benzene readily volatilizes into the air and is somewhat soluble (approximately 1,780 mg/L) in water. It is readily absorbed following oral and inhalation exposure. The toxic effects of benzene in humans and animals from inhalation exposure include effects on the Central Nervous System (CNS), blood, and immune system. Acute exposures to high concentrations of benzene vapors have been associated with dizziness, nausea, vomiting, headache, drowsiness, narcosis, coma, and death. Chronic exposure can produce low blood cell counts. Benzene induces solid tumors and leukemia in rats, and there is some evidence that it may lead to leukemia in humans. Benzene is classified by EPA as a Group A human carcinogen (Clement, 1985).

6.3.3.2 Toluene

Toluene is mobile in the environment, dissolving slightly (approximately 500 mg/l) in water or volatilizing to the air (Norman, 1991). It is readily absorbed via inhalation and dermal exposure. The acute effects of inhalation of toluene are depression of the CNS and narcosis. In animal experiments, acute oral and inhalation exposure can result in CNS depression and lesions of the lungs, liver, and kidneys. Chronic human exposure to toluene has been associated

with CNS and peripheral nervous system effects and impacts on the liver and kidneys (Clement, 1985). Toluene produces disorientation and liver damage (Norman, 1991). In animals, chronic exposure results in CNS toxicity and reduced hematocrit values. There is some evidence that oral exposure may lead to embryotoxicity. Inhalation exposure may also lead to skeletal retardation in animals (Clement, 1985).

6.3.3.3 Ethylbenzene

Ethylbenzene is mobile in the environment, dissolving slightly (approximately 150 mg/L) in water or volatilizing to air. Ethylbenzene is toxic to the liver, kidneys, and CNS (Norman, 1991). Short-term human inhalation exposure can result in sleepiness, fatigue, headache, and mild eye and respiratory irritation. In animals subjected to longer-term exposures, impacts to the liver and kidneys have been observed, as has maternal toxicity (Clement, 1985).

6.3.3.4 Xylenes

Xylenes are relatively mobile in the environment, dissolving slightly (approximately 150 mg/l) in water or volatilizing into the air (Norman, 1991). They are readily absorbed via inhalation or ingestion. Dermal absorption of liquid xylene also occurs readily (Clement, 1985). Xylenes are toxic to the CNS (Norman, 1991). Acute inhalation exposure in humans can result in CNS and lung impacts. In animals liver toxicity, CNS toxicity, and fetotoxicity have been observed from longer-term exposure. There is limited evidence of carcinogenicity to animals (Clement, 1985).

6.3.3.5 Other Alkylbenzenes

Other alkylbenzenes detected include isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, sec-butylbenzene, and p-isopropyltoluene. These chemicals are less volatile and less water soluble than toluene, ethylbenzene, and xylene. Because they can volatilize from soil and surface water and will be biodegraded, they are not very persistent in the environment (Clement, 1985).

Limited toxicity data are available for these chemicals. The alkylbenzenes are not very toxic. However, at high doses they are irritants and can cause central nervous system anomalies. Isopropyl benzene can affect the eyes, upper respiratory system, skin, central nervous system, and kidneys. Trimethylbenzenes can cause dizziness, headaches, fatigue, nausea, gastrointestinal upset, nervous tension, effects on the blood cells (such as anemia) and on the blood's clotting ability, irritation to the skin, eyes, nose, throat, and respiratory system, and possibly teratogenic effects (Clement, 1985; Sittig, 1991; IRIS, 1995).

6.3.3.6 Naphthalene

Naphthalene is relatively mobile in the environment through volatilization and, to a lesser degree, limited (approximately 32 mg/l) solubility in water. Naphthalene readily adsorbs to soil. Biodegradation of naphthalene by microorganisms is more efficient in soil than in aquatic systems. Inhalation of naphthalene may cause headache, loss of appetite, nausea, and kidney damage in humans and animals. Acute hemolytic effects are reported for ingestion or inhalation of large quantities of naphthalene. Both ingestion and inhalation can affect the eye. Effects on skin and neurological systems have also been observed in animals. Developmental toxicity in rats has been observed. There are no studies available suggesting naphthalene is carcinogenic in humans. This compound is not generally considered to be carcinogenic in animals, although there is some evidence suggesting possible weak carcinogenicity in rats. Naphthalene is reported to produce DNA damage in rats (Clement, 1985).

6.3.3.7 Other Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are rather persistent in the environment. They adsorb strongly to soil. Although they are relatively insoluble in water (typically 5 to 0.01 mg/l), the dissolved portion may undergo rapid direct photolysis if the water reaches the surface. Data suggest that PAHs are degraded slowly by microbes. Some PAHs produce carcinogenic effects, while others produce noncarcinogenic impacts (Clement, 1985).

Carcinogens - Several PAHs are considered probable or possible human carcinogens (Norman, 1991). These include: benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)-fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene.

Noncarcinogens - Noncarcinogenic PAHs include: anthracene, benzo(g,h,i)perylene, fluoranthene, naphthalene (discussed earlier), phenanthrene, and pyrene. Noncarcinogenic effects from PAHs include malaise, tremors, vomiting, and eye damage (Norman, 1991), as well as skin disorders, immunosuppression, and adverse effects on the liver and kidneys. Limited available data indicate that PAHs are not potent teratogens or reproductive toxins (Clement, 1985).

6.3.3.8 Alkanes

Most petroleum products, including fuel oils, consist predominantly of aliphatic hydrocarbons including alkanes. Alkanes are essentially insoluble in water; their very limited solubility decreases with weight. Vapor pressure (volatility) also decreases with weight. Because of their high octanol/water partition coefficient, they tend to bind readily to organic materials in soil and are unlikely to be very mobile in the environment. Because of their properties, alkanes were not selected as COPC in groundwater. The principal fate of alkanes is probably biodegradation by microorganisms in the soil. Hexane has been associated with some nervous system effects, but there is no evidence that longer-chain or branched alkanes have this same effect. In tests examining suppression of the action potential in nerve cells, longer-chain alkanes were progressively less active than shorter-chain alkanes. In another animal study, it was noted that toxicity generally increases with the number of carbons up to octane and then declines (Clement, 1985). However, in another study heptane did not exhibit any neurotoxicity (Weaver, 1988). Alkanes are irritants; this effect increases with the number of carbons, at least up to C9 (Clement, 1985). Hexane and octane may cause kidney damage (Norman, 1991). Toxicity of alkanes is generally thought to decline as carbon chain length increases (ASTM, 1994), although there are some conflicting studies. No information is available to suggest that alkanes are likely to be carcinogenic, mutagenic, or teratogenic (Clement, 1985).

6.3.4 Quantitative Toxicity Information

Although there is a low probability that exposure will occur, the toxicities of the COPCs were evaluated to relate potential exposures to risk. Quantitative toxicity data for alkylbenzenes, PAHs, and BTEX available in IRIS (EPA, 1995b) and Health Effects Assessment Summary Tables (EPA, 1994) are presented in Table 5. Toxicity values were not available for several of these chemicals. These chemicals were evaluated in the uncertainty section using the range of available toxicity values for similar chemicals as a surrogate.

6.4 Fate and Transport Evaluation

The only potentially complete exposure pathway evaluated is migration of contaminants from soil near the former bakery tank and groundwater in monitoring well MW-3 to a groundwater receptor located more than ¼ mile downgradient of the site. Of the constituents of fuel oil No. 2 likely to be present in soil, only the alkylated benzenes and lower molecular weight noncarcinogenic PAHs, such as naphthalene and fluorene, are likely to leach to groundwater. This is because alkanes, especially those with ten or more carbon atoms such as in fuel oil No. 2, are immobile in soil and insoluble in groundwater. Also, higher molecular weight PAHs, including cPAHs, are considered nearly immobile in soils. Further, cPAHs are not expected to be present at high levels from a fuel oil No. 2 release because they boil at a temperature higher than that at which this product is distilled. Further, cracking processes, which tend to increase PAH content, are not generally used when refining fuel oil. This is supported by the absence of detectable cPAHs ($<0.51 \mu\text{g/l}$) in the most recent round of groundwater sampling.

BTEX, alkylbenzenes, and PAHs have been analyzed in groundwater from monitoring well MW-3. The average benzene concentration in groundwater is $25.2 \mu\text{g/l}$, and toluene, ethylbenzene, and xylene levels were less than the respective MCLs. The PAHs and the less mobile alkyl benzenes were also detected at relatively low levels in groundwater from monitoring well MW-3. Chemicals detected in MW-3 are unlikely to reach a well over ¼-mile downgradient at significant levels because dispersion, chemical and biological degradation, readsorption to soil, and volatilization will substantially reduce the concentrations.

6.5 Risk Characterization

Although it is considered unlikely that substantial levels of contaminants will reach the nearest known current downgradient well over ¼ mile away, both cancer and noncancer effects potentially posed by the contamination associated with the bakery tank and monitoring well MW-3 area were evaluated. Risks from ingestion of groundwater and inhalation of volatile chemicals released during household water use were estimated for a hypothetical residential receptor extracting their water from monitoring well MW-3. This is not a feasible receptor, but if hypothetical risks from exposure to groundwater drawn from this location do not exceed generally accepted risk levels, then it can be concluded that off-site downgradient receptors are not threatened. This is because downstream receptors would be exposed to lower concentrations than the hypothetical receptor located at monitoring well MW-3. Hypothetical cancer risk estimates were calculated using exposure point concentrations, exposure parameters, and toxicity factors presented in Tables 2, 3, 4 and 5 in the following equation:

$$\text{Cancer Risk} = C(\text{mg/L}) \times \left[\frac{2\text{L/day} \times 350 \text{ days/yr} \times 30 \text{ yr}}{70 \text{ kg} \times 70 \text{ yr} \times 365 \text{ days/yr}} \times SF_o + \frac{0.5\text{L/m}^3 \times 15 \text{ m}^3/\text{day} \times 350 \text{ days/yr} \times 30 \text{ yr}}{70 \text{ kg} \times 70 \text{ yr} \times 365 \text{ days/yr}} \times SF_i \right]$$

Similarly, hypothetical hazard quotients (HQ; the ratio of exposure levels to acceptable levels) were calculated for non-carcinogens as follows:

$$HQ = C(\text{mg/L}) \times \left[\frac{2\text{L/day} \times 350 \text{ days/yr} \times 30 \text{ yr}}{70 \text{ kg} \times 30 \text{ yr} \times 365 \text{ days/yr}} / RfD_o + \frac{0.5\text{L/m}^3 \times 15 \text{ m}^3/\text{day} \times 350 \text{ days/yr} \times 30 \text{ yr}}{70 \text{ kg} \times 30 \text{ yr} \times 365 \text{ days/yr}} / RfD_i \right]$$

For nonvolatile chemicals or volatile chemicals lacking inhalation toxicity factors, the inhalation portion of the equation was dropped.

The estimates of cancer risks and hazard quotients for a hypothetical residential receptor using water from monitoring well MW-3 are presented in Table 6. The total estimated cancer risk was

estimated to be 4.1×10^{-5} , which is within the generally accepted target cancer risk range of 10^{-6} to 10^{-4} . Further, a realistic receptor withdrawing water from a well located over ¼-mile downgradient would be at even lower risk. The hypothetical hazard quotient estimated ranged from 0.0014 to 0.41, with a total hazard index of 0.58 for all noncarcinogenes for which IRIS (1995) or HEAST (1994) reference bases were available. A hazard index less than 1 indicates that adverse noncarcinogenic effects are not expected to occur.

6.6 Uncertainty Analysis

Uncertainties are associated with each step in the site investigation and risk assessment process. To mitigate for these uncertainties, conservative approaches and assumptions were used. A detailed uncertainty analysis was not conducted and is beyond the scope of this assessment. However, the uncertainty associated with detection limits for cPAHs was evaluated. The potential threat posed by alkylbenzenes and nPAHs detected in groundwater for which toxicity data were not available from IRIS (1995) or HEAST (1994) was also considered. These evaluations better define the associated uncertainties and reduce their magnitude but cannot totally eliminate them.

6.6.1 Detection Limits for cPAHs

Typically cPAHs are not a substantial constituent of fuel oil No. 2. However, because of the high toxicity of cPAHs, even at low levels, and because the identity of the fuel in the former bakery tank is not certain, groundwater was analyzed for cPAHs. Even when cPAHs are analyzed for and not detected, some uncertainty remains regarding potential risks because of the difficulty in obtaining detection limits for cPAHs that are below risk-based levels. To reduce the degree of uncertainty, the laboratory was consulted regarding the possibility of achieving lower quantitation limits. As a result, a quantitation limit of $0.5 \mu/l$ was obtained. Thus, if cPAHs are present in groundwater at a concentration between 0 and $0.5 \mu/l$, the associated risk associated with groundwater ingestion at a default residential levels would range from 0 to between 4.3×10^{-8} to 4.3×10^{-5} for each of the seven cPAHs. Further, cPAHs are considered immobile in the subsurface soil. This is because of their tendency to strongly sorb to soil and because of their very low water solubility. Thus, cPAHs, if present, would not migrate far from

the site before being readsorbed. Given that the nearest suspected receptor is over ¼ mile away, any cPAHs potentially present in groundwater at levels below the 0.5 µg/l quantitation limit should not pose a threat to downgradient receptors. Further, future installation of drinking water wells closer to the site is unlikely, due to the availability of city water and the poor quality of area groundwater with its hardness and high levels of naturally-occurring inorganic compounds.

6.6.2 Alkylbenzenes and nPAHs That Lack Toxicity Values

Dibenzofuran; phenanthrene; 2-methylnaphthalene; n-propylbenzene; 1,3,5-trimethylbenzene; 1,2,4-trimethylbenzene; sec-butylbenzene; and p-isopropyltoluene were detected in groundwater from MW-3. However, toxicity values for these chemicals are not available in IRIS (1995) or HEAST (1994). Obtaining toxicity values from other alternative sources or derivation of toxicity values for such chemicals is beyond the scope of this assessment. To better characterize this uncertainty, structurally similar chemicals that often have similar toxicological effects were used as surrogates.

The range of toxicity values available for naphthalene, phenanthrene, and fluorene was used as a surrogate for the remaining three nPAHs that lack toxicity values (dibenzofuran, phenanthrene, 2-methylnaphthalene). Using the sum of the detected concentrations of dibenzofuran, phenanthrene, 2-methylnaphthalene, and the surrogate toxicity values, a HI range of 0.047 to 0.071 was estimated. The range of toxicity values available for toluene, ethylbenzene, and xylenes were used as surrogates for the other alkylbenzenes detected that lack toxicity values (n-propylbenzene; 1,3,5-trimethylbenzene; 1,2,4-trimethylbenzene; sec-butylbenzene; and p-isopropyltoluene). The toxicity values for isopropylbenzene were considered inappropriate for use as a surrogate for other alkylbenzenes due to the limited toxicity data base, low confidence in the study used to derive the toxicity values, and high uncertainty factors applied. Using the sum of detected concentrations of n-propylbenzene; 1,3,5-trimethylbenzene; 1,2,4-trimethylbenzene; sec-butylbenzene; and p-isopropyltoluene; and the surrogate toxicity values, a HI range of 0.0042 to 0.32 was estimated. If these estimates are added to the HI estimate of 0.58 obtained for the chemicals for which toxicity values were available, the total estimated HI across all detected chemicals would still be less than 1.

7.0 SUMMARY AND CONCLUSIONS

The following summary statements and conclusions are based on the above evaluation:

- ✓ 1. The primary source, a 500 gallon bakery tank, no longer exists. Much of the secondary source, the contaminated soil, has been removed. Free product does not appear to be present as shown in Table 1 as a contributing source of releases to groundwater. Only residual levels of heating oil constituents exist in soil; minimal leaching of the more mobile constituents to groundwater may be occurring. Benzene levels in monitoring well MW-3 exceeded the MCL. Toluene, ethylbenzene, and xylenes are less than their respective MCLs in groundwater. Based on six sampling events from monitoring well MW-3, BTEX concentrations do not appear to be fluctuating significantly.
- * 2. There are several known release sites in the project vicinity, including several known gasoline releases. BTEX from the release of gasoline at the former Tesoro gasoline station is known to have migrated onto Foodland property. Other known release sites include the GSA UST and the Texaco gasoline station. It cannot be conclusively determined from available data whether petroleum constituents such as BTEX, from these or other sources, have reached monitoring well MW-3, or if the former Bakery Tank is the only source of the detected chemicals in MW-3.
- ✓ 3. There is no ecological threat posed by the site because there are no complete, significant exposure pathways.
- ✓ 4. The only viable identified complete human exposure pathway is hydrocarbon leaching to groundwater and subsequent migration to a downgradient drinking water well. No known drinking water wells are located within ¼-mile downgradient of the site. Future installation of closer drinking water wells is unlikely, because of the availability of city water and generally poor water quality due to hardness and

high natural inorganic concentrations. The nearest identified drinking water well was 1500 feet to the northeast.

5. The potential threat posed by COPCs capable of migration in groundwater was evaluated. These COPCs include BTEX and the more mobile constituents of heating oil No. 2, such as naphthalene, other low molecular weight PAHs, and alkyl benzenes that were detected in groundwater and appear to have leached from residuals in soil near the water table.
6. Currently, water used on site is from the city water system, and groundwater beneath the site is not used. Future site use is expected to remain the same (grocery store). Because it is unlikely that site use will change in the near future, current or future on-site use of groundwater is not a realistic scenario. However, risks to a hypothetical receptor using water from MW-3 as a source of household water were estimated using standard default residential exposure parameters. Risks from two exposure pathways, drinking water ingestion and inhalation of volatile chemicals released during household water use, were evaluated. The cancer risk from hypothetical exposure to groundwater containing 25.2 $\mu\text{g/l}$ of benzene was estimated to be 4×10^{-5} . This is within the National Contingency Plan (NCP) target cancer risk range of 10^{-6} to 10^{-4} , which is commonly applied in risk management decisions. The HI across all noncarcinogens detected in groundwater for which toxicity data were available from IRIS (1995) and HEAST (1994) was 0.58, indicating that non-cancer effects are not expected to occur.
7. The closest suspected current drinking water well is 1500 feet from the site. Installation of closer drinking water wells in the future is considered unlikely, given the availability of city water and the generally poor natural water quality. Concentrations of chemicals eventually migrating to potential downgradient receptor locations are likely to drop substantially as a result of processes of readsorption to soil within the water table, volatilization, chemical and biological degradation, and

dispersion. Thus, potential realistic receptors at downgradient locations would probably be at a substantially lower risk than a hypothetical receptor using water from MW-3.

8. The lack of toxicity data from IRIS (1995) and HEAST (1994) for several nPAHs and alkylbenzenes detected in groundwater from MW-3 precluded direct estimation of the potential threat that they may pose. An evaluation of the associated uncertainty, using ranges of toxicity data for several structurally similar chemicals as surrogates, indicated that adverse effects from these chemicals are unlikely.
9. The magnitude of residual soil contamination associated with the bakery tank release and groundwater contamination in monitoring well MW-3 is similar to and, in some cases, much lower than known levels in surrounding sites. Many potential sources also exist in the area for which possible releases and contaminant levels are not currently known. This site is not expected to contribute significant levels of migrating contaminants relative to the known and potential contaminant levels and types from many surrounding sites. Further, downgradient locations may be contaminated from migration from other sites that are downgradient, crossgradient, and upgradient of the bakery tank site. Relative to anthropogenic levels that remain in the area, residual petroleum levels in soil at the bakery tank site are not considered a substantial source of release to area groundwater.

8.0 RECOMMENDATION

Based on current and projected site use; limited access to contaminated areas (fence and subsurface); availability of municipal water; lack of drinking water wells in the vicinity; generally poor natural water quality of the aquifer; risk estimates; processes such as volatilization, degradation, readsorption, and dispersion that will reduce concentrations of chemicals reaching potential downgradient receptors; anthropogenic levels in the vicinity; upgradient, crossgradient, and downgradient sources; and other factors considered in the evaluation presented above, no further action appears to be needed at the bakery tank site to be protective of human health and the environment. We recommend that ADEC approval for no further environmental action be sought on the basis of the above evaluation.

The basis of this recommendation is summarized below.

ADEC guidance provides certain factors that should be evaluated to justify alternative cleanup levels (ADEC, 1990a; ADEC, 1990b; ADEC, 1991). These factors were deemed appropriate for determining that no further action is appropriate. Therefore, the information presented in the above sections is summarized below in light of each of these factors:

- ▶ Present and future use of the affected aquifer and adjacent surface water. Based on the well search conducted, the affected aquifer is not currently being used as a drinking water source within ¼-mile downgradient of the site. Because of the availability of city water in the area and the generally poor natural water quality in the aquifer, future use is unlikely to differ from current use. The nearest known surface water body is the Chena River, over ½ mile from the site. Therefore, impact is unlikely.
- ▶ Probability of migration to, and effect on, a source of potable water: Residual heating oil constituents are not expected to migrate readily, although alkylbenzenes, naphthalene, and other low molecular weight PAHs have leached and have some

potential to migrate, in groundwater. BTEX constituents in groundwater in monitoring well MW-3 are also expected to migrate downgradient. However, TEX levels in monitoring well MW-3 are below MCLs and health-based standards. Benzene concentrations are five times the MCL but below the concentration corresponding to a 10^{-4} risk. With as little as five-fold reduction in concentration before reaching a downgradient receptor, benzene levels would drop below the MCL. Analysis of the amount of dispersion, degradation, volatilization, and readsorption/retardation that would occur in the aquifer was beyond the scope of this assessment, but it is not anticipated that significant levels will affect the aquifer at a location where it is currently used as a drinking water source. The nearest likely identified downgradient receptor is more than $\frac{1}{4}$ mile away.

- ▶ Potential for further degradation of the aquifer: In light of the numerous sources of known and possible petroleum releases in the area (both upgradient, crossgradient, and downgradient of the bakery tank site), it is not anticipated that the bakery tank site will contribute significantly to further degradation of the aquifer. Petroleum releases at some surrounding properties have occurred. Some of these were releases of gasoline, which is more mobile and toxic than heating oil. Groundwater impacts, including BTEX levels much higher than detected in monitoring well MW-3, have been linked to some of these releases. A gasoline release at a downgradient site is likely to have impacted groundwater, although analytical results are not available.
- ▶ Technical feasibility of achieving standard cleanup levels. An evaluation of technical feasibility was beyond the scope of this assessment. Free product recovery was found to not be feasible; however, as a result of natural processes, no free product remains available to monitoring well MW-3. Soil remediation may have limited effect on benzene concentrations in groundwater, and groundwater remediation may only have a transient effect. Considering the depth of the residual contamination and its proximity to the building and adjacent property line, some

types of remediation may not be technically feasible. Even if remediation is feasible, the limited potential benefits may not justify the cost.

- ▶ Site characteristics, such as natural rehabilitative processes: An evaluation of natural rehabilitative processes was beyond the scope of this assessment. However, petroleum residuals tend to biodegrade with time. Because the presence of other hydrocarbons in the soil can significantly reduce the amount of leaching, the presence of some hydrocarbons may be reducing the migration of others. For example, the pure component solubility of benzene is 33 to 100 times the dissolved benzene concentration in groundwater contacting gasoline-impacted soils (ASTM, 1994). The pure product solubility of naphthalene, one of the most mobile and prevalent constituents of fuel oil No. 2, is 31,000 $\mu\text{g/L}$ (ASTM, 1994), which is only 21 times the concentration (1,450 $\mu\text{g/L}$) corresponding to a HQ of 1, using default drinking water exposure assumptions. The properties of chemical mixtures at the site may be retarding contaminant migration.
- ▶ Results of the risk evaluation: This preliminary risk evaluation was conducted using available data. Risk estimates for a hypothetical receptor withdrawing water for residential use from monitoring well MW-3 were calculated. This is an unrealistic exposure point, and risks to potential downgradient receptors would be even lower. The total cancer risk to a hypothetical receptor at the former bakery tank location was estimated to be within the generally accepted risk range of 10^{-6} to 10^{-4} . The hazard index across all chemicals for which toxicity values were available from IRIS (1995) or HEAST (1994) was 0.58; an HI less than 1 indicates a health effect is unlikely.
- ▶ Protect surface receptors: A viable exposure pathway for surface receptors was not identified.

- ▶ Contaminant leaching assessment: A contaminant leaching assessment was beyond the scope of this evaluation, although many of the requirements for a contaminant leachate assessment provided in ADEC guidance were met. However, not all the required geological, climate, and hydrogeological information has been documented.

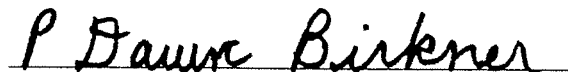
This site appears to meet most of the criteria for use of alternative cleanup levels, which Shannon & Wilson, Inc. considers to be relevant criteria for a no-further-action recommendation.

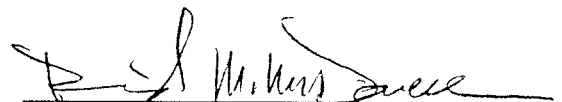
9.0 LIMITATIONS

This preliminary risk evaluation was based on limited sampling and other data on the site and surrounding area obtained by Shannon & Wilson, Inc. and by others, and should not be construed as a definite statement regarding site conditions. The accuracy of the data and statements in various reports and databases, from which information was obtained, was not evaluated but was assumed to be accurate. Conditions at the site and surrounding area may change with time. In addition, changes may occur in wording or interpretation of regulations and guidance documents. This is especially likely with regard to petroleum risk evaluation, for which limited evolving guidance is available; a diversity of opinions exist, and current knowledge and methodologies are limited and in a state of flux. The risk evaluation process involves many uncertainties. Because only limited data were available, conservative assumptions were used to reduce the likelihood of underestimation; however, it is possible that risk estimates may be under- or overestimates.

Shannon & Wilson, Inc. conducted this preliminary risk evaluation within the constraints of the scope and budget and our best judgment, using limited available data to describe the known and anticipated risks associated with potential exposure to historical releases associated with the bakery tank. This preliminary risk evaluation was prepared for the exclusive use of Carrs Foodland, and their representatives, and in no way guarantees that any agency or its staff will reach the same conclusions as Shannon & Wilson, Inc. Shannon & Wilson, Inc. has prepared the attached Appendix, *Important Information About Your Environmental Report* to assist you and others in understanding the use and limitations of our reports.

SHANNON & WILSON, INC.


P. Dawn Birkner
Risk Assessor


David M. McDowell
Associate/Project Manager

10.0 REFERENCES

- Alaska Department of Environmental Conservation (ADEC), 1990a, *Interim Guidance for Soil Cleanup Levels*: Juneau, Alaska, September 26.
- Alaska Department of Environmental Conservation (ADEC), 1990b, *Interim Guidance for Surface and Groundwater Cleanup Levels*: Juneau, Alaska, September 26.
- Alaska Department of Environmental Conservation (ADEC), 1991, *Interim Guidance for Non-UST Contaminated Soil Cleanup Levels*, guidance no. 001, rev. 1: Juneau, Alaska, July 17.
- Alaska Department of Environmental Conservation (ADEC), *Underground Storage Tank Database*, March 30 1995.
- Alaska Department of Environmental Conservation (ADEC), 1995, *Northern Region List of Contaminated Sites*: Juneau, Alaska, March 16, 1995.
- American Society for Testing and Materials (ASTM), 1994, *Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*: Philadelphia, Penn., ASTM Designation ES38-94.
- Calscience Engineering, Inc., 1991, *Final Report, Subsurface Investigation, 101 12th Avenue, Fairbanks, Alaska*: Report prepared by Calscience Engineering, Inc., Cypress, California, for General Services Administration, San Francisco, California, July.
- Clement Associates, Inc., 1985, *Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites, Final Report*: Report prepared by Clement Associates, Inc., Arlington, Virginia, for U.S. Environmental Protection Agency, Washington, D.C., September 27.
- Environmental Fate and Risk, Inc., 1995, *Risk Assessment Report Addendum, Former Northshore Ventures Store #105, 1246 Noble Street, Fairbanks, Alaska*: Report prepared by Environmental Fate and Risk, Inc., Lakewood, Colorado, for Tesoro Petroleum Company, San Antonio, Texas, May.
- Environmental Science and Engineering, Inc., 1993, *Risk Assessment Report, Former Northshore Ventures Store #105, 1246 Noble Street, Fairbanks, Alaska*: Report prepared by

SHANNON & WILSON, INC.

- Environmental Science Engineering, Inc., Gainesville, Florida, for Tesoro Alaska Petroleum Company, Anchorage, Alaska, December.
- Locher Interests Limited, 1991, *Underground Storage Tank Program, Carrs Foodland, 516 Gaffney, Fairbanks, Alaska, Underground Heating Oil Tank Removal and Site Assessment for Carr-Gottstein Properties*: Report prepared by Locher Interests Limited, Anchorage, Alaska, for Carr-Gottstein Properties, Fairbanks, Alaska, August 12.
- Massachusetts Department of Environmental Protection, 1994, *Interim Final Petroleum Report, Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter*: Boston, Massachusetts, August.
- Marshall Sittig, *Handbook of Toxic and Hazardous Chemicals and Carcinogens*, 3rd. Ed. New Jersey: Noyes Publications. 1991.
- Millner, G.C., James, R.C., and Nye, A.C., 1992, *Human Health-Based Soil Cleanup Guidelines for Diesel Fuel No. 2*: Journal of Soil Contamination, vol. 1, no. 2, p. 103-157.
- NIOSH, NIOSH *Picket Guide to Chemical Hazards*, June 1994.
- Norman, Marjorie, 1991, *Toxicities of Petroleum Products*: Report prepared by Marjorie Norman, Clement International, Inc., Bellevue, Washington, for Prezant Associates, Inc., Seattle, Washington.
- Shannon & Wilson, Inc., 1991a, *Monitoring Well Installation and Baseline Monitoring, Northstore Ventures Store #105, 1246 Noble Street, Fairbanks, Alaska*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, for Tesoro Alaska Petroleum Company, Anchorage, Alaska, June 14.
- Shannon & Wilson, Inc., 1991b, *Northstore Ventures Store #105, Underground Storage Tank Removal Site Characterization and Release Investigation*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, for Northstore Ventures, Anchorage, Alaska, April.
- Shannon & Wilson, Inc., 1992, *Release Investigation, Carrs Foodland, Fairbanks, Alaska*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, for Development Manager, Inc., Anchorage, Alaska, July 28.

SHANNON & WILSON, INC.

Shannon & Wilson, Inc., 1993a, *Progress Report, Product Recovery, Bakery Tank Monitoring Well, Carrs Foodland, Fairbanks, Alaska*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, for Development Manager, Inc., Anchorage, Alaska, June 8.

Shannon & Wilson, Inc., 1993b, *Progress Report, Product Recovery, Bakery Tank Monitoring Well, Carrs Foodland, Fairbanks, Alaska*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, for Development Managers, Inc., Anchorage, Alaska, October 29.

Shannon & Wilson, Inc., 1994a, *Status Report, Monitoring Well Installation and Sampling, GSA UST Site, Federal Building, Fairbanks, Alaska, Contract #GS-10P-94-LSC-0113*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, X-0646-02 for General Services Administration, Auburn, Washington, September 23.

Shannon & Wilson, Inc., 1994b, *Underground Storage Tank Closure Site Assessment, Noble Street Texaco, 1200 Noble Street, Fairbanks, Alaska*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, X-0697, for CEM Leasing, Inc., Fairbanks, Alaska, November 8.

Shannon & Wilson, Inc., 1995a, *Bakery Tank Quarterly Groundwater Monitoring, Carrs Foodland, Fairbanks, Alaska*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, X-0412-03, for Development Managers, Inc., Anchorage, Alaska, January 23.

Shannon & Wilson, Inc., 1995b, *Scope of Services, Preliminary Risk Evaluation, Bakery Tank Release, Carrs Foodland, Fairbanks, Alaska*: Letter prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, X-0412-04, for Development Managers, Inc., Anchorage, Alaska, March 31.

Shannon & Wilson, Inc., 1995c, *Status Report, Preliminary Assessment, GSA UST Site, Federal Building, Fairbanks, Alaska, Contract #GS-10P-94-LSC-0113*: Report prepared by Shannon & Wilson, Inc., Fairbanks, Alaska, X-0646-03, for General Services Administration, Auburn, Washington, February 27.

U.S. Geological Survey, 1992, Fairbanks D-2 SE, topographic map: Reston, Virginia, scale 1:25,000.

U.S. Environmental Protection Agency, Region 10, 1991, *Supplemental Guidance for Superfund Risk Assessments in Region 10*: Memorandum prepared by P.A. Cirone and Carol

- Rushin, U.S. Environmental Protection Agency, Region 10, Seattle, Washington, August 23.
- U.S. Environmental Protection Agency, 1989a, *Risk Assessment Guidance for Superfund, Volume 2, Environmental Evaluation Manual, Interim Final*: Washington, D.C., EPA/540/1-89/001.
- U.S. Environmental Protection Agency, 1989b, *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (part A), Interim Final*: Washington, D.C., EPA/540/1-89/002.
- U.S. Environmental Protection Agency, 1991, *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors, Interim Final*: Washington, D.C., OSWER directive 9285.6-03.
- U.S. Environmental Protection Agency, 1992, *Framework for Ecological Risk Assessment*: Washington, D.C., EPA/630/R-92/001.
- U.S. Environmental Protection Agency, 1993, *Supplemental Guidance to RAGS--Estimating Risk from Groundwater Contamination*: Washington, D.C., December.
- U.S. Environmental Protection Agency, 1994, *Health Effect Assessment Summary Tables*: Washington, D.C. (Available from National Technical Information Service, Springfield, Virginia, as PB94-963310.)
- U.S. Environmental Protection Agency, 1995a, CERCLIS list.
- U.S. Environmental Protection Agency, 1995b, *Integrated Risk Information System (IRIS)*: Cincinnati, Ohio.
- U.S. Environmental Protection Agency, 1995c, *RCRA Hazardous Waste Generator's Report*: Washington, D.C., March 24.
- Weaver, N.K., ed., 1988, *The Petroleum Industry: State of the Art Reviews, Occupational Medicine*, vol. 3, no. 3.

TABLE 1

PRODUCT THICKNESS AND WATER LEVEL IN MONITORING WELL NO. 3^a

Date	Water Level (measured from top of casing)	Equipotential Surface Elevation	Product Thickness
06/18/92	15.56	427.51	0.30
07/20/92	16.70	426.31	0.22
10/21/92	18.48	424.52	0.21 ^b
03/04/93	18.29	424.54	0.01
04/20/93	18.13	424.70	0.01
04/28/93	17.47	425.37	0.02
05/25/93	15.68	427.14	trace
08/19/93	16.79	426.03	0.00

Notes: ^a All measurements are in feet.

^b Product recovered after measurement.

TABLE 2

GROUNDWATER BTEX CONCENTRATIONS IN MONITORING WELL NO. 3

Chemical	Concentration (µg/L)						Average ^a
	1/94	4/94	7/94	10/94	1/95	10/95	
Benzene	35	38	8	28	32	10	25.2
Toluene	1	2	0.5 ^b	2	2	1	1.4
Ethylbenzene	52	51	42	44	62	40	52.8
Xylenes	180 23	230	140	250	260	124	205.7

Note: Reported concentration is the highest value of the sample and the laboratory duplicate result.

^a Exposure point concentrations.

^b Result not above MDL, value represents 1/2 of MDL.

TABLE 3

GROUNDWATER VOC AND PAH CONCENTRATIONS IN MONITORING WELL NO. 3

Chemical	Concentration ($\mu\text{g/L}$), 10/95	
	EPA Method 8260	EPA Method 8270
Isopropylbenzene	10	—
n-Propylbenzene	17	—
1,3,5-Trimethylbenzene	68	—
1,2,4-Trimethylbenzene	200	—
sec-Butylbenzene	5	—
p-Isopropyltoluene	15	—
Naphthalene	190	107
2-Methylnaphthalene	—	96
Acenaphthene	—	3
Dibenzofuran	—	3
Fluorene	—	6
Phenanthrene	—	5

Reported concentration is the highest value of the sample and the laboratory duplicate result.

TABLE 4
EXPOSURE PARAMETERS^a

Parameter Name	Parameter Value	Units
Ingestion Rate	2	L/day
Inhalation Rate	15	m ³ /day
Exposure Frequency	350	days/year
Exposure Duration	30	years
Body Weight	70	kg
Averaging Time (carcinogens)	25,550	days
Averaging Time (non-carcinogens)	10,950	days
Volatilization Factor	0.5	L/m ³

Note: ^a From EPA Region 10, 1991.

TABLE 5
QUANTITATIVE TOXICITY DATA^a

Chemical	Oral Slope ^b Factor (mg/kg/day) ⁻¹	Inhalation Slope ^c Factor (mg/kg/day) ⁻¹	Carcinogenic ^d Class	Oral RfD ^e (mg/kg/day)	Inhalation RfD ^f (mg/kg/day)
Benzene	0.029	0.029	A	—	—
Ethylbenzene	—	—	D	0.1	0.286
Toluene	—	—	D	0.2	0.114
Xylene	—	—	D	2	—
Isopropylbenzene	—	—	—	0.04	0.00257
n-Propylbenzene	—	—	—	—	—
1,3,5- Trimethylbenzene	—	—	—	—	—
1,2,4- Trimethylbenzene	—	—	—	—	—
sec-Butylbenzene	—	—	—	—	—
p-Isopropyltoluene	—	—	—	—	—
2-Methylnaphthalene	—	—	—	—	—
Acenaphthene	—	—	—	0.06	—
Dibenzofuran	—	—	D	—	—
Fluorene	—	—	D	0.04	—
Naphthalene	—	—	D	0.04W	—
Phenanthrene	—	—	D	—	—
cPAHs	0.0073-7.3 ^g	—	B2	—	—

Notes: ^a From Integrated Risk Information System (IRIS) or Health Effects Assessment Summary Tables (HEAST) (EPA, 1994; EPA, 1995b) as reported in SmartTox (11/95) unless otherwise noted.

^b The oral slope factor is the estimated cancer risk per unit exposure by ingestion (risk per mg/kg body weight/day).

^c The inhalation slope factor is the estimated cancer risk per unit exposure by inhalation (risk per mg/kg body weight/day).

^d EPA carcinogen classification.

^e The estimated daily exposure by ingestion to the human population (including sensitive groups) that is likely to be without appreciable risk.

^f The estimated daily exposure by inhalation to the human population (including sensitive groups) that is likely to be without appreciable risk.

^g Range based on toxic equivalency factors for cPAHs.

— = Not available. W = Withdrawn

TABLE 6
 CANCER RISK AND HAZARD QUOTIENT ESTIMATES
 FOR A HYPOTHETICAL RECEPTOR^a

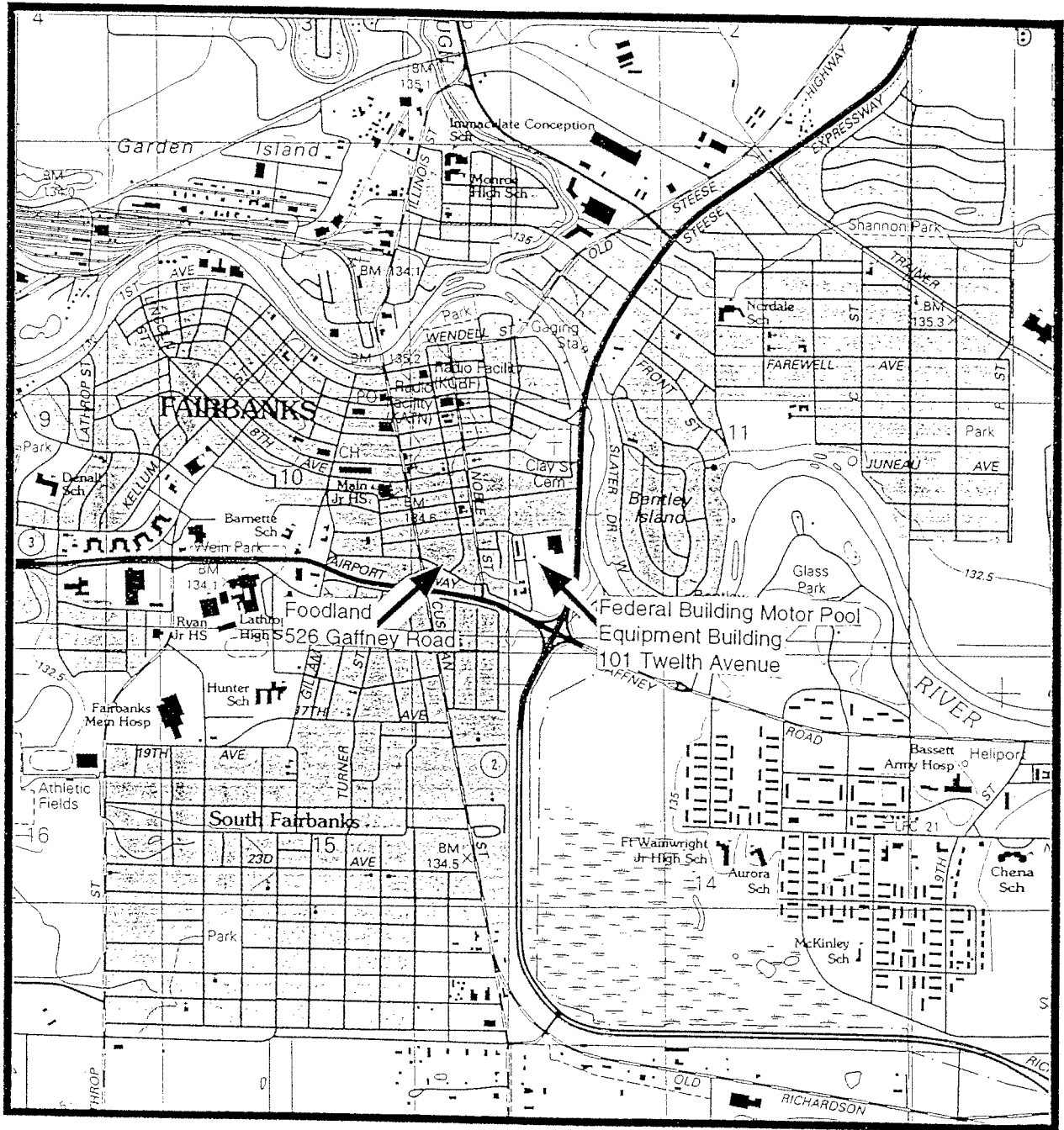
Chemical	Cancer Risk	Hazard Quotient
Benzene	4.1E-5	NA
Toluene	NA	0.0015
Ethylbenzene	NA	0.033
Xylenes	NA	0.0028
Naphthalene ^c	NA	0.13
Acenaphthene	NA	0.0014
Fluorene	NA	0.0041
Isopropylbenzene	NA	0.41
Total HI	4.1E-5	0.58 ^b

Notes: ^a Risk estimates are for a hypothetical resident via drinking water ingestion and inhalation of volatiles released during household use of water to groundwater from the location of MW-3. Region 10 default residential exposure parameters were used. Risks to potential downgradient receptors would be less than these hypothetical risk estimates.

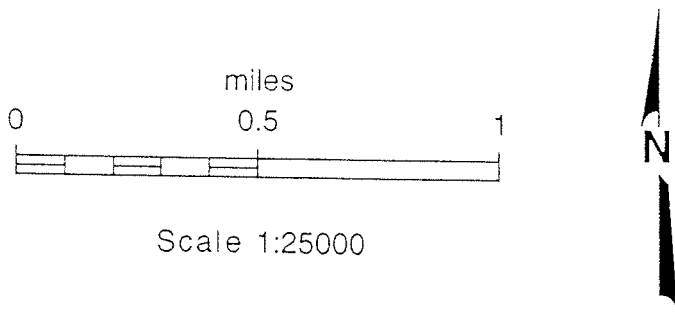
^b HI was conservatively summed across all noncarcinogens, regardless of toxic end point.


^c withdrawn toxicity value used

NA = Not applicable.



Reference: USGS Fairbanks (D-2) SE, Alaska, 1992



Carrs Foodland Fairbanks, Alaska	
SITE VICINITY	
February 1996	X-0412-04
 SHANNON & WILSON, INC. Geotechnical & Environmental Consultants	Figure 1

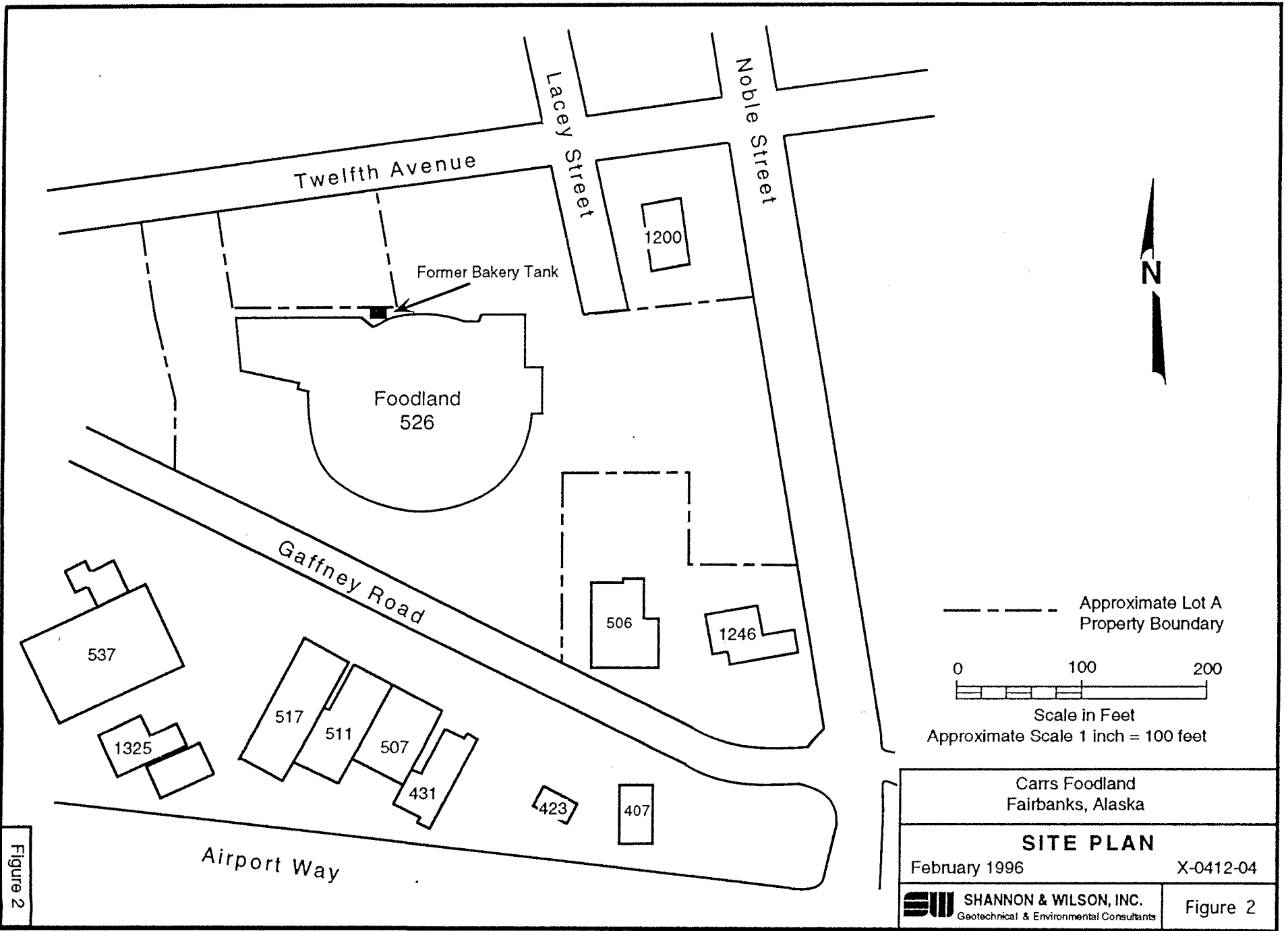

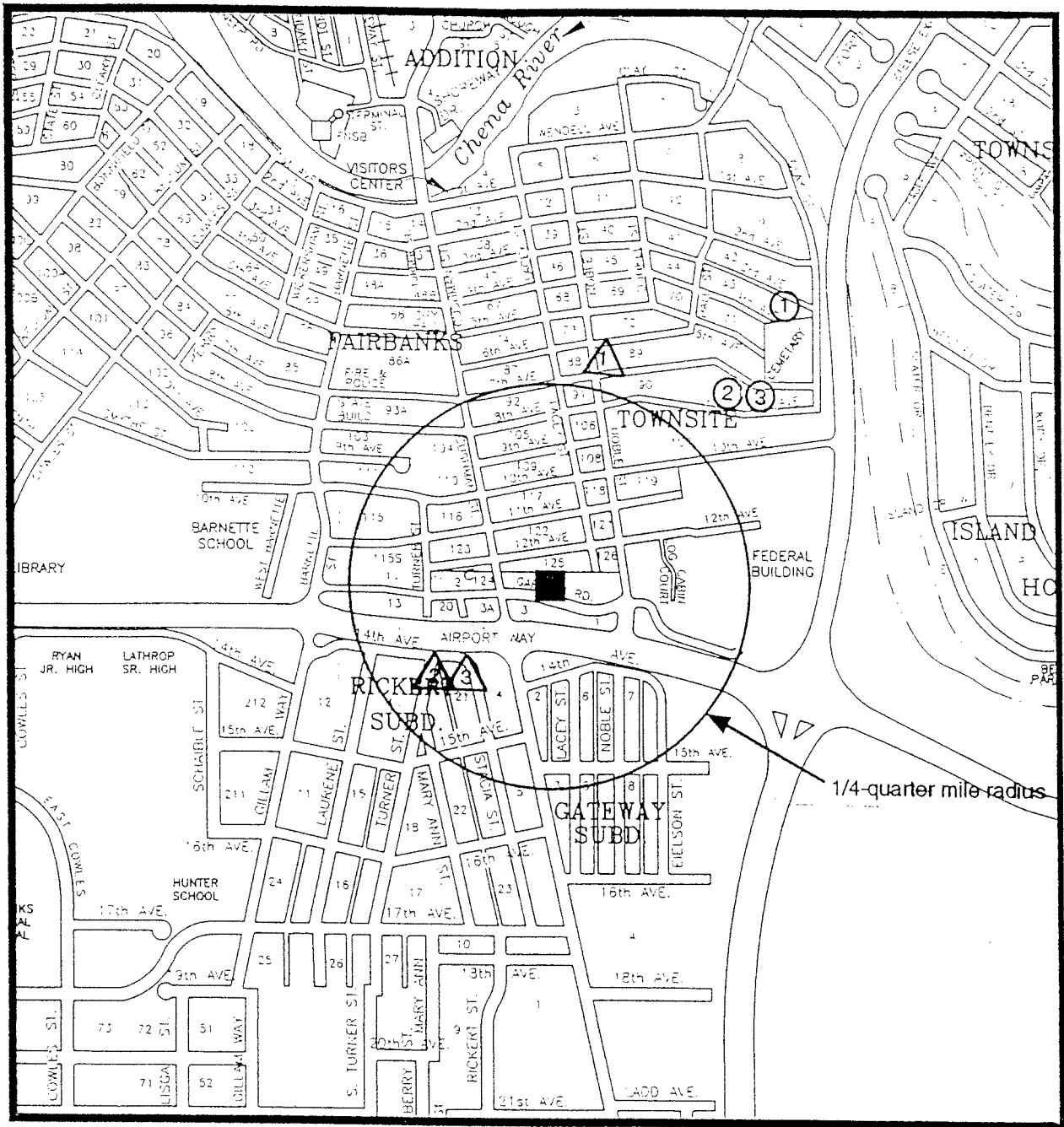


Figure 2

Carrs Foodland Fairbanks, Alaska	
SITE PLAN	
February 1996	X-0412-04
 SHANNON & WILSON, INC. Geotechnical & Environmental Consultants	Figure 2



Reference: City of Fairbanks, Alaska, Feb 1989, modified 3/1/90 and 11/4/91

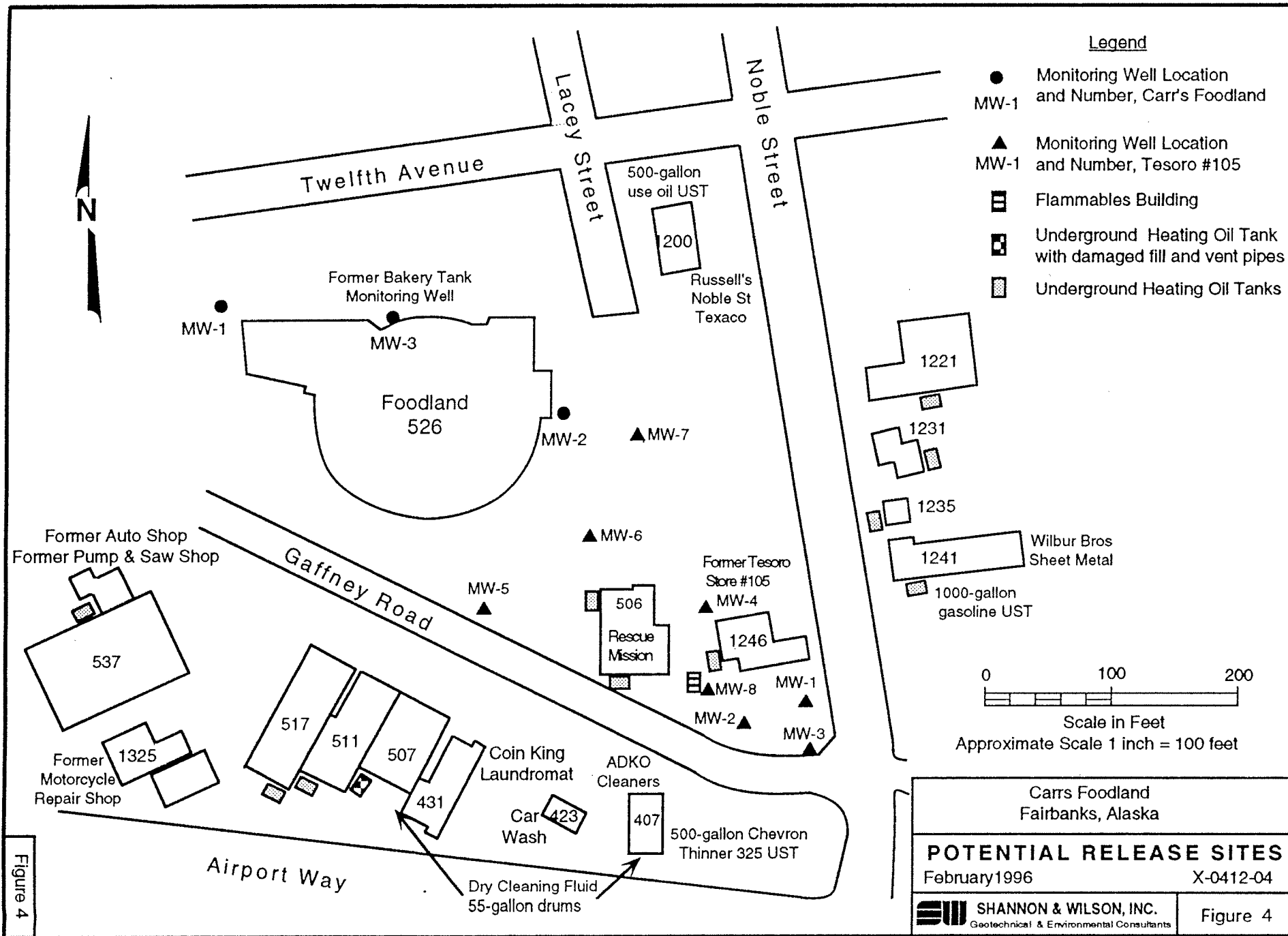
LEGEND

- Foodland, 526 Gaffney Road
- Suspect Addresses
 - ① 170 8th Avenue
 - ② 178 8th Avenue
 - ③ 108 4th Avenue
- Former Suspect Addresses as of June 1995
 - △ 1 329 6th Avenue
 - △ 2 707 14th Avenue
 - △ 3 709 14th Avenue

NOT TO SCALE

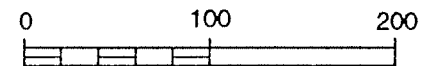


Carrs Foodland Fairbanks, Alaska	
WELL SEARCH	
February 1996	X-0412-04
SHANNON & WILSON, INC. Geotechnical & Environmental Consultants	
Figure 3	



Legend

- Monitoring Well Location and Number, Carr's Foodland
- ▲ Monitoring Well Location and Number, Tesoro #105
- ▤ Flammables Building
- ▥ Underground Heating Oil Tank with damaged fill and vent pipes
- ▧ Underground Heating Oil Tanks



Scale in Feet
Approximate Scale 1 inch = 100 feet

Carrs Foodland
Fairbanks, Alaska

POTENTIAL RELEASE SITES
February 1996 X-0412-04

SHANNON & WILSON, INC.
Geotechnical & Environmental Consultants

Figure 4

Figure 4

REPORT/FILE REVIEW

- Draft, Risk Assessment Report, Former Northstore Ventures Store #105, 1246 Noble Street, Fairbanks, Alaska, (Environmental Science and Engineering, Inc. [ES&E], 1993).
- Draft, Risk Assessment Report Addendum, Former Northstore Ventures Store #105, 1246 Noble Street, Fairbanks, Alaska (Environmental Fate and Risk, Inc., 1995).
- Monitoring Well Installation and Baseline Monitoring, Northstore Ventures Store #105, 1246 Noble Street, Fairbanks, Alaska, (Shannon & Wilson, Inc., 1991a).
- Northstore Ventures Store #105 Underground Storage Tank Removal Site Characterization and Release Investigation, (Shannon & Wilson, Inc., 1991b).
- Underground Storage Tank Closure Site Assessment, Noble Street Texaco, 1200 Noble Street, Fairbanks, Alaska, (Shannon & Wilson, Inc., 1994b).
- Status Report, Monitoring Well Installation and Sampling, GSA UST Site, Federal Building, Fairbanks, Alaska, (Shannon & Wilson, Inc., 1994a).
- Status Report, Preliminary Assessment, GSA UST Site, Federal Building, Fairbanks, Alaska, (Shannon & Wilson, Inc., 1995c).
- Final Report, Subsurface Investigation, 101 12th Avenue, Fairbanks, Alaska (Calscience Engineering, Inc., 1991).
- Report, 1991 Underground Storage Tank Program, Carrs Foodland, 516 Gaffney, Fairbanks, Alaska, Underground Heating Oil Tank Removal & Site Assessment for Carr-Gottstein Properties, (Locher Interests Limited, 1991).
- Release Investigation, Carrs Foodland, Fairbanks, Alaska (Shannon & Wilson, Inc., 1992).
- Progress Report, Product Recovery, Bakery Tank Monitoring Well, Carrs Foodland, Fairbanks, Alaska (Shannon & Wilson, Inc., 1993a).
- Progress Report, Product Recovery, Bakery Tank Monitoring Well, Carrs Foodland, Fairbanks, Alaska, (Shannon & Wilson, Inc., 1993b).
- Bakery Tank Quarterly Groundwater Monitoring, Carrs Foodland, Fairbanks, Alaska (Shannon & Wilson, Inc., 1995a).

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3012 16th Avenue West
Seattle, WA 98119-2029
FAX: (206) 283-5044

November 2, 1995

Scott Thompson, Project Leader
Shannon & Wilson, Inc.
2055 Hill Road
Fairbanks, AK 99707

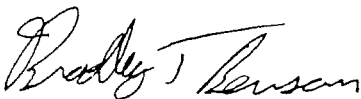
Dear Mr. Thompson:

Enclosed are the results from the testing of material submitted on October 26, 1995 from your X-412-3, Carrs project.

We appreciate this opportunity to be of service to you and hope you will call if you should have any questions.

Sincerely,

FRIEDMAN & BRUYA, INC.



Bradley T. Benson
Chemist

keh
Enclosures
SW21102R.DOC

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By EPA Method 8260

Client Sample Name:	412-1023-MW3	Client:	Shannon & Wilson, Inc.
Date Received:	10/26/95	Project:	X-412-3, Carrs
Date Extracted:	10/27/95	Lab ID:	63190
Date Analyzed:	10/27/95	Data File:	102710.D
Matrix:	Water	Instrument:	GCMS1
Units:	ug/L (ppb)	Operator:	BA

Surrogates:	% Recovery	Lower Limit	Upper Limit
1,2-Dichloroethane-d4	112	76	114
Toluene-d8	85	88	110
4-Bromofluorobenzene	94	86	115

Compounds:	Concentration ug/L (ppb)	Compounds:	Concentration ug/L (ppb)
Dichlorodifluoromethane	<1	Chlorobenzene	<1
Chloromethane	<5	Ethylbenzene	40
Vinyl chloride	<5	1,1,1,2-Tetrachloroethane	<1
Bromomethane	<5	m,p-Xylene	53
Chloroethane	<5	o-Xylene	69
Trichlorofluoromethane	<1	Styrene	<1
1,1-Dichloroethene	<1	Bromoform	<1
Acetone	<10	Bromobenzene	<1
Dichloromethane	<1	1,1,2,2-Tetrachloroethane	<1
trans-1,2-Dichloroethene	<1	1,3-Dichlorobenzene	<1
1,1-Dichloroethane	<1	1,4-Dichlorobenzene	<1
cis-1,2-Dichloroethene	<1	1,2-Dichlorobenzene	<1
Chloroform	<1	Naphthalene	180
1,2-Dichloroethane	<1	2-Hexanone	<5
MTBE	<1	2,2-Dichloropropane	<1
2-Butanone (MEK)	<10	1,1-Dichloropropene	<1
1,1,1-Trichloroethane	<1	Bromodichloromethane	<1
Carbon Tetrachloride	<1	4-Methyl-2-pentanone (MIBK)	<5
Benzene	9	cis-1,3-Dichloropropene	<1
Trichloroethene	<1	trans-1,3-Dichloropropene	<1
1,2-Dichloropropane	<1	1,3-Dichloropropane	<1
Dibromomethane	<1	Isopropylbenzene	10
Toluene	<1	n-Propylbenzene	17
1,1,2-Trichloroethane	<1	1,3,5-Trimethylbenzene	65
Tetrachloroethene	<1	1,2,3-Trichloropropane	<1
Dibromochloromethane	<1	tert-Butylbenzene	<1
1,2-Dibromoethane (EDB)	<1	1,2,4-Trimethylbenzene	200
1,2,4-Trichlorobenzene	<5	sec-Butylbenzene	5
1,2,3-Trichlorobenzene	<5	p-Isopropyltoluene	15
		1,2-Dibromo-3-chloropropane (DBCP)	<1

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By EPA Method 8260

Client Sample Name:	412-1023-MW3 (Duplicate)	Client:	Shannon & Wilson, Inc.
Date Received:	10/26/95	Project:	X-412-3, Carrs
Date Extracted:	10/27/95	Lab ID:	SO 63191 DU 1
Date Analyzed:	10/27/95	Data File:	102711.D
Matrix:	Water	Instrument:	GCMS1
Units:	ug/L (ppb)	Operator:	BA

Surrogates:	% Recovery	Lower Limit	Upper Limit
1,2-Dichloroethane-d4	105	76	114
Toluene-d8	89	88	110
4-Bromofluorobenzene	90	86	115

Compounds:	Concentration ug/L (ppb)	Compounds:	Concentration ug/L (ppb)
Dichlorodifluoromethane	<1	Chlorobenzene	<1
Chloromethane	<5	Ethylbenzene	39
Vinyl chloride	<5	1,1,1,2-Tetrachloroethane	<1
Bromomethane	<5	m,p-Xylene	54
Chloroethane	<5	o-Xylene	70
Trichlorofluoromethane	<1	Styrene	<1
1,1-Dichloroethene	<1	Bromoform	<1
Acetone	<10	Bromobenzene	<1
Dichloromethane	<1	1,1,2,2-Tetrachloroethane	<1
trans-1,2-Dichloroethene	<1	1,3-Dichlorobenzene	<1
1,1-Dichloroethane	<1	1,4-Dichlorobenzene	<1
cis-1,2-Dichloroethene	<1	1,2-Dichlorobenzene	<1
Chloroform	<1	Naphthalene	190
1,2-Dichloroethane	<1	2-Hexanone	<5
MTBE	<1	2,2-Dichloropropane	<1
2-Butanone (MEK)	<10	1,1-Dichloropropene	<1
1,1,1-Trichloroethane	<1	Bromodichloromethane	<1
Carbon Tetrachloride	<1	4-Methyl-2-pentanone (MIBK)	<5
Benzene	10	cis-1,3-Dichloropropene	<1
Trichloroethene	<1	trans-1,3-Dichloropropene	<1
1,2-Dichloropropane	<1	1,3-Dichloropropane	<1
Dibromomethane	<1	Isopropylbenzene	10
Toluene	1	n-Propylbenzene	16
1,1,2-Trichloroethane	<1	1,3,5-Trimethylbenzene	68
Tetrachloroethene	<1	1,2,3-Trichloropropane	<1
Dibromochloromethane	<1	tert-Butylbenzene	<1
1,2-Dibromoethane (EDB)	<1	1,2,4-Trimethylbenzene	200
1,2,4-Trichlorobenzene	<5	sec-Butylbenzene	5
1,2,3-Trichlorobenzene	<5	p-Isopropyltoluene	11
		1,2-Dibromo-3-chloropropane (DBCP)	<1

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By EPA Method 8260

Client Sample Name:	412-1023-TB	Client:	Shannon & Wilson, Inc.
Date Received:	10/26/95	Project:	X-412-3, Carrs
Date Extracted:	10/30/95	Lab ID:	63193
Date Analyzed:	10/27/95	Data File:	102709.D
Matrix:	Water	Instrument:	GCMS1
Units:	ug/L (ppb)	Operator:	BA

Surrogates:	% Recovery	Lower Limit	Upper Limit
1,2-Dichloroethane-d4	108	76	114
Toluene-d8	96	88	110
4-Bromofluorobenzene	91	86	115

Compounds:	Concentration ug/L (ppb)	Compounds:	Concentration ug/L (ppb)
Dichlorodifluoromethane	<1	Chlorobenzene	<1
Chloromethane	<5	Ethylbenzene	<1
Vinyl chloride	<5	1,1,1,2-Tetrachloroethane	<1
Bromomethane	<5	m,p-Xylene	<1
Chloroethane	<5	o-Xylene	<1
Trichlorofluoromethane	<1	Styrene	<1
1,1-Dichloroethene	<1	Bromoform	<1
Acetone	<10	Bromobenzene	<1
Dichloromethane	<1	1,1,2,2-Tetrachloroethane	<1
trans-1,2-Dichloroethene	<1	1,3-Dichlorobenzene	<1
1,1-Dichloroethane	<1	1,4-Dichlorobenzene	<1
cis-1,2-Dichloroethene	<1	1,2-Dichlorobenzene	<1
Chloroform	<1	Naphthalene	<1
1,2-Dichloroethane	<1	2-Hexanone	<5
MTBE	<1	2,2-Dichloropropane	<1
2-Butanone (MEK)	<10	1,1-Dichloropropene	<1
1,1,1-Trichloroethane	<1	Bromodichloromethane	<1
Carbon Tetrachloride	<1	4-Methyl-2-pentanone (MIBK)	<5
Benzene	<1	cis-1,3-Dichloropropene	<1
Trichloroethene	<1	trans-1,3-Dichloropropene	<1
1,2-Dichloropropane	<1	1,3-Dichloropropane	<1
Dibromomethane	<1	Isopropylbenzene	<1
Toluene	<1	n-Propylbenzene	<1
1,1,2-Trichloroethane	<1	1,3,5-Trimethylbenzene	<1
Tetrachloroethene	<1	1,2,3-Trichloropropane	<1
Dibromochloromethane	<1	tert-Butylbenzene	<1
1,2-Dibromoethane (EDB)	<1	1,2,4-Trimethylbenzene	<1
1,2,4-Trichlorobenzene	<5	sec-Butylbenzene	<1
1,2,3-Trichlorobenzene	<5	p-Isopropyltoluene	<1
		1,2-Dibromo-3-chloropropane (DBCP)	<1

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Analysis For Volatile Compounds By EPA Method 8260

Client Sample Name:	Method Blank	Client:	Shannon & Wilson, Inc.
Date Received:	10/26/95	Project:	X-412-3, Carrs
Date Extracted:	10/30/95	Lab ID:	SO 1027 MB 1
Date Analyzed:	10/27/95	Data File:	102708.D
Matrix:	Water	Instrument:	GCMS1
Units:	ug/L (ppb)	Operator:	BA

Surrogates:	% Recovery	Lower Limit	Upper Limit
1,2-Dichloroethane-d4	109	76	114
Toluene-d8	96	88	110
4-Bromofluorobenzene	91	86	115

Compounds:	Concentration ug/L (ppb)	Compounds:	Concentration ug/L (ppb)
Dichlorodifluoromethane	<1	Chlorobenzene	<1
Chloromethane	<5	Ethylbenzene	<1
Vinyl chloride	<5	1,1,1,2-Tetrachloroethane	<1
Bromomethane	<5	m,p-Xylene	<1
Chloroethane	<5	o-Xylene	<1
Trichlorofluoromethane	<1	Styrene	<1
1,1-Dichloroethene	<1	Bromoform	<1
Acetone	<10	Bromobenzene	<1
Dichloromethane	<1	1,1,2,2-Tetrachloroethane	<1
trans-1,2-Dichloroethene	<1	1,3-Dichlorobenzene	<1
1,1-Dichloroethane	<1	1,4-Dichlorobenzene	<1
cis-1,2-Dichloroethene	<1	1,2-Dichlorobenzene	<1
Chloroform	<1	Naphthalene	<1
1,2-Dichloroethane	<1	2-Hexanone	<5
MTBE	<1	2,2-Dichloropropane	<1
2-Butanone (MEK)	<10	1,1-Dichloropropene	<1
1,1,1-Trichloroethane	<1	Bromodichloromethane	<1
Carbon Tetrachloride	<1	4-Methyl-2-pentanone (MIBK)	<5
Benzene	<1	cis-1,3-Dichloropropene	<1
Trichloroethene	<1	trans-1,3-Dichloropropene	<1
1,2-Dichloropropane	<1	1,3-Dichloropropane	<1
Dibromomethane	<1	Isopropylbenzene	<1
Toluene	<1	n-Propylbenzene	<1
1,1,2-Trichloroethane	<1	1,3,5-Trimethylbenzene	<1
Tetrachloroethene	<1	1,2,3-Trichloropropane	<1
Dibromochloromethane	<1	tert-Butylbenzene	<1
1,2-Dibromoethane (EDB)	<1	1,2,4-Trimethylbenzene	<1
1,2,4-Trichlorobenzene	<5	sec-Butylbenzene	<1
1,2,3-Trichlorobenzene	<5	p-Isopropyltoluene	<1
		1,2-Dibromo-3-chloropropane (DBCP)	<1

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: November 2, 1995

Date Received: 10/26/95

Project: X-412-3, Carrs

QUALITY ASSURANCE RESULTS
FOR METHOD 8260

Laboratory Code: 63190

Sample ID: Spike Blank

Reporting Units: ug/L (ppb)

Analyte:	Spike Level	Spike Result	Dup Result	% Recovery		RPD	QC Limits
				MS	MSD		RPD
1,1-Dichloroethene	50	65	55	130	110	17	0-20
Benzene	50	58	50	116	100	15	0-20
Trichloroethene	50	60	49	120	98	20	0-20
Toluene	50	58	48	116	96	19	0-20
Chlorobenzene	50	56	49	112	98	13	0-20

Friedman & Bruya, Inc.

3012 16th Avenue West

Seattle, WA 98119

(206) 285-8282

Analysis of Water Sample for Polynuclear Aromatics by Method 8270

Client: Shannon & Wilson	Date Received: 10/26/95	Analyst: kwilt
Project: Carrs/X-412-3	Date Extracted: 10/30/95	FBI ID #: M Blank
Client ID: Method Blank	Date Analyzed: 10/31/95	Units: ug/L (ppb)

Naphthalene	<0.5
2-Methylnaphthalene	<0.5
Acenaphthylene	<0.5
Acenaphthene	<0.5
Dibenzofuran	<0.5
Fluorene	<0.5
Phenanthrene	<0.5
Anthracene	<0.5
Fluoranthene	<0.5
Pyrene	<0.5
Benzo[a]anthracene	<0.5
Chrysene	<0.5
Benzo(a)pyrene	<0.5
Benzo(b)fluoranthene	<0.5
Benzo(k)fluoranthene	<0.5
Indeno(1,2,3-cd)pyrene	<0.5
Dibenz(a,h)anthracene	<0.5
Benzo(g,h,i)perylene	<0.5

Surrogate Recoveries:

	QC Limits	
Nitrobenzene-d5	35-114	86%
2-Fluorobiphenyl	43-116	86%
Terphenyl-d14	33-141	88%

Friedman & Bruya, Inc.

3012 16th Avenue West
Seattle, WA 98119
(206) 285-8282

Analysis of Water Sample for Polynuclear Aromatics by Method 8270

Client: Shannon & Wilson	Date Received: 10/26/95	Analyst: kwilt
Project: Carrs/X-412-3	Date Extracted: 10/30/95	FBI ID #: 63189
Client ID: 412-1023-MW3	Date Analyzed: 10/31/95	Units: ug/L (ppb)

Naphthalene	107
2-Methylnaphthalene	96
Acenaphthylene	<0.5
Acenaphthene	3
Dibenzofuran	3
Fluorene	6
Phenanthrene	5
Anthracene	<0.5
Fluoranthene	<0.5
Pyrene	<0.5
Benzo[a]anthracene	<0.5
Chrysene	<0.5
Benzo(a)pyrene	<0.5
Benzo(b)fluoranthene	<0.5
Benzo(k)fluoranthene	<0.5
Indeno(1,2,3-cd)pyrene	<0.5
Dibenz(a,h)anthracene	<0.5
Benzo(g,h,i)perylene	<0.5

Surrogate Recoveries:

	QC Limits	
Nitrobenzene-d5	35-114	79%
2-Fluorobiphenyl	43-116	72%
Terphenyl-d14	33-141	75%

Spike Recovery and RPD Summary Report - WATER

Method : C:\HPCHEM\GCMS2\METHODS\8270A.M
 Title : Semivolatiles by SW-846 Method 8270B
 Last Update : Wed Nov 01 09:25:11 1995
 Response via : Initial Calibration

Non-Spiked Sample: 103114.D

Spike Sample	Spike Duplicate Sample
File ID : 103115.D	103116.D
Sample : BlkSpk	BlkSpkDup
Acq Time: 1 Nov 95 3:35 am	1 Nov 95 4:38 am

Compound	Sample Conc	Spike Added	Spike Res	Dup Res	Spike %Rec	Dup %Rec	RPD	QC RPD	Limits % Rec
Phenol	0.0	150	44	33	29	21	30	50	5-112
2-Chlorophenol	0.0	150	112	88	75	59	24	50	23-134
1,4-Dichlorobenzene	0.0	100	76	58	76	58	27	50	20-124
N-nitroso-di-n-propy	0.0	100	76	63	76	63	18	50	1-230
1,2,4-Trichlorobenze	0.0	100	80	59	80	59	30	50	44-142
4-Chloro-3-methylphe	0.0	150	105	85	70	57	21	50	22-147
Acenaphthene	0.0	100	82	61	82	61	29	50	47-145
2,4-Dinitrotoluene	0.0	100	81	60	81	60	30	50	39-139
4-Nitrophenol	0.0	150	43	30	28	20	34	50	1-132
Pentachlorophenol	0.0	150	109	88	73	58	22	50	14-176
Pyrene	0.0	100	89	79	89	79	12	50	52-115

8270A.M

Wed Nov 01 14:47:40 1995

GCMS #2



Dated: February 14, 1996

To: Mr. Steve Agni

Development Managers

X-0412-41

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland